Big Walnut Sanitary Trunk Extension – Phase 2
Geotechnical Data Report

Capital Improvement Project
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Executive Summary

The Big Walnut Sanitary Trunk Extension Phase 2 (BWSTE2) project is located in north-eastern Franklin County Ohio, to the east of Hoover Reservoir. The Project area is bounded by Lee and Schott Roads to the west, Central College Avenue to the south, Harlem Road to the east, and the Franklin/Delaware County line, which runs partially along Smothers Road, to the north.

The purpose of this geotechnical exploration program is to provide subsurface and geotechnical/geologic test information. This program includes data collected during the preliminary and final Geotechnical Data programs.

Fourteen borings were performed for Phase 1 of the Big Walnut Sanitary Trunk Project, that are applicable to the current alignment, and are provided in Appendix B.

A total of 46 borings were performed for this Phase 2 exploration program along the tunnel alignment. Of these, 34 were exploratory borings along the proposed tunnel alignment, and 12 were advanced for the purpose of installing Observation Wells at some of the proposed tunnel shaft sites, for further hydraulic testing. Soil sampling from the ground surface was performed within some borings and, where performed, collected at 2.5 feet intervals down to top of bedrock. Bedrock coring (NQ- and HQ-sized rock core) was used to secure samples of the bedrock penetrated in each boring.

Hazardous gas emissions had previously been detected within the headspace around some of the borings performed during the previous BWSTE1 exploration and construction. As part of this investigation, each drilling team utilized an Altair 5x Gas meter to collect gas level readings after each bedrock core run in the headspace above the casing and recorded the results immediately. The selected monitoring device detects Combustible (COMB), Oxygen (O2), Carbon Monoxide (CO), and Hydrogen Sulfide (H2S) levels.

Table 3.1 summarizes the surveyed locations of each boring, provides the total boring depths and whether or not gas was encountered. It should be noted that Boring B-21 encountered an equipment malfunction during drilling at a depth of 112.5 feet, therefore an offset hole (labeled Boring B-21A) was performed approximately 3 feet from the original Boring B-21 location. Boring B-21A is considered a continuation of Boring B-21 with sampling beginning at a depth of 112.5 feet. The subsurface logs for B-21 and B-21A have been combined and labeled as Boring B-21. Boring B-21B was performed at another location and is considered independent of Boring B-21.

Laboratory testing of soil and bedrock samples was performed on samples collected from the borings during the final exploration phase. No laboratory testing was performed on samples collected during the preliminary exploration phase. These tests included Specific Gravity, Moisture Contents, Unit Weights, Atterberg Limits, Sieve & Hydrometer, Classifications, and Triaxial testing for soil samples and Unconfined Compressive Strength (UCS), Point Load Testing, Uniaxial Compressive Strength, Swelling, Slake Durability (SDI), Splitting Tensile, SINTEF, Cerchar Abrasion, and Petrography for bedrock samples.

1.0 INTRODUCTION

The purpose of this geotechnical exploration program is to provide subsurface and geotechnical/geologic test information for use in design and construction of the Big Walnut Sanitary Trunk Extension Phase 2 (BWSTE2) tunnel and shafts, which is an extension of the existing Big Walnut Sanitary Trunk Phase 1. This exploration program investigated the geotechnical and hydrogeological conditions along the alignment of the tunnel.

1.1 PROJECT LOCATION AND DESCRIPTION

The Big Walnut Sanitary Trunk Extension Phase 2 (BWSTE2) project is located in north-eastern Franklin County Ohio, to the east of Hoover Reservoir. The project site is in an area bounded by Lee and Schott Roads to the west, Central College Avenue to the south, Harlem Road to the east, and the Franklin/Delaware County line, which runs partially along Smothers Road, to the north.

2.0 GEOLOGY

2.1 GENERAL

The Physiographic Regions of Ohio Map, (ODNR, 1998), provided in Appendix A, indicates that the project site is located within the Galion Glaciated Low Plateau, a portion of the Central Lowland Till Plains. This area is described as having moderate relief and consists of a rolling upland transition between the gently rolling till plains and the hilly Glaciated Allegheny Plateau. The ground surface elevation in the physiographic region ranges from approximately 800 to 1,400 feet above Mean Sea Level (MSL). The geology is described as medium to low-lime Wisconsinan-age till over Mississippian-age shales and sandstones.

2.2 SOIL GEOLOGY

The Shaded Drift-Thickness Map of Ohio (ODNR, 2004), provided in Appendix A, shows a drift (glacial deposited soils) thickness ranging from less than 20 feet to more than 160 feet in the project vicinity. A branch of the prehistoric Teays River system is located just east of the project location, which influences the drift thickness and bedrock elevation in the area.

The mapped Quaternary Geology of Ohio Marion Quadrangle (ODNR, 1993), provided in Appendix A, indicates the project area is underlain by Late Wisconsinan age Late Woodfordian ice deposits. The silty loam till in the area is described as ground and end moraines, which consist of flat to gently undulating deposits of glacial soils.

2.3 BEDROCK GEOLOGY

The Shaded Bedrock Topography Map of Ohio (ODNR, 2003) indicates that the bedrock topography in the project vicinity ranges from elevation 700 to 1,000 feet above MSL, depending on the proximity to the Teays River basin. The Bedrock Topography Map of the New Albany Quadrangle, Ohio shows a bedrock elevation in the project area ranging from 825 to 975 feet above MSL, with steep grade changes, indicating a buried valley. The valley is shown to run in a southwest to northeast direction, cutting across the area of interest.

The Bedrock Geology of the New Albany Quadrangle, Ohio map (ODNR, 1995) shows four major bedrock units in the project vicinity. The bedrock units consist of the Sunbury Shale, Berea Sandstone, the Ohio Shale and the Bedford Shale. The Sunbury Shale is described as carbonaceous shale, black to brownish-black in color, very thin bedded, with a thickness of 30 to 90 feet. The Berea Sandstone is described as greenish gray, thin to thick bedded, very fine-grained sandstone. Cross bedding is observed in this unit. The sandstone unit ranges in thickness from 15 to 115 feet. The Ohio Shale is a carbonaceous shale, brownish black to greenish gray in color, which weathers to brown. The Ohio Shale is also laminated to thin bedded, with siderite concretions in the lower portions. The thickness of the Ohio Shale is listed as 250 to more than 500 feet. The Bedford Shale is described as gray, green, red and brown clayey shale with sandstone possible in the upper 25 feet of the unit. The Bedford Shale is also laminated to medium bedded and 80 to 155 feet thick.

3.0 SUBSURFACE EXPLORATION

3.1 EXPLORATION PLAN

Fourteen borings were performed for Phase 1 of the Big Walnut Sanitary Trunk Project, that are applicable to the current alignment, and are provided in Appendix B.

A total of 46 borings were performed for the Phase 2 exploration program along the tunnel alignment. Of these, 34 were exploratory borings along the proposed tunnel alignment, and 12 were advanced for the purpose of installing Observation Wells at some of the proposed tunnel shaft sites, for further hydraulic testing. Resource International Inc. (Rii) and Stantec Consulting Services Inc. performed the drilling, sampling, and in-situ testing of the borings. The borings were advanced using, either, ATV, track, or truck mounted CME 55 drill rigs. To advance through the overburden between sampling attempts, 4.25-inch Hollow Stem Augers (HSA) or mud rotary advancing 4-inch, 6-inch, or 8-inch casing was used until bedrock was encountered. Standard Penetration Test (SPT) soil sampling techniques were attempted within most borings at intervals of 2.5 feet to a depth that encountered the top of bedrock. Bedrock coring (NQ- and HQ-sized bedrock core) was used to obtain samples of the bedrock in each boring.

The soil and bedrock materials encountered were logged in the field by a geologist or geotechnical engineer. The soils encountered were visually classified using the Unified Soil Classification System (USCS) visual descriptors, describing soil type, consistency, and moisture content. The bedrock core samples were visually described and included bedrock type, color, bedding, jointing, fracturing, weathering, and hardness or strength in general accordance with US Army Corps of Engineers guidelines. All samples collected were photographed and retained. Samples identified in the field as good representation of the predominant bedrock units were wrapped with plastic wrap to preserve moisture and reduce potential for damage during transport.

Downhole hydraulic pressure testing (Packer Testing) was performed in each tunnel boring (not including Observation Well borings) in the proposed tunnel zone and other locations. Either double or single packer systems were used, and are noted on the results provided in Appendix D.

Hazardous gas emissions had previously been detected within the headspace around some of the borings performed during the previous BWSTE1 exploration and construction. As part of this investigation, each drilling team utilized an Altair 5x Gas meter to collect gas level readings after each bedrock core run in the headspace above the casing and recorded the results immediately. The selected monitoring device detects Combustible (COMB), Oxygen (O_2), Carbon Monoxide (CO), and Hydrogen Sulfide (H_2S) levels.

After drilling, all boring locations were surveyed by Stantec, and the coordinates were recorded using the Ohio State Plane Coordinate System, South Zone, NAD 83 (2011). The locations of the borings are shown on the Construction Plans. Subsurface Logs of each boring, separated into soil logs and bedrock logs where applicable, are provided in Appendix B. Bedrock Core photos of the recovered bedrock samples from each boring are provided in Appendix C. For reporting purposes on the individual boring logs, the elevations of the respective soil/bedrock strata are truncated to one-tenth of a foot. This practice represents standard geotechnical engineering industry reporting practice, even though the top of boring elevation has been surveyed to one-hundredth of a foot.

Table 3.1 summarizes the surveyed locations of each boring, provides the total boring depths and whether or not gas was encountered. It should be noted that Boring B-21 encountered an equipment malfunction during drilling at a depth of 112.5 feet, therefore an offset hole (labeled Boring B-21A) was performed approximately 3 feet from the original Boring B-21 location. Boring B-21A is considered a continuation of Boring B-21 with sampling beginning at a depth of 112.5 feet. The subsurface logs for B-21 and B-21A have been combined and labeled as Boring B-21. Boring B-21B was performed at another location and is considered independent of Boring B-21.

Select soil samples recovered from the borings were subjected to laboratory testing, such as Specific Gravity, Moisture Contents, Unit Weights, Atterberg Limits, Sieve & Hydrometer, Classifications, and Triaxial testing. The results of this testing are provided in Appendix I. Testing for pH level was conducted on select samples from the bedrock coring in Boring B-21b. Measured pH levels ranged from 3.22 to 3.90. The results of this testing are provided in Appendix J.10. Bedrock core testing on selected bedrock core specimens included Unconfined Compressive Strength (UCS), Point Load Testing, Uniaxial Compressive Strength, Swelling and Slake Durability (SDI), Splitting Tensile, SINTEF, Cerchar Abrasion, Petrography and Direct Shear. Results of this testing are provided in Section 4.0 of this report and in Appendix J.

Table 3.1 – Summary of Exploration Boring Locations

Boring Number	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)	Total Depth (feet)	Gas Encountered
B-1	770411.0	1871174.3	988.1	185.0	No
B-7	770475.8	1870428.3	981.3	180.5	No
B-8	771119.7	1871286.6	1001.9	200.0	No
B-9	771353.5	1870200.9	990.1	196.5	YES
B-12	772094.7	1871551.2	1002.0	205.9	No
B-13	772280.1	1870531.7	998.8	998.8	YES
B-14	774538.3	1870699.6	1008.3	205.5	YES
B-15	775783.7	1872072.1	999.6	30.6	No
B-16	765717.08	1867720.90	972.96	165.0	YES
B-17	765509.58	1867882.29	975.05	180.6	No
B-18	766286.18	1867931.27	981.58	185.0	No
B-19	770427.09	1869729.59	979.15	181.9	No
B-20	770396.65	1870020.40	971.23	178.0	YES
B-21	770485.47	1870321.25	982.25	181.0	No
B-21B	770491.40	1870397.40	981.10	198.0	No
B-22	770624.15	1870496.07	984.12	191.4	YES
B-23	770750.30	1870608.79	986.36	191.6	YES
B-24	770882.43	1870689.14	989.58	196.4	YES
B-25	771204.58	1870990.86	994.96	177.1	No
B-27	772241.96	1870829.99	1001.22	205.6	YES
B-29	773222.16	1870882.59	1001.23	207.5	YES
B-31	774284.12	1871319.50	1004.68	210.7	No
B-33	774854.53	1871939.79	1009.72	213.5	No
B-36	770523.47	1870425.40	982.40	173.1	No
B-38	765381.76	1867703.37	972.35	176.8	YES
B-39	770630.79	1870523.76	984.42	177.5	No
B-40	775913.83	1872010.50	998.10	210.5	No
B-41	767330.49	1867972.33	993.73	190.2	No
B-42	768481.12	1867912.79	995.53	192.0	YES
B-43	769180.47	1868244.95	990.64	186.6	YES
B-44	770202.80	1869013.26	996.08	192.0	YES
B-45	770487.16	1870204.22	979.51	171.9	No
B-46	770414.60	1869921.69	973.25	170.5	No
B-47	768800.40	1867981.90	996.30	185.8	No

Table 3.1 - Summary of Exploration Boring Locations (Cont.)

Boring Number	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)	Total Depth (feet)	Gas Encountered	
OW-1	765355.38	1867749.31	972.96	40.0	No	
OW-2	765355.83	1867800.77	973.80	40.0	No	
OW-3	765429.43	1867712.88	974.72	60.0	No	
OW-4	765405.74	1867712.45	973.77	55.0	No	
OW-5	765355.01	1867707.54	972.38	55.0	No	
OW-6	770656.52	1870522.58	984.96	105.0	No	
OW-7	770531.91	1870523.02	982.90	105.5	No	
OW-8	770606.18	1870495.61	983.73	125.0	No	
OW-9	770603.83	1870423.36	983.02	105.0	No	
OW-10	775857.83	1872007.51	997.89	56.0	No	
OW-11	775837.89	1871961.41	999.06	55.0	No	
OW-12	775983.20	1871981.11	1000.36	56.0	No	
FTB-19	765297.3	1867707.9	971.8	165.2	No	**BWSTE I BORINGS**
FTB-20	768827.2	1868024.1	996.8	189.0	YES	
FTB-21	769756.5	1868747.0	996.8	180.0	No	
FTB-22	770321.5	1869158.9	991.2	165.0	No	
FTB-23	770456.3	1869385.6	984.0	170.0	YES	
FTB-24	765996.5	1867748.0	974.2	168.5	YES	
FTB-25	766896.7	1867802.0	985.3	177.8	No	
FTB-26	767692.3	1867849.8	991.5	182.5	YES	
FTB-30	770461.4	1869375.6	984.4	39.0	No	
ATB-5	768385.8	1867732.4	996.3	200.4	No	

3.2 IN-SITU TESTING

Downhole Packer Testing (ASTM D4630) was performed during the drilling program within selected bedrock intervals, with the results used for estimating permeability of the jointed bedrock mass within the proposed tunnel zone. Both single (performed as the boring is advanced) and double (performed after completion of bedrock coring) packer systems were used and noted on the testing results. These tests were typically conducted within the bottom 50 feet of bedrock obtained at each boring. Water pressures (within the packer units) of 15 psi, 30 psi, and 45 psi were used to conduct each test, and the total flow volume was recorded at intervals of 0, 1, 2, 5, 10, 15 minutes for every packer test conducted. For Borings B-38, B-39, and B-40, Packer Testing was conducted over the total depth of encountered bedrock until the pre-determined boring termination depth was reached. In zones where the packer testing could not be successfully completed (typically due to lack of packer seal), the test attempt is noted, and the testing advanced to the subsequent test interval. The results of these tests are included in Appendix D.

3.3 MONITORING WELL INSTALLATION

Upon reaching the predetermined boring termination depths, the boreholes were, either, backfilled with cement-bentonite grout or a Monitoring Well was installed. The Monitoring Wells were either open borehole with a Shale Trap or a standpipe with a slotted/screened PVC interval. Screened well zones were selected by the tunnel designer MarshWagner, and all wells were finished with flush mount covers and embedded in concrete pads. Logs of the Monitoring Wells installed were developed and show construction details and elevations. The Monitoring Well logs are provided in Appendix E. Monthly groundwater level readings in all of the monitoring wells are provided in Appendix F.

A total of 12 observation wells were installed. These observation wells were used in conjunction with larger diameter wells, installed by a certified well driller, for large scale pump testing at three (3) sites.

3.4 SLUG TESTING

After installation of the monitoring wells at Borings B-38, B-39 and B-40, slug testing was performed at all three locations. The slug testing was performed in general accordance with ASTM D4044/D4044M-15 “Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers”.

A 5-foot length of 1-inch ID PVC pipe filled with clean filter sand was used as the mechanical slug. This mechanical slug was attached to a rope to manually insert and remove from the well. A Solinst F65/M20 Levelogger Pressure Transducer was used to digitally record the change in water head during the slug tests at select time intervals appropriate for the aquifer conditions. The static water level and early changes in water head during the test were also manually measured and recorded.

At each shaft location, the static water level was initially measured to determine the required depths of the pressure transducer and slug to be set. The pressure transducer was set at reading intervals of 0.125 seconds or 60 seconds, based on the predicted response of the aquifer, using the software program “Levelogger 4.3.2”. The pressure transducer was then placed in the well. Five minutes after setting the pressure transducer at the desired depth, the slug was inserted at a steady rate that was not too fast to cause “noise” in the water level readings but not too slow to allow the head to drop faster than the slug insertion rate. It should be noted that this was likely not achieved for Boring sites B-38 and B-40, where the head recovery was faster than the rate of slug insertion based upon review of the data. The water level was then manually measured with the water level reader until the head returned to at least 90 percent of the initial static groundwater readings prior to testing. Once this occurred, the slug was removed from the well at the same rate, and the same procedures were applied during the recovery period. The field data was then input to the AQTESOLV software, which utilizes both the Bower-Rice and Cooper-Bredehoeft-Papadopulos (CBP) methods to determine Hydraulic Conductivity (ft/s), Transmissivity (ft^2/s) and Storage Coefficient (ft^{-1}) values of the aquifers. All three shaft locations were modeled as confined aquifers, due to the clay cap that was identified in each boring location at shallow depths.

3.5 PUMP WELLS

As part of the hydrogeologic characterization of the project site, a Constant Rate Test (CRT) was conducted at Boring sites B-38, B-39 and B-40 using large diameter pump wells, with a network of observation wells to measure aquifer response. The CRT test obtains more reliable in-situ data of the aquifer response at high pumping rates, which can be used to determine hydraulic conductivity, recharge, and other hydrogeologic data of the site. A summary of the testing program and results are provided in Appendix H.

4.0 LABORATORY TESTING

4.1 SOIL TESTING

Testing of select soil samples was conducted on the collected samples (disturbed and undisturbed) from various borings. The testing included classifying the soils encountered and measuring strength using both Unconsolidated-Undrained (UU) and Consolidated-Undrained (CU) Triaxial testing. The results of the classification testing are summarized in the subsurface logs provided in Appendix B, and data sheets from all soil testing performed during Phase 2 investigations are included in Appendix I. Phase 1 data has been included, but data sheets were completed under a separate Contract and are unavailable.

4.2 BEDROCK TESTING

Laboratory testing was performed on select bedrock core samples to characterize the encountered bedrock regarding strength, durability, mineralization, and other factors pertinent to tunnel construction. The following tables (Table 4.1 through Table 4.12) summarize the locations of the testing, along with the results of the tests. The results of the testing are provided in Appendix J. Phase 1 data has been included, but data sheets were completed under a separate Contract and are unavailable.

Table 4.1 – Summary of Uniaxial Compressive Strength Testing (ASTM D7012)

Boring	Core Run ID	Depth (ft)	Bedrock Type	Uniaxial Compressive Strength (PSI)
B-16	HQ-6	148.1-148.9	Bedford Shale	8848
B-16	HQ-7	153.8-154.4	Ohio Shale	7450
B-18	NQ-11	149.2-150.0	Bedford Shale	6784
B-18	NQ-13	162.0-163.1	Ohio Shale	9812
B-20	HQ-15	148.2-149.5	Ohio Shale	9950
B-22	HQ-5	151.6-152.5	Ohio Shale	8208
B-27	NQ-17	166.7-167.3	Bedford Shale	2427
B-31	HQ-19	173.0-174.3	Ohio Shale	12220
B-39	HQ-6	154.6-155.5	Bedford to Ohio Shale	8594
B-39	HQ-7	158.7-159.5	Ohio Shale	5675
B-40	HQ-5	27.8-28.8	Berea Sandstone	16562
B-40	HQ-28	141.1-141.9	Bedford Shale	2553
B-40	HQ-30	153.6-154.3	Ohio Shale	5861
B-40	HQ-32	163.2-164.1	Ohio Shale	7432
B-41	HQ-33	170.0-171.0	Ohio Shale	5745
B-44	NQ-19	165.0-166.3	Ohio Shale	11013
B-46	HQ-20	149.3-150.1	Ohio Shale	6366

Table 4.2 – Summary of Unconfined Compressive Strength Testing (ASTM D7012-14)

Boring	Core Run ID	Depth (ft)	Bedrock Type	Unconfined Compressive Strength (PSI)
B-16	HQ-6	147.7 - 148.1	Bedford Shale	2552
B-16	HQ-7	153.3 - 153.8	Ohio Shale	3738
B-18	NQ-12	152.7 - 153.0	Bedford Shale	4621
B-18	NQ-13	161.0 - 161.4	Ohio Shale	5621
B-20	HQ-16	152.8 - 153.2	Ohio Shale	8405
B-23	HQ-11	156.6 - 157.0	Bedford Shale	9090
B-23	HQ-13	170.6 - 171.1	Ohio Shale	8732
B-27	NQ-18	176.7 - 177.0	Ohio Shale	8796
B-29	NQ-18	170.3 - 170.7	Ohio Shale	4088
B-31	NQ-20	174.8 - 175.2	Ohio Shale	4416
B-33	NQ-18	178.8 - 179.2	Ohio Shale	5232
B-39	HQ-6	154.2 - 154.6	Bedford Shale	3770
B-39	HQ-7	158.3 - 158.7	Ohio Shale	2808
B-40	HQ-5	26.5 - 26.9	Berea Sandstone	11047
B-40	HQ-16	82.8 - 83.2	Interbedded Bedford SH and Berea SS	1157
B-40	HQ-26	134.5 - 134.9	Bedford Shale	1817
B-40	HQ-28	141.9 - 150.3	Bedford Shale	1418
B-40	HQ-30	153.0 - 153.4	Ohio Shale	3261
B-40	HQ-32	162.5 - 162.9	Ohio Shale	5437
B-41	HQ-32	168.5 - 169.0	Ohio Shale	3691
B-42	NQ-18	171.1 - 171.5	Ohio Shale	4010
B-43	HQ-20	164.3 - 164.7	Ohio Shale	8906
B-44	NQ-19	168.2 - 168.6	Ohio Shale	3356
B-46	HQ-20	148.8 - 149.2	Ohio Shale	3544
B-47	HQ-2	14.9 – 15.3	Berea Sandstone	9826
B-47	HQ-3	18.1 – 18.5	Berea Sandstone	10020
B-47	HQ-18	94.5 – 94.9	Interbedded Berea SS and Bedford SH	1860
B-47	HQ-28	143.6 – 144.0	Bedford Shale	1554
B-47	HQ-34	167.3 – 167.7	Ohio Shale	4269

Table 4.3 – Summary of Unconfined Compressive Strength Testing (ASTM D2938)

Boring	Core Run ID	Depth (ft)	Bedrock Type	Unconfined Compressive Strength (PSI)
FTB-19	NQ-2	55.2-65.2	Bedford Shale	5305
FTB-19	NQ-6	95.2-105.2	Bedford Shale	5671
FTB-19	NQ-10	135.2-145.2	Bedford Shale	6243
FTB-19	NQ-11	145.2-155.2	Ohio Shale	11327
FTB-20	NQ-3	19.0-24.0	Berea Sandstone	14622
FTB-20	NQ-6	40.0-50.0	Bedford Shale	10002
FTB-20	NQ-9	70.0-80.0	Bedford Shale	2270
FTB-20	NQ-13	110.0-120.0	Bedford Shale	6498
FTB-20	NQ-15	130.0-140.0	Bedford Shale	7511
FTB-20	NQ-18	160.0-170.0	Ohio Shale	10093
FTB-20	NQ-19	170.0-175.0	Ohio Shale	11014
FTB-21	NQ-18	161.5-171.5	Bedford Shale	7511
FTB-21	NQ-19	171.5-181.5	Ohio Shale	10196
FTB-22	NQ-15	130.0-140.0	Bedford Shale	9153
FTB-22	NQ-16	140.0-150.0	Bedford Shale	4232
FTB-22	NQ-17	150.0-160.0	Bedford Shale	6498
FTB-22	NQ-18	160.0-165.0	Ohio Shale	9728
FTB-23	NQ-4	30.1-40.1	Berea Sandstone	11338
FTB-23	NQ-7	60.1-70.1	Bedford Shale	4969
FTB-23	NQ-10	90.1-100.1	Bedford Shale	7028
FTB-23	NQ-13	120.1-130.1	Bedford Shale	4994
FTB-23	NQ-15	140.1-150.1	Bedford Shale	5246
FTB-23	NQ-16	150.1-160.1	Ohio Shale	9432
FTB-23	NQ-17	160.1-170.1	Ohio Shale	7572
FTB-24	NQ-8	148.5-158.5	Ohio Shale	10175
FTB-24	NQ-9	158.5-168.5	Ohio Shale	7170
FTB-25	NQ-15	147.8-157.8	Bedford Shale	10658
FTB-25	NQ-16	157.8-167.8	Ohio Shale	12397
FTB-26	NQ-16	153.0-163.0	Bedford Shale	12281
FTB-26	NQ-17	163.0-173.0	Ohio Shale	11816

Table 4.4 – Summary of Splitting Tensile Strength Testing (ASTM D3967)

Boring	Core Run ID	Depth (ft)	Bedrock Type	Splitting Tensile Strength (PSI)
B-16	HQ-6	147.4	Bedford Shale	483
B-16	HQ-7	155.4	Ohio Shale	454
B-18	NQ-12	151.1	Bedford Shale	894
B-18	NQ-13	163.5	Ohio Shale	686
B-19	HQ-18	150.0	Ohio Shale	454
B-20	HQ-13	136.8	Bedford Shale	667
B-20	HQ-15	149.9	Ohio Shale	686
B-21	NQ-10	161.7	Ohio Shale	859
B-22	HQ-5	154.2	Bedford Shale	601
B-24	HQ-15	160.7	Bedford Shale	556
B-24	HQ-16	164.8	Ohio Shale	618
B-27	NQ-16	160.7	Bedford Shale	465
B-27	NQ-17	172.4	Ohio Shale	733
B-29	NQ-18	169.1	Ohio Shale	676
B-31	HQ-20	175.2	Ohio Shale	865
B-33	NQ-18	178.3	Ohio Shale	1064
B-36	HQ-4	159.8	Ohio Shale	469
B-39	HQ-6	154.0	Bedford Shale	611
B-39	HQ-7	159.9	Ohio Shale	281
B-40	HQ-5	26.4	Berea Sandstone	869
B-40	HQ-16	83.8	Interbedded Bedford SH and Berea SS	310
B-40	HQ-22	113.2	Bedford Shale	93
B-40	HQ-26	133.2	Bedford Shale	365
B-40	HQ-28	144.0	Bedford Shale	343
B-40	HQ-30	152.9	Ohio Shale	402
B-40	HQ-32	165.3	Ohio Shale	502
B-41	HQ-32	169.3	Ohio Shale	419
B-42	NQ-18	172.0	Ohio Shale	711
B-43	HQ-21	168.7	Ohio Shale	626
B-44	NQ-19	167.4	Ohio Shale	692
B-45	HQ-5	150.9	Bedford Shale	475
B-46	HQ-20	148.4	Ohio Shale	286
B-47	HQ-3	17.5	Berea Sandstone	406
B-47	HQ-12	62.4	Interbedded Bedford SH and Berea SS	225
B-47	HQ-19	96.9	Bedford Shale	237
B-47	HQ-28	144.3	Bedford Shale	274
B-47	HQ-34	170.0	Ohio Shale	365

Table 4.5 – Summary of Slake Durability Index Testing (ASTM D4644-08)

Boring	Core Run ID	Depth (ft)	Bedrock Type	Slake Durability Index
B-16	HQ-6	146.6-147.2	Bedford Shale	96.9
B-16	HQ-6	149.0-149.5	Ohio Shale	95.8
B-18	NQ-12	151.9-152.5	Bedford Shale	96.4
B-18	NQ-13	161.4 - 162.0	Ohio Shale	98.5
B-19	HQ-18	150.1-150.7	Ohio Shale	98.0
B-20	HQ-13	135.8-136.7	Bedford Shale	91.7
B-20	HQ-16	150.7 - 152.0	Ohio Shale	99.8
B-21	NQ-8	152.4-153.2	Bedford Shale	87.4
B-21	NQ-9/NQ-10	160.0 - 161.4	Bedford and Ohio Shales	98.0
B-22	HQ-5	152.5-153.8	Bedford Shale	93.0
B-23	HQ-11	158.0-159.0	Bedford Shale	95.6
B-23	HQ-13	166.6 - 167.3	Ohio Shale	99.1
B-24	HQ-15	159.5-160.5	Bedford Shale	94.1
B-24	HQ-16	163.4-164.4	Ohio Shale	95.2
B-27	NQ-16	164.6-165.6	Bedford Shale	94.9
B-27	NQ-17	171.0-172.3	Ohio Shale	98.2
B-29	NQ-18	171.3-172.0	Ohio Shale	98.5
B-31	NQ-20	176.0-176.9	Ohio Shale	98.9
B-33	NQ-18/NQ-19	180.1-181.5	Ohio Shale	99.1
B-36	HQ-4	158.5-159.4	Ohio Shale	96.1
B-38	HQ-12	109.5-110.5	Bedford Shale	27.8
B-39	HQ-7	155.5-156.3	Ohio Shale	96.8
B-39	HQ-7/HQ-8	160.1-161.2	Ohio Shale	99.1
B-40	HQ-22	111.5-112.5	Bedford Shale	33.7
B-40	HQ-26	131.5-132.5	Bedford Shale	68.0
B-40	HQ-28	140.5-141.1	Bedford Shale	66.0
B-40	HQ-30	154.3-155.0	Ohio Shale	99.6
B-40	HQ-33	167.6-168.5	Ohio Shale	99.2
B-41	HQ-32	167.5-168.5	Ohio Shale	99.2
B-42	NQ-18	172.6-173.7	Ohio Shale	99.1
B-43	HQ-21	169.7-170.8	Ohio Shale	98.6
B-44	NQ-19	168.6-169.8	Ohio Shale	99.1
B-45	HQ-5	149.5-150.3	Bedford Shale	93.1
B-46	HQ-20	146.8-147.5	Ohio Shale	98.9
B-47	HQ-19	96.2 – 96.9	Interbedded Bedford SH and Berea SS	88.0
B-47	HQ-28	144.7 – 145.3	Bedford Shale	69.2
B-47	HQ-34	169.3 – 170.0	Ohio Shale	99.2
FTB-19	NQ-10	135.2-145.2	Bedford Shale	89.1
FTB-19	NQ-11	145.2-155.2	Ohio Shale	93.2
FTB-20	NQ-18	160.0-170.0	Ohio Shale	96.0
FTB-20	NQ-19	170.0-175.0	Ohio Shale	97.8
FTB-21	NQ-18	161.5-171.5	Bedford Shale	93.1

Table 4.5 – Summary of Slake Durability Index Testing (ASTM D4644-08) – Continued

Boring	Core Run ID	Depth (ft)	Bedrock Type	Slake Durability Index
FTB-21	NQ-19	171.5-181.5	Ohio Shale	95.7
FTB-22	NQ-17	150.0-160.0	Bedford Shale	91.9
FTB-22	NQ-18	160.0-165.0	Ohio Shale	96.5
FTB-23	NQ-15	140.1-150.1	Bedford Shale	94.3
FTB-23	NQ-16	150.1-160.1	Ohio Shale	94.5
FTB-23	NQ-17	160.1-170.1	Ohio Shale	97.3
FTB-24	NQ-8	148.5-158.5	Ohio Shale	96.0
FTB-24	NQ-9	158.5-168.5	Ohio Shale	93.2
FTB-25	NQ-15	147.8-157.8	Bedford Shale	96.5
FTB-25	NQ-16	157.8-167.8	Ohio Shale	97.4
FTB-26	NQ-16	153.0-163.0	Bedford Shale	94.9
FTB-26	NQ-17	163.0-173.0	Ohio Shale	98.7

Table 4.6 – Summary of Point Load Strength Index Testing (ASTM D5731-08)

Boring	Core Run ID	Depth (ft)	Axial (A) or Diametral (D)	Bedrock Type	Point Load Index (Is) (PSI)	Corrected Point Load Index (Is_{50})[1] (PSI)
B-16	HQ-6	147.4	A	Bedford Shale	101.1	121.0
B-16	HQ-6	147.2	D	Bedford Shale	75.8	82.8
B-16	HQ-7	155.3	A	Ohio Shale	100.9	120.7
B-16	HQ-7	155.0	D	Ohio Shale	22.3	24.4
B-18	HQ-12	150.8	A	Bedford Shale	969.7	875.2
B-18	HQ-12	150.4	D	Bedford Shale	175.1	172.0
B-18	HQ-13	160.4	A	Ohio Shale	381.1	342.5
B-18	HQ-13	160.8	D	Ohio Shale	34.6	34.1
B-19	HQ-19	149.9	A	Ohio Shale	103.1	123.3
B-19	HQ-19	149.6	D	Ohio Shale	9.3	10.0
B-20	HQ-13	137.8	A	Bedford Shale	67.0	80.2
B-20	HQ-13	137.5	D	Bedford Shale	49.9	54.6
B-20	HQ-15	149.7	A	Ohio Shale	112.9	135.1
B-20	HQ-15	150.1	D	Ohio Shale	147.1	160.9
B-21	HQ-10	161.8	A	Ohio Shale	147.9	177.0
B-21	HQ-10	161.5	D	Ohio Shale	54.2	54.3
B-21B	PQ-5	157.9	A	Ohio Shale	94.6	112.5
B-21B	PQ-5	158.1	A	Ohio Shale	88.0	104.4
B-21B	PQ-5	159.9	A	Ohio Shale	95.2	114.8
B-21B	PQ-5	161.9	A	Ohio Shale	106.4	127.3
B-22	HQ-5	154.1	A	Bedford Shale	101.0	120.8
B-22	HQ-5	153.9	D	Bedford Shale	30.4	32.8
B-23	HQ-10	155.0	A	Bedford Shale	639.9	618.5
B-23	HQ-10	154.7	D	Bedford Shale	239.0	249.7
B-23	HQ-13	168.9	A	Ohio Shale	707.4	679.5
B-23	HQ-13	169.5	D	Ohio Shale	65.9	68.9
B-24	HQ-15	160.8	A	Bedford Shale	185.2	221.7
B-24	HQ-15	160.5	D	Bedford Shale	30.3	32.9
B-24	HQ-16	164.5	A	Ohio Shale	49.4	59.1
B-27	NQ-16	161.2	A	Bedford Shale	160.9	146.4
B-27	NQ-16	160.9	D	Bedford Shale	23.7	23.7
B-27	NQ-17	174.5	A	Ohio Shale	400.0	362.5
B-27	NQ-17	174.2	D	Ohio Shale	34.4	34.7
B-29	NQ-18	170.2	A	Ohio Shale	265.4	242.8

Table 4.6 – Summary of Point Load Strength Index Testing (ASTM D5731-08) - Continued

Boring	Core Run ID	Depth (ft)	Axial (A) or Diametral (D)	Bedrock Type	Point Load Index (Is) (PSI)	Corrected Point Load Index (Is_{50})[1] (PSI)
B-29	NQ-18	169.9	D	Ohio Shale	109.1	109.6
B-31	NQ-20	175.5	A	Ohio Shale	585.2	541.2
B-31	NQ-20	175.3	D	Ohio Shale	29.8	29.9
B-33	NQ-18	178.6	A	Ohio Shale	186.2	222.8
B-33	NQ-18	178.0	D	Ohio Shale	161.0	161.5
B-36	HQ-4	159.5	A	Ohio Shale	90.7	108.5
B-39	HQ-6	153.8	A	Bedford Shale	102.7	122.9
B-39	HQ-6	153.6	D	Bedford Shale	54.6	59.6
B-39	HQ-7	159.8	A	Ohio Shale	28.4	33.9
B-39	HQ-7	159.6	D	Ohio Shale	81.2	88.8
B-40	HQ-5	26.3	A	Berea Sandstone	314.4	376.3
B-40	HQ-5	26.0	D	Berea Sandstone	547.4	597.7
B-40	HQ-16	83.6	A	Interbedded Bedford Shale/Berea Sandstone	36.3	43.5
B-40	HQ-16	83.3	D	Interbedded Bedford Shale/Berea Sandstone	19.3	21.0
B-40	HQ-22	112.5	A	Bedford Shale	14.9	17.8
B-40	HQ-22	112.9	D	Bedford Shale	13.5	14.8
B-40	HQ-26	133.1	A	Bedford Shale	26.1	31.3
B-40	HQ-26	132.8	D	Bedford Shale	32.6	35.6
B-40	HQ-28	143.9	A	Bedford Shale	27.6	33.0
B-40	HQ-28	143.7	D	Bedford Shale	10.7	11.7
B-40	HQ-30	152.8	A	Ohio Shale	56.2	67.2
B-40	HQ-30	152.5	D	Ohio Shale	112.3	122.9
B-40	HQ-32	165.1	A	Ohio Shale	98.6	118.0
B-40	HQ-32	164.8	D	Ohio Shale	82.6	90.3
B-41	HQ-32	169.2	A	Ohio Shale	89.4	106.9
B-41	HQ-32	169.0	D	Ohio Shale	99.5	108.7
B-42	NQ-18	171.9	A	Ohio Shale	101.5	121.5
B-42	NQ-18	171.6	D	Ohio Shale	58.3	58.5
B-43	HQ-21	168.9	A	Ohio Shale	155.9	186.5
B-43	HQ-21	169.3	D	Ohio Shale	11.6	12.4
B-44	NQ-19	168.0	A	Ohio Shale	67.0	80.2
B-44	NQ-19	167.6	D	Ohio Shale	73.0	73.4
B-45	HQ-5	150.7	A	Bedford Shale	57.2	68.5

Table 4.6 – Summary of Point Load Strength Index Testing (ASTM D5731-08) - Continued

Boring	Core Run ID	Depth (ft)	Axial (A) or Diametral (D)	Bedrock Type	Point Load Index (Is) (PSI)	Corrected Point Load Index (Is_{50})[1] (PSI)
B-45	HQ-5	150.4	D	Bedford Shale	20.7	22.6
B-46	HQ-20	148.2	A	Ohio Shale	54.1	64.7
B-46	HQ-20	147.9	D	Ohio Shale	9.2	10.0

[1] **Is_{50} = size-corrected index (index value that would be measured by a diametral test on specimen with D=50 mm)**

Table 4.7 – Summary of Petrography Testing

Boring	Core Run ID	Depth (ft)	Bedrock Type	Macroscopic Sample Description
B-16	HQ-6	148.1 - 148.9	Bedford Shale	Medium Gray Pyritic Shale
B-16	HQ-7	153.8-154.4	Ohio Shale	Medium Gray Pyritic Shale
B-19	HQ-18	148.7-149.5	Ohio Shale	Medium Gray Pyritic Shale
B-20	HQ-13	138.5-139.1	Bedford Shale	Gray Shale
B-20	HQ-15	148.2-149.5	Ohio Shale	Black Shale
B-21	HQ-10	161.9-162.4	Ohio Shale	Black Shale
B-22	HQ-5	151.6-152.5	Bedford Shale	Medium Gray Shale
B-23	NQ-11	156.6-157.0	Bedford Shale	Massive Gray Siltstone
B-23	HQ-11	171.2-171.6	Ohio Shale	Black Shale
B-24	HQ-16	165.1-165.6	Ohio Shale	Dark Gray Weakly Pyritic Shale
B-27	NQ-17	166.7-167.3	Bedford Shale	Olive Siltstone
B-27	NQ-17	173.7-174.2	Ohio Shale	Black Shale
B-29	NQ-18	168.0-169.0	Ohio Shale	Dark Gray Shale
B-31	HQ-19	173.0-174.3	Ohio Shale	Dark Gray Shale
B-33	NQ-18	179.2-180.1	Ohio Shale	Pyritiferous Shale
B-38	HQ-12	107.1-107.9	Bedford Shale	Maroon Siltstone
B-39	HQ-6	154.6-155.5	Bedford Shale	Light Gray Siltstone
B-39	HQ-7	157.7-159.5	Ohio Shale	Medium Gray Shale
B-40	HQ-5	27.8-28.8	Berea Sandstone	Very Fine-Grained Quartz Arenite Sandstone
B-40	HQ-16/17	84.8-85.6	Interbedded Bedford Shale/Berea Sandstone	Light Gray Shaley Siltstone
B-40	HQ-22	113.6-114.5	Bedford Shale	Maroon Mudstone
B-40	HQ-26	133.7-134.5	Bedford Shale	Medium Gray Shale
B-40	HQ-28	141.1-141.9	Bedford Shale	Very Fissile Medium Gray Shale
B-40	HQ-30	153.6-154.3	Ohio Shale	Dark Gray Pyritic Carbon-Rich Shale
B-40	HQ-32	163.2-164.1	Ohio Shale	Dark Gray Pyritic Carbon-Rich Shale
B-41	HQ-33	170.0-171.0	Ohio Shale	Dark Gray Pyritic Shale
B-42	NQ-18	170.0-171.1	Ohio Shale	Black Shale
B-43	HQ-21	167.2-167.9	Ohio Shale	Brown Shale
B-44	NQ-19	165.0-166.3	Ohio Shale	Black Shale
B-45	HQ-5	151.2-151.6	Ohio Shale	Dark Gray Pyritic Shale
B-46	HQ-20	149.3-150.1	Ohio Shale	Black Pyritic Shale

Table 4.8 – Summary of Cerchar Abrasion Testing

Boring	Core Run ID	Depth (ft)	Bedrock Type	Cerchar Abrasivity Index (CAIs)
B-16	HQ-6	148.1 - 148.9	Bedford Shale	0.3
B-16	HQ-7	153.8-154.4	Ohio Shale	0.3
B-18	NQ-12	153.5-154.0	Bedford Shale	0.3
B-18	NQ-13	162.0-163.1	Ohio Shale	0.5
B-19	HQ-18	148.7-149.5	Ohio Shale	0.3
B-20	HQ-12	133.1-133.4	Bedford Shale	0.4
B-20	HQ-15	148.2-149.5	Ohio Shale	0.5
B-21	HQ-10	161.9-162.4	Ohio Shale	0.4
B-22	HQ-5	151.6-152.5	Bedford Shale	0.2
B-23	HQ-11	156.6-157.0	Bedford Shale	0.4
B-23	HQ-13	171.2-171.6	Ohio Shale	0.5
B-24	HQ-16	165.1-165.6	Ohio Shale	0.3
B-27	NQ-17	166.7-167.3	Bedford Shale	0.5
B-27	NQ-17	173.7-174.2	Ohio Shale	0.4
B-29	NQ-18	168.0-169.0	Ohio Shale	0.4
B-31	HQ-19	173.0-174.3	Ohio Shale	0.5
B-33	NQ-18	179.2-180.1	Ohio Shale	0.4
B-38	HQ-12	107.1-107.9	Bedford Shale	0.3
B-39	HQ-6	154.6-155.5	Bedford Shale	0.4
B-39	HQ-7	157.7-159.5	Ohio Shale	0.4
B-40	HQ-5	27.8-28.8	Berea Sandstone	1.0
B-40	HQ-16/17	84.8-85.6	Interbedded Bedford Shale/Berea Sandstone	0.4
B-40	HQ-22	113.6-114.5	Bedford Shale	0.4
B-40	HQ-26	133.7-134.5	Bedford Shale	0.5
B-40	HQ-28	141.1-141.9	Bedford Shale	0.3
B-40	HQ-30	153.6-154.3	Ohio Shale	0.4
B-40	HQ-32	163.2-164.1	Ohio Shale	0.4
B-41	HQ-33	170.0-171.0	Ohio Shale	0.5
B-42	NQ-18	170.0-171.1	Ohio Shale	0.4
B-43	HQ-21	167.2-167.9	Ohio Shale	0.5
B-44	NQ-19	165.0-166.3	Ohio Shale	0.5

Table 4.9 – Summary of SINTEF Testing

Boring	Core Run ID	Depth (ft)	Drilling Rate Index (DRI)	DRI Category	Bit Wear Index (BWI)	Classification of Cutter Life Index (CLI)	CLI Category
B-18	NQ-11	140.0-150.0	78.69	Very High	2.8	106.1	Extremely High
B-18	NQ-13	160.0-170.0	69.05	Very High	1.4	55.4	Very High
B-20	HQ-12	129.5-134.5	79.47	Very High	3.5	200.3	Extremely High
B-20	HQ-13	134.5-139.5	83.96	Extremely High	5.5	62.2	Very High
B-27	NQ-16	155.6-165.6	83.61	Extremely High	10.1	166.4	Extremely High
B-27	NQ-17	165.6-175.6	74.72	Very High	7.0	49.4	Very High
B-33	NQ-18	170.5-180.5	77.51	Very High	4.9	55.7	Very High
B-43	HQ-21	166.6-176.6	83.06	Extremely High	6.4	62.3	Very High

Table 4.10 – Summary of Direct Shear Test

Boring	Core Run ID	Depth (ft)	Peak Friction Angle	Peak Cohesive Intercept (PSI)	Post Peak Friction Angle	Post Peak Cohesive Intercept (PSI)
B-47	HQ-31	152.4-152.9	15.2	4.0	12.3	3.6
B-47	HQ-32	156.8-157.1	61.0	0	33.3	0

Table 4.11 – Summary of pH Results

Boring	Depth (ft)	pH in Water	pH in Calcium Chloride Sol.	Temperature (°C)
B-21B	167.0	3.78	3.22	24.5
B-21B	168.0-170.5	3.94	3.71	24.2
B-21B	170.5-173.0	4.06	3.90	24.2
FTB-19	65.2	7.5	n/a	n/a
FTB-19	155.2	7.2	n/a	n/a
FTB-20	80.0	8.2	n/a	n/a
FTB-20	170.0	8.9	n/a	n/a
FTB-21	181.5	9.0	n/a	n/a
FTB-23	160.1	8.4	n/a	n/a
FTB-26	163.0	9.1	n/a	n/a

Table 4.12 – Summary of Soils Testing

Boring	Sample No.	Depth (ft)	pH	Water Content (%)	Atterberg Limits			Specific Gravity	Unit Weight (wet) (pcf)	Percent Finer Mesh #200
					Liquid Limit	Plastic Limit	Plasticity Index			
FTB-19	S-4	4.5-6.0		11.7	27	16	11			
FTB-19	S-7	9.0-10.5		10.8						
FTB-19	S-9	12.0-13.5	6.9	14.7	19	14	5	2.74		
FTB-19	S-10	13.5-15.0		12.2					141.8	
FTB-19	S-11	15.0-16.5		12.0	22	13	9	2.71	140.5	
FTB-19	S-15	21.0-22.5		14.3						12.5
FTB-19	S-19	28.5-30.0		14.5				2.78		44.3
FTB-19	S-23	39.5-40.0	7.2	13.1				2.78	134.8	
FTB-19	S-27	48.5-50.0		10.9				2.78	127.7	
FTB-20	S-3	3.0-4.5	7.1	17.6	38	21	17	2.81		
FTB-23	S-5	6.0-7.5		13.8	22	17	5	2.74	136.4	
FTB-23	S-9	12.0-13.5	7.8	13.1	24	18	6	2.73		

APPENDICES

Appendix A PUBLISHED GEOLOGIC INFORMATION

STATE OF OHIO
Ted Strickland, Governor

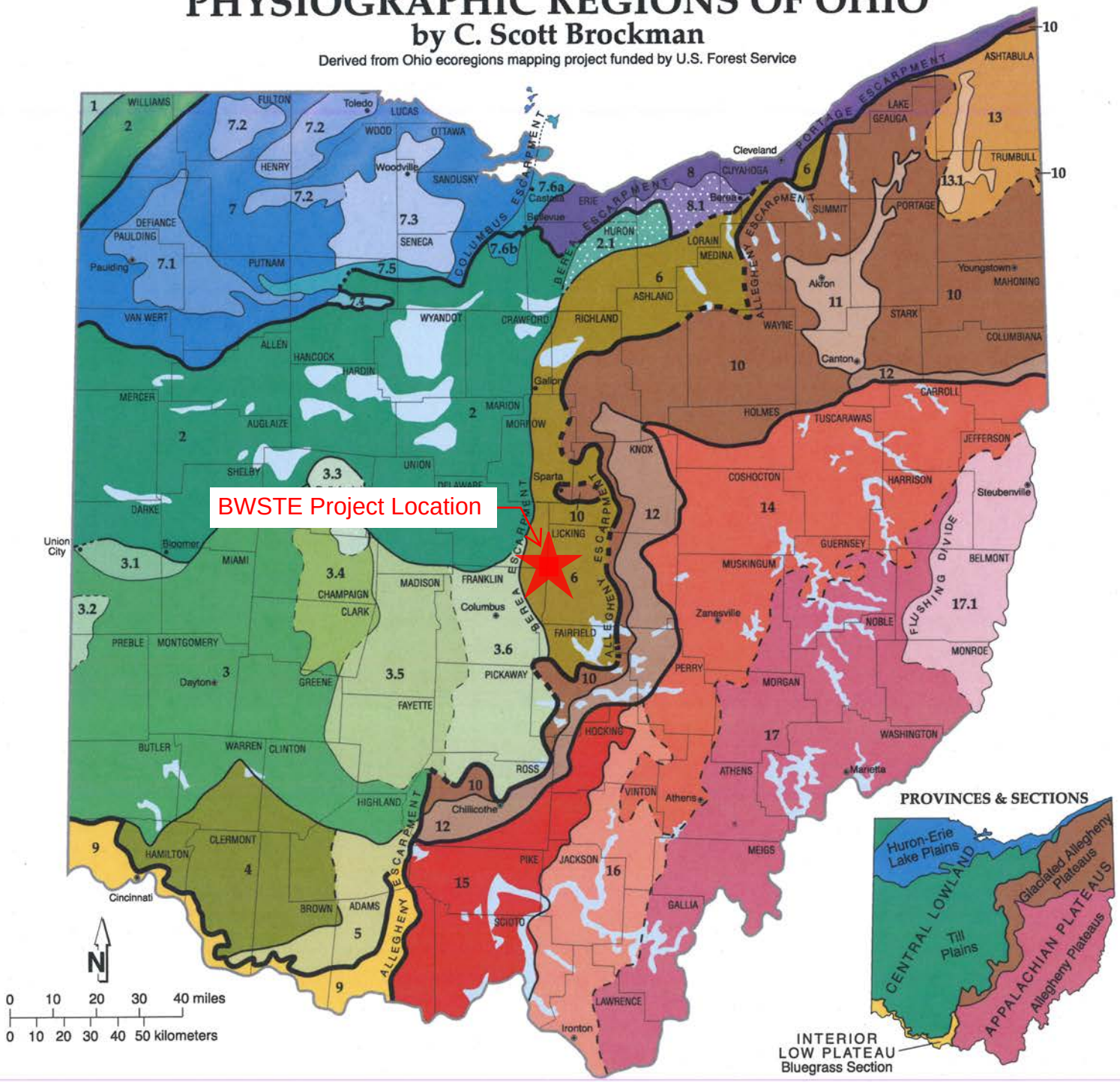
DEPARTMENT OF NATURAL RESOURCES
Sean D. Logan, Director

DIVISION OF GEOLOGICAL SURVEY
Lawrence H. Wickstrom, Chief

PHYSIOGRAPHIC REGIONS OF OHIO

by C. Scott Brockman

Derived from Ohio ecoregions mapping project funded by U.S. Forest Service



Till Plains

- 1. Steuben Till Plain
- 2. Central Ohio Clayey Till Plain
  - 2.1. Berea Headlands of the Till Plain
- 3. Southern Ohio Loamy Till Plain
  - 3.1. Union City-Bloomer Transitional Terrain
  - 3.2. Whitewater Interlobate Plain
  - 3.3. Bellefontaine Upland
  - 3.4. Mad River Interlobate Plain
  - 3.5. Darby Plain
  - 3.6. Columbus Lowland
- 4. Illinoian Till Plain
- 5. Dissected Illinoian Till Plain
- 6. Galion Glaciated Low Plateau

Transitional boundary

Lake basin/deposits outside Huron-Erie Lake Plains

Huron-Erie Lake Plains

- 7. Maumee Lake Plains
  - 7.1. Paulding Clay Basin
  - 7.2. Maumee Sand Plains
  - 7.3. Woodville Lake-Plain Reefs
  - 7.4. Findlay Embayment
  - 7.5. Fostoria Lake-Plain Shoals
  - 7.6a and 7.6b. Bellevue-Castalia Karst Plain
- 8. Erie Lake Plain
  - 8.1. Berea Headlands of the Erie Lake Plain

Bluegrass Section

- 9. Outer Bluegrass Region

Glaciated Allegheny Plateaus

- 10. Killbuck-Glaciated Pittsburgh Plateau
- 11. Akron-Canton Interlobate Plateau
- 12. Illinoian Glaciated Allegheny Plateau
- 13. Grand River Low Plateau
  - 13.1 Grand River Finger-Lake Plain

Allegheny Plateaus

- 14. Muskingum-Pittsburgh Plateau
- 15. Shawnee-Mississippian Plateau
- 16. Ironton Plateau
- 17. Marietta Plateau
  - 17.1. Little Switzerland Plateau

4/98

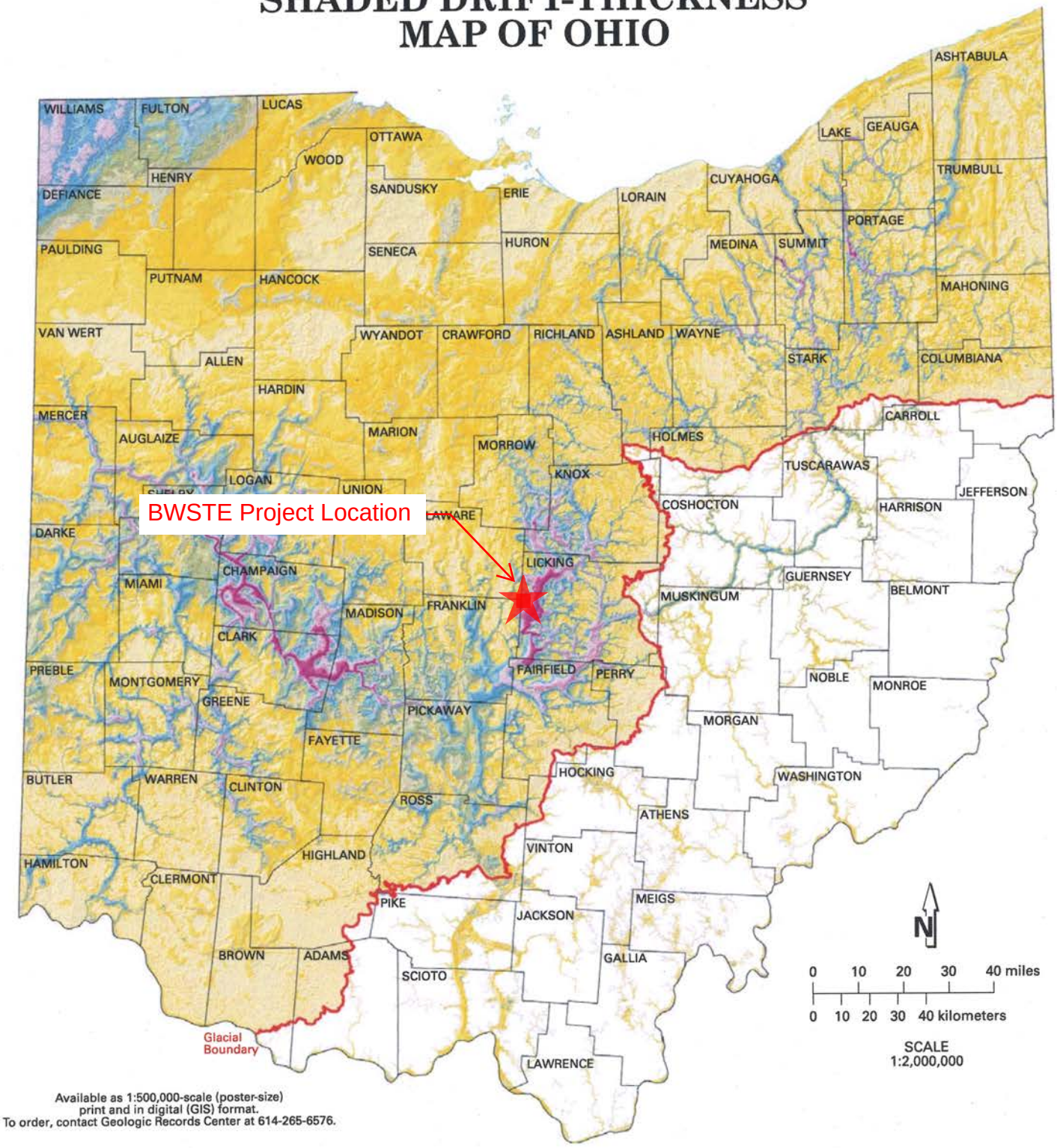
PHYSIOGRAPHIC REGIONS OF OHIO

Major Divisions	Provinces	Sections *	DISTINGUISHING CHARACTERISTICS OF REGIONS & DISTRICTS	GEOLOGY	BOUNDARIES
INTERIOR PLAINS	CENTRAL LOWLAND	Till Plains	**1. Steuben Till Plain.** Hummocky terrain with rolling hills, interspersed flats and closed depressions; wetlands, few streams, deranged drainage; only a small part of the region is in Ohio; elevation 950'-1100', moderately low relief (60')	Wisconsinan-age (latest Ice-Age) loamy till from a northern source (Saginaw glacial lobe) over Mississippian-age Coldwater Shale	Southeast: edge of Wabash Moraine
			2. Central Ohio Clayey Till Plain. Surface of clayey till; well-defined moraines with intervening flat-lying ground moraine and intermoraine lake basins; no boulder belts; about a dozen silt-, clay- and till-filled lake basins range in area from a few to 200 square miles; few large streams; limited sand & gravel outwash; elevation 700'-1150', moderate relief (100')	Clayey, high-lime Wisconsinan-age till from a northeastern source (Erie glacial lobe) and lacustrine materials over Lower Paleozoic-age carbonate rocks and, in the east, shales; loess thin to absent	North: Lake Plain; northeast: limit of Berea Sandstone; east: Berea Escarpment; south: Powell and Union City/Bloomer Moraines; northern segment boundaries: Wabash Moraine and lake plain
			2.1. Berea Headlands of the Till Plain. Gently rolling to flat terrain of thin drift descending to Lake Erie; punctuated by more than 20 streamlined "whalebacks" of Berea Sandstone, 0.5 to 2.5 miles long, 30'-60' high; somewhat poorly drained; elevation 800'-1000', low relief (20')	Thin, clayey, medium-lime Wisconsinan-age till over resistant Mississippian-age Berea Sandstone	South: limit of Berea Sandstone; elsewhere: Berea Escarpment and/or margin of highest Pleistocene lake
			3. Southern Ohio Loamy Till Plain. Surface of loamy till; end and recessional moraines, commonly associated with boulder belts, between relatively flat-lying ground moraine, cut by steep-valleyed large streams; stream valleys filled with outwash and alternate between broad floodplains and narrows; buried valleys common; elevation 530'-1150', moderate relief (200')	Loamy, high-lime Wisconsinan-age till, outwash, and loess over Lower Paleozoic-age carbonate rocks and, in the east, shales	East: Berea and Allegheny Escarpments; north: Powell and Union City/Bloomer Moraines; south: limit of Wisconsinan-age till
			3.1. Union City-Bloomer Transitional Terrain. Well-defined moraines with low-relief, hummocky ground moraine like the Central Ohio Clayey Till Plain to the north; loamy till with loess cap like Southern Ohio Loamy Till Plain to the south; elevation 920'-1075', moderately low relief (30')	Loamy, high-lime Wisconsinan-age till with thin loess cap over Silurian-age dolomites	North: Bloomer Moraine and limit of loamy till; south: Union City Moraine
			3.2. Whitewater Interlobate Plain. An upland between two converging glacial lobes with hummocky moraines, moraine complexes, kames, boulder belts, and broad outwash trains/plains; contains highest elevations in Indiana (1257') and in adjacent Ohio counties (1240'); elevation in Ohio 980'-1240', moderate relief (150')	Loamy, high-lime Wisconsinan-age till and sand and gravel outwash over resistant Silurian-age carbonate rocks (north) and less resistant Ordovician-age shales and limestones (south)	North: limit of Knightstown/Farmersville Moraines and kame fields; east: high, dissected hills draining to Whitewater River
			3.3. Bellefontaine Upland. Moderately high relief (250') dissected topography with moraine complexes, boulder belts, high-gradient major streams, caves and sinkholes; few glacial depressions/kettles compared to surrounding areas; elevation 1100'-1549', includes highest elevation in Ohio (Campbell Hill, 1549')	Loamy, high-lime Wisconsinan-age till over generally deeply buried Silurian- to Devonian-age carbonate rocks and Ohio Shale	North: areas with hilltops above 1200'; elsewhere: hilltops above about 1300'
			3.4. Mad River Interlobate Plain. Area between two major converging glacial lobes with extensive outwash, outwash terraces, and bordering moraines; springs and cool, ground-water-fed surface waters; elevation 800'-1350', moderate relief (200')	Loamy, high-lime Wisconsinan-age till and sand and gravel outwash over Silurian- to Devonian-age carbonate rocks and Ohio Shale	East and north: rear edge of Cable Moraine Complex; south: outwash to Clifton Gorge; west: western edge of Mad River Outwash
			3.5. Darby Plain. Moderately low relief (25'), broadly hummocky ground moraine with several broad, indistinct recessional moraines; between hummocks are broad, poorly drained swales which held wet prairies/meadows in pioneer days; few large streams; elevation 750'-1100'	Loamy, high-lime Wisconsinan-age till and sparse outwash over Silurian- and Devonian-age carbonate rocks and Ohio Shale in the southeast	South and west: front of Reesville and rear of Cable Moraines; north: Powell Moraine; east: increasing eastward slope (see 3.6)
			3.6. Columbus Lowland. Lowland surrounded in all directions by relative uplands, having a broad regional slope toward the Scioto Valley; many larger streams; elevation 600'-850' (950' near Powell Moraine), moderately low relief (25')	Loamy, high-lime (west) to medium-lime (east) Wisconsinan-age till and extensive outwash in Scioto Valley over deep Devonian- to Mississippian-age carbonate rocks, shales, and siltstones	North: Powell Moraine; east and south: Berea and/or Allegheny Escarpments; west: flatter and higher Darby Plain
			4. Illinoian Till Plain. Rolling ground moraine of older till generally lacking ice-constructional features such as moraines, kames, and eskers; many buried valleys; modern valleys alternating between broad floodplains and bedrock gorges; elevation 600'-1100', moderately low relief (50')	Silt-loam, high-lime, Illinoian-age till with loess cap; soils leached several feet; underlain by Ordovician- and Silurian-age carbonate rocks and calcareous shales	North: Wisconsinan glacial margin (Cuba and Hartwell Moraines); elsewhere: limit of common till-covered hillslopes
			5. Dissected Illinoian Till Plain. Hilly former till plain in which glacial deposits have been eroded from many valley sides; relatively high stream density; elevation 600'-1340', moderate relief (200')	Hilltops of high-lime Illinoian-age till with loess cap; slopes of bedrock- and till-derived colluvium and Ordovician- and Silurian-age carbonate rocks and calcareous shales	East: maximum glacial margin; elsewhere: limit of general absence of till on hillslopes
			6. Galion Glaciated Low Plateau. Rolling upland transitional between the gently rolling Till Plain and the hilly Glaciated Allegheny Plateau; mantled with thin to thick drift; elevation 800'-1400', moderate relief (100')	Medium- to low-lime Wisconsinan-age till over Mississippian-age shales and sandstones	North: limit of Berea Sandstone; west: Berea Escarpment; south and east: Allegheny Escarpment
		Huron-Erie Lake Plains	**7. Maumee Lake Plains.** Flat-lying Ice-Age lake basin with beach ridges, bars, dunes, deltas, and clay flats; contained the former Black Swamp; slightly dissected by modern streams; elevation 570'-800', very low relief (5')	Pleistocene-age silt, clay, and wave-planed clayey till over Silurian- and Devonian-age carbonate rocks and shales	Northeast: Lake Erie; elsewhere: margin of highest Pleistocene lake
			7.1. Paulding Clay Basin. Nearly flat lacustrine plain; most clayey of all Lake Plain subregions; low-gradient, highly meandering streams; easily ponded soils; elevation 700'-725', extremely low relief (less than 5')	Pleistocene-age lacustrine clay over clay till and Silurian-age dolomites	Northeast: subdued ("drowned") remnant of Defiance Moraine; elsewhere: limit of lacustrine clay
			7.2. Maumee Sand Plains. Lacustrine plain mantled by sand; includes low dunes, inter-dunal pans, beach ridges, and sand sheets of glacial lakeshores; well to poorly drained; elevation 600'-800', very low relief (10')	Late Wisconsinan-age sand over clay till and lacustrine deposits; Silurian- and Devonian-age carbonate rocks and shales buried deeply.	Limit of sandy deposits and/or low dunes
			7.3. Woodville Lake-Plain Reefs. Very low relief (10') lacustrine plain with low dunes and lake-margin features, punctuated by more than 75 ancient bedrock reefs rising 10' to 40' above the level of the plain and ranging in area from 0.1 to 3.0 square miles; the oblong reefs are thinly draped with drift; elevation 600'-775'	Thin to absent Wisconsinan-age wave-planed clay till, lacustrine deposits, and sand over Silurian-age reefal Lockport Dolomite	Limit of thinly mantled Lockport Dolomite (Bowling Green Fault to the west and the Defiance Moraine to the south)
			7.4. Findlay Embayment. Very low relief (10'), broadly rolling lacustrine plain; embayment of ancestral Lake Erie in which relatively coarse lacustrine sediments collected; elevation 775'-800'	Silty to gravelly Wisconsinan-age lacustrine deposits and wave-planed clayey till over Silurian-age Lockport Dolomite	West: 775' beach ridge; north: Defiance Moraine; south: margin of highest Pleistocene lake level
			7.5. Fostoria Lake-Plain Shoals. Portion of the Defiance Moraine lightly eroded by shallow Lake Maumee with low north-south trending hillocks and shallow, closed depressions; many sandy areas; elevation 750'-825', low relief, decreasing westward (10'-15')	Silty to gravelly Wisconsinan-age lacustrine deposits and wave-planed clay till over deeply covered Silurian-age dolomite	South and east: unmodified Defiance Moraine; elsewhere: very low-relief lake plain
	INT. LOW PLATEAUS	Bluegrass Section	**7.6a and 7.6b. Bellevue-Castalia Karst Plain.** Hummocky plain of rock knobs and numerous sinkholes, large solution features, and caves; large springs; thinly mantled by drift; region straddles both Lake Plain (7.6a) and Till Plain (7.6b); 7.6a has greatest relief of any Lake Plain region (25'); elevation 570'-825'	Columbus and Delaware Limestones overlain by thin clay till in 7.6b, and thin silty and sandy Wisconsinan-age lacustrine deposits and wave-planed clay till in 7.6a	Limit of thinly mantled Columbus and Delaware Limestones, which is marked in the west by the Columbus Escarpment
			8. Erie Lake Plain. Edge of very low-relief (10') Ice-Age lake basin separated from modern Lake Erie by shoreline cliffs; major streams in deep gorges; elevation 570'-800'	Pleistocene-age lacustrine sand, silt, clay, and wave-planed till over Devonian- and Mississippian-age shales and sandstones	North: Lake Erie; south: margin of highest Pleistocene lake
			8.1 Berea Headlands of the Erie Lake Plain. Portion of the Erie Lake Plain underlain by resistant Berea Sandstone; several large sandstone headlands jut into the Ice-Age lake basin; contains several streamlined "whalebacks" of Berea Sandstone, 0.5 to 2.0 miles long, 20'-35' high; poorly drained; elevation 670'-800', very low relief (10')	Thin lacustrine deposits over thin, wave-planed, clayey, medium-lime Wisconsinan-age till; underlain by resistant Berea Sandstone	North: portion of Lake Plain underlain by soft shales; south: margin of highest Pleistocene lake
			9. Outer Bluegrass Region. Moderately high relief (300') dissected plateau of carbonate rocks; in east, caves and other karst features relatively common; in west, thin, early drift caps narrow ridges; elevation 455'-1120'	Ordovician- and Silurian-age dolomites, limestones, and calcareous shales; thin pre-Wisconsinan drift on ridges in west; silt-loam colluvium	Eastern segment: maximum glacial margin and high eastern ridges capped by noncarbonate rocks; connected by Ohio River bluffs to western segment which is bounded by nondissected till plain
APPALACHIAN HIGHLANDS	APPALACHIAN PLATEAUS	Glaciated Allegheny (Southern New York) Plateaus	**10. Killbuck-Glaciated Pittsburgh Plateau.** Ridges and flat uplands generally above 1200', covered with thin drift and dissected by steep valleys; valley segments alternate between broad drift-filled and narrow rock-walled reaches; elevation 600'-1505', moderate relief (200')	Thin to thick Wisconsinan-age clay to loam till over Mississippian- and Pennsylvanian-age shales, sandstones, conglomerates and coals	West and north: resistant sandstones of the Allegheny and Portage Escarpments; south and east: Wisconsinan glacial margin
			11. Akron-Canton Interlobate Plateau. Hummocky area between two converging glacial lobes dominated by kames, kame terraces, eskers, kettles, kettle lakes, and bogs/fens; deranged drainage with many natural lakes; elevation 900'-1200', moderate relief (200')	Sandy Wisconsinan-age and older drift over Devonian- to Pennsylvanian-age sandstones, conglomerates and shales	Limit of common, sandy ice-contact features and deposits
			12. Illinoian Glaciated Allegheny Plateau. Dissected, rugged hills; loess and older drift on ridgetops, but absent on bedrock slopes; dissection similar to unglaciated regions of the Allegheny Plateau; elevation 600'-1400', moderate relief (200')	Colluvium and Illinoian-age till over Devonian- to Pennsylvanian-age shales, siltstones and sandstones	North and west: Wisconsinan glacial margin; south and east: Illinoian (maximum) glacial margin
			13. Grand River Low Plateau. Gently rolling ground and end moraine having thin to thick drift; poorly drained areas and wetlands relatively common; elevation 760'-1200', low relief (20') except near Grand River Valley (200')	Clayey, low-lime Wisconsinan-age till over deeply buried, soft Devonian-age shales and near-surface Mississippian-age sandstones and shales	North: Portage Escarpment; south and west: Defiance Moraine; southeast: increasing relief from proximity of buried Pennsylvanian-age sandstones
			13.1. Grand River Finger-Lake Plain. Very low relief (10') lake deposits in steep-sided troughs (200' relief) within the Grand River Low Plateau; cut by glacial and stream erosion; extensive wetlands; elevation 800'-900'	Surficial lacustrine clay and drift over deeply buried, soft Devonian-age shales	Margins of steeply sloping troughs containing the Grand River and parts of Rock and Mosquito Creeks
		Allegheny (Kanawha) Plateaus	**14. Muskingum-Pittsburgh Plateau.** Moderately high to high relief (300'-600') dissected plateau having broad major valleys that contain outwash terraces, and tributaries with lacustrine terraces; medium-grained bedrock sequences coarser than those in Marietta Plateau (17) but finer than those in Ironton Plateau (16); remnants of ancient Teays-age drainage system uncommon; elevation 650'-1400'	Mississippian and Pennsylvanian-age siltstones, shales, sandstones and economically important coals and claystones; Wisconsinan-age sand, gravel, and lacustrine silt; silt-loam colluvium	North and west: maximum glacial margin; southeast: transition to finer grained bedrock; southwest: transition to coarser grained bedrock
			15. Shawnee-Mississippian Plateau. High relief (400'-800'), highly dissected plateau of coarse and fine grained rock sequences; most rugged area in Ohio; remnants of ancient lacustrine clay-filled Teays drainage system are extensive in lowlands, absent in uplands; elevation 490'-1340'	Devonian- and Mississippian-age shales, siltstones, and locally thick sandstones; Pleistocene-age sandy outwash in Scioto River; Teays-age Minford Clay; silt-loam and channery colluvium	North: Maximum glacial margin; west:: carbonate bedrock; east: limit of Mississippian-age bedrock
			16. Ironton Plateau. Moderately high relief (300') dissected plateau; coarser grained coal-bearing rock sequences more common than in other regions of the Allegheny Plateau; common lacustrine clay-filled Teays Valley remnants; elevation 515'-1060'	Pennsylvanian-age (Pottsville, Allegheny and Conemaugh Groups) cycles of sandstones, siltstones, shales and economically important coals; Pleistocene (Teays)-age Minford Clay; silt-loam and channery colluvium	West: limit of common Pennsylvanian-age bedrock; north and east: gradation to finer rock sequences
			17. Marietta Plateau. Dissected, high-relief (generally 350', to 600' near Ohio River) plateau; mostly fine-grained rocks; red shales and red soils relatively common; landslides common; remnants of ancient lacustrine clay-filled Teays drainage system common; elevation 515'-1400'	Pennsylvanian-age Upper Conemaugh Group through Permian-age Dunkard Group cyclic sequences of red and gray shales, and siltstones, sandstones, limestones and coals; Pleistocene (Teays)-age Minford Clay; red and brown silty-clay loam colluvium; landslide deposits	North and west: transition to medium-grained Lower Conemaugh rocks; east: Flushing Divide
			17.1. Little Switzerland Plateau. Highly dissected, high-relief (generally 450', to 750' along Ohio River) plateau; mostly fine-grained rocks; red shales and red soils relatively common; landslides common; high-gradient shale-bottomed streams subject to flash flooding; no remnants of ancient Teays drainage system; elevation 540'-1400'	Similar to Marietta Plateau but lacking Pleistocene (Teays)-age Minford Clay	North: transition to medium-grained rocks; west and south: Flushing Divide; east: Ohio River

* Section names modified from Fenneman (1938, 1946).

STATE OF OHIO • DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

SHADED DRIFT-THICKNESS MAP OF OHIO



Available as 1:500,000-scale (poster-size) print and in digital (GIS) format.
To order, contact Geologic Records Center at 614-265-6576.

EXPLANATION

Thickness (in feet) of drift in glaciated areas and some non-glaciated areas along glacial boundary, and of outwash and glaciolacustrine deposits in sediment-filled valleys beyond the glacial boundary.

0 - 20	51 - 80	121 - 160	211 - 260	331 - 440
21 - 50	81 - 120	161 - 210	261 - 330	441 - 726

Recommended citation: Ohio Division of Geological Survey, 2004, Shaded drift-thickness map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map SG-3, generalized page-size version with text, 3 p., scale 1:2,000,000.

SHADED DRIFT-THICKNESS MAP OF OHIO

INTRODUCTION

The drift-thickness map of Ohio depicts the thickness and distribution of glacially derived sediments (called drift) and post-glacial stream sediments overlying the buried bedrock surface. This map was produced by subtracting bedrock-surface elevations from land-surface elevations to produce a residual map of drift thickness. Colors portray thickness intervals of glacial and modern sediments, which can range up to several hundred feet.

Prior to the onset of continental glaciation in the Early Pleistocene Epoch, approximately 1.8 million years before present, the Ohio landscape was dominated by rolling hills and deeply incised, mature rivers and streams. A reduced version of the Division of Geological Survey's Shaded-Bedrock Topography map of Ohio (fig. 1) reveals some aspects of this old land surface. Erosion and deposition by Ice-Age continental glaciers advancing into northern and western Ohio produced a low-relief land surface compared to the unglaciated, high-relief land surface of southeastern Ohio (fig. 2). Comparing the shaded elevation map (fig. 2) with the shaded bedrock-topography map (fig. 1) reveals the dramatic impact of glaciation on the state's current landscape.

Drift thickness in western and northern Ohio (fig. 3) is highly variable, a consequence of numerous geologic factors acting in combination or alone. In some areas, drift has been deposited on a relatively flat bedrock surface and changes in drift thickness are primarily the result of variations in the amount of glacial material deposited. In other areas, drift has infilled a deeply incised buried-bedrock surface, and changes in drift thickness are primarily the result of variations in bedrock-surface elevation. In still other instances, the drift surface parallels the underlying bedrock surface to produce areas of relatively uniform drift thickness.

Distinct, narrow linear patterns of thick drift in western and central Ohio are the result of deep incisions in the underlying limestone and dolomite bedrock by a large, northwest flowing drainage system, the Teays Valley system, that existed prior to and during early glaciations (fig. 1). The main Teays Valley entered the state at Wheelersburg (Scioto County), where remnants of the Teays Valley are still evident on the modern land surface. At Chillicothe (Ross County), the valley disappears under glacial sediments which cover western Ohio. However, the valley continues north, below the surface, to Circleville (Pickaway County) and then northwest to Mercer County where the valley exits the state into Indiana. Early southward-advancing glaciers blocked the north-flowing river system of the Teays and created immense lakes in southeastern Ohio.

In northeastern Ohio, narrow thick-drift areas south of Lake Erie were also preglacial bedrock valleys. These valleys were partially filled with thick deposits of till and glaciolacustrine (glacial lake) sediment and then re-excavated by later northward-flowing rivers such as the Cuyahoga River and the East Branch of Rocky River.

In northwestern Ohio, repeated scouring of the relatively soft bedrock surface by glacial ice flowing southwestward from the Lake Erie Basin destroyed most pre-existing drainage systems. In this part of Ohio, the bedrock surface is smooth and the upper surface of the drift has been planed off by wave action and deposition by a post-glacial, high-level ancestral Lake Erie. In the extreme northwest corner of Ohio, in Williams County and portions of Defiance County, drift thickens considerably because of numerous moraines that formed along the northwestern edge of the Erie Lobe.

In western Ohio, draping linear features of thick drift, called ridge moraines, formed along the temporarily stationary ice-front as glacial sediment was released from the ice. These ribbons of thick drift define the lateral dimensions of glacial ice lobes, particularly those of the last Wisconsinan ice sheet (figure 4). Many ridge moraines in western and northeastern Ohio have a draped appearance because south-flowing ice, impeded by bedrock highlands, moved more easily along major lowlands. The numerous resistant bedrock highlands in northeastern Ohio caused ridge moraines to be especially arcuate and closely stacked.

Southeastern Ohio is unglaciated and devoid of ice-deposited sediment (glacial till). Many southeast Ohio valleys, however, carried

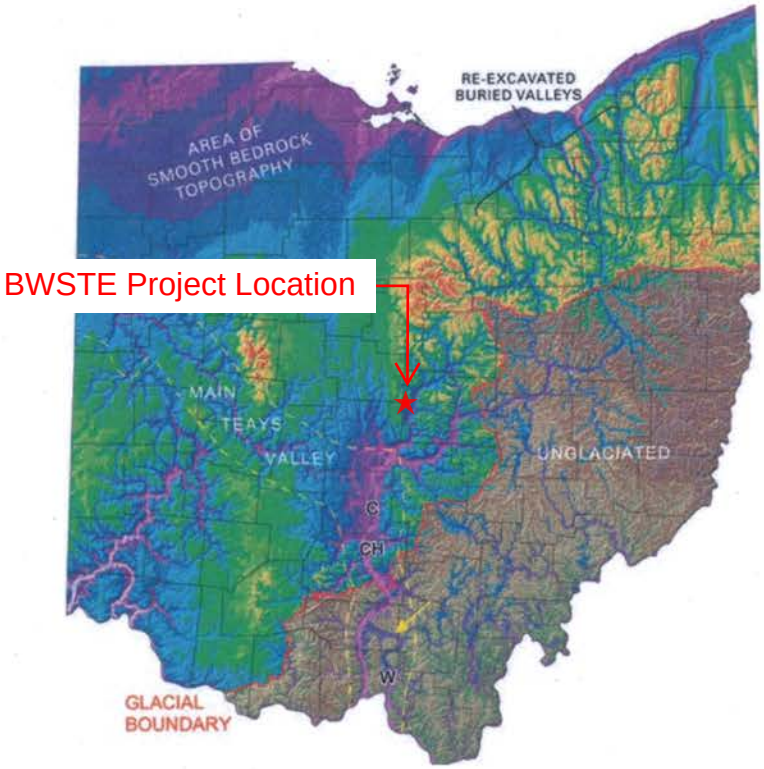


FIGURE 1.—Shaded bedrock-topography map of Ohio showing the sculpted bedrock surface that lies beneath glacial drift in northern and western Ohio and the land surface in unglaciated southeastern Ohio. Note the surface expression of the Teays Valley System south of the glacial boundary (arrow), the location of the main Teays Valley (between yellow dashed lines), the area of smooth bedrock topography, and the area of re-excavated preglacial bedrock valleys in northeastern Ohio. (**W** = Wheelersburg, **C** = Circleville, **CH** = Chillicothe) (modified from Ohio Division of Geological Survey, 2003).

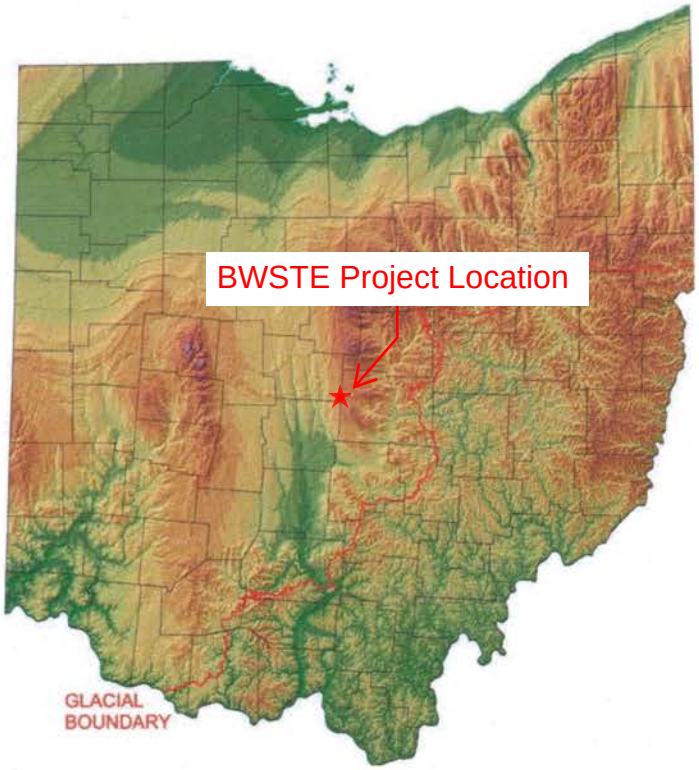


FIGURE 2.—Shaded elevation map of the land surface of Ohio with glacial boundary. Note the smooth landscape of glaciated northern and western Ohio compared to the high-relief landscape of unglaciated southeastern Ohio (modified from Powers, Laine, and Pavey, 2002).

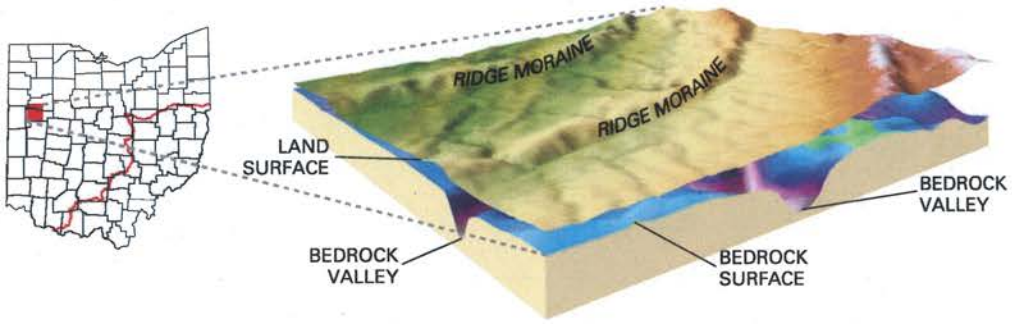


FIGURE 3.—Schematic cross section of glacial drift overlying the bedrock surface. Note areas where drift thickness is controlled by thickening of glacial sediment over a relatively flat bedrock surface, by drift infilling bedrock valleys, or by fluctuations in both the land surface and the bedrock surface. Also note areas where valleys in the buried-bedrock surface are not evident on the land surface (illustration by Donovan M. Powers).

huge volumes of glacial meltwater away from the ice front and toward the Ohio River. In the process, many of these valleys were at times made deeper by the erosive force of fast-flowing meltwater streams, and at other times were partially filled with sediment. Some valleys in unglaciated Ohio contain thick deposits of clay and silt that accumulated on the bottoms of lakes that formed when glacial ice blocked the flow of rivers or when rapidly accumulating meltwater sediments blocked the mouths of smaller tributaries.

METHODS

Two digital data layers are required to generate the drift-thickness map: the surface-elevation layer and the bedrock-topography layer. Drift thickness is calculated by subtracting the bedrock-topography elevation from the land surface elevation. The bedrock-topography component is one of the products resulting from a multi-year effort by the ODNR, Division of Geological Survey to map the bedrock geology of Ohio. Bedrock-topography maps are required to determine the relief on the bedrock surface beneath thick layers of glacial drift. Bedrock-topography maps were created by the Division of Geological Survey for all 788 7½-minute topographic quadrangles in the state as part of a process to produce accurate bedrock-geology maps for glaciated portions of Ohio and for those areas beyond the glacial boundary where valleys are infilled with sediment. Data concentration and contour intervals on the original, hand-drawn bedrock-topography maps vary widely across the state in response to changing geologic and topographic conditions. These data consist mainly of water-well logs on file at the ODNR, Division of Water, supplemented by outcrop data, Ohio Department of Transportation bridge-boring data, and oil-and-gas-well data. During the course of mapping, over 162,000 data points were interpreted for bedrock-surface elevation and in some cases drift thickness. These points were plotted on maps and used as control for the bedrock-topography lines. Individual 24,000-scale bedrock-topography maps are available from the Division's Geologic Records Center.

Elevation contours and data points from the 788 bedrock-topography maps were digitized and compiled for the glaciated portions of the state and for the valleys beyond the glacial boundary containing significant accumulations of sediment deposited during and after glaciation. The bedrock-topography contours were digitally converted in an ArcGIS environment to create a continuous grid model (60 meter grid spacing). A statewide compilation map and digital dataset of the bedrock topography of Ohio (modified from Ohio Division of Geological Survey, 2003) are available from the Division of Geological Survey.

Uncolored areas of southeastern Ohio represent extensive portions of unglaciated Ohio where the land surface and the bedrock surface are essentially the same. On the original maps in these areas, bedrock-topography lines were restricted to the buried-valley portions of the map and were not drawn in upland portions.

The second component needed to create the drift-thickness map, the land-surface topography, is based largely on data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing). These data have been modified extensively by the Ohio Division of Geological Survey to replace some anomalous errors that are inherent in portions of the National Elevation Dataset. A statewide compilation map and digital dataset of the shaded elevation of Ohio (modified from Powers, Laine, and Pavey, 2002) are available from the Division of Geological Survey.

A grid of the digitized bedrock-topography contours was subtracted from a grid of the land-surface Digital Elevation Model to derive a third grid (60 meter grid spacing) representing the thickness of the drift. This grid surface was shaded from the northwest, slightly above the horizon, to produce the appearance of a three-dimensional surface.

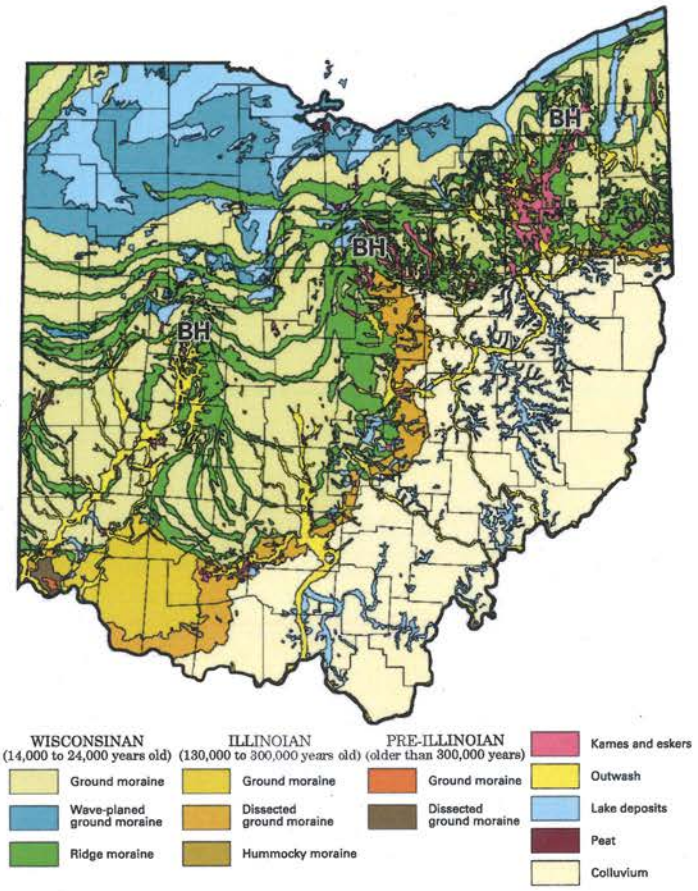


FIGURE 4.—Glacial map of Ohio showing the distribution of glacial sediments and their relative ages. Note glaciated northern and western Ohio, unglaciated southeastern Ohio, and the position of ridge moraines and the lake deposits and wave-planed ground moraine of the Lake Erie Basin. Bedrock highlands (**BH**) impeded the southward advance of glacial ice causing the moraines to form a lobate configuration (illustration by Lisa Van Doren; modified from Pavey and others, 1999).

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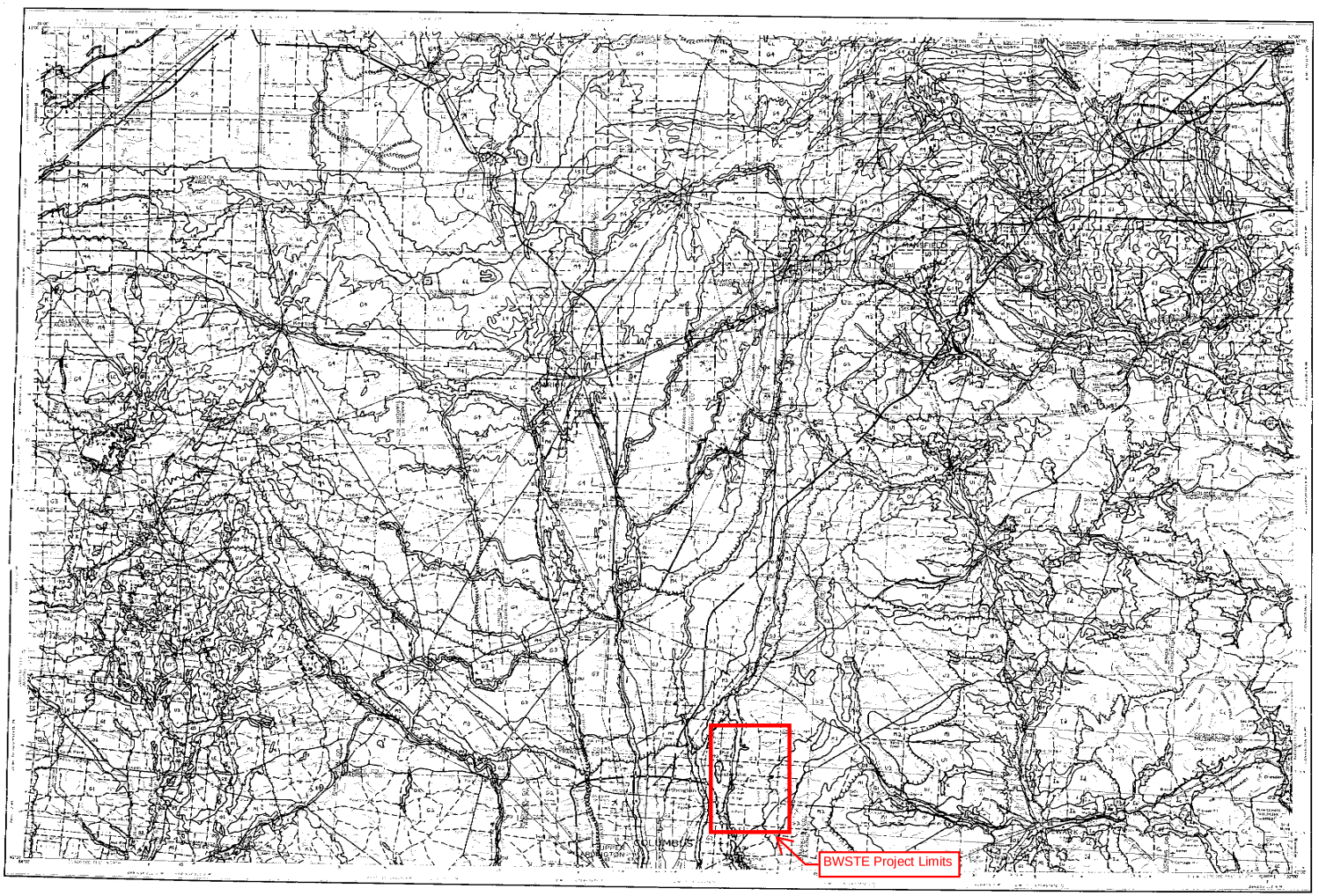
Powers, D. M., Laine, J. F., and Pavey, R. R., 2002 (revised 2003), Shaded elevation map of Ohio: Ohio Division of Geological Survey MG-1, scale 1:500,000.



QUATERNARY GEOLOGY OF OHIO
MARION QUADRANGLE
OPEN FILE MAP 295

FEB - 7 1994

Compiled by Richard P. Goldthwait and Richard R. Pavey.

1993.

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

Scale 1:250,000

QUADRANGLE LOCATION

COMPILATION RESPONSIBILITY:

1. Goldthwait; minor revisions by Pavey.
2. Pavey
3. Pavey; after White, 1982.

PRIMARY DATA SOURCES:

1. Goldthwait, Richard P., manuscript map (1:250,000) on file at the Ohio Geological Survey.
2. Hoare, Gallagher T., 1961, Pleistocene geology of Wyandot County, Ohio: Bowling Green State University, Master's thesis (unpub.), 91 p.
3. Fernandez, Rene L., manuscript map (1:62,500) on file at the Ohio Geological Survey.
4. Totten, Stanley M., manuscript maps (1:62,500) on file at the Ohio Geological Survey.
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6. Gehring, R. W., and Mochling, D. R., 1987, A general soil map of Marion County, Ohio: U.S. Soil Conservation Service, Ohio Division of Soil and Water Conservation, map, one sheet.
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10. Forsyth, Jane L., 1987, Glacial geology of the East Liberty Quadrangle, Ohio: Ohio Geological Survey Report of Investigations 68, map, one sheet with text.
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12. Fernandez, Rene L., 1987, Glacial geomorphology map (of the SSC Project area): Ohio Geological Survey Open File Map 282.
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16. Forsyth, Jane L., 1968, Glacial map of Licking County, Ohio: Ohio Geological Survey Report of Investigations 69, map, one sheet with text.
Powell, Kenneth L., Ohio's organic soils: manuscript maps with text on file at Ohio Division of Soil and Water Conservation. [Source for all peat areas.]

QUATERNARY GEOLOGY OF OHIO
MARION 1:250,000 SHEET

Since publication of the Glacial Map of Ohio (Goldthwait, White, and Forsyth, 1961; Glacial Map of Ohio: U.S. Geological Survey Misc. Geol. Inv. Map I-316; many workers have continued efforts to decipher the Quaternary history of Ohio and to map the deposits of Ohio. The purpose of this map series is to consolidate this information, providing a standardized geologic map in a uniform format for the entire state. Compilation of the western two-thirds of Ohio by the late Dr. Richard P. Goldthwait and Richard R. Pavey, 1993, which has been revised and compiled by staff of the Ohio Geological Survey.

The individual maps used to compile this series vary widely in date, scale, and detail. Many areas of complex geology have been simplified to fit the scale and map units of this series. Refer to the data sources listed below for available maps with more detail at a larger scale.

LEGEND

HOLOCENE (RECENT) - 10 ka* to present:

- W — Water.
- a — Alluvium and alluvial terraces, deposited in present and former floodplains; ranges from silty clay in areas of fine-grained deposits to coarse sand, gravel, or cobbles in areas of shallow bedrock.
- Peat, 0.4 m or more thick, with minor amounts of sand, silt, or clay; also contains organic muck or marl in some areas.

LATE WISCONSINAN - 25 to 13 ka; water-deposited units:

- B — Beach ridges, along shores of former glacial lakes; fine sand to coarse gravel and cobble deposits; includes small areas of dunes and nearshore sand.
- LS — Lacustrine sand, deposited in glacial lakes as shallow-water deltas or nearshore bars and spits; includes many small areas of dunes.
- LL — Lacustrine silt, deposited in low-velocity water of glacial and glacial-lake lakes; may contain fine sand or clay; well laminated in distal portions of deposits; commonly laminated with clay.
- LC — Lacustrine clay, deposited in calm water of glacial lakes; mostly laminated; covered in places with thin organic deposits.
- OL — Outwash, undifferentiated, deposited by meltwater in front of glacial ice; occurs as valley terraces or outwash plains; sand and gravel, well sorted and stratified.
- O1 — High-level outwash terraces (Fernard, Mount Vernon, Vanette levels); formed from 22 to 19 ka; sand and gravel with 10 cm to 1 m of silt or loess cover.
- O2 — Intermediate-level outwash terraces (Groove, Circleville, Ironton levels); formed from 18 to 17 ka; sand and gravel.
- O3 — Low-level valley train outwash (Hood River, Circle, Brinkhaven, Worthington levels); formed from 15 to 14 ka; sand and gravel; contains small areas of peat.
- Kames and kame terraces, deposited by meltwaters in contact with glacial ice; forms groups of hummocks or high valley-side terraces; sand and gravel, poorly sorted and bedded; contains some boulders and till masses.
- Eskers, linear ridges deposited in glacial ice tunnels; often in with kames; sand and gravel, poorly sorted and bedded, contains boulders and till masses.

LATE WISCONSINAN - Late Woodfordian ice deposits, 18ka to 14ka:

Clayey till (Ottawa, Lake Erie tills):

- G4 — Ground moraine, flat to gently undulating.
- L4 — Lake-planed moraine, very flat, planed by waves in glacial lakes; small patches of sand, silt, or clay on the surface in many areas.
- M4 — End moraine, occurs as hummocky ridges higher than adjacent terrain.
- U4 — Hummocky moraine, occurs as non-linear hummocky patches higher than surrounding terrain.

Silty clay till (Hayesville, Kerrysville tills):

- G3 — Ground moraine, flat to gently undulating.
- L3 — Lake-planed moraine, very flat, planed by waves in glacial lakes; small patches of sand, silt, or clay on the surface in many areas.
- M3 — End moraine, occurs as hummocky ridges higher than adjacent terrain.
- U3 — Hummocky moraine, occurs as non-linear hummocky patches higher than surrounding terrain.

Silty loam till (Derby, Bellefontaine, Centerburg tills):

- G2 — Ground moraine, flat to gently undulating.
- M2 — End moraine, occurs as hummocky ridges higher than adjacent terrain.
- U2 — Hummocky moraine, occurs as non-linear hummocky patches higher than surrounding terrain.

LATE WISCONSINAN: Early Woodfordian ice deposits, 24 to 18 ka:

Loam till with thin loess (<1 m) cover (Knox Lake, Mt. Liberty, Caesar, Pickaway Plains, Navarre tills):

- G1 — Ground moraine, flat to gently undulating.
- M1 — End moraine, occurs as hummocky ridges higher than adjacent terrain.
- U1 — Hummocky moraine, occurs as non-linear hummocky patches higher than surrounding terrain.

Thin loam till over sand and gravel:

- UK — Buried kames and eskers, hummocky.
- OK — Buried outwash, smooth to very gently undulating.
- b — Indicates high concentrations of surface boulders ("Boulder Belts") when added to map unit symbols (e.g., G2b, M2b, O1b, Ab).

ILLINOIAN:

Water-deposited units:

- Kames, in hummocks and hollows, ice contact sand and gravel, covered with 10 cm to 3 m loess.
- Outwash, in small benches and high terrace areas, uniform beds of sand and gravel, some coarse silts, 0.5 to 2 m loess cover.
- Lacustrine deposits, clays and silts, massive or laminated; loess or colluvial cover 0.25 to 0.5 m thick.

Silty loam till covered with 1 to 3 m of loess (Bainsboro, Butler, Millbrook tills):

- I2d — Dissected ground moraine, occurs on ridgetops and mixed with weathered bedrock as colluvium on slopes.
- I2 — Hummocky moraine, in non-continuous patches, plugs, or benches, mostly in valleys; mixed with bedrock colluvium on slopes.

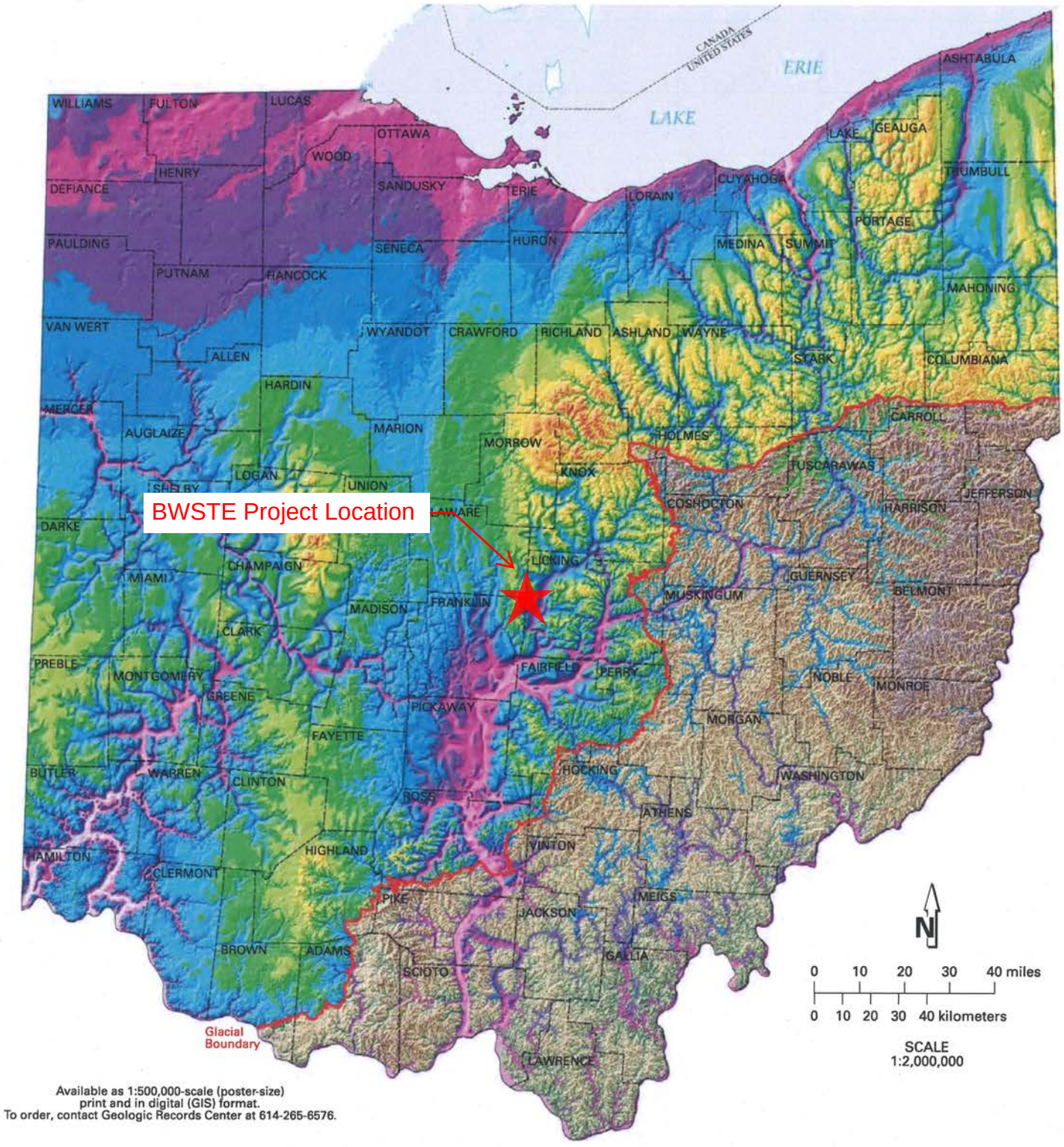
CENOZOIC: Holocene, Pleistocene, and pre-Pleistocene(?):

- Cc — Colluvium derived from local bedrock in unglaciated areas, includes scattered areas of residuum, weathered material, landslides, and bedrock outcrop.
- Former drainage channels, generally eroded by subice meltwaters or at the outlets of glacial lakes; may contain thin or patchy sandy to clayey deposits; arrows indicate direction of drainage.
- Significant glacial boundaries.

* ka = thousand years before present.

STATE OF OHIO • DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

SHADED BEDROCK-TOPOGRAPHY MAP OF OHIO



Available as 1:500,000-scale (poster-size) print and in digital (GIS) format.
To order, contact Geologic Records Center at 614-265-6576.

Bedrock-topography	Elevation	Land surface
	1401-1500	
	1301-1400	
	1201-1300	
	1101-1200	
	1001-1100	
	901-1000	
	801-900	
	701-800	
	601-700	
	501-600	
	401-500	
	301-400	

Elevation in feet above sea level

Recommended citation: Ohio Division of Geological Survey, 2003, Shaded bedrock-topography map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map BG-3, generalized page-size version with text, 2 p., scale 1:2,000,000.

SHADED BEDROCK-TOPOGRAPHY MAP OF OHIO

The shaded bedrock-topography map of Ohio depicts the configuration and elevation of the bedrock surface. In southeastern Ohio, the bedrock surface coincides with present-day land-surface topography and is depicted by earth-tone hues to represent elevation intervals. In glaciated western and northern Ohio, the bedrock surface is buried under mainly glacial sediments that can be several-hundred-feet thick. The land surface in this region was smoothed by glaciation (figure 1) and masks a complexly dissected, underlying bedrock surface. This dissected bedrock surface is the result of erosion before, during, and after glaciation. Spectral hues depict elevation intervals on the buried-bedrock surface and show the bedrock surface as if the overlying glacial sediment were removed.

Prior to and during glaciation, the north-flowing Teays River system dominated surface-water drainage patterns in western and southern Ohio (figure 2). Water flow direction in the main Teays valley was north from Wheelersburg (Scioto County) to Circleville (Pickaway County) and then northwest to Mercer County where the Teays Valley exited the state. Remnants of the Teays Valley are distinct on the present land surface in southern Ohio and form a continuous valley on the buried-bedrock surface across western Ohio. Modern rivers and streams still occupy portions of this valley system. Water flow in the Teays River system was disrupted by early glaciations as southward-advancing glaciers blocked outlets of the north-flowing river system. Drainageways, both large and small, were abandoned or filled with sediment as ice advanced and retreated.

In northwestern Ohio, the generally smooth buried-bedrock surface is the result of repeated scouring by glacial ice advancing westward out of the Lake Erie basin. Another distinctly scoured bedrock surface is in the Grand River Lobe (figure 2) in northeastern Ohio where smooth north-south trending valleys mirror ice-flow direction. South of the scour-dominated surface of northern Ohio, the bedrock surface has been sculpted by water to create a distinct drainage pattern (figure 2). Large volumes of glacial meltwater eroded the bedrock surface, widening and deepening existing valleys of the Teays system and creating new valleys. Some modern rivers and creeks flow in unusually wide valleys; evidence that far greater volumes of water generated from melting glaciers once flowed in these valleys. Flow direction in other valleys has been reversed as glacial ice or glacial sediments blocked formerly northward and westward flowing streams.

Southeastern Ohio is unglaciated and devoid of ice-deposited sediment (glacial till). However, many river valleys in southeast Ohio did carry glacial meltwater away from the ice front and toward the Ohio River. In the process, many of these valleys were at times made deeper by the erosive force of fast-flowing meltwater streams, and at other times partially filled with sediment. Some valleys in unglaciated Ohio contain thick deposits of clay and silt that accumulated on the bottoms of lakes that formed when glacial ice blocked the flow of rivers or when rapidly accumulating meltwater sediments blocked the mouths of rivers.

This map is one of the results of a 7-year effort by the ODNR, Division of Geological Survey to map the bedrock geology of Ohio. Bedrock-topography maps are essential to producing accurate bedrock-geology maps of glaciated Ohio and of partially buried valleys beyond the glacial limit. Bedrock-topography maps were created for all 788 7.5-minute topographic quadrangles in the state and are available from the Division's Geologic Records Center. Some pre-existing county bedrock-topography maps (1:62,500 scale) and data were photographically enlarged to 1:24,000 scale, revised, and utilized in the compilation of 1:24,000-scale, bedrock-topography maps. Data concentration and contour intervals on the original maps vary widely across the state in response to changing geologic and topographic conditions. Data consists mainly of water-well logs on file at the ODNR, Division of Water, supplemented by outcrop data, Ohio Department of Transportation bridge-boring data, and oil-and-gas-well data.

Elevation contours and over 158,000 data points from the 788 bedrock-topography maps were digitized and compiled for the glaciated portions of the state and for the major valleys beyond the glacial boundary containing significant accumulations of sediment deposited during and after glaciation. The bedrock-topography contours were digitally converted in the ARC GIS environment into a continuous grid model (60 meter grid spacing). This surface was shaded from the northwest slightly above the horizon to produce the appearance of a three-dimensional surface.

The land surface represents the topography of the bedrock surface in southeastern Ohio (excluding valleys beyond the glacial boundary) and in some glaciated areas near the glacial limit where meltwater sediments are thin or absent. Land-surface topography is based largely on data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing).

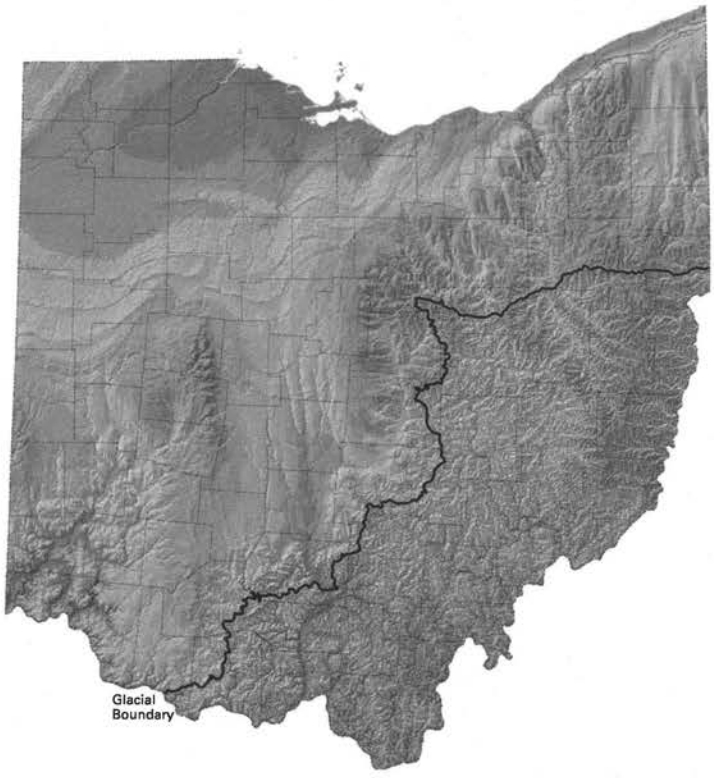


FIGURE 1.—Shaded elevation map of Ohio with the glacial boundary. Note the smooth landscape of glaciated northern and western Ohio compared to the high-relief landscape of unglaciated southeastern Ohio.

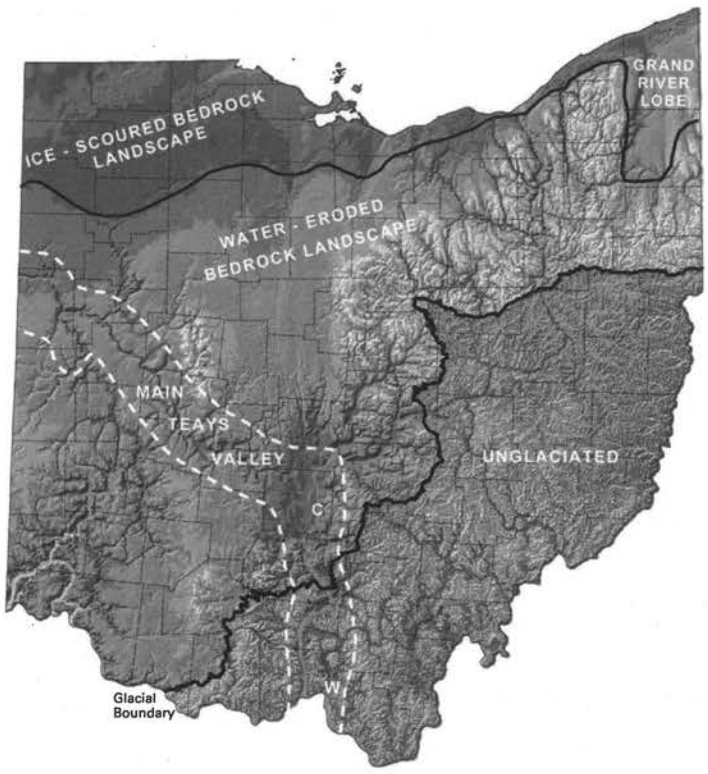
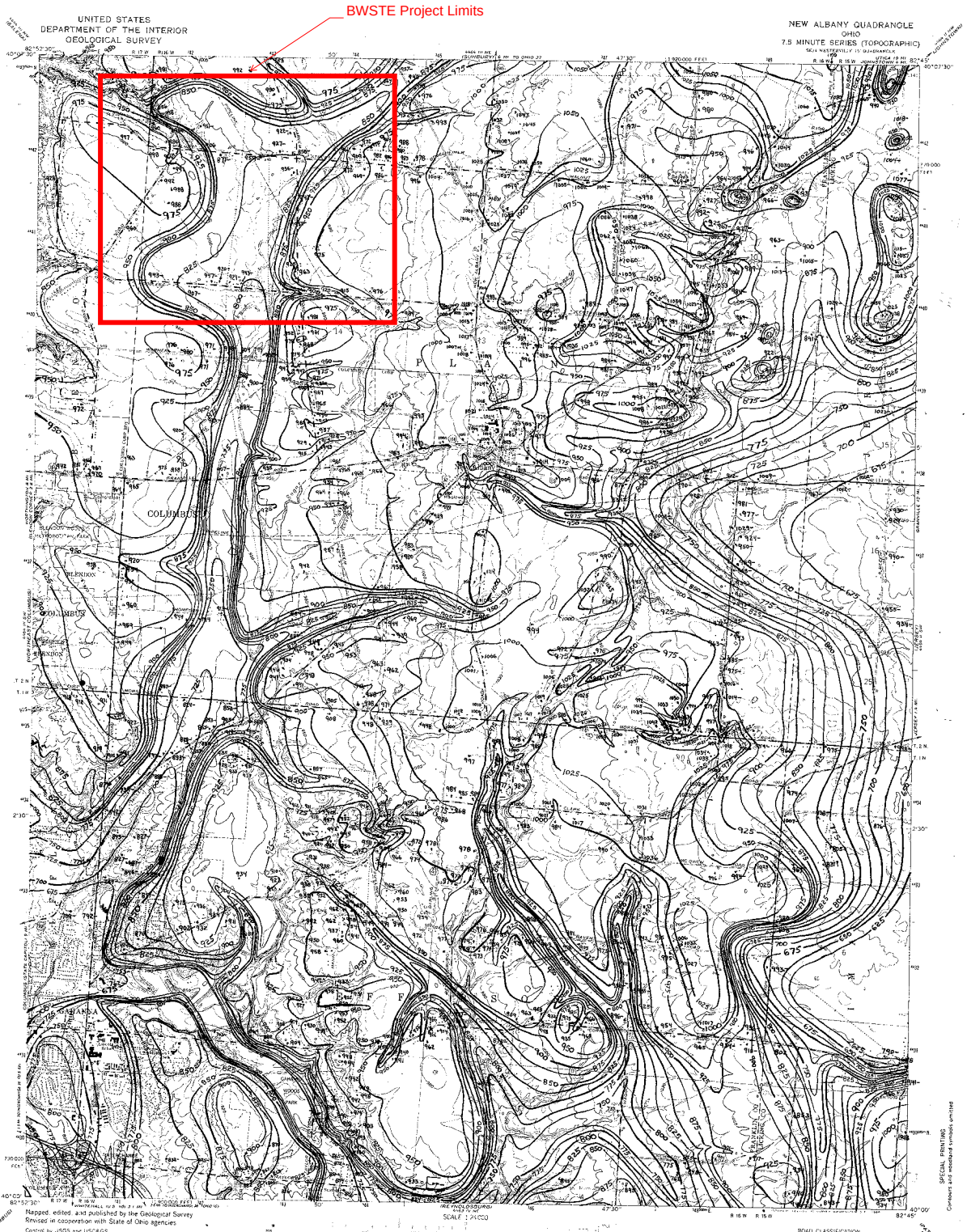


FIGURE 2.—Bedrock-topography map of Ohio showing the extent of the main Teays valley, the unglaciated portion of the state, and the ice-scoured and water-eroded portions of glaciated Ohio (C = Circleville, W = Wheelersburg).



Mapped, edited, and published by the Geological Survey
Revised in cooperation with State of Ohio agencies

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1953. Field checked 1955. Revised 1966

Polyconic projection. 1927 North American datum
10,000-foot grid based on Ohio coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 17, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

Entire area lies within the United States Military District
Land lines based on the Base Line of the United States Military District

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

Revisions shown in purple and woodland compiled in cooperation with State of Ohio agencies from aerial photographs taken 1966 and other sources. This information not field checked

SPECIAL PRINTING
Contours and woodland symbols omitted

EXPLANATION

Borehole data points:

•650 elevation of bedrock surface

•551- borehole bottom elevation NOT reaching bedrock

650

Contour on bedrock surface in feet above sea level

Contour interval 25 ft.

STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY

OPEN-FILE MAP: BT-C3A7

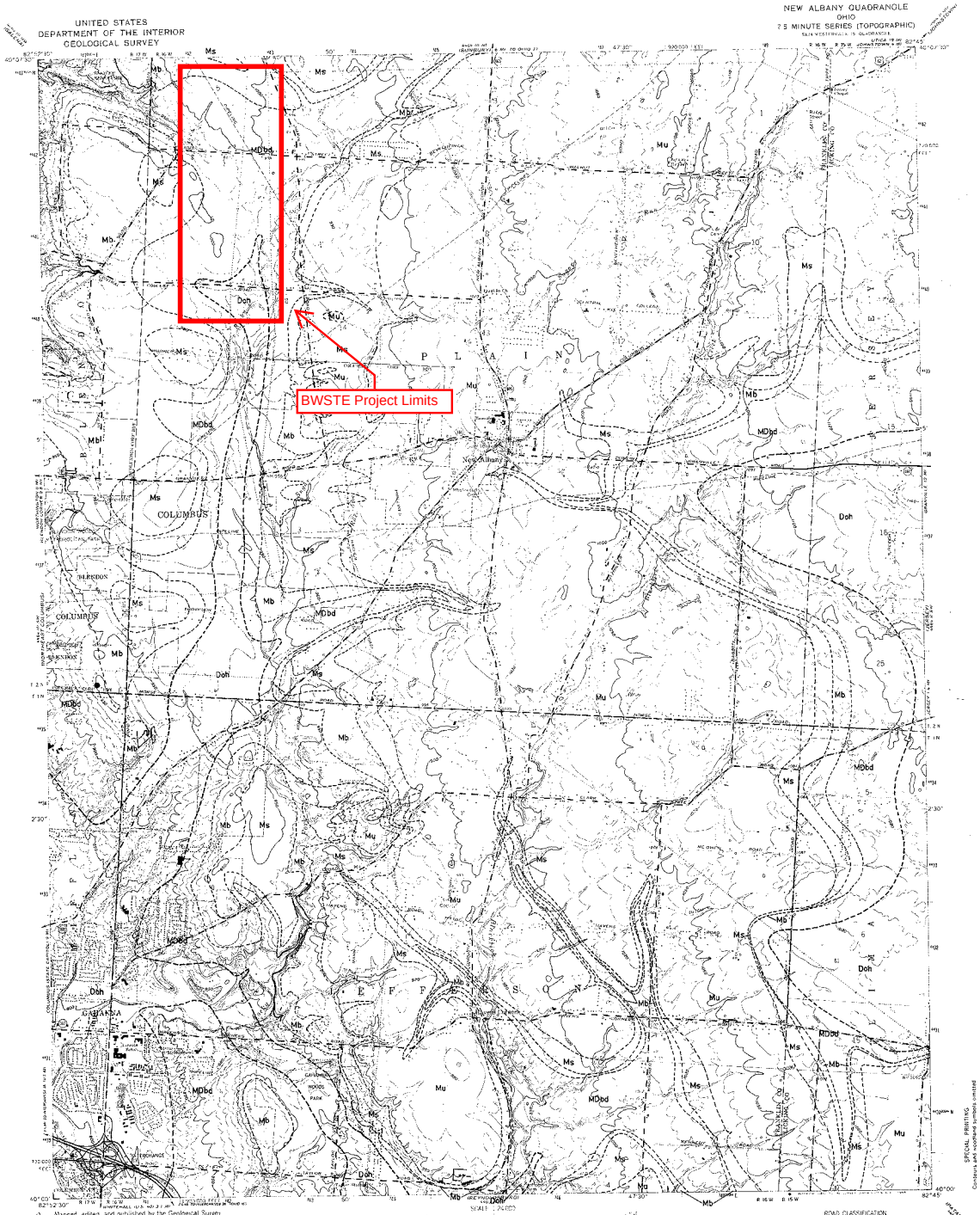
TITLE: BEDROCK TOPOGRAPHY MAP OF THE NEW ALBANY QUADRANGLE, OHIO

Date completed: 1994 Geology by: E. R. SLUCHER

Date Fieldwork conducted: ____ to ____

The information portrayed/contained hereon may be preliminary and subject to revision. The Ohio Geological Survey has technically reviewed this document but disclaims any responsibility or liability for interpretations or decisions based thereon.

Prepared in cooperation with the Department of the Interior
United States Geological Survey
Cooperative Geologic Mapping Program (COGEOMAP)



EXPLANATION

- Mu — Mississippian undivided
- Ms — Sunbury Shale
- Mb — Berea Sandstone. Shown by line where locally in absence of sequence unit
- MDbd — Bedford Shale
- Doh — Ohio Shale

MISSISSIPPIAN

DEVONIAN

Contact. Dashed where inferred. Triangles indicate selected localities where contacts were well exposed at time of mapping

Mapped, edited, and published by the Geological Survey
Revised in cooperation with State of Ohio agencies
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1953. Field checked 1955. Revised 1966
Polyconic projection. 1927 North American datum
10,000-foot grid based on Ohio coordinate system, south zone
1,000-meter Universal Transverse Mercator grid ticks, zone 17, shown in blue
Fine red dashed lines indicate selected fence and field lines where essentially visible on aerial photographs. This information is unchecked
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CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

Revisions shown in purple and woodland compiled in cooperation with State of Ohio agencies from aerial photographs taken 1980 and other sources. This information not field checked

ROAD CLASSIFICATION

Heavy duty — Light duty
Medium duty — Unimproved dirt
Interstate Route — U. S. Route — State Route

NEW ALBANY, OHIO
SE4 WESTERVILLE 15 QUADRANGLE
N4000—W8245/7.5
1966

MPBG

SPECIAL PRINTING
Contours and woodland symbols omitted

For additional information on the bedrock units shown on this map, please refer to Ohio Division of Geological Survey Open-File Report 98-1, *Descriptions of geologic map units: a compendium to accompany Division of Geological Survey open-file bedrock geology maps*. To obtain this document, please contact the Division of Geological Survey, Geologic Records Center at 614-265-6576 or by email at geo.survey@dnr.state.oh.us, or download the open-file report from the Survey's Web site.

STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY

OPEN-FILE MAP: BG-C3A7
TITLE: BEDROCK GEOLOGY MAP OF THE NEW ALBANY QUADRANGLE, OHIO

Date completed: 1995
Date Fieldwork conducted: 1993 to 1995
Geology by: ERNIE R. SLUCHER

The information portrayed/contained herein may be preliminary and subject to revision. The Ohio Geological Survey has technically reviewed this document but disclaims any responsibility or liability for interpretations or decisions based thereon.

Prepared in cooperation with the Department of the Interior
United States Geological Survey
Cooperative Geologic Mapping Program (COGEOMAP)

Appendix B SUBSURFACE LOGS

B.1 Phase 2 Soil and Bedrock Logs

B.2 Phase 1 Exploration Logs (Big Walnut Sanitary Trunk Extension Phase I)

B.1 PHASE 2 SOIL AND BEDROCK LOGS

Boring Log Terminology – Big Walnut Sewer Project
SOIL DESCRIPTION

1) Depth (in feet)

Depth (in feet) refers to the distance below the ground surface.
*For reporting purposes on the boring logs, depth and elevation of the various soil and rock strata are reported to the nearest one-tenth foot, even though the top of boring elevation is surveyed and reported to the nearest one-hundredth. This practice represents standard geotechnical engineering industry reporting practice.

2) Elevation (in feet)

Elevation (in feet) is referenced to mean sea level, unless otherwise noted.

3) Standard Penetration (N)

Standard Penetration (N) is the number of blows required to drive 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.

50/n indicates the number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other that the normal 6-inch increment.

N_{60} indicates Standard Penetration resistance normalized to 60% drill rod energy ratio.

WH indicates Standard Penetration resistance of the Weight of Hammer in the soil strata.

4) Length of Sample Drive

The length of the sampler drive is indicated graphically in horizontal lines across the “Standard Penetration” and “Recovery” columns.

5) Sample Recovery

The sample recovery from each drive is indicated numerically in the column headed “Recovery.”

6) Drive Sample Location

The drive sample location is designated by the heavy vertical bar in the “Sample No., Drive” column.

7) Pressed “Undisturbed” Sample Length

The length of the hydraulically pressed “Undisturbed” sample (i.e., Shelby Tube) is indicated graphically by horizontal lines across the “Press” column.

8) Sample Numbers

Sample numbers are designated consecutively, increasing in depth.

9) Soil Description

a. Terminology

The following terms are used to describe the relative compactness and consistency of soils:

Granular Soils – Compactness

Term	Blows/Foot Standard Penetration
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	over 50

Cohesive Soils – Consistency

Term	Unconfined Compression tons/sq. ft.	Blows/Foot Standard Penetration	Hand Manipulation
Very Soft	less than 0.25	below 2	Easily penetrates 2" by fist
Soft	0.25 – 0.5	2 – 4	Easily penetrates 2" by thumb
Medium Stiff	0.50 – 1.0	5 – 8	Penetrates by thumb with moderate effort
Stiff	1.0 – 2.0	9 – 15	Readily indents by Thumb, but not Penetrates
Very Stiff	2.0 – 4.0	16 – 30	Readily indents by Thumbnail
Hard	over 4.0	over 30	Indent with difficulty by thumbnail

b. Color

If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled."

c. Texture

Texture is based on the Unified Classification System. Soil particle size definitions are as follows:

Description	Size
Boulders	Larger than 8"
Cobbles	8' to 3'
Gravel – Coarse	3" to ¾"
Gravel – Fine	¾" to 4.76 mm
– Coarse	4.76 mm to 2.00 mm

– Medium	2.00 mm to 0.42 mm
– Fine	0.42 mm to 0.074 mm
Silt	0.074 mm to 0.005 mm
Clay	Smaller than 0.005 mm

d. Soil Components

The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.

e. Modifiers

Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes as follows:

Term	Modifier
Trace	0% to 10%
Little	10% to 20%
Some	20% to 35%
"And"	35% to 50%

f. Moisture Content of Cohesive Soils

The moisture content of cohesive soils (silts and clays) is expressed relative to plastic properties as follows:

Term	Relative Moisture or Appearance
Dry	Powdery
Damp	Moisture content slightly below plastic limit
Moist	Moisture content above plastic limit, but below liquid limit
Wet	Moisture content above liquid limit

g. Moisture Content of Cohesionless Soils

The moisture content of cohesionless soils (sands and gravels) is described as follows:

Term	Relative Moisture or Appearance
Dry	No moisture present
Damp	Internal moisture, but none to little surface moisture
Moist	Free water on surface

Big Walnut Sewer Trunk Extension (BWSTE) – Phase 2		Project No. 173409058
Location:	Drill Rig:	**Borehole Log Key**
Coordinates:	Driller:	
Surface Elevation:	Logged By:	
Bottom Elevation:	Prepared By:	
Total Depth:	Checked By:	Date Start: End:
Orientation:	Core Size:	Groundwater Data:

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures per ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
1	2	3	4	5	6	7	8	9

Column Descriptions

1 **Elevation (ft) –** Elevation referenced to MSL.

2 **Depth (ft) –** Distance below the collar of the borehole.

3 **RQD (%) – (**Rock Quality Designation), Amount of intact core (pieces of sound rock greater than 4 inches in length) in each coring interval; calculated as the sum of lengths of intact core divided by length of core run. RQD of moderately weathered/altered rock does not meet soundness requirements, but provides some indication of rock quality with respect to degree of fracturing.

4 **Recovery (%) –** Amount of core recovered from the coring interval; calculated as length of core recovered divided by length of run.

5 **Fractures per ft –** number of discontinuities encountered in a run divided by the length of the run

6 **Discontinuity Description –** Joint Description in this order: depth, angle, type of discontinuity, roughness, aperture, large scale roughness, infilling, other.

7 **Run Number –** A column meant to differentiate between the individual core intervals.

8 **Geologic Description –** Description in this order: Depth Interval, ROCK NAME: Lithology; color, texture, grain size, structure and fabric, mineralogy, sorting, sphericity, roundness, cementation, other. Physical Condition; weathering, strength, discontinuities (general), bedding, shear zones, shears, faults, special conditions.

9 **Comments –** Comments or observations regarding: drilling operations, run lengths, water pressure test results, UCS test results, circulation losses or other pertinent information.

KEY TO DESCRIPTIVE TERMS USED FOR DISCONTINUITIES

A DEPTH OF DISCONTINUITY, MEASURED FROM TOP OF THE HOLE

B DIP OF DISCONTINUITY, MEASURED RELATIVE TO PLANE NORMAL TO THE CORE AXIS

C TYPE OF DISCONTINUITY - Bedding, Joint, Fault, Shear

D DISCONTINUITY ROUGHNESS (SMALL SCALE)

R1	Stepped
R2	Rough
R3	Moderately Rough
R4	Slightly Rough
R5	Smooth
R6	Polished

E DISCONTINUITY APERTURE (INCHES) (ISRM, 1982):

Vt – VERY TIGHT, (LESS THAN 0.004)
t – TIGHT, (0.004-0.01)
PtO – PARTLY OPEN, (0.01-0.02)
O – OPEN, (0.02-0.1)
MW – MODERATELY WIDE, (0.1-0.4)
W – WIDE, (GREATER THAN 0.4)
VW – VERY WIDE

F DISCONTINUITY ROUGHNESS (LARGE SCALE)

Und	Undulating
Pl	Planar
W	Wavy

G DISCONTUNUITY INFILLING

Cl	Clay
Ca	Calcite
Chl	Chloride
Fe	Iron Oxide
Qz	Quartz

SUBSURFACE LOG

Project Number	173409058	Location	N=770410.97, E=1871174.26
Project Name	BWSTE Phase 2	Boring No.	**B-1** Total Depth 184.3 ft
County	Franklin County, OH	Surface Elevation	988.1 ft
Project Type	Geotechnical Exploration	Date Started	7/27/15 Completed 8/3/15
Supervisor	J. Musselman Driller Rii	Depth to Water	Dry Date/Time 8/3/15
Logged By	J. Berk	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
988.1	0.0	Top of Hole							
		Dark Gray, CLAY, Hard to Very Hard, Some Fine Gravel, Moist							Surface casing set to 10 ft Water wash rotary used through overburden, NQ coring used in bedrock

Project Number	173409058	Location	N=770410.97, E=1871174.26
Project Name	BWSTE Phase 2	Boring No.	**B-1**
		Total Depth	184.3 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Dark Gray, CLAY, Hard to Very Hard, Some Fine Gravel, Moist *(Continued)*							

Project Number	173409058	Location	N=770410.97, E=1871174.26
Project Name	BWSTE Phase 2	Boring No.	**B-1**
		Total Depth	184.3 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Dark Gray, CLAY, Hard to Very Hard, Some Fine Gravel, Moist *(Continued)*							

SUBSURFACE LOG

Project Number 173409058 | Location N=770410.97, E=1871174.26

Project Name BWSTE Phase 2 | Boring No. **B-1** | Total Depth 184.3 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Dark Gray, CLAY, Hard to Very Hard, Some Fine Gravel, Moist *(Continued)*							No recordable gas levels identified @ 135ft
853.1	135.0								Began Core
		SHALE - Soft, Highly Weathered, Laminated, Significant Mechanical Fractures, Greenish-Gray		0	1.5	1.5	100	136.5	14 min run
				17	1.4	1.4	100	137.9	15 min run
		136.5ft to 137.9ft - clay filled fractures along bedding planes							15 min run
		Subvertical to vertical fractures		90	2.9	2.6	90	140.8	
845.1	143.0								
		SHALE - Soft to Moderately Hard , Laminated, Greenish-Gray							30 min run
		149ft to 157ft - clay-filled bedding planes, approx. 0.05 ft spacing, highly weathered		23	10.0	10.0	100	150.8	

Project Number 173409058 Location N=770410.97, E=1871174.26

Project Name BWSTE Phase 2 Boring No. **B-1** Total Depth 184.3 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SHALE - Soft to Moderately Hard , Laminated, Greenish-Gray *(Continued)*							35 min run
831.1	157.0	SHALE - Hard, Laminated, Clay Filled Bedding Planes (0.05 to 0.4 ft spacing), Dark Gray		24	10.0	10.0	100	160.8	
		Becoming very hard. Subvertical fracture (1.5 ft length). Vertical fracture (0.3 ft length).		48	9.3	10.0	108	170.8	
		172ft to 175.6ft - iron pyrite nodules. Clay filled bedding plane.		31	10.0	10.0	100	180.8	30 min run
803.8	184.3			100	2.8	2.5	89	184.3	25 min run
803.1	185.0	Bottom of Hole							

Top of Rock = 135.0 Elevation (853.1)

No sampling of overburden soils, description is based on visual observations of auger cuttings.

Boring backfilled with cement-bentonite grout.

No groundwater encountered prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=770475.83, E=1870428.28
Project Name	BWSTE Phase 2	Boring No.	**B-7**
County	Franklin County, OH	Surface Elevation	981.3 ft
Project Type	Geotechnical Exploration	Date Started	9/2/15
Supervisor	J. Musselman	Driller	Rii
Logged By	J. Berk		

Total Depth	180.5 ft
Completed	9/8/15
Depth to Water	1.0 ft
Date/Time	9/3/15
Depth to Water	N/A
Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
981.3	0.0	Top of Hole							
		Overburden soil (No Sampling)							

Project Number 173409058 | Location N=770475.83, E=1870428.28

Project Name BWSTE Phase 2 | Boring No. **B-7** | Total Depth 180.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Overburden soil (No Sampling) *(Continued)*							
		Increased drilling resistance							
937.3	44.0								
		Gray silty fine SAND, some fine to medium gravel, dense		SPT-1	44.0 - 45.5	1.3	18-23-36	--	
934.3	47.0								
		Gray, well graded SAND and GRAVEL, dense		SPT-2	49.0 - 50.5	1.4	24-39-29	--	
931.1	50.2								
		Gray silty CLAY with some fine gravel, stiff		SPT-3	54.0 - 55.5	1.4	11-24-42	--	
922.8	58.5								
		Gray SILT, SAND and GRAVEL, dense		SPT-4	58.0 - 59.5	1.2	21-35-48	--	
				SPT-5	64.0 - 65.5	1.3	37-47-50	--	
				SPT-6	69.0 - 70.5	1.5	21-21-23	--	
909.3	72.0								
		Gray SILT and very fine SAND							

Project Number 173409058 | Location N=770475.83, E=1870428.28

Project Name BWSTE Phase 2 | Boring No. **B-7** | Total Depth 180.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Gray SILT and very fine SAND *(Continued)*		SPT-7	74.0 - 75.5	0.7	6-13-20	--	
				SPT-8	79.0 - 80.5	1.4	12-21-29	--	
899.3	82.0								
		Gray, well graded SAND, some gravel, very dense		SPT-9	84.0 - 85.5	1.5	20-30-40	--	
		Increased gravel		SPT-10	89.0 - 90.5	1.3	49-49-50/4"	--	
				SPT-11	94.0 - 95.5	1.5	30-47-50	--	
884.3	97.0								
		Gray CLAY with Gravel, very hard		SPT-12	99.0 - 100.5	1.3	7-30-50/4"	--	
				SPT-13	104.0 - 105.5	0.6	27-37-50/5"	--	
				SPT-14	109.0 - 110.5	0.8	15-37-50/0"	--	

Project Number 173409058 | Location N=770475.83, E=1870428.28

Project Name BWSTE Phase 2 | Boring No. **B-7** | Total Depth 180.5 ft

Lithology		Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
Elevation	Depth								
		Gray CLAY with Gravel, very hard *(Continued)*		SPT-15	114.0 - 115.5	0.0	50/4"	--	
				SPT-16	119.0 - 120.5	0.3	13-50/2"	--	
				SPT-17	124.0 - 125.5	1.3	9-10-17	--	
				SPT-18	129.0 - 130.5	0.1	50/3"	--	
847.8	133.5								Began Core
		Possible very hard glacial till - Washed out		0	2.0	0.0	0	135.5	
841.3	140.0								
		SHALE - Soft, Weathered to Highly Weathered, Thinly Bedded, Intensely fractured, Dark Gray to Black - Jointing fractures are flat to steeply dipping		0	10.0	2.5	25	145.5	WP: 100psi; DP: 400psi
		Clay filled fracture, smooth, weathered 147.5ft to 151.5ft - intensely fractured, smooth to rough, clay infilling							WP: 100psi; DP: 400psi
		Shale becomes hard							0_2 = 20.8%

Project Number 173409058 Location N=770475.83, E=1870428.28

Project Name BWSTE Phase 2 Boring No. **B-7** Total Depth 180.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft, Weathered to Highly Weathered, Thinly Bedded, Intensely fractured, Dark Gray to Black - Jointing fractures are flat to steeply dipping *(Continued)* Fracture, rough, slightly weathered Fracture, smooth, slightly weathered Iron pyrite nodule		75	10.0	10.0	100	155.5	
				100	10.0	10.0	100	165.5	
		2-in clay filled dipping fracture							
		2.5-in steeply dipping rough fracture, slightly weathered		92	10.0	10.0	100	175.5	0_2 = 20.8%
		2-in clay and fractured shale filled fracture							WP: 100psi; DP: 400psi
800.8	180.5			96	5.0	5.0	100	180.5	

Bottom of Hole

Top of Rock = 140.0
Elevation (841.3)

Boring backfilled with cement-bentonite grout.

No recordable gas levels during coring.

Groundwater initially measured at 1-foot above groundsurface within augers at a drilling depth of 57 feet. Groundwater measured at groundsurface prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=771119.66, E=1871286.62
Project Name	BWSTE Phase 2	Boring No.	**B-8** Total Depth 200.0 ft
County	Franklin County, OH	Surface Elevation	1001.9 ft
Project Type	Geotechnical Exploration	Date Started	9/9/15 Completed 9/15/15
Supervisor	J. Musselman Driller Rii	Depth to Water	7.0 ft Date/Time 9/11/15
Logged By	J. Berk	Depth to Water	25.0 ft Date/Time 9/15/15

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
1001.9	0.0	Top of Hole							
		Overburden soil (No Sampling)							10 ft casing installed
987.4	14.5			SPT-1	14.6 - 15.0	0.1	50/4"	--	Began Core
985.4	16.5	SHALE - Hard, Weathered, Thin bedded, Black - Vuggy Sandstone at bottom of layer 1.5-in clay filled fractured							
		SANDSTONE - Very Hard, Fine Grained, Thin Bedded, Medium Gray 20ft - 25 ft: Iron pyrite nodules Horizontal fracture, weathered, rust stained @ 24ft: Steeply dipping fracture; from 24ft to 25ft - cross bedded		84	9.0	8.2	91	24.0	
		26ft to 29ft - steeply dipping rough fractures, altered rock, iron and manganese staining		88	5.0	5.0	100	29.0	
		Clay filled horizontal fracture		100	6.0	6.0	100	35.0	

Project Number 173409058 Location N=771119.66, E=1871286.62

Project Name BWSTE Phase 2 Boring No. **B-8** Total Depth 200.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDSTONE - Very Hard, Fine Grained, Thin Bedded, Medium Gray *(Continued)* Horizontal clay filled fracture Clay filled fracture 3-in vertical fracture 1-in clay filled horizontal fracture 1-in clay filled horizontal fracture		58	10.0	10.0	100	45.0	6-in vertical fracture
		6-in vertical fractured, unweathered 4-in steeply dipping fracture							Clay filled horizontal fracture WP: 40psi; DP: 400psi
		52ft to 54ft - many clay filled horizontal fractures		77	10.0	10.0	100	55.0	
		Wavy horizontal fracture, shaley Shale layers 1ft vertical fracture							
941.9	60.0	58.5ft to 65ft - many horizontal clay filled fractures							WP: 120psi; DP: 450psi
		Interbedded Shale and Sandstone - thin bedded		30	10.0	9.1	91	65.0	
		Due to core retainer failure, 65ft to 80ft we was only able to retrieve 4.8 feet of broken core							WP: 200-500psi; DP: 350psi

Project Number 173409058 | Location N=771119.66, E=1871286.62

Project Name BWSTE Phase 2 | Boring No. **B-8** | Total Depth 200.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Interbedded Shale and Sandstone - thin bedded *(Continued)*							
921.9	80.0			11	15.0	4.8	32	80.0	
		Sloping fracture		44	5.0	5.0	100	85.0	
		SHALE - Moderately Hard, Thin Bedded, Gray Becomes less hard with friable zones and clay filled fractures Rough clay filled fracture							WP: 75psi; DP: 350psi 0_2 = 20.8%
906.9	95.0	Fractured shale and clay filled seams		60	10.0	10.0	100	95.0	
		SHALE - Soft to Moderately Hard, Thin Bedded, Dark Gray Banded Clay filled horizontal fracture 102ft - 112ft - clay filled slightly weathered fractures		94	10.0	10.0	100	105.0	
		Horizontal clay filled fracture, soft Rock less subject to mechanical fracturing							

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Project Number 173409058 | Location N=771119.66, E=1871286.62

Project Name BWSTE Phase 2 | Boring No. **B-8** | Total Depth 200.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft to Moderately Hard, Thin Bedded, Dark Gray Banded *(Continued)*		96	10.0	9.6	96	115.0	
		119ft to 122ft - red banding							WP: 100-150psi; DP: 350-400psi
		Clay filled fracture							
876.9	125.0	Clay filled fracture		98	10.0	10.0	100	125.0	
		SHALE - Soft to Moderatley Hard, Laminated, Grayish Red to Dark Red Clay filled fracture Steeply dipping very rough fracture		95	10.0	10.0	100	135.0	
		Steeply dipping smooth fracture		100	10.0	10.0	100	145.0	WP: 190psi; DP: 400psi

Project Number 173409058 | Location N=771119.66, E=1871286.62

Project Name BWSTE Phase 2 | Boring No. **B-8** | Total Depth 200.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SHALE - Soft to Moderatley Hard, Laminated, Grayish Red to Dark Red *(Continued)* 153ft to 155ft - horizontal fracturing along bedding planes, clay filled		95	10.0	10.0	100	155.0	
				100	10.0	10.0	100	165.0	WP: 200psi; DP: 500psi 0_2 = 20.8%
		Grading to gray in color, increased hardness Clay filled fracture, slightly weathered Steeply dipping fracture, weathered Horizontal fractures, weathered		94	10.0	10.0	100	175.0	
824.9	177.0								
		SHALE - Hard, Unweathered, Thin Bedded, Black		100	5.0	5.0	100	180.0	
				96	5.0	4.8	96	185.0	WP: 170psi; DP: 400psi

Project Number 173409058 Location N=771119.66, E=1871286.62

Project Name BWSTE Phase 2 Boring No. **B-8** Total Depth 200.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Hard, Unweathered, Thin Bedded, Black *(Continued)*		100	10.0	10.0	100	195.0	
		193ft to 194ft - pyrite inclusions Last 0.5ft of core not retrieved Pyrite inclusion							WP: 190psi; DP: 500psi
801.9	200.0			90	5.0	4.5	90	200.0	

Bottom of Hole

Top of Rock = 15.0
Elevation (986.9)

Boring backfilled with cement-bentonite grout.

No recordable gas levels during coring.

Groundwater initially encountered at a depth 7 ft.

SUBSURFACE LOG

Project Number	173409058	Location	N=771353.5, E=1870200.9
Project Name	BWSTE Phase 2	Boring No.	**B-9** Total Depth 196.5 ft
County	Franklin County, OH	Surface Elevation	990.1 ft
Project Type	Geotechnical Exploration	Date Started	9/22/15 Completed 9/24/15
Supervisor	J. Musselman Driller Stantec	Depth to Water	Dry Date/Time 9/22/15
Logged By	E. Magoto	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
990.1	0.0	Top of Hole							
		Light brown Sandy Lean CLAY (No Sampling)							
		@23 ft - Some small gravel coming out of return water							

Project Number	173409058	Location	N=771353.5, E=1870200.9
Project Name	BWSTE Phase 2	Boring No.	**B-9**
		Total Depth	196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Light brown Sandy Lean CLAY (No Sampling) *(Continued)*							
		@52 ft - Difficult to auger, possible cobbles							

Project Number 173409058 | Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 | Boring No. **B-9** | Total Depth 196.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
935.8	54.3	Light brown Sandy Lean CLAY (No Sampling) *(Continued)*							
934.3	55.8	Light Gray, LEAN CLAY, Very Stiff to Hard, Damp		SPT-1	54.3 - 55.8	1.4	21-15-18	--	HP=4.0tsf
		@ 55.8ft: Highly weathered SHALE							
930.8	59.3	SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. From 60.5' - 61.3' Highly fractured		SPT-2	59.3 - 60.5	1.2	40-45-50/3"	--	Began Core
				50	1.0	1.0	100	61.5	5 min run; WP=300 psi, DP=400-450 psi
		@ 65.8ft - 65.9ft: Clay Seam		10	5.0	4.4	88	66.5	13 min run; WP=325 psi, DP=450 psi
		@ 68.5ft - 68.8ft: Clay Seam @ 70.1ft, 70.5ft & 71.9ft: Slickenslides		30	5.0	4.9	98	71.5	13 min run; WP=300-350 psi, DP=500 psi
		@ 73.2ft: Vertical Fracture		38	5.0	5.0	100	76.5	12 min run; WP=300-350 psi, DP=475 psi
		77.1ft to 78.7ft: Highly Fractured zone							
		80.5ft to 81.5ft: Highly							

Project Number 173409058 | Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 | Boring No. **B-9** | Total Depth 196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Fractured zone @ 80.4ft: Clay seam SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. *(Continued)*		25	10.0	10.0	100	86.5	34 min run; WP=350 psi, DP=550 psi
		@ 88ft: Slickenslides							
		@ 92.4ft to 94.0ft: Highly Fractured zone		16	10.0	10.0	100	96.5	41 min run; WP=250 psi, DP=500 psi
		@ 96.2ft: Clay Seam @ 96.6ft: Rough Joint		46	5.0	4.8	96	101.5	31 min run; WP=275 psi, DP=500 psi , 0_2 =21.2%
		102.1ft - 103.7ft: Highly Fractured Zone 103.2ft to 103.7ft: Clay seam within highly weathered zone @ 104.1ft: Smooth Joint							27 min run; WP=300 psi, DP=700 psi , COMB =5%, 0_2 =21.4%, H2S=1%

Project Number 173409058 | Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 | Boring No. **B-9** | Total Depth 196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
878.6	111.5	SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. *(Continued)* @ 109.0ft to 109.4ft: Vert. Fracture @ 111.0ft to 111.5ft: Rough Joints		66	10.0	10.0	100	111.5	
		SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Red. 111.6ft - 118.0ft: Joints with clay seams		48	10.0	10.0	100	121.5	43 min run; WP=250 psi, DP=550 psi, COMB = 0%, CO=0%, 0_2 =21.3% H_2S = 0%
		121.5ft to 122.7ft: Rough Joint and Highly Fractured Zone 122.8ft to 123.3ft: Vert. Fracture 125.7ft: Smooth Joint 129.7ft: Possible MF		16	10.0	10.0	100	131.5	41 min run; WP=225 psi, DP=550 psi , COMB = 0%, CO=0%, 0_2 =20.8% H_2S = 0%
853.6	136.5	131.2ft to 131.5ft: Vert. Fracture 131.6ft: Clay Seam Joint 132.6ft: Rough Joint 134.1ft: MF 136.3ft: Smooth Joint		80	5.0	5.0	100	136.5	16 min run; WP=250 psi, DP=675 psi , COMB = 0%, CO=0%, 0_2 =20.8%

Project Number 173409058 | Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 | Boring No. **B-9** | Total Depth 196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. *(Continued)* 137.1ft: Smooth Joint 137.4ft and 137.8ft: Clay Filled Joints 139.9ft: Clay Seam 140.2ft: Smooth Joint 141.5ft through 142.7ft: Rough Joints 141.5ft to 142.7ft: Highly Fractured 142.1ft: Clay Filled Joint 143.4ft: Smooth Joint 143.8ft: MF 145.4ft: Clay Filled Joint 147.0ft to 147.2ft: Rough Joint		38	5.0	4.7	94	141.5	H_2S = 0% 18 min run; WP=275 psi, DP=650 psi , COMB = 0%, CO=0%, 0_2 =20.8% H_2S = 0%
				68	10.0	10.0	100	151.5	81 min run; WP=225 psi, DP=500 psi , COMB = 0%, CO=0%, 0_2 =20.8% H_2S = 0%
		152.2ft and 152.5ft: Clay Filled Joints 152.8ft: Smooth Joint 153.7ft: Rough Joint 153.9ft to 154.2ft: Clay Seam 154.9ft to 155.7ft: Highly weathered zone 156.4ft: MF		65	10.0	10.0	100	161.5	61 min run; WP=200 psi, DP=400 psi , COMB = 0%, CO=0%, 0_2 =20.8% H_2S = 0%
		162.1ft: MF 163.0ft: MF 163.7ft: MF 164.3ft: MF							

Project Number 173409058 | Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 | Boring No. **B-9** | Total Depth 196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. *(Continued)*							37 min run; WP=175 psi, DP=500 psi , COMB = 0%, CO=0%, 0_2 =21.2% H_2S = 0%
		170.1ft: Rough Joint		97	10.0	10.0	100	171.5	
		174.5ft: Vertical Fracture							
		176.5ft to 176.7ft: Clay Seam 176.8ft to 177.3ft: Vertical Fracture							51 min run; WP=200 psi, DP=550 psi , COMB=1%, CO=0%, 0_2 =21.4%, H_2S = 0%
		180.0ft: MF		98	10.0	10.0	100	181.5	
		182.9ft: Smooth Joint 184.0ft: MF		100	5.0	5.0	100	186.5	16 min run; WP=225 psi, DP=500 psi , COMB=4%, 0_2 =21.4%
		192.3ft: Smooth Joint							27 min run; WP=180 psi, DP=400 psi , 0_2 =21%

Project Number 173409058 Location N=771353.5, E=1870200.9

Project Name BWSTE Phase 2 Boring No. **B-9** Total Depth 196.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
793.6	196.5	192.7ft: Smooth Joint SHALE -Soft, Moderately to Highly Weathered, Very Fine Grained, Thinly Bedded, Gray. *(Continued)*		100	10.0	10.0	100	196.5	MF @ 195.5ft

Bottom of Hole

Top of Rock = 59.3
Elevation (930.8)

No Sampling of overburden soils, description based on visual observations of auger cuttings.

Used 12 bags of portland cement (~94 lbs/bag) with approximately 108 gallons of water to backfill hole.

No groundwater observed prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=772094.7, E=1871551.2
Project Name	BWSTE Phase 2	Boring No.	**B-12** Total Depth 205.9 ft
County	Franklin County, OH	Surface Elevation	1002.0 ft
Project Type	Geotechnical Exploration	Date Started	10/1/15 Completed 10/5/15
Supervisor	J. Musselman Driller Stantec	Depth to Water	11.0 ft Date/Time 10/5/15
Logged By	E. Magoto	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
1002.0	0.0	Top of Hole							
		Overburden soil (No Sampling)							
985.8	16.2								Began Core
		SANDSTONE - Hard, Slightly Weathered, Medium Grained, Medium to Thick Bedding, Slightly Fractured, flat bedding,, slightly to moderatedly weathered joints with iron staining, slightly rough joints, Light Gray							15 min run; WP=300 psi, DP=500 psi; 0_2 = 20.8%

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Significant iron staining from 16.2' to 16.7'		46	4.8	4.5	94	21.0	
		16.2' to 21.5': Highly fractured SANDSTONE - Hard, Slightly Weathered, Medium Grained, Medium to Thick Bedding, Slightly Fractured, flat bedding,, slightly to moderatedly weathered joints with iron staining, slightly rough joints, Light Gray *(Continued)*		73	4.9	4.9	100	25.9	19 min run; WP=350 psi, DP=500 psi; 0_2 = 20.8% H_2S = 1%
		22.4': MF 23.3': Clay filled rough joint Vert. fracture at 25.2' to 25.9'							
		Rough Joints - 27.8', 29.7', 30.6' to 31', and 32.4' to 32.8'							12 min run; WP= 200 psi, DP=450 psi; 0_2 = 20.8%
		31.9': Clay filled joint							
		33.1': MF							
		34.5': Clay seam 34.7': Smooth Joint		76	10.0	10.0	100	35.9	
		36.1': MF							
		37.3': Rough Joint							26 min run; WP= 250 psi, DP= 450 psi; 0_2 = 20.8% H_2S = 1%
		Rough Joints with Clay filled joints from 38.0' to 38.4' Vert. fracture at 38.7' to 39.3'							
		41.7': Clay filled joint							

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDSTONE - Hard, Slightly Weathered, Medium Grained, Medium to Thick Bedding, Slightly Fractured, flat bedding,, slightly to moderatedly weathered joints with iron staining, slightly rough joints, Light Gray *(Continued)* Highly weathered zone at 42.3' to 42.9' 43.9': MF Highly fractured zones from 45.5' to 46.5' 46.1': Rough joint 47.7': MF Vert. fracture at 48.2' to 49.0' Clay filled joint at 49.3' and 50.3' Rough joints at 50.5' to 51.5' Vert. fracture at 51.9' to 53.2'		70	10.0	10.0	100	45.9	
				64	10.0	9.9	99	55.9	16 min run; WP= 300 psi, DP= 500 psi; 0_2 = 20.8%
		56.2': Clay filled joint 58': Rough joint Clay seam at 58.0' to 58.3' 59.5': Cross bedding							
941.5	60.5								26 min run; WP= 300 psi, DP=450 psi; 0_2 = 20.8% H_2S = 1%
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, slightly to moderately weathered joints, slightly rough joints, Gray Rough Joint at 61.7' to 61.9'							

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
936.1	65.9	62.4': Weathered joint 62.8': Clay filled joint		48	10.0	10.0	100	65.9	
		Interbedded SHALE (85%) and SANDSTONE (15%) Deep bedding grooves throughout all shale 66.7': Rough joint 67.7': Smooth joint Highly weathered zone at 68.4' to 70.4' Vert. Fracture from 70.4' to 70.8'							13 min run; WP= 200 psi, DP= 500 psi; 0_2 = 20.8% H_2S = 1%
926.1	75.9			55	10.0	10.0	100	75.9	
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray Clay seam at 75.9' and 77.0' Sandstone from 77.0' to 77.3' Cross bedding at 80.1' to 82.3' Highly weathered zone at 82.5' to 83.5' Sandstone from 83.5' to 83.9' Rough joints from 83.9' to 84.4'							Rough joint at 77.3ft to 77.5ft 49 min run; WP= 250 psi, DP= 500 psi; 0_2 = 20.8%
		85.4': Smooth joints		36	10.0	10.0	100	85.9	
		86.3': Smooth joint							

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)*							23 min run; WP= 250 psi, DP= 475 psi; 0_2 = 20.6%
		Clay filled joint at 87.4' and 89.3'							
		90.6': MF							
		Sandstone from 92.2' to 92.4'							Smooth Joint at 91.2ft
		94.1': Clay filled joint							
		Slightly weathered zone from 94.9' to 95.9'		46	10.0	10.0	100	95.9	
		Multiple joints from 96.2' to 97.3'							
		Highly fractured zone at 98.6' to 99.0'							30 min run; WP=275 psi, DP= 500 psi; 0_2 = 20.8%
		Rough joint at 101.4' to 101.7'							
		102.6': MF							
		104.4': Rough joint							
		105.2': Clay filled joint		37	10.0	10.0	100	105.9	
		106.2': Smooth Joint							
		Moderately Fractured zone from 105.9' to 107.3							

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)* 111.1': Clay Filled Joint							19 min run; WP= 250 psi, DP= 475 psi; 0_2 = 20.8% H_2S = 1%
		Highly Fractured zone at 115.4' to 115.9' 115.7': Rough Joint 117.0': Rough Joint Highly Fractured zone from 117.0' to 117.5' 118.3': Smooth Joint		21	10.0	10.0	100	115.9	
		Red colored shale from 119.3' to 119.5' 119.4': 45 deg fracture Vert. Fracture at 120.0' to 120.3' Highly fractured zone from 120.3' to 120.9' 123.2': MF							27 min run; WP=250 psi, DP= 475 psi; 0_2 = 20.8%
876.1	125.9			34	10.0	10.0	100	125.9	
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately Fractured, flat bedding, bedding joints slightly to moderately weathered joints, smooth to slightly rough joints, Red 126.2': Smooth Joint Highly Fractured zone from 126.8' to 128.4' Highly Fractured and weathered zone (gray shale) from 128.7' to 130.7'							35 min run; WP= 250 psi, DP= 475 psi; 0_2 = 20.8%

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology		Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
Elevation	Depth								
		SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately Fractured, flat bedding, bedding joints slightly to moderately weathered joints, smooth to slightly rough joints, Red *(Continued)*		42	10.0	10.0	100	135.9	
		132.2': Clay Filled Joint 134.6': MF Vert. Fracture at 134.7' to 134.9' 136.4': Smooth Joint 136.6': Clay filled joint 137.8': MF Highly fractured zone at 138.5' to 139.0'							28 min run; WP= 275 psi, DP= 500 psi; 0_2 = 20.7%
				32	5.0	5.0	100	140.9	
		140.6': Clay Filled Joint MF at 141.3', 141.6', and 141.9' 141.9': 45 deg fracture Highly fractured zone from 142.5' to 143.2'							
		145.2': Smooth Joint 145.7': MF							20 min run; WP= 350 psi, DP= 475 psi; 0_2 = 20.8%
		Highly fractured and weathered at 147.1' to 148.7' 148.8': Rough joint 150.0': Clay filled joint							
851.1	150.9			40	10.0	10.0	100	150.9	
		Highly fractured zone from 150.9' to 151.4' 152.1': Smooth joint							

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Clay seam at 154.0' to 154.1' SHALE- Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)* Highly fractured zone from 154.1' to 155.1' Vert. fracture from 155.1' to 155.6' 155.7': Rough joint 156.7': Smooth Joint 158.7': MF Highly Fractured Zone from 160.9' to 162.9'		59	10.0	10.0	100	160.9	18 min run; WP= 300 psi, DP= 450 psi; 0_2 = 20.8% H_2S = 1%
		165.5': Smooth Joint 166.9': Smooth Joint 167.3': Clay Filled Joint 168.2': Iron pyrite nodule 168.8': Smooth Joint		51	10.0	10.0	100	170.9	19 min run; WP= 250 psi, DP= 500 psi; 0_2 = 20.7%
827.3	174.7	171.8': MF 174.5': Smooth Joint 175.6': Smooth Joint							23 min run; WP= 250 psi, DP= 475 psi; 0_2 = 20.8%

Project Number 173409058 | Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 | Boring No. **B-12** | Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE- Soft to Moderately Hard, Unweathered to Slightly Weathered, Very Fine Grained, Thinly Bedded, Unfractured to Slightly Fractured, flat bedding, unweathered smooth bedding joints, Black *(Continued)*		85	10.0	10.0	100	180.9	
		180.0': Iron Pyrite Nodules							
		182.7': MF							
		183.7': MF							
		Smooth Joint at 184.7' and 184.8'							16 min run; WP= 250 psi, DP= 475 psi; 0_2 = 20.7%
				100	10.0	10.0	100	190.9	
		191.0': MF							
		192.7': Smooth Joint							
		193.7': Smooth Joint							30 min run; WP= 300 psi, DP= 400 psi; 0_2 = 20.8%
		Vert. Fracture at 195.6' to 196.1'							

Project Number 173409058 Location N=772094.7, E=1871551.2

Project Name BWSTE Phase 2 Boring No. **B-12** Total Depth 205.9 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE- Soft to Moderately Hard, Unweathered to Slightly Weathered, Very Fine Grained, Thinly Bedded, Unfractured to Slightly Fractured, flat bedding, unweathered smooth bedding joints, Black *(Continued)* Vert. Fracture at 201.0' to 201.1'		98	10.0	10.0	100	200.9	
									15 min run; WP = 300 psi, DP= 400 psi; 0_2 = 20.8%
		204.7': Smooth Joint							
796.1	205.9	205.7': MF		100	5.0	5.0	100	205.9	

Bottom of Hole

Top of Rock = 16.2
Elevation (985.8)

At a depth of approximately 205.7 feet, water was forced out of the borehole intermittently for a period of several minutes. No abnormally high readings were triggered on the combustible gas monitoring equipment.

Used 11 bags of portland cement (~94 lbs/bag) with approximately 100 gallons of water to backfill hole.

Groundwater encountered at a depth of 11.0 feet prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=772280.1, E=1870531.7
Project Name	BWSTE Phase 2	Boring No.	**B-13** Total Depth 205.0 ft
County	Franklin County, OH	Surface Elevation	998.8 ft
Project Type	Geotechnical Exploration	Date Started	9/28/15 Completed 9/30/15
Supervisor	J. Musselman Driller Stantec	Depth to Water	Dry Date/Time 9/30/15
Logged By	E. Magoto	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
998.8	0.0	Top of Hole							
		Light Brown Silty LEAN CLAY (No Sampling)							
990.4	8.4								Began Core
		SANDSTONE - Hard, Slightly Weathered, Medium Grained, Medium to Thick Bedding, Slightly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints with iron staining, slightly rough joints, Light Gray 10.3' to 11.1' & 11.5' - 11.8': Vert. Fracture w/ significant iron staining 11.3' & 12.0': Clay Filled Joint 12.2' to 13.0': Highly Fractured 13.2': Sloped Joint/Rough with iron staining 14.1': MF 17.5' & 20.3': Smooth Joint 23.4': Clay Filled Joint		63	2.7	2.7	100	11.1	11 min run; WP= 150 psi, DP= 200 psi; O_2 = 20.8%
				64	5.0	4.9	98	16.1	6 min run; WP= 150 psi, DP= 225 psi; O_2 = 20.8%, H_2S = 1%
				88	5.0	5.0	100	21.1	6 min run; WP= 200 psi, DP= 200 psi; O_2 = 20.8%

Project Number 173409058 | Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 | Boring No. **B-13** | Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDSTONE - Hard, Slightly Weathered, Medium Grained, Medium to Thick Bedding, Slightly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints with iron staining, slightly rough joints, Light Gray *(Continued)*							16 min run; WP= 250 psi, DP= 450 psi; O_2 = 20.8%
		25.1': Clay Filled Joint 26.0': MF		78	10.0	9.8	98	31.1	
		27.8': Clay Filled Joint 29.1': Smooth Joint 31.4': Smooth Clay Filled Joint							
		33.8': Clay Filled Joint							
		34.7': MF							
		36.5' to 36.8': 45 deg bedding							15 min run; WP= 250 psi, DP= 400 psi; O_2 = 20.8%
		40.5' to 41.1': Clay seam		82	10.0	10.0	100	41.1	
		42.4': MF							
		44.1' and 45.4': Clay Filled Joint							
		45.6' to 45.8': Clay seam							22 min run; WP= 225 psi, DP= 400 psi; O_2 = 20.8%
		49.5': Smooth Joint 50.5': Rough Joint		81	10.0	10.0	100	51.1	
		51.7': Rough Joint 51.9': Clay Filled Joint							

Project Number	173409058	Location	N=772280.1, E=1870531.7
Project Name	BWSTE Phase 2	Boring No.	**B-13**
		Total Depth	205.0 ft

Lithology		Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
Elevation	Depth								
945.3	53.5								
		SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray 53.5' to 55.9': Highly Fractured Shale zone 58.4' to 59.9': Highly Fractured Shale zone							9 min run; WP= 250 psi, DP= 425 psi; O_2 = 20.8%
937.7	61.1			39	10.0	10.0	100	61.1	
		Interbedded SHALE (75%) and SANDSTONE (25%) 61.1' to 62.5': Highly Fractured zone 63.1': Rough Joint 63.7': Smooth Joint 66.7': Clay Filled Joint 67.9' to 68.2': Vert. Fracture							20 min run; WP= 250 psi, DP= 450 psi; O_2 = 20.8%
927.7	71.1	70.4': Clay Filled Joint		39	10.0	10.0	100	71.1	
		Interbedded SHALE (90%) and SANDSTONE (10%) 71.4': Smooth Joint 71.8': Clay Filled Joint 72.8' to 73.0': Vert. Fracture in Sandstone 75.6' to 77.2': Highly Fractured zone in Shale 77.3' & 78.2': Rough Joint 78.2' to 78.5': Vert. Fracture in Sandstone							27 min run; WP= 250 psi, DP= 450 psi; O_2 = 21.2%

Project Number 173409058 | Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 | Boring No. **B-13** | Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
917.7	81.1	SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray Clay Filled Joint at 81.6' 83.8': Highly weathered joint with clay 84.3': Smooth Joint 84.8': MF 85.3': Clay Filled Joint		38	10.0	10.0	100	81.1	30 min run; WP= 250 psi, DP= 425 psi; O_2 = 20.8%
		90.3': Rough Joint		59	10.0	9.9	99	91.1	
		91.6': Smooth Joint 92.3': Rough Joint 93.3': Vert. Fracture 93.9' to 94.1': Clay Seam							No water return from this point on, approx. 20 ft of core per 500 gallons of water
		95.6', 96' & 96.4': Smooth Joints							26 min run; WP= 250 psi, DP= 450 psi; O_2 = 20.8%
				79	10.0	10.0	100	101.1	
		101.8': Clay Filled Joint 103.3': Rough Joint 104.7': Smooth Joint							22 min run; WP= 250 psi, DP= 425 psi; O_2 = 20.8%
		106.8' to 107.2': Cross Bedding 108.0': MF							

Project Number 173409058 | Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 | Boring No. **B-13** | Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)*		75	10.0	9.4	94	111.1	
		110.1': Rough Joint							
		113.6': Rough Joint							
		116.3': Rough Joint Filled with clay							23 min run; WP= 200 psi, DP= 425 psi; O_2 = 20.8%
		119.3': MF		100	10.0	10.0	100	121.1	
		112.8': MF							
		123.1': Smooth Joint							
		123.1' to 124.2': Cross bedding							
		124.2': Fracture along 45 deg bedding							
872.1	126.7	125.3': MF							20 min run; WP= 250 psi, DP= 450 psi; O_2 = 20.8%
		SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, smooth to slightly rough joints, Red		88	10.0	9.8	98	131.1	
		127.6' - 127.8' & 128.3' & 128.8': Multiple Joints							
		131.1' to 132.0': Highly fractured zone							19 min run; WP= 250 psi, DP= 450 psi; O_2 = 20.8%
		134.2': MF							
		135.4' to 137.0': Highly weathered and fractured							

Project Number 173409058 | Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 | Boring No. **B-13** | Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		zone							
		138.2': Clay filled Joint							
859.3	139.5	139.2': Rough Joint							
		SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray		45	10.0	10.0	100	141.1	Vert. Fracture from 142.4ft to 142.8ft
		139.5' to 139.9': Highly weathered and fractured zone 140.2': Clay filled Joint 141.1' to 141.4': Rough Joint 143.6' to 143.7': Clay Seam 143.9': MF 144.7' to 145.0': Rough Joint 149.2' to 149.5': Vert. Fracture		62	10.0	10.0	100	151.1	23 min run; WP= 275 psi, DP= 500 psi; O_2 = 20.8%
		150.1' - 150.9': Multiple Joints 151.3': MF 152.6': Smooth Joint							Clay Filled Joint at 152.9ft & 153.8ft
		156.8': MF 158.4': Smooth Joint 159.0' to 159.6': Weathered zone with clay filled Joints 160.1': Smooth Joint		64	10.0	10.0	100	161.1	20 min run; WP= 300 psi, DP= 500 psi; O_2 = 20.8%
		162.2' and 164.4': MF							

Project Number 173409058 | Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 | Boring No. **B-13** | Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)*							18 min run; WP= 250 psi, DP= 475 psi; O_2 = 20.8%
				98	10.0	9.8	98	171.1	
		171.9': MF							
		174.7': Smooth Joint							
		175.3': MF							14 min run; WP= 300 psi, DP= 500 psi; O_2 = 20.8%
		180.0': Smooth Joint		97	10.0	9.7	97	181.1	
		181.0': 45 deg fracture							
		181.7': MF							
		183.7' to 184.0': Vert. Fracture							
		185.6' to 186.0': Vert. Fracture							15 min run; WP= 350 psi, DP= 500 psi; O_2 = 20.8%, H_2S = 1%
		187.9': Smooth Joint							
		188.3': MF							
					10.0	10.0	100	191.1	
		191.4': Smooth Joint							

Project Number 173409058 Location N=772280.1, E=1870531.7

Project Name BWSTE Phase 2 Boring No. **B-13** Total Depth 205.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		192.9': MF SHALE - Soft, Moderately Weathered, Very Fine Grained, Thinly Bedded, Moderately to Highly Fractured, flat bedding, bedding joints, slightly to moderately weathered joints, slightly rough joints, Gray *(Continued)* 193.7': Vert. Fracture 198.7': MF		97	10.0	9.7	97	201.1	27 min run; WP= 300 psi, DP= 500 psi; O_2 = 20.8%
		201.6': MF 202.6': Smooth Joint							
793.8	205.0				3.9	3.9	100	205.0	

Bottom of Hole

Top of Rock = 8.4
Elevation (990.4)

No sampling of overburden soils, description is based on visual observations of auger cuttings.

Used approximately 11 bags of portland cement (~94 lb/bag) with approximately 100 gallons of water to backfill hole.

No groundwater encountered prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=774538.3, E=1870699.6
Project Name	BWSTE Phase 2	Boring No.	**B-14** Total Depth 205.5 ft
County	Franklin County, OH	Surface Elevation	1008.3 ft
Project Type	Geotechnical Exploration	Date Started	10/15/15 Completed 10/20/15
Supervisor	J. Musselman Driller Stantec	Depth to Water	Dry Date/Time 10/20/15
Logged By	P. Cichocki	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
1008.3	0.0	Top of Hole							
		Light Brown LEAN CLAY (No Sampling)							
1000.3	8.0								Began Core
		SANDSTONE - Hard, Highly Weathered, Medium Grained, Thinly Bedded, Highly Fractured, flat bedding, highly weathered joints, smooth to rough joints, Gray		0	2.7	2.7	100	10.7	WP = 300 psi, DP = 450 psi; O_2 = 21.3%
		8.4': Smooth Joint Highly weathered joints throughout core 9.0' to 9.2': Rough Joint 9.8': 45 deg fracture 10.4' to 10.7': Highly weathered zone 10.7' to 10.9': Rough Joint 11.8' to 12.1': Vert. fracture 13.2': 45 deg fracture 14.5': MF 15.6': Clay Filled Joint 15.8': Clay Filled Joint 16.6': 45 deg fracture 19.1' to 19.7': Vert Fracture		26	5.0	5.0	100	15.7	WP = 300 psi, DP = 400 psi; O_2 = 21.3%
		21.6': Clay Seam 23.0': 45 deg fracture 23.2': Clay seam with rock fragments 23.8' to 24.0': Rough Joint		62	10.0	10.0	100	25.7	WP = 200 psi, DP = 500 psi; COMB = 4%, O_2 = 20.8% Block off at 24.2ft

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDSTONE - Hard, Highly Weathered, Medium Grained, Thinly Bedded, Highly Fractured, flat bedding, highly weathered joints, smooth to rough joints, Gray *(Continued)* 27.7': MF							WP = 200 psi, DP = 500 psi; O_2 = 20.8%
		30.4': Clay filled Joint							
		34.2' and 34.4': Clay filled joints with rock fragments 34.7': MF 35.6' to 35.7': Rough Joint 35.7' to 35.8': Rough Joint		82	10.0	10.0	100	35.7	Clay Filled Joint at 36.5ft
		37.9': MF							
		39.1' to 39.3': Rough Joint 39.7': MF							WP = 200 psi, DP = 500 psi; COMB = 4%, O_2 = 21.1%
		Verticle fracture							
		43.2' and 43.4': Clay Filled Joint 43.8' to 44.0': Clay Seam with rock fragments		55	10.0	10.0	100	45.7	
		46.7' to 46.8': Clay seam with rock fragments 47.2': Weathered fracture							
		48.7' and 48.8': MF							
		50.1': Clay seam with rock fragments 51.4' to 52.7': Interbedded shale zone							WP = 200 psi, DP = 500 psi; COMB = 4%, O_2 = 21.4%
		53.1': 30 deg fracture							

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
952.6	55.7	54.6': MF 54.9': Clay Filled Joint SANDSTONE - Soft, Highly Weathered, Very Fine Grained, Thin Bedded, Highly Fractured, Shale Interbedding, flat bedding, highly weathered joints, rough joints, Gray 56.7' to 56.9': Vert. Fracture 57.1' to 58.4': Multiple Joints 58.7': 30 deg fracture 60.1': 45 deg Fracture 60.6' to 60.7': Rough Joint 61.8': 45 deg fracture 64.3': MF		49	10.0	10.0	100	55.7	60% Sandstone; 40% Gray Shale WP = 300 psi, DP = 500 psi; COMB = 6%, O_2 = 21.4%
				14	10.0	10.0	100	65.7	
		65.6' to 65.7': Highly Fractured 66.2': Clay Filled Joint 66.2' to 66.4': Sandstone seam 67.2' to 67.3': Vert. Fracture in Sandstone 68.4', 68.6', and 68.7': MF 69.4': Weathered Fracture 69.4' to 71': Sandstone Seam / Verticle fracture 73.8' to 73.9': Clay Seam							50% Sandstone; 50% Gray Shale WP = 200 psi, DP = 500 psi; COMB = 7%, O_2 = 21.5%
				40	10.0	10.0	100	75.7	
		74.3' & 76.4': Smooth Joint 76.7' to 77.1': Rough Joint 77.1' to 77.2': Vert. Fracture 78.1' to 79.0': Rough Joint; deep bedding grooves throught core 81.2': Weathered Fracture 83.1': Highly Weathered							85% Gray Shale; 15% Sandstone WP = 200 psi, DP = 500 psi; COMB = 6%, O_2 = 21.5%

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
922.6	85.7	Joint 84.0', 84.2', and 84.7': MF		37	10.0	10.0	100	85.7	
		SHALE - Soft, Highly Weathered, Very Fine Grained, Thin Bedded, Highly Fractured, flat bedding, highly weathered joints, rough joints, Gray to Red 86.0' to 86.3': Highly Fractured 88.0': MF 89.7': MF 91.0' to 91.2': Clay seam with rock fragments 92.7': MF							Deep Bedding grooves throughout core Smooth Joint at 88.3ft WP = 250 psi, DP = 600 psi; COMB = 3%, O_2 = 21.4%
		95.0' to 95.3': Rough Joint		50	10.0	10.0	100	95.7	
		95.4': Clay Filled Joint 96.4': Smooth Joint 97.7': MF 98.1': Clay Filled Joint 100.7': MF 103.0': Clay Filled Joint		88	10.0	10.0	100	105.7	Deep Bedding grooves throughout core WP = 250 psi, DP = 500 psi; O_2 = 21.5%
		106.4': MF 108.5' to 108.6': Highly Fractured and highly weathered zone 109.8' to 109.9': Highly weathered zone 111.3': Smooth Joint							WP = 300 psi, DP = 600 psi; O_2 = 21.3%

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft, Highly Weathered, Very Fine Grained, Thin Bedded, Highly Fractured, flat bedding, highly weathered joints, rough joints, Gray to Red *(Continued)* 114.9': MF 115.9': MF 118.0' to 118.1': Clay seam		98	10.0	10.0	100	115.7	
		119.5' to 119.6': Clay seam 120.2' to 120.4': Rough Joint Clay seam at 121.3' to 121.4' and from 121.5' to 121.6' 122.5': Clay Filled Joint 123.4' to 123.6': Highly Fractured, Highly weathered 124.0' to 124.2': Rough Joint 124.7' to 125.5': Rough Joint 126.3' to 126.4': Moderately weathered clay and rock filled Joint 45 deg fractures at 126.8', 127.0', and 128.4' 130.1' to 130.4': Rough Joint 131.2': MF 131.8' to 132.5': Rough Joint 132.8' to 134.0': Highly Fractured zone		38	10.0	10.0	100	125.7	WP = 300 psi, DP = 600 psi; O_2 = 21.3% WP = 300 psi, DP = 600 psi; O_2 = 21.3%; H_2S = 1%
872.6	135.7	134.8' to 134.9': Highly weathered 135.1' to 135.3': Highly weathered, highly fractured		13	10.0	10.0	100	135.7	80% Black Shale; 20% Red Shale
		SHALE - Soft, slightly Weathered, Very Fine Grained, Thin Bedding, Slightly to Moderately Fractured, flat bedding, slightly to moderately weathered joints, smooth joints, Black interbedded with Red							WP = 300 psi, DP = 600 psi; O_2 = 20.8%

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		136.9': Clay Joint 138.4': MF 142.4': Smooth Joint SHALE - Soft, slightly Weathered, Very Fine Grained, Thin Bedding, Slightly to Moderately Fractured, flat bedding, slightly to moderately weathered joints, smooth joints, Black interbedded with Red *(Continued)* 143.7' and 143.9': Clay Filled Joint 145.2': MF 146.6': Clay Filled Joint 147.0' to 147.1': Rough Joint 147.3' through 147.7': Red Shale Joints 148.0' to 148.3': Clay filled joint with rock fragments 148.6' and 148.7': Highly weathered Joints 149.9': MF 151.6': Moderately weathered clay Joint 153.7': MF 155.1': Smooth Joint 156.6': Clay Joint 156.8' & 156.9': Clay Filled Joints with rock fragments 157.0' to 157.1': Clay seam Clay Joints at 159.7', 159.8' and 159.9' 165.5': MF 166.8': MF		82	10.0	10.0	100	145.7	90% Black Shale; 10% Red Shale WP = 200 psi, DP = 500 psi; O_2 = 20.8%
				77	10.0	10.0	100	155.7	
				78	5.0	5.0	100	160.7	WP = 200 psi, DP = 500 psi; O_2 = 20.8%
				97	10.0	10.0	100	170.7	WP = 200 psi, DP = 500 psi; O_2 = 20.8%

Project Number 173409058 | Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 | Boring No. **B-14** | Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SHALE - Soft, slightly Weathered, Very Fine Grained, Thin Bedding, Slightly to Moderately Fractured, flat bedding, slightly to moderately weathered joints, smooth joints, Black interbedded with Red *(Continued)*		86	5.0	5.0	100	175.7	WP = 200 psi, DP = 500 psi; O_2 = 21.1%
		172.0': MF 174.7': MF 176.2': Smooth Joint 178.0': MF		84	5.0	5.0	100	180.7	WP = 200 psi, DP = 500 psi; COMB = 1%; O_2 = 20.8%
		180.3' to 180.5': Rough Joint 181.9': Clay Filled Joint 184.2': Rough Joint 189.5': MF		100	10.0	10.0	100	190.7	WP = 250 psi, DP = 500 psi; O_2 = 20.8%
		191.9': Smooth Joint 192.4' & 192.8': MF 194.2': MF 198.7': Smooth Joint		100	10.0	10.0	100	200.7	WP = 275 psi, DP = 525 psi; O_2 = 20.7%

Project Number 173409058 Location N=774538.3, E=1870699.6

Project Name BWSTE Phase 2 Boring No. **B-14** Total Depth 205.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		201.1': Smooth Joint 202.6': MF							WP = 250 psi, DP = 500 psi; O_2 = 20.8%
802.8	205.5	204.6': MF		100	4.8	4.8	100	205.5	

Bottom of Hole

Top of Rock = 8.0
Elevation (1000.3)

No sampling of overburden soils, description is based on visual observations of auger cuttings.

Used approximately 10 bags of portland cement (~94 lb/bag) with approximately 90 gallons of water to backfill hole.

No groundwater encountered prior to coring bedrock.

SUBSURFACE LOG

Project Number	173409058	Location	N=775783.7, E=1872072.1
Project Name	BWSTE Phase 2	Boring No.	**B-15** Total Depth 30.6 ft
County	Franklin County, OH	Surface Elevation	999.6 ft
Project Type	Geotechnical Exploration	Date Started	10/21/15 Completed 10/21/15
Supervisor	J. Musselman Driller Stantec	Depth to Water	Dry Date/Time 10/21/15
Logged By	E. Magoto	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
999.6	0.0	Top of Hole							
998.6	1.0	Asphalt Pavement							
		Brown LEAN CLAY with Gravel, stiff to very stiff, dry to damp		SPT-1	1.0 - 2.5	1.0	27-19-8	--	HP = 1.0 - 1.5 tsf
				SPT-2	2.5 - 4.0	1.2	2-6-5	--	HP = 2.5 - 3.0 tsf
				SPT-3	4.0 - 5.5	0.6	2-2-3	--	HP = 2.0 tsf
				SPT-4	5.5 - 7.0	1.5	2-3-7	--	HP = 1.0 tsf
				SPT-5	7.0 - 8.5	1.5	5-6-8	--	HP = 2.0 - 2.5 tsf
991.1	8.5								
		GRAVEL with Brown LEAN CLAY, very stiff, dry to damp		SPT-6	8.5 - 10.0	1.0	2-6-21	--	Mud Rotary at 8.5ft
989.0	10.6			SPT-7	10.0 - 10.6	0.4	50/5"	--	Began Core
		SANDSTONE - Hard, Highly Weathered, Medium Grained, Thinly Bedded, Highly Fractured, flat bedding, highly weathered joints, smooth to rough joints, Gray to Tan. 11.3' - 11.6' & 13': Rough Joints 13.3': 45 deg Fracture 15.5' to 15.7': Vert. Fracture							WP = 275 psi, DP = 450 psi; O_2 = 20.8%

STANTEC/FMSM_LEGACY PRELIMINARY BORINGS.GPJ FMSM-GRAPHIC LOG.GDT 1/27/16

SUBSURFACE LOG

Project Number 173409058 | Location N=775783.7, E=1872072.1

Project Name BWSTE Phase 2 | Boring No. **B-15** | Total Depth 30.6 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDSTONE - Hard, Highly Weathered, Medium Grained, Thinly Bedded, Highly Fractured, flat bedding, highly weathered joints, smooth to rough joints, Gray to Tan. *(Continued)* 16.2' to 16.4': Deep Bedded groves 17.3': Rough Joint 20.0': Smooth Joint		22	10.0	10.0	100	20.6	
		26.6': Clay Filled Joint 27.7': Clay Filled Joint 28.4': Highly Weathered zone and Fractured zone 29.0' to 29.1': Clay Seam 29.7': Smooth Joint		58	10.0	10.0	100	30.6	WP = 250 psi, DP = 425 psi; O_2 = 20.8%
969.0	30.6	Bottom of Hole							

Top of Rock = 10.6
Elevation (989.0)

Used approximately 2 bags of portland cement (~94 lb/bag) with approximately 20 gallons of water to backfill hole.

No groundwater encountered prior to coring bedrock.

SUBSURFACE LOG

EXPLORATION ID: B-16

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	765717.079 1867720.898	**DATE STARTED**	4/23/18	**COMPLETED**	4/30/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	90.2 % (Avg.)	**SURFACE ELEVATION**	973.0 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	NQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	1.5 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	CME 45 Truck \00	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	5/1/18
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 972.96	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF TO VERY STIFF, LIGHT BROWN TO GRAY, **SILTY CLAY**, TRACE TO WITH SAND, SOME GRAVEL, MOIST - DARK BROWN, SILTY CLAY TOPSOIL @ 0.0' - 0.25'		1															
		2	1-2-3	44	SS-1	2.25	-	-	-	-	-	-	-	-	-		
	W	3															
		4	3-3-4	53	SS-2	2.5	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	4-4-5	100	SS-3	3.25	-	-	-	-	-	-	-	-	-		
	965.0	8															
MEDIUM DENSE, GRAY, **FINE SAND**, SOME TO WITH GRAVEL, WET		9	9-11-16	89	SS-4		-	-	-	-	-	-	-	-	-		
		10															
		11															
		12	8-17-23	72	SS-5		-	-	-	-	-	-	-	-	-		
		13															
	958.9	14	-	67	SS-6		-	-	-	-	-	-	-	-	-		
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, LITTLE COBBLES, MOIST TO WET		15															
		16															
- CRUSHED LIMESTONE COBBLE @ 16.0' - 16.3'		17	7-16-24	28	SS-7		-	-	-	-	-	-	-	-	-		
		18															
		19	8-8-8	83	SS-8	4.0	-	-	-	-	-	-	-	-	-		
	952.5	20															
MEDIUM DENSE, GRAY, **FINE SAND**, SOME GRAVEL, WET		21															
		22	6-10-14	72	SS-9		-	-	-	-	-	-	-	-	-		
	950.5	23															
NO SAMPLING, AUGERED FROM 22.5' TO 51.0'		24															

SUBSURFACE LOG

EXPLORATION ID: B-16

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.0 ft LOCATION 765717.079 1867720.898 DATE STARTED / DATE COMPLETED 4/23/18 - 4/30/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
NO SAMPLING, AUGERED FROM 22.5' TO 51.0' *(continued)*		26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50															
MEDIUM DENSE, GRAY, **FINE SAND**, WET	922.0	51															

SUBSURFACE LOG

EXPLORATION ID: B-16

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.0 ft LOCATION 765717.079 1867720.898 DATE STARTED / DATE COMPLETED 4/23/18 - 4/30/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM DENSE, GRAY, **FINE SAND**, WET *(continued)*		52	14-18-21	72	SS-10		-	-	-	-	-	-	-	-	-		
		53															
		54	10-20-24	89	SS-11		-	-	-	-	-	-	-	-	-		
		55															
		56	12-20-24	83	SS-12		-	-	-	-	-	-	-	-	-		
		57															
		58	12-14-22	83	SS-13		-	-	-	-	-	-	-	-	-		
		59															
		60															
		61	14-27-28	78	SS-14		-	-	-	-	-	-	-	-	-		
		62															
		63	11-24-35	78	SS-15		-	-	-	-	-	-	-	-	-		
		64															
		65	4-24-50/5"	100	SS-16		-	-	-	-	-	-	-	-	-		
		66															
		67	1-5-13	72	SS-17		-	-	-	-	-	-	-	-	-		
		68															
		69	10-24-41	78	SS-18		-	-	-	-	-	-	-	-	-		
		70															
		71	13-36-20	72	SS-19		-	-	-	-	-	-	-	-	-		
- TRACE GRAVEL		72															
		73	19-37-35	67	SS-20		-	-	-	-	-	-	-	-	-		
		74															
		75															
		76															
		77															
STIFF, GRAY, **SILT AND CLAY**, MOIST	895.0	78															

STANTEC BORING SUBSURFACE LOG_BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ_OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-16

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.0 ft LOCATION 765717.079 1867720.898 DATE STARTED / DATE COMPLETED 4/23/18 - 4/30/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF, GRAY, **SILT AND CLAY**, MOIST *(continued)*		79	12-29-32	3	SS-21		-	-	-	-	-	-	-	-	-		
		80															
		81	13-15-16	72	SS-22		-	-	-	-	-	-	-	-	-		
		82															
		83	3-10-20	100	SS-23		-	-	-	-	-	-	-	-	-		
		84															
		85	8-13-15	83	SS-24		-	-	-	-	-	-	-	-	-		
		86															
		87	6-10-14	100	SS-25		-	-	-	-	-	-	-	-	-		
		88															
		89	5-8-9	94	SS-26	3.0	-	-	-	-	-	-	-	-	-		
		90															
		91	4-6-10	89	SS-27	3.0	-	-	-	-	-	-	-	-	-		
		92															
		93	5-10-14	89	SS-28	3.0	-	-	-	-	-	-	-	-	-		
		94															
		95	5-7-9	100	SS-29	3.0	-	-	-	-	-	-	-	-	-		
		96															
		97	5-6-10	89	SS-30	2.5	-	-	-	-	-	-	-	-	-		
		98															
		99	4-6-8	89	SS-31	2.75	-	-	-	-	-	-	-	-	-		
		100															
		101															
		102															
		103															
		104															
		105															

SUBSURFACE LOG

EXPLORATION ID: B-16

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.0 ft LOCATION 765717.079 1867720.898 DATE STARTED / DATE COMPLETED 4/23/18 - 4/30/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF, GRAY, **SILT AND CLAY**, MOIST *(continued)*		106															
		107	3-13-17	94	SS-32	2.75	-	-	-	-	-	-	-	-	-		
		108															
		109	5-7-8	100	SS-33	2.5	-	-	-	-	-	-	-	-	-		
		110															
		111															
	861.1	112	4-35-50/5"	100	SS-34	2.75	-	-	-	-	-	-	-	-	-		
STIFF, GRAY, **STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST		113															
		114	50/3"	50	SS-35		-	-	-	-	-	-	-	-	-		
		115															
		116	50/1"	0	SS-36		-	-	-	-	-	-	-	-	-		
		117															
		118															
	854.0	TR 119	50/4"	0	SS-37		-	-	-	-	-	-	-	-	-		
HIGHLY WEATHERED, VERY SOFT TO SOFT, FINE GRAINED, SHALE, RED, THIN BEDDED, MODERATELY FRACTURED, FLAT BEDDED.		120	50/5"	80	SS-38		-	-	-	-	-	-	-	-	-		
	852.0	121															

Boring Continues on Following Rock Description Log

NOTES: - METHANE ENCOUNTERED DURING CORING ROD REMOVAL

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck\00	**BORING NO. B-16**	
Coordinates: N 765717.1 E 1867720.9	Driller: Rii/ S.P	**Sheet No. 1 of 2**	
Top Drillhole Elevation: 973.0 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 808.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 165.0 feet	Checked By: B. Madras Natarajan	Date Start: 4/23/18 End: 4/30/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
856								Refer to soil borings for details on soil descriptions/characteristics
	118							
854								
	120							
852								
	122				121.3' 0-5°, B, R4-R5, O, Pl, Cl 121.8' 0-5°, B, R4, O, Pl, Cl 122.3' to 122.4' fractured rock			
850		28	75	1.6	122.8' 0-5°, B, R4, O, Pl, Cl 123.2' 0-5°, B, R4, O, Pl, Cl	1	121.0 to 126.0' **BEDFORD SHALE**, red, very fine grained, slightly to moderately weathered, soft to moderately hard, thinly bedded, slightly weathered joints	Top of Rock @ 121.0' Run-1 121.0' - 126' 22 minute run Down Pressure = 400 Psi
	124				123.6' 0-5°, B, R4-R5, O, Pl, Cl 123.8' to 124.2' fractured rock 124.6' 0-5°, B, R4, O, Pl, Cl 124.9' 0-5°, B, R4-R5, O, Pl, Cl 125.3' to 125.6' fractured rock			
848								
	126				126.3' 0-5°, B, R4-R5, PtO-t, Pl, Cl		126.0 to 149.0' **BEDFORD SHALE**, grey, very fine grained, slightly to moderately weathered, soft to moderately hard, thinly bedded, slightly weathered joints	
846					127.2' 0-5°, B, R5, O, Pl, Cl 127.4' 0-5°, B, R4-R5, O, Pl			
	128	86	96	1.4	127.8' 0-5°, B, R4-R5, PtO-t, Pl	2		Run-2 126.0' - 131.0' 15 minute run Down Pressure = 350 Psi
844					128.8' 0-5°, B, R4-R5, O, Pl, Cl			
	130				129.6' 0-5°, B, R4-R5, O, Pl			
842					130.4' 0-5°, B, R4-R5, O, Pl, Cl			
	132				131.5' 0-5°, B, R4-R5, O, Pl			Run-3 131.0' - 136.0' 14 minute run Down Pressure = 400 Psi
840		96	100	0.8		3		
	134				133.5' 0-5°, B, R4-R5, O, Pl, Cl 134.2' 0-5°, B, R4-R5, O, Pl, Cl			
838								
	136				135.5' 0-5°, B, R4-R5, O, Pl, Cl			Run-4 136.0' - 141.0' 15 minute run Down Pressure = 450 Psi
836								
	138				137.5' 0-5°, B, R4-R5, PtO-t, Pl			
834		98	100	1.4	138.7' 0-5°, B, R4-R5, O, Pl 138.8' 0-5°, B, R4-R5, PtO-t, Pl	4		
	140				139.1' 0-5°, B, R4-R5, PtO-t, Pl 139.5' 0-5°, B, R4-R5, O, Pl 139.9' 0-5°, B, R4-R5, PtO-t, Pl			
832					140.5' 0-5°, B, R4, O, Pl			Run-5 141.0' - 146.0' 13 minute run Down Pressure = 450 Psi
	142				141.5' 0-5°, B, R4-R5, O, Pl			
830		100	98	0.8		5		
	144				143.3' 0-5°, B, R4-R5, PtO-t, Pl 143.9' 0-5°, B, R4, O, Pl			
828					145.0' 0-5°, B, R4-R5, O, Pl			
	146							Run-6 146.0' - 151.0' 13 minute run Down Pressure = 400 Psi 147.1' - 148.1' UCS = 2,552 Psi
826					146.5' 0-5°, B, R4, O, Pl 147.0' 0-5°, B, R4-R5, PtO-t, Pl			
	148	100	100	1.4	148.2' 0-5°, B, R4-R5, O, Pl 148.6' 0-5°, B, R4-R5, O, Pl	6		
824					148.9' 0-5°, B, R4-R5, O, Pl			
	150				149.5' 0-5°, B, R4-R5, O, Pl		149.0 to 165.0' **OHIO SHALE**, black, very fine grained, slightly to moderately weathered, moderately hard, slightly to moderately fractured, thinly bedded	
822					150.5' 0-5°, B, R4-R5, O, Pl			
	152							Run-7 151.0' - 156.0' 13 minute run Down Pressure = 400 Psi
820					152.1' 60°, Jt, R4, O, Und 152.4' 0-5°, B, R4-R5, PtO-t, Pl			
	154	100	100	1	152.8' 0-5°, B, R4, O, Pl 153.3' 0-5°, B, R4-R5, PtO-t, Pl	7		153.3' - 153.8' UCS = 3,738 Psi
818					154.8' 0-5°, B, R4, O, Pl			
					155.5' 0-5°, B, R4-R5, PtO-t, Pl			

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck\00	**BORING NO. B-16**	
Coordinates: N 765717.1 E 1867720.9	Driller: Rii/ S.P	**Sheet No. 2 of 2**	
Top Drillhole Elevation: 973.0 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 808.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 165.0 feet	Checked By: B. Madras Natarajan	Date Start: 4/23/18 End: 4/30/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
816								
814	158	82	97	1.6	156.2' 0-5°, B, R4, PtO-t, Pl 156.3' 0-5°, B, R4-R5, O, Pl 157.1' 0-5°, B, R4, PtO-t, Pl 157.3' 0-5°, B, R4-R5, O, Pl 157.5' 0-5°, B, R4, O, Pl 158.3' 0-5°, B, R4-R5, PtO-t, Pl 159.0' 0-5°, B, R4, O, Pl	8		Run-8 156.0' - 161.0' 9 minute run Down Pressure = 300 - 400 Psi
812	160				160.5' 0-5°, B, R4-R5, PtO-t, Pl			
810	162	100	100	1.6	161.7' 0-5°, B, R4, O, Pl 162.5' 0-5°, B, R4, O, Pl 163.3' to 163.9' 0-5°, 3 Bs, R4-R5, O, Pl	9		Run-9 161.0' - 165.0' 12 minute run Down Pressure = 300 Psi Methane gas encountered during coring rod removal
808	164				164.0' 0-5°, B, R4, O, Und 164.4' 0-5°, B, R4-R5, PtO-t, Pl, Cl			Encountered methane during core removal
806	166						**End of Boring at 165.0 feet**	
804	168							
802	170							
800	172							
798	174							
796	176							
794	178							
792	180							
790	182							
788	184							
786	186							
784	188							
782	190							
780	192							
778	194							

SUBSURFACE LOG

EXPLORATION ID: B-17

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	765509.578 1867882.287	**DATE STARTED**	11/28/17	**COMPLETED**	12/4/17
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	90.2 % (Avg.)	**SURFACE ELEVATION**	975.1 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	NQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	CME 45 Truck \00	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	1.2 ft
								DATE/TIME	12/11/17
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 975.05	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
CONCRETE PAVEMENT	974.6																
AGGREGATE BASE	974.4	W 1															
STIFF, BLACK, **SILTY CLAY**, WITH TRACE GRAVEL, MOIST		2	2-5-6	19	SS-1		-	-	-	-	-	-	-	-	-		
	972.1	3															
MEDIUM STIFF TO STIFF, LIGHT BROWN TO GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST		4	4-4-2	44	SS-2		-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	4-5-5	58	SS-3		-	-	-	-	-	-	-	-	-		
		8															
		9	3-4-6	100	SS-4		-	-	-	-	-	-	-	-	-		
		10															
	964.6	11															
LOOSE TO MEDIUM DENSE, GRAY, **FINE SAND**, WITH GRAVEL, WET		12	10-22-18	67	SS-5		-	-	-	-	-	-	-	-	-		
		13															
		14	7-15-19	67	SS-6		-	-	-	-	-	-	-	-	-		
		15															
		16															
		17	10-19-24	67	SS-7		-	-	-	-	-	-	-	-	-		
		18															
		19	19-18-18	72	SS-8		-	-	-	-	-	-	-	-	-		
		20															
		21															
		22	5-14-18	67	SS-9		-	-	-	-	-	-	-	-	-		
		23															
		24	10-18-17	67	SS-10		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-17

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 975.1 ft LOCATION 765509.578 1867882.287 DATE STARTED / DATE COMPLETED 11/28/17 - 12/4/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
LOOSE TO MEDIUM DENSE, GRAY, **FINE SAND**, WITH GRAVEL, WET *(continued)*		26															
MEDIUM DENSE, GRAY, **SILTY SAND**, WET	948.8	27	6-14-17	56	SS-11		-	-	-	-	-	-	-	-	-		
		28															
		29	12-14-18	78	SS-12		-	-	-	-	-	-	-	-	-		
		30															
MEDIUM DENSE, GRAY, **FINE SAND**, WET	944.6	31															
		32	11-19-19	67	SS-13		-	-	-	-	-	-	-	-	-		
		33															
		34	5-15-17	61	SS-14		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37	5-12-13	50	SS-15		-	-	-	-	-	-	-	-	-		
		38															
		39	15-22-21	78	SS-16		-	-	-	-	-	-	-	-	-		
- 1" GRANITE COBBLE IN SPOON		40															
		41															
		42	37-30-28	39	SS-17		-	-	-	-	-	-	-	-	-		
		43															
STIFF TO HARD, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST	931.3	44	7-14-15	67	SS-18		-	-	-	-	-	-	-	-	-		
		45															
		46															
		47	9-13-22	89	SS-19		-	-	-	-	-	-	-	-	-		
		48															
		49	10-16-41	89	SS-20		-	-	-	-	-	-	-	-	-		
		50															
		51															

SUBSURFACE LOG

EXPLORATION ID: B-17

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 975.1 ft LOCATION 765509.578 1867882.287 DATE STARTED / DATE COMPLETED 11/28/17 - 12/4/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
STIFF TO HARD, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST *(continued)*		52	14-31-37	44	SS-21		-	-	-	-	-	-	-	-	-		
	922.1	53															
LOOSE TO MEDIUM DENSE, GRAY, **STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST		54	4-24-50/5"	41	SS-22		-	-	-	-	-	-	-	-	-		
		55															
		56	44-50/5"	64	SS-23		-	-	-	-	-	-	-	-	-		
		57															
		58	47-50/4"	80	SS-24		-	-	-	-	-	-	-	-	-		
		59															
	915.1	60															
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, WET		61															
		62	30-28-39	44	SS-25		-	-	-	-	-	-	-	-	-		
- HARD DRILLING - ISSUES WITH WATER RETURN AND PLUGGING		63															
	912.1	64															
HARD, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST		65	22-22-31	100	SS-26		-	-	-	-	-	-	-	-	-		
		66															
		67	8-12-30	94	SS-27		-	-	-	-	-	-	-	-	-		
		68															
- FINE SAND WITH GRAVEL LAYER FROM 68.5' TO 70.0'		69	17-25-15	0	SS-28a		-	-	-	-	-	-	-	-	-		
	905.1	70	34	83	SS-28b		-	-	-	-	-	-	-	-	-		
VERY STIFF, GRAY, **SILT AND CLAY**, MOIST		71															
		72	6-9-16	100	SS-29		-	-	-	-	-	-	-	-	-		
		73															
		74	4-11-17	100	SS-30		-	-	-	-	-	-	-	-	-		
		75															
		76															
		77	6-9-16	100	SS-31		-	-	-	-	-	-	-	-	-		
		78															

SUBSURFACE LOG

EXPLORATION ID: B-17

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 975.1 ft LOCATION 765509.578 1867882.287 DATE STARTED / DATE COMPLETED 11/28/17 - 12/4/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY STIFF, GRAY, **SILT AND CLAY**, MOIST *(continued)*		79	8-9-16	83	SS-32		-	-	-	-	-	-	-	-	-		
	895.1	80															
VERY STIFF, GRAY, **SILTY CLAY**, MOIST		81															
- CIRCULATION ISSUES - HAD TO PULL BACK 10.0' AND REDRILL		82	9-14-17	89	SS-33		-	-	-	-	-	-	-	-	-		
		83															
		84	16-19-22	56	SS-34		-	-	-	-	-	-	-	-	-		
		85															
- PUSHED COBBLE		86															
		87	7-13-16	33	SS-35		-	-	-	-	-	-	-	-	-		
		88															
		89	8-7-12	78	SS-36		-	-	-	-	-	-	-	-	-		
		90															
		91															
		92	4-6-9	94	SS-37		-	-	-	-	-	-	-	-	-		
		93															
		94	4-6-10	100	SS-38		-	-	-	-	-	-	-	-	-		
		95															
		96															
		97	4-7-9	100	SS-39		-	-	-	-	-	-	-	-	-		
		98															
		99	5-10-14	94	SS-40		-	-	-	-	-	-	-	-	-		
		100															
		101															
		102	7-9-13	100	SS-41		-	-	-	-	-	-	-	-	-		
		103															
		104	4-5-8	100	SS-42		-	-	-	-	-	-	-	-	-		
		105															

SUBSURFACE LOG

EXPLORATION ID: B-17

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 975.1 ft LOCATION 765509.578 1867882.287 DATE STARTED / DATE COMPLETED 11/28/17 - 12/4/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY STIFF, GRAY, **SILTY CLAY**, MOIST *(continued)*		106															
		107	11-15-21	100	SS-43		-	-	-	-	-	-	-	-	-		
		108															
		109	5-7-9	100	SS-44		-	-	-	-	-	-	-	-	-		
		110															
- SHALE AND SANDSTONE COBBLES		111															
		112	5-26-50/4"	100	SS-45		-	-	-	-	-	-	-	-	-		
		113															
		114	11-20-33	83	SS-46		-	-	-	-	-	-	-	-	-		
		115															
		116															
		117	12-22-37	78	SS-47		-	-	-	-	-	-	-	-	-		
		118															
HIGHLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, GREEN TO BROWN, THIN BEDDED.	856.1 TR	119	18-29-37	67	SS-48		-	-	-	-	-	-	-	-	-		
		120															
		121	50/5"	100	SS-49		-	-	-	-	-	-	-	-	-		
		122															
		123															
	851.5		50/1"	100	SS-50		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 144.5 TO 154.5 FEET (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; SAND

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-17**
Coordinates: N 765509.6 E 1867882.3	Driller:	Rii/ S. P	**Sheet No. 1 of 2**
Top Drillhole Elevation: 975.1 feet MSL	Logged By:	John Ristow/ AECOM	
Bottom Elevation: 794.5 feet MSL	Prepared By:	A. Mirza	
Total Depth: 180.6 feet	Checked By:	B. Madras Natarajan	Date Start: 11/28/17 End: 12/4/17
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 1.2

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
856								Refer to soil borings for details on soil descriptions/characteristics
	120							
854								
	122							
852								
	124				124.0' 0-5°, B, R4, O, Pl, Cl 124.2' 0-5°, B, R4-R5, O, Pl, Cl		123.6 to 129.6' **BEDFORD SHALE**, red, very fine grained, slightly to moderately weathered, soft to moderately hard, thinly bedded, slightly weathered joints	Top of Rock 123.6'
850		0	31	1.8	124.3' 0-5°, B, R4, O, Pl 124.5' 0-5°, B, R4, O, Pl, Cl	1		Run-1 123.6' - 127.6' 30 minute run Down Pressure = 400 - 500 Psi
	126				124.9' 0-5°, B, R4, PtO-t, Pl 125.0' 0-5°, B, R4-R5, O, Pl, Cl			
848					125.1' 0-5°, B, R4, O, Pl, Cl			
	128				127.7' 0-5°, B, R4-R5, O, Pl, Cl 128.1' 0-5°, B, R4-R5, PtO-t, Pl			Run-2 127.6' - 132.6' 25 minute run Down Pressure = 450 Psi
846					128.2' 0-5°, B, R4, O, Pl 128.5' 0-5°, B, R5, t, Pl			
	130	36	90	3.2	128.9' 0-5°, B, R5, PtO-t, Pl 129.0' 0-5°, B, R4-R5, O, Pl	2	129.6 to 152.6' **BEDFORD SHALE**, grey, very fine grained, slightly to moderately weathered, soft to moderately hard, thinly bedded, slightly weathered joints	
844					129.2' 0-5°, B, R4, O, Pl 129.3' 0-5°, B, R5, PtO-t, Pl			
	132				129.4' 0-5°, B, R5, t, Pl 129.5' 0-5°, B, R4-R5, O, Pl			
842					129.8' 0-5°, B, R5, t, Pl 130.0' 0-5°, B, R4, O, Pl			Run-3 132.6' - 142.6' 35 minute run Down Pressure = 450 - 575 Psi
	134				130.1' 0-5°, B, R5, PtO-t, Pl 130.2' 0-5°, B, R5, PtO-t, Pl			
840					130.6' 0-5°, B, R4-R5, O, Pl 131.6' 0-5°, B, R5, t, Pl			
	136				134.6' 0-5°, B, R5, PtO-t, Pl 134.7' to 134.9 90° Jt, R4, O, Und 135.1' 0-5°, B, R5, t, Pl			
838					135.7' 0-5°, B, R4, O, Pl 136.4' 0-5°, B, R5, PtO-t, Pl			
	138	86	96	1.5	136.5' 0-5°, B, R5, t, Pl	3		
836					139.0' to 139.2 fractured rock			
	140				139.8' 0-5°, B, R5, PtO-t, Pl 140.2' 0-5°, B, R4-R5, O, Pl			
834					140.3' 0-5°, B, R4, O, Pl 140.4' 0-5°, B, R5, PtO-t, Pl			
	142				140.8' 0-5°, B, R5, t, Pl 141.2' 0-5°, B, R4-R5, O, Pl			
832					141.5' 0-5°, B, R5, t, Pl 142.1' 0-5°, B, R4, O, Pl			Run-4 142.6' - 152.6' 30 minute run Down Pressure = 600 Psi
	144				144.0' 0-5°, B, R5, PtO-t, Pl			
830					144.9' 0-5°, B, R4, O, Pl 145.3' 0-5°, B, R5, PtO-t, Pl			
	146				146.2' 0-5°, B, R5, t, Pl			
828					146.8' 0-5°, B, R4-R5, O, Pl			
	148	89	100	1.2	147.3' 0-5°, B, R5, t, Pl	4		
826					148.9' 0-5°, B, R4, O, Pl			
	150				149.9' 0-5°, B, R4-R5, O, Pl 150.3' 0-5°, B, R5, t, Pl			
824					150.9' 0-5°, B, R4, O, Pl			
	152				151.6' 0-5°, B, R5, PtO-t, Pl 151.9' 0-5°, B, R5, PtO-t, Pl			
822					152.9' 0-5°, B, R5, t, Pl		152.6 to 180.6' **OHIO SHALE**, black, very fine grained, slightly to moderately weathered, moderately hard, slightly to moderately fractured, thinly bedded	Run-5 152.6' - 162.6' 50 minute run Down Pressure = 600 Psi
	154							
820					154.9' 0-5°, B, R5, PtO-t, Pl 155.1' 0-5°, B, R5, PtO-t, Pl			
	156	82	95	1.2	155.2' 0-5°, B, R4, O, Pl 155.9' 0-5°, B, R5, PtO-t, Pl	5		
818					157.2' 0-5°, B, R5, t, Pl			
	158				158.0' 0-5°, B, R4-R5, O, Pl 158.4' 0-5°, B, R5, t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-17	
Coordinates: N 765509.6 E 1867882.3	Driller: Rii/ S. P	Sheet No. 2 of 2	
Top Drillhole Elevation: 975.1 feet MSL	Logged By: John Ristow/ AECOM		
Bottom Elevation: 794.5 feet MSL	Prepared By: A. Mirza		
Total Depth: 180.6 feet	Checked By: B. Madras Natarajan	Date Start: 11/28/17 End: 12/4/17	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
816								
	160				159.2' 0-5°, B, R4, O, Pl			
					159.9' 0-5°, B, R4-R5, O, Pl			
814		82	95	1.2	160.2' 0-5°, B, R5, t, Pl	5		
	162				160.8' 0-5°, B, R4, O, Pl			
812								Run-6 162.6' - 172.6' 45 minute run
					163.2' 0-5°, B, R5, PtO-t, Pl			Down Pressure = 600 Psi
	164				163.6' 0-5°, B, R5, PtO-t, Pl			
810					163.9' 0-5°, B, R5, PtO-t, Pl			
					165.1' 0-5°, B, R4, O, Pl			
	166				165.5' 0-5°, B, R5, PtO-t, Pl			
					166.1' 0-5°, B, R4-R5, O, Pl			
808								
		96	100	1.5	167.0' 0-5°, B, R5, t, Pl			
	168				167.6' to 167.8 90° Jt, R4, O, Und	6		
					168.0' 0-5°, B, R4-R5, O, Pl			
806					168.6' 0-5°, B, R5, t, Pl			
	170							
					170.4' 0-5°, B, R4, O, Pl			
804					171.0' 0-5°, B, R4-R5, O, Pl			
	172				171.8' 0-5°, B, R5, t, Pl			
					172.0' 0-5°, B, R4, O, Pl			
802					172.3' 0-5°, B, R5, PtO-t, Pl			Run-7 172.6' - 180.6' 30 minute run
	174				172.9' 0-5°, B, R5, PtO-t, Pl			Down Pressure = 600 Psi
					173.1' 0-5°, B, R4, O, Pl			
800					173.8' 0-5°, B, R5, PtO-t, Pl			
					174.0' 0-5°, B, R5, t, Pl			
	176				174.6' 0-5°, B, R4, O, Pl			
					175.6' 0-5°, B, R5, PtO-t, Pl			
798		82	94	1.4	176.0' 0-5°, B, R4, O, Pl	7		
					176.3' 0-5°, B, R5, PtO-t, Pl			
	178				177.0' 0-5°, B, R4, O, Pl			
796					177.6' 0-5°, B, R4, O, Pl			
	180				180.2' 0-5°, B, R4, O, Pl			
794							**End of Boring at 180.6 feet**	
	182							
792								
	184							
790								
	186							
788								
	188							
786								
	190							
784								
	192							
782								
	194							
780								
	196							
778								
	198							

SUBSURFACE LOG

EXPLORATION ID: B-18

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	766286.182 1867931.269			**DATE STARTED**	12/12/17	**COMPLETED**	12/18/17
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	90.2 % (Avg.)	**SURFACE ELEVATION**	981.6 ft	**DEPTH TO WATER**	9.1 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	NQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A	**DATE/TIME**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	CME 45 Truck \00	**BOREHOLE INCLINATION (VERT.)**	Vertical		

MATERIAL DESCRIPTION AND NOTES	ELEV. 981.58	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
CONCRETE PAVEMENT	980.9																
STIFF TO VERY STIFF, LIGHT BROWN TO GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST - FILL		1–2	17-6-7	22	SS-1	2.5	-	-	-	-	-	-	-	-	-		
		3–4	6-9-7	67	SS-2	3.0-4.0	-	-	-	-	-	-	-	-	-		
		5–6	2-3-5	56	SS-3	2.5-3.0	-	-	-	-	-	-	-	-	-		
- WEATHERED GLACIAL TILL	W	7–8	3-6-8	61	SS-4	2.5-2.75	-	-	-	-	-	-	-	-	-		
		9–10	10-9-16	33	SS-5	3.5-4.0	-	-	-	-	-	-	-	-	-		
		11–12															
- SAND SEAMS @ 15.3' AND 15.8'		13–14	6-9-13	61	SS-6	3.5-3.75	-	-	-	-	-	-	-	-	-		
		15–16															
		17–18	14-14-11	44	SS-7	2.5	-	-	-	-	-	-	-	-	-		
- CRUSHED, HIGHLY WEATHERED, YELLOW GREEN SANDY SHALE AND SANDSTONE @ 20.0' TO 23.08' - HIT BOULDER		19–20	50/2.4"	67	SS-8		-	-	-	-	-	-	-	-	-		
		21–22															
		23–24	22-33-37	78	SS-9		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **FINE SAND**, TRACE SILT, WET	957.1																

SUBSURFACE LOG

EXPLORATION ID: B-18

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 981.6 ft LOCATION 766286.182 1867931.269 DATE STARTED / DATE COMPLETED 12/12/17 - 12/18/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM DENSE, GRAY, **FINE SAND**, TRACE SILT, WET *(continued)*		26	8-15-17	61	SS-10		-	-	-	-	-	-	-	-	-		
		27															
		28	10-16-17	56	SS-11		-	-	-	-	-	-	-	-	-		
		29															
		30	11-17-18	56	SS-12		-	-	-	-	-	-	-	-	-		
		31															
		32															
		33	11-20-22	78	SS-13		-	-	-	-	-	-	-	-	-		
		34															
		35	15-17-22	67	SS-14		-	-	-	-	-	-	-	-	-		
		36															
		37															
		38	10-18-24	72	SS-15		-	-	-	-	-	-	-	-	-		
		39															
		40	11-14-12	67	SS-16		-	-	-	-	-	-	-	-	-		
		41															
	939.6	42															
HARD, **SILTY CLAY**, WITH SOME SAND AND GRAVEL		43	8-14-31	67	SS-17	4.0-4.5+	-	-	-	-	-	-	-	-	-		
- GLACIAL TILL		44															
		45															
		46	9-8-50/1.2"	29	SS-18	4.5+	-	-	-	-	-	-	-	-	-		
- CRUSHED LIMESTONE FRAGMENTS IN SAMPLE		47															
		48	12-14-13	33	SS-19	4.0	-	-	-	-	-	-	-	-	-		
- LIMESTONE COBBLE IN SAMPLE		49															
- HARD DRILLING AT 50.0'		50															
		51	20-38-50/3"	40	SS-20		-	-	-	-	-	-	-	-	-		
	930.1 TR																

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-18

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 981.6 ft LOCATION 766286.182 1867931.269 DATE STARTED / DATE COMPLETED 12/12/17 - 12/18/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
BROWN TO GRAY STONE FRAGMENTS, SANDSTONE. *(continued)*		52															
		53	50/4"	50	SS-21		-	-	-	-	-	-	-	-	-		
		54															
		55															
		56	17-19-50/2"	43	SS-22		-	-	-	-	-	-	-	-	-		
		57															
		58	50/5"	60	SS-23		-	-	-	-	-	-	-	-	-		
		59															
		60															
INTERBEDDED SANDSTONE AND SHALE	921.6		50/5.5"	18	SS-24		-	-	-	-	-	-	-	-	-		
SLIGHTLY WEATHERED, HARD, FINE GRAINED, SANDSTONE, GRAY, MASSIVE, SLIGHTLY FRACTURED, FLAT SLIGHTLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, GRAY, THIN BEDDED.	921.1																

Boring Continues on Following Rock Description Log

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-18**
Coordinates: N 766286.2 E 1867931.3	Driller: Rii/ S.P		**Sheet No. 1 of 4**
Top Drillhole Elevation: 981.6 feet MSL	Logged By: John Ristow/ AECOM		
Bottom Elevation: 796.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 185.0 feet	Checked By: B. Madras Natarajan	Date Start: 12/12/17 End: 12/18/17	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
926	56							Refer to soil borings for details on soil descriptions/classifications
924	58							
922	60				60.0' to 60.4' fractured rock 60.6' to 60.8' fractured rock 61.2' to 62.0' fractured rock		60.0 to 80.0' **BEREA SANDSTONE** interbedded with **BEDFORD SHALE** **BEREA SANDSTONE**, grey, fine grained, slightly weathered, hard, slightly fractured along flat bedding, **BEDFORD SHALE**, grey, very fine grained, slightly weathered, soft, thinly bedded	Top of Rock @ 60.0'
920	62	0	52	N/A		1		Run-1 60.0' - 64.0' 15 minute run Down Pressure = 450 Psi
918	64	100	100	1.0		2		Run-2 64.0' - 65.0' 10 minute run Down Pressure = 200 Psi
916	66	0	100	2.8	64.8' 0-5°, B, R3-R4, O, Pl, Cl 65.2' 0-5°, B, R4, O, Pl, Cl 65.4' to 65.5' fractured rock 65.7' 0-5°, B, R3-R4, O, Pl, Cl 65.9' 0-5°, B, R4-R5, O, Pl, Cl 66.1' 0-5°, B, R5, PtO-t, Pl 66.4' 0-5°, B, R4, O, Pl 66.7' 0-5°, B, R4-R5, O, Pl 67.1' 0-5°, B, R5, PtO-t, Pl 67.5' 0-5°, B, R4, O, Pl 67.7' 0-5°, B, R3-R4, O, Pl, Cl	3		Run-3 65.0' - 70.0' 15 minute run Down Pressure = 300 Psi
914	68							
912	70	28	69	1.4	68.3' 0-5°, B, R4, O, Pl 68.7' 0-5°, B, R4-R5, O, Pl 69.3' 0-5°, B, R4, O, Pl, Cl 69.7' 0-5°, B, R3-R4, O, Pl, Cl 70.0' to 70.3' fractured rock 70.5' 0-5°, B, R4, O, Pl 70.7' 30°, Jt, R3-R4, O, Und 71.0' 0-5°, B, R5, PtO-t, Pl 71.7' 0-5°, B, R4, O, Pl 72.0' 0-5°, B, R4-R5, O, Pl 72.4' 0-5°, B, R5, PtO-t, Pl 72.8' 0-5°, B, R4, O, Pl 73.4' 0-5°, B, R3-R4, O, Pl 73.7' 0-5°, B, R5, PtO-t, Pl 73.9' 0-5°, B, R4, O, Pl 74.3' 70°, Jt, R4, O, Und 75.7' 70°, Jt, R4, O, Und	4		Run-4 70.0' - 80.0' 40 minute run Down Pressure = 350 Psi
910	72							
908	74							
906	76							
904	78							
902	80				80.2' to 80.3 fractured rock 80.4' 0-5°, B, R4-R5, O, Pl 80.5' 0-5°, B, R5, PtO-t, Pl 80.6' 0-5°, B, R4, O, Pl 80.7' 0-5°, B, R3-R4, O, Pl 81.1' 0-5°, B, R5, PtO-t, Pl 81.2' 0-5°, B, R4, O, Pl 81.3' 0-5°, B, R5, t, Pl 81.4' 0-5°, B, R4-R5, O, Pl 81.5' 0-5°, B, R5, PtO-t, Pl 81.7' 0-5°, B, R4, O, Pl 81.8' 0-5°, B, R4-R5, O, Pl 82.0' 0-5°, B, R4, O, Pl 82.1' 0-5°, B, R4, O, Pl 82.2' 0-5°, B, R4-R5, O, Pl 82.4' 0-5°, B, R5, PtO-t, Pl 82.6' 0-5°, B, R4, O, Pl 83.0' 0-5°, B, R5, t, Pl 83.4' 0-5°, B, R4-R5, O, Pl 83.6' 0-5°, B, R4-R5, O, Pl 83.8' 0-5°, B, R5, PtO-t, Pl 84.2' 0-5°, B, R4, O, Pl	5	80.0 to 104.0' **BEDFORD SHALE** grey, fine grained, slightly weathered, soft, thinly bedded, flat	Run-5 80.0' - 90.0' 25 minute run Down Pressure = 400 Psi
900	82							
898	84	58	100	3.6				
896	86							
894	88							
892	90	66	100	2.9	84.6' 0-5°, B, R3-R4, O, Pl 85.3' 0-5°, B, R5, PtO-t, Pl 85.6' 0-5°, B, R4, O, Pl 86.1' 0-5°, B, R5, t, Pl 86.4' 0-5°, B, R4-R5, O, Pl 87.0' 0-5°, B, R5, PtO-t, Pl 87.3' 0-5°, B, R4, O, Pl 87.5' 0-5°, B, R4-R5, O, Pl 87.7' 0-5°, B, R4, O, Pl 87.8' 0-5°, B, R4, O, Pl	6		Run-6 90.0' - 100.0' 25 minute run Down Pressure = 400 Psi
890	92							
888	94							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-18**
Coordinates: N 766286.2 E 1867931.3	Driller: Rii/ S.P		**Sheet No. 2 of 4**
Top Drillhole Elevation: 981.6 feet MSL	Logged By: John Ristow/ AECOM		
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Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
886	96				88.1' 0-5°, B, R4-R5, O, Pl 88.5' 0-5°, B, R5, PtO-t, Pl 88.9' 0-5°, B, R4-R5, O, Pl 89.2' 0-5°, B, R4, O, Pl 89.5' 0-5°, B, R4, O, Pl			
884	98	66	100	2.9	90.0' 0-5°, B, R4-R5, O, Pl 90.3' 0-5°, B, R5, PtO-t, Pl 90.7' 0-5°, B, R4, O, Pl 90.8' 0-5°, B, R5, t, Pl 90.9' 0-5°, B, R4-R5, O, Pl 91.0' 0-5°, B, R4-R5, O, Pl	6		
882	100				91.2' 0-5°, B, R5, PtO-t, Pl 91.5' 0-5°, B, R4, O, Pl 91.7' 0-5°, B, R3-R4, O, Pl 91.8' 0-5°, B, R5, PtO-t, Pl 92.0' 0-5°, B, R4, O, Pl 92.1' 0-5°, B, R5, t, Pl 92.4' 0-5°, B, R4-R5, O, Pl 93.5' 0-5°, B, R5, PtO-t, Pl 94.2' 0-5°, B, R4, O, Pl			Run-7 100.0' - 110.0' 24 minute run Down Pressure = 425 Psi
880	102							
878	104						104.0 to 135.5' **BEDFORD SHALE** red, very fine grained, slightly weathered, soft, thinly bedded, flat	
876	106	65	99	2.8	94.9' 0-5°, B, R5, PtO-t, Pl 95.0' 0-5°, B, R4, O, Pl 96.3' 0-5°, B, R5, t, Pl 96.4' 0-5°, B, R4-R5, O, Pl 96.8' 0-5°, B, R5, PtO-t, Pl 97.1' 0-5°, B, R5, t, Pl 97.6' 0-5°, B, R4-R5, O, Pl 97.8' 0-5°, B, R4-R5, O, Pl 97.9' 0-5°, B, R5, PtO-t, Pl 98.3' 0-5°, B, R4, O, Pl 98.8' 0-5°, B, R3-R4, O, Pl 99.0' 0-5°, B, R5, PtO-t, Pl 99.7' 0-5°, B, R4, O, Pl	7		
874	108							
872	110				99.9' 0-5°, B, R5, t, Pl			Run-8 110.0' - 120.0' 11 minute run Down Pressure 450 Psi
870	112				100.3' 0-5°, B, R4-R5, O, Pl 101.0' 0-5°, B, R5, PtO-t, Pl 101.3' 0-5°, B, R4, O, Pl 101.4' 0-5°, B, R5, PtO-t, Pl 101.5' 0-5°, B, R4, O, Pl 101.8' 0-5°, B, R5, PtO-t, Pl 102.0' to 102.1' fractured rock 102.8' 0-5°, B, R5, PtO-t, Pl 102.9' 0-5°, B, R5, t, Pl			
868	114							
866	116	65	100	3.4	103.1' 0-5°, B, R4-R5, O, Pl 103.4' 0-5°, B, R4-R5, O, Pl 103.9' 0-5°, B, R5, PtO-t, Pl 104.1' 0-5°, B, R4, O, Pl 104.4' 0-5°, B, R3-R4, O, Pl 104.5' 0-5°, B, R5, PtO-t, Pl 104.9' 0-5°, B, R4, O, Pl 105.0' 0-5°, B, R5, t, Pl 105.8' 0-5°, B, R4-R5, O, Pl 106.8' 0-5°, B, R5, PtO-t, Pl 107.1' 0-5°, B, R4, O, Pl 107.3' 0-5°, B, R5, PtO-t, Pl	8		
864	118							
862	120				107.4' 0-5°, B, R4, O, Pl			Run-9 120.0' - 130.0' 23 minute run Down Pressure = 450 Psi
860	122				108.3' 0-5°, B, R5, PtO-t, Pl 108.7' 0-5°, B, R5, t, Pl 109.6' 0-5°, B, R4-R5, O, Pl 109.8' 0-5°, B, R5, PtO-t, Pl 109.9' 0-5°, B, R4, O, Pl 110.2' 0-5°, B, R5, PtO-t, Pl 110.3' 0-5°, B, R5, t, Pl 110.5' 0-5°, B, R4-R5, O, Pl 111.5' to 111.8' 0-5, 4 Bs, R4-R5, O, Pl 112.1' 0-5°, B, R5, PtO-t, Pl			
858	124							
856	126	85	100	1.4	112.3' 0-5°, B, R4, O, Pl 112.4' 0-5°, B, R5, PtO-t, Pl 113.1' 0-5°, B, R5, t, Pl 113.2' 0-5°, B, R4-R5, O, Pl 113.3' 0-5°, B, R4-R5, O, Pl 113.5' 0-5°, B, R5, PtO-t, Pl 113.8' 0-5°, B, R4, O, Pl 114.1' 0-5°, B, R5, PtO-t, Pl 114.3' 0-5°, B, R4, O, Pl 114.5' 0-5°, B, R5, t, Pl 114.9' 0-5°, B, R4-R5, O, Pl	9		
854	128							
852	130				115.0' 0-5°, B, R5, PtO-t, Pl			Run-10 130.0' - 140.0' 25 minute run Down Pressure = 400 - 450 Psi
850	132				115.2' 0-5°, B, R5, t, Pl 115.7' 0-5°, B, R4-R5, O, Pl 115.9' 0-5°, B, R4-R5, O, Pl 116.1' 0-5°, B, R5, PtO-t, Pl 116.3' 0-5°, B, R4, O, Pl			
848	134	93	100	1.3	116.5' 0-5°, B, R3-R4, O, Pl 116.9' 0-5°, B, R5, PtO-t, Pl 117.3' 0-5°, B, R4, O, Pl 117.8' 0-5°, B, R4-R5, O, Pl 118.3' 0-5°, B, R5, PtO-t, Pl	10		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-18	
Coordinates: N 766286.2 E 1867931.3	Driller: Rii/ S.P	Sheet No. 3 of 4	
Top Drillhole Elevation: 981.6 feet MSL	Logged By: John Ristow/ AECOM		
Bottom Elevation: 796.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 185.0 feet	Checked By: B. Madras Natarajan	Date Start: 12/12/17 End: 12/18/17	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
846	136				119.0' 0-5°, B, R4, O, Pl 119.6' 0-5°, B, R5, PtO-t, Pl 119.9' 0-5°, B, R4, O, Pl 120.1' 0-5°, B, R5, t, Pl		135.5 to 156.0' **BEDFORD SHALE**, grey, very fine grained, slightly weathered, soft, thinly bedded, flat	
844	138	93	100	1.3	120.2' 0-5°, B, R4-R5, O, Pl 122.5' 0-5°, B, R5, PtO-t, Pl 123.8' 0-5°, B, R5, t, Pl 124.4' 0-5°, B, R4-R5, O, Pl 124.9' 0-5°, B, R3-R4, O, Pl 125.0' 0-5°, B, R5, PtO-t, Pl 126.0' 0-5°, B, R4, O, Pl	10		
842	140				126.8' 0-5°, B, R4-R5, O, Pl 127.1' 0-5°, B, R5, PtO-t, Pl 128.3' 0-5°, B, R4, O, Pl 129.1' 0-5°, B, R5, PtO-t, Pl 129.9' 0-5°, B, R4, O, Pl 130.8' 0-5°, B, R4-R5, O, Pl 131.9' 0-5°, B, R5, PtO-t, Pl 132.4' 45°, Jt, R3-R4, O, Und 133.6' 0-5°, B, R4, O, Pl 133.9' 0-5°, B, R4-R5, O, Pl 134.2' 30°, Jt, R4, O, Und			Run-11 140.0' - 150.0' 26 minute run Down Pressure = 450 Psi
840	142							
838	144	95	100	0.6		11		
836	146				135.2' 0-5°, B, R5, PtO-t, Pl 135.8' 0-5°, B, R5, t, Pl 135.9' 0-5°, B, R4-R5, O, Pl 137.7' 0-5°, B, R4-R5, O, Pl 138.1' 0-5°, B, R5, PtO-t, Pl 138.7' 0-5°, B, R4, O, Pl 139.7' 0-5°, B, R3-R4, O, Pl 143.0' 0-5°, B, R5, PtO-t, Pl 145.2' 0-5°, B, R4, O, Pl 145.8' 0-5°, B, R4-R5, O, Pl 147.7' 0-5°, B, R5, PtO-t, Pl			
834	148							
832	150				147.9' 0-5°, B, R4, O, Pl 148.2' 0-5°, B, R5, PtO-t, Pl 150.6' 0-5°, B, R4, O, Pl			Run-12 150.0' - 160.0' 23 minute run Down Pressure = 400 Psi
830	152				151.7' 0-5°, B, R5, t, Pl			152.7' - 153.0' UCS = 4,621 Psi
828	154							
826	156	87	90	0.6	154.9' 0-5°, B, R4, O, Pl	12	156.0 to 185.0' **OHIO SHALE** black, very fine grained, slightly weathered, moderately hard, thinly bedded, flat	
824	158				156.5' 0-5°, B, R4-R5, O, Pl 157.0' 0-5°, B, R4-R5, O, Pl			
822	160				159.2' 0-5°, B, R5, PtO-t, Pl			Run-13 160.0' - 170.0' 16 minute run Down Pressure = 500 Psi 161.0' - 161.4' UCS = 5,621 Psi
820	162				161.8' 0-5°, B, R4, O, Pl			
818	164				163.1' 0-5°, B, R3-R4, O, Pl			
816	166	97	98	0.4	165.7' 0-5°, B, R5, PtO-t, Pl	13		
814	168				167.3' 0-5°, B, R4, O, Pl			
812	170							Run-14 170.0' - 180.0' 25 minute run Down Pressure = 500 Psi
810	172	96	100	0.8	171.8' 0-5°, B, R4-R5, O, Pl	14		
808	174				173.9' 0-5°, B, R5, PtO-t, Pl 174.5' 0-5°, B, R4, O, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-18**
Coordinates: N 766286.2 E 1867931.3	Driller:	Rii/ S.P	**Sheet No. 4 of 4**
Top Drillhole Elevation: 981.6 feet MSL	Logged By:	John Ristow/ AECOM	
Bottom Elevation: 796.6 feet MSL	Prepared By:	A. Mirza	
Total Depth: 185.0 feet	Checked By:	B. Madras Natarajan	Date Start: 12/12/17 End: 12/18/17
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 9.1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
806	176				175.0' 0-5°, B, R5, PtO-t, Pl 175.5' 0-5°, B, R4, O, Pl			
804	178	96	100	0.8	176.8' 0-5°, B, R5, t, Pl 177.3' 0-5°, B, R4, O, Pl 178.3' 0-5°, B, R4-R5, O, Pl	14		
802	180							Run-15 180.0' - 185.0' 12 minute run Down Pressure = 500 Psi
800	182	95	100	0.6	181.3' 0-5°, B, R4, O, Pl 182.1' 0-5°, B, R5, PtO-t, Pl	15		
798	184				183.3' 0-5°, B, R4, O, Pl			
796	186						**End of Boring at 185.0 feet**	
794	188							
792	190							
790	192							
788	194							
786	196							
784	198							
782	200							
780	202							
778	204							
776	206							
774	208							
772	210							
770	212							
768	214							

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-19

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770427.091 1869729.587			**DATE STARTED**	3/6/18	**COMPLETED**	3/13/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	89.8 % (Avg.)	**SURFACE ELEVATION**	979.2 ft	**DEPTH TO WATER**	2.1 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A	**DATE/TIME**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 2	**BOREHOLE INCLINATION (VERT.)**	Vertical		

MATERIAL DESCRIPTION AND NOTES	ELEV. 979.15	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
STIFF TO VERY STIFF, BROWN, **CLAY**, TRACE GRAVEL, DAMP		1	WH-4-5	93	SS-1	2.5 - 3.75	-	-	-	-	-	-	-	-	-		
		2															
		3	5-7-12	100	SS-2	2.75 - 3.75	-	-	-	-	-	-	-	-	-		
	W	4															
	974.2	5															
STIFF TO VERY STIFF, BROWN AND ORANGE MOTTLED, **CLAY**, LITTLE SAND AND STONE FRAGMENTS, MOIST		6	5-8-8	100	SS-3	1.75 - 2.0	-	-	-	-	-	-	-	-	-		
		7															
		8	6-7-7	100	SS-4	1.0	-	-	-	-	-	-	-	-	-		
		9															
	969.2	10															
MEDIUM DENSE TO DENSE, GRAY, **SILTY SAND**, FINE GRAINED, TRACE GRAVEL, DAMP TO MOIST		11	5-3-3	100	SS-5	1.0 - 2.0	-	-	-	-	-	-	-	-	-		
		12															
		13	3-5-7	100	SS-6		-	-	-	-	-	-	-	-	-		
		14															
		15															
		16	11-15-21	100	SS-7		-	-	-	-	-	-	-	-	-		
		17															
		18	18-21-33	100	SS-8		-	-	-	-	-	-	-	-	-		
		19															
		20															
		21	17-17-22	100	SS-9		-	-	-	-	-	-	-	-	-		
		22															
	956.7	23															
MEDIUM DENSE, BROWN, **FINE SAND**, LITTLE GRAVEL, TRACE SILT, MOIST TO WET		24	8-15-19	100	SS-10		-	-	-	-	-	-	-	-	-		

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

Printed on 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-19

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.2 ft LOCATION 770427.091 1869729.587 DATE STARTED / DATE COMPLETED 3/6/18 - 3/13/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
MEDIUM DENSE, BROWN, **FINE SAND**, LITTLE GRAVEL, TRACE SILT, MOIST TO WET *(continued)*		26	6-14-23	100	SS-11		-	-	-	-	-	-	-	-	-		
		27															
		28	34-27-27	100	SS-12		-	-	-	-	-	-	-	-	-		
		29															
		30															
		31	15-15-40	100	SS-13		-	-	-	-	-	-	-	-	-		
		32															
		33	25-35-50/2.4"	83	SS-14		-	-	-	-	-	-	-	-	-		
		34															
	944.2 TR	35	50/3.6"	100	SS-15		-	-	-	-	-	-	-	-	-		
SEVERELY WEATHERED TO DECOMPOSED, SOFT, VERY FINE GRAINED, SHALE, ARENACEOUS, THIN BEDDED, HIGHLY FRACTURED, FLAT, SEVERELY WEATHERED JOINTS.		36															
		37															
		38	50/2.4"	100	SS-16		-	-	-	-	-	-	-	-	-		
		39															
	938.7	40	50/3.6"	100	SS-17		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 145.0 TO 165.0 FEET (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; SAND

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-19**
Coordinates:	N 770427.1 E 1869729.6	Driller:	Stantec/ M.M	**Sheet No. 1 of 4**
Top Drillhole Elevation:	979.2 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	797.3 feet MSL	Prepared By:	A. Mirza	
Total Depth:	181.9 feet	Checked By:	B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 2.1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
944	36							Refer to soil borings for details on soil descriptions/classifications
942	38							
940	40							
938	42			N/A	40.5' to 42.5' fractured rock	1	40.5 to 46.9' Interbedded **SHALE** and **SANDSTONE** **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft, thinly bedded, highly fractured, flat **BEREA SANDSTONE**, gray, fine to medium grained, slightly to moderately weathered, hard, thinly bedded, moderately to highly fractured, flat, moderately weathered joints.	Run-1 40.5' - 46.9' 20 minute run Down Pressure = 200 - 350 Psi
936	44	8	59		42.7' 0-5°, B, R4, O, Pl, Cl 42.9' 0-5°, B, R4-R5, O, Pl, CL 43.1' 0-5°, B, R5, PtO-t, Pl 43.7' 0-5°, B, R5, O, Pl 43.8' to 44.1' fractured rock			
934	46							
932	48			N/A	47.2' 0-5°, B, R5, PtO-t, Pl 47.6' 0-5°, B, R4-R5, O, Pl 47.9' to 48.6' fractured rock	2	46.9 to 56.9' Interbedded **SHALE** and **SANDSTONE** (67% / 33%) **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft, thinly bedded, highly fractured, flat, highly weathered joints. **BEREA SANDSTONE**, gray, fine to medium grained, slightly to moderately weathered, hard, thinly bedded, moderately to highly fractured, flat, moderately weathered joints.	Run-2 46.9' - 56.9' 34 minute run Down Pressure = 400 Psi
930	50				49.1' to 49.8' fractured rock			
928	52	10	32					
926	54							
924	56							
922	58			N/A	56.9' to 57.8' fractured rock 58.2' to 60.1' fractured rock	3	56.9 to 66.9' **BEDFORD SHALE** grey, very fine grained, highly weathered, soft to moderately hard, thinly bedded, highly fractured, flat, highly weathered joints	Run-3 56.9' - 61.9' 13 minute run Down Pressure = 400 Psi
920	60				60.6' to 60.9' fractured rock			
918								
916	62	20	40	N/A	61.9' to 62.5' fractured rock 62.8' 0-5°, B, R5, O, Pl 63.1' 0-5°, B, R4-R5, O, Pl 63.2' to 63.5' fractured rock	4		Run-4 61.9' - 66.9' 22 minute run Down Pressure = 400 Psi
914	64	20	30					
912	66							
910	68	56	90	2	67.2' to 67.4' fractured rock 67.7' 0-5°, B, R4-R5, O, Pl 68.3' 0-5°, B, R5, t, Pl 68.6' 0-5°, B, R5, O, Pl 68.9' 0-5°, B, R4-R5, O, Pl 69.8' 0-5°, B, R4-R5, O, Pl 70.3' 0-5°, B, R5, t, Pl 70.6' 0-5°, B, R4-R5, O, Pl 70.9' 0-5°, B, R5, O, Pl	5	66.9 to 101.9' **BEDFORD SHALE** grey, very fine grained, slightly to moderately weathered, moderately hard, thinly bedded, highly fractured, flat, slightly to highly weathered joints	Run-5 66.9' - 71.9' 10 minute run Down Pressure = 450 Psi
908	70							
906	72	36	96	2.6	71.3' 0-5°, B, R4, PtO-t, Pl 72.1' to 72.5' 0-5°, 5 Bs, R4-R5, O, Pl 72.7' 0-5°, B, R4, PtO-t, Pl 72.9' 0-5°, B, R4-R5, O, Pl 73.3' 0-5°, B, R5, O, Pl 73.5' to 73.9' 0-5°, 6 Bs, R4-R5, O, Pl 74.3' 0-5°, B, R5, PtO-t, Pl	6		Run-6 71.9' - 81.9' 38 minute run Down Pressure = 450 - 500 Psi
	74							

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-19**	
Coordinates: N 770427.1 E 1869729.6	Driller: Stantec/ M.M	**Sheet No. 2 of 4**	
Top Drillhole Elevation: 979.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 797.3 feet MSL	Prepared By: A. Mirza		
Total Depth: 181.9 feet	Checked By: B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 2.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
904					74.6' 0-5°, B, R4, O, Pl 75.2' 0-5°, B, R5, PtO-t, Pl 75.4' to 75.8' fractured rock 76.3' 0-5°, B, R4-R5, O, Pl 76.7' 0-5°, B, R5, O, Pl 76.9' to 77.1' fractured rock 77.4' 0-5°, B, R4, PtO-t, Pl 77.6' 0-5°, B, R5, O, Pl 77.9' 0-5°, B, R5, PtO-t, Pl 78.5' 0-5°, B, R5, t, Pl 78.7' 0-5°, B, R5, PtO-t, Pl 79.2' to 79.3' fractured rock 79.5' to 79.9' 0-5°, 5 Bs, R4-R5, O, Pl 80.8' 0-5°, B, R5, PtO-t, Pl 81.4' to 81.5' fractured rock	6		
902	76							
900	78	36	96	2.6				
898	80							
896	82				81.9' to 82.4' fractured rock 82.4' to 82.9' 0-5°, 5 Bs, R4-R5, PtO-t, Pl 83.2' 0-5°, B, R5, t, Pl 83.4' 0-5°, B, R5, PtO-t, Pl 83.6' to 83.9' 0-5°, 5 Bs, R4-R5, O, Pl 84.2' 0-5°, B, R5, O, Pl 84.4' 0-5°, B, R4-R5, PtO-t, Pl 86.1' to 86.5' fractured rock 86.5' to 87.0' 0-5°, 7 Bs, R4-R5, O, Pl 87.2' 0-5°, B, R5, t, Pl 87.3' 0-5°, B, R5, PtO-t, Pl 87.5' 0-5°, B, R5, t, Pl 87.7' 0-5°, B, R4-R5, O, Pl 88.0' 0-5°, B, R4, O, Pl 88.2' 0-5°, B, R5, PtO-t, Pl 88.4' 0-5°, B, R5, t, Pl 88.6' 0-5°, B, R5, PtO-t, Pl 88.8' 0-5°, B, R5, t, Pl 89.0' 0-5°, B, R5, PtO-t, Pl	7		Run-7 81.9' - 91.9' 45 minute run Down Pressure = 500 Psi
894	84							
892	86	40	87	3.7				
890	88							
888	90							
886	92				89.2' 0-5°, B, R4-R5, t, Pl 89.5' 0-5°, B, R5, O, Pl 89.7' 0-5°, B, R5, PtO-t, Pl 90.1' 0-5°, B, R4-R5, O, Pl 90.4' 0-5°, B, R5, t, Pl 91.6' 0-5°, B, R4-R5, O, Pl 93.4' 0-5°, B, R5, PtO-t, Pl 93.6' 0-5°, B, R4, O, Pl 93.9' 0-5°, B, R5, O, Pl 94.5' 0-5°, B, R4-R5, O, Pl 94.9' 0-5°, B, R5, t, Pl 95.4' 0-5°, B, R4-R5, O, Pl 95.6' 0-5°, B, R5, O, Pl 96.0' to 96.2' fractured rock	8		Run-8 91.9' - 101.9' 56 minute run Down Pressure = 500 Psi Core barrel plugged off during run
884	94							
882	96	20	52	N/A				
880	98							
878	100							
876	102				101.9' to 102.4' fractured rock 102.6' 0-5°, B, R5, t, Pl 102.8' 0-5°, B, R4-R5, O, Pl 103.0' 0-5°, B, R5, O, Pl 103.2' 0-5°, B, R5, PtO-t, Pl 103.3' 0-5°, B, R4, t, Pl 103.6' 0-5°, B, R5, O, Pl 103.7' 0-5°, B, R4-R5, t, Pl 103.8' 0-5°, B, R4-R5, O, Pl 104.9' 0-5°, B, R5, O, Pl	9	101.9 to 126.9' **BEDFORD SHALE** red, very fine grained, highly weathered, soft, thinly bedded, highly to intensely fractured, flat, highly weathered joints	Run-9 101.9' - 106.9' 15 minute run Down Pressure = 450 Psi
874	104	0	100	3.8				
872	106							
870	108				105.9' to 106.9' 0-5°, 10 Bs, R4-R5, O, Pl 106.9' to 108.2' fractured rock 108.2' to 108.9' 0-5°, 9 Bs, R4-R5, O, Pl 109.0' to 109.9' 0-5°, 11 Bs, R4-R5, O, Pl 110.1' 0-5°, B, R5, PtO-t, Pl 110.3' 0-5°, B, R5, O, Pl 110.5' 0-5°, B, R4, t, Pl 110.9' 0-5°, B, R5, PtO-t, Pl	10		Run-10 106.9' - 111.9' 13 minute run Down Pressure = 450 Psi
868	110	0	92	5.4				
866	112				111.3' 0-5°, B, R5, PtO-t, Pl 111.5' 0-5°, B, R4, t, Pl 111.7' 0-5°, B, R5, PtO-t, Pl 112.0' 0-5°, B, R4, O, Pl 112.2' 0-5°, B, R5, PtO-t, Pl 112.5' 0-5°, B, R4-R5, O, Pl	11		Run-11 111.9' - 116.9' 20 minute run Down Pressure = 450 Psi
864	114	10	92	4.2				

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-19**	
Coordinates: N 770427.1 E 1869729.6	Driller: Stantec/ M.M	**Sheet No. 3 of 4**	
Top Drillhole Elevation: 979.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 797.3 feet MSL	Prepared By: A. Mirza		
Total Depth: 181.9 feet	Checked By: B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 2.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
864					112.6' 0-5°, B, R5, t, Pl 112.8' 0-5°, B, R4-R5, O, Pl 113.1' 0-5°, B, R4-R5, O, Pl 113.3' 0-5°, B, R5, PtO-t, Pl	11		
862	116	10	92	4.2	113.5' 0-5°, B, R4, t, Pl 113.7' 0-5°, B, R5, PtO-t, Pl 113.9' 0-5°, B, R5, PtO-t, Pl 114.1' 0-5°, B, R4-R5, O, Pl 114.4' 0-5°, B, R5, O, Pl 114.5' 0-5°, B, R4, t, Pl 114.7' 0-5°, B, R5, t, Pl 114.9' 0-5°, B, R4-R5, O, Pl 115.2' 0-5°, B, R4, PtO-t, Pl 115.6' 0-5°, B, R5, t, Pl 116.2' 0-5°, B, R4-R5, O, Pl	12		Run-12 116.9' - 121.9' 17 minute run Down Pressure = 450 Psi
860	118							
858	120	26	82	5				
856	122				116.4' 0-5°, B, R5, t, Pl 116.5' 0-5°, B, R4-R5, O, Pl 116.6' 0-5°, B, R4-R5, O, Pl 117.1' 0-5°, B, R4-R5, O, Pl 117.3' 0-5°, B, R5, PtO-t, Pl 118.1' 0-5°, B, R4, t, Pl 118.5' 0-5°, B, R5, O, Pl 118.7' 0-5°, B, R5, PtO-t, Pl 118.9' 0-5°, B, R5, t, Pl 119.1' to 120.0' 0-5°, 10 Bs, R4-R5, O, Pl 120.9' to 121.9' 0-5°, 9 Bs, R4-R5, O, Pl	13		Run-13 121.9' - 126.9' 17 minute run Down Pressure = 450 Psi
854	124	14	100	4.8				
852	126							
850	128	38	110	5.2	122.2' 0-5°, B, R5, O, Pl 122.4' 0-5°, B, R4, t, Pl 122.6' 0-5°, B, R5, t, Pl 122.7' 0-5°, B, R4-R5, O, Pl 122.9' 0-5°, B, R4, O, Pl 123.1' 0-5°, B, R4-R5, O, Pl 123.6' 0-5°, B, R5, O, Pl 123.8' to 124.1' fractured rock 124.2' 0-5°, B, R5, t, Pl 124.6' 0-5°, B, R4-R5, O, Pl 124.8' 0-5°, B, R5, t, Pl	14	126.9 to 146.9' **BEDFORD SHALE** grey, very fine grained, moderately weathered, soft to moderately hard, thinly bedded, moderately to highly fractured, flat, moderately to highly weathered joints.	Run-14 126.9' - 131.9' 15 minute run Down Pressure = 400 Psi
848	130							
846	132				125.0' 0-5°, B, R5, PtO-t, Pl 125.3' 0-5°, B, R5, t, Pl 125.5' 0-5°, B, R5, t, Pl 125.7' 0-5°, B, R4-R5, O, Pl 125.9' 0-5°, B, R5, O, Pl 126.1' 126.9' 0-5°, 9 Bs, R4-R5, O, Pl 127.6' 0-5°, B, R4-R5, O, Pl 127.9' 0-5°, B, R5, O, Pl 128.5' 0-5°, B, R5, O, Pl 128.6' to 129.3 0-5°, 10 Bs, R4-R5, O, Pl 129.6' 0-5°, B, R4, O, Pl 129.7' 0-5°, B, R4-R5, O, Pl	15		Run-15 131.9' - 136.9' 14 minute run Down Pressure = 400 Psi
844	134	28	92	3.6				
842	136							
840	138	42	90	1.6	129.9' to 130.5' 0-5°, 9 Bs, R4-R5, O, Pl 130.7' 0-5°, B, R5, O, Pl 130.8' 0-5°, B, R5, PtO-t, Pl 131.9' to 132.4' fractured rock 132.6' 0-5°, B, R5, O, Pl 132.8' to 133.6' 0-5°, 13 Bs, R4-R5, PtO-t, Pl 134.2' 0-5°, B, R5, PtO-t, Pl 135.0' to 135.6' fractured rock 135.7' 0-5°, B, R5, O, Pl	16		Run-16 136.9' - 141.9' 24 minute run Down Pressure = 400 Psi
838	140							
836	142				135.9' 0-5°, B, R4-R5, O, Pl 136.1' 0-5°, B, R5, PtO-t, Pl 137.1' 0-5°, B, R4, O, Pl 138.3' to 138.8' fractured rock 139.0' 0-5°, B, R4, t, Pl 139.2' 0-5°, B, R5, t, Pl 139.6' 0-5°, B, R4-R5, O, Pl 139.9' 0-5°, B, R4, t, Pl 140.3' 0-5°, B, R5, PtO-t, Pl 140.6' to 140.8' fractured rock 141.2' 0-5°, B, R5, O, Pl 141.4' 0-5°, B, R4-R5, t, Pl	17		Run-17 141.9' - 146.9' 10 minute run Down Pressure = 400 Psi
834	144	38	106	3.2				
832	146							
830	148	68	90	1.2	141.5' to 141.9' fractured rock 142.3' 0-5°, B, R4, t, Pl 142.4' 0-5°, B, R5, PtO-t, Pl 142.7' 0-5°, B, R4, O, Pl 142.8' 0-5°, B, R5, PtO-t, Pl 143.2' 0-5°, B, R4-R5, O, Pl 143.4' 0-5°, B, R5, PtO-t, Pl 143.7' 0-5°, B, R4, t, Pl 143.9' 0-5°, B, R5, PtO-t, Pl 144.2' 0-5°, B, R4, O, Pl 144.4' 0-5°, B, R5, PtO-t, Pl	18	146.9 to 181.9' **OHIO SHALE**, black, very fine grained, slightly weathered, moderately hard to hard, thinly bedded, slightly fractured, slightly weathered joints.	Run-18 146.9' - 151.9' 8 minute run Down Pressure = 450 Psi
828	150							
826	152	52	102	2.8	144.6' 0-5°, B, R4-R5, O, Pl 145.1' 0-5°, B, R5, t, Pl 145.3' 0-5°, B, R4-R5, O, Pl 145.5' 0-5°, B, R5, t, Pl 145.9' 0-5°, B, R4-R5, O, Pl 146.4' 0-5°, B, R5, t, Pl	19		Run-19 151.9' - 161.9' 14 minute run Down Pressure = 400 Psi
824	154							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-19**	
Coordinates: N 770427.1 E 1869729.6	Driller: Stantec/ M.M	**Sheet No. 4 of 4**	
Top Drillhole Elevation: 979.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 797.3 feet MSL	Prepared By: A. Mirza		
Total Depth: 181.9 feet	Checked By: B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 2.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
824	156				147.3' 0-5°, B, R5, PtO-t, Pl 147.5' 0-5°, B, R4-R5, O, Pl 147.7' 0-5°, B, R5, PtO-t, Pl 150.9' 0-5°, B, R4, t, Pl 151.2' 0-5°, B, R5, PtO-t, Pl 151.5' 0-5°, B, R4, O, Pl 152.1' 0-5°, B, R4, O, Pl 152.2' 0-5°, B, R5, PtO-t, Pl 152.5' 0-5°, B, R4-R5, O, Pl 153.1' 0-5°, B, R5, PtO-t, Pl 153.4' 0-5°, B, R4, t, Pl 153.6' 0-5°, B, R5, PtO-t, Pl 153.8' 0-5°, B, R4, O, Pl 154.2' 0-5°, B, R5, PtO-t, Pl 154.6' 0-5°, B, R5, PtO-t, Pl			
822	158	52	102	2.8		19		
820	160							
818	162				155.1' 0-5°, B, R4-R5, O, Pl 155.3' 0-5°, B, R5, PtO-t, Pl 156.0' 0-5°, B, R5, t, Pl 156.3' 0-5°, B, R4-R5, O, Pl 156.6' 0-5°, B, R4-R5, O, Pl 156.8' 0-5°, B, R5, PtO-t, Pl 157.0' to 157.8' 0-5°, 5 Bs, R4, O, Pl 158.1' 0-5°, B, R5, PtO-t, Pl 158.3' 0-5°, B, R5, t, Pl 159.1' 0-5°, B, R4, t, Pl 159.3' 0-5°, B, R5, PtO-t, Pl 159.7' 0-5°, B, R4-R5, O, Pl 160.0' to 160.2' 90°, Jt, R3-R4, O, Und 160.7' 0-5°, B, R5, t, Pl 160.8' 0-5°, B, R4, O, Pl 161.1' to 161.3' fractured rock 162.1' 0-5°, B, R5, PtO-t, Pl 163.8' 0-5°, B, R5, O, Pl 164.9' 0-5°, B, R5, PtO-t, Pl 165.7' 0-5°, B, R4, O, Pl 167.3' 0-5°, B, R5, PtO-t, Pl 167.8' 0-5°, B, R4, O, Pl			Run-20 161.9' - 171.9' 13 minute run Down Pressure = 500 Psi
816	164							
814	166							
812	168	91	95	1		20		
810	170							
808	172				169.0' 0-5°, B, R5, O, Pl 169.6' 0-5°, B, R4-R5, t, Pl 171.3' 0-5°, B, R5, O, Pl 171.4' 0-5°, B, R4-R5, O, Pl 172.2' to 172.3' fractured rock 172.7' 0-5°, B, R5, PtO-t, Pl 174.0' 0-5°, B, R4, O, Pl 174.8' 0-5°, B, R5, O, Pl 175.2' 0-5°, B, R5, PtO-t, Pl 175.5' 0-5°, B, R4-R5, t, Pl 175.7' 0-5°, B, R5, PtO-t, Pl 176.6' 0-5°, B, R5, O, Pl 177.2' 0-5°, B, R4-R5, O, Pl 177.6' 0-5°, B, R4-R5, O, Pl 178.4' 0-5°, B, R5, PtO-t, Pl 178.6' 0-5°, B, R4, O, Pl 178.8' 0-5°, B, R5, PtO-t, Pl 179.1' to 179.7' 0-5°, 4 Bs, R4-R5, O, Pl 180.2' to 180.3' fractured rock 180.6' 0-5°, B, R5, O, Pl 181.3' to 181.6' fractured rock			Run-21 171.9' - 181.9' 10 minute run Down Pressure = 500 Psi
806	174							
804	176	64	96	1.8		21		
802	178							
800	180							
798	182						**End of Boring at 181.9 feet**	
796	184							
794	186							
792	188							
790	190							
788	192							
786	194							

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-20

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770396.654 1870020.398	**DATE STARTED**	2/19/18	**COMPLETED**	2/26/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	90.2 % (Avg.)	**SURFACE ELEVATION**	971.2 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	3.0 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	CME 45 Truck \00	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	2/27/18
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 971.23	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY SOFT, BLACK TO GRAY, **SILTY CLAY**, TRACE TO SOME GRAVEL AND SAND, MOIST		1															
		2	WH-WH-1	44	SS-1	0.75	-	-	-	-	-	-	-	-	-		
- ROOTS AND SLIGHT ORGANIC MATTER IN TOP 8.0'		3															
	W	4	WH-WH-WH	83	SS-2	0.5	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	WH-2-1	33	SS-3	0.5	-	-	-	-	-	-	-	-	-		
	963.2	8															
LOOSE, GRAY, **COARSE AND FINE SAND**, WITH GRAVEL, LITTLE STONE FRAGMENTS, MOIST TO WET		9	3-6-4	22	SS-4		-	-	-	-	-	-	-	-	-		
		10															
- SANDSTONE AND LIMESTONE COBBLES >2"		11															
		12	2-6-10	67	SS-5		-	-	-	-	-	-	-	-	-		
		13															
		14	12-11-10	72	SS-6		-	-	-	-	-	-	-	-	-		
		15															
		16															
		17	2-4-6	56	SS-7		-	-	-	-	-	-	-	-	-		
		18															
	952.0	19	5-10-11	100	SS-8		-	-	-	-	-	-	-	-	-		
LOOSE, GRAY, **SILTY SAND**, WET		20															
		21															
- SOFT, MOIST, GRAY SILTY CLAY WITH SAND AND GRAVEL @ 19.25' TO 19.75'		22	6-9-11	78	SS-9		-	-	-	-	-	-	-	-	-		
		23															

SUBSURFACE LOG

EXPLORATION ID: B-20

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 971.2 ft LOCATION 770396.654 1870020.398 DATE STARTED / DATE COMPLETED 2/19/18 - 2/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
LOOSE, GRAY, **SILTY SAND**, WET *(continued)*		25	5-11-13	83	SS-10		-	-	-	-	-	-	-	-	-		
	946.2																
STIFF, GRAY, **SILTY CLAY**, WITH GRAVEL, SOME SAND, MOIST		26															
		27	16-22-33	72	SS-11	2	-	-	-	-	-	-	-	-	-		
		28															
		29	23-18-27	78	SS-12	2	-	-	-	-	-	-	-	-	-		
		30															
	940.2	31															
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, WITH GRAVEL, LITTLE STONE FRAGMENTS, WET		32	8-13-18	83	SS-13		-	-	-	-	-	-	-	-	-		
		33															
		34	13-20-23	67	SS-14		-	-	-	-	-	-	-	-	-		
		35															
	934.7	36															
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, LITTLE STONE FRAGMENTS, MOIST		37	24-23-23	44	SS-15		-	-	-	-	-	-	-	-	-		
		38															
		39	14-15-10	72	SS-16	3.75-4.0	-	-	-	-	-	-	-	-	-		
		40															
		41															
		42	3-12-15	83	SS-17	3.75-4.0	-	-	-	-	-	-	-	-	-		
		43															
		44	25-47-50	56	SS-18	4.0	-	-	-	-	-	-	-	-	-		
		45															
		46															
		47	9-25-37	100	SS-19	3.75-4.0	-	-	-	-	-	-	-	-	-		
		48															
		49	5-27-48	72	SS-20	4.0+	-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-20

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 971.2 ft LOCATION 770396.654 1870020.398 DATE STARTED / DATE COMPLETED 2/19/18 - 2/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
- SANDSTONE COBBLE STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, LITTLE STONE FRAGMENTS, MOIST *(continued)*		50															
		51															
		52	8-32-50/5"	76	SS-21		-	-	-	-	-	-	-	-	-		
		53															
		54	34-50/5"	100	SS-22	4.0+	-	-	-	-	-	-	-	-	-		
		55															
		56															
		57	36-50/5"	82	SS-23	4.0+	-	-	-	-	-	-	-	-	-		
		58															
		59	16-40-25	78	SS-24	4.0+	-	-	-	-	-	-	-	-	-		
		60															
		61															
		62	18-30-45	0	SS-25		-	-	-	-	-	-	-	-	-		
		63															
		64	50/5"	100	SS-26	4.0	-	-	-	-	-	-	-	-	-		
		65															
		66	50/5"	20	SS-27		-	-	-	-	-	-	-	-	-		
		67															
	903.2 TR	68															
SHALE, GRAY, SOFT, SLIGHTLY TO MODERATELY WEATHERED, VERY FINE GRAINED, THIN BEDDED TO LAMINATED, FLAT BEDDING, MODERATELY FRACTURED.		69	50/5"	80	SS-28		-	-	-	-	-	-	-	-	-		
		70															
		71	50/5"	100	SS-29		-	-	-	-	-	-	-	-	-		
		72															
		73															
		74	50/4"	100	SS-30		-	-	-	-	-	-	-	-	-		
		75															

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-20

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 971.2 ft LOCATION 770396.654 1870020.398 DATE STARTED / DATE COMPLETED 2/19/18 - 2/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
SHALE, GRAY, SOFT, SLIGHTLY TO MODERATELY WEATHERED, VERY FINE GRAINED, THIN BEDDED TO LAMINATED, FLAT BEDDING, MODERATELY FRACTURED. *(continued)*		76	50/4"	100	SS-31		-	-	-	-	-	-	-	-	-		
		77															
		78															
	892.1	79	50/3"	100	SS-32		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 140.0' TO 160.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION); HIGH LEVELS HAZARDOUS GAS DURING DRILLING AND WELL IN ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; SAND

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-20**
Coordinates: N 770396.7 E 1870020.4	Driller: AECOM		**Sheet No. 1 of 3**
Top Drillhole Elevation: 971.2 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 178.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/19/18 End: 2/26/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
896	76							Refer to soil borings for details on soil descriptions/classifications
894	78							
892	80	70	100	2.5	79.3' 0-5°, B, R4-R5, O, Pl, Cl		79.1 to 97.8' **BEDFORD SHALE**, grey with red bands, fine grained, slightly weathered, soft, thinly bedded, moderately to highly fractured	Top of Rock @ 79.1'
890	82	74	98	1	80.2' 0-5°, B, R4, O, Pl 80.3' 0-5°, B, R5, t, Pl, Cl 82.5' 0-5°, B, R5, t, Pl 82.7' 0-5°, B, R4-R5, O, Pl	2		Run-1 79.1' - 79.5' 4 minute run Down Pressure = 250 Psi Run-2 79.5' - 84.5' 18 minute run Down Pressure = 400 Psi
888	84							
886	86	72	92	1.2	84.4' 0-5°, B, R4-R5, O, Pl 84.5' to 85.6' fractured rock 84.7' 0-5°, B, R4-R5, O, Pl, Cl 85.6' 0-5°, B, R4, O, Pl 86.3' 0-5°, B, R5, t, Pl, Cl 87.0' 0-5°, B, R5, t, Pl 87.5' 0-5°, B, R4-R5, O, Pl	3		Run-3 84.5' - 89.5' 15 minute run Down Pressure = 400 Psi
884	88							
882	90	73	100	1.2	89.3' 0-5°, B, R4-R5, O, Pl 89.6' to 89.7' fractured rock 90.2' 0-5°, B, R4, O, Pl 90.6' 0-5°, B, R5, t, Pl, Cl 91.5' 0-5°, B, R5, t, Pl 92.1' 0-5°, B, R4-R5, O, Pl 93.0' 0-5°, B, R4-R5, O, Pl 93.6' 0-5°, B, R5, t, Pl, Cl	4		Run-4 89.5' - 94.5' 16 minute run Down Pressure = 400 Psi
880	92							
878	94							
876	96	60	100	1.0	94.7' 0-5°, B, R5, t, Pl 95.4' 0-5°, B, R4-R5, O, Pl 95.8' 0-5°, B, R5, t, Pl, Cl 96.2' to 97.4' fractured rock 98.4' 0-5°, B, R4-R5, O, Pl 98.7' 0-5°, B, R5, t, Pl, Cl	5		Run-5 94.5' - 99.5' 13 minute run Down Pressure = 400 Psi
874	98							
872	100						97.8 to 116.5' **BEDFORD SHALE**, red, fine grained, slightly weathered, soft, thinly bedded, flat, moderately fractured	
870	102	93	94	1.6	99.7' 0-5°, B, R4-R5, O, Pl 100.1' 60°, Jt, R4, O, Und 101.0' 0-5°, B, R4-R5, O, Pl 102.3' 0-5°, B, R4-R5, O, Pl 102.4' 0-5°, B, R5, t, Pl, Cl 103.3' 0-5°, B, R5, t, Pl 103.6' 60°, Jt, R4-R5, t, Und	6		Run-6 99.5' - 104.5' 12 minute run Down Pressure = 400 Psi
868	104							
866	106	60	100	1.2	104.4' 0-5°, B, R4-R5, O, Pl 106.1' 0-5°, B, R4-R5, O, Pl 106.3' 0-5°, B, R5, t, Pl, Cl 106.4' 0-5°, B, R5, t, Pl 107.8' 45°, Jt, R4-R5, O, Und 108.4' 0-5°, B, R4-R5, O, Pl 108.6' 0-5°, B, R4, O, Pl	7		Run-7 104.5' - 109.5' 10 minute run Down Pressure = 400 Psi
864	108							
862	110							
860	112	71	94	1.2	109.0' 109.5' fractured rock 110.4' 0-5°, B, R4-R5, O, Pl 111.2' 0-5°, B, R5, t, Pl, Cl 112.2' 0-5°, B, R5, t, Pl 113.4' 60°, Jt, R4, O, Und	8		Run-8 109.5' - 114.5' 11 minute run Down Pressure = 400 Psi
858	114							
		50	100		114.2' 0-5°, B, R5, t, Pl, Cl			Run-9 114.5' - 119.5' 10 minute

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-20	
Coordinates: N 770396.7 E 1870020.4	Driller: AECOM	Sheet No. 2 of 3	
Top Drillhole Elevation: 971.2 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 178.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/19/18 End: 2/26/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
856					114.3' 60°, Jt, R4, Pto-t, Und			run
	116				115.7' 0-5°, B, R4-R5, O, Pl			Down Pressure = 400 Psi
					115.9' 0-5°, B, R4-R5, O, Pl			
854		50	100	1.2	116.3' 0-5°, B, R5, t, Pl	9	116.5 to 129.5' **BEDFORD SHALE**, grey with red bands, fine grained, unweathered to slightly weathered, soft, thinly bedded, flat, moderately fractured	
					117.3' 0-5°, B, R4, t, Pl			
	118				117.5' 118.1' fractured rock			
					118.3' 0-5°, B, R5, t, Pl			
852					118.9' 119.1' fractured rock			
	120				119.6' 0-5°, B, R5, t, Pl			Run-10 119.5' - 124.5' 14 minute run
					120.3' 0-5°, B, R4-R5, O, Pl			Down Pressure = 400 Psi
850								
					121.3' 0-5°, B, R4-R5, O, Pl			
	122	76	99	1.8	121.7' 0-5°, B, R5, t, Pl	10		
					122.3' 0-5°, B, R5, t, Pl			
848					122.4' 0-5°, B, R4-R5, O, Pl			
					122.8' 0-5°, B, R5, t, Pl			
	124				123.0' 0-5°, B, R4-R5, O, Pl			
					123.6' 0-5°, B, R4-R5, O, Pl			
846								Run-11 124.5' - 129.5' 12 minute run
	126				125.7' 0-5°, B, R5, t, Pl			Down Pressure = 400 Psi
					126.4' 0-5°, B, R4-R5, O, Pl			
844		76	100	2	127.0' 0-5°, B, R4, O, Pl	11		
	128				127.1' 0-5°, B, R5, t, Pl			
					127.3' 127.5' fractured rock			
					127.6' 0-5°, B, R5, t, Pl			
842					128.3' 0-5°, B, R4-R5, O, Pl			
					128.6' 0-5°, B, R4-R5, O, Pl			
	130				129.1' 0-5°, B, R5, t, Pl		129.5 to 144.5' **BEDFORD SHALE**, grey, fine grained, unweathered, soft, thinly bedded, flat, moderately fractured	Run-12 129.5' - 134.5' 13 minute run
					129.2' 0-5°, B, R5, t, Pl			Down Pressure = 450 Psi
840					129.3' 0-5°, B, R4-R5, O, Pl			
					129.6' 0-5°, B, R5, t, Pl			
	132	65	100	2.2	129.7' 0-5°, B, R4-R5, O, Pl	12		
					130.0' 0-5°, B, R4-R5, O, Pl			
838					130.3' 0-5°, B, R5, t, Pl			
					130.7' 0-5°, B, R4, O, Pl			
					130.8' 131.2' fractured rock			
	134				131.3' 0-5°, B, R4-R5, O, Pl			
					131.4' 0-5°, B, R4-R5, O, Pl			
836					131.6' 0-5°, B, R5, t, Pl			Run-13 134.5' - 139.5' 14 minute run
					131.9' 0-5°, B, R5, t, Pl			Down Pressure = 500 Psi
	136				133.6' 0-5°, B, R4-R5, O, Pl			
					134.1' 0-5°, B, R5, t, Pl			
834		68	90	1.6	134.7' 0-5°, B, R4-R5, O, Pl	13		
					135.3' 0-5°, B, R4-R5, O, Pl			
	138				136.1' 0-5°, B, R5, t, Pl			
					136.4' 0-5°, B, R4-R5, O, Pl			
					136.5' 0-5°, B, R5, t, Pl			
832					137.4' 0-5°, B, R5, t, Pl			
					137.6' 0-5°, B, R4-R5, O, Pl			
	140				138.4' 0-5°, B, R5, t, Pl			Run-14 139.5' - 144.5' 11 minute run
					139.5' 139.6' fractured rock			Down Pressure = 500 Psi
830								
	142	90	100	0.8		14		
					142.3' 0-5°, B, R5, t, Pl, Cl			
828								
					143.3' 0-5°, B, R4-R5, O, Pl			
	144				143.6' 60°, Jt, R4, O, Und			
					143.9' 0-5°, B, R4-R5, O, Pl			
					144.5' 0-5°, B, R4-R5, O, Pl		144.5 to 178.0' **OHIO SHALE**, black, fine grained, unweathered, moderately hard, thinly bedded, flat, moderately fractured, slightly pyritic	Run-15 144.5' - 149.5' 9 minute run
826					144.8' 0-5°, B, R5, t, Pl, Cl			Down Pressure = 500 Psi
	146				145.7' 0-5°, B, R5, t, Pl			
					146.0' 60°, Jt, R4-R5, t, Und			
824		83	100	1.8		15		Methane encountered, shut down for 1 hour to vent
					147.2' 0-5°, B, R4-R5, O, Pl			
	148				147.3' 0-5°, B, R4-R5, O, Pl			
					148.1' 0-5°, B, R5, t, Pl, Cl			
822								
					149.3' 0-5°, B, R5, t, Pl			Run-16 149.5' - 154.5' 13 minute run
	150				149.4' 45°, Jt, R4-R5, O, Und			Down Pressure = 350 Psi
					149.7' 0-5°, B, R4-R5, O, Pl			
820								
					151.3' 0-5°, B, R4, O, Pl			
	152	78	100	1.2		16		
					152.1' 0-5°, B, R4-R5, O, Pl			
818					152.4' 0-5°, B, R4-R5, O, Pl			152.8' - 153.2' UCS = 8,405 Psi
					153.4' 0-5°, B, R5, t, Pl			
	154				154.0' 0-5°, B, R4-R5, O, Pl			
		90	98					Run-17 154.5' - 159.5' 10 minute

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	**BORING NO. B-20**	
Coordinates: N 770396.7 E 1870020.4	Driller: AECOM	**Sheet No. 3 of 3**	
Top Drillhole Elevation: 971.2 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 178.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/19/18 End: 2/26/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
816								
	156				154.6' 0-5°, B, R5, t, Pl 155.4' 0-5°, B, R5, t, Pl 155.7' 0-5°, B, R4-R5, O, Pl 155.8' 0-5°, B, R4-R5, O, Pl			run Down Pressure = 400 Psi
814		90	98	1.6	156.6' 0-5°, B, R5, t, Pl 156.7' 0-5°, B, R4-R5, O, Pl	17		
	158				157.6' 0-5°, B, R5, t, Pl 158.0' 0-5°, B, R5, t, Pl			
812								
	160				159.7' 0-5°, B, R4-R5, O, Pl			Run-18 159.5' - 164.5' 15 mimnute run Down Pressure = 400 Psi
810								
	162	92	99	0.6	161.7' 0-5°, B, R4, PtO-t, Pl 161.8' 0-5°, B, R4, O, Pl	18		
808								
	164							
806								Run-19 164.5' - 169.5' 10 minute run Down Pressure = 400 Psi
	166				166.0' 0-5°, B, R4-R5, O, Pl			
804		78	99	1	167.1' 0-5°, B, R5, t, Pl	19		
	168				167.8' 45°, Jt, R4-R5, O, Und 168.6' 0-5°, B, R5, PtO-t, Pl			
802								
	170				169.2' 0-5°, B, R4-R5, O, Pl			Run-20 169.5' - 174.5' 10 minute run Down Pressure = 400 Psi
800					170.5' 0-5°, B, R4, O, Pl 171.0' 0-5°, B, R5, t, Pl			
	172	65	97	1.6	171.2' 0-5°, B, R5, PtO-t, Pl 171.8' 0-5°, B, R4-R5, O, Pl 171.9' 0-5°, B, R4, O, Pl 172.0' 0-5°, B, R5, PtO-t, Pl 172.9' 0-5°, B, R4-R5, O, Pl	20		
798								
	174				173.2' 0-5°, B, R5, t, Pl			
796					174.3' 0-5°, B, R4-R5, O, Pl			Run-21 174.5' - 178.0' 10 minute run Down Pressure = 400 Psi
	176	67	100	2.0	175.1' 0-5°, B, R5, t, Pl 175.8' 0-5°, B, R4-R5, O, Pl 176.0' 0-5°, B, R4-R5, O, Pl 176.1' 0-5°, B, R5, t, Pl	21		
794					177.0' to 177.8' 0-5°, 3 Bs, R4-R5, O, Pl			
	178						**End of Boring at 178.0 feet**	
792								
	180							
790								
	182							
788								
	184							
786								
	186							
784								
	188							
782								
	190							
780								
	192							
778								
	194							

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770485.471 1870321.245	**DATE STARTED**	12/18/17	**COMPLETED**	1/23/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	89.8 % (Avg.)	**SURFACE ELEVATION**	982.3 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	NQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	6.9 ft
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 2	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	12/22/17
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF TO VERY STIFF, BROWN AND GRAY MOTTLED, **CLAY**, LITTLE ROCK FRAGMENTS, TRACE TO LITTLE SAND	982.25	1	3-4-6	87	SS-1	2.5 - 3.0	-	-	-	-	-	-	-	-	-		
		2															
		3	5-6-9	100	SS-2	2.5 - 4.5+	-	-	-	-	-	-	-	-	-		
		4															
- SANDSTONE FRAGMENTS IN SPOON THROUGHOUT - COBBLE ZONE		5															
		6	9-11-13	100	SS-3	4.5+	-	-	-	-	-	-	-	-	-		
		7															
	W	8	5-9-12	100	SS-4	4.5	-	-	-	-	-	-	-	-	-		
		9															
		10															
		11	8-10-10	73	SS-5	3.5 - 4.0	-	-	-	-	-	-	-	-	-		
		12															
MEDIUM DENSE, GRAY, **SILTY SAND**, FINE TO COARSE GRAINED, TRACE TO LITTLE STONE FRAGMENTS, MOIST	969.8	13	5-9-12	87	SS-6		-	-	-	-	-	-	-	-	-		
		14															
		15															
		16	9-13-17	87	SS-7		-	-	-	-	-	-	-	-	-		
		17															
- LARGER GRAVEL IN SAMPLE		18	7-12-16	80	SS-8		-	-	-	-	-	-	-	-	-		
		19															

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.3 ft LOCATION 770485.471 1870321.245 DATE STARTED / DATE COMPLETED 12/18/17 - 1/23/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM DENSE, GRAY, **SILTY SAND**, FINE TO COARSE GRAINED, TRACE TO LITTLE STONE FRAGMENTS, MOIST *(continued)*		21	8-14-17	93	SS-9		-	-	-	-	-	-	-	-	-		
- INCREASE IN RIVER GRAVEL PRESENT		22															
		23	8-12-15	93	SS-10		-	-	-	-	-	-	-	-	-		
		24															
		25															
		26	9-14-19	93	SS-11		-	-	-	-	-	-	-	-	-		
		27															
	954.8																
MEDIUM DENSE, GRAY, **SILTY SAND**, VERY FINE TO FINE GRAINED, LITTLE TO SOME GRAVEL, MOIST TO WET		28	7-14-14	93	SS-12		-	-	-	-	-	-	-	-	-		
- SEAM OF VERY FINE SILTY SAND IN SAMPLE		29															
- TRANSITION ZONE		30															
		31	4-12-16	80	SS-13		-	-	-	-	-	-	-	-	-		
		32															
		33	6-10-11	87	SS-14		-	-	-	-	-	-	-	-	-		
		34															
		35															
- WET SAMPLE, POSSIBLY WASHED OUT		36	8-12-15	67	SS-15		-	-	-	-	-	-	-	-	-		
		37															
		38	8-11-14	80	SS-16		-	-	-	-	-	-	-	-	-		
		39															
		40															
		41	9-10-15	93	SS-17		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.3 ft LOCATION 770485.471 1870321.245 DATE STARTED / DATE COMPLETED 12/18/17 - 1/23/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM DENSE, GRAY, **SILTY SAND**, VERY FINE TO FINE GRAINED, LITTLE TO SOME GRAVEL, MOIST TO WET *(continued)*		42															
- TRACE CLAY AND GRAVEL		43	10-13-20	100	SS-18		-	-	-	-	-	-	-	-	-		
		44															
	937.3	45															
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, COARSE TO FINE GRAINED, DAMP TO MOIST		46	17-29-40	100	SS-19		-	-	-	-	-	-	-	-	-		
		47															
- SANDSTONE FRAGMENTS IN SAMPLE		48	35-40-49	100	SS-20		-	-	-	-	-	-	-	-	-		
		49															
		50															
- INCREASE IN CLAY CONCENTRATION IN SAMPLE - SANDSTONE IN SAMPLE - START OF GLACIAL TILL		51	40-25-50/3.6"	100	SS-21		-	-	-	-	-	-	-	-	-		
		52															
	929.8	53	28-39-50/3.6"	100	SS-22		-	-	-	-	-	-	-	-	-		
HARD, GRAY, **CLAY**, WITH ROCK AND STONE FRAGMENTS, TRACE TO LITTLE SAND, DAMP		54															
		55	19-50/3.6"	100	SS-23		-	-	-	-	-	-	-	-	-		
- SANDSTONE FRAGMENTS IN BOTTOM 0.2 FT OF SAMPLE		56															
		57															
	924.3	58	16-39-50/2.4"	100	SS-24		-	-	-	-	-	-	-	-	-		
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, COARSE TO FINE GRAINED, DAMP TO MOIST - COULD NOT REMOVE ROD, FORCED TO GO DEEPER		59															
		60	50/3.6"	100	SS-25		-	-	-	-	-	-	-	-	-		
- POSSIBLE OBSTRUCTION IN SPOON TO STOP ADVANCING		61															
		62															

STANTEC BORING SUBSURFACE LOG, BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.3 ft LOCATION 770485.471 1870321.245 DATE STARTED / DATE COMPLETED 12/18/17 - 1/23/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, COARSE TO FINE GRAINED, DAMP TO MOIST *(continued)*		63	25-50/4.8"	89	SS-26		-	-	-	-	-	-	-	-	-		
		64															
- LARGE SANDSTONE COBBLE IN TOE OF SHOE		65															
		66	44-38-50/4.8"	100	SS-27		-	-	-	-	-	-	-	-	-		
		67															
- GRAVEL IN SPOON WITH MUD		68	50/2.4"	50	SS-28		-	-	-	-	-	-	-	-	-		
		69															
- GRAVEL PRESENT IN SAMPLE		70	50/3.6"	100	SS-29		-	-	-	-	-	-	-	-	-		
		71															
		72															
- 1" GRAY SANDSTONE COBBLE		73	22-29-34	93	SS-30		-	-	-	-	-	-	-	-	-		
		74															
- INCREASE IN GRAVEL CONTENT		75	19-50/4.8"	100	SS-31		-	-	-	-	-	-	-	-	-		
		76															
		77															
	904.8																
MEDIUM DENSE, GRAY, **SILTY SAND**, VERY FINE TO FINE GRAINED, LITTLE TO SOME GRAVEL, MOIST TO WET		78	18-29-31	93	SS-32		-	-	-	-	-	-	-	-	-		
		79															
		80															
		81	15-25-46	93	SS-33		-	-	-	-	-	-	-	-	-		
		82															
	899.8																
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, COARSE TO FINE GRAINED, DAMP TO MOIST - INCREASE IN FINE SILTY SAND AND SANDSTONE		83	22-49-50/3.6"	77	SS-34		-	-	-	-	-	-	-	-	-		
		84															

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.3 ft LOCATION 770485.471 1870321.245 DATE STARTED / DATE COMPLETED 12/18/17 - 1/23/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
FRAGMENTS VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, COARSE TO FINE GRAINED, DAMP TO MOIST *(continued)*		85	27-50/3.6"	100	SS-35		-	-	-	-	-	-	-	-	-		
		86															
		87															
- SANDSTONE FRAGMENTS AT BOTTOM OF SAMPLE		88	38-50/4.8"	100	SS-36		-	-	-	-	-	-	-	-	-		
		89															
		90															
		91	21-42-50/3.6"	85	SS-37		-	-	-	-	-	-	-	-	-		
		92															
- LESS SILTY SAND		93	24-48-50/4.8"	64	SS-38		-	-	-	-	-	-	-	-	-		
		94															
	887.3	95															
HARD, GRAY, **CLAY**, WITH ROCK AND STONE FRAGMENTS, TRACE TO LITTLE SAND, DAMP - INCREASE IN SILT		96	6-21-37	73	SS-39	4.5+	-	-	-	-	-	-	-	-	-		
		97															
	884.8	98	16-23-27	100	SS-40	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **SILTY SAND**, VERY FINE TO FINE GRAINED, LITTLE TO SOME GRAVEL, MOIST TO WET		99															
	882.3	100	23-23-40	73	SS-41	4.5+	-	-	-	-	-	-	-	-	-		
HARD, GRAY, **CLAY**, WITH ROCK AND STONE FRAGMENTS, TRACE TO LITTLE SAND, DAMP		101															
		102															
		103	11-26-47	100	SS-42		-	-	-	-	-	-	-	-	-		
		104															
- ROCK FRAGMENTS IN BOTTOM OF SAMPLE		105	18-50/3.6"	75	SS-43		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-21

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.3 ft LOCATION 770485.471 1870321.245 DATE STARTED / DATE COMPLETED 12/18/17 - 1/23/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
HARD, GRAY, **CLAY**, WITH ROCK AND STONE FRAGMENTS, TRACE TO LITTLE SAND, DAMP *(continued)*		106															
		107															
- HIGHLY WEATHERED SANDSTONE FRAGMENTS WITH CLAY		108	50/4.8"	100	SS-44		-	-	-	-	-	-	-	-	-		
		109															
- SANDSTONE FRAGMENTS		110	50/3.6"	100	SS-45		-	-	-	-	-	-	-	-	-		
		111															
		112															
- LARGE SANDSTONE FRAGMENTS IN SAMPLE		113	30-50/4.8"	89	SS-46	4.5	-	-	-	-	-	-	-	-	-		
		114															
	867.4	115															
VERY STIFF, GRAY BROWN MOTTLED, **CLAY**, WITH STONE FRAGMENTS, TRACE TO LITTLE VERY FINE SAND, MOIST - LESS SANDSTONE FRAGMENTS - GRAVEL IN TOP OF SAMPLE		115	22-50/4.8"	89	SS-47	4.5	-	-	-	-	-	-	-	-	-		
		116															
		117															
- GLACIAL TILL RESEMBLENCE - RIVER GRAVEL IN CLAY - WEATHERED SANDSTONE IN BOTTOM OF SAMPLE		118	28-50/2.4"	71	SS-48		-	-	-	-	-	-	-	-	-		
		119															
- RESIDUAL SOIL		120	50/4.8"	75	SS-49		-	-	-	-	-	-	-	-	-		
		TR															
	861.3	121															

Boring Continues on Following Rock Description Log

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

NOTES: DRILL EQUIPMENT BROKE IN HOLE IN B-21 AT 112.5 FEET. OFFSET BORING 3 FEET AND DRILLED TO 112.5 FEET TO RESUME SAMPLING. B-21A CORRESPONDS TO THE OFFSET LOCATION.

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 55 Track 2	**BORING NO. B-21**
Coordinates: N 770485.5 E 1870321.2	Driller:	Stantec	**Sheet No. 1 of 2**
Top Drillhole Elevation: 982.3 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation: 801.4 feet MSL	Prepared By:	B. Madras Natarajan	
Total Depth: 180.9 feet	Checked By:	A. Mirza	Date Start: 12/18/17 End: 1/23/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 8.4

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
866	116							Refer to soil borings for details on soil descriptions/classifications. Drill equipment broke in hole in B-21 at 112.5 ft, offset boring 3 feet and drilled to 112.5 feet to resume sampling. Boring B-21A corresponds to the offset location.
864	118							
862	120							
860	122	NA	33	0.0		1	121.0 to 132.7' **Glacial Till** interbedded with **BEREA SANDSTONE** **Glacial Till**, brown, very stiff clay, moist **BEREA SANDSTONE** brown, fine grained, highly weathered, soft to moderately hard, thinly bedded	Run-1 121.0' - 123.7' 11 minute run Down Pressure = 300 Psi
858	124	NA	39	0.0		2		Run-2 123.7' - 126.0' 31 minute run' Down Pressure = 150 Psi
856	126	0	100	0.0		3		Run-3 126.0' - 129.9' 14 minute run Down Pressure = 150 Psi
854	128							
852	130							Run-4 129.9' - 135.9' Possible loss near bottom of zone
850	132	0	87	4.1	131.9' 0-5°, B, R4, O, Pl, Cl 132.2' to 132.9' 0-5°, 5 Bs, R4, O, Pl, Cl 133.1' to 133.9' 0-5°, 5 Bs, R4, O, Pl, Cl	4	132.7 to 160.0' **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft to moderately hard, highly fractured, thinly bedded, highly weathered joints	Top of Rock @ 131.7'
848	134				134.1' to 134.9' 0-5°, 5 Bs, R4, PtO-t, Pl 135.1' 0-5°, B, R4-R5, PtO-t, Pl			
846	136				135.9' to 136.9' fractured rock	5		Run-5 135.9' - 145.9' 50 minute run Down Pressure = 300 Psi
844	138				137.1' to 137.9' 0-5°, 5 Bs, R4, PtO-t, Pl, Cl 138.0' to 138.9' 0-5°, 5 Bs, R4, PtO-t, Pl, Cl			
842	140	0	69	2.7	138.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl 138.4' 0-5°, B, R3-R4, O, Pl, Cl 138.7' 0-5°, B, R4, O, Pl, Cl 138.9' 0-5°, B, R4, PtO-t, Pl, Cl 139.0' 0-5°, B, R3-R4, O, Pl, Cl 139.1' 0-5°, B, R4, O, Pl, Cl 139.3' 0-5°, B, R4, O, Pl, Cl 139.6' to 139.9' 0-5°, Multiple Jts, R3-R4, O, Pl, Cl			
840	142				140.0' to 140.9' 0-5°, 6 Bs, R3-R4, O, Pl 141.0' to 141.8' 0-5°, 4 Bs, R4, O, Pl 142.0' 0-5°, B, R4, PtO-t, Pl 142.1' 0-5°, B, R4, PtO-t, Pl, Cl 142.3' 0-5°, B, R4-R5, O, Pl 142.5' 0-5°, B, R4, PtO-t, Pl, Cl			
838	144							
836	146				145.9' to 150.9 Recovered 6" of fractured rock	6		Run-6 145.9' - 150.9' 25 minute run Down Pressure = 300 Psi
834	148	0	12	NA				
832	150							
		0	100	NA	150.9' to 151.6 fractured rock	7		Run-7 150.9' - 151.6' 25 minute run Down Pressure = 250 Psi
830	152	30	91	2.6	151.8' 0-5°, B, R3-R4, O, Pl, Cl 152.0' 0-5°, B, R4-R5, PtO-t, Pl, Cl 152.3' 0-5°, B, R4, O, Pl, Cl 152.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 153.3' 0-5°, B, R4, O, Pl, Cl 153.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 153.8' 0-5°, B, R4, O, Pl, Cl	8		Run-8 151.6' - 155.9' 18 minute run Down Pressure = 400 Psi
828	154							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-21**	
Coordinates: N 770485.5 E 1870321.2	Driller: Stantec	**Sheet No. 2 of 2**	
Top Drillhole Elevation: 982.3 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 801.4 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 180.9 feet	Checked By: A. Mirza	Date Start: 12/18/17 End: 1/23/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 8.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
826	156	30	91	2.6	154.0' 0-5°, B, R4-R5, O, Pl, Cl 154.3' 0-5°, B, R4-R5, O, Pl, Cl	8		
					154.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 154.9' 0-5°, B, R4, PtO-t, Pl 154.9' to 155.4' fractured rock 156.0' 0-5°, B, R4-R5, O, Pl 156.2' 0-5°, B, R4-R5, O, Pl			Run-9 155.9' - 160.9' 25 minute run Down Pressure = 500 Psi
824	158	0	46	1.8	156.3' 0-5°, B, R4, O, Pl 156.6' 0-5°, B, R4, O, Pl 156.8' 0-5°, B, R4, PtO-t, Pl 157.1' to 157.5' 0-5°, 4 Bs, R4-R5, O, Pl	9		
822	160						160.0 to 170.0' **OHIO SHALE**, black, very fine grained, moderately weathered, moderately hard, thinly bedded, moderately weathered joints	
					161.3' 0-5°, B, R3-R4, PtO-t, Pl 161.9' 0-5°, B, R4-R5, O, Pl 162.4' 0-5°, B, R4, PtO-t, Pl 162.8' 0-5°, B, R4, t, Pl			Run-10 160.9' - 165.9' 23 minute run Down Pressure = 500 Psi
820	162							
818	164	66	100	NA	163.2' 0-5°, B, R4, PtO-t, Pl 164.4' to 165.9' fractured rock	10		
816	166				165.9' to 166.8' fractured rock			Run-11 165.9' - 170.9' 20 minute run Down Pressure = 500 Psi
					167.2' 0-5°, B, R4, PtO-t, Pl 167.5' 0-5°, B, R4-R5, t, Pl			
814	168	40	100	1.8	167.7' 0-5°, B, R4, PtO-t, Pl 167.8' 0-5°, B, R4-R5, PtO-t, Pl 168.6' 0-5°, B, R4, PtO-t, Pl	11		
812	170				169.0' 0-5°, B, R4, PtO-t, Pl 169.4' 0-5°, B, R4, PtO-t, Pl 169.7' 0-5°, B, R4, PtO-t, Pl			
					170.4' 0-5°, B, R4-R5, t, Pl		170.0 to 180.9' **OHIO SHALE**, black, very fine grained, slightly weathered, moderately hard, slightly weathered joints	Run-12 170.9' - 180.9' 51 minute run Down Pressure = 500-600 Psi
810	172				171.5' 0-5°, B, R4-R5, O, Pl			
808	174				173.3' 0-5°, B, R4, O, Pl 173.7' 0-5°, B, R4-R5, O, Pl 174.0' 0-5°, B, R4, t, Pl 174.5' 0-5°, B, R4-R5, t, Pl			
806	176	80	100	1.2	175.6' 0-5°, B, R4-R5, O, Pl 176.2' to 176.6 90°, Jt, R3-R4, O, Und 176.6' 0-5°, B, R4-R5, PtO-t, Pl	12		
804	178				177.2' 0-5°, B, R4-R5, t, Pl 178.2' 0-5°, B, R4-R5, PtO-t, Pl			
802	180				178.8' 0-5°, B, R4, PtO-t, Pl			
800	182						**End of Boring at 180.9 feet**	
798	184							
796	186							
794	188							
792	190							
790	192							
788	194							

Big Walnut Sewer Tunnel Extension - Phase 2		Project No. 173409058
Location: Tunnel Alignment	Drill Rig: Rotosonic Truck	**BORING NO. B-21B**
Coordinates: N 770491.4 E 1870397.4	Driller: Cascade/R. Tustin	**Sheet No. 1 of 5**
Surface Elevation: 981.1 feet MSL	Logged By: RII/N. Calendine	
Bottom Elevation: 807.9 feet MSL	Prepared By: RII/C.Straub	
Total Depth: 198.0 feet	Checked By:	Date Start: 4/3/19 End: 4/5/19
Orientation: 29 degrees from vertical	Core Size: PQ	Groundwater Elevation:18

Elevation, feet MSL	Depth, feet	RQD, % / Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
980	2					0.0 to 0.5'	
						0.5 to 12.0'	
978	4	75					
976	6						
974	8						
972	10						
970	12	70				12.0 to 34.0'	
968	14						
966	16						
964	18		▽				
962	20						
960	22	100					
958	24						
956	26						
954	28						
952	30	100				34.0 to 39.0'	
950	32						
948	34						
	36						
	38	100				39.0 to 47.0'	

CORE LOG REV APR 2019 CS BWSTE_PHASE2_R0 IMPORTED B21B.GPJ KLEINFELDER LV CORE APR06.GDT 7/2/19

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: Rotosonic Truck		**BORING NO. B-21B**
Coordinates: N 770491.4 E 1870397.4	Driller: Cascade/R. Tustin		**Sheet No. 2 of 5**
Surface Elevation: 981.1 feet MSL	Logged By: RII/N. Calendine		
Bottom Elevation: 807.9 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 198.0 feet	Checked By:	Date Start: 4/3/19 End: 4/5/19	
Orientation: 29 degrees from vertical	Core Size: PQ	Groundwater Elevation:18	

Elevation, feet MSL	Depth, feet	RQD, % / Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
946							
944	42						
942	44	100					
940	46						
938	48					47.0 to 78.0' 48.0' -WATER ADDED TO THE BOREHOLE DURING DRILLING @ 48.0'	
936	50						
934	52	100				52.3' -7" LAYER OF COBBLES/GRAVEL @ 52.3'	
932	54						
930	56						
928	58						
926	60	90					
924	62						
922	64						
920	66						
918	68					68.0' -LOW RECOVERY PROBABLY DUE TO WATER PLUGGING OFF HOLE.	
916	70						
914	72	50					
912	74						
	76						
	78					78.0 to 83.0'	
		100					

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: Rotosonic Truck		**BORING NO. B-21B**
Coordinates: N 770491.4 E 1870397.4	Driller: Cascade/R. Tustin		**Sheet No. 3 of 5**
Surface Elevation: 981.1 feet MSL	Logged By: RII/N. Calendine		
Bottom Elevation: 807.9 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 198.0 feet	Checked By:	Date Start: 4/3/19 End: 4/5/19	
Orientation: 29 degrees from vertical	Core Size: PQ	Groundwater Elevation:18	

Elevation, feet MSL	Depth, feet	RQD, % / Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
910	82						
908	84	100				83.0 to 88.0'	
906	86						
904	88					88.0 to 91.0' 88.5' -ROUNDED AGGREGATE FROM 88.0'-91.0'	
902	90						
900	92	100				91.0 to 102.0' 91.5' -LARGER RIVER COBBLES PRESENT FROM 91.0' to 102.0'	
898	94						
896	96						
894	98						
892	100						
890	102	100				102.0 to 110.0'	
888	104						
886	106						
884	108						
882	110	100				110.0 to 114.0'	
880	112						
878	114					114.0 to 118.0'	
	116						
	118	100				118.0 to 128.0'	

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: Rotosonic Truck		**BORING NO. B-21B**
Coordinates: N 770491.4 E 1870397.4	Driller: Cascade/R. Tustin		**Sheet No. 4 of 5**
Surface Elevation: 981.1 feet MSL	Logged By: RII/N. Calendine		
Bottom Elevation: 807.9 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 198.0 feet	Checked By:	Date Start: 4/3/19 End: 4/5/19	
Orientation: 29 degrees from vertical	Core Size: PQ	Groundwater Elevation:18	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
876								
874	122							
872	124		100					
870	126							
868	128						128.0 to 135.0'	Refer to soil borings for details on soil descriptions/characteristics
866	130							
864	132		100					
862	134							
860	136						135.0 to 138.0' **SHALE,** GRAY, WEATHERED, WET.	Top of Rock @ 135.0'
858	138						138.0 to 158.0' **BEDFORD SHALE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, VERY SOFT TO MODERATELY WEATHERED, VERY SOFT TO MODERATELY HARD, VERY THIN TO MEDIUM BEDDED, INTENSELY FRACTURED TO MODERATELY FRACTURED, TIGHT TO MODERATELY WIDE APERATURE, VERY ROUGH TO SLIGHTLY ROUGH, LAMINATED/SHEARED TO DISINTEGRATED, POOR TO VERY POOR 142.0' -RC-1: LOGGER NOTED THAT ROCK FELL OUT OF CORE BARREL WHEN PULLING OUT OF HOLE AND HAD TO PUT BACK IN TO TRY TO RETRIEVE SAMPLE.	Run-1 138.0' - 148.0' 8 minute run
856	140				138.9' 30-35°, B, R4, MW, Pl 139.5' 30-35°, B, R4, MW, Pl 140.1' 30-35°, B, R4, MW, Pl, Cl 140.6' 30-35°, B, R4, MW, Pl 140.9' 30-35°, B, R4, VW, Pl 141.2' 30-35°, B, R2, WO, Pl, Cl 141.7' to 143.1, clay with friable shale fragments, no open seams			
854	142	38	89					
852	144							
850	146				145.7' to 148.0 rubbilized small pieces			
848	148				148.0' to 148.7, 30-35°, 6 B's, R4-R5, PtO, Pl			Run-2 148.0' - 158.0' 10 minute run
846	150				149.3' 30-35°, B, R4-R5, PtO, Pl 149.4' 30-35°, B, R4-R5, PtO, Pl 149.5' to 149.6, 30-35°, 3 B's, R2, PtO, Und 150.0' 30-35°, B, R4-R5, PtO, Pl 150.1' to 151.0, large pieces rounded around outside edges			
844	152	6	80				152.0' -RC-2: LOGGER NOTED DRILLER HAD TO SLAM CORE BARREL IN 3' INTERVALS TO GET SAMPLE TO CATCH IN COLLECTOR, WHICH LIKELY RESULTED IN BREAKING UP ROCK SECTIONS.	
842	154				154.5' to 158.0, rubbilized small to medium pieces			
	156							
	158				158.1' 30-35°, B, R4-R5, PtO, Pl 158.3' 30-35°, B, R4-R5, PtO, Pl 159.0' to 159.8 large pieces rounded around outside edges		158.0 to 168.0' **OHIO SHALE**, BLACK, UNWEATHERED, MEDIUM HARD TO HARD, THIN TO MEDIUM BEDDED, PYRITIC, CARBONACEOUS, HIGHLY	Run-3 158.0' - 168.0' 37 minute run
		14	50					

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: Rotosonic Truck		**BORING NO. B-21B**
Coordinates: N 770491.4 E 1870397.4	Driller: Cascade/R. Tustin		**Sheet No. 5 of 5**
Surface Elevation: 981.1 feet MSL	Logged By: RII/N. Calendine		
Bottom Elevation: 807.9 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 198.0 feet	Checked By:	Date Start: 4/3/19 End: 4/5/19	
Orientation: 29 degrees from vertical	Core Size: PQ	Groundwater Elevation:18	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
840	162				159.8' to 160.6 rubbilized 161.3' 30-35°, B, R3, PtO, Und 161.4' to 163.0' rubbilized small pieces		FRACTURED TO MODERATELY FRACTURED, NARROW TO WIDE APERATURE, SLIGHTLY ROUGH TO VERY ROUGH, LAMINATED/SHEARED TO DISINTEGRATED, POOR TO VERY POOR. 160.0' -RC-3: DRILLER HAD TO STOP HALF WAY THROUGH RUN TO CHECK FOR FLUID LEAK CAUSING LONGER DRILLING TIME. VIBRATION RATE WAS INCREASED DURING THIS RUN. 165.0' -POSSIBLE VOID ENCOUNTERED @ APPROXIMATELY 165', DRILLER OBSERVED RAPID DROP WITH BARREL 167.0' -DRILLER CONVERTED TO SOIL SAMPLING FROM 168.0' TO 173.0', RETRIEVED 10' OF MATERIAL INCLUDING 5' OF CAVED IN MATERIAL FROM ABOVE INTERVALS.	
838	164	14	50					
836	166							
834	168							
832	170		100				168.0 to 170.5' **CLAYEY GRAVEL (SHALE FRAGMENTS) WITH SAND,** BLACK, ANGULAR FRAGMENTS, VERY MOIST.	
830	172						170.5 to 173.0' **CLAYEY SAND WITH GRAVEL (PULVERIZED SHALE FRAGMENTS),** BLACK, VERY MOIST.	
828	174	28	100		173.1' 30-35°, B, R4-R5, MW, ground surface 173.5' 30-35°, B, R4-R5, PtO, Pl 173.9' 30-35°, B, R3, MW, Und		173.0 to 198.0' **OHIO SHALE**, BLACK, UNWEATHERED, MEDIUM HARD TO HARD, THIN TO MEDIUM BEDDED, PYRITIC, CARBONACEOUS, HIGHLY FRACTURED TO MODERATELY FRACTURED, NARROW TO WIDE APERATURE, SLIGHTLY ROUGH TO VERY ROUGH, LAMINATED/SHEARED TO DISINTEGRATED, POOR TO VERY POOR.	Run-4 173.0' - 178.0' 10 minute run
826	176				175.5' 30-35°, B, R4, W, Und 175.6' 30-35°, B, R4, W, Und 175.8' to 176.6 large pieces rounded around outside edges 176.6' to 178.0 rubbilized			
824	178				178.0' to 178.8 large pieces rounded around outside edges 178.8' 30-35°, B, R3-R4, MW-W, Und			Run-5 178.0' - 188.0' 21 minute run
822	180				179.6' 30-35°, B, R3-R4, MW-W, Und 180.2' 30-35°, B, R3-R4, MW-W, Und 180.4' 30-35°, B, R3-R4, MW-W, Und 181.1' 30-35°, B, R3-R4, MW-W, Und			
820	182	63	90		182.6' 30-35°, B, R5, PtO, Pl 183.2' 30-35°, B, R4-R5, PtO, Pl 183.6' 30-35°, B, R5, MW, Pl		182.0' -RC-4: DRILLER HAD TO STOP A FEW TIMES DURING DRILLING THROUGH THIS RUN	
818	184				184.2' 30-35°, B, R3-R4, MW, Pl 184.6' 30-35°, B, R3-R4, MW, Pl 185.0' 30-35°, B, R3-R4, MW, Pl			
816	186				185.8' 30-35°, B, R3-R4, MW, Pl 186.1' 30-35°, B, R3-R4, MW, Pl 186.3' 30-35°, B, R3-R4, MW, Pl 186.8' 30-35°, B, R3-R4, MW, Pl			
814	188							Run-6 188.0' - 198.0' 11 minute run
812	190				188.8' 30-35°, B, R3-R4, MW, Pl 188.9' 30-35°, B, R3-R4, MW, Und 189.3' 30-35°, B, R3-R4, MW, Und 189.5' 30-35°, B, R3-R4, MW, Und 190.2' 30-35°, B, R3-R4, MW, Pl 190.4' 30-35°, B, R3-R4, MW, Pl			
810	192				191.3' 30-35°, B, R4-R5, MW, Pl 191.5' 30-35°, B, R4-R5, MW, Pl 191.9' 30-35°, B, R4-R5, MW, Pl			
808	194	20	80		193.0' 30-35°, B, R4, O-MW, Pl 193.4' 30-35°, B, R3-R4, O-MW, Pl 194.0' 30-35°, B, R4-R5, PtO, Pl 194.2' 30-35°, B, R4-R5, O, Pl 194.5' 30-35°, B, R2-R3, PtO, Und 194.9' 30-35°, B, R3, RtO, Pl			
	196				195.2' 30-35°, B, R2-R3, O, Pl 195.6' 30-35°, B, R2, MW, Und			
	198						**End of Boring at 198.0 feet**	

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770624.38 1870496.04			**DATE STARTED**	2/5/18	**COMPLETED**	2/15/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	89.8 % (Avg.)	**SURFACE ELEVATION**	984.0 ft	**DEPTH TO WATER**	15.0 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A	**DATE/TIME**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 2	**BOREHOLE INCLINATION (VERT.)**	Vertical	**DATE/TIME**	2/5/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY STIFF TO HARD, BROWN, **SANDY CLAY**, LITTLE TO SOME STONE FRAGMENTS, TRACE SILT, DAMP	983.98	1	4-4-5	80	SS-1	2.5	-	-	-	-	-	-	-	-	-		
		2															
		3	20-22-24	100	SS-2	4.5	-	-	-	-	-	-	-	-	-		
		4															
		5															
		6	13-20-24	47	SS-3		-	-	-	-	-	-	-	-	-		
		7															
STIFF TO HARD, GRAY, **SANDY CLAY**, TRACE TO LITTLE STONE FRAGMENT, LITTLE SILT, FINE GRAINED, DAMP	976.5	8	13-18-24	100	SS-4	4.5+	-	-	-	-	-	-	-	-	-		
		9															
		10															
		11	11-13-13	67	SS-5	3.5	-	-	-	-	-	-	-	-	-		
		12															
		13	6-6-10	100	SS-6	1.75	-	-	-	-	-	-	-	-	-		
		14															
DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE TO SOME GRAVEL, TRACE TO LITTLE SILT AND CLAY, WET	969.0	15	17-19-25	100	SS-7		-	-	-	-	-	-	-	-	-		
	W	16															
		17															
		18	10-14-16	100	SS-8		-	-	-	-	-	-	-	-	-		
		19															
		20															
		21	12-17-19	100	SS-9		-	-	-	-	-	-	-	-	-		
		22															
		23	21-34-50	100	SS-10		-	-	-	-	-	-	-	-	-		
		24															

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.0 ft LOCATION 770624.38 1870496.04 DATE STARTED / DATE COMPLETED 2/5/18 - 2/15/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE TO SOME GRAVEL, TRACE TO LITTLE SILT AND CLAY, WET *(continued)*		26	30-31-33	87	SS-11		-	-	-	-	-	-	-	-	-		
		27															
VERY DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, LITTLE ROCK FRAGMENTS, MOIST	956.5	28	15-40-50/4.8"	100	SS-12		-	-	-	-	-	-	-	-	-		
		29															
DENSE TO VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, COARSE GRAINED, MOIST	954.0	30															
		31	28-29-40	67	SS-13		-	-	-	-	-	-	-	-	-		
		32															
		33	12-17-22	80	SS-14		-	-	-	-	-	-	-	-	-		
		34															
		35	50/1.2"	100	SS-15		-	-	-	-	-	-	-	-	-		
		36															
		37															
		38	33-36-40	100	SS-16		-	-	-	-	-	-	-	-	-		
		39															
		40															
		41	30-31-45	100	SS-17		-	-	-	-	-	-	-	-	-		
		42															
		43	18-20-32	100	SS-18		-	-	-	-	-	-	-	-	-		
		44															
		45															
		46	20-30-33	100	SS-19		-	-	-	-	-	-	-	-	-		
		47															
		48	22-23-26	100	SS-20		-	-	-	-	-	-	-	-	-		
		49															
DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, MOIST	934.0	50															
		51	16-20-22	100	SS-21		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT -BWSTE Ph 2- **CLIENT** City of Columbus **PROJECT NUMBER** 173409058 **SURFACE ELEVATION** 984.0 ft **LOCATION** 770624.38 1870496.04 **DATE STARTED / DATE COMPLETED** 2/5/18 - 2/15/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, MOIST *(continued)*		52															
		53	8-14-21	87	SS-22		-	-	-	-	-	-	-	-	-		
		54															
		55															
		56	12-14-20	100	SS-23		-	-	-	-	-	-	-	-	-		
		57															
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, TRACE SILT AND CLAY, MOIST	926.5	58	42-37-39	100	SS-24		-	-	-	-	-	-	-	-	-		
		59															
		60															
		61	25-35-44	100	SS-25		-	-	-	-	-	-	-	-	-		
		62															
		63	30-31-33	100	SS-26		-	-	-	-	-	-	-	-	-		
		64															
		65															
		66	20-28-32	93	SS-27		-	-	-	-	-	-	-	-	-		
		67															
		68	14-36-51	73	SS-28		-	-	-	-	-	-	-	-	-		
		69															
DENSE TO VERY DENSE, BROWN AND GRAY, **SILTY SAND**, FINE TO VERY FINE, MOIST TO WET	914.0	70															
		71	18-22-28	93	SS-29		-	-	-	-	-	-	-	-	-		
		72															
		73	15-32-46	100	SS-30		-	-	-	-	-	-	-	-	-		
		74															
		75															
		76	3-7-14	60	SS-31		-	-	-	-	-	-	-	-	-		
		77															
	906.5	78	32-31-28	100	SS-32		-	-	-	-	-	-	-	-	-		

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.0 ft LOCATION 770624.38 1870496.04 DATE STARTED / DATE COMPLETED 2/5/18 - 2/15/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST TO WET *(continued)*		79															
	904.0	80															
DENSE, BROWN AND GRAY, **SILTY SAND**, MOIST TO WET		81	4-10-20	100	SS-33		-	-	-	-	-	-	-	-	-		
		82															
	901.5	83	10-23-36	100	SS-34		-	-	-	-	-	-	-	-	-		
VERY DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST TO WET		84															
		85															
		86	16-22-28	87	SS-35		-	-	-	-	-	-	-	-	-		
		87															
		88	6-12-24	80	SS-36		-	-	-	-	-	-	-	-	-		
		89															
		90															
		91	16-30-36	87	SS-37		-	-	-	-	-	-	-	-	-		
		92															
		93	27-50/4.8"	100	SS-38		-	-	-	-	-	-	-	-	-		
		94															
		95															
		96	20-50/4.8"	100	SS-39		-	-	-	-	-	-	-	-	-		
		97															
	886.5	98															
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, FINE TO VERY FINE, MOIST TO WET		99	32-39-48	100	SS-40		-	-	-	-	-	-	-	-	-		
		100															
		101	13-18-22	80	SS-41		-	-	-	-	-	-	-	-	-		
		102															
		103	17-22-30	100	SS-42		-	-	-	-	-	-	-	-	-		
		104															
		105															

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.0 ft LOCATION 770624.38 1870496.04 DATE STARTED / DATE COMPLETED 2/5/18 - 2/15/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, FINE TO VERY FINE, MOIST TO WET *(continued)*		106	15-27-34	100	SS-43		-	-	-	-	-	-	-	-	-		
		107															
HARD, GRAY, **SANDY CLAY**, FINE GRAINED, TRACE STONE FRAGMENTS, DAMP TO MOIST	876.5	108	14-23-26	100	SS-44		-	-	-	-	-	-	-	-	-		
		109															
DENSE TO VERY DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL AND STONE FRAGMENTS, LITTLE CLAY, TRACE SILT, MOIST TO WET	874.0	110	22-23-26	100	SS-45		-	-	-	-	-	-	-	-	-		
		111															
		112															
HARD, GRAY, **SANDY CLAY**, FINE GRAINED, TRACE STONE FRAGMENTS, DAMP	871.5	113	14-50/2.4"	100	SS-46		-	-	-	-	-	-	-	-	-		
		114															
		115															
		116	24-50-50/1.2"	91	SS-47		-	-	-	-	-	-	-	-	-		
		117															
		118	50/2.4"	100	SS-48		-	-	-	-	-	-	-	-	-		
		119															
		120	50/4.8"	100	SS-49		-	-	-	-	-	-	-	-	-		
		121															
		122															
		123	50/1.2"	100	SS-50		-	-	-	-	-	-	-	-	-		
		124															
		125															
DENSE TO VERY DENSE, GRAY, **FINE SAND**, TO VERY FINE, TRACE TO LITTLE STONE FRAGMENTS, TRACE SILT AND CLAY, DAMP TO MOIST	859.0	126	23-47-50/2.4"	100	SS-51		-	-	-	-	-	-	-	-	-		
		127															
		128	50/3.6"	0	SS-52		-	-	-	-	-	-	-	-	-		
		129															
		130															
		131	31-31-38	20	SS-53		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-22

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.0 ft LOCATION 770624.38 1870496.04 DATE STARTED / DATE COMPLETED 2/5/18 - 2/15/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
STIFF TO VERY STIFF, BROWN, **CLAY**, DAMP TO MOIST	851.5																
HIGHLY WEATHERED, VERY SOFT TO SOFT, VERY FINE GRAINED, SHALE, GRAY, ARGILLACEOUS, THIN BEDDED, INTENSELY FRACTURED, FLAT, HIGHLY WEATHERED JOINTS.	851.0	TR 133	18-50/2.4"	100	SS-54		-	-	-	-	-	-	-	-	-		
		134															
	848.8	135	50/2.4"	100	SS-55		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 152.0 TO 172.0 FEET (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; SAND

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-22**	
Coordinates: N 770624.2 E 1870496.1	Driller: Stantec	**Sheet No. 1 of 2**	
Top Drillhole Elevation: 984.5 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 793.1 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 191.4 feet	Checked By: A. Mirza	Date Start: 2/5/18 End: 2/15/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 17.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
854								Refer to soil borings for details on soil descriptions/classifications
852	132							
850	134							
848	136	0	100	0.0	136.4' 0-5°, B,, R4-R5, PtO-t, Pl, Cl 136.5' 0-5°, B, R4-R5, t, Pl, Cl	1	135.2 to 160.0' **BEDFORD SHALE**, light gray, very fine grained, highly weathered, very soft to soft, highly fractured, thinly bedded, highly weathered joints	Top of Rock @ 135.2' Run-1 135.2' - 136.4' 9 minute run Down Pressure = 50 - 100 Psi
846	138							Run-2 136.4' - 141.4' 28 minute run Down Pressure = 450 Psi
844	140	0	100	0.4		2		
842	142							Run-3 141.4' - 146.4' 27 minute run Down Pressure = 500 Psi
840	144	10	100	0.0		3		
838	146							Run-4 146.4' - 151.4' 29 minute run Down Pressure = 450 Psi
836	148	0	70	2.8	146.7' 0-5°, B, R4, Pt-t, Pl, Cl 147.1' 0-5°, B, R4-R5, t, Pl, Cl 147.3' 0-5°, B, R4, PtO-t, Pl, Cl 147.4' 0-5°, B, R3-R4, PtO-t, Und, Cl 147.7' 0-5°, B, R5, O, Und, Cl 147.9' 0-5°, B, R5, PtO-t, Pl, Cl 148.2' 0-5°, B, R4-R5, t, Pl 148.6' 0-5°, B, R4, PtO-t, Pl, Cl 148.8' 0-5°, B, R5, PtO-t, Pl, Cl 149.0' 0-5°, B, R4-R5, t, Pl, Cl	4		146.4' - 151.4' Gas Meter H2S = 0 to 1
834	150							
832	152	52	90	3.2	149.2' 0-5°, B, R3-R4, O, Und 149.4' 0-5°, B, R4-R5, PtO-t, Pl 149.6' 0-5°, B, R4-R5, PtO-t, Pl 149.8' 0-5°, B, R5, PtO-t, Pl 151.6' 0-5°, B, R4-R5, PtO-t, Pl 152.5' 0-5°, B, R5, PtO-t, Und 152.8' 0-5°, B, R4-R5, PtO-t, Pl 152.8' 0-5°, B, R4-R5, t, Pl 153.0' 0-5°, B, R5, PtO-t, Pl, Cl 153.1' 0-5°, B, R4-R5, PtO-t, Pl 153.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl	5		Run-5 151.4' - 156.4' 17 minute run Down Pressure = 500 Psi
830	154							
828	156				153.3' 0-5°, B, R4, t, Pl			Run-6 156.4' - 161.4' 21 minute run Down Pressure = 400 Psi
826	158	52	100	3.2	153.7' 0-5°, B, R4-R5, PtO-t, Pl 154.2' 0-5°, B, R4-R5, PtO-t, Pl 154.5' 0-5°, B, R4, PtO-t, Pl 154.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 154.7' 0-5°, B, R4-R5, PtO-t, Pl 155.1' 0-5°, B, R5, PtO-t, Pl 155.3' 0-5°, B, R5, PtO-t, Pl, Cl 155.7' 0-5°, B, R4-R5, Pt-t, Pl 156.6' 0-5°, B, R5, PtO-t, Pl 156.9' 0-5°, B, R4-R5, Pt-t, Pl	6		
824	160						160.0 to 191.4' **OHIO SHALE**, dark gray to black, very fine grained, moderately to highly weathered, soft to moderately hard, moderately to highly fractured, thinly bedded, moderately to highly weathered joints	
822	162	20	100	4.0	157.5' 0-5°, B, R5, PtO-t, Pl 157.9' 0-5°, B, R4-R5, PtO-t, Pl 158.3' 0-5°, B, R4-R5, PtO-t, Pl 158.5' 0-5°, B, R4-R5, PtO-t, Pl 158.7' 0-5°, B, R5, PtO-t, Pl 159.1' 0-5°, B, R5, PtO-t, Pl 159.5' 0-5°, B, R4-R5, PtO-t, Pl 159.7' 0-5°, B, R5, PtO-t, Pl 159.8' 0-5°, B, R5, PtO-t, Pl 159.9' 0-5°, B, R4-R5, PtO-t, Pl 160.2' 0-5°, B, R4-R5, PtO-t, Pl	7		Run-7 161.4' - 166.4' 10 minute run Down Pressure = 300 Psi
820	164							
818	166				160.5' 0-5°, B, R5, PtO-t, Pl			Run-8 166.4' - 171.4' 8 minute run Down Pressure = 300 Psi
816	168	78	86	0.8	160.8' 0-5°, B, R5, PtO-t, Pl 161.0' 0-5°, B, R5, PtO-t, Pl 161.7' 0-5°, B, R4-R5, PtO-t, Pl 161.8' 0-5°, B, R4-R5, PtO-t, Pl 161.9' 0-5°, B, R4-R5, PtO-t, Pl 162.3' 0-5°, B, R5, t, Pl 162.7' 0-5°, B, R5, t, Pl	8		

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-22**	
Coordinates: N 770624.2 E 1870496.1	Driller: Stantec	**Sheet No. 2 of 2**	
Top Drillhole Elevation: 984.5 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 793.1 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 191.4 feet	Checked By: A. Mirza	Date Start: 2/5/18 End: 2/15/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 17.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
814		78	86	0.8	162.9' 0-5°, B, R4-R5, PtO-t, Pl 163.3' 0-5°, B, R5, t, Pl 163.5' 0-5°, B, R5, t, Pl	8		
812	172	62	100	1.6	163.7' 0-5°, B, R4-R5, PtO-t, Pl 164.0' 0-5°, B, R5, t, Pl 164.8' 0-5°, B, R5, t, Pl 165.0' 0-5°, B, R4-R5, t, Pl 165.2' 0-5°, B, R5, t, Pl 165.4' 0-5°, B, R4-R5, PtO-t, Pl 165.6' 0-5°, B, R4-R5, t, Pl 165.7' 0°, B, R4, t,Pl 165.8' 0-5°, B, R5, PtO-t, Pl 165.9' 0-5°, B, R4-R5, PtO-t, Pl 166.0' 0-5°, B, R4, t, Pl	9		Run-9 171.4' - 176.4' 19 minute run Down Pressure = 250 - 300 Psi 171.4' - 176.4' Gas Meter H2S = 0 to 1
810	174							
808	176							
806	178	42	92	2.8	166.3' 0-5°, B, R5,PtO-t, Pl 168.5' 0-5°, B, R4-R5, t, Pl 169.7' 0-5°, B, R4, PtO-t, Pl 170.5' 0-5°, B, R4-R5, t, Pl 170.7' 0-5°, B, R4, t,Pl 171.8' 0-5°, B, R5, PtO-t, Pl 171.9' 0-5°, B, R4-R5, t, Pl 172.2' 0-5°, B, R4-R5, t, Pl 172.4' 0-5°, B, R5, PtO-t, Pl 173.4' 0-5°, B, R5, PtO-t, Pl 173.8' 0-5°, B, R4-R5, t, Pl	10		Run-10 176.4' - 181.4' 27 minute run Down Pressure = 350 Psi
804	180							
802	182	38	96	NA	174.2' 0-5°, B, R5, PtO-t, Pl 174.7' 0-5°, B, R5, t, Pl 175.0' to 175.8' fractured rock 176.7' 0-5°, B, R5, t, Pl 176.9' 0-5°, B, R4-R5, t, Pl 177.0' 0-5°, B, R5, PtO-t, Pl 177.6' 0-5°, B, R5, t, Pl 177.7' 0-5°, B, R5, t, Pl 178.2' 0-5°, B, R4-R5, t, Pl 178.4' 0-5°, B, R4-R5, t, Pl 178.5' 0-5°, B, R5, t, Pl	11		Run-11 181.4' - 186.4' 11 minute run Down Pressure = 350 Psi
800	184							
798	186							
796	188	87	92	NA	178.7' 0-5°, B, R4-R5, t, Pl 179.0' 0-5°, B, R5, t, Pl 179.2' 0-5°, B, R5, t, Pl 179.3' 0-5°, B, R4-R5, t, Pl 180.2' 0-5°, B, R5, t, Pl 180.6' 0-5°, B, R4-R5, t, Pl	12		Run-12 186.4' -191.4' 25 minute run Down Pressure = 375 Psi
794	190							
792	192						**End of Boring at 191.4 feet**	
790	194							
788	196							
786	198							
784	200							
782	202							
780	204							
778	206							
776	208							

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

Stantec

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-23

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770750.303 1870608.785	**DATE STARTED**	11/28/17	**COMPLETED**	12/7/17
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	89.8 % (Avg.)	**SURFACE ELEVATION**	986.4 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	10.4 ft
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 2	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	12/13/17
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF TO HARD, BROWN AND GRAY MOTTLED, **CLAY**, TRACE TO LITTLE GRAVEL, TRACE SAND AND SILT, DAMP	986.36	1	WH-3-3	67	SS-1	1.75	-	-	-	-	-	-	-	-	-		
		2															
		3	3-5-7	93	SS-2	1.5-1.75	-	-	-	-	-	-	-	-	-		
		4															
		5															
		6	8-12-19	93	SS-3	4.5	-	-	-	-	-	-	-	-	-		
		7															
- SANDSTONE FRAGMENTS IN SPOON		8	10-16-16	87	SS-4	4.5	-	-	-	-	-	-	-	-	-		
		9															
- MIXING TUB ADDED - 1.5 BAGS OF GEL-X ADDED, 200 GALLONS OF WATER -LITTLE TO SOME GRAVEL	W	10															
		11	6-7-7	60	SS-5	4.5	-	-	-	-	-	-	-	-	-		
	974.4	12															
MEDIUM STIFF, GRAY, **SILT AND CLAY**, LITTLE GRAVEL, DAMP TO MOIST - LARGE STONE IN SAMPLE		13	8-8-6	67	SS-6	1.75	-	-	-	-	-	-	-	-	-		
		14															
		15															
		16	2-6-20	80	SS-7	2.25	-	-	-	-	-	-	-	-	-		
	969.6	17															
DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT AND CLAY, LITTLE TO SOME GRAVEL, WET		18	13-17-18	93	SS-8		-	-	-	-	-	-	-	-	-		
		19															
		20															
		21	12-14-14	80	SS-9		-	-	-	-	-	-	-	-	-		
		22															
		23	10-17-17	87	SS-10		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-23

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 986.4 ft LOCATION 770750.303 1870608.785 DATE STARTED / DATE COMPLETED 11/28/17 - 12/7/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM DENSE, GRAY, **SILTY SAND**, WET	961.9	25															
		26	7-13-14	100	SS-11		-	-	-	-	-	-	-	-	-		
		27															
- THICKENED DRILLING MUD MIX		28	8-14-16	100	SS-12		-	-	-	-	-	-	-	-	-		
		29															
STIFF, GRAY, **SILTY CLAY**, VERY FINE GRAINED, DAMP TO MOIST	956.9	30															
		31	4-5-8	100	SS-13		-	-	-	-	-	-	-	-	-		
		32															
		33	5-5-9	100	SS-14		-	-	-	-	-	-	-	-	-		
		34															
		35															
		36	5-9-14	100	SS-15		-	-	-	-	-	-	-	-	-		
		37															
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, WET TO MOIST	949.4	38	11-22-30	100	SS-16		-	-	-	-	-	-	-	-	-		
		39															
		40															
- SEAMS OF BROWN SAND @ 41.0' TO 41.5'		41	15-21-31	100	SS-17		-	-	-	-	-	-	-	-	-		
		42															
VERY DENSE, GRAY, **FINE SAND**, TRACE TO LITTLE SILT AND CLAY, LITTLE GRAVEL, MOIST	944.4	43	20-21-35	100	SS-18		-	-	-	-	-	-	-	-	-		
		44															
VERY DENSE, BROWN, **FINE SAND**, TRACE CLAY, LITTLE TO SOME GRAVEL AND STONE FRAGMENTS, MOIST	941.9	45															
		46	27-39-47	93	SS-19		-	-	-	-	-	-	-	-	-		
		47															
- GLACIAL TILL - SANDSTONE IN SAMPLE		48	50/4.8"	100	SS-20		-	-	-	-	-	-	-	-	-		
		49															

STANTEC BORING SUBSURFACE LOG, BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-23

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 986.4 ft LOCATION 770750.303 1870608.785 DATE STARTED / DATE COMPLETED 11/28/17 - 12/7/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY DENSE, BROWN, **FINE SAND**, TRACE CLAY, LITTLE TO SOME GRAVEL AND STONE FRAGMENTS, MOIST *(continued)*		50	50/3.6"	100	SS-21		-	-	-	-	-	-	-	-	-		
- SANDSTONE IN SAMPLE		51															
		52															
- LARGE COBBLES - ROCK FRAGMENTS IN SPOON		53	50/9.6	100	SS-22		-	-	-	-	-	-	-	-	-		
		54															
HARD, BROWN, **CLAY**, SOME SAND, COBBLES, TRACE TO LITTLE STONE FRAGMENTS, TRACE GRAVEL, DAMP	931.9	55	17-35-40	100	SS-23		-	-	-	-	-	-	-	-	-		
		56															
		57															
		58	16-30-40	87	SS-24		-	-	-	-	-	-	-	-	-		
		59															
- INCREASE IN SAND AND GRAVEL IN SAMPLE		60	40-50/4.8"	100	SS-25		-	-	-	-	-	-	-	-	-		
		61															
		62															
- ROCK FRAGMENTS AND TRACE SAND IN SAMPLE		63	50/4.8"	50	SS-26		-	-	-	-	-	-	-	-	-		
		64															
VERY DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET	921.9	65	28-27-28	100	SS-27		-	-	-	-	-	-	-	-	-		
		66															
		67															
		68	26-26-28	100	SS-28		-	-	-	-	-	-	-	-	-		
		69															
		70															
		71	36-44-39	93	SS-29		-	-	-	-	-	-	-	-	-		
		72															
		73	21-24-28	87	SS-30		-	-	-	-	-	-	-	-	-		
		74															
VERY DENSE, GRAY, **SILTY SAND**, WET	911.9	75															

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-23

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 986.4 ft LOCATION 770750.303 1870608.785 DATE STARTED / DATE COMPLETED 11/28/17 - 12/7/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY DENSE, GRAY, **SILTY SAND**, WET *(continued)*		76	23-32-34	87	SS-31		-	-	-	-	-	-	-	-	-		
		77															
		78	22-25-25	87	SS-32		-	-	-	-	-	-	-	-	-		
		79															
- VERY FINE SAND @ 80.0' TO 80.6'		80															
- MEDIUM TO COARSE GRAVEL @ 80.6' TO 81.5'		81	16-29-38	100	SS-33		-	-	-	-	-	-	-	-	-		
	904.4	82															
VERY DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL AND STONE FRAGMENTS, TRACE SILT, WET		83	21-27-27	100	SS-34		-	-	-	-	-	-	-	-	-		
		84															
		85															
		86	24-25-26	100	SS-35		-	-	-	-	-	-	-	-	-		
		87															
- INCREASE IN SILT AND CLAY		88	17-31-30	53	SS-36		-	-	-	-	-	-	-	-	-		
- VERY FINE SAND		89															
	896.9	90															
HARD, BROWN AND GRAY MOTTLED, **CLAY**, SOME SAND, COBBLES, TRACE TO LITTLE STONE FRAGMENTS, TRACE GRAVEL, DAMP TO MOIST		91	16-21-27	100	SS-37		-	-	-	-	-	-	-	-	-		
		92															
- TRACE SANDSTONE AND SHALE FRAGMENTS IN SAMPLE		93	6-38-50/4.8"	100	SS-38		-	-	-	-	-	-	-	-	-		
		94															
		95	40-50/4.8"	0	SS-39		-	-	-	-	-	-	-	-	-		
		96															
		97															
- ENCOUNTERED COBBLES		98	22-27-28	100	SS-40		-	-	-	-	-	-	-	-	-		
		99															
		100	14-37-50/4.8"	100	SS-41		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-23

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 986.4 ft LOCATION 770750.303 1870608.785 DATE STARTED / DATE COMPLETED 11/28/17 - 12/7/17

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
HARD, BROWN AND GRAY MOTTLED, **CLAY**, SOME SAND, COBBLES, TRACE TO LITTLE STONE FRAGMENTS, TRACE GRAVEL, DAMP TO MOIST *(continued)*		102															
		103	32-47-54	100	SS-42		-	-	-	-	-	-	-	-	-		
- WEATHERED SANDSTONE AND WEATHERED SHALE FRAGMENTS THROUGHOUT SAMPLE -POTENTIAL TOP OF ROCK AT 102.5'		104															
		105	32-50/2.4"	100	SS-43		-	-	-	-	-	-	-	-	-		
- ROCK FRAGMENTS IN SAMPLE		106															
		107															
- LARGE SANSDSTONE FRAGMENTS IN SAMPLE	878.4	TR 108	50/3.6"	100	SS-44		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; CEMENT

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-23**
Coordinates:	N 770750.3 E 1870608.8	Driller:	Stantec/M.M	**Sheet No. 1 of 3**
Top Drillhole Elevation:	986.4 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	794.8 feet MSL	Prepared By:	A. Mirza	
Total Depth:	191.6 feet	Checked By:	B. Madras Natarajan	Date Start: 11/28/17 End: 12/7/17
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 10.4

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
886								Refer to soil borings for details on soil descriptions/characteristics
884	102							
882	104							
880	106							
878	108						108.0 to 126.6' **Glacial Till** interbedded with **BEREA SANDSTONE**	
876	110	0	33	N/A		1	**Glacial Till**, brown, very stiff clay, moist **BEREA SANDSTONE** brown, fine grained, highly weathered, soft to moderately hard, thinly bedded	Run-1 108.0' -111.6 2.4' Washed Out
874	112							
872	114	0	26	N/A		2		Run-2 111.6' - 116.6' 3.7' Washed Out
870	116							
868	118	0	58	N/A		3		Run-3 116.6' - 121.6' 2.1' Washed Out Down Pressure = 300 Psi
866	120							
864	122	23	97	N/A		4		
862	124							
860	126							Top of Rock @ 126.6'
858	128	82	100	N/A		5	126.6 to 139.0' **BEDFORD SHALE**, red, very fine grained, highly weathered to decomposed, soft, moderately to highly fractured, thinly bedded, weathered joints	Run-4 121.6' -126.6' Recovered 2.5 ft from previous run, high rock chatter, increased run time Run-5 126.6' - 131.6' Down Pressure = 500 to 1000 Psi Picked up 2.5' from previous run
856	130							
854	132							Run-6 131.6' - 141.6' Gas pocket encountered, highly weathered to decomposed rock Down Pressure = 500 to 1000 Psi
852	134	9	50	N/A	133.7' 0-5°, B, R3, O Pl, Cl 133.8' 0-5°, B, R3-R4, O, Pl, Cl 133.9' 0-5°, B, R4, O, Pl, Cl 134.0' 0-5°, B, R3-R4, PtO-t, Pl, Cl 134.1' 0-5°, B, R3-R4, O, Pl, Cl 134.2' 0-5°, B, R3-R4, O, Pl, Cl 134.5' 0-5°, B, R3-R4, PtO-t, Pl, Cl 135.3' 0-5°, B, R3-R4, PtO-t, Pl, Cl 135.6' 0-5°, B, R3-R4, O, Und, Cl	6		
850	136							
848	138						139.0 to 161.6' **BEDFORD SHALE**, gray, very fine grained, highly weathered	

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-23	
Coordinates: N 770750.3 E 1870608.8	Driller: Stantec/M.M	Sheet No. 2 of 3	
Top Drillhole Elevation: 986.4 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 794.8 feet MSL	Prepared By: A. Mirza		
Total Depth: 191.6 feet	Checked By: B. Madras Natarajan	Date Start: 11/28/17 End: 12/7/17	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 10.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
846		1 9 1	50	N/A		6	to decomposed, soft, moderately to highly fractured, thinly bedded, flat, slightly rough to smooth joints	
844	142				141.6' to 142.6' 0-5°, 10 Bs, R3-R4, O, Pl, Cl 142.6' to 143.6' fractured rock			Run-7 141.6' - 146.6' lost 1.6' sample
842	144	6	68	4.4	143.6' to 145.6' 0-5°, 12 Bs, R3-R4, O, Pl, Cl	7		
840	146							
838	148				146.6' to 147.8' fractured rock			Run-8 146.6' - 151.6' Low recovery could be an equipment issue, good water return throughout
836	150	6	24	N/A		8		
834	152	5	100	6	151.6' to 153.6' 0-5°, 12 Jts, R3-R4, O, Pl, Cl	9		Run-9 151.6' - 153.6'
832	154	73	90	2.3	153.8' 0-5°, B, R3-R4, PtO-t, Pl, Cl 154.0' 0-5°, B, R3-R4, PtO-t, Pl, Cl 154.3' 0-5°, B, R3, O Pl, Cl 154.5' 0-5°, B, R3-R4, O, Pl, Cl 155.2' 0-5°, B, R3-R4, PtO-t, Pl, Cl 155.8' 0-5°, B, R3-R4, PtO-t, Pl, Cl	10		Run-10 153.6' - 156.6'
830	156							
828	158	82	100	1.4	156.2' 0-5°, B, R3, O Pl, Cl 157.9' 0-5°, B, R3-R4, O, Pl, Cl 158.4' 0-5°, B, R3-R4, PtO-t, Pl, Cl 159.3' 0-5°, B, R3, O Pl, Cl 159.9' 0-5°, B, R3-R4, O, Pl, Cl 160.1' to 161.6' 90° Jt, R3, O, Und, Cl	11		Run-11 156.6' - 161.6' 156.6' - 157.0' UCS = 9,090 psi 156.6' - 161.6' Gas Meter COMB = 1 CO = 1
826	160							
824	162				161.8' 0-5°, B, R4-R5, O, Pl, Cl 162.1' to 162.8' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl	12	161.6 to 191.6' **OHIO SHALE**, dark gray, very fine grained, slightly to moderately weathered, soft to moderately hard, slightly to moderately fractured, thinly bedded	Run-12 161.6' - 166.6'
822	164	17	100	4.8	163.0' to 163.9' 0-5°, 5 Bs, R4-R5, O, Pl, Cl 164.1' 0-5°, B, R4, O Pl, Cl 164.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 164.7' 0-5°, B, R4, O Pl, Cl 164.8' 0-5°, B, R3-R4, O, Pl, Cl 165.0' to 165.8' 0-5°, 5 Bs, R4, O Pl, Cl			161.6' - 166.6' Gas Meter COMB = 1 CO = 1
820	166							
818	168	38	100	4.8	166.1' to 166.9' 0-5°, 4 Bs, R3, O Pl, Cl 167.2' to 167.9' 0-5°, 7 Bs, R4-R5, PtO-t, Pl, Cl 168.0' 0-5°, B, R4, O Pl, Cl 168.2' 0-5°, B, R4-R5, O, Pl, Cl 168.4' 0-5°, B, R4, O Pl, Cl 168.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 168.8' 0-5°, B, R4, O Pl, Cl 169.0' to 169.9' 0-5°, 5 Bs, R4, O Pl, Cl 170.3' to 170.8' 0-5°, 4 Bs, R4-R5, PtO-t, Pl, Cl	13		Run-13 166.6' - 171.6' 170.6' - 171.1' UCS = 8,732 psi
816	170							
814	172				171.2' to 171.8' 0-5°, 4 Bs, R3, O Pl, Cl 172.1' to 172. 6' 0-5°, 4 Bs, R4, O Pl, Cl			Run-14 171.6' - 176.6' Down Pressure = 300 Psi
812	174	38	100	3.8	173.4' to 173.8' 0-5°, 3 Bs, R4-R5, O, Pl, Cl 174.1' 0-5°, B, R4, O Pl, Cl 174.4' 0-5°, B, R4, O Pl, Cl 174.7' 0-5°, B, R4-R5, PtO-t, Pl, Cl 175.0' 0-5°, B, R4-R5, O Pl, Cl 175.1' 0-5°, B, R4, O Pl, Cl	14		
810	176							
808	178	40	96	3.4	175.4' 0-5°, B, R4-R5 PtO-t, Pl, Cl 175.6' 0-5°, B, R4, O Pl, Cl 176.0' to 176.8' 0-5°, 5 Bs, R4, O Pl, Cl 177.0' to 177.6' 0-5°, 4 Bs, R4-R5, PtO-t, Pl, Cl 178.1' to 178.8' 0-5°, 4 Bs, R4-R5 O Pl, Cl 179.1' 0-5°, B, R4, O Pl, Cl	15		Run-15 176.6' - 181.6' 50 minute run Down Pressure = 300 Psi

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-23	
Coordinates: N 770750.3 E 1870608.8	Driller: Stantec/M.M	Sheet No. 3 of 3	
Top Drillhole Elevation: 986.4 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 794.8 feet MSL	Prepared By: A. Mirza		
Total Depth: 191.6 feet	Checked By: B. Madras Natarajan	Date Start: 11/28/17 End: 12/7/17	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 10.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
806		40	96	3.4	179.5' 0-5°, B, R4, O Pl, Cl 179.8' 0-5°, B, R4, O Pl, Cl 180.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl 180.6' 0-5°, B, R4-R5 O Pl, Cl	15		
804	182				180.8' 0-5°, B, R4, O Pl, Cl 181.2' to 181.9' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl 182.1' to 182.8' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl			Run-16 181.6' - 186.6' 35 minute run Down Pressure = 300 Psi
802	184	29	84	4.4	183.2' 0-5°, B, R4-R5 O Pl, Cl 183.4' 0-5°, B, R4, O Pl, Cl 183.6' 0-5°, B, R4-R5, PtO-t, Pl, Cl 183.8' 0-5°, B, R4-R5, PtO-t, Pl, Cl 184.2' to 184.9' 0-5°, 4 Bs, R4, O Pl, Cl 185.1' to 185.8' 0-5°, 5 Bs, R4-R5 O Pl, Cl	16		
800	186				186.0' 0-5°, B, R4-R5, PtO-t, Pl, Cl 186.6' to 187.9' 80°, Jt, R3-R4, O, Und			Run-17 186.6' - 191.6' 27 minute run Down Pressure = 300 Psi
798	188	92	98	2.6	188.0' to 188.9' 0-5°, 4 Bs, R4, PtO-t Pl, Cl 189.0' to 189.6' 0-5°, 3 Bs, R4, PtO-t Pl, Cl 190.0' to 190.6' 0-5°, 3 Bs, R4-R5, t Pl, Cl 191.0' 0-5°, B, R4, PtO-t Pl, Cl	17		
796	190							
794	192				191.4' 0-5°, B, R4, O Pl, Cl		**End of Boring at 191.6 feet**	
792	194							
790	196							
788	198							
786	200							
784	202							
782	204							
780	206							
778	208							
776	210							
774	212							
772	214							
770	216							
768	218							

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-24

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770882.433 1870689.139	**DATE STARTED**	2/21/18	**COMPLETED**	3/1/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	89.8 % (Avg.)	**SURFACE ELEVATION**	989.6 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 2	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
MEDIUM STIFF TO STIFF, BROWN GRAY MOTTLED, **SILTY CLAY**, DAMP	989.58	1	2-3-3	78	SS-1	2.0 - 2.25	-	-	-	-	-	-	-	-	-		
		2															
		3	9-7-9	100	SS-2		-	-	-	-	-	-	-	-	-		
		4															
		5															
		6	6-11-17	100	SS-3	2.75	-	-	-	-	-	-	-	-	-		
		7															
		8	6-12-20	100	SS-4	4.5+	-	-	-	-	-	-	-	-	-		
		9															
	979.4	10															
DENSE, GRAY, **SILT**, TRACE SAND AND GRAVEL, DAMP		11	18-10-13	72	SS-5	4.5+	-	-	-	-	-	-	-	-	-		
		12															
		13	5-5-9	100	SS-6	4.25 - 4.5	-	-	-	-	-	-	-	-	-		
		14															
		15															
		16	8-34-27	67	SS-7		-	-	-	-	-	-	-	-	-		
		17															
		18	5-11-14	100	SS-8		-	-	-	-	-	-	-	-	-		
		19															
	969.6	20															
VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND AND GRAVEL, DAMP		21	8-12-19	56	SS-9		-	-	-	-	-	-	-	-	-		
		22															
		23	12-14-25	100	SS-10	4.5+	-	-	-	-	-	-	-	-	-		
	W	24															

SUBSURFACE LOG

EXPLORATION ID: B-24

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 989.6 ft LOCATION 770882.433 1870689.139 DATE STARTED / DATE COMPLETED 2/21/18 - 3/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, SOME GRAVEL, TRACE CLAY, WET	964.4	26	14-21-22	100	SS-11		-	-	-	-	-	-	-	-	-		
		27															
		28	-	39	SS-12		-	-	-	-	-	-	-	-	-		
		29															
		30															
		31	21-50/2.4"	78	SS-13		-	-	-	-	-	-	-	-	-		
		32															
		33	24-50/1.2"	39	SS-14		-	-	-	-	-	-	-	-	-		
		34															
		35															
		36	19-42-50/4.8"	72	SS-15		-	-	-	-	-	-	-	-	-		
		37															
		38	24-26-44	100	SS-16		-	-	-	-	-	-	-	-	-		
		39															
		40															
		41	13-25-24	78	SS-17		-	-	-	-	-	-	-	-	-		
		42															
		43	50/4.8"	28	SS-18		-	-	-	-	-	-	-	-	-		
		44															
		45															
		46	20-50/4.8"	67	SS-19		-	-	-	-	-	-	-	-	-		
		47															
		48	29-27-33	100	SS-20		-	-	-	-	-	-	-	-	-		
		49															
		50															
VERY DENSE, BROWN TO GRAY, **FINE SAND**, SOME SILT, MOIST TO WET	939.3	51	14-26-27	100	SS-21		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-24

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 989.6 ft LOCATION 770882.433 1870689.139 DATE STARTED / DATE COMPLETED 2/21/18 - 3/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY DENSE, BROWN TO GRAY, **FINE SAND**, SOME SILT, MOIST TO WET *(continued)*		52															
		53	23-26-29	100	SS-22		-	-	-	-	-	-	-	-	-		
		54															
		55															
		56	14-20-26	100	SS-23		-	-	-	-	-	-	-	-	-		
		57															
		58	43-50/4.8"	61	SS-24		-	-	-	-	-	-	-	-	-		
		59															
		60															
		61	13-29-44	100	SS-25		-	-	-	-	-	-	-	-	-		
		62															
		63	13-24-32	100	SS-26		-	-	-	-	-	-	-	-	-		
		64															
VERY STIFF, BROWN, **SILTY CLAY**, SOME GRAVEL AND SAND, DAMP TO MOIST	924.6	65															
		66	15-26-50	100	SS-27	4.5+	-	-	-	-	-	-	-	-	-		
		67															
		68	19-27-35	100	SS-28	3.5	-	-	-	-	-	-	-	-	-		
		69															
		70															
		71	16-50/3.6"	56	SS-29		-	-	-	-	-	-	-	-	-		
		72															
		73	33-46-50/4.8"	47	SS-30	4.5+	-	-	-	-	-	-	-	-	-		
		74															
		75															
		76	13-17-30	100	SS-31	4.5+	-	-	-	-	-	-	-	-	-		
		77															
		78	21-45-50/3.6"	78	SS-32		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-24

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 989.6 ft LOCATION 770882.433 1870689.139 DATE STARTED / DATE COMPLETED 2/21/18 - 3/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY STIFF, BROWN, **SILTY CLAY**, SOME GRAVEL AND SAND, DAMP TO MOIST *(continued)*		79															
		80															
		81	35-49-46	100	SS-33		-	-	-	-	-	-	-	-	-		
		82															
VERY STIFF, GRAY, **CLAYEY SILT**, TRACE SAND, DAMP	907.1	83	32-50-50/2.4"	78	SS-34		-	-	-	-	-	-	-	-	-		
		84															
VERY DENSE, GRAY, **SILTY SAND**, SOME STONE FRAGMENTS, DAMP	904.6	85															
		86	50+	28	SS-35		-	-	-	-	-	-	-	-	-		
		87															
SEVERELY WEATHERED, SHALE, GRAY (AUGERED).	902.1	88	50+	22	SS-36		-	-	-	-	-	-	-	-	-		
		89															
	899.2 TR	90	50+	42	SS-37		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-24	
Coordinates: N 770882.4 E 1870689.1	Driller: Stantec/ M.M	Sheet No. 1 of 3	
Top Drillhole Elevation: 989.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 196.4 feet	Checked By: B. Madras Natarajan	Date Start: 2/21/18 End: 3/1/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 27	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
904	86							Refer to soil borings for details on soil descriptions/classifications
902	88							
900	90							
		0	100	2	90.6' 0-5°, B, R4-R5, O, Pl, Cl	1	90.4 to 116.4' **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft, thinly bedded, highly fractured	Top of Rock @ 90.4' Run-1 90.4' - 91.4' 9 minute run Down Pressure = 200 Psi
898	92				91.2' 0-5°, B, R5, O, Pl, Cl 91.7' 0-5°, B, R4-R5, PtO-t, Pl 91.9' 0-5°, B, R5, t, Pl, Cl 91.9' to 94.9' fractured rock			Run-2 91.4' - 96.4' 23 minute run Down Pressure = 300 Psi
896	94	0	98	2.8		2		
894	96				94.9' to 96.3' 0-5°, 12 Bs, R4-R5, PtO-t, Pl, Cl			
892	98				96.4' to 97.0' 0-5°, 5 Bs, R3-R4, PtO-t, Pl, Cl 98.0' to 98.4' 0-5°, 4 Bs, R4-R5, O, Pl, Cl			Run-3 96.4' - 101.4' 21 minute run Down Pressure = 350 - 400 Psi
890	100	48	100	6.4	98.4' to 99.4' 0-5°, 10 Bs, R4-R5, O, Pl, Cl 99.4' to 100.0' 0-5, 8 Bs, R4-R5, PtO-t, Pl, Cl 100.0' to 100.6' fractured rock 100.8' to 101.4' 0-5, 5 Bs, R4-R5, O, Pl, Cl	3		
888	102				101.4' to 101.8' fractured rock 102.0' to 102.6' fractured rock			Run-4 101.4' - 106.4' 25 minute run Down Pressure = 350 - 400 Psi
886	104	22	92	2.4	102.9' 0-5°, B, R5, t, Pl 103.0' 0-5°, B, R5, PtO-t, Pl 103.1' to 103.4' fractured rock 103.6' 0-5°, B, R4-R5, O, Pl 104.0' 0-5°, B, R5, t, Pl 104.2' 0-5°, B, R5, PtO-t, Pl 104.4' 0-5°, B, R4-R5, O, Pl 104.7' 0-5°, B, R5, t, Pl	4		
884	106				105.1' 0-5°, B, R5, PtO-t, Pl 105.3' 0-5°, B, R5, t, Pl 105.5' 0-5°, B, R4, t, Pl 105.9' 0-5°, B, R5, PtO-t, Pl 106.6' 0-5°, B, R4-R5, O, Pl 107.0' to 107.3' fractured rock 107.8' 0-5°, B, R4-R5, O, Pl 108.0' 0-5°, B, R5, PtO-t, Pl 108.5' 0-5°, B, R4-R5, O, Pl 108.6' 0-5°, B, R5, t, Pl 108.8' 0-5°, B, R4, t, Pl			Run-5 106.4' - 111.4' 30 minute run Down Pressure = 450 Psi
882	108	28	100	2.4		5		
880	110							
878	112				109.2' 0-5°, B, R5, PtO-t, Pl 109.4' 0-5°, B, R5, t, Pl 109.8' to 110.1' fractured rock 110.3' 0-5°, B, R5, PtO-t, Pl 110.5' 0-5°, B, R4-R5, O, Pl			Run-6 111.4' - 116.4' 42 minute run Down Pressure = 350 - 400 Psi
876	114	50	100	3	110.7' 0-5°, B, R5, t, Pl 111.2' 0-5°, B, R5, PtO-t, Pl 111.6' 0-5°, B, R5, t, Pl 111.8' 0-5°, B, R4, t, Pl 112.2' 0-5°, B, R5, PtO-t, Pl	6		
874	116				112.5' 0-5°, B, R5, PtO-t, Pl 112.8' 0-5°, B, R4-R5, O, Pl 113.2' 0-5°, B, R5, t, Pl		116.4 to 141.4' **BEDFORD SHALE**, red, very fine grained, highly weathered, soft, thinly bedded, highly fractured	Run-7 116.4' - 121.4' 20 minute run Down Pressure = 400 Psi
872	118				113.5' 0-5°, B, R4-R5, t, Pl 114.3' 0-5°, B, R4, O, Pl 114.4' 0-5°, B, R5, t, Pl			
870	120	20	100	2.6	114.7' 0-5°, B, R5, PtO-t, Pl 115.0' 0-5°, B, R4, t, Pl 115.2' 0-5°, B, R5, O, Pl 115.7' 0-5°, B, R5, PtO-t, Pl 116.0' 0-5°, B, R5, t, Pl 116.1' 0-5°, B, R5, PtO-t, Pl	7		
868	122				116.6' to 117.6' fractured rock 117.8' to 118.0' fractured rock			Run-8 121.4' - 126.4' 34 minute run Down Pressure = 500 Psi
866	124	16	100	2	118.2' 0-5°, B, R5, t, Pl 118.4' 0-5°, B, R4-R5, t, Pl 118.9' 0-5°, B, R4, O, Pl 119.2' 0-5°, B, R5, t, Pl 119.4' 0-5°, B, R5, PtO-t, Pl 119.6' 0-5°, B, R4-R5, O, Pl	8		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-24	
Coordinates: N 770882.4 E 1870689.1	Driller: Stantec/ M.M	Sheet No. 2 of 3	
Top Drillhole Elevation: 989.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 196.4 feet	Checked By: B. Madras Natarajan	Date Start: 2/21/18 End: 3/1/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 27	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
864	126	16	100	2	120.2' 0-5°, B, R5, t, Pl 120.8' 0-5°, B, R5, PtO-t, Pl 121.2' 0-5°, B, R5, t, Pl	8		
862	128	26	92	2.2	121.6' 0-5°, B, R4, t, Pl 122.4' 0-5°, B, R5, PtO-t, Pl 123.0' 0-5°, B, R5, PtO-t, Pl 123.2' 0-5°, B, R4, O, Pl 123.6' 0-5°, B, R5, t, Pl 123.8' 0-5°, B, R5, PtO-t, Pl 124.2' 0-5°, B, R4-R5, O, Pl 124.6' 0-5°, B, R5, t, Pl 124.8' 0-5°, B, R5, PtO-t, Pl 125.3' 0-5°, B, R4-R5, O, Pl 125.5' 0-5°, B, R5, t, Pl	9		Run-9 126.4' - 131.4' 22 minute run Down Pressure = 500 Psi
860	130							
858	132				125.7' 0-5°, B, R5, PtO-t, Pl 126.0' 0-5°, B, R5, t, Pl 126.2' 0-5°, B, R4, t, Pl 126.6' 0-5°, B, R5, PtO-t, Pl 126.8' 0-5°, B, R4-R5, O, Pl			Run-10 131.4' - 136.4' 21 minute run Down Pressure = 500 Psi
856	134	0	64	1.4	127.0' 0-5°, B, R5, PtO-t, Pl 127.2' 0-5°, B, R5, t, Pl 127.6' 0-5°, B, R4, t, Pl 127.8' 0-5°, B, R5, PtO-t, Pl 128.4' 0-5°, B, R4-R5, O, Pl 128.8' 0-5°, B, R5, t, Pl	10		
854	136							
852	138	66	100	1	129.4' 0-5°, B, R5, O, Pl 129.8' to 130.2' fractured rock 130.4' 0-5°, B, R4-R5, O, Pl 130.9' 0-5°, B, R5, PtO-t, Pl 131.4' to 131.8' fractured rock 132.5' to 132.8' fractured rock 133.0' 0-5°, B, R5, t, Pl 133.1' 0-5°, B, R4, O, Pl 133.3' 0-5°, B, R5, PtO-t, Pl 133.5' 0-5°, B, R4-R5, O, Pl 133.6' 0-5°, B, R5, PtO-t, Pl	11		Run-11 136.4' - 141.4' 32 minute run Down Pressure = 500 Psi
850	140							
848	142	0	40	3.2	133.8' 0-5°, B, R4, t, Pl 134.4' 0-5°, B, R5, PtO-t, Pl 137.6' 0-5°, B, R4, O, Pl 139.6' 140.0' fractured rock 140.2' 0-5°, B, R4, O, Pl 140.6' 0-5°, B, R4, t, Pl 140.8' 0-5°, B, R5, PtO-t, Pl 141.3' 0-5°, B, R4, t, Pl 141.4' to 142.4' 0-5°, 8 Bs, R4-R5, O, Pl 142.4' to 143.4' 0-5°, 8 Bs, R4-R5, O, Pl	12	141.4 to 161.4' **BEDFORD SHALE**, grey, very fine grained, moderately to highly weathered, soft to moderately hard, thinly bedded, highly fractured	Run-12 141.4' - 146.4' 21 minute run Down Pressure = 500 Psi
846	144							
844	146							
842	148	22	74	4.4	147.0' to 147.4' 0-5, 5 Bs, R4-R5, O, Pl 147.4' to 148.4' 0-5, 11 Bs, R5, O, Pl	13		Run-13 146.4' - 151.4' 30 minute run Down Pressure = 450 Psi
840	150				148.5' 0-5°, B, R5, PtO-t, Pl 148.7' 0-5°, B, R4-R5, O, Pl 149.3' 0-5°, B, R5, PtO-t, Pl 149.4' 0-5°, B, R4, t, Pl 149.6' 0-5°, B, R5, PtO-t, Pl 150.0' 0-5°, B, R5, PtO-t, Pl			
838	152	7	100	3.4	151.6' 0-5°, B, R4-R5, O, Pl 152.0' 0-5°, B, R4, PtO-t, Pl 152.3' 0-5°, B, R5, O, Pl 152.5' to 152.9' fractured rock 153.2' 0-5°, B, R5, t, Pl 153.8' 0-5°, B, R4, O, Pl 154.1' 0-5°, B, R5, PtO-t, Pl 154.3' 0-5°, B, R4-R5, O, Pl 154.5' 0-5°, B, R5, PtO-t, Pl 154.6' 0-5°, B, R4, t, Pl 155.0' 0-5°, B, R5, PtO-t, Pl	14		Run-14 151.4' - 156.4' 21 minute run Down Pressure = 450 - 500 Psi
836	154							
834	156							
832	158	32	100	3.8	155.2' 0-5°, B, R4, O, Pl 155.3' 0-5°, B, R5, PtO-t, Pl 155.5' 0-5°, B, R4-R5, O, Pl 155.7' 0-5°, B, R5, t, Pl 155.9' 0-5°, B, R5, PtO-t, Pl 156.1' 0-5°, B, R5, t, Pl 156.2' 0-5°, B, R4, t, Pl 156.6' 0-5°, B, R5, PtO-t, Pl 156.8' 0-5°, B, R5, PtO-t, Pl 157.0' 0-5°, B, R4, O, Pl	15		Run-15 156.4' - 161.4' 9 minute run Down Pressure = 450 - 475 Psi
830	160							
828	162	96	100	0.6	157.7' 0-5°, B, R5, t, Pl 157.9' 0-5°, B, R5, PtO-t, Pl 158.2' 0-5°, B, R4-R5, O, Pl 158.4' 0-5°, B, R5, t, Pl 158.4' to 159.2' 0-5°, 8 Bs, R4-R5, O, Pl 159.6' 0-5°, B, R5, t, Pl 160.0' 0-5°, B, R5, PtO-t, Pl 160.2' 0-5°, B, R5, t, Pl	16	161.4 to 196.4' **OHIO SHALE**, black, very fine grained, slightly weathered, moderately hard, thinly bedded, slightly to moderately fractured	Run-16 161.4' - 166.4' 12 minute run Down Pressure = 400 Psi
826	164							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-24	
Coordinates: N 770882.4 E 1870689.1	Driller: Stantec/ M.M	Sheet No. 3 of 3	
Top Drillhole Elevation: 989.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 793.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 196.4 feet	Checked By: B. Madras Natarajan	Date Start: 2/21/18 End: 3/1/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 27	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
824	166	96	100	0.6	160.6' 0-5°, B, R4, O, Pl 161.6' 0-5°, B, R4-R5, PtO-t, Pl 162.2' 0-5°, B, R5, PtO-t, Pl	16		
822	168	100	100	1.6	165.8' 0-5°, B, R4, O, Pl 166.2' to 166.8' fractured rock 166.6' 0-5°, B, R5, PtO-t, Pl 166.8' 0-5°, B, R5, t, Pl 167.1' 0-5°, B, R4, O, Pl 167.9' 0-5°, B, R4, t, Pl 168.3' 0-5°, B, R5, PtO-t, Pl 169.9' 0-5°, B, R4, O, Pl 170.1' 0-5°, B, R5, PtO-t, Pl 170.9' 0-5°, B, R4, O, Pl	17		Run-17 166.4' - 171.4' 6 minute run Down Pressure = 450 Psi
820	170							
818	172	66	100	3	171.4' to 172.2' 0-5, 8 Bs, R4-R5, O, Pl 172.9' 0-5°, B, R4-R5, O, Pl 173.2' 0-5°, B, R5, PtO-t, Pl 173.4' 0-5°, B, R4, t, Pl 173.7' 0-5°, B, R5, PtO-t, Pl 174.0' 0-5°, B, R4, O, Pl 174.8' 0-5°, B, R5, PtO-t, Pl 175.2' 0-5°, B, R4-R5, O, Pl	18		Run-18 171.4' - 176.4' 5 minute run Down Pressure = 450 Psi
816	174							
814	176							
812	178	92	100	1.2	176.6' 0-5°, B, R5, t, Pl 176.8' 0-5°, B, R5, PtO-t, Pl 177.6' 0-5°, B, R5, t, Pl 178.4' 0-5°, B, R4, t, Pl 178.7' 0-5°, B, R5, PtO-t, Pl 180.2' 0-5°, B, R4-R5, O, Pl	19		Run-19 176.4' - 181.4' 5 minute run Down Pressure = 475 Psi
810	180							
808	182	70	98	2.4	181.6' 0-5°, B, R5, t, Pl 182.4' 0-5°, B, R5, PtO-t, Pl 182.7' 0-5°, B, R5, t, Pl 183.2' 0-5°, B, R4, t, Pl 183.4' 0-5°, B, R5, PtO-t, Pl 184.2' 0-5°, B, R4-R5, O, Pl 184.7' 0-5°, B, R5, PtO-t, Pl 185.0' 0-5°, B, R4, O, Pl 185.5' 0-5°, B, R5, PtO-t, Pl 185.7' 0-5°, B, R4-R5, O, Pl	20		Run-20 181.4' - 186.4' 8 minute run Down Pressure = 450 Psi Possible Gas pocket encountered during drilling
806	184							
804	186							
802	188	82	98	2.2	186.0' 0-5°, B, R5, t, Pl 186.2' 0-5°, B, R5, PtO-t, Pl 186.5' 0-5°, B, R5, t, Pl 186.6' 0-5°, B, R5, PtO-t, Pl 186.9' 0-5°, B, R5, t, Pl 187.9' 0-5°, B, R4-R5, O, Pl 188.2' 0-5°, B, R5, t, Pl 188.7' 0-5°, B, R5, PtO-t, Pl 188.9' 0-5°, B, R5, t, Pl 189.1' 0-5°, B, R5, PtO-t, Pl 189.3' 0-5°, B, R5, t, Pl	21		Run-21 186.4' - 191.4' 6 minute run Down Pressure = 450 Psi
800	190							
798	192	64	98	2.6	189.7' 0-5°, B, R4, t, Pl 190.1' 0-5°, B, R5, PtO-t, Pl 191.7' 0-5°, B, R4-R5, O, Pl 192.0' 0-5°, B, R5, t, Pl 192.7' 0-5°, B, R4-R5, O, Pl 193.1' 0-5°, B, R5, t, Pl 193.9' 0-5°, B, R5, PtO-t, Pl 194.2' 0-5°, B, R4-R5, t, Pl 194.7' 0-5°, B, R5, PtO-t, Pl 195.0' to 195.9' 0-5°, 5 Bs, R4-R5, O, Pl	22		Run-22 191.4' - 196.4' 5 minute run Down Pressure = 470 Psi
796	194							
794	196							
792	198				196.1' 0-5°, B, R4-R5, O, Pl		**End of Boring at 196.4 feet**	
790	200							
788	202							
786	204							

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SUBSURFACE LOG

EXPLORATION ID: B-25

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	771204.581 1870990.863	**DATE STARTED**	5/11/18	**COMPLETED**	5/22/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical	**HAMMER TYPE**	Auto	**EFFICIENCY**	92.4 % (Avg.)	**SURFACE ELEVATION**	995.0 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 1	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 994.96	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
AUGERED TO REFUSAL AT DEPTH OF 10.2'		W 1 2 3 4 5 6 7 8 9 10															
	984.8	TR															

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 155.0 TO 175.0 FEET (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; SAND

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 1	**BORING NO. B-25**
Coordinates:	N 771204.6 E 1870990.9	Driller:	Stantec/ M.M	**Sheet No. 1 of 5**
Top Drillhole Elevation:	995.0 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	817.9 feet MSL	Prepared By:	A. Mirza	
Total Depth:	177.1 feet	Checked By:	B. Madras Natarajan	Date Start: 5/11/18 End: 5/22/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 1.4

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
994	2							Refer to soil borings for details on soil descriptions/classifications
992	4							
990	6							
988	8							
986	10							
984	12	64	100	2.8	10.2' 11.2' 0-5°, 5 Bs, R3-R4, O, Pl, Cl 11.2' to 12.2 0-5°, 7 Bs, R3-R4, O, Pl, Cl 12.3' 0-5°, B, R4-R5, O, Pl 12.5' 0-5°, B, R4-R5, O, Pl 12.7' 0-5°, B, R5, t, Pl 14.2' 0-5°, B, R5, PtO-t, Pl 14.7' 0-5°, B, R4-R5, O, Pl 14.9' 0-5°, B, R5, t, Pl 15.8' 0-5°, B, R5, PtO-t, Pl	1	10.2 to 52.5' **BEREA SANDSTONE**, grey, fine grained, moderately weathered, moderately hard to hard, ferriferous, medium bedded, moderate to highly fractured, flat, highly weathered joints.	Top of Rock @ 10.2' Run-1 10.2' - 17.1' 18 minute run Down Pressure = 0 - 150 Psi
982	14							
980	16							
978	18	69	93	1.8	17.3' 0-5°, B, R5, t, Pl 17.4' 0-5°, B, R4, t, Pl 17.6' 0-5°, B, R5, PtO-t, Pl 18.3' 0-5°, B, R4-R5, O, Pl 19.7' 0-5°, B, R5, PtO-t, Pl 21.8' 0-5°, B, R5, t, Pl 21.9' 0-5°, B, R4, t, Pl 22.4' 0-5°, B, R5, PtO-t, Pl 22.5' 0-5°, B, R5, PtO-t, Pl 22.6' 0-5°, B, R4-R5, O, Pl 23.1' 0-5°, B, R5, t, Pl 23.5' 0-5°, B, R4-R5, t, Pl 23.6' 0-5°, B, R4, O, Pl 24.5' 0-5°, B, R5, t, Pl 24.8' 0-5°, B, R5, PtO-t, Pl 25.5' 0-5°, B, R4-R5, O, Pl 25.6' 0-5°, B, R5, t, Pl	2		Run-2 17.1' - 27.1' 10 minute run Down Pressure = 150 Psi
976	20							
974	22							
972	24							
970	26							
968	28	72	94	2.0	26.1' 0-5°, B, R4-R5, t, Pl 27.4' 0-5°, B, R4, O, Pl 27.5' 0-5°, B, R5, t, Pl 27.7' 0-5°, B, R5, PtO-t, Pl 28.1' to 28.2' fractured rock 28.5' 0-5°, B, R5, t, Pl 29.2' 0-5°, B, R5, PtO-t, Pl 29.8' 0-5°, B, R4-R5, O, Pl 30.3' 0-5°, B, R5, t, Pl 30.4' 0-5°, B, R5, PtO-t, Pl 31.0' 0-5°, B, R5, t, Pl 31.7' 0-5°, B, R4, t, Pl 31.8' 0-5°, B, R5, PtO-t, Pl 31.9' 0-5°, B, R4-R5, O, Pl 32.2' 0-5°, B, R5, PtO-t, Pl 33.0' 0-5°, B, R5, t, Pl 33.5' 0-5°, B, R4, O, Pl 33.7' 0-5°, B, R5, t, Pl 34.1' 0-5°, B, R5, PtO-t, Pl 34.2' 0-5°, B, R4-R5, O, Pl 35.3' 0-5°, B, R5, t, Pl 35.8' 0-5°, B, R5, t, Pl	3		Run-3 27.1' - 37.1' 13 minute run Down Pressure = 150 Psi
966	30							
964	32							
962	34							
960	36							
958	38	46	89	1.6	37.3' 0-5°, B, R5, PtO-t, Pl 37.4' 0-5°, B, R4-R5, O, Pl 37.5' 0-5°, B, R5, t, Pl 37.7' to 37.8' fractured rock 38.7' to 38.9' fractured rock	4		Run-4 37.1' - 47.1' 24 minute run Down Pressure = 200 Psi
956								

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	**BORING NO. B-25**	
Coordinates: N 771204.6 E 1870990.9	Driller: Stantec/ M.M	**Sheet No. 2 of 5**	
Top Drillhole Elevation: 995.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 817.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 177.1 feet	Checked By: B. Madras Natarajan	Date Start: 5/11/18 End: 5/22/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
954					39.1' 0-5°, B, R4-R5, O, Pl 39.3' to 39.4' fractured rock 40.1' 0-5°, B, R4-R5, O, Pl 41.3' 0-5°, B, R5, t, Pl 41.5' 0-5°, B, R4, O, Pl 41.6' to 42.1' 90°, Jt, R4, O, Und 42.1' to 42.7' 80°, Jt, R4, O, Und			
952	42							
950	44	46	89	1.6	42.9' 0-5°, B, R5, PtO-t, Pl 43.0' 0-5°, B, R4-R5, O, Pl 43.5' to 44.0' fractured rock 44.1' 0-5°, B, R5, PtO-t, Pl 44.7' 0-5°, B, R5, t, Pl 44.8' 0-5°, B, R4, O, Pl 44.9' 0-5°, B, R5, t, Pl 45.1' 0-5°, B, R4, O, Pl	4		
948	46				45.7' to 45.9' fractured rock			
946	48				47.7' 0-5°, B, R5, t, Pl 48.2' 0-5°, B, R4, O, Pl 48.3' to 48.5' fractured rock 48.6' 0-5°, B, R4-R5, O, Pl 48.9' 0-5°, B, R5, t, Pl 49.0' 0-5°, B, R4, O, Pl 49.9' 0-5°, B, R4, O, Pl 50.0' 0-5°, B, R5, t, Pl 50.4' 0-5°, B, R4, O, Pl			Run-5 47.1' - 57.1' 26 minute run Down Pressure = 200 Psi
944	50							
942	52	22	73	1.9	50.5' to 50.7' fractured rock 50.9' to 51.1' 90°, Jt, R4, O, Und 51.3' 0-5°, B, R4, t, Pl 51.5' 0-5°, B, R5, PtO-t, Pl 51.7' 0-5°, B, R4-R5, O, Pl 52.0' 0-5°, B, R5, PtO-t, Pl 52.4' 0-5°, B, R5, t, Pl 52.8' 0-5°, B, R4-R5, O, Pl 53.1' 0-5°, B, R5, PtO-t, Pl 53.2' 0-5°, B, R5, t, Pl 53.5' 0-5°, B, R4-R5, O, Pl	5	52.5 to 57.0' Interbedded BEDFORD SHALE (80%) and BEREA SANDSTONE (20%)	
940	54							
938	56				53.7' to 53.9' fractured rock		57.0 to 87.1' **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft to moderately hard, thinly bedded, highly to intensely fractured, flat, highly weathered joints	Run-6 57.1' - 62.1' 46 minute run Down Pressure = 200 Psi
936	58				54.1' 0-5°, B, R5, t, Pl 57.1' to 58.1' 0-5, 9 Bs, R4-R5, O, Pl 58.1' to 59.1' fractured rock			
934	60	16	84		59.1' to 60.1' 0-5, 8 Bs, R4-R5, O, Pl 60.2' 0-5°, B, R4-R5, O, Pl 60.3' 0-5°, B, R5, t, Pl 60.7' 0-5°, B, R5, PtO-t, Pl	6		
932	62			2.2	62.1' to 62.6' fractured rock			Run-7 62.1' - 67.1' 15 minute run Down Pressure = 150 Psi
930	64	0	64		62.8' 0-5°, B, R4-R5, O, Pl 63.1' to 63.4' fractured rock 63.6' to 64.1' fractured rock 64.2' 0-5°, B, R4-R5, O, Pl 64.3' to 64.6' fractured rock	7		
928	66							
926	68				67.1' to 68.0' fractured rock 68.4' 0-5°, B, R4, t, Pl 68.6' 0-5°, B, R5, PtO-t, Pl			Run-8 67.1' - 77.1' 39 minute run Down Pressure = 150 Psi
924	70				69.4' 0-5°, B, R4-R5, O, Pl 69.7' to 69.8' fractured rock 70.3' to 70.5' fractured rock 70.7' to 71.3' fractured rock			
922	72	28	87	0.8	71.7' to 72.2' fractured rock 72.4' to 73.0' fractured rock	8		
920	74				73.2' 0-5°, B, R5, t, Pl 73.3' 0-5°, B, R4-R5, O, Pl 73.7' 0-5°, B, R5, PtO-t, Pl 74.4' 0-5°, B, R5, t, Pl 74.8' 0-5°, B, R4-R5, O, Pl 74.8' to 75.3' fractured rock			
918	76							
916	78	12	72	1.6	77.2' 0-5°, B, R4-R5, O, Pl 77.7' to 77.8' fractured rock 78.3' to 78.5' fractured rock 78.7' 0-5°, B, R5, PtO-t, Pl 78.9' 0-5°, B, R4-R5, O, Pl	9		Run-9 77.1' - 82.1' 21 minute run Down Pressure = 100 Psi

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	BORING NO. B-25	
Coordinates: N 771204.6 E 1870990.9	Driller: Stantec/ M.M	Sheet No. 3 of 5	
Top Drillhole Elevation: 995.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 817.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 177.1 feet	Checked By: B. Madras Natarajan	Date Start: 5/11/18 End: 5/22/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
914		12	72	1.6	79.1' 0-5°, B, R5, PtO-t, Pl 79.4' 0-5°, B, R5, t, Pl 79.7' 0-5°, B, R4-R5, O, Pl 80.1' 0-5°, B, R5, PtO-t, Pl	9		
	82				80.3' 0-5°, B, R5, t, Pl 82.3' to 82.4' fractured rock			Run-10 82.1' - 87.1' 18 minute run Down Pressure = 100 Psi
912					82.5' 0-5°, B, R5, PtO-t, Pl			
	84				83.3' 0-5°, B, R4-R5, O, Pl			
910		36	86	2.4	84.0' 0-5°, B, R5, t, Pl 84.4' 0-5°, B, R5, PtO-t, Pl 84.5' 0-5°, B, R5, O, Pl	10		
	86				84.8' 0-5°, B, R4, t, Pl 85.0' 0-5°, B, R5, t, Pl 85.1' 0-5°, B, R4-R5, O, Pl			
908					85.2' 0-5°, B, R4, PtO-t, Pl			
					85.5' 0-5°, B, R5, t, Pl 85.8' 0-5°, B, R4, O, Pl 86.0' to 86.3' fractured rock 87.3' 0-5°, B, R5, t, Pl 87.6' 0-5°, B, R4, t, Pl 88.2' 0-5°, B, R5, PtO-t, Pl 88.7' 0-5°, B, R4-R5, O, Pl 89.0' 0-5°, B, R5, PtO-t, Pl 89.4' 0-5°, B, R5, O, Pl 90.3' 0-5°, B, R4, t, Pl 90.6' 0-5°, B, R5, PtO-t, Pl 91.3' 0-5°, B, R4-R5, O, Pl 91.6' to 92.1' fractured rock 92.3' 0-5°, B, R4-R5, O, Pl 92.6' to 93.5' 90°, Jt, R4, O, Und 94.2' 0-5°, B, R5, t, Pl 94.5' 0-5°, B, R5, PtO-t, Pl 95.0' 0-5°, B, R5, t, Pl 95.5' 0-5°, B, R4, t, Pl 95.7' 0-5°, B, R5, PtO-t, Pl 95.9' 0-5°, B, R4-R5, O, Pl	11	87.1 to 121.6' **BEDFORD SHALE,** grey, very fine grained, moderately weathered, moderately hard, arenaceous, thinly bedded, moderately fractured, flat, moderately weathered joints	Run-11 87.1' - 97.1' 40 minute run Down Pressure = 150 Psi
898					96.0' 0-5°, B, R5, PtO-t, Pl			
	98				97.3' 0-5°, B, R5, t, Pl 97.6' 0-5°, B, R4, t, Pl 98.4' 0-5°, B, R5, PtO-t, Pl			Run-12 97.1' - 107.1' 45 minute run Down Pressure = 150 Psi Increase in water use during Run 12
896					99.2' 0-5°, B, R5, PtO-t, Pl			
	100				99.4' 0-5°, B, R4-R5, O, Pl 99.6' 0-5°, B, R5, t, Pl 99.8' 0-5°, B, R5, PtO-t, Pl			
894					100.0' 0-5°, B, R5, O, Pl 100.2' 0-5°, B, R4, t, Pl			
	102	23	99	3.7	100.4' 0-5°, B, R5, PtO-t, Pl 100.5' 0-5°, B, R4-R5, O, Pl 100.8' 0-5°, B, R4, O, Pl	12		
892					101.0' to 102.0' 0-5, 8 Bs, R4, O, Pl			
	104				102.1' 0-5°, B, R4-R5, O, Pl 102.5' 0-5°, B, R5, PtO-t, Pl 102.8' 0-5°, B, R5, t, Pl 102.9' 0-5°, B, R4, t, Pl			
890					103.0' 0-5°, B, R5, PtO-t, Pl 103.2' to 103.5' fractured rock 104.0' 0-5°, B, R4-R5, O, Pl			
	106				104.3' 0-5°, B, R5, t, Pl			
888					104.5' 0-5°, B, R5, PtO-t, Pl			Run-13 107.1' - 117.1' 41 minute run Down Pressure = 375 Psi
	108				104.7' 0-5°, B, R5, t, Pl 105.9' 0-5°, B, R5, PtO-t, Pl 106.1' 0-5°, B, R5, O, Pl			
886					106.2' 0-5°, B, R4, t, Pl			
	110				106.5' 0-5°, B, R5, PtO-t, Pl 107.3' 0-5°, B, R4-R5, O, Pl 107.6' to 108.0' 0-5, 6 Bs, R4-R5, PtO-t, Pl			
884					108.2' 0-5°, B, R4, t, Pl 109.0' 0-5°, B, R5, PtO-t, Pl			
	112	49	94	3.0	109.1' to 110.0' 0-5°, 10 Bs, R3-R5, PtO-t, Pl 110.0' to 111.0' 0-5°, 9 Bs, R4-R5, O, Pl 111.0' to 111.5' 0-5°, 5 Bs, R3-R4, O, Pl	13		
882					111.5' to 111.7' fractured rock			
	114				111.9' 0-5°, B, R4, O, Pl 113.4' 0-5°, B, R5, PtO-t, Pl 114.4' 0-5°, B, R4-R5, O, Pl 114.5' 0-5°, B, R5, t, Pl			
880					114.9' 0-5°, B, R5, PtO-t, Pl 115.3' 0-5°, B, R5, PtO-t, Pl			
	116				116.1' 0-5°, B, R4, t, Pl			
878								Run-14 117.1' - 127.1' 38 minute run Down Pressure = 400 Psi Increase in water use during Run 14
	118	39	94	2.4	117.5' to 117.7' fractured rock	14		
876					118.8' 0-5°, B, R5, PtO-t, Pl			

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	BORING NO. B-25	
Coordinates: N 771204.6 E 1870990.9	Driller: Stantec/ M.M	Sheet No. 4 of 5	
Top Drillhole Elevation: 995.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 817.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 177.1 feet	Checked By: B. Madras Natarajan	Date Start: 5/11/18 End: 5/22/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
874					120.9' 0-5°, B, R4, O, Pl			
	122				121.1' to 122.1' 0-5, 9 Bs, R3-R5, O, Pl		121.6 to 147.1' **BEDFORD SHALE**, red, very fine grained, moderately to highly weathered, soft to moderately hard, argillaceous, thinly bedded, highly to moderately fractured, highly weathered joints	Shaded Red Water Return Throughout Run-14
872					122.2' 0-5°, B, R5, PtO-t, Pl			
		39	94	2.4	122.4' 0-5°, B, R4, t, Pl 122.6' 0-5°, B, R5, PtO-t, Pl	14		
	124				123.0' 0-5°, B, R4, O, Pl 123.5' 0-5°, B, R5, PtO-t, Pl			
870					123.6' 0-5°, B, R4-R5, O, Pl 123.9' 0-5°, B, R5, t, Pl			
	126				124.2' 0-5°, B, R5, PtO-t, Pl 124.4' 0-5°, B, R5, t, Pl			
868					124.7' 0-5°, B, R4, t, Pl 125.4' 0-5°, B, R5, PtO-t, Pl			
					125.7' 0-5°, B, R5, PtO-t, Pl			Run-15 127.1' - 137.1' 36 minute run Down Pressure = 475 Psi
	128				126.3' 0-5°, B, R4-R5, O, Pl 127.3' 0-5°, B, R5, t, Pl			
866					127.4' 0-5°, B, R4, PtO-t, Pl 127.7' 0-5°, B, R5, PtO-t, Pl			
	130				128.2' 0-5°, B, R4, O, Pl 128.4' to 128.6' fractured rock			
864								
					131.2' 0-5°, B, R4-R5, O, Pl			
	132	83	100	1.2	131.4' 0-5°, B, R5, PtO-t, Pl 132.0' 0-5°, B, R4, t, Pl	15		
862					132.7' 0-5°, B, R5, PtO-t, Pl			
	134				133.3' 0-5°, B, R4, O, Pl			
860					134.5' 0-5°, B, R4-R5, PtO-t, Pl			
	136				136.0' 0-5°, B, R5, t, Pl			
858								
					137.1' to 137.6' 0-5°, 5 Bs, R4-R5, O, Pl			Run-16 137.1' - 147.1' 35 minute run Down Pressure = 475 Psi
	138				138.0' 0-5°, B, R5, t, Pl			
856					138.2' 0-5°, B, R4-R5, PtO-t, Pl 138.4' 0-5°, B, R4-R5, O, Pl			
	140				138.5' to 138.7' fractured rock 139.0' 0-5°, B, R5, PtO-t, Pl			
854					139.4' 0-5°, B, R4, O, Pl 139.7' 0-5°, B, R5, PtO-t, Pl			
		9	100	4.7	139.9' 0-5°, B, R4-R5, O, Pl 140.0' 0-5°, B, R5, O, Pl	16		
	142				140.1' to 141.0' 0-5°, 7 Bs, R4-R5, PtO-t, Pl			
852					141.3' 0-5°, B, R4, t, Pl			
					141.7' 0-5°, B, R5, PtO-t, Pl			
	144				141.8' 0-5°, B, R4, O, Pl 142.1' 0-5°, B, R5, PtO-t, Pl			
850					142.4' 0-5°, B, R4-R5, O, Pl 142.5' 0-5°, B, R5, PtO-t, Pl			
	146				142.7' 0-5°, B, R4, t, Pl 142.9' 0-5°, B, R5, PtO-t, Pl			
848					143.1' 0-5°, B, R4, O, Pl			
					143.3' 0-5°, B, R5, PtO-t, Pl		147.1 to 152.0' Interbedded red (50%) and grey (50%) **BEDOFRD SHALE**, same as above	Run-17 147.1' - 157.1' 55 minute run Down Pressure = 350 Psi
	148				143.6' 0-5°, B, R4-R5, O, Pl 143.8' 0-5°, B, R5, t, Pl			
846					144.2' 0-5°, B, R4-R5, O, Pl 144.4' 0-5°, B, R4-R5, O, Pl			
	150				144.6' 0-5°, B, R5, PtO-t, Pl 144.8' 0-5°, B, R4, t, Pl			
844					145.0' 0-5°, B, R5, PtO-t, Pl 145.1' to 146.0' 0-5°, 7 Bs, R4, O, Pl			
					146.2' 0-5°, B, R4, t, Pl			
	152	23	90	3.0	146.4' 0-5°, B, R5, PtO-t, Pl 146.7' 0-5°, B, R4, O, Pl	17	152.0 to 167.1' **OHIO SHALE**, black, very fine grained, slightly to moderately weathered, moderately hard, thinly bedded, moderate to highly fractured, flat, moderately to highly weathered joints	
842					147.2' 0-5°, B, R5, PtO-t, Pl			
					147.5' 0-5°, B, R4-R5, O, Pl 147.7' 0-5°, B, R5, PtO-t, Pl			
	154				147.9' 0-5°, B, R4, O, Pl 148.0' 0-5°, B, R5, PtO-t, Pl			
840					148.1' 0-5°, B, R4-R5, O, Pl 148.4' to 148.6' fraactured rock			
	156				148.7' 0-5°, B, R5, t, Pl			
					148.9' 0-5°, B, R4, O, Pl			
838					149.1' 0-5°, B, R5, PtO-t, Pl 149.2' 0-5°, B, R4-R5, O, Pl			
	158				149.5' 0-5°, B, R5, PtO-t, Pl			Run-18 157.1' - 167.1' 60 minute run Down Pressure = 450 Psi
		44	94	2.7	149.8' 0-5°, B, R4, t, Pl 150.2' 0-5°, B, R5, PtO-t, Pl	18		
836					150.3' 0-5°, B, R4, O, Pl 150.4' 0-5°, B, R5, PtO-t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	BORING NO. B-25	
Coordinates: N 771204.6 E 1870990.9	Driller: Stantec/ M.M	Sheet No. 5 of 5	
Top Drillhole Elevation: 995.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 817.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 177.1 feet	Checked By: B. Madras Natarajan	Date Start: 5/11/18 End: 5/22/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.4	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
834					150.6' 0-5°, B, R4-R5, O, Pl 151.0' 0-5°, B, R5, t, Pl 151.5' 0-5°, B, R4, t, Pl 151.8' 0-5°, B, R5, PtO-t, Pl			
	162				152.1' to 152.7' 0-5°, 5 Bs, R5, PtO-t, Pl 153.4' 0-5°, B, R4, O, Pl 154.0' to 154.4' fractured rock			
832					155.0' to 155.7' 0-5°, 5 Bs, R5, PtO-t, Pl			
	164	44	94	2.7	157.2' to 157.9 0-5°, 4 Bs, R4, O, Pl 158.1' to 158.8 0-5°, 5 Bs, R5, PtO-t, Pl 159.0' to 159.9' 0-5°, 4 Bs, R4, O, Pl 160.2' to 160.5' 0-5°, 3 Bs, R4, O, Pl 161.0' 0-5°, B, R5, PtO-t, Pl 161.5' 0-5°, B, R5, t, Pl 161.9' 0-5°, B, R4, O, Pl	18		
830					162.0' to 162.6' 0-5°, 4 Bs, R4, PtO-t, Pl			
	166				163.4' 0-5°, B, R4, O, Pl 164.0' 0-5°, B, R4-R5, t, Pl 164.1' to 164.4' fractured rock 164.9' 0-5°, B, R4-R5, t, Pl 165.1' to 165.8' 0-5°, 5 Bs, R5, O, Pl 167.1' to 167.5 fractured rock 168.4' 0-5°, B, R5, PtO-t, Pl 168.6' 0-5°, B, R5, t, Pl 169.8' 0-5°, B, R4, t, Pl 170.0' 0-5°, B, R5, PtO-t, Pl 170.4' 0-5°, B, R4-R5, O, Pl 170.8' 0-5°, B, R5, PtO-t, Pl 171.0' to 171.3' 0-5°, 3 Bs, R5, O, Pl 172.1' to 172.9' 0-5°, 4 Bs, R4-R5, O, Pl 173.1' to 173.7' 0-5°, 4 Bs, R4, PtO-t, Pl 174.0' 0-5°, B, R4-R5, O, Pl 174.5' 0-5°, B, R5, t, Pl 175.1' to 175.7' 0-5°, 4 Bs, R4-R5, O, Pl 176.0' to 176.8' 0-5°, 4 Bs, R5, PtO-t, Pl 177.0' 0-5°, B, R5, t, Pl			Run-19 167.1' - 177.1' 22 minute run Down Pressure = 475 Psi
828	168							
826								
	170							
824								
	172	59	100	3.0		19		
822								
	174							
820								
	176							
818								
	178						**End of Boring at 177.1 feet**	
816								
	180							
814								
	182							
812								
	184							
810								
	186							
808								
	188							
806								
	190							
804								
	192							
802								
	194							
800								
	196							
798								
	198							
796								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-27**
Coordinates:	N 772242.0 E 1870830.0	Driller:	Stantec/ M.M	**Sheet No. 1 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	795.6 feet MSL	Prepared By:	A. Mirza	
Total Depth:	205.6 feet	Checked By:	B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 3.1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
1000	2							
998	4							
996	6							
994	8							
992	10							
990	12	57	100	1.7	11.8' 0-5°, B, R4-R5, O, Pl 12.1' 0-5°, B, R4-R5, O, Pl 12.2' 30°, Jt, R4-R5, O, Pl 13.0' 0-5°, B, R5, PtO-t, Pl 13.3' 0-5°, B, R5, t, Pl 13.4' 0-5°, B, R4-R5, O, Pl 14.4' 0-5°, B, R4-R5, O, Pl 14.7' 0-5°, B, R5, PtO-t, Pl	1	10.2 to 56.5' **BEREA SANDSTONE**, grey, fine grained, slightly weathered, hard, medium bedded, slightly to moderately fractured	Top of Rock @ 10.2' Run-1 10.2' - 15.6' 12 minute run Down Pressure = 450 Psi
988	14							
986	16				15.0' 0-5°, B, R4, t, Pl			
984	18	92	100	0.9	16.4' 0-5°, B, R5, PtO-t, Pl 18.9' 0-5°, B, R4-R5, O, Pl 19.3' 0-5°, B, R5, PtO-t, Pl 19.5' 0-5°, B, R4, O, Pl	2		Run-2 15.6' - 25.6' 32 minute run Down Pressure = 350 Psi
982	20							
980	22				20.5' 0-5°, B, R5, PtO-t, Pl 20.8' 0-5°, B, R4-R5, O, Pl			
978	24							
976	26				24.6' 0-5°, B, R4-R5, O, Pl 24.9' 0-5°, B, R5, PtO-t, Pl 25.4' 0-5°, B, R4, O, Pl 26.0' 0-5°, B, R5, PtO-t, Pl			Run-3 25.6' - 35.6' 22 minute run Down Pressure = 450 to 500 Psi
974	28				27.0' to 27.1' fractured rock 27.4' 0-5°, B, R5, PtO-t, Pl 28.3' 0-5°, B, R5, PtO-t, Pl 28.4' 0-5°, B, R5, t, Pl			
972	30	71	100	1.2	29.8' 0-5°, B, R4, t, Pl 29.9' 0-5°, B, R5, PtO-t, Pl 30.2' 0-5°, B, R4-R5, O, Pl 30.4' 0-5°, B, R5, PtO-t, Pl 30.9' 0-5°, B, R5, PtO-t, Pl	3		
970	32							
968	34				34.3' 0-5°, B, R4-R5, O, Pl 35.0' 0-5°, B, R4, O, Pl			
966	36				35.3' 0-5°, B, R5, PtO-t, Pl 36.2' 30°, Jt, R4-R5, O, Pl 36.5' 0-5°, B, R4-R5, O, Pl 36.7' 0-5°, B, R5, PtO-t, Pl			Run-4 35.6' - 45.6' 26 minute run Down Pressure = 450 Psi
964	38	89	100	1.6	38.3' 0-5°, B, R4, O, Pl 39.1' 0-5°, B, R5, PtO-t, Pl	4		
962								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-27**
Coordinates:	N 772242.0 E 1870830.0	Driller:	Stantec/ M.M	**Sheet No. 2 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	795.6 feet MSL	Prepared By:	A. Mirza	
Total Depth:	205.6 feet	Checked By:	B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 3.1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
960					39.3' 0-5°, B, R5, O, Pl 39.9' 0-5°, B, R5, PtO-t, Pl 40.8' 0-5°, B, R4-R5, O, Pl			
	42				41.8' 0-5°, B, R5, PtO-t, Pl 42.0' 0-5°, B, R5, PtO-t, Pl			High Water Loss near 41.7'
958		89	100	1.6	42.3' 0-5°, B, R5, t, Pl 43.1' 0-5°, B, R4, t, Pl	4		
	44				43.2' 0-5°, B, R5, PtO-t, Pl 43.4' 0-5°, B, R4-R5, O, Pl 44.3' 0-5°, B, R5, PtO-t, Pl			
956					44.8' 60°, R4-R5, O, Und			
	46							Run-5 45.6' - 55.6' 40 minute run Down Pressure = 500 Psi 800 Gallons of water used for run
954					47.1' 0-5°, B, R5, PtO-t, Pl			
	48				47.4' 0-5°, B, R4-R5, O, Pl 47.7' 0-5°, B, R5, t, Pl			
952					47.9' 0-5°, B, R4-R5, O, Pl 48.1' 0-5°, B, R4-R5, O, Pl			
	50	53	97	1.5	48.3' 0-5°, B, R5, t, Pl 48.8' 0-5°, B, R4, O, Pl 49.3' 0-5°, B, R5, PtO-t, Pl	5		
950					50.6' 0-5°, B, R5, t, Pl 50.9' 0-5°, B, R4, t, Pl			
	52				51.2' 0-5°, B, R5, PtO-t, Pl			
948					52.7' 0-5°, B, R5, t, Pl			
	54				53.1' 0-5°, B, R4-R5, O, Pl 53.2' 0-5°, B, R4-R5, O, Pl 53.4' 0-5°, B, R5, t, Pl			
946								
	56				55.7' to 56.0' fractured rock			Run-6 55.6' - 65.6' 40 minute run Down Pressure = 350 to 700 Psi 650 Gallons of water used
944					56.2' 0-5°, B, R4-R5, O, Pl 56.4' to 56.8' fractured rock			
	58				57.2' 0-5°, B, R5, O, Pl 57.4' to 57.6' fractured rock			
942					58.0' 0-5°, B, R4-R5, O, Pl 58.5' 0-5°, B, R5, O, Pl			
	60				58.6' 0-5°, B, R5, PtO-t, Pl 58.9' 0-5°, B, R5, PtO-t, Pl 59.2' 0-5°, B, R4, O, Pl			
940		20	90	1.9	59.3' 0-5°, B, R5, O, Pl 59.6' 0-5°, B, R5, t, Pl	6	56.5 to 62.2' **BEDFORD SHALE**, grey, very fine grained, moderately to highly weathered, moderately hard, thinly bedded, moderately to highly fractured	
	62				59.7' to 59.8' fractured rock 60.1' to 60.2' fractured rock			
938					60.6' 0-5°, B, R4, O, Pl 60.8' 0-5°, B, R4-R5, O, Pl			
	64				60.9' 0-5°, B, R5, t, Pl 61.0' 0-5°, B, R4, O, Pl 61.4' 0-5°, B, R5, PtO-t, Pl			
936					61.6' 0-5°, B, R5, O, Pl 61.8' 0-5°, B, R5, t, Pl			
	66				62.2' to 62.9' fractured rock 63.0' 0-5°, B, R5, t, Pl		62.2 to 85.6' Interbedded BEDFORD SHALE and BEREA SANDSTONE (60%/40%) **BEDFORD SHALE**, grey, very fine grained, moderately to highly weathered, moderately hard, thinly bedded, moderately to highly fractured **BAREA SANDSTONE**, grey, fine grained, slightly weathered, hard, medium bedded, slightly to moderately fractured	Run-7 65.6' - 75.6' 29 minute run Down Pressure = 500 Psi 500 gallons of water used
934					63.1' 0-5°, B, R4, O, Pl 63.3' 0-5°, B, R5, PtO-t, Pl			
	68				63.5' 0-5°, B, R4-R5, O, Pl 65.6' to 65.9' fractured rock			
932					66.4' 0-5°, B, R5, PtO-t, Pl 66.8' 0-5°, B, R4, t, Pl			
	70				67.3' 0-5°, B, R4-R5, O, Pl 67.6' 0-5°, B, R4, O, Pl			
930		65	100	1.9	68.3' to 68.4' fractured rock 69.2' 0-5°, B, R5, PtO-t, Pl	7		
	72				69.7' 0-5°, B, R4-R5, O, Pl 70.0' 0-5°, B, R5, PtO-t, Pl			
928					70.1' to 70.1' 90°, R4-R5, O, Und 70.3' 0-5°, B, R5, PtO-t, Pl			
	74				70.6' 0-5°, B, R4-R5, PtO-t, Pl 71.1' 0-5°, B, R4-R5, O, Pl			
926					71.9' 0-5°, B, R5, PtO-t, Pl 72.3' 0-5°, B, R4-R5, O, Pl			
	76				72.5' 0-5°, B, R5, PtO-t, Pl 73.4' 0-5°, B, R4, t, Pl 74.4' 0-5°, B, R5, PtO-t, Pl			
924					74.5' 0-5°, B, R4, O, Pl 74.9' 0-5°, B, R5, PtO-t, Pl			Run-8 75.6' - 85.6' 35 minute run Down Pressure = 500 Psi 500 gallons of water used
	78	85	98	1.3	75.3' 0-5°, B, R4-R5, O, Pl 75.9' 0-5°, B, R5, PtO-t, Pl	8		
922					76.9' 0-5°, B, R5, t, Pl 77.4' 0-5°, B, R4, t, Pl 77.6' 0-5°, B, R5, PtO-t, Pl 77.8' 0-5°, B, R4-R5, O, Pl 78.8' 0-5°, B, R5, PtO-t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-27**
Coordinates:	N 772242.0 E 1870830.0	Driller:	Stantec/ M.M	**Sheet No. 3 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	795.6 feet MSL	Prepared By:	A. Mirza	
Total Depth:	205.6 feet	Checked By:	B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 3.1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
920					80.3' 0-5°, B, R4, O, Pl			75.6' - 85.6' Gas Meter H2s = 0 to 1
	82				81.5' 0-5°, B, R5, PtO-t, Pl			
918		85	98	1.3	82.4' 0-5°, B, R4-R5, O, Pl	8		
	84				83.7' 0-5°, B, R5, t, Pl 84.2' 0-5°, B, R5, PtO-t, Pl 84.6' 0-5°, B, R5, t, Pl			
916					85.1' 0-5°, B, R5, PtO-t, Pl			
	86				85.9' 0-5°, B, R5, t, Pl 86.3' 0-5°, B, R4-R5, O, Pl		85.6 to 125.6' **BEDFORD SHALE**, grey, very fine grained, moderately weathered, soft to moderately hard, thinly bedded, slighty fractured, slightly weathered joints, friable	Run-9 85.6' - 95.6' 22 minute run Down Pressure = 500 Psi
914					86.4' 0-5°, B, R4, t, Pl 86.9' 0-5°, B, R5, PtO-t, Pl			
	88				87.8' 0-5°, B, R4, O, Pl			
912					88.7' 0-5°, B, R5, PtO-t, Pl			
	90				89.5' 0-5°, B, R4-R5, O, Pl 89.9' 0-5°, B, R5, t, Pl			
910		79	100	2.1	90.4' 0-5°, B, R5, PtO-t, Pl 90.6' 0-5°, B, R5, t, Pl	9		
	92				91.0' 0-5°, B, R4, t, Pl 91.1' 0-5°, B, R5, PtO-t, Pl 91.3' 0-5°, B, R5, PtO-t, Pl			
908					91.6' 0-5°, B, R4-R5, O, Pl 92.0' 0-5°, B, R5, t, Pl			
	94				92.5' 0-5°, B, R4, PtO-t, Pl 92.7' 0-5°, B, R5, PtO-t, Pl 93.3' 0-5°, B, R5, PtO-t, Pl			
906					93.7' 0-5°, B, R4, O, Pl			
	96				94.0' 0-5°, B, R5, PtO-t, Pl 94.8' 0-5°, B, R4-R5, O, Pl			Run-10 95.6' - 105.6' 15 minute run Down Pressure = 500 Psi
904					96.1' 0-5°, B, R5, t, Pl			
	98				97.7' 0-5°, B, R5, PtO-t, Pl			
902					98.6' 0-5°, B, R5, t, Pl 98.8' 0-5°, B, R4, t, Pl			
	100							
900		94	100	1.0	100.3' 0-5°, B, R4-R5, O, Pl	10		
	102				101.2' 0-5°, B, R4-R5, O, Pl 102.0' 0-5°, B, R4, O, Pl 102.4' 0-5°, B, R4-R5, O, Pl			
898								
	104				104.1' 0-5°, B, R4, O, Pl			
896								
	106				105.4' 0-5°, B, R5, PtO-t, Pl			Run-11 105.6' - 115.6' 30 minute run Down Pressure = 500 Psi
894								
	108				108.0' 0-5°, B, R4-R5, O, Pl 108.4' 0-5°, B, R5, t, Pl			
892								
	110				109.4' 0-5°, B, R5, PtO-t, Pl			
		78	97	1.2		11		
890					111.0' 0-5°, B, R5, t, Pl 111.2' 0-5°, B, R4, t, Pl			
	112				111.5' 0-5°, B, R5, PtO-t, Pl 111.6' 0-5°, B, R5, t, Pl			
888					112.3' 0-5°, B, R5, PtO-t, Pl 112.5' 0-5°, B, R4-R5, PtO-t, Pl			
	114				113.1' 0-5°, B, R4-R5, O, Pl 113.6' 0-5°, B, R5, t, Pl			
886					114.6' 0-5°, B, R5, PtO-t, Pl			
	116							Run-12 115.6' - 125.6' 12 minute run Down Pressure = 500 Psi
884								
	118	93	100	0.2	117.9' 0-5°, B, R5, O, Pl	12		
882					119.3' to 119.7' fractured rock			

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-27	
Coordinates: N 772242.0 E 1870830.0	Driller: Stantec/ M.M	Sheet No. 4 of 6	
Top Drillhole Elevation: 1001.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 795.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 205.6 feet	Checked By: B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 3.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
880								
	122							
878		93	100	0.2	122.8' 0-5°, B, R5, PtO-t, Pl	12		
	124							
876								
	126						125.6 to 153.2' **BEDFORD SHALE**, red and gray to red, very fine grained, moderately weathered, soft to moderately hard, thinly bedded, slighty fractured, slightly weathered joints, friable	Run-13 125.6' - 135.6' 57 minute run Down Pressure = 375 Psi
874					127.0' 0-5°, B, R5, O, Pl			
	128				127.6' 0-5°, B, R4-R5, O, Pl			
872					129.0' 0-5°, B, R5, PtO-t, Pl 129.2' 0-5°, B, R5, O, Pl			
	130	81	100	1.6	129.4' 0-5°, B, R4-R5, O, Pl 129.8' 0-5°, B, R5, O, Pl	13		
870					130.0' 0-5°, B, R4-R5, O, Pl 130.2' 0-5°, B, R5, PtO-t, Pl			
	132				130.4' 0-5°, B, R4-R5, O, Pl 130.8' 0-5°, B, R5, PtO-t, Pl			
868					131.2' 0-5°, B, R4, O, Pl 131.3' 0-5°, B, R5, PtO-t, Pl			
	134				132.2' 0-5°, B, R4, O, Pl 132.9' 0-5°, B, R5, PtO-t, Pl 134.2' 0-5°, B, R4-R5, O, Pl			
866					135.3' to 135.6' 90°, R4-R5, O, Und			
	136							Run-14 135.6' - 145.6' 40 minute run Down Pressure = 375 Psi
864					136.8' 0-5°, B, R4-R5, O, Pl 137.2' 0-5°, B, R5, t, Pl			
	138				137.5' 0-5°, B, R5, PtO-t, Pl 138.4' 0-5°, B, R5, t, Pl			
862					138.9' 0-5°, B, R5, PtO-t, Pl			
	140	100	100	1.3	139.7' 0-5°, B, R5, t, Pl	14		
860					140.9' 0-5°, B, R4-R5, O, Pl 141.4' 0-5°, B, R5, t, Pl			
	142				142.2' 0-5°, B, R5, PtO-t, Pl			
858								
	144				143.7' 0-5°, B, R5, t, Pl 144.0' 0-5°, B, R5, PtO-t, Pl			
856					144.3' 0-5°, B, R5, t, Pl 144.5' 0-5°, B, R5, PtO-t, Pl			
	146							Run-15 145.6' - 155.6' 26 minute run Down Pressure = 500 Psi
854					146.4' 0-5°, B, R5, t, Pl			
	148				148.0' 0-5°, B, R5, PtO-t, Pl			
852								146.8' - 152.7' Gas Meter COMB = 4 to reading over limit
	150	100	100	0.6	150.0' 0-5°, B, R5, t, Pl	15		
850					150.7' 0-5°, B, R5, PtO-t, Pl			
	152				151.6' 0-5°, B, R5, t, Pl			
848					152.6' 0-5°, B, R4-R5, O, Pl			
	154						153.2 to 169.2' **BEDFORD SHALE**, grey, very fine grained, slightly weathered, moderately hard, thinly bedded, unfractured to slighty fractured	
846								
	156							Run-16 155.6' - 165.6' 26 minute run Down Pressure = 375 Psi
844								
	158	97	100	0.8		16		
842								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2		**BORING NO. B-27**
Coordinates: N 772242.0 E 1870830.0	Driller: Stantec/ M.M		**Sheet No. 5 of 6**
Top Drillhole Elevation: 1001.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 795.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 205.6 feet	Checked By: B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 3.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
840					159.9' to 160.2' 0-5°, 4 Bs, R4-R5, O, Pl			
					160.7' 0-5°, B, R4-R5, O, Pl			
	162							
		97	100	0.8		16		
838	164							
836					164.9' 0-5°, B, R5, PtO-t, Pl			
					165.3' 0-5°, B, R4, O, Pl			
	166				165.5' 0-5°, B, R5, PtO-t, Pl			Run-17 165.6' - 175.6' 40 minute run
834								Down Pressure = 375 Psi
	168							
832							169.2 to 205.6' **OHIO SHALE**, black, very fine grained, unweathered, moderately hard, thinly bedded, unfractured to slightly fractured, unweathered to slightly joints.	
	170							
		100	100	0.3	170.5' 0-5°, B, R4, O, Pl	17		
830	172							
828								
	174							
826					175.3' 0-5°, B, R5, t, Pl			
	176							Run-18 175.6' - 185.6' 33 minute run
824					176.7' 0-5°, B, R4-R5, O, Pl			Down Pressure = 475 Psi
	178							176.7' - 177.0' UCS = 8,796 Psi
822								
	180				179.7' 0-5°, B, R4-R5, O, Pl			
		98	100	0.3		18		
820	182							
818								
	184							
816					184.9' 0-5°, B, R5, t, Pl			
	186							Run-19 185.6' - 195.6' 21 minute run
814					186.6' 0-5°, B, R4, O, Pl			Down Pressure = 450 Psi
	188							
812					189.1' to 189.6' 90°, Jt, R3-R4, O, Und			
	190				190.1' 0-5°, B, R4-R5, O, Pl			
		93	100	0.5	190.6' 0-5°, B, R5, t, Pl	19		
810					190.9' 0-5°, B, R4, O, Pl			
	192							
808								
	194							
806								
	196				196.2' 0-5°, B, R5, PtO-t, Pl			Run-20 195.6' - 205.6' 23 minute run
804								Down Pressure = 300 to 400 Psi
	198	100	100	0.6		20		Gas meter set off with high comb levels, no gas found after packer testing
802					198.6' 0-5°, B, R4-R5, O, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-27	
Coordinates: N 772242.0 E 1870830.0	Driller: Stantec/ M.M	Sheet No. 6 of 6	
Top Drillhole Elevation: 1001.2 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 795.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 205.6 feet	Checked By: B. Madras Natarajan	Date Start: 1/25/18 End: 2/1/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 3.1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
800								
	202	100	100	0.6	200.2' to 200.9' 90°, Jt, R3-R4, O, Und 201.5' 0-5°, B, R4-R5, O, Pl 201.8' 0-5°, B, R5, t, P	20		195.6' - 205.6' Gas Meter COMB = 33
798								
	204				205.3' 0-5°, B, R4-R5, O, Pl			
796								
	206						**End of Boring at 205.6 feet**	
794								
	208							
792								
	210							
790								
	212							
788								
	214							
786								
	216							
784								
	218							
782								
	220							
780								
	222							
778								
	224							
776								
	226							
774								
	228							
772								
	230							
770								
	232							
768								
	234							
766								
	236							
764								
	238							
762								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates:	N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 1 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth:	207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
1000	2							
998	4							
996	6							
994	8				7.5' to 9.0' 90°, Jt, R4, O, Und	1	7.5 to 46.0' **BEREA SANDSTONE**, grey, fine grained, slightly to moderately weathered, moderately hard to hard, thin to medium bedded, moderately to highly fractured	Top of rock @7.5' Run-1 7.5' - 10.5' 10 minute run Down Pressure = 250 Psi
992	10	0	94	2.7	9.1' 0-5°, B, R4, O, Pl, Cl 9.2' 0-5°, B, R4-R5, O, Pl, Cl 9.8' 0-5°, B, R5, O, Pl, Cl 9.9' 0-5°, B, R4, PtO-t, Pl, Cl			
990	12				10.1' 0-5°, B, R5, O, Pl, Cl 10.3' 0-5°, B, R4, O, Pl, Cl 10.5' 0-5°, B, R4-R5, t, Pl 10.7' to 11.2' fractured rock	2		Run-2 10.5' - 15.5' 20 minute run Down Pressure = 300 Psi
988	14	0	95	4.0	11.4' 0-5°, B, R4, t, Pl 11.5' 0-5°, B, R5, PtO-t, Pl 11.7' 0-5°, B, R4-R5, O, Pl 11.8' 0-5°, B, R4, O, Pl 11.9' 0-5°, B, R5, PtO-t, Pl 12.1' 30°, Jt, R4, O, Und			
986	16				12.2' 0-5°, B, R5, PtO-t, Pl 12.3' 0-5°, B, R4-R5, O, Pl 12.6' 0-5°, B, R5, PtO-t, Pl 12.8' 0-5°, B, R4, t, Pl 13.2' 0-5°, B, R5, PtO-t, Pl 13.3' 0-5°, B, R4, O, Pl 13.7' 0-5°, B, R5, PtO-t, Pl 13.8' 0-5°, B, R4, t, Pl 14.1' 0-5°, B, R5, PtO-t, Pl 14.3' 0-5°, B, R4-R5, O, Pl 14.8' 0-5°, B, R4, O, Pl 14.9' 0-5°, B, R5, PtO-t, Pl 15.0' 30°, Jt, R4, O, Und 15.1' 0-5°, B, R5, PtO-t, Pl 15.6' 0-5°, B, R4-R5, O, Pl 15.8' 0-5°, B, R5, PtO-t, Pl 16.0' 0-5°, B, R4, t, Pl 16.1' 0-5°, B, R5, PtO-t, Pl 16.4' 0-5°, B, R4-R5, O, Pl 16.6' 0-5°, B, R5, PtO-t, Pl 16.7' 0-5°, B, R4-R5, O, Pl 17.0' 0-5°, B, R5, PtO-t, Pl	3		Run-3 15.5' - 25.5' 20 minute run Down Pressure = 350 Psi
984	18							
982	20	45	100	2.5				
980	22							
978	24							
976	26				17.3' 0-5°, B, R4, t, Pl 17.4' 0-5°, B, R5, PtO-t, Pl 17.9' 0-5°, B, R4, O, Pl 18.3' 0-5°, B, R5, PtO-t, Pl 18.4' 0-5°, B, R4, t, Pl 18.8' 0-5°, B, R5, PtO-t, Pl 19.1' 0-5°, B, R4-R5, O, Pl 20.5' 0-5°, B, R4, O, Pl 21.3' 0-5°, B, R4, O, Pl 21.5' 0-5°, B, R5, PtO-t, Pl 21.8' 30°, Jt, R4, O, Und	4		Run-4 25.5' - 35.5' 15 minute run Down Pressure = 350 Psi
974	28							
972	30	85	100	1.6				
970	32							
968	34							
966	36				28.1' 0-5°, B, R5, PtO-t, Pl 28.4' 0-5°, B, R4-R5, O, Pl 28.7' 0-5°, B, R5, PtO-t, Pl 28.8' 0-5°, B, R4, t, Pl 29.1' 0-5°, B, R5, PtO-t, Pl	5		Run-5 35.5' - 45.5' 20 minute run
964	38	67	100	1.2	30.4' 0-5°, B, R4, O, Pl 31.0' 0-5°, B, R5, PtO-t, Pl 31.4' 0-5°, B, R4-R5, O, Pl 33.3' 0-5°, B, R5, t, Pl 34.2' 0-5°, B, R4-R5, O, Pl			
962								

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates:	N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 2 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth:	207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
960	42	67	100	1.2	34.4' 0-5°, B, R5, PtO-t, Pl 35.8' 0-5°, B, R4-R5, O, Pl 36.2' to 36.6' fractured rock 37.4' 0-5°, B, R4, O, Pl 37.8' 0-5°, B, R5, PtO-t, Pl 38.0' 0-5°, B, R4-R5, O, Pl 39.1' 0-5°, B, R5, t, Pl 39.4' to 39.5' fractured rock 40.4' 0-5°, B, R4, O, Pl 40.6' 0-5°, B, R5, PtO-t, Pl 40.7' to 41.7' fractured rock 42.6' 0-5°, B, R4, O, Pl	5		
958	44							
956	46				43.7' 0-5°, B, R4, O, Pl 43.9' 0-5°, B, R4-R5, O, Pl 44.1' 45°, B, R4-R5, O, Pl 45.1' 0-5°, B, R4, O, Pl 45.7' 0-5°, B, R5, PtO-t, Pl 45.9' to 46.1 fractured rock 46.5' 0-5°, B, R5, t, Pl 46.8' 0-5°, B, R4, O, Pl 47.6' 0-5°, B, R4-R5, O, Pl 48.4' to 48.5' fractured rock	6	46.0 to 85.5' Interbedded **BEDFORD SHALE** (50%) and **BEREA SANDSTONE** (50%) **BEDFORD SHALE**, grey, very fine grained, unweathered to slightly weathered, soft, thinly bedded, flat **BEREA SANDSTONE**, grey, fine to medium grained, slightly weathered, hard, thinly bedded, highly fractured, flat	Run-6 45.5' - 55.5' 22 minute run Down Pressure = 350 Psi
954	48							
952	50	51	95	1.2	48.9' 0-5°, B, R4, O, Pl 49.9' 0-5°, B, R5, PtO-t, Pl 50.7' 0-5°, B, R4-R5, O, Pl			
950	52				52.0' to 52.5' fractured rock 52.7' 0-5°, B, R4-R5, O, Pl			
948	54				53.8' 0-5°, B, R4, O, Pl 54.0' 0-5°, B, R5, t, Pl 54.3' 0-5°, B, R4, O, Pl			
946	56				55.9' 0-5°, B, R4-R5, O, Pl 56.2' 0-5°, B, R5, t, Pl 56.6' 0-5°, B, R4, O, Pl	7		Run-7 55.5' - 65.5' 20 minute run Down Pressure = 500 Psi
944	58				57.6' 0-5°, B, R5, PtO-t, Pl 58.3' 0-5°, B, R4-R5, O, Pl 58.4' 0-5°, B, R5, t, Pl 58.6' 0-5°, B, R4, O, Pl			
942	60	37	100	2.3	58.8' 0-5°, B, R4-R5, O, Pl 59.0' 0-5°, B, R4-R5, O, Pl 59.3' 0-5°, B, R5, PtO-t, Pl 59.4' 0-5°, B, R4-R5, O, Pl 59.8' 0-5°, B, R5, PtO-t, Pl 60.2' 0-5°, B, R4, t, Pl 61.0' 0-5°, B, R5, PtO-t, Pl 61.3' 0-5°, B, R4-R5, O, Pl 61.9' 0-5°, B, R5, PtO-t, Pl 62.6' 0-5°, B, R4-R5, O, Pl 62.7' 0-5°, B, R5, PtO-t, Pl 62.8' 0-5°, B, R4, t, Pl 63.2' 0-5°, B, R5, PtO-t, Pl			
940	62							
938	64							
936	66				63.4' 0-5°, B, R4, O, Pl 64.0' 0-5°, B, R5, PtO-t, Pl 65.1' 0-5°, B, R4, O, Pl 66.0' 0-5°, B, R5, PtO-t, Pl 66.3' 0-5°, B, R4-R5, O, Pl 66.4' 0-5°, B, R5, t, Pl 66.7' 0-5°, B, R5, PtO-t, Pl 67.0' 0-5°, B, R5, t, Pl 67.2' 0-5°, B, R4, t, Pl 67.6' 0-5°, B, R5, PtO-t, Pl	8		Run-8 65.5' - 75.5' 18 minute run Down Pressure = 500 Psi
934	68							
932	70	34	99	2.0	68.9' 0-5°, B, R4-R5, O, Pl 69.4' 0-5°, B, R5, t, Pl 69.8' 0-5°, B, R4, PtO-t, Pl 70.0' 0-5°, B, R5, PtO-t, Pl 70.8' 0-5°, B, R5, PtO-t, Pl 70.9' 0-5°, B, R5, t, Pl 71.4' 0-5°, B, R4, O, Pl 71.6' 0-5°, B, R5, PtO-t, Pl 72.4' 0-5°, B, R5, t, Pl 72.8' 0-5°, B, R4, t, Pl 73.4' 0-5°, B, R5, PtO-t, Pl 74.3' 0-5°, B, R5, PtO-t, Pl			
930	72							
928	74							
926	76				74.9' 0-5°, B, R4, t, Pl 75.9' to 76.0' fractured rock 76.1' 0-5°, B, R4, t, Pl 76.6' 0-5°, B, R5, PtO-t, Pl	9		Run-9 75.5' - 85.5' 23 minute run Down Pressure = 500 Psi
924	78	65	100	2.2	77.8' 0-5°, B, R5, PtO-t, Pl 77.9' 0-5°, B, R4-R5, O, Pl 78.1' 0-5°, B, R5, t, Pl 78.7' 0-5°, B, R5, PtO-t, Pl			
922								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates:	N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 3 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth:	207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
920					78.9' 0-5°, B, R5, t, Pl 79.0' 0-5°, B, R5, PtO-t, Pl 79.3' 0-5°, B, R5, PtO-t, Pl 79.4' 0-5°, B, R4-R5, O, Pl			
	82				79.8' 0-5°, B, R5, t, Pl			
918		65	100	2.2	80.2' 0-5°, B, R4, PtO-t, Pl 80.6' 0-5°, B, R5, PtO-t, Pl 81.2' 0-5°, B, R5, PtO-t, Pl	9		
	84				81.4' 0-5°, B, R4, O, Pl 82.9' 0-5°, B, R5, PtO-t, Pl 83.0' 0-5°, B, R4-R5, O, Pl			
916					83.6' 0-5°, B, R5, t, Pl			
	86				83.7' 0-5°, B, R5, PtO-t, Pl 84.5' 0-5°, B, R5, t, Pl 85.2' 0-5°, B, R4, t, Pl		85.5 to 126.2' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, flat	Run-10 85.5' - 95.5' 20 minute run Down Pressure = 500 Psi
914					85.9' 0-5°, B, R4-R5, O, Pl 86.4' to 86.5' fractured rock			
	88				86.9' to 87.1' fractured rock 87.3' 0-5°, B, R5, PtO-t, Pl			
912					87.6' 0-5°, B, R4-R5, O, Pl 88.5' 0-5°, B, R5, PtO-t, Pl			
	90	81	99	1.5	89.2' 0-5°, B, R5, t, Pl 89.3' 0-5°, B, R4, t, Pl	10		
910					90.0' 0-5°, B, R5, PtO-t, Pl 90.5' 0-5°, B, R5, PtO-t, Pl			
	92				90.8' 0-5°, B, R5, t, Pl 91.9' 0-5°, B, R4, O, Pl			
908								
	94				93.2' 0-5°, B, R5, PtO-t, Pl 93.6' 0-5°, B, R5, t, Pl 94.1' 0-5°, B, R4, t, Pl			
906					94.7' 0-5°, B, R5, PtO-t, Pl			
	96				95.3' 0-5°, B, R5, PtO-t, Pl 95.6' 0-5°, B, R4-R5, O, Pl			Run-11 95.5' - 105.5' 21 minute run Down Pressure = 500 Psi
904					96.4' 0-5°, B, R5, t, Pl			
	98				97.5' 0-5°, B, R4, O, Pl			
902								
	100				99.2' 0-5°, B, R5, PtO-t, Pl 99.6' 0-5°, B, R4-R5, O, Pl			
900		85	100	1.4	100.6' 0-5°, B, R5, PtO-t, Pl 100.8' 0-5°, B, R5, t, Pl	11		
	102				101.4' 0-5°, B, R4, t, Pl 102.0' 0-5°, B, R5, PtO-t, Pl			
898					102.8' 0-5°, B, R4-R5, O, Pl			
	104				104.0' 0-5°, B, R5, PtO-t, Pl 104.2' 0-5°, B, R5, t, Pl			
896					104.7' 0-5°, B, R4, t, Pl			
	106				104.8' 0-5°, B, R5, PtO-t, Pl			Run-12 105.5' - 115.5' 30 minute run Down Pressure = 500 Psi
894					106.8' 0-5°, B, R5, PtO-t, Pl			
	108							
892					109.2' 0-5°, B, R4-R5, O, Pl			
	110	96	100	1.0	110.3' 0-5°, B, R5, t, Pl	12		
890					110.5' 0-5°, B, R4, O, Pl			
	112				111.6' 0-5°, B, R5, PtO-t, Pl 112.1' 0-5°, B, R4-R5, O, Pl			
888					112.5' 0-5°, B, R5, PtO-t, Pl			
	114				113.3' 0-5°, B, R4, t, Pl 113.4' 0-5°, B, R5, PtO-t, Pl			
886					113.7' 0-5°, B, R4, O, Pl			
	116							Run-13 115.5' - 125.5' 23 minute run Down Pressure = 500 Psi
884					116.6' 0-5°, B, R5, PtO-t, Pl			
	118	98	100	1.2		13		
882					118.7' 0-5°, B, R4-R5, O, Pl 119.3' 0-5°, B, R5, t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates: N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 4 of 6**
Top Drillhole Elevation: 1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth: 207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
880	122	98	100	1.2	119.6' 0-5°, B, R4-R5, O, Pl 120.4' 0-5°, B, R4-R5, O, Pl 120.5' 0-5°, B, R5, PtO-t, Pl 121.0' 0-5°, B, R4, t, Pl 121.4' 0-5°, B, R5, PtO-t, Pl	13		
878	124				122.9' 0-5°, B, R5, PtO-t, Pl 123.4' 0-5°, B, R4, t, Pl 124.3' 0-5°, B, R5, PtO-t, Pl			
876	126				125.4' 0-5°, B, R4-R5, O, Pl 125.6' 0-5°, B, R5, t, Pl			Run-14 125.5' - 135.5' 19 minute run Down Pressure = 500 Psi
874	128				125.7' 0-5°, B, R4-R5, O, Pl 126.2' 0-5°, B, R5, t, Pl 126.4' 0-5°, B, R4-R5, O, Pl 126.6' 0-5°, B, R5, PtO-t, Pl 126.7' 0-5°, B, R4-R5, PtO-t, Pl 128.5' 0-5°, B, R4, t, Pl		126.2 to 138.2' **BEDFORD SHALE**, red, very fine grained, unweathered, soft, thinly bedded, flat	
872	130	87	99	1.4	130.2' 60°, Jt, R3-R4, O, Und 130.3' 0-5°, B, R5, PtO-t, Pl	14		
870	132				131.6' 0-5°, B, R4, O, Pl 132.1' 0-5°, B, R5, PtO-t, Pl			
868	134				133.3' 0-5°, B, R4-R5, O, Pl 134.4' 0-5°, B, R5, PtO-t, Pl 134.7' 0-5°, B, R4, t, Pl			
866	136				136.3' 0-5°, B, R5, PtO-t, Pl			Run-15 135.5' - 145.5' 19 minute run Down Pressure = 500 Psi
864	138				137.3' 0-5°, B, R4, O, Pl 137.7' 0-5°, B, R5, PtO-t, Pl 137.9' 0-5°, B, R4-R5, O, Pl		138.2 to 151.5' **BEDFORD SHALE**, grey with red bands, very fine grained, unweathered, soft, thinly bedded, flat	
862	140	75	100	1.5	139.1' 0-5°, B, R5, t, Pl 140.0' 0-5°, B, R4-R5, O, Pl	15		
860	142				141.2' 0-5°, B, R4-R5, O, Pl 142.1' 0-5°, B, R5, PtO-t, Pl 142.4' 0-5°, B, R4, t, Pl			
858	144				142.9' 0-5°, B, R5, O, Pl 143.6' 0-5°, B, R5, PtO-t, Pl 143.9' 0-5°, B, R5, t, Pl			
856	146				144.7' 0-5°, B, R4, t, Pl 145.2' 0-5°, B, R5, PtO-t, Pl 145.3' 0-5°, B, R4, O, Pl			Run-16 145.5' - 155.5' 26 minute run Down Pressure = 500 Psi
854	148				146.3' 0-5°, B, R5, PtO-t, Pl 147.3' 0-5°, B, R4-R5, O, Pl			
852	150	100	100	0.7		16		
850	152				151.4' 0-5°, B, R5, PtO-t, Pl 152.3' 0-5°, B, R4, t, Pl		151.5 to 165.5' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, flat	
848	154				153.3' 0-5°, B, R5, PtO-t, Pl			
846	156				154.8' 0-5°, B, R5, PtO-t, Pl 155.2' 0-5°, B, R4-R5, O, Pl 155.7' 0-5°, B, R5, t, Pl 156.1' 0-5°, B, R4-R5, O, Pl 156.5' 0-5°, B, R5, t, Pl 156.9' 0-5°, B, R5, t, Pl			Run-17 155.5' - 165.5' 40 minute run Down Pressure = 500 Psi
844	158	85	100	2.0	157.3' 0-5°, B, R4-R5, O, Pl 157.8' 0-5°, B, R5, PtO-t, Pl 158.0' 0-5°, B, R4-R5, t, Pl	17		
842					158.5' 0-5°, B, R5, PtO-t, Pl 158.8' 0-5°, B, R4, t, Pl			

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Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates:	N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 5 of 6**
Top Drillhole Elevation:	1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth:	207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
840					159.1' 0-5°, B, R5, PtO-t, Pl 159.7' 0-5°, B, R4, O, Pl			
	162				160.0' 0-5°, B, R5, PtO-t, Pl 160.5' 0-5°, B, R4-R5, O, Pl 160.7' 0-5°, B, R5, t, Pl			
838		85	100	2.0	160.9' 0-5°, B, R4-R5, O, Pl 161.2' 0-5°, B, R5, t, Pl	17		
	164				162.0' 0-5°, B, R5, t, Pl 163.4' 0-5°, B, R4-R5, O, Pl 163.8' 0-5°, B, R5, t, Pl			
836					164.2' 0-5°, B, R4-R5, O, Pl			
	166						165.5 to 207.5' **OHIO SHALE**, black, very fine grained, unweathered, moderately hard, thinly bedded, flat	Run-18 165.5' - 175.5' 18 minute run Down Pressure = 600 Psi
834								
	168				167.4' 0-5°, B, R5, t, Pl 167.9' 0-5°, B, R5, PtO-t, Pl			
832					168.9' 0-5°, B, R4-R5, t, Pl			
	170				169.4' 0-5°, B, R5, PtO-t, Pl 169.6' 0-5°, B, R4, t, Pl			
830		91	99	1.1	170.2' 0-5°, B, R5, PtO-t, Pl	18		170.3' - 170.7' UCS = 4,088 Psi
	172							
828					173.0' 0-5°, B, R5, PtO-t, Pl			
	174				173.1' 0-5°, B, R4, t, Pl 173.8' 0-5°, B, R5, PtO-t, Pl 174.1' 0-5°, B, R4, O, Pl			
826					175.0' 0-5°, B, R5, PtO-t, Pl			
	176							Run-19 175.5' - 185.5' 13 minute run Down Pressure = 600 Psi
824								
	178				177.4' 0-5°, B, R4-R5, O, Pl			
822								
	180				179.3' 0-5°, B, R5, t, Pl 179.6' 0-5°, B, R4-R5, O, Pl			
820		100	100	0.9		19		
	182				181.3' 0-5°, B, R4-R5, O, Pl 181.7' 0-5°, B, R5, t, Pl 182.2' 0-5°, B, R4, O, Pl			
818								
	184				183.6' 0-5°, B, R5, PtO-t, Pl 183.8' 0-5°, B, R4-R5, O, Pl			
816					185.0' 0-5°, B, R5, PtO-t, Pl			
	186				185.8' 0-5°, B, R4, t, Pl			Run-20 185.5' - 195.5' 14 minute run Down Pressure = 500 Psi Methane encountered, vented for 760 minutes
814					186.0' 0-5°, B, R5, PtO-t, Pl 186.3' 0-5°, B, R4, O, Pl			
	188				187.3' 0-5°, B, R5, PtO-t, Pl 188.1' 0-5°, B, R4-R5, O, Pl			
812								
	190				189.1' 0-5°, B, R5, t, Pl 189.9' 0-5°, B, R4, t, Pl			
810		100	100	1.3	190.5' 0-5°, B, R5, PtO-t, Pl	20		
	192				191.6' 0-5°, B, R5, PtO-t, Pl			
808					192.9' 0-5°, B, R4-R5, PtO-t, Pl			
	194				193.3' 0-5°, B, R4-R5, O, Pl 193.6' 0-5°, B, R5, t, Pl 193.9' 0-5°, B, R4, t, Pl			
806								
	196							Run-21 195.5' - 205.5' 20 minute run Down Pressure = 660 Psi
804					196.4' 0-5°, B, R5, PtO-t, Pl 196.9' 0-5°, B, R5, PtO-t, Pl			
	198	99	100	1.2	197.1' 0-5°, B, R4, O, Pl 197.9' 0-5°, B, R5, t, Pl	21		
802					199.0' 0-5°, B, R5, PtO-t, Pl 199.4' 0-5°, B, R4-R5, O, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-29**
Coordinates: N 77322.2 E 1870882.6	Driller:	Rii/ S.P	**Sheet No. 6 of 6**
Top Drillhole Elevation: 1001.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 793.7 feet MSL	Prepared By:	A. Mirza	
Total Depth: 207.5 feet	Checked By:	B. Madras Natarajan	Date Start: 1/23/18 End: 1/25/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 1.7

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
800	202	99	100	1.2	200.0' 0-5°, B, R5, t, Pl 200.5' 0-5°, B, R4-R5, O, Pl 201.0' 0-5°, B, R4-R5, O, Pl 202.0' 0-5°, B, R5, t, Pl 202.7' 0-5°, B, R4, O, Pl 203.1' 0-5°, B, R5, PtO-t, Pl	21		
798	204							
796	206	79	100	1.5	206.8' 0-5°, B, R5, t, Pl 207.1' 0-5°, B, R4, t, Pl 207.4' 0-5°, B, R5, PtO-t, Pl	22		Run-22 205.5' - 207.5' 10 minute run Down Pressure = 600 Psi
794	208						**End of Boring at 207.5 feet**	
792	210							
790	212							
788	214							
786	216							
784	218							
782	220							
780	222							
778	224							
776	226							
774	228							
772	230							
770	232							
768	234							
766	236							
764	238							
762								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-31**
Coordinates:	N 774284.1 E 1871319.5	Driller:	Rii/ S.P	**Sheet No. 1 of 6**
Top Drillhole Elevation:	1004.7 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	794.0 feet MSL	Prepared By:	A. Mirza	
Total Depth:	210.7 feet	Checked By:	B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.3

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
1004							▽	
1002	2							
1000	4							
998	6				6.5' to 9.7' 0-5°, 15 Bs, R3-R4, O, Pl	1	6.5 to 10.5' **BEREA SANDSTONE**, brown, fine to medium grained, moderately to highly weathered, soft to moderately hard, thinly bedded, highly fractured, flat,	Run-1 6.5' - 9.7' 10 minute run Down Pressure = 250 Psi
996	8	0	96	4.7				
994	10				9.7' to 10.7' 0-5°, 10 Bs, R4-R5, O, Pl	2	10.5 to 49.0' **BEREA SANDSTONE**, grey, fine grained, slightly to moderately weathered, moderately hard, thinly bedded, moderately fractured, flat, unweathered joints	Run-2 9.7' - 14.7' 6 minute run Down Pressure = 250 Psi
992	12	0	100	4.0	11.1' 0-5°, B, R4, t, Pl 11.3' 0-5°, B, R5, PtO-t, Pl 11.5' to 11.7' fractured rock 11.9' 0-5°, B, R4-R5, O, Pl 12.1' 0-5°, B, R5, t, Pl 12.2' 0-5°, B, R5, PtO-t, Pl 12.3' 0-5°, B, R4-R5, t, Pl			
990	14				12.5' 0-5°, B, R5, PtO-t, Pl			
988	16				14.9' 0-5°, B, R5, t, Pl 15.1' 0-5°, B, R4-R5, O, Pl 15.6' 0-5°, B, R5, t, Pl 15.9' 0-5°, B, R4-R5, O, Pl 16.3' 0-5°, B, R4, O, Pl			Run-3 14.7' - 24.7' 25 minute run Down Pressure = 375 Psi
986	18				17.0' 0-5°, B, R4-R5, O, Pl 17.4' 0-5°, B, R4, O, Pl 17.5' 0-5°, B, R5, PtO-t, Pl 17.6' 0-5°, B, R4-R5, O, Pl 17.8' 0-5°, B, R5, t, Pl			
984	20	23	98	2.2	18.3' 0-5°, B, R5, PtO-t, Pl 18.6' 0-5°, B, R5, t, Pl 19.8' 0-5°, B, R4, t, Pl 20.3' 0-5°, B, R5, PtO-t, Pl 20.5' 0-5°, B, R4-R5, O, Pl	3		
982	22				21.2' 0-5°, B, R5, t, Pl 21.7' 0-5°, B, R5, PtO-t, Pl 22.0' 0-5°, B, R5, t, Pl 22.3' 0-5°, B, R4, t, Pl			
980	24				22.8' 0-5°, B, R5, PtO-t, Pl 23.2' 0-5°, B, R4-R5, O, Pl 23.7' 0-5°, B, R4-R5, O, Pl			Run-4 24.7' - 34.7' 22 minute run Down Pressure = 375 Psi
978	26				25.1' 0-5°, B, R4, O, Pl 26.4' 0-5°, B, R4-R5, O, Pl			
976	28				26.5' 0-5°, B, R4, O, Pl 27.9' 0-5°, B, R5, PtO-t, Pl			
974	30	77	99	1.7	29.1' 0-5°, B, R4-R5, O, Pl 29.8' 0-5°, B, R5, t, Pl 30.3' 0-5°, B, R5, PtO-t, Pl 30.4' 0-5°, B, R5, t, Pl 30.8' 0-5°, B, R4, t, Pl	4		
972	32				31.1' 0-5°, B, R5, PtO-t, Pl 31.3' 0-5°, B, R5, t, Pl 32.5' 0-5°, B, R5, PtO-t, Pl 32.6' 0-5°, B, R4-R5, t, Pl			
970	34				34.2' 0-5°, B, R5, PtO-t, Pl			
968	36				34.3' 0-5°, B, R5, t, Pl 34.4' 0-5°, B, R4-R5, O, Pl 34.5' 0-5°, B, R5, t, Pl 34.7' to 34.9' fractured rock 35.1' 0-5°, B, R4, O, Pl			Run-5 34.7' - 44.7' 20 minute run Down Pressure = 375 Psi
966	38	63	90	1.5	36.3' 0-5°, B, R4-R5, O, Pl 37.3' 0-5°, B, R4, O, Pl 37.5' 0-5°, B, R5, PtO-t, Pl 37.6' 0-5°, B, R5, t, Pl 38.1' to 38.6' fractured rock	5		
					39.5' 0-5°, B, R5, PtO-t, Pl			

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-31**
Coordinates: N 774284.1 E 1871319.5	Driller: Rii/ S.P		**Sheet No. 2 of 6**
Top Drillhole Elevation: 1004.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 794.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 210.7 feet	Checked By: B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
964					39.6' 0-5°, B, R4, t, Pl 39.7' 0-5°, B, R5, PtO-t, Pl 40.2' 0-5°, B, R4, O, Pl 40.9' 0-5°, B, R5, PtO-t, Pl			
	42	63	90	1.5	41.9' 0-5°, B, R4-R5, O, Pl 42.1' 0-5°, B, R5, t, Pl 42.4' 0-5°, B, R4-R5, O, Pl 42.9' to 43.1' fractured rock	5		
962					43.9' 0-5°, B, R4, O, Pl			
	44				44.1' to 44.4' fractured rock			
960					44.9' to 45.4' fractured rock			Run-6 44.7' - 49.7' 15 minute run Down Pressure = 250 Psi No water return
	46				45.7' 0-5°, B, R4, O, Pl 45.9' 0-5°, B, R5, O, Pl			
958		61	90	1.2	47.2' to 47.3' fractured rock	6		
	48				48.1' 0-5°, B, R5, t, Pl			
956					49.1' to 49.2' fractured rock			
	50				49.3' 0-5°, B, R5, t, Pl 49.6' 0-5°, B, R4-R5, O, Pl 50.0' 0-5°, B, R5, t, Pl 50.6' 0-5°, B, R4-R5, O, Pl 50.7' to 51.1' fractured rock		49.0 to 84.7' Interbedded **BEREA SANDSTONE** (70%) and **BEDFORD SHALE** (30%) **BEREA SANDSTONE**, grey, fine grained, unweathered, moderately hard to hard, thinly bedded, highly fractured **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded	Run-7 49.7' - 54.7' 5 minute run Down Pressure = 400 Psi
954					51.2' 0-5°, B, R5, t, Pl 51.3' 0-5°, B, R4-R5, O, Pl 51.6' 0-5°, B, R5, t, Pl 51.8' 0-5°, B, R4-R5, O, Pl			
	52	25	100	2.4	52.0' to 52.2' fractured rock 52.2' 0-5°, B, R5, t, Pl	7		
952					52.3' 0-5°, B, R4-R5, O, Pl			
	54				52.9' to 53.1' fractured rock			Run-8 54.7' - 64.7' 30 minute run
950					53.6' 0-5°, B, R5, PtO-t, Pl 53.9' 0-5°, B, R4, t, Pl 54.1' 0-5°, B, R5, PtO-t, Pl 54.3' 0-5°, B, R4, O, Pl			
	56				54.5' 0-5°, B, R5, PtO-t, Pl 54.8' to 55.0' fractured rock			
948					55.1' 0-5°, B, R4, t, Pl 55.3' 0-5°, B, R5, PtO-t, Pl 55.6' 0-5°, B, R4, O, Pl			
	58				55.8' 0-5°, B, R5, PtO-t, Pl 56.1' 0-5°, B, R4-R5, O, Pl 56.2' 0-5°, B, R5, t, Pl			
946					56.3' to 56.7' fractured rock			
	60	50	95	2.0	56.8' 0-5°, B, R5, PtO-t, Pl 57.0' 0-5°, B, R5, t, Pl 57.1' 0-5°, B, R4, t, Pl 57.7' 0-5°, B, R5, PtO-t, Pl 57.8' 0-5°, B, R4-R5, O, Pl	8		
944					58.1' 0-5°, B, R5, t, Pl 58.3' 0-5°, B, R5, t, Pl			
	62				58.9' 0-5°, B, R4, t, Pl 59.1' 0-5°, B, R5, PtO-t, Pl 59.6' 0-5°, B, R4-R5, O, Pl 59.8' 0-5°, B, R5, t, Pl			
942					61.4' 0-5°, B, R5, PtO-t, Pl 64.1' 0-5°, B, R4, t, Pl 65.1' 0-5°, B, R5, PtO-t, Pl 65.7' 0-5°, B, R4, O, Pl			
	64				66.6' 0-5°, B, R4-R5, O, Pl 66.8' 0-5°, B, R4, O, Pl 66.9' 0-5°, B, R4-R5, O, Pl			
940					67.8' 0-5°, B, R4, O, Pl 68.1' 0-5°, B, R5, PtO-t, Pl 68.2' to 68.4' fractured rock			Run-9 64.7' - 74.7' 25 minute run Down Pressure = 300 to 400 Psi Voids during drilling @ 67.9' to 68.1'
	66				69.0' 0-5°, B, R4-R5, O, Pl 69.4' 30°, Jt, R4-R5, O, Und 69.8' 80°, Jt, R3-R4, O, Und 70.5' 0-5°, B, R4, t, Pl			
938					71.4' 0-5°, B, R5, PtO-t, Pl 71.9' 0-5°, B, R4-R5, O, Pl 72.4' 0-5°, B, R5, PtO-t, Pl			
	68				72.6' 0-5°, B, R4, O, Pl 73.3' 0-5°, B, R4-R5, O, Pl			
936					74.3' 0-5°, B, R4, PtO-t, Pl 74.6' to 74.7' fractured rock			
	70	61	95	1.9	75.0' 0-5°, B, R4, O, Pl 75.3' to 75.6' fractured rock	9		
934					75.7' 0-5°, B, R5, t, Pl 76.1' 0-5°, B, R5, PtO-t, Pl 76.2' 0-5°, B, R5, t, Pl			
	72				76.6' 0-5°, B, R5, PtO-t, Pl 77.1' 0-5°, B, R5, t, Pl 77.5' 0-5°, B, R4, t, Pl			
932					77.7' 0-5°, B, R5, PtO-t, Pl			
	74							
930								Run-10 74.7' - 84.7' 25 minute run Down Pressure = 400 to 500 Psi
	76							
928								
	78	65	100	1.7		10		
926								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-31**
Coordinates: N 774284.1 E 1871319.5	Driller: Rii/ S.P		**Sheet No. 3 of 6**
Top Drillhole Elevation: 1004.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 794.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 210.7 feet	Checked By: B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
924					78.3' 0-5°, B, R4-R5, O, Pl 78.5' 0-5°, B, R5, t, Pl 79.6' 0-5°, B, R4-R5, O, Pl 79.7' 0-5°, B, R5, t, Pl			
922	82	65	100	1.7	80.3' 0-5°, B, R5, PtO-t, Pl 80.6' 0-5°, B, R4-R5, t, Pl 81.4' 0-5°, B, R5, PtO-t, Pl 82.8' 0-5°, B, R5, PtO-t, Pl	10		
920	84				84.3' 0-5°, B, R5, t, Pl		84.7 to 119.1' Interbedded BEDFORD SHALE (80%) and BEREA SANDSTONE (20%) **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded **BEREA SANDSTONE**, grey, fine grained, unweathered, thinly bedded	Run-11 84.7' - 94.7' 30 minute run Down Pressure = 400 to 450 Psi
918	86				84.9' 0-5°, B, R4, t, Pl 85.4' 0-5°, B, R5, PtO-t, Pl 85.7' 0-5°, B, R4-R5, O, Pl 85.8' 0-5°, B, R5, PtO-t, Pl 86.3' 0-5°, B, R4, O, Pl			
916	88				87.0' 0-5°, B, R5, PtO-t, Pl 87.7' 0-5°, B, R4-R5, O, Pl 87.8' 0-5°, B, R5, t, Pl 88.5' 0-5°, B, R5, PtO-t, Pl			
914	90	56	99	2.1	89.2' 0-5°, B, R5, t, Pl 89.3' 0-5°, B, R5, PtO-t, Pl 89.5' 0-5°, B, R5, t, Pl 89.8' 0-5°, B, R4-R5, O, Pl	11		
912	92				90.5' 0-5°, B, R5, t, Pl 90.9' 0-5°, B, R5, PtO-t, Pl 91.4' 0-5°, B, R5, t, Pl 91.5' 0-5°, B, R5, PtO-t, Pl			
910	94				91.6' 0-5°, B, R5, t, Pl 92.2' 0-5°, B, R5, PtO-t, Pl 93.6' 0-5°, B, R5, t, Pl			
908	96				94.8' 0-5°, B, R4, t, Pl 95.1' 0-5°, B, R5, PtO-t, Pl			Run-12 94.7' - 104.7' 30 minute run Down Pressure = 600 Psi
906	98				97.6' 0-5°, B, R4-R5, O, Pl 98.2' 0-5°, B, R5, t, Pl			
904	100	83	100	1.4	98.8' 0-5°, B, R4-R5, O, Pl 98.9' 0-5°, B, R5, t, Pl 99.7' 0-5°, B, R5, PtO-t, Pl 100.1' 0-5°, B, R4-R5, t, Pl	12		
902	102				101.5' 0-5°, B, R5, PtO-t, Pl 102.0' 0-5°, B, R5, PtO-t, Pl 102.5' 0-5°, B, R5, t, Pl 102.6' 0-5°, B, R4, t, Pl			
900	104				103.7' 0-5°, B, R5, PtO-t, Pl			
898	106				104.6' 0-5°, B, R4-R5, O, Pl 105.4' 0-5°, B, R5, PtO-t, Pl 106.3' 0-5°, B, R4, O, Pl 106.8' 0-5°, B, R5, PtO-t, Pl			Run-13 104.7' - 114.7' 30 minute run Down Pressure = 500 to 600 Psi
896	108				108.2' 0-5°, B, R4-R5, O, Pl 108.3' 0-5°, B, R5, t, Pl			
894	110	85	100	1.7	108.8' 0-5°, B, R5, PtO-t, Pl 109.0' 0-5°, B, R4-R5, O, Pl 109.5' 0-5°, B, R5, t, Pl 110.3' 0-5°, B, R5, PtO-t, Pl 110.9' 0-5°, B, R5, t, Pl	13		
892	112				111.6' 0-5°, B, R4, t, Pl 111.9' 0-5°, B, R5, PtO-t, Pl 112.0' 0-5°, B, R4-R5, O, Pl 112.3' 0-5°, B, R5, PtO-t, Pl 112.6' 0-5°, B, R4, O, Pl 112.9' 0-5°, B, R5, PtO-t, Pl			
890	114				113.8' 0-5°, B, R4-R5, O, Pl			
888	116							Run-14 114.7' - 124.7' 30 minute run Down Pressure = 500 Psi
886	118	77	98	1.7	116.8' 0-5°, B, R5, t, Pl 117.1' 0-5°, B, R5, PtO-t, Pl 118.0' 0-5°, B, R5, t, Pl 118.6' 0-5°, B, R5, PtO-t, Pl 119.2' 0-5°, B, R5, t, Pl	14	119.1 to 137.7' **BEDFORD SHALE**, red,	

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-31**
Coordinates:	N 774284.1 E 1871319.5	Driller:	Rii/ S.P	**Sheet No. 4 of 6**
Top Drillhole Elevation:	1004.7 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	794.0 feet MSL	Prepared By:	A. Mirza	
Total Depth:	210.7 feet	Checked By:	B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 1.3

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
884					119.4' 0-5°, B, R5, PtO-t, Pl 119.7' 0-5°, B, R5, t, Pl 121.0' 0-5°, B, R4, t, Pl 121.2' 0-5°, B, R5, PtO-t, Pl 121.6' 0-5°, B, R4-R5, O, Pl 121.7' 0-5°, B, R5, t, Pl 122.0' 0-5°, B, R4-R5, O, Pl 122.4' 0-5°, B, R5, t, Pl 123.9' 0-5°, B, R4-R5, t, Pl	14	very fine grained, unweathered, soft, thinly bedded, flat	
882	122	77	98	1.7				
880	124				124.0' 0-5°, B, R5, PtO-t, Pl 124.1' 0-5°, B, R5, PtO-t, Pl 124.3' 0-5°, B, R5, PtO-t, Pl 124.8' 0-5°, B, R5, t, Pl 125.8' 0-5°, B, R4, t, Pl 126.1' 0-5°, B, R5, PtO-t, Pl 126.4' 0-5°, B, R4-R5, O, Pl 126.5' 0-5°, B, R5, PtO-t, Pl 126.9' 0-5°, B, R4, O, Pl 127.0' 0-5°, B, R4-R5, O, Pl 127.7' 0-5°, B, R5, t, Pl			Run-15 124.7' - 134.7' 34 minute run Down Pressure = 500 Psi
878	126							
876	128							
874	130	68	99	2.0	128.1' 0-5°, B, R5, PtO-t, Pl 128.8' 0-5°, B, R4-R5, t, Pl 129.1' 0-5°, B, R5, PtO-t, Pl 129.6' 0-5°, B, R5, PtO-t, Pl 130.2' 0-5°, B, R5, t, Pl 130.5' 0-5°, B, R4, t, Pl 131.0' 0-5°, B, R5, PtO-t, Pl 132.3' 0-5°, B, R4-R5, O, Pl 132.8' 0-5°, B, R5, PtO-t, Pl 133.0' 0-5°, B, R4, O, Pl	15		
872	132							
870	134				134.5' 0-5°, B, R5, PtO-t, Pl 134.6' 0-5°, B, R4-R5, O, Pl 135.3' 0-5°, B, R5, t, Pl 135.6' 0-5°, B, R5, PtO-t, Pl 136.2' 0-5°, B, R5, t, Pl 136.5' 0-5°, B, R5, PtO-t, Pl 136.8' 0-5°, B, R5, t, Pl 137.1' 0-5°, B, R4-R5, O, Pl 137.6' 0-5°, B, R5, t, Pl 137.8' 0-5°, B, R5, PtO-t, Pl 138.5' 0-5°, B, R5, t, Pl			Run-16 134.7' - 144.7' 20 minute run Down Pressure = 600 Psi
868	136							
866	138						137.7 to 150.7' **BEDFORD SHALE**, red, very fine grained, unweathered, soft, thinly bedded, flat	
864	140	79	100	1.6	139.2' 0-5°, B, R5, PtO-t, Pl 139.3' 0-5°, B, R5, t, Pl 139.6' 0-5°, B, R4-R5, O, Pl 140.4' 0-5°, B, R5, t, Pl	16		
862	142				141.9' 0-5°, B, R5, PtO-t, Pl 142.6' 0-5°, B, R5, t, Pl			
860	144				144.3' 0-5°, B, R5, PtO-t, Pl			Run-17 144.7' - 154.7' 21 minute run Down Pressure = 600 Psi
858	146				145.5' 0-5°, B, R5, t, Pl 146.1' 0-5°, B, R4, t, Pl			
856	148				147.9' 0-5°, B, R5, PtO-t, Pl 148.6' 0-5°, B, R4-R5, O, Pl			
854	150	82	99	1.5	149.2' 0-5°, B, R5, PtO-t, Pl 149.6' 0-5°, B, R4, O, Pl 149.9' 0-5°, B, R5, PtO-t, Pl 150.2' 0-5°, B, R4-R5, O, Pl 150.6' 0-5°, B, R5, t, Pl 151.3' 0-5°, B, R5, t, Pl 151.8' 0-5°, B, R4, t, Pl	17		
852	152				152.4' 0-5°, B, R5, PtO-t, Pl 152.9' 0-5°, B, R4, O, Pl		150.7 to 166.1' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, flat	
850	154				153.9' 0-5°, B, R5, PtO-t, Pl 154.1' 0-5°, B, R4-R5, O, Pl			Run-18 154.7' - 164.7' 25 minute run Down Pressure = 600 Psi
848	156				155.0' 0-5°, B, R4-R5, PtO-t, Pl 155.8' 0-5°, B, R5, PtO-t, Pl			
846	158	93	99	1.5	156.6' 0-5°, B, R4, O, Pl 157.1' 0-5°, B, R4, t, Pl 157.7' 0-5°, B, R5, PtO-t, Pl 158.4' 0-5°, B, R4, O, Pl 159.0' 0-5°, B, R5, PtO-t, Pl	18		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-31	
Coordinates: N 774284.1 E 1871319.5	Driller: Rii/ S.P	Sheet No. 5 of 6	
Top Drillhole Elevation: 1004.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 794.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 210.7 feet	Checked By: B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
844					160.0' 0-5°, B, R4-R5, O, Pl 160.6' 0-5°, B, R5, PtO-t, Pl 161.0' 0-5°, B, R4, t, Pl 161.1' 0-5°, B, R5, PtO-t, Pl			
842	162	93	99	1.5	162.5' 0-5°, B, R4, O, Pl 162.8' 0-5°, B, R5, PtO-t, Pl 163.2' 0-5°, B, R4-R5, O, Pl	18		
840	164				163.8' 0-5°, B, R5, t, Pl			
838	166				166.2' 0-5°, B, R4-R5, O, Pl		166.1 to 210.7' **OHIO SHALE**, black, very fine grained, unweathered, moderately hard, thinly bedded, flat	Run-19 164.7' - 174.7' 20 minute run Down Pressure = 600 Psi
836	168				167.7' 0-5°, B, R5, t, Pl 168.0' 0-5°, B, R4-R5, O, Pl 168.2' 0-5°, B, R5, PtO-t, Pl			
834	170	96	100	1.4	168.8' 0-5°, B, R4-R5, O, Pl 169.2' 0-5°, B, R5, PtO-t, Pl 169.6' 0-5°, B, R4, t, Pl 169.7' 0-5°, B, R5, PtO-t, Pl 170.1' 0-5°, B, R4, O, Pl 171.1' 0-5°, B, R5, PtO-t, Pl	19		
832	172				172.5' 70°, Jt, R3-R4, O, Pl 172.8' 0-5°, B, R5, t, Pl			
830	174				173.0' 0-5°, B, R4, O, Pl 174.3' 0-5°, B, R5, PtO-t, Pl			Run-20 174.7' - 184.7' 17 minute run Down Pressure = 600 Psi 174.8' - 175.2' UCS = 4,416 Psi
828	176				175.8' 0-5°, B, R4-R5, O, Pl 176.9' 0-5°, B, R5, t, Pl			
826	178				178.3' 0-5°, B, R4, t, Pl 179.0' 0-5°, B, R5, PtO-t, Pl			
824	180	88	100	1.2	179.6' 0-5°, B, R4, O, Pl 180.4' 0-5°, B, R5, PtO-t, Pl	20		
822	182				181.5' 0-5°, B, R4-R5, O, Pl 182.8' 0-5°, B, R5, t, Pl			
820	184				183.9' 0-5°, B, R5, PtO-t, Pl 184.1' 0-5°, B, R5, t, Pl			
818	186				184.3' 0-5°, B, R4, O, Pl 184.4' 0-5°, B, R4-R5, PtO-t, Pl 185.7' 0-5°, B, R5, PtO-t, Pl 186.2' 0-5°, B, R4, O, Pl			Run-21 184.7' - 194.7' 25 minute run Down Pressure = 600 Psi
816	188				186.8' 0-5°, B, R4, t, Pl 187.3' 0-5°, B, R5, PtO-t, Pl			
814	190	88	100	1.4	188.2' 0-5°, B, R4, O, Pl 188.5' 0-5°, B, R5, PtO-t, Pl 188.6' 0-5°, B, R4-R5, O, Pl 188.8' 0-5°, B, R5, PtO-t, Pl 189.5' 0-5°, B, R4, t, Pl	21		
812	192				191.1' 0-5°, B, R5, PtO-t, Pl 192.0' 0-5°, B, R4, O, Pl			
810	194				192.9' 0-5°, B, R5, PtO-t, Pl 193.9' 0-5°, B, R4-R5, O, Pl 194.3' 0-5°, B, R5, t, Pl			
808	196				195.6' 0-5°, B, R4-R5, O, Pl 196.4' 0-5°, B, R5, t, Pl			Run-22 194.7' - 204.7' 20 minute run Down Pressure = 600 Psi
806	198	100	99	0.9	197.5' 0-5°, B, R4-R5, O, Pl 198.3' 0-5°, B, R5, t, Pl 198.9' 0-5°, B, R5, PtO-t, Pl	22		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-31	
Coordinates: N 774284.1 E 1871319.5	Driller: Rii/ S.P	Sheet No. 6 of 6	
Top Drillhole Elevation: 1004.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 794.0 feet MSL	Prepared By: A. Mirza		
Total Depth: 210.7 feet	Checked By: B. Madras Natarajan	Date Start: 1/15/18 End: 1/19/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 1.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
804								
	202	100	99	0.9	199.7' 0-5°, B, R5, t, Pl 200.6' 0-5°, B, R4, O, Pl 201.0' 0-5°, B, R5, PtO-t, Pl	22		
802								
	204							
800								Run-23 204.7' - 210.7' 15 minute run
	206				205.3' 0-5°, B, R4, O, Pl 206.1' 0-5°, B, R4, t, Pl 206.8' 0-5°, B, R5, PtO-t, Pl			
798								
	208	94	100	0.8	207.7' 0-5°, B, R4, O, Pl 208.0' 0-5°, B, R4-R5, PtO-t, Pl	23		
796								
	210				209.7' 0-5°, B, R5, PtO-t, Pl			
794							**End of Boring at 210.7 feet**	
	212							
792								
	214							
790								
	216							
788								
	218							
786								
	220							
784								
	222							
782								
	224							
780								
	226							
778								
	228							
776								
	230							
774								
	232							
772								
	234							
770								
	236							
768								
	238							
766								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-33**
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM		**Sheet No. 1 of 6**
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
1008	2							
1006	4							
1004	6							
1002	8							
1000	10						▽	
998	12				12.0' to 15.5' 0-5°, 15 Bs, R3-R4, O, Pl, Cl			
996	14	0	95	7.1		1	12.0 to 53.5' **BEREA SANDSTONE**, grey, moderately hard to hard, moderately to slightly weathered, fine grained, thin bedded to laminated, highly fractured, flat joints	Top of Rock @ 12.0' Run-1 12.0' - 15.5' 10 minute run Down Pressure = 250 Psi
994	16				15.5' to 20.5' 0-5°, 12 Bs, R4-R5, O, Pl			
992	18	13	100	6.2		2		Run-2 15.5' - 20.5' 10 minute run Down Pressure = 100 Psi
990	20							
988	22				20.8' 21.3 80° Jt, R3-R4, O, Und 21.6' to 22.5' 80° Jt, R4-R5, O, Pl			Run-3 20.5' - 30.5' 25 minute run Down Pressure = 200 Psi
986	24				22.9' 0-5°, B, R4-R5, O, Pl 23.0' 0-5°, B, R5, t, Pl 23.3' 0-5°, B, R5, PtO-t, Pl 23.7' 0-5°, B, R4-R5, O, Pl			
984	26	46	100	1.4	24.9' 0-5°, B, R4, O, Pl 25.3' 0-5°, B, R5, PtO-t, Pl 25.4' 0-5°, B, R5, t, Pl 25.8' 0-5°, B, R4-R5, O, Pl 26.2' 0-5°, B, R4-R5, O, Pl	3		
982	28				26.7' 0-5°, B, R5, t, Pl			
980	30				29.4' 0-5°, B, R5, PtO-t, Pl 29.8' 0-5°, B, R4-R5, O, Pl			
978	32				30.0' 0-5°, B, R4, O, Pl 31.0' 0-5°, B, R5, t, Pl 32.0' 0-5°, B, R5, PtO-t, Pl			Run-4 30.5' - 40.5' 18 minute run Down Pressure = 250 Psi for the first 6.0' and 300 Psi for last 4.0'
976	34				33.5' 0-5°, B, R4-R5, O, Pl 34.0' 0-5°, B, R4, O, Pl			
974	36	72	100	1.5	35.9' 0-5°, B, R5, PtO-t, Pl 36.2' 0-5°, B, R5, t, Pl 36.8' 0-5°, B, R4-R5, O, Pl 36.9' 0-5°, B, R4-R5, O, Pl 37.7' 0-5°, B, R5, t, Pl 37.9' 0-5°, B, R5, PtO-t, Pl 38.7' 0-5°, B, R4-R5, O, Pl	4		
972	38							
970					39.5' 0-5°, B, R5, t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-33**
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM		**Sheet No. 2 of 6**
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
968	42				39.7' 0-5°, B, R4-R5, O, Pl 39.9' 0-5°, B, R4-R5, O, Pl 40.3' 0-5°, B, R5, t, Pl 40.7' 0-5°, B, R5, PtO-t, Pl 40.8' 0-5°, B, R4-R5, O, Pl 41.3' 0-5°, B, R4, O, Pl 41.5' 0-5°, B, R5, t, Pl 41.9' 0-5°, B, R5, PtO-t, Pl 42.1' 0-5°, B, R4-R5, O, Pl 42.3' 0-5°, B, R4, O, Pl 42.5' 0-5°, B, R5, PtO-t, Pl 42.7' 0-5°, B, R5, t, Pl 42.9' 0-5°, B, R5, t, Pl 43.1' 0-5°, B, R4-R5, O, Pl 43.5' 0-5°, B, R4-R5, O, Pl 44.3' 0-5°, B, R5, t, Pl 45.0' 0-5°, B, R5, PtO-t, Pl 45.5' 0-5°, B, R4-R5, O, Pl 46.0' 0-5°, B, R4, O, Pl 46.6' 0-5°, B, R5, t, Pl 46.8' 0-5°, B, R5, PtO-t, Pl 47.3' 0-5°, B, R4-R5, O, Pl 47.8' 0-5°, B, R4, O, Pl	5		Run-5 40.5' - 50.5' 26 minute run Down Pressure = 250 Psi
966	44							
964	46	50	99	1.8				
962	48							
960	50				48.2' 0-5°, B, R4-R5, O, Pl 48.7' 0-5°, B, R4, O, Pl 49.0' 0-5°, B, R5, t, Pl 50.3' 0-5°, B, R5, PtO-t, Pl 50.5' to 50.8' fractured rock 51.5' 0-5°, B, R5, PtO-t, Pl 51.8' 0-5°, B, R5, t, Pl 52.0' 0-5°, B, R5, t, Pl 52.1' 0-5°, B, R4-R5, O, Pl 52.2' 0-5°, B, R4-R5, O, Pl 53.0' 0-5°, B, R5, t, Pl 54.2' 0-5°, B, R5, PtO-t, Pl 54.3' 0-5°, B, R4-R5, O, Pl 54.5' to 54.7' fractured rock 54.9' 0-5°, B, R4-R5, O, Pl 55.0' 0-5°, B, R4-R5, O, Pl 55.2' 0-5°, B, R5, t, Pl 55.4' 0-5°, B, R5, PtO-t, Pl 56.1' 0-5°, B, R5, t, Pl 56.3' 0-5°, B, R5, t, Pl 56.9' 0-5°, B, R4-R5, O, Pl 57.3' 0-5°, B, R5, t, Pl 57.5' 0-5°, B, R5, PtO-t, Pl	6	53.5 to 90.5' **BEREA SANDSTONE** interbedded with **BEDFORD SHALE** (60% / 40%) **BEREA SANDSTONE**, grey, fine grained, slightly weathered, hard, thinly bedded, highly fractured **BEDFORD SHALE**, grey, very fine grained, slightly weathered, soft, thinly bedded, highly fractured	Run-6 50.5' - 60.5' 60 minute run Down Pressure = 100 to 150 Psi
958	52							
956	54							
954	56	50	99	2				
952	58							
950	60							
948	62				58.0' to 58.3' fractured rock 58.6' 0-5°, B, R4, O, Pl 59.0' 0-5°, B, R5, PtO-t, Pl 60.1' 0-5°, B, R5, t, Pl 60.2' 0-5°, B, R4-R5, O, Pl 60.3' 0-5°, B, R4-R5, O, Pl 60.6' 0-5°, B, R5, t, Pl 61.1' 0-5°, B, R5, PtO-t, Pl 61.4' 0-5°, B, R4, O, Pl 61.6' 0-5°, B, R5, PtO-t, Pl 62.4' 0-5°, B, R5, t, Pl 62.7' 0-5°, B, R4-R5, O, Pl 62.9' 0-5°, B, R4-R5, O, Pl 63.2' 63.4' fractured rock 63.7' 0-5°, B, R4, O, Pl 64.0' 0-5°, B, R5, t, Pl 64.3' 0-5°, B, R5, PtO-t, Pl 64.4' 0-5°, B, R4-R5, O, Pl 64.7' 0-5°, B, R4, O, Pl 64.8' 0-5°, B, R5, PtO-t, Pl 65.3' 0-5°, B, R5, t, Pl	7		Run-7 60.5' - 70.5' 25 minute run Down Pressure = 250 Psi
946	64							
944	66	41	99	2.2				
942	68							
940	70							
938	72				65.7' 0-5°, B, R4-R5, O, Pl 66.2' 0-5°, B, R4-R5, O, Pl 66.3' 0-5°, B, R5, t, Pl 66.7' 0-5°, B, R5, PtO-t, Pl 66.9' 0-5°, B, R4-R5, O, Pl 67.1' 0-5°, B, R5, t, Pl 67.4' 0-5°, B, R4-R5, O, Pl 67.8' 0-5°, B, R4-R5, O, Pl 68.0' 0-5°, B, R5, t, Pl 68.9' 0-5°, B, R5, PtO-t, Pl 69.5' 0-5°, B, R4-R5, O, Pl 70.1' 0-5°, B, R4, O, Pl 70.3' 0-5°, B, R5, t, Pl 70.6' 0-5°, B, R5, PtO-t, Pl 70.8' 71' fractured rock 71.4' 0-5°, B, R4-R5, O, Pl 71.8' 0-5°, B, R5, t, Pl 72.0' 0-5°, B, R5, PtO-t, Pl 72.3' 0-5°, B, R4-R5, O, Pl 72.6' 90°, Jt, R3-R4, O, Und 72.8' 0-5°, B, R4-R5, O, Pl	8		Run-8 70.5' - 80.5' 25 minute run Down Pressure = 100 to 250 Psi
936	74							
934	76	49	98	2				
932	78							
930								

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-33	
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM	Sheet No. 3 of 6	
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
928	82			2	73.3' 0-5°, B, R4-R5, O, Pl 73.4' 0-5°, B, R5, t, Pl 74.0' 0-5°, B, R5, PtO-t, Pl 74.3' 0-5°, B, R4-R5, O, Pl 74.6' 0-5°, B, R5, t, Pl 74.9' 0-5°, B, R4-R5, O, Pl 75.2' 0-5°, B, R4-R5, O, Pl 76.4' 0-5°, B, R5, t, Pl 77.2' 0-5°, B, R4-R5, O, Pl 77.7' 0-5°, B, R5, t, Pl 78.3' 0-5°, B, R4-R5, O, Pl 79.0' 45°, Jt, R4-R5, O, Und			Run-9 80.5' - 90.5' 30 minute run Down Pressure = 400 Psi
926	84							
924	86	70	100	2.1		9		
922	88				79.6' 0-5°, B, R4-R5, O, Pl 80.7' 0-5°, B, R4-R5, O, Pl 80.9' 0-5°, B, R5, t, Pl 81.2' 0-5°, B, R5, PtO-t, Pl 81.7' 0-5°, B, R4-R5, O, Pl 82.3' 0-5°, B, R4, O, Pl 83.1' 0-5°, B, R5, PtO-t, Pl 83.7' 0-5°, B, R5, t, Pl 84.1' 0-5°, B, R4-R5, O, Pl 84.2' 0-5°, B, R4-R5, O, Pl 85.2' 0-5°, B, R5, t, Pl			
920	90							
918	92				85.5' 0-5°, B, R5, PtO-t, Pl 86.1' 0-5°, B, R4-R5, O, Pl 86.4' 0-5°, B, R5, t, Pl 86.9' 0-5°, B, R4-R5, O, Pl 87.2' 0-5°, B, R4-R5, O, Pl 87.6' 0-5°, B, R5, t, Pl 88.0' 0-5°, B, R5, PtO-t, Pl 89.4' 0-5°, B, R4-R5, O, Pl 89.6' 0-5°, B, R4, O, Pl 90.3' 0-5°, B, R5, t, Pl 90.4' 0-5°, B, R5, PtO-t, Pl 90.6' 0-5°, B, R4-R5, O, Pl 91.0' 0-5°, B, R4, O, Pl 91.8' 0-5°, B, R5, PtO-t, Pl 92.3' 0-5°, B, R5, t, Pl 93.1' 0-5°, B, R4-R5, O, Pl 93.3' 0-5°, B, R4-R5, O, Pl 94.0' 0-5°, B, R5, t, Pl 94.4' 0-5°, B, R5, PtO-t, Pl 94.8' 0-5°, B, R4-R5, O, Pl 95.4' 0-5°, B, R4, O, Pl 96.3' 0-5°, B, R5, t, Pl		90.5 to 120.5' **BEDFORD SHALE** grey, very fine grained, slightly weathered, soft to moderately hard, thinly bedded, highly fractured	Run-10 90.5' - 100.5' 33 minute run Down Pressure = 250 Psi
916	94							
914	96	84	99	1.9		10		
912	98							
910	100							
908	102				97.4' 0-5°, B, R5, PtO-t, Pl 98.0' 0-5°, B, R4-R5, O, Pl 98.3' 0-5°, B, R4, O, Pl 98.6' 0-5°, B, R5, PtO-t, Pl 99.2' 0-5°, B, R5, t, Pl 99.4' 0-5°, B, R4-R5, O, Pl 99.7' 0-5°, B, R4-R5, O, Pl 100.7' 0-5°, B, R5, t, Pl 101.4' 0-5°, B, R5, PtO-t, Pl 101.8' 0-5°, B, R4-R5, O, Pl 102.6' 0-5°, B, R5, t, Pl 103.5' 0-5°, B, R4-R5, O, Pl 103.8' 0-5°, B, R4-R5, O, Pl 104.4' 0-5°, B, R5, t, Pl 104.9' 0-5°, B, R5, PtO-t, Pl 105.4' 0-5°, B, R4-R5, O, Pl 106.0' 0-5°, B, R4, O, Pl 107.4' 0-5°, B, R5, t, Pl 107.9' 0-5°, B, R5, PtO-t, Pl 108.6' 0-5°, B, R4-R5, O, Pl			Run-11 100.5' - 110.5' 25 minute run Down Pressure = 400 Psi
906	104							
904	106	81	100	1.4		11		
902	108							
900	110							
898	112				110.3' 0-5°, B, R4, O, Pl 112.0' 0-5°, B, R5, PtO-t, Pl 112.1' 0-5°, B, R4-R5, O, Pl 112.8' 0-5°, B, R4, O, Pl			Run-12 110.5' - 120.5'
896	114							
894	116	78	99	1.4	114.4' 0-5°, B, R5, PtO-t, Pl 115.4' 0-5°, B, R5, t, Pl 115.5' 0-5°, B, R4-R5, O, Pl 116.0' 0-5°, B, R4-R5, O, Pl 116.3' 0-5°, B, R5, t, Pl	12		
892	118				117.3' 0-5°, B, R5, PtO-t, Pl 117.5' 0-5°, B, R4-R5, O, Pl 118.4' 0-5°, B, R4, O, Pl 118.6' 0-5°, B, R5, t, Pl 119.0' 0-5°, B, R5, PtO-t, Pl			
890								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-33	
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM	Sheet No. 4 of 6	
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
888	122				120.2' 0-5°, B, R4-R5, O, Pl 121.8' 0-5°, B, R4, O, Pl		120.5 to 126.0' **BEDFORD SHALE** blue and red banded, soft, slightly weathered, very fine grained, thin bedded, flat	Run-13 120.5' - 130.5' 30 minute run Down Pressure = 400 Psi
886	124							
884	126	88	98	0.9	124.7' 0-5°, B, R5, PtO-t, Pl 124.8' 0-5°, B, R5, t, Pl 125.3' 0-5°, B, R4-R5, O, Pl 125.5' 0-5°, B, R4-R5, O, Pl 125.7' 0-5°, B, R5, t, Pl 127.2' 127.4' fractured rock	13	126.0 to 142.9' **BEDFORD SHALE**, grey with red bands, very fine grained, moderately weathered, soft, thinly bedded	
882	128				128.8' 0-5°, B, R4, O, Pl			
880	130				130.1' 0-5°, B, R5, t, Pl			Run-14 130.5' - 140.5' 25 minute run Down Pressure = 400 Psi
878	132				131.7' 0-5°, B, R5, PtO-t, Pl 132.0' 0-5°, B, R4-R5, O, Pl 132.3' 0-5°, B, R4, O, Pl			
876	134				132.4' 0-5°, B, R5, PtO-t, Pl 133.0' 0-5°, B, R5, t, Pl 133.8' 0-5°, B, R4-R5, O, Pl			
874	136	82	99	1.6	135.1' 0-5°, B, R4-R5, O, Pl 136.4' 0-5°, B, R5, t, Pl	14		
872	138				137.0' 0-5°, B, R5, PtO-t, Pl 137.8' 0-5°, B, R4-R5, O, Pl 138.0' 0-5°, B, R5, t, Pl			
870	140				139.1' 0-5°, B, R4-R5, O, Pl 139.4' 0-5°, B, R4-R5, O, Pl 139.7' 0-5°, B, R5, t, Pl			
868	142				139.8' 0-5°, B, R5, PtO-t, Pl 139.9' 0-5°, B, R4-R5, O, Pl 141.7' 0-5°, B, R4, O, Pl			Run-15 140.5' - 150.5' 30 minute run Down Pressure = 400 Psi
866	144				142.0' 0-5°, B, R5, t, Pl 142.2' 0-5°, B, R5, PtO-t, Pl 142.4' 0-5°, B, R4-R5, O, Pl 143.0' 0-5°, B, R4, O, Pl 143.5' 0-5°, B, R5, PtO-t, Pl 144.0' 0-5°, B, R4-R5, O, Pl		142.9 to 156.1' **BEDFORD SHALE** grey with red bands, very fine grained, slightly weathered, soft, thinly bedded	
864	146	91	100	1.2	145.4' 0-5°, B, R4, O, Pl	15		
862	148				147.4' 0-5°, B, R5, PtO-t, Pl 147.8' 0-5°, B, R5, t, Pl			
860	150				148.8' 0-5°, B, R4-R5, O, Pl 149.9' 0-5°, B, R4-R5, O, Pl			
858	152				150.9' 0-5°, B, R5, t, Pl 151.9' 0-5°, B, R5, PtO-t, Pl 152.3' 0-5°, B, R4-R5, O, Pl			Run-16 150.5' - 160.5' 33 minute run Down Pressure = 400 Psi
856	154				154.2' 0-5°, B, R4, O, Pl			
854	156	86	100	1.2	154.4' 0-5°, B, R5, PtO-t, Pl 154.6' 0-5°, B, R4-R5, O, Pl 155.0' 0-5°, B, R4, O, Pl 155.6' 0-5°, B, R5, PtO-t, Pl	16		
852	158				157.3' 0-5°, B, R5, t, Pl		156.1 to 170.5' **OHIO SHALE** black, very fine grained, unweathered, moderately hard, thinly bedded, unfractured, flat	
850					158.6' 0-5°, B, R4-R5, O, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-33	
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM	Sheet No. 5 of 6	
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
848	162				159.8' 0-5°, B, R4-R5, O, Pl 160.3' 0-5°, B, R5, t, Pl 160.6' 0-5°, B, R5, PtO-t, Pl 161.1' 0-5°, B, R4-R5, O, Pl			Run-17 160.5' - 170.5' 22 minute run Down Pressure = 450 - 500 Psi
846	164				162.3' 0-5°, B, R4-R5, O, Pl 162.4' 0-5°, B, R5, t, Pl 163.0' 0-5°, B, R5, PtO-t, Pl 164.0' 0-5°, B, R4-R5, O, Pl			
844	166	91	100	1.2	164.6' 0-5°, B, R4, O, Pl 165.0' 0-5°, B, R5, t, Pl 165.5' 0-5°, B, R5, PtO-t, Pl 166.0' 0-5°, B, R4-R5, O, Pl	17		
842	168				167.0' 0-5°, B, R4, O, Pl 167.6' 0-5°, B, R5, PtO-t, Pl			
840	170							
838	172						170.5 to 213.5' **OHIO SHALE** black, very fine grained, unweathered, moderately hard, thinly bedded, unfractured, flat	Run-18 170.5' - 180.5' 20 minute run Down Pressure = 450 - 500 Psi
836	174				172.4' 0-5°, B, R4-R5, O, Pl 172.6' 0-5°, B, R4, O, Pl 172.9' 0-5°, B, R5, PtO-t, Pl 173.7' 0-5°, B, R5, t, Pl			
834	176	91	99	1	174.6' 0-5°, B, R4-R5, O, Pl 174.7' 0-5°, B, R5, t, Pl 175.0' 0-5°, B, R5, PtO-t, Pl 176.4' 0-5°, B, R4-R5, O, Pl	18		
832	178				177.1' 0-5°, B, R4, O, Pl			178.8' - 179.2' UCS = 5,232 Psi
830	180				180.0' 0-5°, B, R5, PtO-t, Pl			Run-19 180.5' - 190.5' 20 minute run Down Pressure = 450 - 500 Psi
828	182				182.4' 0-5°, B, R4-R5, O, Pl 183.0' 0-5°, B, R4, O, Pl			
826	184				183.4' 0-5°, B, R5, PtO-t, Pl 184.7' 0-5°, B, R4-R5, O, Pl			
824	186	94	100	0.9	185.6' 0-5°, B, R4, O, Pl	19		
822	188				187.8' 0-5°, B, R5, PtO-t, Pl 188.0' 0-5°, B, R5, t, Pl 188.4' 0-5°, B, R4-R5, O, Pl			
820	190				189.4' 0-5°, B, R5, t, Pl			
818	192				190.4' 190.5 fractured rock			Run-20 190.5' - 200.5' 16 minute run Down Pressure = 450 - 500 Psi
816	194				193.6' 0-5°, B, R5, PtO-t, Pl			
814	196	100	100	0.1		20		
812	198							
810								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-33	
Coordinates: N 774854.5 E 1871939.8	Driller: AECOM	Sheet No. 6 of 6	
Top Drillhole Elevation: 1009.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 796.2 feet MSL	Prepared By: A. Mirza		
Total Depth: 213.5 feet	Checked By: B. Madras Natarajan	Date Start: 1/8/18 End: 1/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 9.7	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
808	202				200.8' 0-5°, B, R5, t, Pl 201.4' 0-5°, B, R4-R5, O, Pl 201.9' 0-5°, B, R5, t, Pl			Run-21 200.5' - 210.5' 15 minute run Down Pressure = 450 - 500 Psi
806	204				203.0' 0-5°, B, R5, PtO-t, Pl			
804	206	96	100	1.1	204.6' 0-5°, B, R4-R5, O, Pl 205.2' 0-5°, B, R4, O, Pl 206.2' 0-5°, B, R5, PtO-t, Pl	21		
802	208				207.4' 0-5°, B, R4-R5, O, Pl 208.0' 0-5°, B, R4, O, Pl			
800	210				209.4' 0-5°, B, R5, PtO-t, Pl			
798	212	100	100	0.3	213.3' 0-5°, B, R4-R5, O, Pl	22		Run-22 210.5' - 213.5' 10 minute run Down Pressure = 450 - 500 Psi
796	214						**End of Boring at 213.5 feet**	
794	216							
792	218							
790	220							
788	222							
786	224							
784	226							
782	228							
780	230							
778	232							
776	234							
774	236							
772	238							
770								

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770523.468 1870425.396	**DATE STARTED**	4/19/18	**COMPLETED**	4/26/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	92.4 % (Avg.)	**SURFACE ELEVATION**	982.4 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul Cichocki / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 1	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 982.4	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- AUGERED THROUGH TOP 60' AND BEGAN SAMPLING AT ELEVATION 920'		W 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24															

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.4 ft LOCATION 770523.468 1870425.396 DATE STARTED / DATE COMPLETED 4/19/18 - 4/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- AUGERED THROUGH TOP 60' AND BEGAN SAMPLING AT ELEVATION 920' *(continued)*		26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51															

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.4 ft LOCATION 770523.468 1870425.396 DATE STARTED / DATE COMPLETED 4/19/18 - 4/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- AUGERED THROUGH TOP 60' AND BEGAN SAMPLING AT ELEVATION 920' *(continued)*		52 53 54 55 56 57 58 59															
VERY DENSE, GRAY, **COARSE AND FINE SAND**, AND GRAVEL WITH STONE FRAGMENTS, TRACE SILT AND CLAY, WET - FULL SPOON FROM SOIL CAVE IN - SANDSTONE FRAGMENTS BLOCKING BOTTOM OF SPOON - GLACIAL TILL - TRACE FINE SAND - DRILLING MUD ADDED TO HELP FROM CAVE IN - WEATHERED SANDSTONE IN BOTTOM OF SPOON - MORE FINE SAND - GLACIAL TILL - SANDSTONE AND SHALE SEAMS	922.4	60	33-47-50/2.4"	100	SS-1		-	-	-	-	-	-	-	-	-		
		61 62 63	48-45-50	87	SS-2		-	-	-	-	-	-	-	-	-		
		64 65 66	27-38-50/3.6"	92	SS-3		-	-	-	-	-	-	-	-	-		
- SANDSTONE FRAGMENTS IN BOTTOM OF SPOON		67 68 69	32-52-51	93	SS-4		-	-	-	-	-	-	-	-	-		
- SANDSTONE IN BOTTOM OF SPOON - SMALLER SHALE AND SANDSTONE FRAGMENTS - MORE FINE AND COARSE SAND		70 71 72	14-35-50/2.4"	100	SS-5		-	-	-	-	-	-	-	-	-		
- SOME CLAY - STONE FRAGMENTS IN CLAY SAMPLE WITH SAND		73 74	50/4.8"	100	SS-6		-	-	-	-	-	-	-	-	-		
VERY DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, MOIST - POSSIBLY BROKE THROUGH ROCK LAYER - VERY FINE SAND AND SILT	907.4	75 76 77	76-38-50	100	SS-7		-	-	-	-	-	-	-	-	-		
		78	11-20-30	100	SS-8		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.4 ft LOCATION 770523.468 1870425.396 DATE STARTED / DATE COMPLETED 4/19/18 - 4/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
VERY DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, MOIST *(continued)*		79															
		80															
		81	14-21-47	100	SS-9		-	-	-	-	-	-	-	-	-		
		82															
- WET - SEPARATED FROM WATER WHEN TAPPED - COARSE GRAINED GRAVEL AT BOTTOM OF SPOON		83	15-24-50	100	SS-10		-	-	-	-	-	-	-	-	-		
		84															
	897.4	85	50/4.8"	100	SS-11		-	-	-	-	-	-	-	-	-		
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST TO WET		86															
		87															
		88	50/3.6"	100	SS-12		-	-	-	-	-	-	-	-	-		
		89															
- WEATHERED SANDSTONE FRAGMENTS		90	50/3.6"	100	SS-13		-	-	-	-	-	-	-	-	-		
		91															
- DIFFICULT KEEPING HOLE CLEAR EVEN WITH DRILLING MUD - SPOON COMPLETELY FILLED - GLACIAL TILL		92															
		93	50-50/1.2"	100	SS-14		-	-	-	-	-	-	-	-	-		
		94															
		95															
		96															
		97															
- ACCIDENTALLY DRILLED PAST NEXT SAMPLE ZONE - SPOON FULL OF BLOWOUT	884.9	98	50/6"	100	SS-15		-	-	-	-	-	-	-	-	-		
VERY DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE CLAY AND SILT, MOIST		99															
	882.4	100															
HARD, GRAY, **SANDY CLAY**, VERY FINE GRAINED, TRACE SILT AND GRAVEL, DAMP TO MOIST		101	28-38-44	100	SS-16	4.5+	-	-	-	-	-	-	-	-	-		
		102															
		103	25-38-50/4.8"	100	SS-17	4.5+	-	-	-	-	-	-	-	-	-		
		104															
		105															

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.4 ft LOCATION 770523.468 1870425.396 DATE STARTED / DATE COMPLETED 4/19/18 - 4/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- TRACE TO LITTLE GRAVEL - INCREASE IN SAND CONTENT AND DECREASE IN CLAY CONTENT - SANDSTOEN FRAGMENT IN BOTTOM OF SPOON HARD, GRAY, **SANDY CLAY**, VERY FINE GRAINED, TRACE SILT AND GRAVEL, DAMP TO MOIST *(continued)*		106	30-36-50/2.4"	100	SS-18	4.5+	-	-	-	-	-	-	-	-	-		
		107															
		108	18-24-50/4.8"	100	SS-19	4.5+	-	-	-	-	-	-	-	-	-		
		109															
- SHALE FRAGMENTS IN SAMPLE NEAR SHOE		110															
		111	26-38-44	100	SS-20	4.5	-	-	-	-	-	-	-	-	-		
		112															
- GLACIAL TILL	869.9	113	50/3.6"	100	SS-21	4.5+	-	-	-	-	-	-	-	-	-		
HARD, GRAY, **CLAY**, TRACE SILT, LITTLE TO SOME FINE SAND, SOME ROCK FRAGMENTS AND GRAVEL, DAMP		114															
- GLACIAL TILL		115	50/2.4"	100	SS-22	4.5	-	-	-	-	-	-	-	-	-		
		116															
		117															
- SANDSTONE FRAGMENTS NEAR TOP OF SAMPLE RECOVERY	864.9	118	30-50/3.6"	100	SS-23		-	-	-	-	-	-	-	-	-		
HARD, GRAY, **SILT**, MOIST TO WET		119															
HARD, RED AND GRAY, **SANDY CLAY**, VERY FINE GRAINED, LITTLE SANDSTONE FRAGMENTS, MOIST - POSSIBLE RESIDUAL SOIL	862.4	120	50/2.4"	100	SS-24		-	-	-	-	-	-	-	-	-		
		121															
		122															
- DECOMPOSED ROCK	859.9	123	23-50/3.6"	100	SS-25	4.5+	-	-	-	-	-	-	-	-	-		
HARD, GRAY, **CLAY**, LITTLE SILT AND STONE FRAGMENTS, MOIST		124															
HIGHLY WEATHERED TO DECOMPOSED, VERY SOFT, VERY FINE GRAINED SHALE, GRAY, THIN BEDDED, INTENSELY FRACTURED.	857.4 TR	125	50/2.4"	100	SS-26		-	-	-	-	-	-	-	-	-		
		126															
		127															
- DECOMPOSED SANDSTONE AND SHALE		128	50/2.4"	100	SS-27		-	-	-	-	-	-	-	-	-		
		129															
HIGHLY WEATHERED TO DECOMPOSED, MODERATELY HARD, FINE GRAINED, SANDSTONE, BROWN, THIN, INTENSELY FRACTURED. - SANDSTONE IN BOTTOM OF SPOON	852.4	130	50/1.2"	100	SS-28		-	-	-	-	-	-	-	-	-		
		131															

SUBSURFACE LOG

EXPLORATION ID: B-36

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.4 ft LOCATION 770523.468 1870425.396 DATE STARTED / DATE COMPLETED 4/19/18 - 4/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- ROLLER BIT REFUSAL @ 132.0' - RAN AUGERS PAST 132.0' THEN DROVE SS TO ENSURE ROCK - AUGER REFUSAL @ 133.6'	848.8	133	50/2.4"	100	SS-29		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	**BORING NO. B-36**	
Coordinates: N 770523.5 E 1870425.4	Driller: Stantec/M.M	**Sheet No. 1 of 2**	
Top Drillhole Elevation: 980.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 806.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 173.1 feet	Checked By: B. Madras Natarajan	Date Start: 4/19/18 End: 4/30/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 0	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
850								Refer to soil borings for details on soil descriptions/classifications
848	132							
846	134				133.8' 0-5°, B, R3-R4, PtO-t, Pl, Cl 134.2' to 134.9' 0-5°, 5 Jts, R3-R4, O, Pl, Cl		133.6 to 155.0' **BEDFORD SHALE**, grey, very fine grained, highly weathered, very soft to soft, highly fractured, thinly bedded, highly weathered joints	Top of Rock @ 133.6' Run-1 133.6' - 142.1' 37 minute run Down Pressure = 200 - 300 Psi
844	136				135.2' 0-5°, B, R4, t, Pl, Cl 135.4' 0-5°, B, R4-R5, O, Pl, Cl 135.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 135.6' 0-5°, B, R4, O, Pl, Cl 135.7' 0-5°, B, R3-R4, PtO-t, Pl, Cl			
842	138	74	100	4.8	135.9' 0-5°, B, R4-R5, PtO-t, Pl, Cl 136.0' 0-5°, B, R4, PtO-t, Pl, Cl 136.2' to 136.9' 0-5°, 6 Bs, R4, t, Pl, Cl 137.0' to 137.8' 0-5°, 4 Bs, R3-R4, PtO-t, Pl, Cl	1		
840	140				138.3' 0-5°, B, R4, O, Pl, Cl 138.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 138.8' 0-5°, B, R4-R5, PtO-t, Pl, Cl 139.1' 0-5°, B, R4, PtO-t, Pl, Cl 139.2' 0-5°, B, R4, t, Pl, Cl			139.6' - 140.2' Clay Covered 141.8' to 142.1' Clay Covered
838	142				139.8' 0-5°, B, R3-R4, O, Pl, Cl 140.1' to 140.9' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl 141.0' to 142.3' 0-5°, 6 Bs, R4-R5, PtO-t, Pl, Cl			Run-2 142.1' - 147.1' 16 minute run Down Pressure = 300 Psi 145.5' to 146.1' Clay Covered
836	144	28	98	4.0	142.5' 0-5°, B, R4, t, Pl, Cl 142.7' to 142.9' 0-5°, 3 Bs, R3-R4, O, Pl, Cl 143.2' 0-5°, B, R4, t, Pl, Cl 143.4' 0-5°, B, R4, O, Pl, Cl 143.6' to 143.9' fracture rock	2		
834	146				144.2' to 144.8' 0-5°, 4 Bs, R3-R4, O, Pl, Cl 145.0' to 145.5' 0-5°, 4 Bs, R4-R5, PtO-t, Pl, Cl 146.0' 0-5°, B, R3-R4, O, Pl, Cl 146.1' to 147.2' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl			Run-3 147.1' - 157.1' 18 minute run Down Pressure = 300 to 400 Psi
832	148				148.0' to 148.6' 0-5°, 4 Bs, R4, t, Pl, Cl 149.3' to 149.9' fractured rock 149.7' 0-5°, B, R4-R5, PtO-t, Pl, Cl			
830	150				150.0' to 150.7' 0-5°, 5 Bs, R4-R5, PtO-t, Pl, Cl 151.0' to 151.5' fractured rock 151.9' 0-5°, B, R4-R5, PtO-t, Pl, Cl 152.1' 0-5°, B, R4, t, Pl, Cl			
828	152	50	93	3.2	152.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl 152.6' 0-5°, B, R4, t, Pl, Cl 153.0' 0-5°, B, R4-R5, PtO-t, Pl, Cl 153.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 154.0' 0-5°, B, R4, t, Pl, Cl	3		
826	154				154.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl 154.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 155.1' 0-5°, B, R4, t, Pl, Cl		155.0 to 173.1' **OHIO SHALE**, black, very fine grained, moderately weathered, moderately hard, thinly bedded, moderately highly weathered joints	
824	156				155.5' 0-5°, B, R4-R5, PtO-t, Pl, Cl 155.7' 0-5°, B, R4, t, Pl, Cl 156.2' 0-5°, B, R4-R5, PtO-t, Pl, Cl 157.3' to 158.1' 0-5°, 4 Bs, R4, t, Pl, Cl 159.0' 0-5°, B, R4-R5, PtO-t, Pl			Run-4 157.1' - 167.1' 11 minute run Down Pressure = 350 Psi
822	158				159.2' 0-5°, B, R4, t, Pl 159.5' 0-5°, B, R4-R5, PtO-t, Pl 159.9' 0-5°, B, R4-R5, PtO-t, Pl 160.2' 0-5°, B, R4, t, Pl 160.3' 0-5°, B, R4, PtO-t, Pl			
820	160				160.5' 0-5°, B, R4-R5, PtO-t, Pl 161.0' to 161.9' 0-5°, 4 Bs, R4, t, Pl 162.2' 0-5°, B, R4-R5, PtO-t, Pl 162.5' to 162.7' fractured rock 162.9' 0-5°, B, R4, PtO-t, Pl			
818	162	55	97	3.3	163.1' to 163.5' 0-5°, 4 Bs, R4-R5, PtO-t, Pl 164.0' 0-5°, B, R4, t, Pl 164.3' 0-5°, B, R4-R5, PtO-t, Pl 164.7' 0-5°, B, R4, t, Pl 164.9' 0-5°, B, R4, PtO-t, Pl	4		
816	164				165.3' 0-5°, B, R4-R5, PtO-t, Pl 165.8' 0-5°, B, R4, t, Pl 167.8' 0-5°, B, R4-R5, PtO-t, Pl 167.9' 0-5°, B, R4, t, Pl			
814	166							
812	168	62	100	3.3	168.2' to 168.9' 0-5°, 5 Bs, R4-R5, PtO-t, Pl	5		Run-5 167.1' - 173.1' 6 minute run Down Pressure = 400 - 450 Psi

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	**BORING NO. B-36**	
Coordinates: N 770523.5 E 1870425.4	Driller: Stantec/M.M	**Sheet No. 2 of 2**	
Top Drillhole Elevation: 980.0 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 806.9 feet MSL	Prepared By: A. Mirza		
Total Depth: 173.1 feet	Checked By: B. Madras Natarajan	Date Start: 4/19/18 End: 4/30/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 0	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
810								
808	172	62	100	3.3	169.2' to 169.8' 0-5°, 4 Bs, R4, t, Pl 170.2' to 172.7' 0-5°, 7 Bs, R4, t, Pl 172.5' to 173.1' fractured rock	5		
806	174						**End of Boring at 173.1 feet**	
804	176							
802	178							
800	180							
798	182							
796	184							
794	186							
792	188							
790	190							
788	192							
786	194							
784	196							
782	198							
780	200							
778	202							
776	204							
774	206							
772	208							

SUBSURFACE LOG EXPLORATION ID: B-38

PROJECT -BWSTE Ph 2- | DRILLING / SAMPLING TOOLS (TYPE / SIZE) 4.25" HSA SPT | LOCATION 765381.76 1867703.37 | DATE STARTED 3/26/18 | COMPLETED 4/9/18
CLIENT City of Columbus | PROJECT TYPE Geotechnical Exploration | HAMMER TYPE Auto | EFFICIENCY 89.8 % (Avg.) | SURFACE ELEVATION 972.3 ft | DEPTH TO WATER 2.5 ft | DATE/TIME 3/28/18
PID NUMBER | PROJECT LOCATION | DRILLING / SAMPLING TOOLS (TYPE / SIZE) HQ | ELEVATION DATUM MSL | DEPTH TO WATER N/A | DATE/TIME N/A
PROJECT NUMBER 173409058 | INSPECTOR Paul / Stantec | DRILLING CONTRACTOR Stantec / M.M | DRILL RIG TYPE AND ID CME 55 Track 2 | BOREHOLE INCLINATION (VERT.) Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 972.27	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
STIFF, BROWN MOTTLED GRAY, **SANDY CLAY**, DAMP		1	3-4-6	100	SS-1	2.0	-	-	-	-	-	-	-	-	-		
		2															
		3	3-4-6	100	SS-2	0.5	-	-	-	-	-	-	-	-	-		
		4															
	967.3	5															
STIFF TO VERY STIFF, BROWN MOTTLED GRAY, **CLAY**, LITTLE GRAVEL, TRACE SILT, TRACE VERY FINE GRAINED SAND, DAMP		6	5-7-9	100	SS-3	3.5	-	-	-	-	-	-	-	-	-		
	W	7															
		8	4-5-5	100	SS-4	1.75	8	10	20	62	-	21	14	7	12	CL	
		9															
		10															
		11	5-7-9	100	SS-5	2.5	-	-	-	-	-	-	-	-	-		
		12															
		13	7-12-14	100	SS-6	4.5+	27	8	16	49	-	23	15	8	11	CL	
		14															
		15															
		16	17-18-20	100	SS-7	4.5+	-	-	-	-	-	-	-	-	-		
		17															
		18	24-24-28	93	SS-8	4.5+	-	-	-	-	-	-	-	-	-		
		19															
	952.3	20															
DENSE TO VERY DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET		21	7-9-27	87	SS-9		-	-	-	-	-	-	-	-	-		
		22															
		23	25-26-38	87	SS-10		48	18	15	14	5	-	-	-	10		
		24															

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG EXPLORATION ID: B-38

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 972.3 ft LOCATION 765381.76 1867703.37 DATE STARTED / DATE COMPLETED 3/26/18 - 4/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
DENSE TO VERY DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET *(continued)*		26	27-50/1.2"	83	SS-11		-	-	-	-	-	-	-	-	-		
		27															
		28	28-37-50	100	SS-12		-	-	-	-	-	-	-	-	-		
		29															
		30															
		31	13-30-31	93	SS-13		54	21	13	8	4	-	-	-	12		
		32															
		33	26-42-43	73	SS-14		-	-	-	-	-	-	-	-	-		
		34															
	937.3	35															
VERY DENSE, GRAY, **SILTY SAND**, VERY FINE GRAINED, TRACE STONE FRAGMENTS, WET		36	10-20-34	100	SS-15		0	1	56	32	11	-	-	-	19		
		37															
		38	14-31-39	100	SS-16		31	3	6	50	10	-	-	-	17		
		39															
		40															
-SANDSTONE FRAGMENTS IN SHOE	931.3	TR 41	45-32-50/4.8"	29	SS-17		-	-	-	-	-	-	-	-	-		
HIGHLY WEATHERED, MODERATELY HARD TO HARD, FINE GRAINED, SANDSTONE, BROWN, FERRIFEROUS, THIN BEDDED, HIGHLY FRACTURED, FLAT, HIGHLY WEATHERED JOINTS.		42															
	928.8	43															

Boring Continues on Following Rock Description Log

NOTES: BORING SCOPED, CAMERA FOOTAGE FOUND CDF WAS LOCATED BETWEEN 149.0' TO 158.0' WITH A VOID FROM 157.3' TO 158.5', WELL - SCREENED FROM 20.0' TO 40.0' (SEE WELL ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; SAND

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-38**
Coordinates:	N 765380.6 E 1867702.9	Driller:	Stantec/ M.M	**Sheet No. 1 of 4**
Top Drillhole Elevation:	972.4 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	795.6 feet MSL	Prepared By:	A. Mirza	
Total Depth:	176.8 feet	Checked By:	B. Madras Natarajan	Date Start: 3/26/18 End: 4/9/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 2.5

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
932								Refer to soil borings for details on soil descriptions/classifications
930	42							
928	44			1.2	43.5' to 44.2' fractured rock	1	43.5 to 51.8' Interbedded **BEREA SANDSTONE** and **BEDFORD SHALE** **BEREA SANDSTONE**, brown, fine grained, highly weathered, moderately hard to hard, ferriferous, thinly bedded, highly fractured, flat, highly weathered joints **BEDFORD SHALE**, grey, very fine grained, highly weathered to decomposed, soft to very soft, thinly bedded, highly fractured, decomposed joints	Top of Rock @43.5' Run-1 43.5' - 51.8' 32 minute run Down Pressure = 250 Psi
926	46				44.5' 0-5°, B, R4-R5, O, Pl, Cl 45.1' 0-5°, B, R5, O, Pl, Cl 45.5' 0-5°, B, R4, t, Pl, Cl 45.8' 0-5°, B, R5, O, Pl, Cl 46.2' 0-5°, B, R4, O, Pl, Cl 46.4' 0-5°, B, R4-R5, O, Pl, Cl			
924	48	0	31					
922	50							
920	52			N/A	52.0' to 53.3' fractured rock	2	51.8 to 71.8' **BEDOFORD SHALE**, grey, very fine grained, highly weathered to decomposed, soft to very soft, thinly bedded, highly fractured, decomposed joints.	Run-2 51.8' - 56.8' 14 minute run Down Pressure = 350 Psi
918	54	0	30					
916	56							
914	58	28	64	N/A	56.8' to 57' fractured rock 57.4' 0-5°, B, R4-R5, O, Pl, Cl 58.1' 0-5°, B, R4, O, Pl, Cl 58.3' 0-5°, B, R4-R5, O, Pl, Cl 58.6' 0-5°, B, R5, O, Pl, Cl 59.0' 0-5°, B, R5, O, Pl, Cl 59.6' 0-5°, B, R4, t, Pl, Cl 60.2' 0-5°, B, R5, O, Pl, Cl	3		Run-3 56.8' - 61.8' 8 minute run Down Pressure = 100-250 Psi
912	60							
910	62			N/A	61.8' to 63.8' fractured rock	4		Run-4 61.8' - 66.8' 14 minute run Down Pressure = 400 Psi
908	64	0	50		64.0' to 64.2' fractured rock			
906	66							
904	68	26	48	N/A	66.8' 67.7' fractured rock	5		Run-5 66.8' - 71.8' 27 minute run Down Pressure = 450 Psi
902	70							
900	72			1.6	72.7' 0-5°, B, R4, t, Pl, Cl 72.9' 0-5°, B, R5, O, Pl 73.0' 0-5°, B, R4, t, Pl, Cl 73.1' 0-5°, B, R5, O, Pl, Cl 73.2' to 73.4' fractured rock 73.5' 0-5°, B, R5, t, Pl 73.7' 0-5°, B, R4-R5, O, Pl 74.0' 0-5°, B, R5, t, Pl 75.5' 0-5°, B, R4-R5, O, Pl	6	71.8 to 81.8' **BEDFORD SHALE**, grey, very fine grained, moderately to highly weathered, soft to moderately hard, thinly bedded, highly to moderately fractured	Run-6 71.8' - 76.8' 36 minute run Down Pressure = 500 Psi Drill Bit blocked - switched mid-run
898	74	36	60					
896	76							
894	78	26	26	N/A	77.0' 0-5°, B, R5, PtO-t, Pl 77.2' 0-5°, B, R4-R5, PtO-t, Pl 77.5' 0-5°, B, R4, t, Pl 78.0' to 78.4' fractured rock	7		Run-7 76.8' - 81.8' 20 minute run Down Pressure = 400 Psi

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-38**	
Coordinates: N 765380.6 E 1867702.9	Driller: Stantec/ M.M	**Sheet No. 2 of 4**	
Top Drillhole Elevation: 972.4 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 795.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 176.8 feet	Checked By: B. Madras Natarajan	Date Start: 3/26/18 End: 4/9/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 2.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
892		26	26	N/A		7		
890	82				81.8' to 82.0' fractured rock 82.2' 0-5°, B, R4-R5, O, Pl 82.4' 0-5°, B, R5, PtO-t, Pl 82.7' 0-5°, B, R4, t, Pl		81.8 to 96.8' **BEDFORD SHALE**, grey, very fine grained, highly weathered to decomposed, soft to very soft, thinly bedded, highly fractured, decomposed joints.	Run-8 81.8' - 86.8' 19 minute run Down Pressure = 400 Psi Possible loss between 81.8' to 82.5'
888	84	8	86	2.2	82.8' 0-5°, B, R5, PtO-t, Pl 83.1' 0-5°, B, R4, O, Pl 83.5' 0-5°, B, R4, O, Pl 84.1' 0-5°, B, R5, PtO-t, Pl 84.4' 0-5°, B, R4-R5, O, Pl 84.6' 0-5°, B, R5, PtO-t, Pl 84.9' 0-5°, B, R4, t, Pl	8		
886	86							
884	88				85.2' 0-5°, B, R5, PtO-t, Pl 87.0' 0-5°, B, R4, O, Pl 87.4' 0-5°, B, R5, PtO-t, Pl 87.7' 0-5°, B, R5, PtO-t, Pl 87.9' 0-5°, B, R4-R5, O, Pl			Run-9 86.8' - 91.8' 30 minute run Down Pressure = 250 Psi
882	90	18	60	1.8	88.1' 0-5°, B, R5, PtO-t, Pl 88.4' 0-5°, B, R4, t, Pl 88.5' 0-5°, B, R5, PtO-t, Pl 89.2' 0-5°, B, R4, O, Pl 89.7' 0-5°, B, R5, PtO-t, Pl	9		
880	92				92.0' 0-5°, B, R4-R5, O, Pl			Run-10 91.8' - 96.8' 20 minute run Down Pressure = 250 Psi
878	94	40	60	1	94.0' 0-5°, B, R5, t, Pl 94.1' 0-5°, B, R4-R5, t, Pl 94.3' 0-5°, B, R5, O, Pl 94.5' 0-5°, B, R4, O, Pl	10		
876	96							
874	98				96.8' to 97.8' fractured rock 97.8' to 99.8' 0-5°, 9 Bs, R4-R5, O, Pl		96.8 to 106.8' Interbedded red and grey **BEDFORD SHALE**	Run-11 96.8' - 106.8' 32 minute run Down Pressure = 400 Psi
872	100				100.0' to 100.3' fractured roc 100.5' 0-5°, B, R5, PtO-t, Pl 100.7' 0-5°, B, R4-R5, O, Pl			
870	102	46	88	2.4	100.9' 0-5°, B, R5, PtO-t, Pl 101.1' 0-5°, B, R4, t, Pl 101.3' 0-5°, B, R5, PtO-t, Pl 101.5' 0-5°, B, R4, O, Pl 102.0' 0-5°, B, R5, PtO-t, Pl 102.3' 0-5°, B, R4-R5, O, Pl	11		
868	104				103.4' 0-5°, B, R5, t, Pl 103.6' 0-5°, B, R4-R5, O, Pl 105.0' 0-5°, B, R4-R5, O, Pl 105.5' 0-5°, B, R5, PtO-t, Pl 105.7' 0-5°, B, R4, t, Pl 106.0' 0-5°, B, R4, t, Pl			
866	106							
864	108				106.5' 0-5°, B, R4-R5, PtO-t, Pl 107.0' 0-5°, B, R4, O, Pl		106.8 to 126.8' **BEDOFRD SHALE**, red, very fine grained, slightly to moderately weathered, moderately hard, thinly bedded, slightly to moderately fractured, flat, slightly weathered joints	Run-12 106.8' - 116.8' 21 minute run Down Pressure = 375 Psi Possible loss in fractured zone
862	110				109.1' 0-5°, B, R5, PtO-t, Pl 109.5' 0-5°, B, R4-R5, t, Pl 109.8' 0-5°, B, R4-R5, O, Pl 110.2' 40°, Jt, R3-R4, O, Und 110.6' 30°, Jt, R4-R5, O, Und			
860	112	84	94	1.2	111.0' 0-5°, B, R5, PtO-t, Pl	12		
858	114				114.1' 0-5°, B, R4, O, Pl 114.3' 0-5°, B, R4, t, Pl			
856	116				115.4' 0-5°, B, R4-R5, O, Pl 115.6' 0-5°, B, R5, PtO-t, Pl 115.8' 0-5°, B, R4-R5, O, Pl			
854	118	7	64	1.6	116.8' to 117.5' fractured rock 117.8' 0-5°, B, R5, PtO-t, Pl 118.2' 0-5°, B, R4-R5, O, Pl 118.5' 0-5°, B, R5, PtO-t, Pl 118.8' 0-5°, B, R4, t, Pl	13		Run-13 116.8' - 126.8' 32 minute run Down Pressure = 400 Psi

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Track 2	**BORING NO. B-38**
Coordinates:	N 765380.6 E 1867702.9	Driller:	Stantec/ M.M	**Sheet No. 3 of 4**
Top Drillhole Elevation:	972.4 feet MSL	Logged By:	Paul Cichocki/Stantec	
Bottom Elevation:	795.6 feet MSL	Prepared By:	A. Mirza	
Total Depth:	176.8 feet	Checked By:	B. Madras Natarajan	Date Start: 3/26/18 End: 4/9/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 2.5

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
852					119.2' 0-5°, B, R5, PtO-t, Pl 119.4' 0-5°, B, R4, O, Pl 119.6' 0-5°, B, R5, PtO-t, Pl 119.8' 0-5°, B, R4-R5, O, Pl 120.0' 0-5°, B, R4, t, Pl 120.2' 0-5°, B, R5, PtO-t, Pl 120.6' 0-5°, B, R4, O, Pl 120.7' 0-5°, B, R4, O, Pl 121.0' to 121.5' fractured rock 121.8' 0-5°, B, R4, O, Pl 122.0' 0-5°, B, R4, t, Pl 122.5' 0-5°, B, R4-R5, O, Pl 122.8' 0-5°, B, R5, PtO-t, Pl			
850	122							
848	124	7	64	1.6		13		
846	126							
844	128				126.8' to 127.6' 0-5°, 8 Bs, R3-R4, O, Pl 128.0' 0-5°, B, R4-R5, O, Pl 128.3' 0-5°, B, R5, t, Pl 128.7' 0-5°, B, R4-R5, O, Pl 129.3' 0-5°, B, R5, PtO-t, Pl 129.6' 0-5°, B, R4-R5, O, Pl 129.8' 0-5°, B, R5, PtO-t, Pl 130.0' 0-5°, B, R4, O, Pl 130.2' 0-5°, B, R5, PtO-t, Pl 130.4' 0-5°, B, R4, O, Pl 130.8' 0-5°, B, R5, PtO-t, Pl 131.0' 0-5°, B, R4-R5, O, Pl 131.3' 0-5°, B, R5, t, Pl 131.9' 132.3' 0-5°, 5 Bs, R4, O, Pl 132.6' 0-5°, B, R4-R5, O, Pl 132.9' 0-5°, B, R5, PtO-t, Pl 133.3' 0-5°, B, R4, O, Pl 133.8' to 134.4' 0-5°, 9 Bs, R4-R5, O, Pl 135.1' 0-5°, B, R5, t, Pl 135.3' 0-5°, B, R4-R5, O, Pl	14	126.8 to 149.0' **BEDFORD SHALE**, grey, very fine grained, moderately weathered, moderately hard, thinly bedded, moderately to highly fractured, moderately to highly weathered joints.	Run-14 126.8' - 136.8' 32 minute run Down Pressure = 400 Psi
842	130							
840	132	29	93	4.5				
838	134							
836	136							
834	138				135.4' 0-5°, B, R5, t, Pl 135.5' 0-5°, B, R5, PtO-t, Pl 135.6' 0-5°, B, R4-R5, t, Pl 135.8' 0-5°, B, R5, PtO-t, Pl 136.2' 0-5°, B, R5, t, Pl 137.3' 0-5°, B, R5, PtO-t, Pl 137.5' to 138.5' 0-5°, 8 Bs, R4-R5, PtO-t, Pl 138.7' 0-5°, B, R4, O, Pl 139.3' 0-5°, B, R3-R4, O, Pl 139.5' 140.0' 0-5°, 7 Bs, R4-R5, O, Pl 140.3' 0-5°, B, R5, PtO-t, Pl 140.5' 0-5°, B, R5, t, Pl 140.8' 0-5°, B, R4-R5, O, Pl 141.1' 0-5°, B, R4-R5, O, Pl 141.3' 0-5°, B, R5, PtO-t, Pl 141.7' 0-5°, B, R4, O, Pl 142.1' 0-5°, B, R3-R4, O, Pl 142.2' 0-5°, B, R5, t, Pl 142.4' 0-5°, B, R4, t, Pl 142.7' 0-5°, B, R5, PtO-t, Pl 142.9' 0-5°, B, R4-R5, O, Pl 143.3' 0-5°, B, R5, PtO-t, Pl			Run-15 136.8' - 146.8' 29 minute run Down Pressure = 400 Psi slipped rock (1.3') from Run 15 recovered in Run 16
832	140							
830	142	30	87	4.4		15		
828	144							
826	146							
824	148				143.8' 0-5°, B, R4, O, Pl 144.0' 0-5°, B, R5, PtO-t, Pl 144.1' 0-5°, B, R4-R5, O, Pl 144.2' 0-5°, B, R5, PtO-t, Pl 144.4' 0-5°, B, R4, O, Pl 144.6' 0-5°, B, R5, O, Pl 145.0' to 145.6' 0-5°, 8 Bs, R4, O, Pl 146.2' 0-5°, B, R4-R5, O, Pl 147.2' 0-5°, B, R5, PtO-t, Pl 147.9' 0-5°, B, R4, O, Pl 148.4' 0-5°, B, R4, O, Pl 148.6' to 149.0' 0-5°, 4 Bs, R4, O, Pl 149.0' to 152.7' void encountered			Run-16 146.8' - 156.8' 19 minute run Down Pressure = 400 Psi washed out material from 152.7' to 156.8' Gas meter set off with high comb levels and low O2 pushed core barrel 2.0' into CDF
822	150						149.0 to 158.0' CDF encountered in boring from 149.0' to 158.0'	
820	152	28	38	N/A		16		
818	154							
816	156							
814	158	24	88	5.4	156.8' to 158.0' washed (out of CDF) 158.0' to 158.5' fractured rock 158.6' 0-5°, B, R5, PtO-t, Pl 158.8' 0-5°, B, R4-R5, PtO-t, Pl 158.9' 0-5°, B, R4-R5, O, Pl	17	158.0 to 176.8' **OHIO SHALE**, Black, very fine grained, slightly weathered, moderately hard, very thinly bedded, slightly to highly fractured, slightly	Run-17 156.8' - 166.8' 25 minute run Down Pressure = 50-400 Psi control density fill (CDF) from 158.0' - 158.8' water continued out of augers slowing down after 5 minutes of run

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-38**	
Coordinates: N 765380.6 E 1867702.9	Driller: Stantec/ M.M	**Sheet No. 4 of 4**	
Top Drillhole Elevation: 972.4 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 795.6 feet MSL	Prepared By: A. Mirza		
Total Depth: 176.8 feet	Checked By: B. Madras Natarajan	Date Start: 3/26/18 End: 4/9/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 2.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
812					159.2' 0-5°, B, R5, PtO-t, Pl 159.4' 0-5°, B, R4-R5, O, Pl 159.5' 0-5°, B, R5, PtO-t, Pl 159.6' 0-5°, B, R4, t, Pl 160.0' 0-5°, B, R5, PtO-t, Pl 160.9' 0-5°, B, R4, O, Pl 161.3' 0-5°, B, R5, PtO-t, Pl 161.7' 0-5°, B, R4-R5, O, Pl 162.5' to 163.4' 0-5°, 12 Bs, R4-R5, O, Pl 162.7' to 163.5' 0-5°, 11 Bs, R4-R5, O, Pl 163.1' 0-5°, B, R4, O, Pl 163.2' 0-5°, B, R5, PtO-t, Pl 163.4' 0-5°, B, R4-R5, O, Pl 163.6' 0-5°, B, R5, t, Pl 163.9' 0-5°, B, R4-R5, O, Pl		weathered joints	completion
810	162							
808	164	24	88	5.4		17		
806	166							
804	168				164.0' 0-5°, B, R4, O, Pl 164.1' 0-5°, B, R5, t, Pl 164.2' 0-5°, B, R4, O, Pl 164.3' 0-5°, B, R5, t, Pl 164.5' 165.3' 0-5°, 11 Bs, R4-R5, O, Pl 167.0' 0-5°, B, R5, PtO-t, Pl 169.3' 0-5°, B, R4, O, Pl			Run-18 166.8' - 176.8' 30 minute run Down Pressure = 350 Psi
802	170							
800	172	82	90	1.2	171.6' 0-5°, B, R5, PtO-t, Pl 171.9' 0-5°, B, R4-R5, O, Pl 172.7' 0-5°, B, R5, t, Pl 172.8' 0-5°, B, R4-R5, O, Pl 173.0' 0-5°, B, R4-R5, O, Pl 173.8' 0-5°, B, R5, t, Pl 174.0' 0-5°, B, R4, O, Pl 175.3' 0-5°, B, R5, PtO-t, Pl 175.5' 0-5°, B, R4-R5, O, Pl 175.8' 0-5°, B, R5, O, Pl	18		
798	174							
796	176							
794	178						**End of Boring at 176.8 feet**	
792	180							
790	182							
788	184							
786	186							
784	188							
782	190							
780	192							
778	194							
776	196							
774	198							

Stantec

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SUBSURFACE LOG EXPLORATION ID: B-39

PROJECT -BWSTE Ph 2- | DRILLING / SAMPLING TOOLS (TYPE / SIZE) Mud Rotary SPT | LOCATION 770630.79 1870523.76 | DATE STARTED 4/11/18 | COMPLETED 4/18/18
CLIENT City of Columbus | PROJECT TYPE Geotechnical Exploration | HAMMER TYPE Auto | EFFICIENCY 90.2 % (Avg.) | SURFACE ELEVATION 984.3 ft | DEPTH TO WATER 8.4 ft | DATE/TIME 4/19/18
PID NUMBER | PROJECT LOCATION | DRILLING / SAMPLING TOOLS (TYPE / SIZE) HQ | ELEVATION DATUM MSL | DEPTH TO WATER N/A | DATE/TIME N/A
PROJECT NUMBER 173409058 | INSPECTOR John Ristow / AECOM | DRILLING CONTRACTOR Rii / S.P | DRILL RIG TYPE AND ID CME 45 Truck \00 | BOREHOLE INCLINATION (VERT.) Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 984.26	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY STIFF, LIGHT BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST		1–3	3-5-6	56	SS-1	3.25 - 3.75	-	-	-	-	-	-	-	-	-		
HARD, LIGHT BROWN, **SILTY CLAY**, WITH SAND, SOME GRAVEL, MOIST	980.8	4–5	5-8-10	67	SS-2	4.0 - 4.25	-	-	-	-	-	-	-	-	-		
		6–7	5-15-16	39	SS-3	4.0	-	-	-	-	-	-	-	-	-		
	W	8															
VERY STIFF, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST	975.3	9–10	5-10-12	72	SS-4	3.25 - 3.5	-	-	-	-	-	-	-	-	-		
		12–13	2-4-6	78	SS-5	3.25 - 3.75	11	11	13	35	30	25	16	9	13	CL	
MEDIUM DENSE, GRAY, **FINE SAND**, POORLY GRADED, SOME GRAVEL, WET	969.2	15–16	3-4-21	56	SS-6	3.25	-	-	-	-	-	-	-	-	-		
		17–18	17-25-17	67	SS-7		18	20	44	12	6	-	-	-	14		
	963.8	20–21	15-14-18	72	SS-8		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **SILT**, WET	962.3	22–23	16-18-26	67	SS-9		9	14	35	34	8	-	-	-	13		
MEDIUM DENSE, GRAY, **FINE SAND**, SOME SILT AND GRAVEL, WET	959.8	24															

STANTEC BORING SUBSURFACE LOG_BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ_OH DOT.GDT 8/2/19

Printed on 8/2/19

SUBSURFACE LOG EXPLORATION ID: B-39

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.3 ft LOCATION 770630.79 1870523.76 DATE STARTED / DATE COMPLETED 4/11/18 - 4/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET *(continued)*		26	10-18-17	67	SS-10		-	-	-	-	-	-	-	-	-		
		27															
		28	13-20-23	67	SS-11		58	12	8	15	7	-	-	-	8		
		29															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, POORLY GRADED, SANDSTONE FRAGMENTS, WET	954.8	30	8-18-25	50	SS-12		-	-	-	-	-	-	-	-	-		
		31															
HARD, GRAY, **SILTY CLAY**, WITH ROCK FRAGMENTS AND GRAVEL, MOIST	952.3	32															
		33	24-40-49	72	SS-13		38	19	13	21	9	NP	NP	NP	8	CL	
		34															
		35	10-19-26	44	SS-14		-	-	-	-	-	-	-	-	-		
		36															
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, SANDSTONE FRAGMENTS, WET	947.3	37															
		38	40-27-38	78	SS-15		-	-	-	-	-	-	-	-	-		
		39															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, POORLY GRADED, MEDIUM TO FINE GRAINED, WET	944.8	40	9-12-15	67	SS-16		-	-	-	-	-	-	-	-	-		
		41															
		42															
		43	4-10-16	72	SS-17		-	-	-	-	-	-	-	-	-		
		44															
		45	14-23-22	78	SS-18		39	22	23	10	6	-	-	-	12		
		46															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, POORLY GRADED, MEDIUM TO FINE GRAINED, WET	937.3	47															
		48	9-14-19	72	SS-19		-	-	-	-	-	-	-	-	-		
		49															
		50	15-19-23	72	SS-20		-	-	-	-	-	-	-	-	-		
		51															

SUBSURFACE LOG EXPLORATION ID: B-39

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.3 ft LOCATION 770630.79 1870523.76 DATE STARTED / DATE COMPLETED 4/11/18 - 4/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, POORLY GRADED, MEDIUM TO FINE GRAINED, WET *(continued)*		52															
		53	13-16-17	67	SS-21		-	-	-	-	-	-	-	-	-		
		54															
	929.8	55	13-17-21	67	SS-22		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **SILT**, WET		56															
		57															
		58	6-13-14	78	SS-23		0	0	13	76	11	-	-	-	23		
		59															
		60	9-15-20	83	SS-24		-	-	-	-	-	-	-	-	-		
		61															
	922.3	62															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, MEDIUM TO COARSE GRAINED, SANDSTONE AND LIMESTONE FRAGMENTS, WET		63	17-25-21	72	SS-25		-	-	-	-	-	-	-	-	-		
		64															
		65	13-30-21	56	SS-26		-	-	-	-	-	-	-	-	-		
		66															
		67															
		68	14-33-29	67	SS-27		-	-	-	-	-	-	-	-	-		
		69															
		70	26-28-35	72	SS-28		45	21	13	14	7	-	-	-	12		
		71															
		72															
		73	4-21-23	67	SS-29		-	-	-	-	-	-	-	-	-		
		74															
		75	18-24-29	33	SS-30		-	-	-	-	-	-	-	-	-		
		76															
		77															
		78	12-17-19	78	SS-31		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG EXPLORATION ID: B-39

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.3 ft LOCATION 770630.79 1870523.76 DATE STARTED / DATE COMPLETED 4/11/18 - 4/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, MEDIUM TO COARSE GRAINED, SANDSTONE AND LIMESTONE FRAGMENTS, WET *(continued)*		79															
		80	10-15-18	61	SS-32		-	-	-	-	-	-	-	-	-		
		81															
		82															
		83	11-21-25	72	SS-33		-	-	-	-	-	-	-	-	-		
		84															
		85	17-18-19	67	SS-34		-	-	-	-	-	-	-	-	-		
		86															
		87															
		88	11-23-19	72	SS-35		-	-	-	-	-	-	-	-	-		
		89															
	894.8																
LOOSE, GRAY, **SILT**, WET	894.2	90	6-15-24	78	SS-36		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, MEDIUM TO COARSE GRAINED, WET		91															
		92															
		93	14-19-13	72	SS-37		-	-	-	-	-	-	-	-	-		
		94															
	889.8																
MEDIUM DENSE, GRAY, **SILT**, WET		95	8-16-21	67	SS-38		-	-	-	-	-	-	-	-	-		
		96															
	887.3	97															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, MEDIUM TO COARSE GRAINED, WET		98	14-21-19	72	SS-39		-	-	-	-	-	-	-	-	-		
		99															
		100	14-13-23	78	SS-40		-	-	-	-	-	-	-	-	-		
		101															
	882.3	102															
MEDIUM DENSE, GRAY, **SILT**, WET		103	10-20-21	78	SS-41		0	0	25	63	12	-	-	-	18		
		104															
	879.8	105															

SUBSURFACE LOG EXPLORATION ID: B-39

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 984.3 ft LOCATION 770630.79 1870523.76 DATE STARTED / DATE COMPLETED 4/11/18 - 4/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
HARD, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST *(continued)*		106	6-16-21	72	SS-42		-	-	-	-	-	-	-	-	-		
		107															
		108	7-12-14	56	SS-43		-	-	-	-	-	-	-	-	-		
		109															
		110	11-15-45	67	SS-44		12	7	21	36	24	21	14	7	9	CL	
		111															
		112															
		113	11-24-31	50	SS-45		-	-	-	-	-	-	-	-	-		
		114															
		115	11-18-37	3	SS-46		-	-	-	-	-	-	-	-	-		
		116															
HARD, GRAY, **CLAY**, SHALE AND SANDSTONE FRAGMENTS, MOIST	867.3	117	14-50/4"	80	SS-47		0	0	1	99		-	-	-	19		
		118	50/5"	60	SS-48		-	-	-	-	-	-	-	-	-		
		119															
	864.3	120	50/3"	17	SS-49		-	-	-	-	-	-	-	-	-		
			50/1"	0	SS-50		-	-	-	-	-	-	-	-	-		
HARD, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, SANDSTONE FRAGMENTS, WET - ATTEMPTED ROCK CORE, CLAYEY GRAVEL MATERIAL, HAD TO SWITCH BACK TO SPT - DOWN PRESSURE = 250 TO 300 PSI - 13 MINUTE RUN REC. = 1.0 FT		121															
		122															
		123					-	-	-	-	-	-	-	-	-		
		124															
		125															
	858.6	126															
MEDIUM DENSE, LIGHT BROWN, **FINE SAND**, WET																	
	857.9																
HARD, LIGHT BROWN, **SILTY CLAY**, MOIST		127	15-38-48	78	SS-51		-	-	-	-	-	-	-	-	-		
		128															
	856.3	TR															
MODERATELY WEATHERED, VERY SOFT TO SOFT, VERY FINE GRAINED, SHALE, RED, THIN BEDDED, HIGHLY FRACTURED, FLAT BEDDING AND FRACTURES.		129	17-45-50/3"	100	SS-52		-	-	-	-	-	-	-	-	-		
		130															
	853.8																

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 133.5' TO 143.5' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; SAND

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-39**
Coordinates: N 770631.5 E 1870522.9	Driller:	Rii/ S.P	**Sheet No. 1 of 2**
Top Drillhole Elevation: 984.7 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 807.2 feet MSL	Prepared By:	B. Madras Natarajan	
Total Depth: 177.5 feet	Checked By:	A. Mirza	Date Start: 4/11/18 End: 4/18/18
Orientation: Vertical	Core Size:	HQ	Groundwater Depth: 8.4

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
								Refer to soil borings for details on soil descriptions/classifications
858	126							
856	128							
854	130							
852	132	60	97	0.4		1	130.5 to 155.0' **BEDFORD SHALE**, grey with red bands, very fine grained, slightly weathered, soft, thinly bedded, flat bedding	Top of Rock @ 134.7' Run-1 130.5' - 135.5' 14 minute run Down Pressure = 300 Psi
850	134							
848	136	55	86	1.0	135.2' 0°, B, R3-R4, O, Pl, Cl 135.3' 0-5°, B, R4, O, Pl 135.8' 0-5°, Jt, R4-R5, PtO-t, Pl 136.6' 0-5°, B, R4, O, Pl, Cl 136.8' 0-5°, B, R4-R5, PtO-t, Pl	2		Run-2 135.5' - 140.5' 14 minute run Down Pressure = 400 Psi
846	138				138.1' 0-5°, B, R4, O, Pl, Cl 138.2' to 138.7' 90°, Jt, R4, O, Pl, Cl			
844	140							
842	142	70	100	1.0	140.8' 0-5°, B, R5, t, Pl 142.8' 0-5°, B, R4-R5, t, Pl	3		Run-3 140.5' - 145.5' 16 minute run Down Pressure = 400 Psi
840	144				143.6' 0-5°, B, R4-R5, t, Pl 143.9' to 144.5' 90°, Jt, R4, O, Pl, Cl 144.8' 0-2°, B, R5, t, Pl			
838	146	63	63	1.0	146.0' 0-5°, B, R4, O, Pl, Cl 146.8' to 147.1' 90°, Jt, R4, O, Pl, Cl	4		Run-4 145.5' - 147.5' 10 minute run Down Pressure = 400 Psi
836	148	72	100	1.3	147.8' 0-5°, B, R4-R5, O, Pl 148.5' 0-5°, B, R4, O, Pl	5		Run-5 147.5' - 150.5' 11 minute run Down Pressure = 400 Psi
834	150				149.5' 0-5°, B, R4, O, Pl			
832	152	92	100	1.2	150.5' 0-5°, B, R4, O, Pl 150.7' 0-5°, B, R4, PtO-t, Pl 151.5' 0-5°, B, R4-R5, O, Pl 151.8' 0-5°, B, R4, O, Pl 152.3' 0-5°, B, R4, PtO-t, Pl 153.0' 0-5°, B, R4, O, Pl	6		Run-6 150.5' - 155.5' 10 minute run Down Pressure = 450 Psi
830	154				153.8' 0-5°, B, R4-R5, O, Pl			154.2' - 154.6' UCS = 3,770 Psi
828	156	88	97	1.6	156.4' 0-5°, B, R4, PtO-t, Pl 156.5' 0-5°, B, R4, O, Pl 157.4' 0-5°, B, R4-R5, PtO-t, Pl	7	155.0 to 177.5' **OHIO SHALE**, black, fine grained, unweathered, moderately hard, moderately fractured, thinly bedded, rare to some pyrite	Run-7 155.5' - 160.5' 13 minute run Down Pressure = 450 Psi
826	158				158.2' 0-5°, B, R4, PtO-t, Pl 158.8' 0-5°, B, R4-R5, PtO-t, Pl			
824	160				159.7' 0-5°, B, R4-R5, PtO-t, Pl 160.0' 0-5°, B, R4, PtO-t, Pl 160.2' 0-5°, B, R4-R5, O, Pl 160.7' 0-5°, B, R4-R5, PtO-t, Pl 161.2' 0-5°, B, R5, t, Pl	8		Run-8 160.5' - 165.5' 11 minute run Down Pressure = 500 to 700 Psi
822	162	88	100	1.4	162.4' 0-5°, B, R4-R5, PtO-t, Pl 163.0' 0-5°, B, R5, t, Pl 163.4' 0-5°, B, R4-R5, PtO-t, Pl			
820	164							

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-39**
Coordinates: N 770631.5 E 1870522.9	Driller:	Rii/ S.P	**Sheet No. 2 of 2**
Top Drillhole Elevation: 984.7 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 807.2 feet MSL	Prepared By:	B. Madras Natarajan	
Total Depth: 177.5 feet	Checked By:	A. Mirza	Date Start: 4/11/18 End: 4/18/18
Orientation: Vertical	Core Size:	HQ	Groundwater Depth: 8.4

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
818	166				165.1' 0-5°, B, R5, t, Pl 165.2' 0-5°, B, R4-R5, PtO-t, Pl 165.7' 0-5°, B, R4-R5, PtO-t, Pl 166.1' 0-5°, B, R5, t, Pl 166.3' 0-5°, B, R4-R5, PtO-t, Pl			Run-9 165.5' - 170.5' 12 minute run Down Pressure = 300 Psi
816	168	92	100	0.8		9		
814	170				170.2' 0-5°, B, R4-R5, PtO-t, Pl			Run-10 170.5' - 175.5' 12 minute run Down Pressure = 300 Psi
812	172	93	97	0.8	172.3' 0-5°, B, R4-R5, PtO-t, Pl 172.4' 0-5°, B, R5, t, Pl 173.0' 0-5°, B, R4-R5, PtO-t, Pl 173.1' 0-5°, B, R4-R5, PtO-t, Pl	10		
810	174							
808	176	63	75	NA	176.2' to 176.6' Possibility of a soft zone (Could've been washed away)	11		Run-11 175.5' - 177.5' 10 minute run Down Pressure = 300 Psi
806	178						**End of Boring at 177.5 feet**	
804	180							
802	182							
800	184							
798	186							
796	188							
794	190							
792	192							
790	194							
788	196							
786	198							
784	200							
782	202							
780	204							

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SUBSURFACE LOG EXPLORATION ID: B-40

PROJECT -BWSTE Ph 2- | DRILLING / SAMPLING TOOLS (TYPE / SIZE) Mud Rotary SPT | LOCATION 775913.845 1872010.701 | DATE STARTED 3/22/18 | COMPLETED 3/27/18
CLIENT City of Columbus | PROJECT TYPE Geotechnical Exploration | HAMMER TYPE Auto | EFFICIENCY 90.2 % (Avg.) | SURFACE ELEVATION 998.4 ft | DEPTH TO WATER 0.5 ft | DATE/TIME 3/28/18
PID NUMBER | PROJECT LOCATION | DRILLING / SAMPLING TOOLS (TYPE / SIZE) HQ | ELEVATION DATUM MSL | DEPTH TO WATER N/A | DATE/TIME N/A
PROJECT NUMBER 173409058 | INSPECTOR John Ristow / AECOM | DRILLING CONTRACTOR Rii / S.P | DRILL RIG TYPE AND ID CME 45 Truck \00 | BOREHOLE INCLINATION (VERT.) Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
VERY STIFF, LIGHT BROWN, **SILTY CLAY**, WITH SAND, TRACE TO SOME GRAVEL, MOIST	998.35	W															
		1	2-3-4	39	SS-1	2.75	-	-	-	-	-	-	-	-	-		
- FILL MATERIAL @ 0.0' - 3.0'		2															
		3															
		4	4-5-5	72	SS-2	2.75	5	8	12	30	45	35	19	16	12	CL	
- WEATHERED TILL		5															
		6															
		7	3-6-7	72	SS-3	3.5	-	-	-	-	-	-	-	-	-		
		8															
- WET SOIL	989.9	TR															
HIGHLY TO MODERATELY WEATHERED, SOFT TO MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, LIGHT BROWN, THIN BEDDED, HIGHLY TO INTENSELY FRACTURED, CLEAN FRACTURE SURFACES.	989.4	9	50/3"	100	SS-4		-	-	-	-	-	-	-	-	-		

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 10.0' TO 35.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; SAND

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-40**
Coordinates:	N 770631.5 E 1870522.9	Driller:	Rii/ S.P	**Sheet No. 1 of 6**
Top Drillhole Elevation:	998.1 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	787.6 feet MSL	Prepared By:	B. Madras Natarajan	
Total Depth:	210.5 feet	Checked By:	A. Mirza	Date Start: 3/22/18 End: 3/27/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
998								Refer to soil borings for details on soil descriptions/classifications
996	2							
994	4							
992	6							
990	8							
988	10	0	93	5.5	8.9' 0-5°, Jt, R5, PtO-t, Pl 9.1' 0-5°, Jt, R4-R5, O, Pl 9.2' 0-5°, Jt, R5, PtO-t, Pl	1	8.5 to 36.0' Top of Rock @ 8.5' 9.0' **BEREA SANDSTONE**, brown, medium to fine grained, highly to moderately weathered, soft to moderately hard, highly to intensely fractured, thinly bedded, clean fractured surfaces	Top of Rock @ 8.5' Run-1 8.5' - 10.5' 7 minute run Down Pressure = 250 Psi
986	12	13	85	3.4	9.4' 0-5°, Jt, R4-R5, t, Pl 9.5' 0-5°, Jt, R5, PtO-t, Pl 9.7' 0-5°, Jt, R5, t, Pl 9.8' 0-5°, Jt, R4-R5, t, Pl 9.9' 0-5°, Jt, R5, t, Pl 10.1' 0-5°, Jt, R4-R5, O, Pl 10.2' 0-5°, Jt, R4-R5, t, Pl 10.3' 45°, Jt, R4-R5, PtO-t, Und 10.5' to 11.0' 90°, Jt, R4, O, Und 11.2' 0-5°, Jt, R4-R5, O, Pl 11.3' 0-5°, Jt, R5, PtO-t, Pl 11.4' 0-5°, Jt, R4-R5, t, Pl	2		Run-2 10.5' - 15.5' 9 minute run Down Pressure = 300 Psi
984	14							
982	16	43	100	3.6	11.6' 0-5°, Jt, R5, O, Pl 11.8' 0-5°, Jt, R4-R5, PtO-t, Pl 12.0' 0-5°, Jt, R4-R5, O, Pl 12.2' 0-5°, Jt, R4-R5, PtO-t, Pl 12.5' 0-5°, Jt, R4-R5, O, Pl 12.7' 0-5°, Jt, R4-R5, PtO-t, Pl 12.9' 0-5°, Jt, R4-R5, O, Pl 13.2' 0-5°, Jt, R4-R5, t, Pl 13.4' 0-5°, Jt, R4, PtO-t, Pl 13.8' 0-5°, Jt, R4-R5, t, Pl 13.9' 0-5°, Jt, R4-R5, t, Pl	3	17.5' **BEREA SANDSTONE**, grey, medium to fine grained, moderately to slightly weathered, moderately hard, highly fractured, thinly bedded, ferriferous fractures	Run-3 15.5' - 20.5' 7 minute run Down Pressure = 400 Psi
980	18							
978	20							
976	22	48	100	3.0	14.3' 0-5°, Jt, R4, t, Pl 14.7' 0-5°, Jt, R4-R5, O, Pl 15.6' 0-5°, Jt, R4-R5, t, Pl 15.8' 0-5°, Jt, R4-R5, PtO-t, Pl 16.3' 0-5°, Jt, R4-R5, PtO-t, Pl 16.5' 0-5°, Jt, R4-R5, PtO-t, Pl 16.7' 0-5°, B, R4-R5, t, Pl 16.9' 0-5°, Jt, R4-R5, PtO-t, Pl 17.4' 0-5°, B, R4-R5, t, Pl 17.5' to 19.5' 90°, Jt, R3-R4, O, Und 17.8' 0-5°, B, R4-R5, t, Pl	4		Run-4 20.5' - 25.5' 9 minute run Down Pressure = 350 - 400 Psi
974	24							
972	26	44	95	2.8	18.0' 0-5°, Jt, R4-R5, PtO-t, Pl 18.2' 0-5°, Jt, R4-R5, PtO-t, Pl 18.7' 0-5°, B, R4-R5, t, Pl 19.2' 0-5°, Jt, R4-R5, PtO-t, Pl 19.3' 0-5°, Jt, R4, O, Pl 19.6' 0-5°, Jt, R4-R5, PtO-t, Pl 19.8' 0-5°, B, R4, t, Pl 20.0' 0-5°, B, R4-R5, t, Pl 20.4' 0-5°, B, R4-R5, t, Pl 20.9' 0-5°, Jt, R4, O, Pl 21.0' 0-5°, B, R4-R5, t, Pl	5	26.0' **BEREA SANDSTONE**, grey, medium to fine grained, slightly weathered to unweathered, moderately hard, moderately to highly fractured, thinly bedded, flat to vertical fractures	Run-5 25.5' - 30.5' 8 minute run Down Pressure = 400 Psi 26.5' - 26.9' UCS = 11,047 Psi
970	28							
968	30							
966	32	47	96	2.2	21.2' 0-5°, Jt, R4, O, Pl 21.4' 0-5°, Jt, R4, O, Pl 21.7' 0-5°, Jt, R4-R5, O, Pl 21.8' 0-5°, B, R4-R5, t, Pl 21.9' 0-5°, B, R4-R5, t, Pl 22.2' 0-5°, Jt, R4-R5, O, Pl 22.5' 0-5°, Jt, R4, O, Pl 23.0' 0-5°, B, R4-R5, t, Pl 23.2' 0-5°, Jt, R4, O, Pl 23.4' 0-5°, Jt, R4, O, Pl 23.6' 0-5°, B, R4-R5, t, Pl	6		Run-6 30.5' - 35.5' 10 minute run Down Pressure = 400 Psi
964	34							
962	36							
960	38	7	80	2.8	23.8' 0-5°, Jt, R4, O, Pl 24.5' 0-5°, Jt, R4, O, Pl 25.8' 0-5°, Jt, R4, O, Pl 26.9' 0-5°, B, R4-R5, t, Pl 27.1' 0-5°, Jt, R4, O, Pl 27.2' 0-5°, B, R4-R5, t, Pl 27.3' 0-5°, Jt, R4, O, Pl 27.5' 0-5°, Jt, R4, O, Pl 27.9' 0-5°, B, R4-R5, t, Pl 28.9' 0-5°, B, R4-R5, t, Pl	7	36.0 to 54.0' Interbedded **BEDFORD SHALE** and **BEREA SANDSTONE** (55%/45%) 36.0' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, moderately fractured, thinly bedded 36.0' **BEREA SANDSTONE**, grey, medium to fine grained, unweathered,	Run-7 35.5' - 40.5' 18 minute run Down Pressure = 250 - 300 Psi

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	**BORING NO. B-40**	
Coordinates: N 770631.5 E 1870522.9	Driller: Rii/ S.P	**Sheet No. 2 of 6**	
Top Drillhole Elevation: 998.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 787.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 210.5 feet	Checked By: A. Mirza	Date Start: 3/22/18 End: 3/27/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
958					29.1' 0-5°, Jt, R4, O, Pl		moderately hard, moderately fractured, thinly bedded	
					29.2' 0-5°, B, R4-R5, t, Pl			
					29.4' 0-5°, Jt, R4, O, Pl			
					29.5' 0-5°, B, R4-R5, t, Pl			
956	42				29.7' 0-5°, B, R4-R5, t, Pl			
					30.2' 0-5°, B, R4-R5, t, Pl			
		8	100	3.4	30.6' 0-5°, Jt, R4, O, Pl	8		Run-8 40.5' - 45.5' 11 minute run Down Pressure = 300 Psi
954	44				30.7' 0-5°, B, R4-R5, t, Pl			
					31.1' 0-5°, Jt, R4, O, Pl			
					31.3' 0-5°, B, R4-R5, t, Pl			
					31.5' 0-5°, B, R4-R5, t, Pl			
					31.8' 0-5°, B, R4-R5, t, Pl			
952	46				32.4' 0-5°, Jt, R4, O, Pl			
					32.5' 0-5°, B, R4-R5, t, Pl			Run-9 45.5' - 50.5' 17 minute run Down Pressure = 400 Psi
					32.8' 0-5°, Jt, R4, O, Pl			
					33.1' 0-5°, B, R4-R5, t, Pl			
					33.2' to 35.5' 90°, Jt, R3-R4, O, Und			
950	48	13	96	4.0	35.6' 0-5°, B, R4-R5, t, Pl	9		
					35.9' 40°, Jt, R3-R4, O, Und			
					36.2' to 36.7' 0-5°, B, R4-R5, t, Pl			
					36.9' 0-5°, Jt, R4, O, Pl			
948	50				37.0' 0-5°, Jt, R4, O, Pl			
					37.2' 0-5°, Jt, R4, O, Pl			
					37.4' 0-5°, B, R4-R5, t, Pl			Run-10 50.5' - 55.5' 14 minute run Down Pressure = 400 Psi
					37.6' to 38.5' 90°, Jt, R3-R4, O, Und			
946	52				38.6' 0-5°, B, R4-R5, t, Pl			
					38.7' 0-5°, B, R4-R5, t, Pl			
					38.8' 0-5°, Jt, R4, O, Pl			
		13	97	3.8	39.0' 0-5°, Jt, R4, O, Pl	10		
					39.3' 0-5°, Jt, R4, PtO-t, Pl			
944	54				39.6' 0-5°, Jt, R4, O, Pl			
					40.6' 0-5°, Jt, R4, O, Pl		54.0 to 80.0' Interbedded **BEDFORD SHALE** and **BEREA SANDSTONE** (55%/45%)	
					40.8' to 41.3' 5 Jts			
					41.5' 0-5°, B, R4-R5, t, Pl			
					41.7' to 42.3' 0-5°, B, R4-R5, t, Pl			
942	56				42.5' 0-5°, Jt, R4, O, Pl		54.0' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, moderately fractured, thinly bedded	Run-11 55.5' - 60.5' 16 minute run Down Pressure = 400 Psi
					42.7' 0-5°, Jt, R4, O, Pl			
					42.9' 0-5°, B, R4-R5, t, Pl			
					43.3' 0-5°, Jt, R4, O, Pl			
940	58	20	90	4.8	43.7' 0-5°, B, R4-R5, t, Pl	11	54.0' **BEREA SANDSTONE**, light grey, medium to fine grained, unweathered, moderately hard, moderately fractured, thinly bedded	
					43.9' 0-5°, Jt, R4, O, Pl			
					44.1' 0-5°, Jt, R4, O, Pl			
					44.3' 0-5°, B, R4-R5, t, Pl			
					44.5' 0-5°, Jt, R4, O, Pl			
938	60				44.6' 0-5°, B, R4-R5, t, Pl			
					44.8' 0-5°, Jt, R4, O, Pl			
					45.0' 0-5°, Jt, R4, O, Pl			Run-12 60.5' - 65.5' 15 minute run Down Pressure = 400 Psi
					45.1' 0-5°, B, R4-R5, t, Pl			
936	62				45.3' Sandstone lenses are two-four inches thick			
		17	40	2.4	45.8' 0-5°, Jt, R4, O, Pl	12		
					45.9' 0-5°, Jt, R4, O, Pl			
					46.1' 0-5°, Jt, R4, O, Pl			
934	64				46.2' 0-5°, Jt, R4, O, Pl			
					46.4' 0-5°, Jt, R4, O, Pl			
					46.5' 0-5°, Jt, R4, O, Pl			
					46.7' 0-5°, Jt, R4, O, Pl			
932	66				46.9' 0-5°, Jt, R4, O, Pl			Run-13 65.5' - 70.5' 14 minute run Down Pressure = 400 Psi
					47.1' 0-5°, Jt, R4, O, Pl			
					47.4' 0-5°, Jt, R4, O, Pl			
					47.5' 0-5°, Jt, R4, O, Pl			
930	68	35	100	2.8	47.7' 0-5°, B, R4-R5, t, Pl	13		
					47.9' 0-5°, B, R4-R5, t, Pl			
					48.1' 0-5°, B, R4-R5, t, Pl			
					48.2' 0-5°, B, R4-R5, t, Pl			
					48.5' to 49.6' 0-5°, 5 Jts, R4, O, Pl			
928	70				49.9' 0-5°, B, R4-R5, t, Pl			
					50.1' 0-5°, B, R4-R5, t, Pl			
					50.3' 0-5°,B, R4-R5, t, Pl			Run-14 70.5' - 75.5' 10 minute run Down Pressure = 500 Psi
					50.4' 0-5°,B, R4-R5, t, Pl			
926	72				50.6' 0-5°,B, R4-R5, t, Pl			
					50.8' 0-5°,B, R4-R5, t, Pl			
					50.9' 0-5°,B, R4-R5, t, Pl			
		53	100	2.6	51.2' 0-5°,B, R4-R5, t, Pl	14		
					51.4' 0-5°,B, R4-R5, t, Pl			
924	74				51.9' 0-5°,B, R4-R5, t, Pl			
					52.0' 0-5°,B, R4-R5, t, Pl			
					52.1' 0-5°,B, R4-R5, t, Pl			
					52.3' 0-5°,B, R4-R5, t, Pl			
922	76				52.4' 0-5°,B, R4-R5, t, Pl			Run-15 75.5' - 80.5' 10 minute run Down Pressure = 500 Psi
					52.6' 0-5°,B, R4-R5, t, Pl			
					52.8' 0-5°,B, R4-R5, t, Pl			
					53.1' to 53.5' Broken Sandstone			
920	78	48	94	1.4	53.7' 0-5°,B, R4-R5, t, Pl	15		
					53.9' 0-5°,B, R4-R5, t, Pl			
					54.2' 0-5°,B, R4-R5, t, Pl			
					54.5' 0-5°,B, R4-R5, t, Pl			
					54.8' 0-5°,B, R4-R5, t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-40**
Coordinates: N 770631.5 E 1870522.9	Driller: Rii/ S.P		**Sheet No. 3 of 6**
Top Drillhole Elevation: 998.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 787.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 210.5 feet	Checked By: A. Mirza	Date Start: 3/22/18 End: 3/27/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
918					55.1' 0-5°, B, R4-R5, t, Pl		80.0 to 92.0' Interbedded **BEDFORD SHALE** and **BEREA SANDSTONE** (55%/45%)	
					55.7' 0-5°, B, R4-R5, t, Pl			
					55.8' 0-5°, B, R4-R5, t, Pl			
					56.0' 0-5°, B, R4-R5, t, Pl			
916	82				56.1' 0-5°, B, R4-R5, t, Pl			
					56.4' 0-5°, B, R4-R5, t, Pl			
		84	100	1.8	56.7' 0-5°, B, R4-R5, t, Pl	16	80.0' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, moderately fractured, thinly bedded	Run-16 80.5' - 85.5' 9 minute run Down Pressure = 500 Psi
					56.8' 0-5°, B, R4-R5, t, Pl		80.0' **BEREA SANDSTONE**, light grey, medium to fine grained, unweathered, moderately hard, moderately fractured, thinly bedded	
914	84				57.1' 0-5°, B, R4-R5, t, Pl			
					57.4' 0-5°, B, R4-R5, t, Pl			
					57.5' 0-5°, B, R4-R5, t, Pl			
					57.8' 0-5°, B, R4-R5, t, Pl			
912	86				57.9' 0-5°, B, R4-R5, t, Pl			
					58.0' 0-5°, B, R4-R5, t, Pl			Run-17 85.5' - 90.5' 11 minute run Down Pressure = 500 Psi
					58.1' 0-5°, B, R4-R5, t, Pl			
					58.2' 0-5°, B, R4-R5, t, Pl			
					58.4' 0-5°, B, R4-R5, t, Pl			
910	88	80	100	2.4	58.5' 0-5°, B, R4, PtO-t, Pl	17		
					58.6' 0-5°, B, R4, PtO-t, Pl			
					58.7' 0-5°, B, R4, PtO-t, Pl			
					58.9' 0-5°, B, R4-R5, t, Pl			
908	90				59.3' 0-5°, B, R4-R5, t, Pl			
					59.5' 0-5°, B, R4, PtO-t, Pl			
					59.6' 0-5°, B, R4-R5, t, Pl			Run-18 90.5' - 95.5' 13 minute run Down Pressure = 500 Psi
					60.0' 0-5°, B, R4-R5, t, Pl			
906	92				60.7' 0-5°, B, R4-R5, t, Pl			
					60.8' 0-5°, B, R4-R5, t, Pl			
					61.1' 0-5°, B, R4-R5, t, Pl		92.0 to 150.5' **BEDFORD SHALE**, blue with red bands, fine grained, unweathered, soft, moderately fractured, thinly bedded, flat bedding and fractures	
		83	100	1.4	61.3' 0-5°, B, R4, PtO-t, Pl	18		
					61.5' 0-5°, B, R4-R5, t, Pl			
904	94				61.6' 0-5°, B, R4-R5, t, Pl			
					61.8' 0-5°, B, R4-R5, t, Pl			
					62.0' to 62.2' fractured rock			
					62.5' 0-5°, B, R4-R5, t, Pl			
902	96				63.0' 0-5°, B, R4-R5, t, Pl			Run-19 95.5' - 100.5' 12 minute run Down Pressure = 400 Psi
					63.3' to 63.8' 0-5°, B, R4-R5, t, Pl			
					64.2' 0-5°, B, R4-R5, t, Pl			
					65.5' to 66.4' fractured rock			
					66.6' 0-5°, B, R4-R5, t, Pl			
900	98	93	100	1.4	66.8' 0-5°, B, R4-R5, t, Pl	19		
					67.0' 0-5°, B, R4-R5, t, Pl			
					67.2' 0-5°, B, R4, PtO-t, Pl			
					67.5' 0-5°, B, R4-R5, t, Pl			
898	100				68.2' 0-5°, B, R4, PtO-t, Pl			
					68.3' 0-5°, B, R4-R5, t, Pl			
					68.6' 0-5°, B, R4, PtO-t, Pl			Run-20 100.5' - 105.5' 12 minute run Down Pressure = 400 Psi
					68.8' 0-5°, B, R4, PtO-t, Pl			
					69.2' 0-5°, B, R4-R5, t, Pl			
896	102				69.5' 0-5°, B, R4, PtO-t, Pl			
					70.0' 0-5°, B, R4-R5, t, Pl			
		83	100	1.8	70.2' 0-5°, B, R4, PtO-t, Pl	20		
					70.7' 0-5°, B, R4-R5, t, Pl			
894	104				71.0' 0-5°, B, R4-R5, t, Pl			
					71.3' 0-5°, B, R4-R5, t, Pl			
					71.8' 0-5°, B, R4, PtO-t, Pl			
					72.1' 0-5°, B, R4-R5, t, Pl			
					72.5' 0-5°, B, R4, PtO-t, Pl		105.5' **BEDFORD SHALE**, red, fine grained, unweathered, soft, moderately fractured, thinly bedded, fresh fractures	Run-21 105.5' - 110.5' 13 minute run Down Pressure = 450 Psi
892	106				73.0' 0-5°, B, R4-R5, t, Pl			
					73.4' 0-5°, B, R4, PtO-t, Pl			
					73.8' 0-5°, B, R4-R5, t, Pl			
					74.3' 0-5°, B, R4, PtO-t, Pl			
890	108	63	86	1.8	74.5' 0-5°, B, R4, PtO-t, Pl	21		
					75.0' 0-5°, B, R4-R5, t, Pl			
					75.3' 0-5°, B, R4, PtO-t, Pl			
					75.9' 0-5°, B, R4, PtO-t, Pl			
					76.0' 0-5°, B, R4, PtO-t, Pl			
888	110				76.2' 0-5°, B, R4-R5, t, Pl			
					77.0' 0-5°, B, R4, PtO-t, Pl			Run-22 110.5' - 115.5' 13 minute run Down Pressure = 450 Psi
					77.1' to 78.3' 90°, Jt, R3-R4, PtO-t, Und			
					78.4' 0-5°, B, R4-R5, t, Pl			
886	112				79.2' to 79.7' 90°, Jt, R3-R4, PtO-t, Und			
					80.6' 0-5°, B, R4-R5, t, Pl			
		90	100	0.8	80.7' 0-5°, B, R4, PtO-t, Pl	22		
					81.1' 0-5°, B, R4-R5, t, Pl			
884	114				82.1' 0-5°, B, R4, PtO-t, Pl			
					82.5' 0-5°, B, R4, PtO-t, Pl			
					82.7' 0-5°, B, R4-R5, t, Pl			
					84.2' 0-5°, B, R4, PtO-t, Pl			
					84.5' 0-5°, B, R4-R5, t, Pl			Run-23 115.5' - 120.5' 12 minute run Down Pressure = 450 Psi
882	116				84.6' 0-5°, B, R4, PtO-t, Pl			
					86.2' 0-5°, B, R4, PtO-t, Pl			
					86.5' 0-5°, B, R4-R5, t, Pl			
					86.6' 0-5°, B, R4-R5, t, Pl			
880	118	90	100	1.2	87.0' 0-5°, B, R4, PtO-t, Pl	23		
					87.3' 0-5°, B, R4-R5, t, Pl			
					87.7' 0-5°, B, R4-R5, t, Pl			
					88.5' 0-5°, B, R4, PtO-t, Pl			
					88.7' 0-5°, B, R4-R5, t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-40	
Coordinates: N 770631.5 E 1870522.9	Driller: Rii/ S.P	Sheet No. 4 of 6	
Top Drillhole Elevation: 998.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 787.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 210.5 feet	Checked By: A. Mirza	Date Start: 3/22/18 End: 3/27/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
878					89.1' 0-5°, B, R4, PtO-t, Pl			
					89.6' 0-5°, B, R4-R5, t, Pl			Run-24 120.5' - 125.5' 13 minute run
					89.8' 0-5°, B, R4, PtO-t, Pl			Down Pressure = 450 Psi
876	122				90.2' 0-5°, B, R4-R5, t, Pl			
					91.4' 0-5°, B, R4, PtO-t, Pl			
		80	98	2.4	91.6' 0-5°, B, R4-R5, t, Pl			
					91.8' 0-5°, B, R4, PtO-t, Pl	24		
874	124				92.1' 0-5°, B, R4-R5, t, Pl			
					92.8' 0-5°, B, R4, PtO-t, Pl			
					93.5' 0-5°, B, R4-R5, t, Pl			
					93.7' 0-5°, B, R4, PtO-t, Pl		124.5' **BEDFORD SHALE**, grey with red bands, fine grained, unweathered, soft, moderately fractured, thinly bedded, flat bedding	
					97.0' 0-5°, B, R4, PtO-t, Pl			
872	126				97.5' 0-5°, B, R4-R5, t, Pl			Run-25 125.5' - 130.5' 14 minute run
					98.1' 0-5°, B, R4, PtO-t, Pl			Down Pressure = 500 Psi
					98.5' 0-5°, B, R4-R5, t, Pl			
					99.1' 0-5°, B, R4, PtO-t, Pl			
					99.5' 0-5°, B, R4-R5, t, Pl			
870	128	88	100	1.2	99.7' 0-5°, B, R4, PtO-t, Pl	25		
					101.6' 0-5°, B, R4-R5, t, Pl			
					102.5' 0-5°, B, R4, PtO-t, Pl			
					102.6' 0-5°, B, R4-R5, t, Pl			
868	130				103.7' 0-5°, B, R4, PtO-t, Pl			
					103.9' 0-5°, B, R4-R5, t, Pl			
					104.5' 0-5°, B, R4, PtO-t, Pl			Run-26 130.5' - 135.5' 25 minute run
					104.6' 0-5°, B, R4-R5, t, Pl			Down Pressure = 500 - 550 Psi
866	132				104.8' 0-5°, B, R4, PtO-t, Pl			
					105.5' 0-5°, B, R4-R5, t, Pl			
					105.9' 0-5°, B, R4, PtO-t, Pl			
		100	100	0.0	106.4' 0-5°, B, R4, PtO-t, Pl	26		
					106.8' 0-5°, B, R4-R5, t, Pl			
864	134				107.0' 0-5°, B, R4-R5, t, Pl			
					107.6' 0-5°, B, R4-R5, t, Pl			
					107.7' 0-5°, B, R4, PtO-t, Pl			
					108.4' 0-5°, B, R4-R5, t, Pl			
862	136				108.5' 0-5°, B, R4, PtO-t, Pl			Run-27 135.5' - 140.5' 12 minute run
					109.5' 0-5°, B, R4-R5, t, Pl			Down Pressure = 500 - 550 Psi
					111.2' 0-5°, B, R4, PtO-t, Pl			
					111.3' 0-5°, B, R4-R5, t, Pl			
					112.3' 0-5°, B, R4, PtO-t, Pl			
860	138	100	100	0.0	114.9' 0-5°, B, R4, PtO-t, Pl	27	136.5' **BEDFORD SHALE**, grey, fine grained, unweathered, soft, slightly fractured, flat bedding, fractures on bedding planes	
					116.0' 0-5°, B, R4-R5, t, Pl			
					116.2' 0-5°, B, R4, PtO-t, Pl			
					116.4' 0-5°, B, R4-R5, t, Pl			
					117.2' 0-5°, B, R4, PtO-t, Pl			
858	140				118.4' 0-5°, B, R4-R5, t, Pl			
					119.5' 0-5°, B, R4, PtO-t, Pl			Run-28 140.5' - 145.5' 12 minute run
					121.1' 0-5°, B, R4-R5, t, Pl			Down Pressure = 550 - 600 Psi
					121.6' 0-5°, B, R4-R5, t, Pl			
856	142				122.5' 0-5°, B, R4, PtO-t, Pl			
					122.6' 0-5°, B, R4-R5, t, Pl			
		100	100	0.6	122.8' 0-5°, B, R4, PtO-t, Pl	28		
					123.6' 0-5°, B, R4-R5, t, Pl			
854	144				123.8' 0-5°, B, R4-R5, t, Pl			
					123.9' 0-5°, B, R4-R5, t, Pl			
					124.0' 0-5°, B, R4-R5, t, Pl			
					125.0' 0-5°, B, R4, PtO-t, Pl			
					125.2' 0-5°, B, R4-R5, t, Pl			
852	146				125.4' 0-5°, B, R4-R5, t, Pl			Run-29 145.5' - 150.5' 10 minute run
					125.7' 0-5°, B, R4-R5, t, Pl			Down Pressure = 550 Psi
					126.1' to 126.3' 90°, Jt, R3-R4, PtO-t, Und			
					126.6' 0-5°, B, R4-R5, t, Pl			
					127.4' 0-5°, B, R4-R5, t, Pl			
850	148	92	100	0.4	128.5' 0-5°, B, R4-R5, t, Pl	29		
					129.9' 0-5°, B, R4-R5, t, Pl			
					141.0' 0-5°, B, R4-R5, t, Pl			
					144.2' 0-5°, B, R4, PtO-t, Pl			
848	150				145.1' 0-5°, B, R4-R5, t, Pl			
					147.3' 0-5°, B, R4, t, Pl			
					150.1' 0-5°, B, R4-R5, t, Pl		150.5 to 210.5' **OHIO SHALE**, black, fine grained, unweathered, moderately hard, slightly fractured, thinly bedded, flat bedding, fractures on bedding planes, pyritic	Run-30 150.5' - 155.5' 10 minute run
846	152							Down Pressure = 500 Psi
		100	100	0.0		30		
844	154							
								Run-31 155.5' - 160.5' 10 minute run
842	156							Down Pressure = 500 Psi
		99	99	0.4		31		
840	158				158.9' 0-5°, B, R, t, Pl			

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-40	
Coordinates: N 770631.5 E 1870522.9	Driller: Rii/ S.P	Sheet No. 5 of 6	
Top Drillhole Elevation: 998.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 787.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 210.5 feet	Checked By: A. Mirza	Date Start: 3/22/18 End: 3/27/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
838								
					160.3' 0-5°, B, R4, PtO-t, Pl			Run-32 160.5' - 165.5' 11 minute run Down Pressure = 500 Psi
836	162							
		85	98	0.2		32		
834	164				164.2' 0-5°, B, R4-R5, t, Pl			
					165.5' to 166.5' 90°, Jt, R3-R4, PtO-t, Und			Run-33 165.5' - 170.5' 8 minute run Down Pressure = 500 Psi
832	166				166.8' 0-5°, B, R4, PtO-t, Pl			
					167.1' 0-5°, B, R4-R5, t, Pl			
830	168	75	100	0.8	167.9' 0-5°, B, R4, PtO-t, Pl	33		
828	170							
								Run-34 170.5' - 175.5' 8 minute run Down Pressure = 500 Psi
826	172							
		100	100	0.0		34		
824	174							
					175.6' 0-5°, B, R4, t, Pl			Run-35 175.5' - 180.5' 12 minute run Down Pressure = 500 Psi
822	176				176.5' 0-5°, B, R4, PtO-t, Pl			
		88	100	1.2		35		
820	178				178.5' 0-5°, B, R4-R5, t, Pl			
					178.6' 0-5°, B, R4, PtO-t, Pl			
818	180				180.1' 0-5°, B, R4-R5, t, Pl			
					180.3' 0-5°, B, R4, PtO-t, Pl			Run-36 180.5' - 185.5' 11 minute run Down Pressure = 500 Psi
816	182				181.1' 0-5°, B, R4, PtO-t, Pl			
		100	100	0.4	182.7' 0-5°, B, R4-R5, t, Pl	36		
814	184							
								Run-37 185.5' - 190.5' 11 minute run Down Pressure = 500 Psi
812	186							
		100	100	0.4	188.1' 0-5°, B, R4-R5, t, Pl	37		
810	188				188.6' 0-5°, B, R4, PtO-t, Pl			
808	190							
								Run-38 190.5' - 195.5' 12 minute run Down Pressure = 500 Psi
806	192				192.0' 0-5°, B, R4-R5, t, Pl			
		100	100	0.6	192.5' 0-5°, B, R4, PtO-t, Pl	38		
804	194							
					194.6' 0-5°, B, R4, t, Pl			
802	196							Run-39 195.5' - 200.5' 9 minute run Down Pressure = 500 Psi
					196.4' 0-5°, B, R4-R5, t, Pl			
800	198	100	100	0.6	197.5' 0-5°, B, R4, t, Pl	39	197.5' **OHIO SHALE**, black, fine grained, unweathered, soft to moderately hard, slightly fractured, thinly bedded, pyritic	
					198.7' 0-5°, B, R4, PtO-t, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-40**
Coordinates: N 770631.5 E 1870522.9	Driller:	Rii/ S.P	**Sheet No. 6 of 6**
Top Drillhole Elevation: 998.1 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 787.6 feet MSL	Prepared By:	B. Madras Natarajan	
Total Depth: 210.5 feet	Checked By:	A. Mirza	Date Start: 3/22/18 End: 3/27/18
Orientation: Vertical	Core Size:	HQ	Groundwater Depth: 1

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
798								
796	202	75	90	1.2	201.2' 0-5°, B, R4-R5, t, Pl 201.7' 0-5°, B, R4, t, Pl 202.0' 0-5°, B, R4, PtO-t, Pl 202.3' 0-5°, B, R4, t, Pl 202.5' 0-5°, B, R4-R5, PtO-t, Pl 202.7' 0-5°, B, R4, PtO-t, Pl	40		Run-40 200.5' - 205.5' 11 minute run Down Pressure = 500 Psi
794	204							
792	206							Run-41 205.5' - 210.5' 15 minute run Down Pressure = 500 Psi
790	208	100	100	0.0		41		
788	210						**End of Boring at 210.5 feet**	
786	212							
784	214							
782	216							
780	218							
778	220							
776	222							
774	224							
772	226							
770	228							
768	230							
766	232							
764	234							
762	236							
760	238							

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-41**
Coordinates:	N 767330.5 E 1867972.3	Driller:	Rii/ S.P	**Sheet No. 1 of 5**
Top Drillhole Elevation:	993.7 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	803.7 feet MSL	Prepared By:	A. Mirza	
Total Depth:	190.0 feet	Checked By:	B. Madras Natarajan	Date Start: 2/12/18 End: 2/14/18
Orientation:	Vertical	Core Size:	HQ	Groundwater Depth: 12.2

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
982	12							
980	14	15	100	6.6	13.5' to 15.0' 0-5°, 10 Bs, R4-R5, O, Pl	1	13.5 to 51.7' **BEREA SANDSTONE**, grey, fine to medium grained, slightly to moderately weathered, moderately hard to hard, thinly bedded, flat, ferriferous	Top of Rock @ 13.5' Run-1 13.5' - 15.0' 13 minute run Down Pressure = 250 psi
978	16				15.0' to 20' 0-5°, 20 Bs, R4-R5, O, Pl			Run-2 15.0' - 20.0' 6 minute run Down Pressure = 300 psi
976	18	61	100	4		2		
974	20				20.1' 0-5°, B, R5, PtO-t, Pl			Run-3 20.0' - 25.0' 10 minute run Down Pressure = 300 psi
972	22	61	98	1.2	21.8' 0-5°, B, R4, O, Pl 22.3' 0-5°, B, R4-R5, O, Pl 22.4' 0-5°, B, R5, PtO-t, Pl	3		
970	24				23.5' 0-5°, B, R5, t, Pl 24.2' 0-5°, B, R4-R5, t, Pl			
968	26				25.4' to 25.6' 90°, Jt, R4, O, Pl			Run-4 25.0' - 30.0' 16 minute run Down Pressure = 300 psi
966	28	38	90	1.4	26.2' 0-5°, B, R5, t, Pl 26.4' 0-5°, B, R4-R5, O, Pl 27.0' 0-5°, B, R5, PtO-t, Pl 28.4' 0-5°, B, R4-R5, O, Pl 28.9' 0-5°, B, R5, t, Pl 29.0' 0-5°, B, R5, O, Pl	4		
964	30				30.2' to 30.4' 90°, Jt, R4, O, Pl 30.6' 0-5°, B, R5, t, Pl			Run-5 30.0' - 35.0' 10 minute run Down Pressure = 300 psi
962	32	60	98	1.8	31.4' 0-5°, B, R4, t, Pl 31.7' 0-5°, B, R5, PtO-t, Pl 31.8' 0-5°, B, R4-R5, O, Pl 32.7' 0-5°, B, R5, t, Pl 33.0' 0-5°, B, R5, O, Pl 33.4' 0-5°, B, R4, t, Pl 34.0' to 35.0' 90°, Jt, R4, O, Pl	5		
960	34							
958	36				35.5' 0-5°, B, R4-R5, O, Pl 36.2' to 36.4' 90°, Jt, R4, O, Pl			Run-6 35.0' - 40.0' 12 minute run Down Pressure = 300 psi
956	38	61	100	1	37.5' 0-5°, B, R4-R5, O, Pl 38.4' to 38.6' 90°, Jt, R4, O, Pl	6		
954	40				39.4' 0-5°, B, R5, PtO-t, Pl			
952	42	55	90	2	40.5' 0-5°, B, R4-R5, O, Pl 40.9' 0-5°, B, R5, t, Pl 41.7' 0-5°, B, R5, O, Pl 42.3' 0-5°, B, R4-R5, O, Pl 42.5' to 42.9' 0-5°, 5 Bs, R3-R4, O, Pl	7		Run-7 40.0' - 45.0' 12 minute run Down Pressure = 300 psi
950	44				43.8' 0-5°, B, R5, t, Pl			
948	46				45.7' 0-5°, B, R5, PtO-t, Pl 45.9' 0-5°, B, R4-R5, O, Pl 46.1' 0-5°, B, R5, PtO-t, Pl 46.7' 0-5°, B, R5, t, Pl			Run-8 45.0' - 50.0' 9 minute run Down Pressure = 300 psi
946	48	21	94	2.4	47.0' 0-5°, B, R4-R5, O, Pl 47.2' to 47.3' 90°, Jt, R3-R4, O, Pl 47.7' 0-5°, B, R4-R5, O, Pl 48.1' 0-5°, B, R5, t, Pl 48.6' to 46.8' fractured rock	8		
944								

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-41**
Coordinates: N 767330.5 E 1867972.3	Driller: Rii/ S.P		**Sheet No. 2 of 5**
Top Drillhole Elevation: 993.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.7 feet MSL	Prepared By: A. Mirza		
Total Depth: 190.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/12/18 End: 2/14/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 12.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
942	52	28	94	3.6	48.9' 0-5°, B, R5, t, Pl 49.3' 0-5°, B, R5, PtO-t, Pl 50.3' 0-5°, B, R5, t, Pl 50.4' 0-5°, B, R5, PtO-t, Pl 50.5' 0-5°, B, R5, t, Pl 50.6' 0-5°, B, R5, PtO-t, Pl 51.2' 0-5°, B, R5, PtO-t, Pl 51.6' 0-5°, B, R5, t, Pl 51.8' 0-5°, B, R4-R5, O, Pl 52.1' 0-5°, B, R5, t, Pl 52.3' 0-5°, B, R5, PtO-t, Pl	9	51.7 to 90.0' Interbedded BEREA SANDSTONE (60%) and BEDFORD SHALE (40%) **BEREA SANDSTONE**, grey, fine to medium grained, slightly weathered, hard, thinly bedded, flat **BEDFORD SHALE**, grey, very fine grained, slightly weathered, soft, thinly bedded, flat	Run-9 50.0' - 55.0' 13 minute run Down Pressure = 300 psi
940	54							
938	56	53	100	3.2	52.5' 0-5°, B, R5, t, Pl 52.6' 0-5°, B, R5, t, Pl 52.7' 0-5°, B, R5, PtO-t, Pl 52.9' to 53.3' fractured rock 53.9' 0-5°, B, R5, PtO-t, Pl 54.3' 0-5°, B, R5, t, Pl 54.5' 0-5°, B, R5, PtO-t, Pl 54.7' 0-5°, B, R5, t, Pl 54.8' 0-5°, B, R4-R5, O, Pl 55.0' 0-5°, B, R4, O, Pl 55.2' 0-5°, B, R5, PtO-t, Pl	10		Run-10 55.0' - 60.0' 15 minute run Down Pressure = 400 psi
936	58							
934	60	30	99	2.2	55.4' 0-5°, B, R5, t, Pl 55.8' 0-5°, B, R5, PtO-t, Pl 55.9' 0-5°, B, R5, t, Pl 56.5' 0-5°, B, R5, PtO-t, Pl 57.0' 0-5°, B, R4-R5, t, Pl 57.1' 0-5°, B, R5, O, Pl 57.6' 0-5°, B, R5, PtO-t, Pl 58.1' 0-5°, B, R4-R5, O, Pl 58.4' 0-5°, B, R5, t, Pl 58.6' 0-5°, B, R4-R5, O, Pl 58.9' 0-5°, B, R4-R5, O, Pl	11		Run-11 60.0' - 65.0' 14 minute run Down Pressure = 400 psi
932	62							
930	64							
928	66	65	100	2	59.1' 0-5°, B, R4-R5, O, Pl 59.5' 0-5°, B, R5, PtO-t, Pl 59.6' 0-5°, B, R4, t, Pl 60.1' 0-5°, B, R5, PtO-t, Pl 60.2' 0-5°, B, R5, PtO-t, Pl 60.5' 0-5°, B, R4-R5, O, Pl 60.7' 0-5°, B, R5, t, Pl 60.8' 0-5°, B, R5, PtO-t, Pl 61.3' 0-5°, B, R5, t, Pl 62.4' 0-5°, B, R4, t, Pl 63.0' 0-5°, B, R5, PtO-t, Pl	12		Run-12 65.0' - 70.0' 12 minute run Down Pressure = 300 to 400 psi
926	68							
924	70	31	100	2.2	63.8' to 64.0' 90°, Jt, R4-R5, O, Pl 64.3' 0-5°, B, R5, PtO-t, Pl 64.6' 0-5°, B, R4-R5, O, Pl 65.2' 0-5°, B, R5, PtO-t, Pl 65.3' 0-5°, B, R4, t, Pl 66.6' 0-5°, B, R5, PtO-t, Pl 67.3' 0-5°, B, R4, O, Pl 68.1' to 68.3' fractured rock 68.5' 0-5°, B, R4, t, Pl 68.8' 0-5°, B, R5, PtO-t, Pl 69.2' 0-5°, B, R4, O, Pl	13		Run-13 70.0' - 75.0' 12 minute run Down Pressure = 400 psi
922	72							
920	74							
918	76	83	99	2.2	69.5' 0-5°, B, R5, PtO-t, Pl 69.7' 0-5°, B, R4-R5, O, Pl 70.1' 0-5°, B, R5, PtO-t, Pl 70.3' 0-5°, B, R4, t, Pl 70.5' 0-5°, B, R5, PtO-t, Pl 70.6' 0-5°, B, R4, O, Pl 71.1' 0-5°, B, R5, PtO-t, Pl 72.5' 0-5°, B, R4-R5, O, Pl 73.7' 0-5°, B, R5, t, Pl 73.9' 0-5°, B, R4-R5, O, Pl 74.1' 0-5°, B, R4-R5, O, Pl	14		Run-14 75.0' - 80.0' 10 minute run Down Pressure = 400 psi
916	78							
914	80	9	100	1.8	74.6' 0-5°, B, R5, PtO-t, Pl 74.8' 0-5°, B, R4, t, Pl 75.0' 0-5°, B, R5, PtO-t, Pl 75.6' 0-5°, B, R5, PtO-t, Pl 76.2' 0-5°, B, R4-R5, O, Pl 76.5' 0-5°, B, R5, t, Pl 77.0' 0-5°, B, R5, PtO-t, Pl 77.3' 0-5°, B, R5, t, Pl 78.2' 0-5°, B, R4, t, Pl 78.3' 0-5°, B, R5, PtO-t, Pl 78.6' 0-5°, B, R4-R5, O, Pl	15		Run-15 80.0' - 85.0'
912	82							
910	84							
908	86	63	100	1.2	79.0' 0-5°, B, R5, t, Pl 79.3' 0-5°, B, R5, PtO-t, Pl 80.2' 0-5°, B, R5, t, Pl 80.3' 0-5°, B, R4, t, Pl 81.2' 0-5°, B, R5, PtO-t, Pl 81.9' 0-5°, B, R4-R5, O, Pl 82.2' 0-5°, B, R5, PtO-t, Pl 82.7' 0-5°, B, R4, O, Pl 83.0' 0-5°, B, R5, PtO-t, Pl 83.4' 0-5°, B, R4-R5, O, Pl 84.7' 0-5°, B, R5, t, Pl	16		Run-16 85.0' - 90.0' 9 minute run Down Pressure = 450 psi
906	88							
904								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-41**
Coordinates: N 767330.5 E 1867972.3	Driller: Rii/ S.P		**Sheet No. 3 of 5**
Top Drillhole Elevation: 993.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.7 feet MSL	Prepared By: A. Mirza		
Total Depth: 190.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/12/18 End: 2/14/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 12.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
902	92	80	98	1.2	85.1' 0-5°, B, R5, PtO-t, Pl 86.3' 0-5°, B, R5, t, Pl 87.2' 0-5°, B, R5, PtO-t, Pl 87.9' 0-5°, B, R5, PtO-t, Pl 88.7' 0-5°, B, R4, O, Pl 89.3' 0-5°, B, R5, PtO-t, Pl 90.6' 0-5°, B, R4-R5, O, Pl 90.8' 0-5°, B, R5, PtO-t, Pl 91.3' 0-5°, B, R4, t, Pl 91.8' 0-5°, B, R5, PtO-t, Pl 92.2' 0-5°, B, R4, O, Pl	17	90.0 to 108.5' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	Run-17 90.0' - 95.0' 12 minute run Down Pressure = 450 psi
900	94							
898	96	75	99	1.6	93.0' 0-5°, B, R5, PtO-t, Pl 93.9' 0-5°, B, R4-R5, O, Pl 94.1' 0-5°, B, R5, t, Pl 94.2' 0-5°, B, R4-R5, O, Pl 94.4' 0-5°, B, R4-R5, O, Pl 94.7' 0-5°, B, R5, PtO-t, Pl 95.0' 0-5°, B, R4, t, Pl 95.3' 0-5°, B, R5, PtO-t, Pl 95.6' 0-5°, B, R5, PtO-t, Pl 96.3' 0-5°, B, R4-R5, O, Pl 97.7' 0-5°, B, R5, t, Pl	18		Run-18 95.0' - 100.0' 11 minute run Down Pressure = 450 psi
896	98							
894	100							
892	102	81	100	1.2	98.3' 0-5°, B, R5, PtO-t, Pl 99.1' 0-5°, B, R5, t, Pl 99.7' 0-5°, B, R4, t, Pl 100.3' 0-5°, B, R5, PtO-t, Pl 101.0' 0-5°, B, R4-R5, O, Pl 101.2' 0-5°, B, R5, PtO-t, Pl 101.8' 0-5°, B, R5, t, Pl 102.4' 0-5°, B, R4, t, Pl	19		Run-19 100.0' - 105.0' 10 minute run Down Pressure = 450 to 500 psi
890	104				103.9' 0-5°, B, R5, PtO-t, Pl			
888	106	81	94	1	105.0' 0-5°, B, R5, PtO-t, Pl 105.3' 0-5°, B, R4-R5, O, Pl 105.9' 0-5°, B, R5, t, Pl 106.5' 0-5°, B, R5, PtO-t, Pl	20		Run-20 105.0' - 110.0' 11 minute run Down Pressure = 450 to 500 psi
886	108							
884	110						108.5 to 121.7' **BEDFORD SHALE**, grey with red bands, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	Run-21 110.0' - 115.0' 5 minute run Down Pressure = 500 psi
882	112	85	100	1.6	110.9' 0-5°, B, R4, t, Pl 111.3' 0-5°, B, R5, PtO-t, Pl 111.9' 0-5°, B, R5, PtO-t, Pl 112.5' 0-5°, B, R4, t, Pl 112.6' 0-5°, B, R5, PtO-t, Pl	21		
880	114				113.6' 0-5°, B, R4, O, Pl 114.1' 0-5°, B, R5, PtO-t, Pl 114.7' 0-5°, B, R4-R5, O, Pl			
878	116	80	92	1.2	115.0' 0-5°, B, R5, t, Pl 115.8' 0-5°, B, R4-R5, O, Pl 116.4' 0-5°, B, R4-R5, O, Pl 117.0' 0-5°, B, R5, PtO-t, Pl	22		Run-22 115.0' - 120.0' 13 minute run Down Pressure = 500 psi
876	118				117.7' 0-5°, B, R4, t, Pl 118.6' 0-5°, B, R5, PtO-t, Pl 119.2' 0-5°, B, R5, O, Pl			
874	120	100	96	1	120.1' 0-5°, B, R5, PtO-t, Pl 120.3' 0-5°, B, R4-R5, O, Pl 121.2' 0-5°, B, R5, t, Pl	23	121.7 to 143.5' **BEDFORD SHALE**, red, very fine grained, unweathered, soft, thinly bedded, slightly to moderately fractured, flat	Run-23 120.0' - 125.0' 12 minute run Down Pressure = 500 psi
872	122							
870	124				124.1' 0-5°, B, R4-R5, O, Pl 124.8' to 125' fractured rock			
868	126	90	100	1.6	125.1' 0-5°, B, R5, t, Pl 125.7' 0-5°, B, R5, PtO-t, Pl 126.1' 0-5°, B, R5, t, Pl	24		Run-24 125.0' - 130.0' 11 minute run Down Pressure = 500 psi
866	128				127.6' 0-5°, B, R4, t, Pl 128.1' 0-5°, B, R5, PtO-t, Pl			
864					129.2' 0-5°, B, R4-R5, O, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-41**
Coordinates: N 767330.5 E 1867972.3	Driller: Rii/ S.P		**Sheet No. 4 of 5**
Top Drillhole Elevation: 993.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.7 feet MSL	Prepared By: A. Mirza		
Total Depth: 190.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/12/18 End: 2/14/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 12.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
862	132	100	99	1	129.7' 0-5°, B, R5, t, Pl 129.8' 0-5°, B, R4-R5, O, Pl 130.6' 0-5°, B, R5, t, Pl 131.2' 0-5°, B, R5, PtO-t, Pl 132.3' 0-5°, B, R4-R5, t, Pl	25		Run-25 130.0' - 135.0' 17 minute run Down Pressure = 500 psi
860	134				133.4' 0-5°, B, R5, PtO-t, Pl 134.2' 0-5°, B, R5, PtO-t, Pl			
858	136	90	94	1	134.9' 0-5°, B, R5, t, Pl 135.4' 0-5°, B, R4, t, Pl	26		Run-26 135.0' - 140.0' 13 minute run Down Pressure = 500 psi
856	138				137.3' 0-5°, B, R5, PtO-t, Pl 137.7' 0-5°, B, R4-R5, O, Pl			
854	140				139.1' 0-5°, B, R5, PtO-t, Pl			
852	142	94	100	1	140.3' 0-5°, B, R4, O, Pl 142.4' 0-5°, B, R4-R5, O, Pl	27		Run-27 140.0' - 145.0' 15 minute run
850	144				142.5' 0-5°, B, R5, t, Pl 143.8' 0-5°, B, R5, t, Pl		143.5 to 150.0' **BEDFORD SHALE**, grey with red bands, very fine grained, unweathered, soft, thinly bedded, slightly to moderately fractured, flat	
848	146	100	100	0.8	145.0' 0-5°, B, R4-R5, O, Pl 145.1' 0-5°, B, R5, t, Pl 145.2' 0-5°, B, R5, PtO-t, Pl	28		Run-28 145.0' - 150.0' 11 minute run Down Pressure = 500 psi
846	148							
844	150				149.1' 0-5°, B, R4-R5, t, Pl			
842	152	78	100	0.4	149.9' 0-5°, B, R5, PtO-t, Pl 151.3' 0-5°, B, R5, PtO-t, Pl 151.9' 0-5°, B, R5, t, Pl	29	150.0 to 164.5' **OHIO SHALE**, black, very fine grained, unweathered, soft to moderately hard, thinly bedded, slightly to moderately fractured, flat	Run-29 150.0' - 155.0' 12 minute run Down Pressure = 500 psi
840	154							
838	156	100	100	1	155.2' 0-5°, B, R4, t, Pl 156.1' 0-5°, B, R5, t, Pl 156.9' 0-5°, B, R4-R5, O, Pl	30		Run-30 155.0' - 160.0' 14 minute run Down Pressure = 500 psi
836	158				158.0' to 158.5' 90°, R3-R4, O, Und 158.6' to 158.9' fractured rock			
834	160				159.8' 0-5°, B, R5, PtO-t, Pl			Run-31 160.0' - 165.0' 11 minute run Down Pressure = 500 psi
832	162	100	97	1	162.1' 0-5°, B, R4, O, Pl	31		
830	164							
828	166						164.5 to 190.0' **OHIO SHALE**, black, very fine grained, unweathered, soft to moderately hard, thinly bedded, slightly to moderately fractured, flat, pyritic	Run-32 165.0' - 170.0' 9 minute run Down Pressure = 500 psi
826	168	100	100	0		32		168.5' - 169.0' UCS = 3,691 psi 168.5' - 169.0' UCS = 3,691 Psi
824								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-41	
Coordinates: N 767330.5 E 1867972.3	Driller: Rii/ S.P	Sheet No. 5 of 5	
Top Drillhole Elevation: 993.7 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.7 feet MSL	Prepared By: A. Mirza		
Total Depth: 190.0 feet	Checked By: B. Madras Natarajan	Date Start: 2/12/18 End: 2/14/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 12.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
822	172	97	96	0.2		33		Run-33 170.0' - 175.0' 9 minute run Down Pressure = 500 PSI
820	174				174.1' 0-5°, B, R5, t, Pl			
818	176							Run-34 175.0' - 180.0' 6 minute run Down Pressure = 500 psi
816	178	100	100	0.6	177.6' 0-5°, B, R5, PtO-t, Pl 178.1' 0-5°, B, R4-R5, O, Pl	34		
814	180				179.6' 0-5°, B, R5, t, Pl			Run-35 180.0' - 185.0' 10 minute run Down Pressure = 500 psi
812	182	100	99	1	181.2' 0-5°, B, R4-R5, O, Pl 181.9' 0-5°, B, R4-R5, O, Pl	35		
810	184				183.2' 0-5°, B, R5, t, Pl 183.9' 0-5°, B, R4, O, Pl 184.5' 0-5°, B, R5, PtO-t, Pl			
808	186				185.9' 0-5°, B, R5, t, Pl 186.1' 0-5°, B, R4, t, Pl			Run-36 185.0' - 190.0' 10 minute run Down Pressure = 500 psi
806	188	100	100	0.6	187.0' 0-5°, B, R5, PtO-t, Pl	36		
804	190						**End of Boring at 190.0 feet**	
802	192							
800	194							
798	196							
796	198							
794	200							
792	202							
790	204							
788	206							
786	208							
784								

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-42**
Coordinates:	N 768481.1 E 1867912.8	Driller:	Rii/ S.P	**Sheet No. 1 of 5**
Top Drillhole Elevation:	995.5 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	803.5 feet MSL	Prepared By:	A. Mirza	
Total Depth:	192.0 feet	Checked By:	B. Madras Natarajan	Date Start: 3/16/18 End: 3/20/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 7.8

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
994	2							
992	4							
990	6				5.5' to 7.0' 0-5°, 15 Bs, R4-R5, O, Pl			
988	8	0	91	6.8	7.1' to 7.2' fractured rock 7.3' 0-5°, B, R5, PtO-t, Pl 7.4' 0-5°, B, R5, O, Pl 7.6' 0-5°, B, R4, t, Pl 7.7' 0-5°, B, R4, t, Pl 7.9' 0-5°, B, R5, PtO-t, Pl	1	5.5 to 12.0' **BEREA SANDSTONE**, grey, fine to medium grained, highly weathered, soft to moderately hard, thinly bedded, highly to intensely fractured, ferriferous ▽	Top of Rock @ 5.5' Run-1 5.5' - 10.0' 10 minute run Down Pressure = 250 psi
986	10				8.1' to 8.7' 0-5°, 7 Bs, R4-R5, O, Pl 9.0' to 9.3' fractured rock 9.4' 0-5°, B, R5, t, Pl 9.7' 0-5°, B, R5, PtO-t, Pl			
984	12				10.1' 0-5°, B, R4-R5, t, Pl 10.2' 0-5°, B, R5, O, Pl 10.4' to 10.9' 0-5°, 5 Bs, R4-R5, O, Pl 11.0' to 11.9' 0-5°, 10 Bs, R4-R5, O, Pl 12.1' 0-5°, B, R5, PtO-t, Pl 12.5' 0-5°, B, R5, t, Pl			Run-2 10.0' - 20.0' 18 minute run Down Pressure = 350 psi
982	14				12.7' 0-5°, B, R5, PtO-t, Pl			
980	16	12	100	4.8	12.8' 0-5°, B, R5, t, Pl 12.9' 0-5°, B, R4, t, Pl 13.1' 0-5°, B, R5, PtO-t, Pl 13.2' 0-5°, B, R4-R5, O, Pl 13.3' 0-5°, B, R5, t, Pl 13.5' 0-5°, B, R4-R5, O, Pl	2	12.0 to 50.7' **BEREA SANDSTONE**, grey, fine to medium grained, slightly weathered, moderately hard, thinly bedded, highly fractured, ferriferous	
978	18				13.6' 0-5°, B, R5, t, Pl 14.9' 0-5°, B, R5, PtO-t, Pl 15.2' 0-5°, B, R4-R5, t, Pl 15.5' 0-5°, B, R5, PtO-t, Pl 15.7' 0-5°, B, R4-R5, PtO-t, Pl			
976	20				15.8' 0-5°, B, R5, t, Pl 16.2' 0-5°, B, R4, t, Pl 16.3' 0-5°, B, R5, O, Pl 16.6' 0-5°, B, R4-R5, t, Pl 16.8' to 17.0' fractured rock			Run-3 20.0' - 30.0' 18 minute run Down Pressure = 350 to 400 psi
974	22				17.1' 0-5°, B, R5, t, Pl 17.4' 0-5°, B, R4, t, Pl 17.5' 0-5°, B, R5, PtO-t, Pl 17.9' 0-5°, B, R4-R5, O, Pl 18.2' 0-5°, B, R5, t, Pl			
972	24				18.4' 0-5°, B, R4-R5, O, Pl			
970	26	80	100	2.5	18.6' 0-5°, B, R5, t, Pl 18.8' 0-5°, B, R5, PtO-t, Pl 19.5' 0-5°, B, R4-R5, t, Pl 19.7' 0-5°, B, R5, PtO-t, Pl 20.2' 0-5°, B, R5, PtO-t, Pl	3		
968	28				20.7' 0-5°, B, R4-R5, O, Pl 20.9' 0-5°, B, R5, PtO-t, Pl 21.1' 0-5°, B, R4, t, Pl 21.6' 0-5°, B, R5, PtO-t, Pl 21.9' 0-5°, B, R4-R5, PtO-t, Pl			
966	30				23.0' 0-5°, B, R5, t, Pl 23.4' 0-5°, B, R4-R5, O, Pl			
964	32				23.7' 0-5°, B, R5, t, Pl 23.9' 0-5°, B, R5, PtO-t, Pl 24.5' 0-5°, B, R4-R5, t, Pl 24.9' 0-5°, B, R5, PtO-t, Pl 25.3' 0-5°, B, R5, PtO-t, Pl			Run-4 30.0' - 40.0' 16 minute run Down Pressure = 300 to 400 psi
962	34				25.5' 0-5°, B, R5, t, Pl 25.8' 0-5°, B, R5, PtO-t, Pl 26.1' 0-5°, B, R5, PtO-t, Pl 26.2' 0-5°, B, R4-R5, O, Pl 26.3' 0-5°, B, R5, t, Pl			
960	36	51	99	2	26.4' 0-5°, B, R4, O, Pl 27.8' 0-5°, B, R5, PtO-t, Pl 28.5' 0-5°, B, R4-R5, O, Pl 28.6' 0-5°, B, R5, PtO-t, Pl 29.2' 0-5°, B, R4, t, Pl	4		
958	38				29.6' 0-5°, B, R5, PtO-t, Pl 30.4' 0-5°, B, R4, O, Pl 30.5' 0-5°, B, R5, PtO-t, Pl 30.6' 0-5°, B, R4-R5, O, Pl 31.1' 0-5°, B, R5, t, Pl			
956					31.4' 0-5°, B, R4-R5, O, Pl 32.4' 0-5°, B, R4, O, Pl			

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-42**
Coordinates: N 768481.1 E 1867912.8	Driller: Rii/ S.P		**Sheet No. 2 of 5**
Top Drillhole Elevation: 995.5 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.5 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/16/18 End: 3/20/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.8	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
954	42	63	95	1.8	33.0' 0-5°, B, R5, PtO-t, Pl 34.1' 0-5°, B, R4-R5, O, Pl 34.2' 0-5°, B, R4, O, Pl 34.3' 0-5°, B, R5, PtO-t, Pl 35.0' to 35.6' 90°, Jt, R4-R5, O, Und 35.8' to 35.9' fractured rock 37.0' 0-5°, B, R5, PtO-t, Pl 37.4' 0-5°, B, R4-R5, O, Pl 37.8' 0-5°, B, R4-R5, PtO-t, Pl 38.1' 0-5°, B, R4-R5, O, Pl 38.3' to 38.5' fractured rock 38.7' 0-5°, B, R4-R5, O, Pl 39.0' 0-5°, B, R5, PtO-t, Pl 39.3' 0-5°, B, R4-R5, O, Pl 39.4' 0-5°, B, R5, t, Pl 40.4' 0-5°, B, R4-R5, O, Pl 40.7' 0-5°, B, R5, PtO-t, Pl 42.3' 0-5°, B, R4-R5, O, Pl 42.6' 0-5°, B, R5, PtO-t, Pl 42.7' 0-5°, B, R4-R5, O, Pl 44.1' to 44.5' 0-5°, 5 Bs, R4-R5, O, Pl 45.5' 0-5°, B, R5, O, Pl	5		Run-5 40.0' - 50.0' 12 minute run Down Pressure = 400 psi
952	44							
950	46							
948	48							
946	50							
944	52				46.1' 0-5°, B, R4-R5, O, Pl 46.2' to 46.3' fractured rock 46.5' 0-5°, B, R5, t, Pl 46.6' 0-5°, B, R5, PtO-t, Pl 47.5' 0-5°, B, R4-R5, O, Pl 47.8' 0-5°, B, R5, O, Pl 49.2' to 49.3' fractured rock 50.1' to 50.3' fractured rock 50.7' 0-5°, B, R4-R5, O, Pl 50.9' 0-5°, B, R5, O, Pl 51.0' to 51.3' 0-5°, 4 Bs, R4-R5, O, Pl 51.7' to 51.9' 0-5°, 3 Bs, R4, O, Pl 52.1' 0-5°, B, R4, O, Pl 52.5' 0-5°, B, R5, PtO-t, Pl 52.7' 0-5°, B, R5, t, Pl 52.8' 0-5°, B, R4, O, Pl 53.0' 0-5°, B, R5, O, Pl 53.3' 0-5°, B, R5, t, Pl 53.4' 0-5°, B, R4-R5, O, Pl 53.5' 0-5°, B, R4, O, Pl 53.7' 0-5°, B, R5, PtO-t, Pl 53.9' 0-5°, B, R5, t, Pl	6	50.7 to 103.3' Interbedded **BEREA SANDSTONE** and **BEDFORD SHALE** **BEREA SANDSTONE**, grey, fine to medium grained, slightly weathered, moderately hard, thinly bedded, flat **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	Run-6 50.0' - 60.0' 21 minute run (blockage after 11 minutes) Down Pressure = 400 psi
942	54	17	98	4.7				
940	56							
938	58							
936	60				54.3' to 54.7' 0-5°, 5 Bs, R4-R5, O, Pl 55.0' 0-5°, B, R5, t, Pl 55.1' 0-5°, B, R5, PtO-t, Pl 55.2' 0-5°, B, R5, t, Pl 55.4' 0-5°, B, R5, O, Pl 55.6' 0-5°, B, R5, PtO-t, Pl 55.8' 0-5°, B, R5, PtO-t, Pl 56.1' 0-5°, B, R4, O, Pl 56.2' 0-5°, B, R4, O, Pl 56.3' 0-5°, B, R5, PtO-t, Pl 56.4' 0-5°, B, R5, PtO-t, Pl 56.6' 0-5°, B, R4, O, Pl 56.7' 0-5°, B, R4-R5, O, Pl 57.2' 0-5°, B, R5, O, Pl 57.4' 0-5°, B, R4-R5, O, Pl 57.6' 0-5°, B, R5, t, Pl 57.9' 0-5°, B, R5, PtO-t, Pl 58.2' 0-5°, B, R4-R5, O, Pl 58.4' 0-5°, B, R5, PtO-t, Pl 58.7' 0-5°, B, R5, O, Pl 58.9' 0-5°, B, R4, t, Pl 59.2' 0-5°, B, R5, PtO-t, Pl	7		Run-7 60.0' - 70.0' 19 minute run Down Pressure = 300 to 500 psi
934	62							
932	64							
930	66	56	100	2.9				
928	68							
926	70							
924	72				59.4' 0-5°, B, R4-R5, O, Pl 60.1' 0-5°, B, R5, O, Pl 60.4' 0-5°, B, R4-R5, O, Pl 60.5' 0-5°, B, R5, t, Pl 60.7' 0-5°, B, R5, PtO-t, Pl 61.2' 0-5°, B, R5, PtO-t, Pl 61.3' 0-5°, B, R5, O, Pl 61.4' 0-5°, B, R4-R5, O, Pl 62.6' 0-5°, B, R4-R5, O, Pl 62.7' 0-5°, B, R5, t, Pl 62.9' 0-5°, B, R5, PtO-t, Pl 63.0' 0-5°, B, R4-R5, O, Pl 63.4' 0-5°, B, R4-R5, O, Pl 63.6' to 63.7' fractured rock 63.8' 0-5°, B, R5, t, Pl 64.1' 0-5°, B, R4-R5, O, Pl 64.2' 0-5°, B, R4-R5, O, Pl 64.5' 0-5°, B, R5, PtO-t, Pl 65.5' 0-5°, B, R4, t, Pl 65.6' 0-5°, B, R5, PtO-t, Pl 65.8' 0-5°, B, R5, PtO-t, Pl 65.9' 0-5°, B, R5, O, Pl	8		Run-8 70.0' - 80.0' 20 minute run Down Pressure = 400 psi
922	74							
920	76	34	100	3.9				
918	78							
916								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-42**
Coordinates: N 768481.1 E 1867912.8	Driller: Rii/ S.P		**Sheet No. 3 of 5**
Top Drillhole Elevation: 995.5 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.5 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/16/18 End: 3/20/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.8	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
914	82				66.4' 0-5°, B, R4-R5, O, Pl 66.5' 0-5°, B, R4-R5, t, Pl 67.8' 0-5°, B, R5, t, Pl 68.1' 0-5°, B, R5, PtO-t, Pl 68.4' 0-5°, B, R5, t, Pl 69.2' 0-5°, B, R4, t, Pl 69.5' 0-5°, B, R5, PtO-t, Pl 69.7' 0-5°, B, R4-R5, PtO-t, Pl 70.4' 0-5°, B, R4-R5, O, Pl 70.6' 0-5°, B, R5, t, Pl 71.1' 0-5°, B, R4-R5, t, Pl 71.6' 0-5°, B, R4, O, Pl 71.8' to 71.9' fractured rock 72.2' 0-5°, B, R5, t, Pl 72.3' 0-5°, B, R5, PtO-t, Pl 72.4' 0-5°, B, R4-R5, O, Pl 72.6' 0-5°, B, R5, t, Pl 72.7' 0-5°, B, R4-R5, O, Pl 72.9' 0-5°, B, R4-R5, O, Pl 73.2' 0-5°, B, R5, t, Pl 73.3' 0-5°, B, R4, O, Pl 73.6' 0-5°, B, R5, PtO-t, Pl	9		Run-9 80.0' - 90.0' 15 minute run Down Pressure = 450 psi
912	84							
910	86	72	100	2.5				
908	88							
906	90				73.8' 0-5°, B, R5, t, Pl 73.9' 0-5°, B, R4-R5, O, Pl 74.0' 0-5°, B, R5, t, Pl 74.6' 0-5°, B, R4-R5, O, Pl 74.8' 0-5°, B, R4-R5, O, Pl 74.9' 60°, Jt, R3-R4, O, Und 75.1' 0-5°, B, R4, O, Pl 75.6' 0-5°, B, R5, PtO-t, Pl 75.7' 0-5°, B, R4-R5, O, Pl 75.8' 0-5°, B, R5, PtO-t, Pl 76.1' 0-5°, B, R4, t, Pl 76.5' 0-5°, B, R5, PtO-t, Pl 76.7' 0-5°, B, R4, O, Pl 77.2' 0-5°, B, R5, PtO-t, Pl 77.4' 0-5°, B, R4-R5, O, Pl 77.5' 0-5°, B, R5, t, Pl 77.7' 0-5°, B, R4-R5, O, Pl 77.8' 0-5°, B, R4-R5, O, Pl 77.9' 0-5°, B, R5, PtO-t, Pl 78.4' 0-5°, B, R4, t, Pl 78.5' 0-5°, B, R5, PtO-t, Pl 79.2' 0-5°, B, R5, PtO-t, Pl	10		Run-10 90.0' - 100.0' 20 minute run Down Pressure = 400 psi
904	92							
902	94							
900	96	72	100	2.2				
898	98							
896	100				79.5' 0-5°, B, R5, t, Pl 79.8' 0-5°, B, R4-R5, O, Pl 80.1' 0-5°, B, R5, t, Pl 80.3' 0-5°, B, R5, PtO-t, Pl 80.4' 0-5°, B, R4-R5, t, Pl 80.7' 0-5°, B, R5, PtO-t, Pl 80.9' 0-5°, B, R5, PtO-t, Pl 81.1' 0-5°, B, R5, t, Pl 81.7' 0-5°, B, R4, t, Pl 82.1' 0-5°, B, R5, PtO-t, Pl 82.2' 0-5°, B, R4-R5, O, Pl 82.5' 0-5°, B, R5, PtO-t, Pl 83.2' 0-5°, B, R4, O, Pl 83.4' 0-5°, B, R5, PtO-t, Pl 84.5' 0-5°, B, R4-R5, O, Pl 84.6' 0-5°, B, R5, t, Pl 84.8' 0-5°, B, R4-R5, O, Pl 85.0' 0-5°, B, R5, PtO-t, Pl 85.5' 0-5°, B, R4, t, Pl 85.9' 0-5°, B, R5, PtO-t, Pl 86.8' 0-5°, B, R4, O, Pl 87.0' 0-5°, B, R5, PtO-t, Pl	11	103.3 to 117.5' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat, unweathered joints	Run-11 100.0' - 110.0' 19 minute run Down Pressure = 400 psi
894	102							
892	104	94	99	1				
890	106							
888	108							
886	110				87.3' 0-5°, B, R4-R5, O, Pl 87.9' 0-5°, B, R5, PtO-t, Pl 88.5' 0-5°, B, R5, PtO-t, Pl 89.5' 0-5°, B, R5, t, Pl 89.7' 0-5°, B, R4, t, Pl 90.4' 0-5°, B, R5, PtO-t, Pl 90.7' 0-5°, B, R4-R5, O, Pl 91.0' 0-5°, B, R5, PtO-t, Pl 91.1' 0-5°, B, R4, O, Pl 91.8' 0-5°, B, R5, PtO-t, Pl 92.1' 0-5°, B, R4-R5, O, Pl 92.3' 0-5°, B, R5, t, Pl 93.0' 0-5°, B, R4-R5, O, Pl 93.2' 0-5°, B, R5, PtO-t, Pl 94.2' 0-5°, B, R5, PtO-t, Pl 94.3' 0-5°, B, R5, t, Pl 95.0' 0-5°, B, R4, t, Pl 95.8' 0-5°, B, R5, PtO-t, Pl	12		Run-12 110.0' - 120.0' 17 minute run Down Pressure = 400 psi
884	112							
882	114							
880	116	99	99	0.8				
878	118				96.1' to 96.4' 0-5°, 4 Bs, R4-R5, O, Pl 97.0' 0-5°, B, R5, t, Pl 97.8' 0-5°, B, R4-R5, O, Pl 98.6' 0-5°, B, R4-R5, O, Pl		117.5 to 150.0' **BEDFORD SHALE**, red, very fine grained, unweathered, soft, thinly bedded, slightly to moderately fractured, flat, unweathered joints	
876								

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Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-42**
Coordinates: N 768481.1 E 1867912.8	Driller: Rii/ S.P		**Sheet No. 4 of 5**
Top Drillhole Elevation: 995.5 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.5 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/16/18 End: 3/20/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.8	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
874	122				99.2' 0-5°, B, R5, PtO-t, Pl 99.6' 0-5°, B, R4, O, Pl 101.2' 0-5°, B, R3-R4, O, Pl 101.5' 0-5°, B, R5, t, Pl 101.9' 0-5°, B, R4, t, Pl 103.4' 0-5°, B, R5, PtO-t, Pl 104.1' 0-5°, B, R4-R5, O, Pl 106.5' 0-5°, B, R5, PtO-t, Pl 107.8' 0-5°, B, R4, O, Pl 107.9' 0-5°, B, R5, PtO-t, Pl 108.1' 0-5°, B, R4-R5, O, Pl 109.2' 0-5°, B, R5, PtO-t, Pl 110.6' 0-5°, B, R4, O, Pl 111.2' 0-5°, B, R5, O, Pl 111.7' 0-5°, B, R5, PtO-t, Pl 112.1' 0-5°, B, R4-R5, O, Pl 114.4' 0-5°, B, R5, PtO-t, Pl 116.7' 0-5°, B, R4, O, Pl 117.4' 0-5°, B, R5, PtO-t, Pl 118.1' 0-5°, B, R5, PtO-t, Pl 120.1' 0-5°, B, R5, t, Pl 120.2' 0-5°, B, R4, t, Pl			Run-13 120.0' - 130.0' 20 minute run Down Pressure = 500 psi 24% LEL (vented to 0% after 15 minutes)
872	124							
870	126	92	100	1.6		13		120.0' - 130.0' Gas Meter LEL = 24
868	128							
866	130				120.4' 0-5°, B, R5, PtO-t, Pl 120.6' 0-5°, B, R4-R5, O, Pl 121.8' 0-5°, B, R5, PtO-t, Pl 122.4' 0-5°, B, R4, O, Pl 123.9' 0-5°, B, R5, PtO-t, Pl 124.2' 0-5°, B, R4-R5, O, Pl 125.1' 0-5°, B, R5, t, Pl 125.2' 0-5°, B, R4-R5, O, Pl 125.7' 0-5°, B, R5, PtO-t, Pl 126.4' 0-5°, B, R4, t, Pl 127.6' 0-5°, B, R5, PtO-t, Pl 128.1' 0-5°, B, R4, O, Pl 129.4' 0-5°, B, R5, PtO-t, Pl 129.7' 0-5°, B, R4-R5, O, Pl 133.2' 0-5°, B, R5, PtO-t, Pl 133.9' 0-5°, B, R5, PtO-t, Pl 134.4' 0-5°, B, R4-R5, O, Pl 134.9' 0-5°, B, R4-R5, t, Pl 135.6' 0-5°, B, R4-R5, O, Pl 135.8' 0-5°, B, R5, t, Pl 136.3' 0-5°, B, R5, t, Pl 136.5' 0-5°, B, R4-R5, O, Pl			Run-14 130.0' - 140.0' 19 minute run Down Pressure = 500 psi
864	132							
862	134							
860	136	76	100	1.5		14		
858	138							
856	140				136.6' 0-5°, B, R5, t, Pl 137.7' 0-5°, B, R4-R5, O, Pl 138.3' 0-5°, B, R5, PtO-t, Pl 138.4' 0-5°, B, R4, O, Pl 138.8' 0-5°, B, R5, PtO-t, Pl 139.0' 0-5°, B, R5, PtO-t, Pl 139.7' 0-5°, B, R4-R5, O, Pl 140.5' 0-5°, B, R5, t, Pl 141.7' 0-5°, B, R4, O, Pl 142.3' 0-5°, B, R5, PtO-t, Pl 142.8' 0-5°, B, R4-R5, O, Pl 143.1' 0-5°, B, R4, PtO-t, Pl 143.2' 0-5°, B, R5, PtO-t, Pl 143.4' 0-5°, B, R4, t, Pl 143.6' 0-5°, B, R4-R5, PtO-t, Pl 143.7' 0-5°, B, R4-R5, O, Pl 144.3' 0-5°, B, R5, PtO-t, Pl 144.7' 0-5°, B, R5, O, Pl 145.2' 0-5°, B, R4-R5, O, Pl 145.4' 0-5°, B, R5, PtO-t, Pl 146.4' 0-5°, B, R5, O, Pl 147.9' 0-5°, B, R4-R5, O, Pl			Run-15 140.0' - 150.0' 25 minute run Down Pressure = 500 psi
854	142							
852	144							
850	146	82	100	1.9		15		
848	148							
846	150				148.4' 0-5°, B, R5, O, Pl			
844	152				149.6' 0-5°, B, R4, O, Pl 149.8' 0-5°, B, R5, O, Pl 149.9' 0-5°, B, R5, PtO-t, Pl 150.3' 0-5°, B, R4-R5, O, Pl 150.4' 0-5°, B, R5, O, Pl 150.5' 0-5°, B, R4-R5, O, Pl 150.6' 0-5°, B, R5, O, Pl 150.8' 0-5°, B, R5, PtO-t, Pl 151.6' 0-5°, B, R5, t, Pl 151.7' 0-5°, B, R4, O, Pl		150.0 to 163.2' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat, unweathered joints	Run-16 150.0' - 160.0' 21 minute run Down Pressure = 450 psi
842	154							
840	156	69	97	2.1	152.8' 0-5°, B, R5, PtO-t, Pl 154.2' 0-5°, B, R4-R5, O, Pl 154.3' 0-5°, B, R4-R5, t, Pl 154.6' 0-5°, B, R4-R5, O, Pl 154.9' 0-5°, B, R4-R5, O, Pl 155.1' 0-5°, B, R5, PtO-t, Pl 155.4' 0-5°, B, R4, t, Pl 155.7' 0-5°, B, R5, O, Pl 155.8' 0-5°, B, R5, PtO-t, Pl 156.2' 0-5°, B, R5, O, Pl 156.5' 0-5°, B, R4, t, Pl	16		
838	158							
836								

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	**BORING NO. B-42**	
Coordinates: N 768481.1 E 1867912.8	Driller: Rii/ S.P	**Sheet No. 5 of 5**	
Top Drillhole Elevation: 995.5 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 803.5 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/16/18 End: 3/20/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.8	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
834	162				157.6' 0-5°, B, R5, PtO-t, Pl 158.3' 0-5°, B, R4, O, Pl 158.6' 0-5°, B, R5, PtO-t, Pl 160.4' 0-5°, B, R4-R5, O, Pl 161.3' 0-5°, B, R5, t, Pl			Run-17 160.0' - 170.0' 19 minute run Down Pressure = 500 psi
832	164				162.8' 0-5°, B, R4-R5, O, Pl 163.2' 0-5°, B, R5, t, Pl		163.2 to 192.0' **OHIO SHALE**, black, very fine grained, unweathered, soft to moderately hard, thinly bedded, slightly to moderately fractured, flat, pyritic	
830	166	94	100	1.7	164.5' 0-5°, B, R4-R5, t, Pl 164.8' 0-5°, B, R4-R5, O, Pl 164.9' 0-5°, B, R5, t, Pl 165.1' 0-5°, B, R4-R5, O, Pl 165.6' 0-5°, B, R5, PtO-t, Pl 165.9' 0-5°, B, R4, O, Pl	17		
828	168				166.5' 0-5°, B, R5, PtO-t, Pl 166.8' 0-5°, B, R4-R5, O, Pl 167.4' 0-5°, B, R5, t, Pl 167.8' 0-5°, B, R4-R5, O, Pl			
826	170				168.0' 0-5°, B, R5, t, Pl 168.2' 0-5°, B, R5, t, Pl 169.9' 0-5°, B, R4-R5, O, Pl 170.1' 0-5°, B, R5, t, Pl			Run-18 170.0' - 180.0' 34 minute run Down Pressure = 500 psi 171.1' - 171.5' UCS = 4,010 psi
824	172				171.0' 0-5°, B, R4-R5, O, Pl 171.7' 0-5°, B, R5, t, Pl 171.9' 0-5°, B, R5, PtO-t, Pl			
822	174				173.2' 0-5°, B, R4-R5, t, Pl 173.9' 0-5°, B, R5, PtO-t, Pl 174.1' 0-5°, B, R4, t, Pl			
820	176	95	100	1.8	175.0' 0-5°, B, R5, PtO-t, Pl 175.4' 0-5°, B, R5, PtO-t, Pl 175.5' 0-5°, B, R4, t, Pl 175.6' 0-5°, B, R5, PtO-t, Pl 176.1' 0-5°, B, R4-R5, O, Pl	18		
818	178				176.4' 0-5°, B, R4, t, Pl 177.2' 0-5°, B, R5, O, Pl 177.8' 0-5°, B, R5, PtO-t, Pl 178.3' 0-5°, B, R5, PtO-t, Pl 179.0' 0-5°, B, R4, O, Pl			
816	180				179.8' 0-5°, B, R5, O, Pl 179.9' 0-5°, B, R5, PtO-t, Pl			Run-19 180.0' - 190.0' 18 minute run Down Pressure = 500 psi
814	182				181.2' 0-5°, B, R4-R5, O, Pl 181.8' 0-5°, B, R5, t, Pl 182.4' 0-5°, B, R4-R5, O, Pl			
812	184				182.5' 0-5°, B, R4-R5, O, Pl 183.8' 0-5°, B, R5, t, Pl 184.2' 0-5°, B, R4, O, Pl			
810	186	87	98	1.6	184.6' 0-5°, B, R5, PtO-t, Pl 185.0' 0-5°, B, R5, t, Pl 185.4' 0-5°, B, R4, t, Pl 186.3' 0-5°, B, R5, PtO-t, Pl	19		
808	188				187.2' 0-5°, B, R5, t, Pl 187.9' 0-5°, B, R4, O, Pl 188.6' 0-5°, B, R5, PtO-t, Pl 188.8' 0-5°, B, R4, O, Pl			
806	190				189.5' 0-5°, B, R5, PtO-t, Pl 189.7' to 190.0' fractured rock			
804	192	88	96	0.5	191.8' 0-5°, B, R5, t, Pl	20		Run-20 190.0' - 192.0' 5 minute run Down Pressure = 500 psi
802	194						**End of Boring at 192.0 feet**	
800	196							
798	198							
796								

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-43**	
Coordinates: N 769180.5 E 1868245.0	Driller: Stantec	**Sheet No. 1 of 5**	
Top Drillhole Elevation: 990.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 804.0 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 186.6 feet	Checked By: A. Mirza	Date Start: 3/19/18 End: 3/22/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 2.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
990	0							
988	2							
986	4							
984	6							
982	8							
980	10	28	91	6.1	8.6' to 9.2' fractured rock 9.2' 0-5°, B, R3, O, Pl 9.3' 0-5°, B, R3, O, Pl 9.4' 0-5°, B, R3, t, Pl 9.6' 2 Bs, R4, PtO, Pl 9.8' to 10.0' 0-5°, 4 Bs, R4, t, Pl 10.2' to 11.4' 0-5°, 8 Bs, R3-R5, PtO-O, Pl 10.3' to 10.8' 0-5°, 12 Bs, R4-R5, PtO-t, Pl 10.8' to 12.4' 0-5°, 4Bs, R4, PtO-t, Pl 12.4' to 13.2' 0-5°, 5 Bs, R4, PtO-O, Pl 12.6' 0-5°, B, R4, PtO, Pl 13.2' to 14.6' 0-5°, 10 Bs, R3-R4, PtO-O, Pl	1	8.6 to 56.6' **BEREA SANDSTONE**, grey, medium to fine grained, moderately to slightly weathered, moderately hard, moderately to highly fractured, thinly bedded, ferriferous fractures	Top of Rock @ 8.6' Run-1 8.6' - 16.6' 13 minute run Down Pressure = 400 psi
978	12							
976	14							
974	16							
972	18	63	98	3.1	18.8' to 20.2' 0-5°, 7 Bs, R3, O, Pl 20.5' to 21.9' 0-5°, 6 Bs, R4-R5, t, Pl 21.9' to 22.1' 0-5°, 3 Bs, R3, O, Pl 23.0' 0-5°, B, R3, O, Pl 23.3' to 23.8' 0-5°, 7 Bs, R4-R5, t, Pl 23.4' fractured rock 24.7' to 24.9' fractured rock 24.9' to 26.6' 0-5°, 7 Bs, R3-R5, PtO-O, Pl	2		Run-2 16.6' - 26.6' 11 minute run Down Pressure = 350 psi
970	20							
968	22							
966	24							
964	26							
962	28	59	95	2.9	26.8' to 27.2' 0-5°, 4 Bs, R4-R5, PtO-O, Pl 27.8' 0-5°, B, R3, O, Pl 28.1' fractured rock 28.2' to 28.3' 0-5°, 3 Bs, R4-R5, PtO-t, Pl 28.8' to 28.9' 0-5°, 3 Bs, R4-R5, PtO-t, Pl 29.5' 0-5°, B, R4, PtO, Pl 29.8' 0-5°, B, R4, PtO, Pl 30.6' fractured rock 31.6' 0-20°, B, R4, O, Pl 31.8' 0-20°, B, R4, O, Pl 32.0' 0-5°, B, R4, PtO, Pl 32.7' to 32.9' 0-5°, 4 Bs, R3-R4, PtO, Pl 34.0' to 36.6' 0-5°, 9 Bs, R3-R4, PtO-O, Pl-Und	3		Run-3 26.6' - 36.6' 13 minute run Down Pressure = 375 psi
960	30							
958	32							
956	34							
954	36							
952	38	15	67	3.9	36.6' to 41.2' 0-10°, 30 Bs, R3-R5, PtO-t, Pl 38.8' to 39.5' 90°, Jt, R3, t, Und	4		Run-4 36.6' - 46.6' 38 minute run Down Pressure = 400 psi

LAKE LOGS BWSTE_PHASE2_ROCK LOGS (7_25_2019).GPJ KLEINFELDER LV CORE APR06.GDT 8/2/19

Stantec

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-43	
Coordinates: N 769180.5 E 1868245.0	Driller: Stantec	Sheet No. 2 of 5	
Top Drillhole Elevation: 990.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 804.0 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 186.6 feet	Checked By: A. Mirza	Date Start: 3/19/18 End: 3/22/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 2.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
950	42	15	67	3.9	42.0' to 46.6' 0-5°, 8 Bs, R3-R5, PtO, Pl	4		
948	44							
946	46							
944	48			2.3	46.6' to 47' fractured rock 47.0' to 48.5' 0-5°, 20 Bs, R3-R5, PtO-t, Pl 48.8' to 49.3' 90°, Jt, R3, O, Und 49.3' 0-10°, B, R4, PtO, Pl 49.6' to 50.9' fracturedrock	5		Run-5 46.6' - 56.6' 21 minute run Down Pressure = 400 psi
942	50	7	50					
940	52							
938	54							
936	56							
934	58	8	66	4.8	56.6' to 57.3' 0-5°, 8 Bs, R3-R5, PtO-t, Pl 57.5' 0-5°, 3 Bs, R4, PtO, Pl 57.9' to 58.2' fractured rock 58.3' to 59.1' 0-5°, 9 Bs, R4, PtO-O, Pl 59.4' to 61.6' 0-5°, 4 Bs, R4, PtO-O, Pl	6	56.6 to 91.6' **BEDFORD SHALE**, grey, very fine grained, highly weathered, soft, highly fractured, thinly bedded, highly weathered joints, sandstone stringers	Run-6 56.6' - 61.6' 12 minute run Down Pressure = 400 psi
932	60							
930	62			6.6	61.6' to 62.4' fractured rock 62.7' to 65.9' 0-5°, 33 Bs, R4, PtO-O, Pl	7		Run-7 61.6' - 66.6' 8 minute run Down Pressure = 400 psi
928	64	8	92					
926	66							
924	68	68	90	1.5	66.6' to 66.9' 0-5°, 4 Bs, R4, PtO-O, Pl 66.9' to 67.7' fractured rock 68.0' to 68.6' 0-5°, 6 Bs, R4, PtO-t, Pl 69.2' 0-5°, B, R3-R4, PtO, Pl 70.1' to 70.2' fractured rock 70.4' 0-5°, B, R4, t, Pl 70.6' 0-5°, B, R4, PtO, Pl 71.1' 0-5°, B, R4, PtO, Pl 71.3' 0-5°, B, R4, PtO, Pl 71.8' to 71.9' fractured rock	8		Run-8 66.6' - 76.6' 22 minute run Down Pressure = 450 psi
922	70							
920	72							
918	74							
916	76							
914	78	49	85	3.1	76.2' to 76.6' fractured rock 76.6' to 82.6' 0-5°, 23 Bs, R4-R5, PtO-O, Pl	9		Run-9 76.6' - 86.6' 25 minute run Down Pressure = 400 psi
912								

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-43**	
Coordinates: N 769180.5 E 1868245.0	Driller: Stantec	**Sheet No. 3 of 5**	
Top Drillhole Elevation: 990.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 804.0 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 186.6 feet	Checked By: A. Mirza	Date Start: 3/19/18 End: 3/22/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 2.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
910	82	49	85	3.1	82.6' to 86.6' 0-5°, 8 Bs, R4-R5, PtO-t, Pl	9		
908								
906	84							
904	86							
902	88	0	14	0.6	86.6' to 87.0' 0-10°, 3 Bs, R4, PtO-O, Pl	10		Run-10 86.6' - 91.6' 22 minute run Down Pressure = 450 psi
900	90							
898	92	86	100	1.6	91.6' 0-5°, B, R4, t, Pl 91.7' 0-5°, B, R4, t, Pl 92.6' 0-5°, B, R4, t, Pl 92.8' 0-5°, B, R4, t, Pl 94.4' 0-5°, B, R4, t, Pl 94.7' 0-5°, B, R4, PtO, Pl 95.9' 0-5°, B, R4, PtO, Pl	11	91.6 to 109.4' **BEDFORD SHALE**, grey, very fine grained, moderately weathered, soft to moderately hard, moderately to highly fractured, flat bedding, highly weathered joints	Run-11 91.6' - 96.6' 6 minute run Down Pressure = 400 psi
896	94							
894	96							
892	98	10	46	3.2	96.6' to 97.2' 0-5°, 7 Bs, R4-R5, PtO-t, Pl 96.7' 0-5°, B, R4, PtO, Pl 97.7' to 98.9' 0-5°, 9 Bs, R4-R5, t-O, Pl	12		Run-12 96.6' - 101.6' 16 minute run Down Pressure = 400 psi
890	100							
888	102	28	100	7.4	101.6' to 102.3' 0-5°, 9 Bs, R4-R5, t-O, Pl 102.7' 0-5°, B, R4, t, Pl 102.9' to 103.4' 0-5°, 5 Bs, R4, PtO-t, Pl 104.0' 0-5°, B, R5, t, Pl 104.2' to 104.7' fractured rock 104.7' to 105.6' 0-5°, 8 Bs, R4, t, Pl 105.6' to 106.6' 0-5°, 13 Bs, R4, t, Pl	13		Run-13 101.6' - 106.6' 33 minute run Down Pressure = 400 psi
886	104							
884	106							
882	108	10	94	8.6	106.6' to 109.9' 0-5°, 35 Bs, R4, O-t, Pl 110.4' to 111.6' 0-5°, 8 Bs, R4, PtO, Pl	14	109.4 to 135.6' **BEDFORD SHALE**, grey with red bands, very fine grained, highly weathered, soft, highly fractured, thinly bedded, highly to severely weathered joints, agrillaceous	Run-14 106.6' - 111.6' 11 minute run Down Pressure = 400 psi
880	110							
878	112	20	92	8.4	112.0' 15-20°, B, R4, PtO, Pl 112.4' 15-20°, B, R4, PtO, Pl 112.9' to 116.6' 0-5°, 40 Bs, R4, PtO-t, Pl	15		Run-15 111.6' - 116.6' 14 minute run Down Pressure = 400 psi
876	114							
874	116	42	93	4.6	116.6' to 121.6' 0-5°, 45 Bs, R4, PtO-t, Pl	16		Run-16 116.6' - 126.6' 21 minute run Down Pressure = 450 psi
872	118							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	**BORING NO. B-43**	
Coordinates: N 769180.5 E 1868245.0	Driller: Stantec	**Sheet No. 4 of 5**	
Top Drillhole Elevation: 990.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 804.0 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 186.6 feet	Checked By: A. Mirza	Date Start: 3/19/18 End: 3/22/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 2.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
870								
	122							
868		42	93	4.6	122.2' 0-5°, B, R4, PtO, Pl	16		
	124							
866								
	126							
864								Run-17 126.6' - 136.6' 33 minute run Down Pressure = 450 psi
	128				127.0' 0-5°, B, R4, PtO, Pl 127.3' 0-5°, B, R4, PtO, Pl			
862								
					128.9' 0-5°, B, R4, PtO, Pl			
	130				129.8' 0-5°, B, R4, PtO, Pl 129.9' 0-5°, B, R4, PtO, Pl			
860					130.5' 0-5°, B, R4-R5, t, Pl			
		63	100	5.1	130.8' 0-5°, B, R4-R5, t, Pl	17		
858	132				132.0' 0-5°, B, R4-R5, t, Pl 132.3' 0-5°, B, R4-R5, O, Pl 132.6' 0-5°, B, R4-R5, t, Pl 132.9' 0-5°, B, R4-R5, PtO, Pl			
					133.1' to 133.2' 0-5°, 2 Bs, R4-R5, PtO, Pl			
856	134				133.6' to 136.6' 0-5°, 38 Bs, R4-R5, PtO-t, Pl			
					134.0' to 137.8' 0-5°, 13 Bs, R4-R5, PtO-t, Pl			
	136							
854							135.6 to 186.6' **OHIO SHALE**, black, very fine grained, slightly to moderately weathered, soft to moderately hard, moderately to highly fractured, thinly bedded, slightly to highly weathered joints	Run-18 136.6' - 146.6' 41 minute run Down Pressure = 450 psi
	138				138.0' to 138.6' 0-5°, 11 Bs, R4-R5, PtO-t, Pl			
852					138.6' to 141.8' 0-5°, 25 Bs, R4-R5, t, Pl			
	140							
850								
		12	99	9.0		18		
848	142				141.8' to 143' 0-5°, 14 Bs, R4-R5, PtO, Pl			
					143.5' to 147.4' 0-5°, 33 Bs, R4-R5, PtO-t, Pl			
846	144							
	146							
844								Run-19 146.6' - 156.6' 27 minute run Down Pressure = 475 psi
	148				147.8' to 150.2' 0-5°, 14 Bs, R4-R5, PtO-t, Pl			
842								
	150							
840					150.8' to 160.0' 0-5°, 3 Jts, R3, PtO, Pl			
		61	93	2.9	151.3' 0-5°, B, R4, PtO, Pl	19		
838	152				152.2' 0-5°, B, R4, O, Pl 152.5' 80°, B, R3, t, Pl 152.8' 0-5°, B, R4, PtO, Pl			
					153.7' 0-5°, B, R4, PtO, Pl			
836	154							
					155.3' 0-5°, B, R4, PtO, Pl			
	156							
834								Run-20 156.6' - 166.6' 21 minute run Down Pressure = 475 psi
	158				157.1' 0-5°, B, R3, PtO, Pl			
832		66	100	3.8	158.2' to 166.6' 0-5°, 37 Bs, R4-R5, PtO-t, Pl	20		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 2	BORING NO. B-43	
Coordinates: N 769180.5 E 1868245.0	Driller: Stantec	Sheet No. 5 of 5	
Top Drillhole Elevation: 990.6 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 804.0 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 186.6 feet	Checked By: A. Mirza	Date Start: 3/19/18 End: 3/22/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 2.3	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
830								
828	162							
826	164	66	100	3.8		20		164.3' - 164.7' UCS = 8,906 psi 164.3' - 164.7' UCS = 8,906 Psi
824	166							
822	168				168.2' to 168.3' 0-5°, 2 Bs, R4-R5, PtO, Pl			Run-21 166.6' - 176.6' 30 minute run Down Pressure = 475 psi
820	170				170.7' to 172.3' 0-5°, 7 Bs, R4-R5, PtO-t, Pl			
818	172	91	98	1.5		21		166.6' - 176.6' Gas Meter COMB = 16 H2S
816	174				173.1' 0-5°, B, R4, t, Pl 174.3' to 177' 0-5°, 6 Bs, R4, PtO-t, Pl			
814	176							
812	178				178.5' 0-5°, B, R4, t, Pl			Run-22 176.6' - 186.6' 14 minute run Down Pressure = 500 psi
810	180							
808	182	91	100	1.4	181.7' to 186.6' 0-5°, 12 Bs, R4, PtO-t, Pl	22		176.6' - 186.6' Gas Meter COMB = 7 H2s = 1
806	184							
804	186							
802	188						**End of Boring at 186.6 feet**	
800	190							
798	192							
796	194							
794	196							
792	198							

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	**BORING NO. B-44**	
Coordinates: N 770202.8 E 1869013.3	Driller: Rii/ S.P	**Sheet No. 1 of 5**	
Top Drillhole Elevation: 996.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 804.1 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
996								
994	2							
992	4							
990	6				5.0' to 5.9' 0-5°, 10 Bs, R4-R5, O, Pl 6.0' to 6.9' 0-5°, 9 Bs, R4-R5, O, Pl	1	5.0 to 13.2' **BEREA SANDSTONE**, brown, fine to medium grained, slightly to moderately weathered, moderately hard to hard, thin bedded, moderately to highly fractured, flat	Top of Rock @ 5.0' Run-1 5.0' - 10.0' 9 minute run Down Pressure = 250 to 300 psi
988	8	0	86	7	7.1' to 7.9' 0-5°, 8 Bs, R4-R5, O, Pl 8.0' 8.1' fractured rock 8.2' 0-5°, B, R5, O, Pl 8.3' 0-5°, B, R4-R5, O, Pl 8.4' 0-5°, B, R4-R5, O, Pl			
986	10				8.5' 0-5°, B, R5, PtO-t, Pl 8.7' 0-5°, B, R4, t, Pl 8.8' 0-5°, B, R5, PtO-t, Pl 9.1' 0-5°, B, R4-R5, O, Pl 9.2' 0-5°, B, R4-R5, O, Pl			Run-2 10.0' - 15.0' 16 minute run Down Pressure = 300 psi
984	12	6	92	4.2	10.1' to 10.9' 0-5°, 6 Bs, R4-R5, O, Pl 11.1' to 11.2' 90°, Jt, R4-R5, O, Und 11.4' to 11.8' fractured rock	2		
982	14				11.9' 0-5°, B, R4-R5, O, Pl 12.1' to 12.8' 0-5°, 7 Bs, R4-R5, O, Pl 13.0' 0-5°, B, R4-R5, O, Pl		13.2 to 48.0' **BEREA SANDSTONE**, gray, fine to medium grained, slightly weathered, moderately hard, thin bedded, moderately to highly fractured, flat	
980	16				13.2' 0-5°, B, R5, PtO-t, Pl 13.5' 0-5°, B, R5, t, Pl 14.2' 0-5°, B, R4-R5, O, Pl 14.5' 0-5°, B, R4-R5, O, Pl 14.9' 0-5°, B, R5, PtO-t, Pl			Run-3 15.0' - 25.0' 23 minute run Down Pressure = 350 psi
978	18				15.1' 0-5°, B, R4, t, Pl 15.4' 0-5°, B, R5, PtO-t, Pl 15.9' 0-5°, B, R4-R5, O, Pl 16.1' 0-5°, B, R5, PtO-t, Pl 16.7' 0-5°, B, R4, O, Pl			
976	20	54	96	3.4	16.8' 0-5°, B, R5, PtO-t, Pl 16.9' 0-5°, B, R4-R5, O, Pl 17.0' 0-5°, B, R5, PtO-t, Pl 17.3' 0-5°, B, R4, O, Pl 17.4' 0-5°, B, R5, PtO-t, Pl	3		
974	22				17.5' 0-5°, B, R4-R5, O, Pl 17.8' 0-5°, B, R4, O, Pl 18.0' 0-5°, B, R5, PtO-t, Pl 18.1' 0-5°, B, R5, O, Pl 18.2' 0-5°, B, R4-R5, O, Pl			
972	24				18.6' 0-5°, B, R5, PtO-t, Pl 19.3' 60°, Jt, R4-R5, O, Und 19.4' 0-5°, B, R4, t, Pl			
970	26				19.5' 0-5°, B, R5, PtO-t, Pl 19.9' 0-5°, B, R4, O, Pl 20.3' 0-5°, B, R4, O, Pl 20.6' 0-5°, B, R5, PtO-t, Pl 21.2' 0-5°, B, R5, O, Pl			Run-4 25.0' - 35.0' 22 minute run Down Pressure = 300 psi
968	28				21.4' 0-5°, B, R5, PtO-t, Pl 21.7' 0-5°, B, R4, t, Pl 21.8' 0-5°, B, R5, PtO-t, Pl 21.9' 0-5°, B, R4, O, Pl 22.3' 0-5°, B, R5, PtO-t, Pl			
966	30	55	99	2.1	22.4' 0-5°, B, R5, PtO-t, Pl 22.6' 0-5°, B, R4-R5, O, Pl 23.3' 0-5°, B, R5, PtO-t, Pl 24.1' 0-5°, B, R4, t, Pl 24.2' 0-5°, B, R5, PtO-t, Pl	4		
964	32				24.6' 0-5°, B, R4, O, Pl 25.1' 0-5°, B, R5, PtO-t, Pl 25.2' 0-5°, B, R4-R5, O, Pl 25.3' 0-5°, B, R4, O, Pl			
962	34				25.7' 0-5°, B, R5, PtO-t, Pl 26.1' 0-5°, B, R4-R5, O, Pl 27.2' to 27.4' fractured rock			
960	36				27.5' 0-5°, B, R5, O, Pl 28.1' 0-5°, B, R5, PtO-t, Pl 28.7' 0-5°, B, R4, O, Pl 28.8' 0-5°, B, R5, PtO-t, Pl 28.9' 0-5°, B, R5, O, Pl			Run-5 35.0' - 45.0' 23 minute run Down Pressure = 350 psi
958	38	54	90	2.2	29.6' 0-5°, B, R5, PtO-t, Pl 31.0' 0-5°, B, R5, O, Pl 31.1' 0-5°, B, R5, PtO-t, Pl 31.2' 0-5°, B, R4, O, Pl 31.5' to 32.2' fractured rock 33.1' 0-5°, B, R4, t, Pl	5		

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-44**
Coordinates:	N 770202.8 E 1869013.3	Driller:	Rii/ S.P	**Sheet No. 2 of 5**
Top Drillhole Elevation:	996.1 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	804.1 feet MSL	Prepared By:	A. Mirza	
Total Depth:	192.0 feet	Checked By:	B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 7.2

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
956					34.2' 0-5°, B, R5, PtO-t, Pl 34.3' 0-5°, B, R4, O, Pl 34.4' 0-5°, B, R4-R5, O, Pl 34.5' 0-5°, B, R5, PtO-t, Pl			
954	42	54	90	2.2	35.1' 0-5°, B, R4-R5, O, Pl 35.7' 0-5°, B, R5, O, Pl 36.0' 0-5°, B, R4, t, Pl 36.1' 0-5°, B, R5, PtO-t, Pl	5		
952	44				36.8' 0-5°, B, R4, O, Pl 36.9' 0-5°, B, R5, PtO-t, Pl 37.6' 0-5°, B, R4-R5, PtO-t, Pl			
950	46				38.7' 0-5°, B, R4-R5, O, Pl 38.8' 0-5°, B, R5, PtO-t, Pl 39.3' 60°, Jt, R4-R5, O, Und 39.8' 0-5°, B, R5, PtO-t, Pl 39.9' to 40.0' fractured rock			Run-6 45.0' - 55.0', 26 minute run Down Pressure = 400 psi
948	48				40.3' 0-5°, B, R5, O, Pl 40.4' 0-5°, B, R4, O, Pl 40.9' to 41.1' fractured rock 41.3' 0-5°, B, R4-R5, O, Pl 41.7' 0-5°, B, R4-R5, PtO-t, Pl		48.0 to 99.0' Interbedded **SANDSTONE** and **SHALE** **BAREA SANDSTONE**, gray, fine to medium grained,unweathered, moderately hard, thin bedded, moderately to highly fractured, flat **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately to highly fractured, flat	
946	50	25	93	3.2	41.9' to 42.2' fractured rock 42.8' 0-5°, B, R5, O, Pl 42.9' 0-5°, B, R4, O, Pl 43.2' 0-5°, B, R5, PtO-t, Pl 43.7' 0-5°, B, R5, O, Pl	6		
944	52				45.2' 80°, Jt, R3-R4, O, und 45.5' 0-5°, B, R5, PtO-t, Pl 46.1' 0-5°, B, R4, t, Pl			
942	54				46.2' 0-5°, B, R5, PtO-t, Pl 47.1' 0-5°, B, R4, O, Pl 47.2' 0-5°, B, R5, PtO-t, Pl 47.5' 0-5°, B, R5, PtO-t, Pl			
940	56				47.6' 0-5°, B, R4-R5, O, Pl 47.8' 0-5°, B, R5, PtO-t, Pl 47.9' 0-5°, B, R4, t, Pl 48.0' 0-5°, B, R5, PtO-t, Pl			Run-7 55.0' - 65.0', 23 minute run Down Pressure = 400 psi
938	58				48.2' 0-5°, B, R4, O, Pl 48.4' 0-5°, B, R5, PtO-t, Pl 48.5' 0-5°, B, R4-R5, O, Pl 48.8' 0-5°, B, R5, t, Pl 48.9' 0-5°, B, R4-R5, t, Pl			
936	60	6	92	3.8	49.0' to 49.3' fractured rock 49.5' 0-5°, B, R5, PtO-t, Pl 49.6' 0-5°, B, R4-R5, O, Pl 50.0' 0-5°, B, R4, O, Pl 50.3' 0-5°, B, R5, PtO-t, Pl	7		
934	62				50.6' 0-5°, B, R4-R5, t, Pl 51.0' to 51.5' 90°, Jt, R4-R5, O, Und 52.0' 0-5°, B, R4-R5, t, Pl 52.2' 0-5°, B, R4-R5, O, Pl 53.2' to 53.9' 0-5°, 7 Bs, R4-R5, O, Pl			
932	64				55.1' 0-5°, B, R4, t, Pl 55.3' 0-5°, B, R4-R5, t, Pl 55.5' 0-5°, B, R5, O, Pl 55.6' 0-5°, B, R4-R5, O, Pl			
930	66				55.7' 0-5°, B, R5, PtO-t, Pl 55.9' 0-5°, B, R5, O, Pl 56.0' to 56.3' 0-5°, 4 Bs, R4-R5, O, Pl 56.5' 0-5°, B, R5, PtO-t, Pl			Run-8 65.0' - 75.0', 19 minute run Down Pressure = 400 psi
928	68				56.8' 0-5°, B, R4-R5, O, Pl 56.9' 0-5°, B, R5, O, Pl 57.0' to 57.4' fractured rock 57.8' 0-5°, B, R5, t, Pl			
926	70	42	99	2.3	57.9' 0-5°, B, R4-R5, O, Pl 58.2' 0-5°, B, R5, O, Pl 58.4' 0-5°, B, R5, PtO-t, Pl 58.6' 0-5°, B, R4, t, Pl 58.8' 0-5°, B, R5, O, Pl	8		
924	72				59.0' to 59.1' fractured rock 59.2' 0-5°, B, R4, t, Pl 60.0' to 60.1' fractured rock 60.2' to 60.6' 0-5°, 5 Bs, R5, O, Pl			
922	74				60.8' 0-5°, B, R5, PtO-t, Pl 60.9' 0-5°, B, R4-R5, O, Pl 61.2' 0-5°, B, R5, t, Pl 61.4' 0-5°, B, R4-R5, O, Pl 61.7' 0-5°, B, R4-R5, O, Pl			
920	76				62.3' 0-5°, B, R5, PtO-t, Pl 62.6' 0-5°, B, R4-R5, t, Pl 62.8' 0-5°, B, R4, t, Pl 63.2' 0-5°, B, R4-R5, PtO-t, Pl			Run-9 75.0' - 80.0', 10 minute run Down Pressure = 400 psi
918	78	11	100	2.2	63.5' 0-5°, B, R4, O, Pl 65.1' 0-5°, B, R5, PtO-t, Pl 66.1' 0-5°, B, R4-R5, t, Pl 66.2' 0-5°, B, R4-R5, O, Pl 66.4' 0-5°, B, R5, PtO-t, Pl 66.5' 0-5°, B, R4, t, Pl	9		

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 45 Truck \00	**BORING NO. B-44**
Coordinates:	N 770202.8 E 1869013.3	Driller:	Rii/ S.P	**Sheet No. 3 of 5**
Top Drillhole Elevation:	996.1 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation:	804.1 feet MSL	Prepared By:	A. Mirza	
Total Depth:	192.0 feet	Checked By:	B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18
Orientation:	Vertical	Core Size:	NQ	Groundwater Depth: 7.2

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
916					66.8' 0-5°, B, R5, PtO-t, Pl 66.9' 0-5°, B, R4, O, Pl 67.2' 0-5°, B, R5, PtO-t, Pl 67.3' 0-5°, B, R4-R5, PtO-t, Pl 67.6' 0-5°, B, R5, PtO-t, Pl 67.7' 0-5°, B, R4-R5, t, Pl 68.2' 0-5°, B, R4-R5, O, Pl 68.4' 0-5°, B, R5, PtO-t, Pl 68.9' 0-5°, B, R4, t, Pl 69.5' 0-5°, B, R5, PtO-t, Pl 70.1' to 70.2' fractured rock			Run-10 80.0' - 85.0' 10 minute run Down Pressure = 400 psi
914	82	74	93	2		10		
912	84							
910	86				70.4' 0-5°, B, R5, PtO-t, Pl 70.6' 0-5°, B, R4-R5, O, Pl 71.7' 0-5°, B, R5, PtO-t, Pl 73.1' 0-5°, B, R4, t, Pl 73.6' 0-5°, B, R5, PtO-t, Pl 73.9' 0-5°, B, R4, O, Pl 74.2' 0-5°, B, R5, PtO-t, Pl 75.1' 0-5°, B, R4-R5, O, Pl 75.5' 0-5°, B, R4, t, Pl 75.8' 0-5°, B, R5, PtO-t, Pl 76.5' 0-5°, B, R4, O, Pl 77.4' 0-5°, B, R4-R5, O, Pl 77.6' 0-5°, B, R5, O, Pl 78.1' 0-5°, B, R4, O, Pl 78.4' to 78.6' fractured rock			Run-11 85.0' - 95.0' 21 minute run Down Pressure = 400 psi
908	88							
906	90	73	100	2.2		11		
904	92				78.9' 0-5°, B, R5, PtO-t, Pl 79.4' 0-5°, B, R4, O, Pl 79.7' 0-5°, B, R5, O, Pl 80.1' 0-5°, B, R4, t, Pl 80.4' to 80.7' fractured rock 81.0' 0-5°, B, R4-R5, O, Pl 81.4' 0-5°, B, R5, PtO-t, Pl			
902	94							
900	96				81.8' 0-5°, B, R4, O, Pl 82.4' 0-5°, B, R5, PtO-t, Pl 82.5' 0-5°, B, R4-R5, O, Pl 82.9' 0-5°, B, R5, t, Pl 83.3' 0-5°, B, R5, PtO-t, Pl 84.4' 0-5°, B, R5, t, Pl 85.9' 0-5°, B, R5, PtO-t, Pl 86.0' 0-5°, B, R5, t, Pl 86.1' 0-5°, B, R4-R5, O, Pl 86.6' 0-5°, B, R5, t, Pl			Run-12 95.0' - 105.0' 20 minute run Down Pressure = 400 psi
898	98							
896	100	61	100	2.2	86.9' 0-5°, B, R5, PtO-t, Pl 87.1' 0-5°, B, R5, t, Pl 87.7' 0-5°, B, R5, PtO-t, Pl 88.1' 0-5°, B, R5, t, Pl 88.5' 0-5°, B, R5, PtO-t, Pl 89.2' 0-5°, B, R5, t, Pl 89.3' 0-5°, B, R4, t, Pl 89.4' 0-5°, B, R5, PtO-t, Pl 89.6' 0-5°, B, R4-R5, O, Pl 90.6' 0-5°, B, R5, t, Pl 91.1' 0-5°, B, R4-R5, O, Pl 91.6' 0-5°, B, R5, t, Pl	12	99.0 to 105.0' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	
894	102							
892	104							
890	106				92.0' 0-5°, B, R4-R5, O, Pl 92.4' 0-5°, B, R5, PtO-t, Pl 92.8' 0-5°, B, R4, t, Pl 93.1' 0-5°, B, R5, PtO-t, Pl 93.6' 0-5°, B, R4, O, Pl 94.2' 0-5°, B, R5, O, Pl 95.3' 0-5°, B, R5, PtO-t, Pl 96.0' 0-5°, B, R4-R5, O, Pl 96.4' 0-5°, B, R5, PtO-t, Pl 96.6' 0-5°, B, R4, t, Pl 97.1' 0-5°, B, R5, PtO-t, Pl		105.0 to 120.5' **BEDFORD SHALE**, grey with red bands, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	Run-13 105.0' - 115.0' 20 minute run Down Pressure = 400 psi
888	108							
886	110	85	99	1.7	97.4' 0-5°, B, R4, O, Pl 98.5' 0-5°, B, R5, PtO-t, Pl 99.1' 0-5°, B, R4-R5, PtO-t, Pl 99.7' 0-5°, B, R4-R5, O, Pl 99.8' 0-5°, B, R5, O, Pl 100.2' 0-5°, B, R5, PtO-t, Pl 100.9' 0-5°, B, R4, O, Pl 101.6' 0-5°, B, R4-R5, PtO-t, Pl 101.7' 0-5°, B, R4-R5, O, Pl 102.5' 0-5°, B, R4, O, Pl 102.8' to 103.0' fractured rock	13		
884	112							
882	114							
880	116				103.1' 0-5°, B, R4, O, Pl 103.2' 0-5°, B, R5, PtO-t, Pl 103.9' 0-5°, B, R4-R5, O, Pl 104.0' 0-5°, B, R5, O, Pl 104.2' 0-5°, B, R4-R5, O, Pl 104.6' 0-5°, B, R5, t, Pl			Run-14 115.0' - 125.0' 30 minute run Down Pressure = 400 psi
878	118	79	99	1.3	105.5' 0-5°, B, R4-R5, O, Pl 106.5' 0-5°, B, R5, O, Pl 107.1' 0-5°, B, R4-R5, O, Pl 107.2' 0-5°, B, R5, PtO-t, Pl 107.5' 0-5°, B, R4, t, Pl	14		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-44**
Coordinates: N 770202.8 E 1869013.3	Driller:	Rii/ S.P	**Sheet No. 4 of 5**
Top Drillhole Elevation: 996.1 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 804.1 feet MSL	Prepared By:	A. Mirza	
Total Depth: 192.0 feet	Checked By:	B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 7.2

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
876					108.4' 108.5' fractured rock 108.8' 0-5°, B, R5, PtO-t, Pl 109.2' 0-5°, B, R5, t, Pl 109.8' 0-5°, B, R5, PtO-t, Pl 109.9' 0-5°, B, R5, t, Pl 110.1' 0-5°, B, R4-R5, O, Pl 110.2' 0-5°, B, R5, t, Pl 110.8' 0-5°, B, R4-R5, PtO-t, Pl 111.1' 0-5°, B, R5, t, Pl 112.5' 0-5°, B, R5, PtO-t, Pl 113.1' 0-5°, B, R5, t, Pl			
874	122	79	99	1.3		14	120.5 to 146.6' **BEDFORD SHALE**, red, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	
872	124							
870	126				113.2' 0-5°, B, R5, O, Pl 118.6' 0-5°, B, R5, PtO-t, Pl 118.7' 0-5°, B, R4-R5, O, Pl 118.8' 0-5°, B, R5, PtO-t, Pl 119.6' 0-5°, B, R4, O, Pl 119.8' 0-5°, B, R5, PtO-t, Pl 119.9' 0-5°, B, R4, O, Pl 120.8' 0-5°, B, R5, t, Pl 121.1' 0-5°, B, R5, O, Pl 121.3' 0-5°, B, R4, t, Pl			Run-15 125.0' - 135.0' 20 minute run Down Pressure = 400 psi
868	128							
866	130	78	100	1.9	122.7' 0-5°, B, R5, PtO-t, Pl 123.2' 0-5°, B, R4, O, Pl 124.0' 0-5°, B, R5, PtO-t, Pl 124.7' 0-5°, B, R4-R5, O, Pl 125.5' 0-5°, B, R4-R5, PtO-t, Pl 125.6' 0-5°, B, R5, t, Pl 125.7' 0-5°, B, R4, t, Pl 125.8' 0-5°, B, R5, PtO-t, Pl 125.9' 0-5°, B, R4-R5, O, Pl 126.0' 0-5°, B, R4, O, Pl 126.2' 0-5°, B, R4-R5, O, Pl 126.3' 0-5°, B, R4, O, Pl	15		
864	132							
862	134							
860	136				127.1' 0-5°, B, R5, t, Pl 128.9' 0-5°, B, R4-R5, O, Pl 130.4' 60°, Jt, R4-R5, O, Pl 131.0' 0-5°, B, R4-R5, O, Pl 131.8' 0-5°, B, R5, t, Pl 132.5' 0-5°, B, R5, PtO-t, Pl 132.8' 0-5°, B, R5, t, Pl 132.9' 0-5°, B, R5, PtO-t, Pl 133.1' 0-5°, B, R5, t, Pl 133.6' 0-5°, B, R4, t, Pl			Run-16 135.0' - 145.0' 20 minute run Down Pressure = 400 psi
858	138							
856	140	67	99	2.9	134.3' 0-5°, B, R5, PtO-t, Pl 135.4' 0-5°, B, R4-R5, O, Pl 136.2' 0-5°, B, R5, PtO-t, Pl 136.6' 0-5°, B, R4, O, Pl 137.1' 0-5°, B, R5, PtO-t, Pl 137.2' 0-5°, B, R4-R5, O, Pl 138.0' 0-5°, B, R5, t, Pl 138.7' 0-5°, B, R5, t, Pl 139.3' 0-5°, B, R4, t, Pl 139.4' 0-5°, B, R5, PtO-t, Pl 139.6' 0-5°, B, R4-R5, O, Pl 139.7' 0-5°, B, R5, O, Pl	16		
854	142							
852	144							
850	146				139.8' 0-5°, B, R4-R5, O, Pl 140.0' 0-5°, B, R4, t, Pl 140.1' 140.6' 0-5°, 6 Bs, R4-R5, O, Pl 140.8' 0-5°, B, R4, t, Pl 141.1' 0-5°, B, R5, PtO-t, Pl 141.2' 0-5°, B, R4, O, Pl 141.9' 0-5°, B, R5, PtO-t, Pl 142.4' 0-5°, B, R4-R5, O, Pl 142.6' 0-5°, B, R5, O, Pl 143.0' to 143.4' fractured rock 143.8' 0-5°, B, R4, O, Pl			Run-17 145.0' - 155.0' 29 minute run Down Pressure = 400 psi
848	148						146.6 to 150.5' **BEDFORD SHALE**, grey, very fine grained, unweathered, soft, thinly bedded, moderately fractured, flat	
846	150	59	99	3.1	144.4' 0-5°, B, R5, PtO-t, Pl 144.6' 0-5°, B, R5, PtO-t, Pl 144.8' 0-5°, B, R5, t, Pl 145.3' 0-5°, B, R5, O, Pl 145.4' 0-5°, B, R4-R5, t, Pl 145.5' 60°, Jt, R4-R5, O, Und 145.6' 0-5°, B, R5, PtO-t, Pl 145.7' 0-5°, B, R5, t, Pl 145.9' 0-5°, B, R5, PtO-t, Pl 146.2' 0-5°, B, R5, t, Pl 146.3' 0-5°, B, R4-R5, O, Pl	17		
844	152						150.5 to 192.0' **OHIO SHALE** black, very fine grained, unweathered, moderately hard, thin bedded, moderately fractured.	
842	154							
840	156				146.6' 0-5°, B, R5, t, Pl 146.7' 0-5°, B, R5, PtO-t, Pl 146.8' 0-5°, B, R5, t, Pl 147.1' 0-5°, B, R5, PtO-t, Pl 147.3' 0-5°, B, R5, t, Pl 147.5' 0-5°, B, R4, t, Pl			Run-18 155.0' - 165.0' 24 minute run Down Pressure = 450 psi 39% LEL (0% after venting for 15 minutes)
838	158	89	100	1.5	147.6' 0-5°, B, R5, PtO-t, Pl 147.7' 0-5°, B, R4-R5, O, Pl 147.9' 0-5°, B, R5, PtO-t, Pl 148.1' 0-5°, B, R4, O, Pl 148.6' 0-5°, B, R5, PtO-t, Pl	18		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00	BORING NO. B-44	
Coordinates: N 770202.8 E 1869013.3	Driller: Rii/ S.P	Sheet No. 5 of 5	
Top Drillhole Elevation: 996.1 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 804.1 feet MSL	Prepared By: A. Mirza		
Total Depth: 192.0 feet	Checked By: B. Madras Natarajan	Date Start: 3/6/18 End: 3/13/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 7.2	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
836					148.8' 0-5°, B, R4-R5, O, Pl 148.9' 0-5°, B, R5, t, Pl 149.1' 0-5°, B, R5, t, Pl 149.4' 0-5°, B, R4, t, Pl			155.0' - 165.0' Gas Meter LEL = 39
834	162	89	100	1.5	149.5' 0-5°, B, R5, PtO-t, Pl 150.3' 0-5°, B, R4, O, Pl 151.1' 0-5°, B, R5, PtO-t, Pl 151.6' 0-5°, B, R4-R5, O, Pl 152.9' 0-5°, B, R4-R5, PtO-t, Pl 153.5' 0-5°, B, R4-R5, O, Pl 154.3' 0-5°, B, R5, PtO-t, Pl	18		
832	164							
830	166				156.6' 0-5°, B, R4-R5, O, Pl 157.1' 0-5°, B, R5, PtO-t, Pl 157.3' 0-5°, B, R4, t, Pl 157.4' 0-5°, B, R5, PtO-t, Pl 157.9' 0-5°, B, R4, O, Pl 158.4' 0-5°, B, R5, PtO-t, Pl			Run-19 165.0' - 175.0' 20 minute run Down Pressure = 500 psi
828	168				158.8' 70°, Jt, R3-R4, O, Pl 159.6' 0-5°, B, R5, t, Pl 160.1' 0-5°, B, R4, O, Pl			168.2' - 168.6' UCS = 3,356 psi
826	170	87	100	1.9	161.1' 0-5°, B, R5, PtO-t, Pl 162.9' 0-5°, B, R4-R5, O, Pl 163.1' 0-5°, B, R5, O, Pl 163.6' 0-5°, B, R4, t, Pl 164.2' 0-5°, B, R5, PtO-t, Pl 164.7' 0-5°, B, R4-R5, O, Pl	19		
824	172				166.2' 0-5°, B, R5, O, Pl 167.1' 0-5°, B, R4-R5, O, Pl 167.3' 0-5°, B, R5, t, Pl 168.1' 0-5°, B, R4-R5, PtO-t, Pl 168.6' 0-5°, B, R5, t, Pl 169.1' 0-5°, B, R5, PtO-t, Pl 169.2' 0-5°, B, R4, O, Pl			
822	174							
820	176				169.6' 0-5°, B, R5, PtO-t, Pl 169.7' 0-5°, B, R4-R5, O, Pl 169.9' 0-5°, B, R4, t, Pl 170.6' 0-5°, B, R5, PtO-t, Pl 171.2' 0-5°, B, R5, O, Pl 171.7' 0-5°, B, R5, PtO-t, Pl			Run-20 175.0' - 185.0' 20 minute run Down Pressure = 500 psi
818	178				172.8' 0-5°, B, R4-R5, O, Pl 173.1' 0-5°, B, R5, O, Pl 173.4' 0-5°, B, R4-R5, O, Pl 173.9' 0-5°, B, R4-R5, t, Pl 174.3' 0-5°, B, R4-R5, PtO-t, Pl			
816	180	87	97	1.5	174.8' 0-5°, B, R5, t, Pl 175.2' 0-5°, B, R5, PtO-t, Pl 176.3' 0-5°, B, R4, O, Pl 177.1' 0-5°, B, R5, PtO-t, Pl 177.2' 0-5°, B, R4-R5, t, Pl 178.2' 0-5°, B, R5, O, Pl 178.7' 0-5°, B, R4-R5, O, Pl 179.0' 45°, Jt, R4-R5, O, Und	20		
814	182							
812	184				179.6' 0-5°, B, R5, O, Pl 179.9' 0-5°, B, R4-R5, t, Pl 180.1' 0-5°, B, R4, O, Pl			
810	186				180.3' 45°, Jt, R4-R5, O, Und 181.6' 0-5°, B, R5, t, Pl 182.7' 0-5°, B, R4-R5, O, Pl 183.6' 0-5°, B, R4, O, Pl 184.0' 0-5°, B, R4, PtO-t, Pl			Run-21 185.0' - 192.0' 15 minute run Down Pressure = 500 psi
808	188	92	100	0.4	187.2' 0-5°, B, R4-R5, t, Pl 188.2' 0-5°, B, R5, O, Pl	21		
806	190							
804	192				191.2' 0-5°, B, R4, O, Pl		**End of Boring at 192.0 feet**	
802	194							
800	196							
798	198							

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770487.16 1870204.22	**DATE STARTED**	5/1/18	**COMPLETED**	5/9/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	92.4 % (Avg.)	**SURFACE ELEVATION**	979.5 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	HQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	Paul / Stantec	**DRILLING CONTRACTOR**	Stantec / M.M	**DRILL RIG TYPE AND ID**	CME 55 Track 1	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 979.51	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
- USED ROLLER BIT TO ELEVATION 920.00' AS DIRECTED		W															

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.5 ft LOCATION 770487.16 1870204.22 DATE STARTED / DATE COMPLETED 5/1/18 - 5/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
		21															
		22															
		23															
		24															
		25															
		26															
		27															
		28															
		29															
		30															
		31															
		32															
		33															
		34															
		35															
		36															
		37															
		38															
		39															
		40															
		41															

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.5 ft LOCATION 770487.16 1870204.22 DATE STARTED / DATE COMPLETED 5/1/18 - 5/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
		42															
		43															
		44															
		45															
		46															
		47															
		48															
		49															
		50															
		51															
		52															
		53															
		54															
		55															
		56															
		57															
		58															
		59															
	919.5	60															
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, FINE TO VERY FINE GRAINED, MOIST TO WET		61	16-22-28	100	SS-1		-	-	-	-	-	-	-	-	-		
		62															

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.5 ft LOCATION 770487.16 1870204.22 DATE STARTED / DATE COMPLETED 5/1/18 - 5/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
DENSE TO VERY DENSE, GRAY, **SILTY SAND**, FINE TO VERY FINE GRAINED, MOIST TO WET *(continued)*		63	18-34-40	100	SS-2		-	-	-	-	-	-	-	-	-		
		64															
		65															
		66	22-36-49	87	SS-3		-	-	-	-	-	-	-	-	-		
		67															
	911.6	68	36-50/4.8"	100	SS-4		-	-	-	-	-	-	-	-	-		
DENSE TO VERY DENSE, BROWN, **GRAVEL WITH SAND**, TRACE SILT, WET - SANDSTONE FRAGMENT IN BOTTOM OF SAMPLE		69															
- SOME STONE FRAGMENTS		70															
		71	36-28-26	87	SS-5		-	-	-	-	-	-	-	-	-		
		72															
- SANDSTONE FRAGMENTS IN BOTTOM OF SAMPLE		73	23-28-42	87	SS-6		-	-	-	-	-	-	-	-	-		
		74															
		75	29-50/4.8"	100	SS-7		-	-	-	-	-	-	-	-	-		
- SANDSTONE FRAGMENTS IN BOTTOM OF SAMPLE		76															
		77															
		78	38-40-46	100	SS-8		-	-	-	-	-	-	-	-	-		
	900.8	79															
HARD, BROWN AND GRAY, **SANDY CLAY**, LITTLE STONE FRAGMENTS, DAMP TO MOIST		80															
- GLACIAL TILL - COARSER SAND @ 80.0' - 80.4'		81	16-22-39	100	SS-9	4.5+	-	-	-	-	-	-	-	-	-		
		82															
		83	19-29-50	100	SS-10	4.5+	-	-	-	-	-	-	-	-	-		
		84															

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.5 ft LOCATION 770487.16 1870204.22 DATE STARTED / DATE COMPLETED 5/1/18 - 5/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
HARD, BROWN AND GRAY, **SANDY CLAY**, LITTLE STONE FRAGMENTS, DAMP TO MOIST *(continued)*		85															
- SHALE SEAM @ 85.6' - 85.8'		86	32-32-50/3.6"	100	SS-11	4.5+	-	-	-	-	-	-	-	-	-		
		87															
- SANDSTONE FRAGMENTS IN BOTTOM OF SAMPLE		88	20-38-48	100	SS-12	4.5+	-	-	-	-	-	-	-	-	-		
		89															
- MORE RESIDUAL THAN PREVIOUS SAMPLES - SANDSTONE FRAGMENTS IN SAMPLE		90															
		91	38-30-36	67	SS-13	4.5+	-	-	-	-	-	-	-	-	-		
		92															
HARD, ORANGEY BROWN AND GRAY MOTTLED, **CLAY**, SOME STONE FRAGMENTS, DAMP TO MOIST	887.0	93	22-26-36	100	SS-14	4.5+	-	-	-	-	-	-	-	-	-		
		94															
- SANDSTONE FRAGMENT IN BOTTOM OF SAMPLE		95															
		96	18-28-50	100	SS-15	4.5+	-	-	-	-	-	-	-	-	-		
		97															
		98	16-26-36	100	SS-16	4.5+	-	-	-	-	-	-	-	-	-		
		99															
- RESIDUAL SHALE FRAGMENTS WITHIN CLAY		100															
		101	17-29-40	100	SS-17	4.5+	-	-	-	-	-	-	-	-	-		
		102															
- INCREASED STONE FRRAGMENT CONTENT		103	27-40-50/4.8"	86	SS-18	4.5+	-	-	-	-	-	-	-	-	-		
		104															
		105															

SUBSURFACE LOG

EXPLORATION ID: B-45

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 979.5 ft LOCATION 770487.16 1870204.22 DATE STARTED / DATE COMPLETED 5/1/18 - 5/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	MON. WELL
HARD, ORANGEY BROWN AND GRAY MOTTLED, **CLAY**, SOME STONE FRAGMENTS, DAMP TO MOIST *(continued)*		106	20-33-50/4.8"	100	SS-19	4.5+	-	-	-	-	-	-	-	-	-		
		107															
		108	19-28-42	100	SS-20	4.5+	-	-	-	-	-	-	-	-	-		
		109															
- TRACE TO LITTLE SILT		110															
		111	23-27-36	87	SS-21	4.5+	-	-	-	-	-	-	-	-	-		
		112															
HARD, GRAY AND BROWN MOTTLED, **CLAY**, AND STONE FRAGMENTS, MOIST	867.0	113	33-50/4.8"	100	SS-22	4.5+	-	-	-	-	-	-	-	-	-		
		114															
- WEATHERED SHALE IN BOTTOM OF SAMPLE		115															
		116	39-48-50/1.2"	91	SS-23		-	-	-	-	-	-	-	-	-		
		117															
HIGHLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, RED, ARGILLACEOUS, THIN BEDDED, INTENSELY FRACTURED, FLAT.	862.5 TR	118	50-50/4.8"	44	SS-24		-	-	-	-	-	-	-	-	-		
		119															
	859.4	120															

Boring Continues on Following Rock Description Log

NOTES: INSTALLED MONITORING WELL - SCREENED FROM 129.5' TO 154.5' (SEE WELL LOG FOR BACKFILL DESCRIPTIONS)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT; SAND

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	BORING NO. B-45	
Coordinates: N 770487.2 E 1870204.2	Driller: Stantec	Sheet No. 1 of 2	
Top Drillhole Elevation: 979.5 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 807.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 171.9 feet	Checked By: A. Mirza	Date Start: 5/1/18 End: 5/9/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
864	116							Refer to soil borings for details on soil descriptions/classifications
862	118							
860	120							
858	122				120.1' to 121.6' fractured rock 121.8' 0-5°, B, R5, t, Pl 122.3' to 122.8' fractured rock		120.1 to 126.9' **BEDFORD SHALE**, red, very fine grained, highly weathered, soft, intensely fractured, thinly bedded, argillaceous	Top of Rock @ 126.0' Run-1 120.1' - 126.9' 24 minute run Down Pressure = 200 Psi 2.5' of sample lost, washed out
856	124	16	63	N/A	123.2' 0-5°, B, R5, PtO-t, Pl 123.5' 0-5°, B, R4, t, Pl	1		
854	126							
852	128				127.2' 0-5°, B, R5, PtO-t, Pl 127.9' 0-5°, B, R4-R5, t, Pl		126.9 to 131.9' **BEDFORD SHALE**, grey with red bands, very fine grained, moderately weathered, moderately hard, slightly fractured, thinly bedded	Run-2 126.9' - 131.9' 19 minute run Down Pressure = 250 Psi
850	130	96	100	1.0	128.9' 0-5°, B, R3, Pt-t,Pl 129.2' 0-5°, B, R4-R5, PtO-t, Pl 130.5' 0-5°, B, R4-R5, O, Pl	2		
848	132				131.5' 0-5°, B, R4-R5, t, Pl 131.9' to 132.4' 0-5°, 4 Bs, R5, t, Pl		131.9 to 151.0' **BEDFORD SHALE**, grey, very fine grained, slightly to moderately weathered, moderately hard, slightly fractured, thinly bedded	Run-3 131.9' - 141.9' 70 minute run Down Pressure = 300 Psi
846	134				132.6' 0-5°, B, R5, PtO-t, Pl 132.9' 0-5°, B, R4, O,Pl 133.4' 0-5°, B, R4-R5, t, Pl 133.9' 0-5°, B, R4-R5, PtO-t, Pl			
844	136				134.7' 0-5°, B, R4-R5, O, Pl 135.1' 0-5°, B, R5, O, Pl 135.3' 0-5°, B, R4-R5, O, Pl			
842	138	27	53	N/A	135.9' to 137.2' fractured rock	3		
840	140							
838	142				142.1' 0-5°, B, R4, t, Pl 142.4' 0-5°, B, R3-R4, t, Pl 142.6' 0-5°, B, R4, Pt, und			Run-4 141.9' - 146.9' 10 minute run Down Pressure = 0 - 100 Psi
836	144	66	100	2.2	143.5' 0-5°, B, R4, Pt-t, und 144.0' 0°, B, R4-R5, PtO-t, Pl 144.2' 0-5°, B, R5, t, Pl 144.4' 0°, B, R4-R5, PtO-t, Pl 145.2' 0°, B, R5, t, Pl	4		
834	146				146.2' 0-5°, B, R4-R5, PtO-t, Pl 146.6' 0-5°, B, R4, t, und			Run-5 146.9' - 151.9' 15 minute run Down Pressure = 0 - 100 Psi
832	148				146.8' 0-5°, B, R3-R4, O,Pl 147.2' 0-5°, B, R3-R5, t, Pl 147.4' 0°, B, R4, Pt-t, und 148.4' 0-5°, B, R4, t, Pl			
830	150	60	100	0.8	149.2' 0°, B, R4-R5, PtO-t, Pl	5		
828	152				152.2' 0-5°, B, R5, t, Pl 152.6' 0°, B, R5, PtO-t, Pl		151.0 to 171.9' **OHIO SHALE**, black, very fine grained, slightly weathered, moderately hard, slightly fractured, thinly bedded, slightly weathered joints	Run-6 151.9' - 161.9' 11 minute run Down Pressure = 200 Psi
826	154	56	100	2.0	153.3' 0-5°, B, R4-R5, Pt-t, Pl 153.7' 0-5°, B, R4-R5, O, und 154.1' 0-5°, B, R3-R4, t, Pl	6		

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Track 1	BORING NO. B-45	
Coordinates: N 770487.2 E 1870204.2	Driller: Stantec	Sheet No. 2 of 2	
Top Drillhole Elevation: 979.5 feet MSL	Logged By: Paul Cichocki/Stantec		
Bottom Elevation: 807.6 feet MSL	Prepared By: B. Madras Natarajan		
Total Depth: 171.9 feet	Checked By: A. Mirza	Date Start: 5/1/18 End: 5/9/18	
Orientation: Vertical	Core Size: HQ	Groundwater Depth: 1.5	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
824	156				154.6' 0-5°, B, R4, PtO-t, Pl 154.8' 0-5°, B, R5, t, Pl 155.6' 0-5°, B, R4-R5, PtO-t, Pl 156.1' 0-5°, B, R4, t, Pl 156.5' to 156.7' 90°, Jt, R3-R4, O, Und			
822	158	56	100	2.0	157.2' 0-5°, B, R5, t, Pl 157.5' 0-5°, B, R5, t, Pl 158.1' 0-5°, B, R4-R5, O, und 158.6' 0-5°, B, R4-R5, PtO-t, Pl	6		
820	160				159.2' 0-5°, B, R5, O, Pl 159.5' 0-5°, B, R4, t, Pl 160.2' 0-5°, B, R5, t, und			
818	162				161.1' 0-5°, B, R5, PtO-t, Und 161.3' 0-5°, B, R3-R4, t, Pl 161.7' 0-5°, B, R3-R4, t,Pl			Run-7 161.9' - 171.9' 30 minute run Down Pressure = 250 to 350 Psi
816	164				162.5' 0-5°, B, R4, PtO-t, und 162.8' 0-5°, B, R5, O, Pl 163.4' 0-5°, B, R5, T,Pl 163.6' 0-5°, B, R4-R5, t,Pl 163.8' 0-5°, B, R3-R4, PtO-t, Pl			
814	166				165.2' 0-5°, B, R5, O, Pl 165.5' 0-5°, B, R4-R5, t, Pl 165.6' 0-5°, B, R3-R4, PtO-t, und			
812	168	75	100	1.9	165.8' 0-5°, B, R4-R5, t, und 166.8' 0-5°, B, R3, PtO-t, Pl 167.2' 0-5°, B, R3-R4, t, Pl 167.7' 0-5°, B, R5, PtO-t, Pl 168.0' 0-5°, B, R5, PtO-t, Pl 168.3' 0-5°, B, R4-R5, PtO-t, Pl	7		
810	170				169.3' 0-5°, B, R5, PtO-t, Pl 169.6' 0-5°, Jt, R4, Pt-t, Pl			
808	172				170.5' 0-5°, B, R4, t, Pl 170.9' 0-5°, B, R5, t, Pl 171.4' 0-5°, B, R5, Pt-O-O, und			
806	174						**End of Boring at 171.9 feet**	
804	176							
802	178							
800	180							
798	182							
796	184							
794	186							
792	188							
790	190							
788	192							
786	194							

Stantec

SUBSURFACE LOG

EXPLORATION ID: B-46

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	Mud Rotary SPT	**LOCATION**	770414.602 1869921.689			**DATE STARTED**	5/7/18	**COMPLETED**	5/10/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Auto	**EFFICIENCY**	90.2 % (Avg.)	**SURFACE ELEVATION**	973.2 ft	**DEPTH TO WATER**	0.0 ft
PID NUMBER		**PROJECT LOCATION**		**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	NQ	**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A	**DATE/TIME**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	CME 45 Truck \00	**BOREHOLE INCLINATION (VERT.)**	Vertical		

MATERIAL DESCRIPTION AND NOTES	ELEV. 973.2	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
- AUGERED DOWN TO 48.0' BEFORE SAMPLING AS DIRECTED		W 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24															

SUBSURFACE LOG

EXPLORATION ID: B-46

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.2 ft LOCATION 770414.602 1869921.689 DATE STARTED / DATE COMPLETED 5/7/18 - 5/10/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
		26															
		27															
		28															
		29															
		30															
		31															
		32															
		33															
		34															
		35															
		36															
		37															
		38															
		39															
		40															
		41															
		42															
		43															
		44															
		45															
		46															
		47															
STIFF, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST	925.2	48															
- DENSE, WET, GRAY MEDIUM TO FINE GRAINED SAND WITH SOME GRAVEL @ 48.3' - 49.0'		49	8-47-30	78	SS-1	3.5	-	-	-	-	-	-	-	-	-		
		50															
- CRUSHED SHALE FRAGMENTS		51	12-18-50/5"	65	SS-2	3.5	-	-	-	-	-	-	-	-	-		

STANTEC BORING SUBSURFACE LOG BWSTE PHASE 2 SOIL LOGS POST GRADATION CURVES.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: B-46

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.2 ft LOCATION 770414.602 1869921.689 DATE STARTED / DATE COMPLETED 5/7/18 - 5/10/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	ABAN-DONED
STIFF, GRAY, **SILTY CLAY**, WITH SAND AND GRAVEL, MOIST *(continued)*	920.0	TR 52 53															

Boring Continues on Following Rock Description Log

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-46**
Coordinates: N 770414.6 E 1869921.7	Driller:	Rii/ S.P	**Sheet No. 1 of 3**
Top Drillhole Elevation: 973.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 802.7 feet MSL	Prepared By:	A. Mirza	
Total Depth: 170.5 feet	Checked By:	B. Madras Natarajan	Date Start: 5/7/18 End: 5/10/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 0

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
922	52							Refer to soil borings for details on soil descriptions/characteristics Top of Rock @ 52.3'
920	54	0	30	1.7	53.2' 0-5°, B, R4-R5, O, Pl 53.4' 0-5°, B, R5, O, Pl 53.5' 0-5°, B, R4-R5, PtO-t, Pl 53.6' 0-5°, B, R5, t, Pl 53.7' to 54.2' fractured rck	1	52.3 to 85.5' Interbedded **BEREA SANDSTONE** and **BEDFORD SHALE** (55%/45%) **BEREA SANDSTONE**, grey, fine grained, slightly to moderately weathered, hard, thinly bedded, slightly to moderately fractured, flat **BEDFORD SHALE**, grey, very fine grained, lightly to moderately weathered, soft, thinly bedded, slightly to moderately fractured, flat	Run-1 52.3' - 55.5' 20 minute run Down Pressure = 300 Psi
918	56				55.5' to 55.8' fractured rock 56.0' 0-5°, B, R5, O, Pl 56.3' to 56.6' fractured rock 56.7' 0-5°, B, R4-R5, O, Pl 56.8' 0-5°, B, R5, t, Pl			Run-2 55.5' - 60.5' 17 minute run Down Pressure = 450 Psi
916	58	20	98	2.6	56.9' 0-5°, B, R5, PtO-t, Pl 57.0' 0-5°, B, R4-R5, O, Pl 57.1' 0-5°, B, R5, t, Pl 57.2' to 57.4' fractured rock 57.6' 0-5°, B, R4-R5, O, Pl	2		
914	60				58.1' 0-5°, B, R5, PtO-t, Pl 58.4' 0-5°, B, R5, t, Pl 58.7' 0-5°, B, R4, t, Pl			Run-3 60.5' - 65.5' 13 minute run Down Pressure = 400 Psi
912	62				59.0' 0-5°, B, R5, PtO-t, Pl 59.3' 0-5°, B, R4-R5, O, Pl 59.5' to 59.6' fractured rock			
910	64	48	96	1.8	60.0' 0-5°, B, R5, PtO-t, Pl 60.7' to 60.8' fractured rock 61.1' 0-5°, B, R4-R5, O, Pl 61.2' 0-5°, B, R5, t, Pl 61.3' to 61.5' fractured rock	3		
908	66				61.4' 0-5°, B, R5, PtO-t, Pl 61.6' 0-5°, B, R4-R5, O, Pl 61.8' 0-5°, B, R5, t, Pl			Run-4 65.5' - 70.5' 14 minute run Down Pressure = 350 Psi
906	68	38	96	3	61.9' 0-5°, B, R4-R5, t, Pl 62.3' 0-5°, B, R4, O, Pl 62.8' 0-5°, B, R5, t, Pl 63.2' 0-5°, B, R5, PtO-t, Pl 63.5' 0-5°, B, R4, t, Pl	4		
904	70				64.4' 0-5°, B, R5, O, Pl 64.9' 0-5°, B, R5, PtO-t, Pl 65.5' 0-5°, B, R5, t, Pl 65.6' 0-5°, B, R5, PtO-t, Pl			
902	72				65.7' 0-5°, B, R5, O, Pl 66.0' to 66.1' fractured rock 66.8' 0-5°, B, R5, PtO-t, Pl			Run-5 70.5' - 75.5' 16 minute run Down Pressure = 350 - 400 Psi
900	74	65	100	1.2	66.9' 0-5°, B, R4-R5, O, Pl 67.0' 0-5°, B, R5, t, Pl 67.4' 0-5°, B, R4-R5, t, Pl 68.4' 0-5°, B, R4, O, Pl 68.6' 0-5°, B, R5, t, Pl	5		
898	76				69.0' 0-5°, B, R5, PtO-t, Pl 69.1' 0-5°, B, R4, t, Pl 69.7' 0-5°, B, R5, O, Pl 69.8' 0-5°, B, R5, PtO-t, Pl 70.2' 0-5°, B, R5, t, Pl			Run-6 75.5' - 80.5' 14 minute run Down Pressure = 400 Psi
896	78	79	96	1.6	72.3' 0-5°, B, R5, PtO-t, Pl 72.4' 0-5°, B, R4-R5, O, Pl 72.8' 0-5°, B, R5, t, Pl 73.7' 0-5°, B, R4-R5, t, Pl 74.8' 0-5°, B, R4, O, Pl	6		
894	80				75.0' 0-5°, B, R5, t, Pl 75.5' 0-5°, B, R5, PtO-t, Pl 76.2' 0-5°, B, R4, t, Pl 76.7' 0-5°, B, R5, O, Pl			
892	82				76.8' 0-5°, B, R5, PtO-t, Pl 77.2' 0-5°, B, R4, O, Pl 77.7' 0-5°, B, R5, t, Pl 78.9' 0-5°, B, R5, PtO-t, Pl 79.0' 0-5°, B, R4, t, Pl			Run-7 80.5' - 85.5' 15 minute run Down Pressure = 450 Psi
890	84	77	100	1.8	80.7' 0-5°, B, R5, O, Pl 81.0' 0-5°, B, R5, PtO-t, Pl 81.4' 0-5°, B, R5, t, Pl 82.3' 0-5°, B, R4, O, Pl 82.7' 60°, Jt, R4, O, Und	7		
888	86				83.5' 0-5°, B, R5, PtO-t, Pl 84.6' 0-5°, B, R4-R5, O, Pl 84.7' 0-5°, B, R5, t, Pl 85.3' 0-5°, B, R4-R5, t, Pl 85.5' 0-5°, B, R4, O, Pl		85.5 to 97.5' **BEDFORD SHALE**, grey with red bands, fine grained, unweathered to slightly weathered, soft, thinly bedded, flat bedded	Run-8 85.5' - 90.5' 12 minute run Down Pressure = 500 Psi
886	88	98	100	0.8	86.9' 0-5°, B, R5, t, Pl 87.8' 0-5°, B, R5, PtO-t, Pl 88.6' 0-5°, B, R4, t, Pl	8		
884	90							
	170	170	100					Run-9 90.5' - 95.5' 12 minute run

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig:	CME 45 Truck \00	**BORING NO. B-46**
Coordinates: N 770414.6 E 1869921.7	Driller:	Rii/ S.P	**Sheet No. 2 of 3**
Top Drillhole Elevation: 973.2 feet MSL	Logged By:	John Ristow/AECOM	
Bottom Elevation: 802.7 feet MSL	Prepared By:	A. Mirza	
Total Depth: 170.5 feet	Checked By:	B. Madras Natarajan	Date Start: 5/7/18 End: 5/10/18
Orientation: Vertical	Core Size:	NQ	Groundwater Depth: 0

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
882					91.1' 0-5°, B, R5, O, Pl			Down Pressure = 500 Psi
	92				91.7' 0-5°, B, R5, PtO-t, Pl			
880		70	100	1.6	92.4' 0-5°, B, R4, O, Pl	9		
	94				93.3' 0-5°, B, R5, t, Pl			
878					94.0' 60°, Jt, R4, O, Und 94.4' 0-5°, B, R4, O, Pl 94.6' 0-5°, B, R5, t, Pl			
	96				95.3' 0-5°, B, R4,O, Pl 95.5' 0-5°, B, R4, t, Pl			Run-10 95.5' - 100.5' 10 minute run Down Pressure = 500 Psi
876					96.5' 0-5°, B, R5, O, Pl			
	98	76	99	1.6	97.5' 0-5°, B, R5, PtO-t, Pl	10	97.5 to 117.5' **BEDFORD SHALE**, red, fine grained, unweathered to slightly weathered, soft, thinly bedded, flat bedded	
874					98.2' 0-5°, B, R5, PtO-t, Pl 98.4' 0-5°, B, R4-R5, O, Pl 98.7' 0-5°, B, R5, t, Pl 98.9' 0-5°, B, R4-R5, t, Pl			
	100				100.2' 0-5°, B, R4, O, Pl			Run-11 100.5' - 105.5' 20 minute run Down Pressure = 250 - 500 Psi
872					101.0' 0-5°, B, R5, t, Pl 101.2' to 101.3' fractured rock			
	102				101.6' 0-5°, B, R5, PtO-t, Pl 101.7' 0-5°, B, R4-R5, O, Pl			
870		45	100	1.6	102.0' 0-5°, B, R5, t, Pl 102.1' 0-5°, B, R4-R5, t, Pl	11		
	104				102.9' 0-5°, B, R4, O, Pl 103.0' to 103.2' fractured rock 104.4' 0-5°, B, R5, PtO-t, Pl			
868					104.9' 0-5°, B, R4-R5, O, Pl			
	106							Run-12 105.5' - 110.5' 15 minute run Down Pressure = 500 Psi
866								
	108	87	100	0.2		12		
864								
	110				109.9' 0-5°, B, R5, t, Pl			
862					110.6' 60°, Jt, R4, O, Und 110.9' 60°, Jt, R4, O, Und 111.4' 0-5°, B, R5, t, Pl			Run-13 110.5' - 115.5' 13 minute run Down Pressure = 400 - 500 Psi
	112							
860		77	100	1.4	112.8' 0-5°, B, R4, O, Pl 113.2' to 113.3' fractured rock	13		
	114				113.9' 0-5°, B, R5, t, Pl			
858					114.6' 0-5°, B, R5, PtO-t, Pl 114.9' 0-5°, B, R4-R5, O, Pl			
	116				115.6' 0-5°, B, R5, t, Pl			Run-14 115.5' - 120.5' 13 minute run Down Pressure = 450 Psi
856					116.3' 0-5°, B, R4-R5, t, Pl			
	118	34	100	2	117.7' 0-5°, B, R4, O, Pl 118.1' 0-5°, B, R5, t, Pl	14	117.5 to 128.5' **BEDFORD SHALE**, grey with red bands, fine grained, unweathered to slightly weathered, soft, thinly bedded, flat bedded	
854					118.5' 0-5°, B, R5, PtO-t, Pl 118.8' 0-5°, B, R4, t, Pl			
	120				119.2' 0-5°, B, R5, O, Pl 119.4' 0-5°, B, R5, PtO-t, Pl			
852					119.9' 0-5°, B, R4, t, Pl 120.1' 0-5°, B, R5, O, Pl			Run-15 120.5' - 125.5' 13 minute run Down Pressure = 500 Psi
	122				121.1' 0-5°, B, R5, PtO-t, Pl 121.4' 0-5°, B, R5, t, Pl			
850		66	100	1.8	121.6' 0-5°, B, R5, t, Pl 121.8' 0-5°, B, R5, PtO-t, Pl	15		
	124				122.1' 0-5°, B, R4-R5, O, Pl 123.1' 0-5°, B, R5, t, Pl			
848					123.9' 0-5°, B, R4-R5, t, Pl 124.5' 0-5°, B, R4, O, Pl			
	126				124.7' 0-5°, B, R5, t, Pl 125.5' 0-5°, B, R5, PtO-t, Pl			Run-16 125.5' - 130.5' 9 minute run Down Pressure = 500 Psi
846					126.0' 0-5°, B, R4, t, Pl 126.3' 0-5°, B, R5, O, Pl			
	128	78	100	1.6	126.5' 0-5°, B, R5, t, Pl 127.0' 0-5°, B, R5, PtO-t, Pl	16		
844					127.1' 0-5°, B, R4, t, Pl 127.8' 0-5°, B, R5, O, Pl		128.5 to 142.5' **BEDFORD SHALE**, grey, fine grained, unweathered to slightly weathered, soft, thinly bedded, flat bedded	
	130							
		99	99	1	130.2' 0-5°, B, R4, t, Pl			Run-17 130.5' - 135.5' 10 minute

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 45 Truck \00		**BORING NO. B-46**
Coordinates: N 770414.6 E 1869921.7	Driller: Rii/ S.P		**Sheet No. 3 of 3**
Top Drillhole Elevation: 973.2 feet MSL	Logged By: John Ristow/AECOM		
Bottom Elevation: 802.7 feet MSL	Prepared By: A. Mirza		
Total Depth: 170.5 feet	Checked By: B. Madras Natarajan	Date Start: 5/7/18 End: 5/10/18	
Orientation: Vertical	Core Size: NQ	Groundwater Depth: 0	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	Fractures / ft	Discontinuity Description	Run Number	Geologic Classification and Physical Description	Comments
842								
	132				131.3' 0-5°, B, R5, O, Pl 131.5' 0-5°, B, R4, O, Pl			run Down Pressure = 500 Psi
					132.4' 0-5°, B, R5, t, Pl			
840		99	99	1	133.1' 0-5°, B, R5, PtO-t, Pl	17		
	134							
838					134.4' 0-5°, B, R4, t, Pl			
	136				135.9' 0-5°, B, R5, O, Pl			Run-18 135.5' - 140.5' 10 minute run Down Pressure = 500 Psi
836					136.8' 0-5°, B, R5, PtO-t, Pl			
	138	92	99	1.2	137.6' 0-5°, B, R5, PtO-t, Pl 138.1' 0-5°, B, R4, O, Pl	18		
834								
	140				139.5' 0-5°, B, R5, t, Pl			
832					140.3' 0-5°, B, R4, t, Pl 140.5' 0-5°, B, R5, O, Pl			Run-19 140.5' - 145.5' 10 minute run Down Pressure = 500 Psi
	142				141.3' 0-5°, B, R5, t, Pl 142.0' 0-5°, B, R5, PtO-t, Pl			
830		98	100	1		19	142.5 to 170.5' **OHIO SHALE**, black, fine grained, unweathered, soft to moderately hard, thinly bedded, slightly fractured, flat bedded, fresh fractures.	
	144							
828					144.4' 0-5°, B, R5, t, Pl			
	146				145.4' 0-5°, B, R5, PtO-t, Pl 145.8' 0-5°, B, R5, t, Pl			Run-20 145.5' - 150.5' 7 minute run Down Pressure = 550 Psi
826					147.0' 0-5°, B, R4-R5, t, Pl			
	148	100	100	2.2	147.2' 0-5°, B, R4, O, Pl 147.5' 0-5°, B, R5, t, Pl 147.6' 0-5°, B, R5, PtO-t, Pl	20		
824					147.7' 0-5°, B, R4, t, Pl 148.0' 0-5°, B, R5, O, Pl			148.8' - 149.2' UCS = 3,544 Psi
	150				148.6' 0-5°, B, R5, PtO-t, Pl 149.4' 0-5°, B, R4, O, Pl			
822					149.5' 0-5°, B, R4-R5, t, Pl			Run-21 150.5' - 155.5' 8 minute run Down Pressure = 550 Psi
	152				150.0' 0-5°, B, R4, O, Pl 150.7' 0-5°, B, R5, t, Pl 151.6' 0-5°, B, R5, PtO-t, Pl			
820		85	100	1.2	151.9' 0-5°, B, R5, t, Pl 153.1' 0-5°, B, R5, PtO-t, Pl	21		
	154				153.8' 45°, Jt, R4, O, Und			
818					154.6' 60°, Jt, R4, O, Und			
	156							Run-22 155.5' - 160.5' 10 minute run Down Pressure = 500 - 600 Psi
816					157.1' 0-5°, B, R5, PtO-t, Pl			
	158	94	94	1.2	157.6' 0-5°, B, R5, t, Pl 158.0' 0-5°, B, R4-R5, t, Pl	22		
814					158.6' 0-5°, B, R4, O, Pl			
	160				159.4' 0-5°, B, R5, t, Pl 159.6' 0-5°, B, R5, PtO-t, Pl			
812					160.3' to 160.5' fractured rock			Run-23 160.5' - 165.5' 8 minute run Down Pressure = 500 Psi
	162				161.4' 0-5°, B, R5, PtO-t, Pl 161.9' 0-5°, B, R5, t, Pl			
810		93	100	1	162.6' 0-5°, B, R4-R5, t, Pl	23		
	164				163.6' 0-5°, B, R4, O, Pl 164.1' 0-5°, B, R5, t, Pl			
808								
	166				165.6' 0-5°, B, R5, PtO-t, Pl 165.7' 0-5°, B, R4, t, Pl			Run-24 165.5' - 170.5' 7 minute run Down Pressure = 500 Psi
806					166.1' 0-5°, B, R5, O, Pl 166.6' 0-5°, B, R5, PtO-t, Pl			
	168	100	100	1.2		24		
804					168.3' 0-5°, B, R4, O, Pl 168.6' 0-5°, B, R4-R5, t, Pl			
	170							

End of Boring at 170.5 feet

Stantec

RESOURCE INTERNATIONAL, INC.

PROJECT: BIG WALNUT SEWER TRUNK EXT. PH 2	DRILLING FIRM / OPERATOR: RII / J. WEBB	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: '	**EXPLORATION ID B-47**	
TYPE: GEOTECHNICAL INVESTIGATION	SAMPLING FIRM / LOGGER: RII / N. C./J. K.	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: NA BR ID:	DRILLING METHOD: 4.5" CFA / HQ3WL	CALIBRATION DATE: 2/20/07	ELEVATION: 0.0 (MSL) EOB: 6.3 ft.		PAGE 1 OF 1
START: 5/6/19 END: 5/17/19	SAMPLING METHOD: SPT/HQ	ENERGY RATIO (%): 83.4	LAT / LONG: NOT RECORDED		

MATERIAL DESCRIPTION AND NOTES	ELEV. 0.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS (GI)	INST.
1.0' - TOPSOIL (12.0")	-1.0	1	WOH	-	33	SS-1A	-	-	-	-	-	-	-	-	-	-		
			WOH	-	100	SS-1B	-	-	-	-	-	-	-	-	-	-		
BROWN TO MOTTLED BROWN, GRAY, ORANGISH BROWN **LEAN CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, TRACE ORGANICS, MOIST.		2	WOH	-	100	SS-1C	-	-	-	-	-	-	-	-	-	-	CL (V)	
			WOH 2 5	10	67	SS-2	-	-	-	-	-	-	-	-	-	-	CL (V)	
		3																
	-4.5	4	2 3 50/2"	-	100	SS-3	-	-	-	-	-	-	-	-	-	-	CL (V)	
SANDSTONE; brown and gray, weathered, angular, silty, broken fragments. Very moist.		TR 5																
	-6.3	6	50/4"	-	56	SS-4	-	-	-	-	-	-	-	-	-	-	Rock	

BORING CONTINUED ON FOLLOWING ROCK DESCRIPTION LOG

BORING CONTINUES ON FOLLOWING ROCK DESCIPTION LOG

NOTES: PACKER TESTING WAS PERFORMED IN THE BOREHOLE AFTER DRILLING COMPLETION. BOREHOLE WAS SEALED WITH BENTONITE CEMENT GROUT UPON COMPLETION OF PACKER TESTING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Truck	**BORING NO. B-47**
Coordinates:	N 768800.4 E 1867981.9	Driller:	RII/J. Webb	**Sheet No. 1 of 5**
Surface Elevation:	996.3 feet MSL	Logged By:	RII/N.C.&J.K.	
Bottom Elevation:	810.5 feet MSL	Prepared By:	RII/C.Straub	
Total Depth:	185.8 feet	Checked By:	Stantec/M.Barga	Date Start: 5/6/19 End: 5/17/19
Orientation:	Vertical	Core Size:	HQ3WL	Groundwater Elevation:

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
996			33				0.0 to 4.7' SEE SOIL DESCRIPTIONS ON SOIL LOG	Refer to soil borings for details on soil descriptions/characteristics
			100					
			100					
994	2		67					
992	4		100				4.7 to 6.3' **SANDSTONE;** BROWN AND GRAY, WEATHERED, BROKEN FRAGMENTS, VERY MOIST.	TOP OF ROCK @ 4.7'
990	6		67		6.4' to 6.8', 0-5°, 4 Jts, R2-R4, t-MW, Pl, Fe		6.3 to 48.3' **BEREA SANDSTONE,** BROWN TO GRAY, HIGHLY WEATHERED TO UNWEATHERED, MEDIUM HARD TO VERY HARD, VERY FINE GRAINED TO FINE GRAINED, VERY THIN TO THIN BEDDED (WAVY TO PARALLEL PLANAR), HIGHLY JOINTED, INTENSELY FRACTURED TO HIGHLY FRACTURED, TIGHT TO MODERATELY WIDE APERATURE, SLIGHTLY ROUGH TO VERY ROUGH, SILTY.	Run-1 6.3' - 10.3' Down Pressure = 350 psi
988	8	0	92		6.9' to 7.0', 5-10°, 3 Jts, R2-R4, PtO-MW, Pl, Fe 7.2' 0-5°, J, R3, PtO, Pl, Fe 7.3' 0-5°, J, R3, PtO, Pl, Fe 7.4' to 7.7', clay seam 7.7' 5-10°, J, R2, O-MW, Pl, Fe 7.8' 5-10°, J, R2, O-MW, Pl, Fe 7.9' to 9.2', 0-5°, 13 Jts, R3, MW, W, Fe 9.5' to 9.6', rubbilized 9.6' to 41.5', 5-10°, 2 Jts, R4, PtO-O, Pl, Fe		7.4' CLAY SEAM (3.0") 11.4' COLOR CHANGES TO GRAY 11.6' CLAY SEAM (2.0") 12.0' CLAY SEAM (0.5") 12.4' TO 13.9' - FE STAINING IN JOINTS	
986	10							Run-2 10.3' - 15.3' Down Pressure = 350 psi
984	12	60	100		10.4' 0-5°, 2 Jts, R4, PtO, Pl, Fe 10.6' 0-5°, 2 Jts, R3, PtO-O, W, Fe 10.9' 0-5°, J, R2, O, MW, Fe 11.3' 0-5°, J, R2, O, MW, Fe 11.6' to 11.8', clay seam 12.0' to 12.1', clay seam 12.5' to 13.8', 0-5° 6 Jts, R4, t-PtO, Und, Fe			
982	14							
980	16				14.4' 0-5°, J, R3, O, Und 14.9' 0-5°, J, R3, O, Und 15.4' to 15.8' vertical fracture (Mech?) 15.9' 0-5°, J, R3, O, Und		16.1' CLAY SEAM (0.1") 16.3' CLAY SEAM (0.25")	Run-3 15.3' - 20.3' Down Pressure = 350 psi
978	18	83	100		16.1' 0-5°, J, R4, O, Pl, Cl 16.3' 0.25" clay seam 16.8' 0-5°, J, R3, O, Und			
976	20				19.4' 0-5°, J, R2, O, Pl		20.3' TO 21.3' TRACE SHALE LAMINAE	Run-4 20.3' - 25.3' Down Pressure = 350 psi
974	22	87	97		20.9' Mech. 22.2' 0-5°, 2 Jts, R3, O, Pl			PID = no gas
972	24				23.6' 10-15°, J, R4, PtO, Pl, Cl 23.7' 10-15°, J, R4, PtO, Pl, Cl 23.8' 10-15°, J, R4, PtO, Pl, Cl 24.2' 10-15°, J, R4, PtO, Pl, Cl		23.6' , 23.8', 24.2', 24.4' SLIGHTLY ANGLED JOINTS WITH TRACE CLAY	
970	26				24.4' 10-15°, J, R4, PtO, W, Cl 24.5' 0-5°, J, R4, PtO, W 25.5' 0-5°, J, R4, PtO, Pl			Run-5 25.3' - 30.3' Down Pressure = 350 psi
968	28	64	95		27.7' 0-5°, J, R3, O, Pl, Cl 27.8' 0-5°, J, R3, O, Pl 27.9' ground 28.1' to 29.2', 0-5°, 6 Jts, R4, O, Pl		27.8' BIOTURBATED SHALE SEAM	
966	30							Run-6 30.3' - 35.3' Down Pressure = 350 psi
964	32	86	98		30.7' 0-5°, B, R2, MW, Pl 30.8' 0-5°, B, R4, MW, Pl 31.8' Mech.			
962	34				33.0' 0-5°, J, R4-R5, O, Pl 33.1' 0-5°, J, R4-R5, O, Pl 34.4' shale stringer 34.7' 0-5°, J, R2, O, Pl (Mech?)		32.8' TOTAL LOSS OF WATER PRESSURE, CORE BIT FELL OFF, PULLED TOOLING TO RETRIEVE	
960	36				36.7' ground			Run-7 35.3' - 40.3' Down Pressure = 350 psi
958	38	80	98		37.3' 0-5°, 2 Jts, R4-R5, PtO, Pl 38.1' 0-5°, J, R4-R5, O, Pl 38.3' 0-5°, J, R4-R5, O, Pl, Cl 39.4' 0-5°, B, R5, PtO, Pl		38.1' BIOTURBATED SHALE SEAM	

MW/HILL

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Truck		**BORING NO. B-47**
Coordinates: N 768800.4 E 1867981.9	Driller: RII/J. Webb		**Sheet No. 2 of 5**
Surface Elevation: 996.3 feet MSL	Logged By: RII/N.C.&J.K.		
Bottom Elevation: 810.5 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 185.8 feet	Checked By: Stantec/M.Barga	Date Start: 5/6/19 End: 5/17/19	
Orientation: Vertical	Core Size: HQ3WL	Groundwater Elevation:	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
956					39.6' 0-5°, B, R5, PtO, Pl 40.0' 0.5" clay seam 40.1' Mech. 40.2' Mech. 41.8' 0-5°, J, R4-R5, PtO, Und-Pl,		40.0' CLAY SEAM (0.5")	Run-8 40.3' - 45.3' Down Pressure = 350 psi
954	42	67	100		42.7' 15-20°, J, R5, t-PtO, Und, bioturbated 43.1' 15-20o, J, R5, t-PtO, Und, bioturbated 43.4' to 44.0', soft shaley/clayey bioturbated zone		42.3' TO 44.0' - BIOTURBATED ZONE, SHALEY	
952	44				44.5' Mech. 45.1' 0-5°, J, R4, PtO, Pl, 0.25" clay seam 45.4' 0-5°, B, R2, O-MW, Pl, shale frags. 45.7' 0-5°, J, R3, O, Pl, Cl		45.3' INCREASING SHALE LAMINAE THROUGHOUT	Run-9 45.3' - 50.3' Down Pressure = 350 psi
950	46				47.1' 0-5°, B, R3, O, Pl, Cl			
948	48	73	97		48.1' 0-5°, B, R3, O, Pl, Cl 48.3' 0-5°, B, R3, O, Pl, Cl 48.4' 0-5°, B, R3, O, Pl, shale frags 48.7' to 49.4', shale laminae		48.3 to 71.9' **BEREA-INTERBEDDED SANDSTONE/SHALE/SILTSTONE; SANDSTONE**, GRAY, UNWEATHERED, HARD TO VERY HARD, VERY FINE GRAVINE/SILTY, VERY THIN TO MEDIUM BEDDED (PLANAR TO LENTICULAR), INTENSELY FRACTURED TO MODERATELY FRACTURED, VERY NARROW TO MODERATELY WIDE, SMOOTH TO VERY ROUGH, BLOCKY/DISTURBED/SEAMY, POOR TO FAIR.	
946	50				49.9' 0-5°, 2 Bs, R4, PtO, Pl, Cl 50.6' 0-5°, 2 Bs, R4, PtO, Pl			Run-10 50.3' - 55.3' Down Pressure = 400 psi
944	52	73	93		51.3' 0-5°, B, R4, PtO, Pl 52.7' 0-5°, B, R2, MW, W, shale frags.			
942	54				53.8' 0-5°, B, R5, O-MW, Pl 54.2' to 54.3' vertical healed joint		**SHALE**, DARK GRAY TO BLACK, UNWEATHERED, VERY SOFT TO HARD, LAMINATED TO MEDIUM BEDDED (PLANAR TO LENTICULAR, FISSILE), INTENSELY TO MODERATELY FRACTURED, TIGHT TO NARROW, SMOOTH TO SLIGHTLY ROUGH, BLOCKY/DISTURBED/SEAMY, POOR TO FAIR.	
940	56				56.5' 0-5°, B, R5, O-MW, Pl 57.1' Mech.			Run-11 55.3' - 60.3' Down Pressure = 400 psi
938	58	41	99		57.2' 0-5°, B, R4, PtO, Pl 57.4' 0-5°, B, R3, O-MW, Pl 57.5' 0-5°, B, R2, MW, Und 57.6' 0-5°, B, R4, O, Pl 57.7' 0-5°, B, R4, O, Pl 57.8' 0-5°, B, R4, O, Pl		**SILTSTONE**, GRAY, UNWEATHERED, MEDIUM HARD TO HARD, VERY FINE GRAINED, LAMINATED TO THIN BEDDED (PLANAR TO LENTICULAR), INTENSELY TO MODERATELY FRACTURED, VERY NARROW TO MODERATELY WIDE, SMOOTH TO VERY ROUGH, BLOCKY/DISTURBED/SEAMY, POOR TO FAIR. 61.3' TO 70.3' - TRACE BIOTURBATED LENSES, SILTSTONE INCLUSIONS	PID = no gas
936	60				58.1' 0-5°, B, R3, O, Pl			Run-12 60.3' - 65.3' Down Pressure = 400 psi
934	62	80	98		58.2' 0-5°, B, R3, PtO-O, Pl 58.3' 0-5°, B, R3, PtO-O, Pl 58.6' 0-5°, B, R3, PtO-O, Pl 58.9' 0-5°, B, R3, PtO-O, Pl 59.2' 0-5°, B, R3, PtO-O, Pl 59.3' 0-5°, B, R3, PtO-O, Pl 59.5' 0-5°, B, R3, PtO-O, Pl 59.6' 0-5°, B, R3, PtO-O, Pl 59.9' 0-5°, B, R3, PtO-O, Pl 60.2' 0-5°, B, R3, PtO-O, Pl 60.3' ground			
932	64				60.8' 0-5°, B, R3, PtO, Pl 61.5' 0-5°, B, R4, PtO, Pl 62.0' ground			Run-13 65.3' - 70.3' Down Pressure = 400 psi
930	66				62.4' 0-5°, B, R3-R4, PtO, Pl 62.8' 0-5°, B, R3-R4, PtO, Pl			
928	68	83	98		63.1' 0-5°, 2 Bs, R3-R4, PtO, Pl 63.7' 0-5°, B, R3-R4, PtO, Pl 65.1' 0-5°, B, R2, O, Pl 65.9' 0-5°, B, R4, PtO, Pl 66.0' 0-5°, B, R2, O, Und			
926	70				66.6' 0-5°, B, R4, PtO, Pl 68.1' 0-5°, B, R3, PtO, Pl 68.4' 0-5°, B, R3, PtO, Pl		70.3' BECOMING INCREASINGLY SHALEY	Run-14 70.3' - 75.3' Down Pressure = 400 psi
924	72				69.3' 0-5°, B, R2, O, Pl 69.4' 0-5°, B, R2, O, Pl			
922	74	73	100		70.9' 0-5°, B, R4, PtO, Pl 71.4' 0-5°, B, R3, PtO-O, Pl 72.3' bioturbated/possible polished surface? 72.7' 0-5°, B, R4, PtO, Pl 74.2' bioturbated/possible polished surface?		71.9 to 102.4' **BEREA/BEDFORD SHALE**, GRAY, UNWEATHERED, SOFT TO MEDIUM HARD, VERY FINE GRAINED, THIN TO THICK BEDDING, (PLANAR), HIGHLY TO MOEDERATELY FRACTURED, VERY NARROW TO MODERATELY WIDE APERATURES, SMOOTH TO SLIGHTLY ROUGH, BLOCKY/DISTURBED/SEAMY, POOR TO FAIR, TRACE SILTSTONE AND SANDSTONE LAMINAE THROUGHOUT. 77.3' -HQ-15 - SANDSTONE/SILTSTONE LAMINAE THROUGHOUT	
920	76				76.3' to 76.4', healed undulated, possible polished?			Run-15 75.3' - 80.3' Down Pressure = 400 psi
918	78	86	97		76.6' 0-5°, B, R4, PtO, Pl			

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Truck	**BORING NO. B-47**
Coordinates:	N 768800.4 E 1867981.9	Driller:	RII/J. Webb	**Sheet No. 3 of 5**
Surface Elevation:	996.3 feet MSL	Logged By:	RII/N.C.&J.K.	
Bottom Elevation:	810.5 feet MSL	Prepared By:	RII/C.Straub	
Total Depth:	185.8 feet	Checked By:	Stantec/M.Barga	Date Start: 5/6/19 End: 5/17/19
Orientation:	Vertical	Core Size:	HQ3WL	Groundwater Elevation:

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
916							80.3' -HQ-16: DECREASING SILTSTONE/SANDSTONE LAMINAE	Run-16 80.3' - 85.3' Down Pressure = 400 psi
	82				80.9' 0-5°, B, R4, PtO, Pl			
914		88	100					
	84				83.3' 0-5°, B, R2, O, Pl			
912							84.0' SHALE SHOWING SOME MINOR PITTING FROM CORING? WEAKER ZONE	
	86				85.7' 0-5°, B, R4, PtO, Pl			Run-17 85.3' - 90.3' Down Pressure = 400 psi
910		82	100					
	88				88.5' 0-5°, B, R4, PtO, Pl			
908								
	90				90.8' 5-10°, B, R3, PtO-O, Und			Run-18 90.3' - 95.3' Down Pressure = 400 psi
906								
	92				92.1' 0-5°, B, R4, PtO, Pl			
904		96	100					
	94				93.0' 0-5°, B, R4, PtO, Pl		93.0' -HQ-18 - VERY MINOR/TRACE SANDSTONE/SILTSTONE LAMINAE PRESENT	
902								
	96							Run-19 95.3' - 100.3' Down Pressure = 400 psi
900								
	98				97.2' 0-5°, B, R4, PtO, Pl			
898		98	100		97.7' 0-5°, B, R4, PtO, Pl			PID = no gas
	100							
896								Run-20 100.3' - 105.3' Down Pressure = 400 psi
	102							
894		93	96				102.4 to 162.3' **BEDFORD SHALE,** DARK GRAY AND RED, UNWEATHERED, SOFT TO HARD, VERY FINE GRAINED, MEDIUM TO THICK BEDDING (PLANAR TO WAVY), SLIGHTLY FRACTURED, VERY NARROW TO MEDERATELY WIDE APERATURE, SLIGHTLY ROUGN TO ROUGH, LAMINATED/SHEARED TO BLOCKY/DISTURBED/SEAMY, FAIR.	
	104							
892								
	106				105.8' 0-5°, J, R4, PtO, Pl 106.0' 0-5°, J, R4, PtO, Pl 106.8' 0-5°, J, R2, O, Und			Run-21 105.3' - 110.3' Down Pressure = 400 psi 15 minute run
890					106.9' 5-10°, J, R4, O, Pl			
	108	87	100		107.3' 0-5°, J, R3, O, Pl		107.4' STARTING TO SHOW RED BANDING	
888					108.7' 0-5°, J, R4, O, Und			
	110							
886					110.2' 0-5°, 2 Jts, R2, O, Pl			Run-22 110.3' - 115.3' Down Pressure = 400 psi 20 minute run
	112				111.7' 5-10°, J, R4-R5, T, Pl			
884		85	100		113.0' 0-5°, J, R4, PtO, Pl			
	114				113.8' 0-5°, J, R2, O-MW, Pl 113.9' 5-10°, J, R3, PtO-O, Pl 114.1' 0-5°, J, R4, PtO-O, Pl 115.0' broken from shoe			
882							115.3' INCREASINGLY RED IN COLOR	Run-23 115.3' - 120.3' Down Pressure = 400 psi 20 minute run
	116				115.7' 0-5°, J, R4, PtO, Pl			
880								
	118	100	100					
878					119.3' 0-5°, J, R4, PtO, Pl			

MW/HILL

Big Walnut Sewer Tunnel Extension - Phase 2				Project No. 173409058
Location: Tunnel Alignment		Drill Rig:	CME 55 Truck	**BORING NO. B-47**
Coordinates:	N 768800.4 E 1867981.9	Driller:	RII/J. Webb	**Sheet No. 4 of 5**
Surface Elevation:	996.3 feet MSL	Logged By:	RII/N.C.&J.K.	
Bottom Elevation:	810.5 feet MSL	Prepared By:	RII/C.Straub	
Total Depth:	185.8 feet	Checked By:	Stantec/M.Barga	Date Start: 5/6/19 End: 5/17/19
Orientation:	Vertical	Core Size:	HQ3WL	Groundwater Elevation:

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
876							120.3' ROCK IS BREAKING AT 20-40 DEGREE ANGLES (MECHANICALLY)	Run-24 120.3' - 125.3' Down Pressure = 400 psi 19 minute run
874	122	95	98				122.5' TO 138.8' - RED IN COLOR, MORE LIKE CLAYSHALE (LESS FISSILE)	
872	124				124.4' 10-15°, J, R4, PtO, Pl			
					125.1' broken from shoe			Run-25 125.3' - 130.3' Down Pressure = 400 psi 17 minute run
870	126				125.8' 0-5°, J, R3, MW, Pl 125.9' 0-5°, J, R3, MW, Pl			
868	128	88	98		127.1' 0-5°, J, R4, PtO, Pl 127.3' 0-5°, J, R4, PtO-O, Pl 127.4' 0-5°, 2 Jts, R4, PtO-O, Pl			
866	130							Run-26 130.3' - 135.3' Down Pressure = 400 psi 18 minute run
864	132	88	88					
862	134							
860	136				136.5' 0-5°, J, R3, PtO-O, Pl			Run-27 135.3' - 140.3' Down Pressure = 400 psi 19 minute run
858	138	100	100					PID = no gas
856	140				139.1' 0-5°, J, R3, PtO-O, Pl 139.2' 0-5°, J, R3, PtO-O, Pl, Cl		140.3' RECOVERED ENTIRE RUN (HQ-28) INTACT, COLOR CHANGES BACK TO GRAY WITH TRACE RED BANDS	Run-28 140.3' - 145.6' Down Pressure = 400 psi 22 minute run
854	142	100	100					
852	144							
850	146	100	100					Run-29 145.6' - 148.3' Down Pressure = 400 psi 15 minute run
848	148	100	100				148.3' HQ-30 RECOVERED ENTIRE RUN INTACT	Run-30 148.3' - 150.3' Down Pressure = 400 psi 12 minute run
846	150						150.3' MINOR PITTING FROM CORING PROCESS? WEAKER SHALE	Run-31 150.3' - 155.6' Down Pressure = 400 psi 21 minute run
844	152	100	100					
842	154				154.1' 0-5°, J, R3, t-PtO, Und			
840	156							Run-32 155.6' - 160.8' Down Pressure = 400 psi 23 minute run
838	158	100	100				157.8' AND 158.1' - LIGHT BROWNISH GRAY BANDS (SILTSTONE SEAMS)	

Big Walnut Sewer Tunnel Extension - Phase 2			Project No. 173409058
Location: Tunnel Alignment	Drill Rig: CME 55 Truck	BORING NO. B-47	
Coordinates: N 768800.4 E 1867981.9	Driller: RII/J. Webb	Sheet No. 5 of 5	
Surface Elevation: 996.3 feet MSL	Logged By: RII/N.C.&J.K.		
Bottom Elevation: 810.5 feet MSL	Prepared By: RII/C.Straub		
Total Depth: 185.8 feet	Checked By: Stantec/M.Barga	Date Start: 5/6/19 End: 5/17/19	
Orientation: Vertical	Core Size: HQ3WL	Groundwater Elevation:	

Elevation, feet MSL	Depth, feet	RQD, %	Recovery, %	WPT, cm/sec	Discontinuity Description	Graphic Log	Geologic Classification and Physical Description	Comments
836		100	100				160.5' LIGHT GRAY SILTSTONE SEAM	Run-33 160.8' - 166.1' Down Pressure = 400 psi 26 minute run
834	162						162.3 to 185.8' **OHIO SHALE,** BLACK, UNWEATHERED, MEDIUM HARD TO HARD, VERY FINE GRAINED/CLAYEY, MEDIUM TO THICK BEDDED (PLANAR, FISSILE), SLIGHTLY FRACTURED, VERY NARROW, SLIGHLY ROUGH, VERY BLOCKY, FAIR, CARBONACEOUS, PYRITIC.	
832	164	100	100					
830	166							Run-34 166.1' - 171.2' Down Pressure = 400 psi 20 minute run
828	168	100	100					PID = no gas
826	170							
824	172						172.1' PYRITE NODULE	Run-35 171.2' - 175.7' Down Pressure = 400 psi 14 minute run
822	174	100	100					
820	176							Run-36 175.7' - 180.7' Down Pressure = 400 psi 17 minute run
818	178	98	100		177.4' ground		177.9' PYRITE NODULE	
816	180							
814	182				181.2' ground			Run-37 180.7' - 185.8' Down Pressure = 400 psi 23 minute run
812	184	97	100					
810	186				185.0' 0-5°, J, R5, W, PI		**End of Boring at 185.8 feet**	
808	188							
806	190							
804	192							
802	194							
800	196							
798	198							

MW/HILL

SUBSURFACE LOG

EXPLORATION ID: OW-01

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	765355.381 1867749.314	**DATE STARTED**	6/22/18	**COMPLETED**	6/22/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	973.0 ft	**DEPTH TO WATER**	3.7 ft	**DATE/TIME**	1/18/18
PID NUMBER		**PROJECT LOCATION**	B-38	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A	**DATE/TIME**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical		

MATERIAL DESCRIPTION AND NOTES	ELEV. 972.96	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
	972.0	1															
VERY STIFF, LIGHT BROWN AND GRAY, **SILTY CLAY**, TRACE TO SOME SAND AND GRAVEL, MOIST		2	4-4-6	50	SS-1	2.5 - 4.5	-	-	-	-	-	-	-	-	-		
		3															
-ATTEMPTED SHELBY TUBE -PUSHED 10" PRIOR TO TUBE CRUSHING -DOWN PRESSURE = 100 - 1150 PSI	▼	4	-	0	ST-1		-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	14-7-9	61	SS-2	3.25 - 4.25	-	-	-	-	-	-	-	-	-		
		8															
		9	24-16-8	33	SS-3	4.0 - 4.5+	-	-	-	-	-	-	-	-	-		
		10															
		11															
		12	14-17-21	100	SS-4	2.5 - 4.5+	-	-	-	-	-	-	-	-	-		
		13															
		14	-	89	SS-5	3.75 - 4.5+	-	-	-	-	-	-	-	-	-		
		15															
-ATTEMPTED SHELBY TUBE -DOWN PRESSURE = 1450 PSI -SHELBY TUBE CRUSHED		16	-	0	ST-2		-	-	-	-	-	-	-	-	-		
		17	15-11-11	56	SS-6	3.0 - 4.0	-	-	-	-	-	-	-	-	-		
		18															
		19	12-12-13	100	SS-7	4.0 - 4.5+	-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-01

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.0 ft LOCATION 765355.381 1867749.314 DATE STARTED / DATE COMPLETED 6/22/18 - 6/22/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF, LIGHT BROWN AND GRAY, **SILTY CLAY**, TRACE TO SOME SAND AND GRAVEL, MOIST *(continued)*		21															
	951.5	22	14-40-48	67	SS-8	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, MEDIUM TO COARSE GRAINED, SOME GRAVEL, MOIST TO WET		23															
		24	50/3"	0	SS-9		-	-	-	-	-	-	-	-	-		
		25															
		26															
		27	22-34-38	56	SS-10		-	-	-	-	-	-	-	-	-		
		28															
		29	10-18-27	78	SS-11		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32	13-23-36	78	SS-12		-	-	-	-	-	-	-	-	-		
		33															
		34	25-26-22	89	SS-13		-	-	-	-	-	-	-	-	-		
		35															
	937.0	36															
MEDIUM DENSE, GRAY, **FINE SAND**, SOME MEDIUM GRAINED AND SILT, WET		37	11-17-19	100	SS-14		-	-	-	-	-	-	-	-	-		
		38															
		39	15-21-23	100	SS-15		-	-	-	-	-	-	-	-	-		
	933.0	40															
		EOB															

NOTES: SCREENED FROM 20.0' TO 40.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

Stantec

SUBSURFACE LOG

EXPLORATION ID: OW-02

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	765355.831 1867800.765	**DATE STARTED**	6/19/18	**COMPLETED**	6/20/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	973.8 ft
PID NUMBER		**PROJECT LOCATION**	B-38	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 973.8	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
VERY STIFF TO HARD, LIGHT BROWN, **SILTY CLAY**, AND GRAVEL, SOME SAND, MOIST	972.8	1	4-5-5	81	SS-1	3.5 - 4.5+	-	-	-	-	-	-	-	-	-		
		2															
		3															
		4	8-8-8	75	SS-2	4.25 - 4.5+	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	6-8-8	72	SS-3	2.0 - 4.5+	-	-	-	-	-	-	-	-	-		
		8															
VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	965.1	9	3-7-7	78	SS-4	2.25 - 2.5	-	-	-	-	-	-	-	-	-		
LOOSE, GRAY, **GRAVEL WITH SAND**, MEDIUM GRAINED, POORLY GRADED, WET	964.6	10															
		11															
		12	5-8-9	83	SS-5		-	-	-	-	-	-	-	-	-		
		13															
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	960.1	14	6-6-8	83	SS-6	3.5 - 4.5+	-	-	-	-	-	-	-	-	-		
-ATTEMPTED SHELBY TUBE FROM 15.0' TO 17.0' (DP=1500 PSI), UNUSABLE TUBE, END DAMAGED		15															
		16	-	0	ST-1		-	-	-	-	-	-	-	-	-		
-COBBLE AND CRUSHED LIMESTONE IN SS-7 SAMPLE		17	16-13-8	11	SS-7		-	-	-	-	-	-	-	-	-		
		18															
		19	5-6-6	83	SS-8	2.0 - 4.5+	-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-02

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.8 ft LOCATION 765355.831 1867800.765 DATE STARTED / DATE COMPLETED 6/19/18 - 6/20/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST *(continued)*		21															
		22	9-12-17	100	SS-9	2.25 - 4.5+	-	-	-	-	-	-	-	-	-		
		23															
		24	29-33-32	100	SS-10	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **SANDY SILT**, TRACE GRAVEL, MOIST TO WET	949.0	25															
MEDIUM DENSE TO DENSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, MEDIUM TO COARSE GRAINED, WET	947.8	26															
		27	7-8-11	50	SS-11		-	-	-	-	-	-	-	-	-		
		28															
		29	31-29-26	67	SS-12		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32	16-21-23	72	SS-13		-	-	-	-	-	-	-	-	-		
		33															
		34	24-21-24	83	SS-14		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37	12-13-18	94	SS-15		-	-	-	-	-	-	-	-	-		
		38															
		39	27-21-23	83	SS-16	3.75	-	-	-	-	-	-	-	-	-		
VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	934.6																
	933.8	40															
		EOB															

NOTES: SCREENED FROM 20.0' TO 39.1' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-03

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	765429.434 1867712.875	**DATE STARTED**	6/26/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)
PID NUMBER		**PROJECT LOCATION**	B-38	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII

SURFACE ELEVATION	974.7 ft	**COMPLETED**	6/27/18
DEPTH TO WATER	5.3 ft	**DATE/TIME**	10/1/18
DEPTH TO WATER	N/A	**DATE/TIME**	N/A
BOREHOLE INCLINATION (VERT.)	Vertical		

MATERIAL DESCRIPTION AND NOTES	ELEV. 974.72	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
	973.7																
STIFF TO VERY STIFF, GRAY AND BROWN, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST		1															
		2	2-3-6	44	SS-1	2.25 -3.25	-	-	-	-	-	-	-	-	-		
		3															
		4	4-3-5	61	SS-2	1.75	-	-	-	-	-	-	-	-	-		
		5															
-DOWN PRESSURE 50 - 450 PSI FOR TUBE -PUSHED 2.0' -RECOVERY = 2.0' SU = 0.62 TSF		6															
		7	-	100	ST-1	3.25 - 3.75	3	3	13	51	30	29	18	11	21	CL	
		8															
		9	5-7-9	50	SS-3	3.0	-	-	-	-	-	-	-	-	-		
	965.0	10															
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, WET		11															
		12	9-13-14	89	SS-4		-	-	-	-	-	-	-	-	-		
		13															
		14	12-15-20	78	SS-5		-	-	-	-	-	-	-	-	-		
		15															
		16															
		17	8-15-19	72	SS-6		-	-	-	-	-	-	-	-	-		
		18															
	956.1	19															
HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST			10-13-20	100	SS-7	4.5+	-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-03

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 974.7 ft LOCATION 765429.434 1867712.875 DATE STARTED / DATE COMPLETED 6/26/18 - 6/27/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST *(continued)*		21															
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, WET	953.7																
HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	953.2	22	14-15-19	78	SS-8	4.5+	-	-	-	-	-	-	-	-	-		
		23															
		24	9-12-18	83	SS-9	4.0 - 4.5+	-	-	-	-	-	-	-	-	-		
		25															
		26															
		27	13-18-24	67	SS-10	4.5+	-	-	-	-	-	-	-	-	-		
		28															
		29	26-27-26	89	SS-11	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, AND GRAVEL, SOME ROCK FRAGMENTS, WET	945.3	30															
		31															
-SHALE AND SANDSTONE FRAGMENTS THROUGHOUT ZONE		32	35-37-35	56	SS-12		-	-	-	-	-	-	-	-	-		
		33															
		34	35-33-31	78	SS-13		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37	31-30-39	89	SS-14		-	-	-	-	-	-	-	-	-		
		38															
		39	27-27-35	56	SS-15		-	-	-	-	-	-	-	-	-		
		40															
		41															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-03

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 974.7 ft LOCATION 765429.434 1867712.875 DATE STARTED / DATE COMPLETED 6/26/18 - 6/27/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, AND GRAVEL, SOME ROCK FRAGMENTS, WET *(continued)*		42	10-23-27	72	SS-16		-	-	-	-	-	-	-	-	-		
		43															
		44	23-22-26	67	SS-17		-	-	-	-	-	-	-	-	-		
		45															
-SANDSTONE COBBLE ENCOUNTERED		46	50/0.5"	100	SS-18		-	-	-	-	-	-	-	-	-		
		47															
		48															
HARD, GRAY, **SANDY CLAY**, SOME SILT AND GRAVEL, MOIST	926.2	49	21-32-37	78	SS-19	4.5+	-	-	-	-	-	-	-	-	-		
		50															
		51															
		52	19-25-31	72	SS-20	4.5+	-	-	-	-	-	-	-	-	-		
		53															
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, WET	920.7	54	13-19-22	100	SS-21	4.5+	-	-	-	-	-	-	-	-	-		
		55															
MEDIUM DENSE TO DENSE, GRAY, **SILT**, SOME ROCK FRAGMENTS, MOIST	918.7	56	26-50/5"	73	SS-22		-	-	-	-	-	-	-	-	-		
-SHALE FRAGMENTS ENCOUNTERED		57															
		58															
		59	47-50/4"	120	SS-23		-	-	-	-	-	-	-	-	-		
	914.7	60															
		EOB															

NOTES: SCREENED FROM 40.0' TO 55.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION), LOCATION MOVED 8.0' EAST TO GET OFF 72" SEWER LINE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-04

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	765405.742 1867712.445	**DATE STARTED**	6/28/18	**COMPLETED**	6/28/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	973.8 ft
PID NUMBER		**PROJECT LOCATION**	B-38	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	4.3 ft
								DATE/TIME	10/1/18
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 973.77	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
STIFF, BROWN GRAY, **SILTY CLAY**, TRACE GRAVEL, MOIST	972.8	1															
		2	2-3-3	44	SS-1		-	-	-	-	-	-	-	-	-		
		3															
-DOWN PRESSURE 50 - 200 PSI FOR TUBE -PUSHED 2.0' -RECOVERY = 1.4' SU = 0.61 TSF		4	-	71	ST-1	1.75	11	2	5	30	52	51	19	32	28	CH	
		5															
		6															
		7	6-6-7	0	SS-2		-	-	-	-	-	-	-	-	-		
		8															
LOOSE, GRAY BROWN, **COARSE AND FINE SAND**, TRACE GRAVEL, WET	965.3	9	9-14-8	67	SS-3	3.0	-	-	-	-	-	-	-	-	-		
STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	964.5	10															
		11															
		12	6-8-11	94	SS-4	4.5+	-	-	-	-	-	-	-	-	-		
		13															
		14	12-8-10	72	SS-5	4.5+	-	-	-	-	-	-	-	-	-		
		15															
		16															
		17	7-8-8	100	SS-6	4.5+	-	-	-	-	-	-	-	-	-		
		18															
		19	5-9-12	89	SS-7	4.0 - 4.5	-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-04

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.8 ft LOCATION 765405.742 1867712.445 DATE STARTED / DATE COMPLETED 6/28/18 - 6/28/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST *(continued)*		21															
		22	10-13-15	100	SS-8	4.5+	-	-	-	-	-	-	-	-	-		
		23															
		24	12-15-24	100	SS-9	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, MEDIUM GRAINED, SOME GRAVEL, WET	949.0	25															
		26															
		27	7-21-31	83	SS-10		-	-	-	-	-	-	-	-	-		
		28															
		29	13-23-31	83	SS-11		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32	15-23-32	78	SS-12		-	-	-	-	-	-	-	-	-		
		33															
		34	33-31-29	67	SS-13		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37	16-31-27	83	SS-14		-	-	-	-	-	-	-	-	-		
		38															
		39	13-18-21	89	SS-15		-	-	-	-	-	-	-	-	-		
		40															
		41															

SUBSURFACE LOG

EXPLORATION ID: OW-04

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 973.8 ft LOCATION 765405.742 1867712.445 DATE STARTED / DATE COMPLETED 6/28/18 - 6/28/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, MEDIUM GRAINED, SOME GRAVEL, WET *(continued)*		42	16-24-27	89	SS-16		-	-	-	-	-	-	-	-	-		
		43															
		44	45-36-45	61	SS-17		-	-	-	-	-	-	-	-	-		
		45															
HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	927.8	46	11-19-27	67	SS-18	4.5+	-	-	-	-	-	-	-	-	-		
		47															
		48															
		49	18-30-31	89	SS-19	4.5+	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, MEDIUM GRAINED, TRACE GRAVEL, WET	924.5																
HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	923.9	50															
		51															
		52	14-19-21	44	SS-20	4.5+	-	-	-	-	-	-	-	-	-		
		53															
		54	10-13-27	67	SS-21	4.5+	-	-	-	-	-	-	-	-	-		
	918.8	55															
		EOB															

NOTES: SCREENED FROM 25.0' TO 45.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION), LOCATION MOVED 8.0' EAST TO GET OFF 72" SEWER LINE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-05

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	765355.013 1867707.538	**DATE STARTED**	6/25/18	**COMPLETED**	6/26/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	972.4 ft
PID NUMBER		**PROJECT LOCATION**	B-38	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	RII / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 972.38	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
	971.4																
STIFF, LIGHT BROWN AND GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST		1															
		2	3-3-3	67	SS-1	2.5 - 3.5	-	-	-	-	-	-	-	-	-		
		3															
-DOWN PRESSURE 50 - 400 PSI FOR TUBE -PUSHED 2.0' -RECOVERY = 1.5' SU = 0.58 TSF		4	-	75	ST-1	2.0	2	3	10	42	43	40	18	22	23	CL	
		5															
		6															
	965.9																
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, MEDIUM GRAINED, SOME GRAVEL, MOIST TO WET		7	4-10-13	78	SS-2	3.5	-	-	-	-	-	-	-	-	-		
		8															
	963.3	9															
MEDIUM STIFF, GRAY, **SILT**, WET	963.0		13-8-8	89	SS-3	0.5 - 3.5	-	-	-	-	-	-	-	-	-		
STIFF, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST		10															
		11															
		12	16-15-15	39	SS-4	0.75 - 3.0	-	-	-	-	-	-	-	-	-		
		13															
		14	5-7-7	100	SS-5	4.5+	-	-	-	-	-	-	-	-	-		
		15															
		16															
		17	6-8-9	89	SS-6	4.0 - 4.5+	-	-	-	-	-	-	-	-	-		
		18															
	953.4	19															
STIFF, GRAY, **SANDY CLAY**, MOIST TO DAMP			14-25-31	100	SS-7	4.5+	-	-	-	-	-	-	-	-	-		
	952.7																

SUBSURFACE LOG

EXPLORATION ID: OW-05

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 972.4 ft LOCATION 765355.013 1867707.538 DATE STARTED / DATE COMPLETED 6/25/18 - 6/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
DENSE, GRAY, **COARSE AND FINE SAND**, SOME GRAVEL AND ROCK FRAGMENTS, WET *(continued)*		21															
		22	18-23-28	83	SS-8		-	-	-	-	-	-	-	-	-		
		23															
		24	46-36-42	33	SS-9		-	-	-	-	-	-	-	-	-		
		25															
		26															
		27	15-32-39	78	SS-10		-	-	-	-	-	-	-	-	-		
		28															
		29	32-36-50/4"	72	SS-11		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32	42-42-29	78	SS-12		-	-	-	-	-	-	-	-	-		
		33															
LOOSE, GRAY, **FINE SAND**, SOME SILT, WET	938.4	34	27-21-17	72	SS-13		-	-	-	-	-	-	-	-	-		
		35															
DECOMPOSED, SOFT, VERY FINE GRAINED, SHALE, GRAY MOTTLED YELLOW, TRACE SANDSTONE.	936.4 TR	36	17-14-19	78	SS-14		-	-	-	-	-	-	-	-	-		
		37															
		38															
		39	18-33-37	33	SS-15		-	-	-	-	-	-	-	-	-		
		40															
		41															

SUBSURFACE LOG

EXPLORATION ID: OW-05

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 972.4 ft LOCATION 765355.013 1867707.538 DATE STARTED / DATE COMPLETED 6/25/18 - 6/26/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
DECOMPOSED, SOFT, VERY FINE GRAINED, SHALE, GRAY MOTTLED YELLOW, TRACE SANDSTONE. *(continued)*		42	16-24-50/4"	63	SS-16		-	-	-	-	-	-	-	-	-		
		43	50/0"		SS-17		-	-	-	-	-	-	-	-	-		
	928.9																
INTERBEDDED SANDSTONE AND SHALE -MODERATELY WEATHERED, MODERATELY HARD, MEDIUM GRAINED, SANDSTONE, ORANGE, THIN BEDDED, HIGHLY FRACTURED, FLAT		44	0	44	HQ-1											CORE	
-HIGHLY WEATHERED, VERY SOFT, FINE GRAINED, SHALE, GRAY, THIN BEDDED, HIGHLY FRACTURED, FLAT. RC-1 REC. = 0.7' RQD = 0.0' DOWN PRESSURE = 200 PSI RC-2 REC. = 3.6' RQD = 0.0' DOWN PRESSURE = 200 PSI		45 46 47 48 49 50	0	72	HQ-2											CORE	
RC-3 REC. = 2.2' RQD = 0.0 DOWN PRESSURE = 200 PSI		51 52 53 54	0	43	HQ-3											CORE	
	917.4	55 EOB															

NOTES: SCREENED FROM 20.0' TO 35.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION), LOCATION MOVED 8.0' EAST TO GET OFF 72" SEWER LINE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-06

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	770656.52 1870522.58	**DATE STARTED**	7/16/18	**COMPLETED**	7/18/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	985.0 ft
PID NUMBER		**PROJECT LOCATION**	B-39	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	RII / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF, LIGHT BROWN MOTTLED GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	984.96	1															
		2															
		3															
		4	5-8-10	67	SS-1	3.25 - 4.5	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7															
		8															
		9	5-6-10	56	SS-2	3.5 - 4.25	-	-	-	-	-	-	-	-	-		
		10															
		11															
		12															
ST-1 DOWN PRESSURE = 100 - 500 PSI RECOVERY = 0.0'		13	-	0	ST-1		-	-	-	-	-	-	-	-	-		
		14															
ST-2 DOWN PRESSURE = 1450 PSI PUSHED TUBE 1.75' RECOVERY = 1.0' SU = 0.41 TSF		15	-	50	ST-2	4.5+	14	9	11	40	26	24	15	9	14	CL	
		16															
		17															
		18															
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE GRAVEL, WET	966.5	19	18-23-23	72	SS-3		-	-	-	-	-	-	-	-	-		

STANTEC BORING SUBSURFACE LOG, BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-06

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 985.0 ft LOCATION 770656.52 1870522.58 DATE STARTED / DATE COMPLETED 7/16/18 - 7/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE GRAVEL, WET *(continued)*		21 22 23															
		24	14-13-17	50	SS-4		-	-	-	-	-	-	-	-	-		
		25 26 27 28															
STIFF, GRAY, **SILTY CLAY**, WET	956.5	29	10-8-6	100	SS-5	2.0 - 2.75	-	-	-	-	-	-	-	-	-		
		30 31 32 33															
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, SOME SILT, WET	951.5	34	24-20-20	83	SS-6		-	-	-	-	-	-	-	-	-		
		35 36 37 38															
STIFF, GRAY, **SILTY CLAY**, WET	946.5	39	41-39-40	89	SS-7		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE GRAVEL, SOME CLAY, WET	945.5	40 41															

SUBSURFACE LOG

EXPLORATION ID: OW-06

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 985.0 ft LOCATION 770656.52 1870522.58 DATE STARTED / DATE COMPLETED 7/16/18 - 7/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE GRAVEL, SOME CLAY, WET *(continued)*		42															
		43															
		44	18-18-24	67	SS-8		-	-	-	-	-	-	-	-	-		
		45															
		46															
		47															
		48															
		49	39-36-44	83	SS-9		-	-	-	-	-	-	-	-	-		
		50															
		51															
		52															
		53															
		54	50	100	SS-10		-	-	-	-	-	-	-	-	-		
		55															
		56															
		57															
		58															
		59	30-36-28	78	SS-11		-	-	-	-	-	-	-	-	-		
		60															
		61															
		62															

SUBSURFACE LOG

EXPLORATION ID: OW-06

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 985.0 ft LOCATION 770656.52 1870522.58 DATE STARTED / DATE COMPLETED 7/16/18 - 7/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE GRAVEL, SOME CLAY, WET *(continued)*		63															
		64	40-27-28	56	SS-12		-	-	-	-	-	-	-	-	-		
		65															
		66															
		67															
		68															
	916.2	69	20-27-28	67	SS-13		-	-	-	-	-	-	-	-	-		
HARD, GRAY, **SILT**, SOME FINE SAND, WET		70															
		71	-	50	ST-3		-	-	-	-	-	-	-	-	-		
ST-3 DOWN PRESSURE = 1400 PSI PUSHED TUBE 1.0'		72															
		73															
		74	10-21-25	72	SS-14	1.0	-	-	-	-	-	-	-	-	-		
		75															
		76															
		77															
		78															
	906.5	79	20-31-38	72	SS-15		-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, WET		80															
		81															
		82															
		83															
		84															

SUBSURFACE LOG

EXPLORATION ID: OW-06

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 985.0 ft LOCATION 770656.52 1870522.58 DATE STARTED / DATE COMPLETED 7/16/18 - 7/18/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, WET *(continued)*		85	23-31-46	83	SS-16		-	-	-	-	-	-	-	-	-		
		86															
		87															
		88															
		89	23-42-50/5"	82	SS-17		-	-	-	-	-	-	-	-	-		
		90															
		91															
		92															
		93															
		94	28-27-30	67	SS-18		-	-	-	-	-	-	-	-	-		
		95															
		96															
		97															
		98															
		99	17-23-28	56	SS-19		-	-	-	-	-	-	-	-	-		
		100															
		101															
		102															
		103															
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	881.5	104	11-15-22	78	SS-20	4.5+	-	-	-	-	-	-	-	-	-		
	880.0	105 EOB															

NOTES: SCREENED FROM 20.0' TO 104.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-07

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	770531.91 1870523.02	**DATE STARTED**	7/10/18	**COMPLETED**	7/12/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	982.9 ft
PID NUMBER		**PROJECT LOCATION**	B-39	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF TO HARD, LIGHT BROWN GRAY MOTTLED, **SILTY CLAY**, SOME GRAVEL AND SAND, MOIST	982.9	1															
		2															
		3															
		4	2-7-9	89	SS-1	3.75 - 4.5	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7															
		8															
		9	4-5-6	44	SS-2	3.75 - 4.0	-	-	-	-	-	-	-	-	-		
		10															
		11															
		12															
		13	-	0	ST-1		-	-	-	-	-	-	-	-	-		
		14															
		15	-	17	ST-2		-	-	-	-	-	-	-	-	-		
		16															
		17															
		18															
MEDIUM DENSE TO DENSE, GRAY, **FINE SAND**, TO MEDIUM GRAINED, SOME GRAVEL, WET	964.4	19	1-1-1	28	SS-3		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-07

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.9 ft LOCATION 770531.91 1870523.02 DATE STARTED / DATE COMPLETED 7/10/18 - 7/12/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE TO DENSE, GRAY, **FINE SAND**, TO MEDIUM GRAINED, SOME GRAVEL, WET *(continued)*		21															
		22															
		23															
		24	10-12-11	44	SS-4		-	-	-	-	-	-	-	-	-		
		25															
		26															
		27															
		28															
		29	12-18-22	78	SS-5		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32															
		33															
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE GRAVEL AND SAND, MOIST	949.4	34	15-18-17	78	SS-6	2.5 - 2.75	-	-	-	-	-	-	-	-	-		
		35															
		36															
		37															
		38															
		39	9-6-9	100	SS-7	2.5 - 2.75	-	-	-	-	-	-	-	-	-		
		40															
		41															

SUBSURFACE LOG

EXPLORATION ID: OW-07

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.9 ft LOCATION 770531.91 1870523.02 DATE STARTED / DATE COMPLETED 7/10/18 - 7/12/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE GRAVEL AND SAND, MOIST *(continued)*		42															
		43															
MEDIUM DENSE TO DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT AND CLAY, WET	939.4	44	22-23-21	100	SS-8	2.5	-	-	-	-	-	-	-	-	-		
		45															
		46	-	0	ST-3		-	-	-	-	-	-	-	-	-		
		47															
		48															
		49	50/5"	11	SS-9		-	-	-	-	-	-	-	-	-		
		50															
		51															
		52															
		53															
		54	45-37-50/5"	72	SS-10		-	-	-	-	-	-	-	-	-		
		55															
		56															
		57															
		58															
		59	50/5.75"	33	SS-11		-	-	-	-	-	-	-	-	-		
		60															
		61															
		62															

SUBSURFACE LOG

EXPLORATION ID: OW-07

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.9 ft LOCATION 770531.91 1870523.02 DATE STARTED / DATE COMPLETED 7/10/18 - 7/12/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE TO DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT AND CLAY, WET *(continued)*		63															
		64	39-37-50/5"	72	SS-12		-	-	-	-	-	-	-	-	-		
		65															
		66															
		67															
		68															
		69	40-34-33	78	SS-13		-	-	-	-	-	-	-	-	-		
		70															
		71															
		72															
		73															
VERY STIFF, GRAY, **SILT**, LITTLE COARSE TO FINE SAND, TRACE GRAVEL, MOIST	909.4	74	47-30-34	28	SS-14	2.0	-	-	-	-	-	-	-	-	-		
		75															
		76															
		77															
		78															
DENSE TO VERY DENSE, GRAY, **COARSE AND FINE SAND**, SOME GRAVEL AND SILT, WET	903.9	79	13-33-48	72	SS-15		-	-	-	-	-	-	-	-	-		
		80															
		81															
		82															
		83															
		84															

SUBSURFACE LOG

EXPLORATION ID: OW-07

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 982.9 ft LOCATION 770531.91 1870523.02 DATE STARTED / DATE COMPLETED 7/10/18 - 7/12/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
DENSE TO VERY DENSE, GRAY, **COARSE AND FINE SAND**, SOME GRAVEL AND SILT, WET *(continued)*		85	29-35-50	78	SS-16		-	-	-	-	-	-	-	-	-		
		86															
		87															
		88															
		89	30-32-40	67	SS-17		-	-	-	-	-	-	-	-	-		
		90															
		91															
		92															
		93															
		94	50/5.75"	11	SS-18		-	-	-	-	-	-	-	-	-		
		95															
		96															
		97															
		98															
		99	37-48-50/5"	0	SS-19		-	-	-	-	-	-	-	-	-		
		100															
		101															
		102															
		103															
	879.4																
HARD, GRAY, **SILTY CLAY**, TRACE GRAVEL, MOIST ST-4 DOWN PRESSURE = 650 - 1500 PSI PUSHED TUBE 0.5' RECOVERY = 0.0 FT		104	13-29-31	100	SS-20	4.5+	-	-	-	-	-	-	-	-	-		
		105	-	0	ST-4		-	-	-	-	-	-	-	-	-		
	877.4	EOB															

NOTES: SCREENED FROM 20.9' TO 105.9' (PREPACKED SCREENS) (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	770606.18 1870495.61	**DATE STARTED**	7/26/18	**COMPLETED**	8/1/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	983.7 ft
PID NUMBER		**PROJECT LOCATION**	B-39	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	9.5 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 983.73	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF, LIGHT BROWN TO GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, WEATHERED TILL, MOIST		1															
		2															
		3															
		4	6-8-10	94	SS-1	3.75 - 4.5+	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7															
		8															
		9	8-11-11	78	SS-2	4.25 - 4.5+	-	-	-	-	-	-	-	-	-		
		10															
		11															
ST-1 - DOWN PRESSURE = 100 - 450 PSI -PUSHED 2.0' SU = 1.17 TSF		12	-	83	ST-1	4.0 - 4.5+	8	11	14	41	26	25	16	9	-	CL	
		13															
	970.0	14	5-5-18	28	SS-3	1.0 - 4.0	-	-	-	-	-	-	-	-	24		
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, WET		15															
		16															
		17															
		18															
		19	10-13-14	61	SS-4		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.7 ft LOCATION 770606.18 1870495.61 DATE STARTED / DATE COMPLETED 7/26/18 - 8/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, WET *(continued)*		21															
		22															
		23															
		24	16-17-18	56	SS-5		-	-	-	-	-	-	-	-	-		
		25															
		26															
		27															
		28															
		29	37-26-23	72	SS-6		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32															
		33															
		34	19-24-22	78	SS-7		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37															
		38															
	945.2																
MEDIUM DENSE, GRAY, **SILTY SAND**, WET		39	13-12-14	50	SS-8		-	-	-	-	-	-	-	-	-		
		40															
		41															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.7 ft LOCATION 770606.18 1870495.61 DATE STARTED / DATE COMPLETED 7/26/18 - 8/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **SILTY SAND**, WET *(continued)*		42															
		43															
		44	13-16-15	67	SS-9		-	-	-	-	-	-	-	-	-		
ST-2 - DOWN PRESSURE = 250 - 1300 PSI - NO RECOVERY, END OF TUBE BENT DURING DRIVING - PUSHED 11"		45	-	0	ST-2		-	-	-	-	-	-	-	-	-		
		46															
		47															
		48															
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE TO SOME GRAVEL, WET	935.2	49	47-33-31	44	SS-10		-	-	-	-	-	-	-	-	-		
		50															
		51															
		52															
		53															
		54	17-22-22	50	SS-11		-	-	-	-	-	-	-	-	-		
		55															
		56															
		57															
		58															
		59	15-19-22	67	SS-12		-	-	-	-	-	-	-	-	-		
		60															
		61															
		62															

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.7 ft LOCATION 770606.18 1870495.61 DATE STARTED / DATE COMPLETED 7/26/18 - 8/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
		63															
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE SILT, WET	920.2	64	17-19-20	61	SS-13		-	-	-	-	-	-	-	-	-		
		65															
		66															
		67															
		68															
		69	25-38-46	44	SS-14		-	-	-	-	-	-	-	-	-		
		70															
		71															
		72															
		73															
		74	20-19-24	67	SS-15		-	-	-	-	-	-	-	-	-		
		75															
		76															
		77															
		78															
		79	18-20-25	61	SS-16		-	-	-	-	-	-	-	-	-		
		80															
		81															
		82															
		83															
		84															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.7 ft LOCATION 770606.18 1870495.61 DATE STARTED / DATE COMPLETED 7/26/18 - 8/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE SILT, WET *(continued)*		85	25-35-18	72	SS-17		-	-	-	-	-	-	-	-	-		
		86															
		87															
		88															
		89	17-26-27	67	SS-18		-	-	-	-	-	-	-	-	-		
		90															
		91															
		92															
		93															
		94	28-30-31	78	SS-19		-	-	-	-	-	-	-	-	-		
		95															
		96															
		97															
		98															
		99	21-23-23	72	SS-20		-	-	-	-	-	-	-	-	-		
		100															
		101															
		102															
		103															
		104	16-28-35	61	SS-21		-	-	-	-	-	-	-	-	-		
		105															

SUBSURFACE LOG

EXPLORATION ID: OW-08

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.7 ft LOCATION 770606.18 1870495.61 DATE STARTED / DATE COMPLETED 7/26/18 - 8/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE SILT, WET *(continued)*		106															
		107															
		108															
		109	27-31-44	67	SS-22		-	-	-	-	-	-	-	-	-		
		110															
		111															
		112															
		113															
- SOME CLAY AND SILT		114	34-34-37	78	SS-23		-	-	-	-	-	-	-	-	-		
		115															
		116															
		117															
		118															
	865.2	119	50/2"	100	SS-24		-	-	-	-	-	-	-	-	-		
HARD, GRAY, **SILTY CLAY**, WITH GRAVEL, TRACE TO SOME SAND AND COBBLES, MOIST		120															
		121															
		122															
		123															
		124	37-50/2"	75	SS-25		-	-	-	-	-	-	-	-	-		
	858.7	125															
		EOB															

NOTES: SCREENED FROM 13.0' TO 113.0' (PREPACKED SCREENS) (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	770603.83 1870423.36	**DATE STARTED**	7/20/18	**COMPLETED**	7/24/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	983.0 ft
PID NUMBER		**PROJECT LOCATION**	B-39	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	8.3 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	10/1/18
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 983.02	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
VERY STIFF, LIGHT BROWN TO GRAY MOTTLED, **SILTY CLAY**, TRACE TO SOME SAND AND GRAVEL, MOIST		1															
		2															
		3															
		4	3-6-7	83	SS-1	3.5 - 4.0	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7															
ST-1 -ATTEMPTED DENNISON SAMPLE AT 10' -NO RECOVERY -800 PSI PULLDOWN -25 PSI WATER PRESSURE		8															
		9	5-18-13	89	SS-2	3.75 - 4.0	-	-	-	-	-	-	-	-	-		
		10	-	0	ST-1		-	-	-	-	-	-	-	-	-		
ST-2 -DOWN PRESSURE = 100 - 500 PSI -RECOVERY = 1.7' SU = 1.16 TSF		11															
		12	-	83	ST-2		14	10	13	38	25	24	16	8	23	CL	
		13															
	969.5																
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME GRAVEL, WET		14	14-15-16	78	SS-3		-	-	-	-	-	-	-	-	-		
		15															
		16															
		17															
		18															
		19	12-14-12	67	SS-4		-	-	-	-	-	-	-	-	-		

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.0 ft LOCATION 770603.83 1870423.36 DATE STARTED / DATE COMPLETED 7/20/18 - 7/24/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME GRAVEL, WET *(continued)*		21															
		22															
		23															
		24	11-12-12	61	SS-5		-	-	-	-	-	-	-	-	-		
		25															
		26															
		27															
		28															
		29	12-14-8	44	SS-6		-	-	-	-	-	-	-	-	-		
		30															
		31															
		32															
		33															
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME SILT AND GRAVEL, TRACE ROCK FRAGMENTS, WET	949.5	34	21-25-25	72	SS-7		-	-	-	-	-	-	-	-	-		
		35															
		36															
		37															
		38															
		39	39-29-27	72	SS-8		-	-	-	-	-	-	-	-	-		
		40															
		41															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.0 ft LOCATION 770603.83 1870423.36 DATE STARTED / DATE COMPLETED 7/20/18 - 7/24/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME SILT AND GRAVEL, TRACE ROCK FRAGMENTS, WET *(continued)*		42															
		43															
		44	29-27-27	67	SS-9		-	-	-	-	-	-	-	-	-		
		45															
		46															
		47															
		48															
		49	32-40-39	100	SS-10		-	-	-	-	-	-	-	-	-		
		50															
		51															
		52															
		53															
		54	15-19-15	50	SS-11		-	-	-	-	-	-	-	-	-		
ST-3 ATTEMPTED AT 55.0' -DOWN PRESSURE = 1000 PSI -RECOVERY = 0.0'		55															
		56	-	0	ST-3		-	-	-	-	-	-	-	-	-		
		57															
		58															
		59	30-29-26	56	SS-12		-	-	-	-	-	-	-	-	-		
		60															
		61															
		62															

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.0 ft LOCATION 770603.83 1870423.36 DATE STARTED / DATE COMPLETED 7/20/18 - 7/24/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME SILT AND GRAVEL, TRACE ROCK FRAGMENTS, WET *(continued)*		63															
		64	40-35-38	72	SS-13		-	-	-	-	-	-	-	-	-		
		65															
		66															
		67															
		68															
		69	20-21-17	78	SS-14		-	-	-	-	-	-	-	-	-		
		70															
		71															
		72															
		73															
	909.5																
MEDIUM DENSE, GRAY, **SANDY SILT**, SOME FINE GRAINED SAND, WET		74	14-21-21	72	SS-15		-	-	-	-	-	-	-	-	-		
		75															
		76															
		77															
		78															
-LARGE (>2") COBBLE BLOCKED SHOE		79	42-50/4"	20	SS-16		-	-	-	-	-	-	-	-	-		
		80															
		81															
		82															
		83															
	899.5	84															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.0 ft LOCATION 770603.83 1870423.36 DATE STARTED / DATE COMPLETED 7/20/18 - 7/24/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MEDIUM DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, COARSE GRAINED, TRACE SILT, WET *(continued)*		85	23-21-23	61	SS-17		-	-	-	-	-	-	-	-	-		
		86															
		87															
		88															
		89	45-42-31	28	SS-18		-	-	-	-	-	-	-	-	-		
		90															
		91															
		92															
		93															
		94	50-50/5"	0	SS-19		-	-	-	-	-	-	-	-	-		
		95															
		96															
		97															
		98															
		99	38-32-50/5"	47	SS-20		-	-	-	-	-	-	-	-	-		
		100															
		101															
		102															
		103															
HARD, GRAY, **SILTY CLAY**, SOME SAND, GRAVEL, AND SANDSTONE FRAGMENTS, MOIST	879.2	104	36-33-47	47	SS-21	4.5+	-	-	-	-	-	-	-	-	-		
ATTEMPTED ST-4 AT 105.0' -DOWN PRESSURE = 1000 PSI	878.0	105 EOB	-		ST-4		-	-	-	-	-	-	-	-	-		

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-09

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 983.0 ft LOCATION 770603.83 1870423.36 DATE STARTED / DATE COMPLETED 7/20/18 - 7/24/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-RECOVERY = 0.0'																	

NOTES: SCREENED FROM 13.0' TO 103.0' (PREPACKED SCREENS) (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; CEMENT

SUBSURFACE LOG

EXPLORATION ID: OW-10

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	775857.83 1872007.51	**DATE STARTED**	7/3/18	**COMPLETED**	7/5/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	997.9 ft
PID NUMBER		**PROJECT LOCATION**	B-40	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	1.6 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	N/A
								DATE/TIME	10/1/18

MATERIAL DESCRIPTION AND NOTES	ELEV. 997.89	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
STIFF, LIGHT BROWN MOTTLED GRAY, **SILTY CLAY**, TRACE SAND, TRACE SANDSTONE FRAGMENTS, MOIST	996.9	1															
		2	2-2-3	78	SS-1	1.75 - 2.25	-	-	-	-	-	-	-	-	-		
		3															
		4	3-4-4	61	SS-2	1.75 - 2.25	-	-	-	-	-	-	-	-	-		
		5															
STIFF, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	991.9	6															
		7	8-6-5	78	SS-3	1.5 - 2.25	-	-	-	-	-	-	-	-	-		
		8															
		9	38-50/3	56	SS-4		-	-	-	-	-	-	-	-	-		
MODERATELY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, LIGHT BROWN AND ORANGE, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT BEDDED.	988.6 TR	10															
		10	0	54	HQ-1											CORE	
RC-1 REC. = 0.5' RQD = 0.0' = 0% DOWN PRESSURE = 250 PSI		11															
		12															
RC-2 REC. = 4.3' RQD = 0.0' = 0% DOWN PRESSURE = 400 PSI		13	0	87	HQ-2											CORE	
		14															

SUBSURFACE LOG

EXPLORATION ID: OW-10

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 997.9 ft LOCATION 775857.83 1872007.51 DATE STARTED / DATE COMPLETED 7/3/18 - 7/5/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
MODERATELY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, LIGHT BROWN AND ORANGE, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT BEDDED. *(continued)*		16															
RC-3 REC. = 5.0' RQD = 2.5' = 50% DOWN PRESSURE = 400 PSI	981.0	17															
SLIGHTLY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, GRAY, ORANGE STAINING, THIN BEDDED, HIGHLY TO MODERATELY FRACTURED, FLAT BEDDED.		18	50	100	HQ-3											CORE	
		19															
		20															
		21															
RC-4 REC. = 4.0' RQD = 1.7' = 34% DOWN PRESSURE = 450 PSI		22															
		23	34	80	HQ-4											CORE	
		24															
		25															
		26															
RC-5 REC. = 4.5' RQD = 2.0' = 40% DOWN PRESSURE = 400 PSI		27															
		28															
		29	40	90	HQ-5											CORE	
		30															

SUBSURFACE LOG

EXPLORATION ID: OW-10

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 997.9 ft LOCATION 775857.83 1872007.51 DATE STARTED / DATE COMPLETED 7/3/18 - 7/5/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
SLIGHTLY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, GRAY, ORANGE STAINING, THIN BEDDED, HIGHLY TO MODERATELY FRACTURED, FLAT BEDDED. *(continued)* RC-6 REC. = 4.9' RQD = 3.0' = 60% DOWN PRESSURE = 400 PSI		32 – 36	61	98	HQ-6											CORE	
RC-7 REC. = 4.8' RQD = 1.4' = 28% DOWN PRESSURE = 400 PSI		36 – 41	29	95	HQ-7											CORE	
INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, LIGHT GRAY, THIN TO MEDIUM BEDDED, MODERATELY FRACTURED, FLAT BEDDED SLIGHTLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY, THIN BEDDED, MODERATELY FRACTURED, FLAT.	959.8																
RC-8 REC. = 4.9' RQD = 0.7' = 14% DOWN PRESSURE = 400 PSI		41 – 46	15	98	HQ-8											CORE	
RC-9 REC. = 4.0'		46 – 47															

SUBSURFACE LOG

EXPLORATION ID: OW-10

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 997.9 ft LOCATION 775857.83 1872007.51 DATE STARTED / DATE COMPLETED 7/3/18 - 7/5/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
RQD = 1.1' = 22% DOWN PRESSURE = 300 PSI INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, LIGHT GRAY, THIN TO MEDIUM BEDDED, MODERATELY FRACTURED, FLAT BEDDED SLIGHTLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY, THIN BEDDED, MODERATELY FRACTURED, FLAT. *(continued)*		48	22	80	HQ-9											CORE	
		49															
		50															
		51															
RC-10 REC. = 3.8' RQD = 1.0' = 20% DOWN PRESSURE = 250 PSI		52	20	77	HQ-10											CORE	
		53															
		54															
		55															
	941.9	56															
		EOB															

NOTES: SHALE TRAP INSTALLED AT 16.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

SUBSURFACE LOG

EXPLORATION ID: OW-11

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	775837.89 1871961.41	**DATE STARTED**	7/2/18	**COMPLETED**	7/3/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	999.1 ft
PID NUMBER		**PROJECT LOCATION**	B-40	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	N/A
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical

MATERIAL DESCRIPTION AND NOTES	ELEV. 999.06	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
VERY STIFF TO HARD, BROWN, **CLAYEY SILT**, LITTLE FINE SAND, TRACE SHALE FRAGMENTS AND ORGANICS	998.1	1	2-4-5	61	SS-1	2.5 - 4.5	-	-	-	-	-	-	-	-	-		
		2															
		▼ 3															
HARD, BROWN, **CLAYEY SILT**, LITTLE FINE AND COARSE SAND, TRACE SHALE FRAGMENTS AND ORGANICS	995.6	4	4-4-4	100	SS-2	2.5 - 4.5+	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	4-4-5	72	SS-3	2.0 - 4.5	-	-	-	-	-	-	-	-	-		
		8															
HIGHLY WEATHERED, HARD, FINE GRAINED, SANDSTONE, BROWN AND GRAY, HIGHLY FRACTURED.	990.6	TR 9	6-32-38	83	SS-4		-	-	-	-	-	-	-	-	-		
		10															
		11	50/4"	100	SS-5		-	-	-	-	-	-	-	-	-		
		12															
MODERATELY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, ORANGE BROWN, THIN TO MEDIUM BEDDED, HIGHLY FRACTRUED, FLAT.	986.6	13															
RC-1 REC. = 2.8' RQD = 0.0' = 0%		14	0	93	HQ-1											CORE	

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-11

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 999.1 ft LOCATION 775837.89 1871961.41 DATE STARTED / DATE COMPLETED 7/2/18 - 7/3/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
DOWN PRESSURE = 250 PSI MODERATELY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, ORANGE BROWN, THIN TO MEDIUM BEDDED, HIGHLY FRACTRUED, FLAT. *(continued)* RC-2 REC. = 4.8' RQD = 1.6' = 32% DOWN PRESSURE = 250 PSI		16 17 18 19 20	32	95	HQ-2											CORE	
SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT. RC-3 REC. = 5.0' RQD = 2.6' = 52% DOWN PRESSURE = 250 PSI IRON STAINED JOINTS AND FRACTURES THROUGHOUT ZONE	978.6	21 22 23 24 25	51	100	HQ-3											CORE	
RC-4 REC. = 5.0' RQD = 2.9' = 58% DOWN PRESSURE = 400 PSI		26 27 28 29 30	58	100	HQ-4											CORE	

SUBSURFACE LOG

EXPLORATION ID: OW-11

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 999.1 ft LOCATION 775837.89 1871961.41 DATE STARTED / DATE COMPLETED 7/2/18 - 7/3/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
RC-5 REC. = 4.0' RQD = 1.8' = 36% DOWN PRESSURE = 400 PSI SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT. *(continued)*		32 33 34 35	36	80	HQ-5											CORE	
RC-6 REC. = 4.5' RQD = 1.4' = 28% DOWN PRESSURE = 400 PSI	962.1	36 37															
INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT SLIGHTLY TO MODERATELY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT.		38 39 40	29	90	HQ-6											CORE	
RC-7 REC. = 5.0' RQD = 2.7' = 54% DOWN PRESSURE = 400 PSI SHALE STRINGERS FOUND WITHIN SANDSTONE THROUGHOUT ZONE		41 42 43 44 45	53	100	HQ-7											CORE	
RC-8 REC. = 5.0' RQD = 1.7' = 34% DOWN PRESSURE = 400 PSI		46 47															

STANTEC BORING SUBSURFACE LOG BWSTE OBSERVATION WELL COMPLETE LOGS.GPJ OH.DOT.GDT 8/2/19

SUBSURFACE LOG

EXPLORATION ID: OW-11

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 999.1 ft LOCATION 775837.89 1871961.41 DATE STARTED / DATE COMPLETED 7/2/18 - 7/3/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT SLIGHTLY TO MODERATELY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT. *(continued)*		48 49 50	33	100	HQ-8											CORE	
RC-9 REC. = 5.0' RQD = 0.8' = 16% DOWN PRESSURE = 400 PSI		51 52 53 54 55	15	100	HQ-9											CORE	
	943.6	EOB															

NOTES: SHALE TRAP INSTALLED AT 15.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

SUBSURFACE LOG

EXPLORATION ID: OW-12

PROJECT	-BWSTE Ph 2-	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**	4.25" HSA SPT	**LOCATION**	775983.203 1871981.11	**DATE STARTED**	7/6/18	**COMPLETED**	7/9/18
CLIENT	City of Columbus	**PROJECT TYPE**	Geotechnical Exploration	**HAMMER TYPE**	Automatic	**EFFICIENCY**	84.2 % (Avg.)	**SURFACE ELEVATION**	1000.4 ft
PID NUMBER		**PROJECT LOCATION**	B-40	**DRILLING / SAMPLING TOOLS (TYPE / SIZE)**		**ELEVATION DATUM**	MSL	**DEPTH TO WATER**	3.8 ft
PROJECT NUMBER	173409058	**INSPECTOR**	John Ristow / AECOM	**DRILLING CONTRACTOR**	Rii / S.P	**DRILL RIG TYPE AND ID**	RII	**BOREHOLE INCLINATION (VERT.)**	Vertical
								DEPTH TO WATER	N/A
								DATE/TIME	N/A

MATERIAL DESCRIPTION AND NOTES	ELEV. 1000.36	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
-TOPSOIL																	
VERY STIFF, BROWN AND GRAY MOTTLE, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	999.4	1	4-6-8	56	SS-1	3.0 - 4.5+	-	-	-	-	-	-	-	-	-		
		2															
		3															
		4	6-6-8	78	SS-2	4.5+	-	-	-	-	-	-	-	-	-		
		5															
		6															
		7	8-12-15	72	SS-3	4.5+	-	-	-	-	-	-	-	-	-		
		8															
VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND AND GRAVEL, MOIST	991.4	9	8-6-5	67	SS-4	3.5 - 4.0	-	-	-	-	-	-	-	-	-		
		10															
MODERATELY TO HIGHLY WEATHERED, MODERATELY HARD TO HARD, MEDIUM TO FINE GRAINED, SANDSTONE, BROWN, THIN BEDDED, HIGHLY FRACTURED, FLAT TO STEEPLY. RC-1 REC. = 3.6' RQD = 0.0' = 0% DRAWDOWN = 250 PSI -IRON STAINED JOINTS AND FRACTURES THROUGHOUT ZONE	989.9 TR	11	0	90	HQ-1											CORE	
		12															
		13															
		14															

SUBSURFACE LOG

EXPLORATION ID: OW-12

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 1000.4 ft LOCATION 775983.203 1871981.11 DATE STARTED / DATE COMPLETED 7/6/18 - 7/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
RC-2 REC. = 4.0' RQD = 0.9' = 18% DRAWDOWN = 250 - 350 PSI MODERATELY TO HIGHLY WEATHERED, MODERATELY HARD TO HARD, MEDIUM TO FINE GRAINED, SANDSTONE, BROWN, THIN BEDDED, HIGHLY FRACTURED, FLAT TO STEEPLY. *(continued)*		16 17 18 19	18	80	HQ-2											CORE	
RC-3 REC. = 4.8' RQD = 0.5' = 10% DRAWDOWN = 350 PSI		20 21 22 23 24	10	95	HQ-3											CORE	
SLIGHTLY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY FRACTURED, FLAT TO STEEPLY.	975.4	25 26 27 28 29	28	80	HQ-4											CORE	
RC-4 REC. = 4.0' RQD = 1.4' = 28% DRAWDOWN = 350 PSI																	
RC-5 REC. = 4.7' RQD = 2.0' = 40% DRAWDOWN = 350 PSI		30															

SUBSURFACE LOG

EXPLORATION ID: OW-12

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 1000.4 ft LOCATION 775983.203 1871981.11 DATE STARTED / DATE COMPLETED 7/6/18 - 7/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
SLIGHTLY WEATHERED, MODERATELY HARD, MEDIUM TO FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY FRACTURED, FLAT TO STEEPLY. *(continued)*		32 33 34	40	93	HQ-5											CORE	
INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD TO HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT SLIGHTLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY TO BLACK, THIN BEDDED, HIGHLY FRACTURED, FLAT. RC-6 REC. = 5.0' RQD = 2.2' = 44% DRAWDOWN = 400 PSI	965.9	35 36 37 38 39	43	100	HQ-6											CORE	
RC-7 REC. = 5.0' RQD = 0.9' = 18% DRAWDOWN = 400 PSI 70% SANDSTONE, 30% SHALE		40 41 42 43 44	18	100	HQ-7											CORE	
RC-8 REC. = 5.0' RQD = 0.0' = 0% DRAWDOWN = 400 PSI 50% SANDSTONE, 50% SHALE		45 46 47	0	100	HQ-8											CORE	

SUBSURFACE LOG

EXPLORATION ID: OW-12

PROJECT -BWSTE Ph 2- CLIENT City of Columbus PROJECT NUMBER 173409058 SURFACE ELEVATION 1000.4 ft LOCATION 775983.203 1871981.11 DATE STARTED / DATE COMPLETED 7/6/18 - 7/9/18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	CLASS	BACK FILL
INTERBEDDED SANDSTONE AND SHALE SLIGHTLY WEATHERED, MODERATELY HARD TO HARD, FINE GRAINED, SANDSTONE, GRAY, THIN BEDDED, MODERATELY TO HIGHLY FRACTURED, FLAT SLIGHTLY WEATHERED, SOFT, VERY FINE GRAINED, SHALE, DARK GRAY TO BLACK, THIN BEDDED, HIGHLY FRACTURED, FLAT. *(continued)*		48 49															
RC-9 REC. = 4.9' RQD = 0.4' = 8% DRAWDOWN = 400 PSI 60% SANDSTONE, 40% SHALE		50 51 52 53 54	8	98	HQ-9											CORE	
RC-10 REC. = 1.5' RQD = 0.3' = 6% DRAWDOWN = 400 PSI 50% SANDSTONE, 50% SHALE	944.4	55 56 EOB	22	100	HQ-10											CORE	

NOTES: SHALE TRAP INSTALLED AT 10.0' (SEE WELL LOG FOR BACKFILL DESCRIPTION)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS

B.2 PHASE 1 EXPLORATION LOGS (Big Walnut Sanitary Trunk Extension Phase I)

Stantec

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-19
Driller: R Brungs	Location:	N 765297.3 E 1867707.9			Page 1 of 7
Geologist: L Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 750	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/26/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 11/29/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS:
Piezometer Installed at Completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
0	971.8													
1.0	970.8	Topsoil - 12"		WOH 3 3	16"	1	2.25							
4.5	967.3	Stiff, gray and brown SILTY CLAY (CL), some fine to coarse sand, little gravel; slightly organic; damp to moist.		3 3 4	18"	2	2.0							
				4 3 4	9"	3	1.5							
5				4 4 3	18"	4	4.0							LL = 27; PL = 16 W = 14.3
7.5	964.3	Very stiff to hard, brown SILTY CLAY (CL), some gravel, little to some fine to coarse sand; damp. @ 7.0', seepage.		5 5 7	18"	5	3.75							
8.5	963.3	Medium dense, gray, fine to medium SAND (SM), some silt; wet.		5 5 5	18"	6								
10		Very stiff, brownish gray SILTY CLAY (CL), some gravel, little fine to coarse sand; moist. @ 10.5', little to some fine to coarse sand, little gravel.		10 10 10	18"	7	3.75							
				12 12 12	18"	8	2.25							
		@ 13.5', damp.		12 12 16	18"	9	2.75							LL = 19; PL = 14 W = 14.7 Specific Gravity = 2.74
15				10 10 15	18"	10	3.5							
		@ 16.5', hard.		7 7 7	18"	11	4.0							W_d = 125.5 pcf LL = 22; PL = 13 W = 12.0 Specific Gravity = 2.71
18.0	953.8			7 11 14	18"	12	4.5							@ 18' water in spoon
19.5	952.3	Very dense, gray, fine to medium SAND (SM), some silt, little gravel, contains rock fragment layers; wet.		11 19 44	18"	13								
20		Very dense brown fine to coarse SAND (SC), little to some gravel, little silty clay; wet.		19 42 33	18"	14								
				17 17 35	18"	15		20	16	34	18	8	4	W = 14.3
				30 42 30	18"	16								
25		@ 24', greenish gray boulder.		11 25										@ 24', 2' heave in augers; washed out.

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-19
Driller:	R Brungs	Location:	N 765297.3 E 1867707.9			Page 2 of 7
Geologist:	L Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	CME 750	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/26/2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 11/29/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS:
Piezometer Installed at Completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
25	946.8													
		Very dense, brown, fine to coarse GRAVEL (GM), 'and' silt, some fine to coarse sand, trace clay; wet.	SOIL	48	18"	17								
				26 37 41	16"	18								
				24 30 39	18"	19		29	4	7	16	39	5	W = 14.5
31.0	940.8													
		Very soft to soft, gray SHALE, decomposed.		26 50/3	9"	20								
				18 25 38	18"	21								
				24 28 45	18"	22								
				39 50/3	9"	23								W = 13.6 Specific Gravity = 2.78 W_d = 119.1 pcf
				50/2	2"	24								
				46 50/5	11"	25								
46.0	925.8													
		Soft, gray SHALE, highly weathered.		50/3	3"	26								
				50/4	4"	27								W = 10.9 Specific Gravity = 2.79 W_d = 115.2 pcf
50														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		***LOG of BORING:***	FTB-19
Driller: R Brungs	*Location:*	N 765297.3 E 1867707.9			***Page 3 of 7***
Geologist: L Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: CME 750	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	11/26/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	11/29/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS:
Piezometer Installed at Completion

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	*SOIL / ROCK*	*Blows per 6" / RQD (%) & Core Length (in.)*	*Recovery (in.) / Recovery (in./%)*	*Sample No. / Run No.*	*Hand Penetrometer (tsf) / Drill rate (min/ft)*	*GRADATION: % Aggregate / Bedding*	*% C. Sand / Weathering*	*% M. Sand / Hardness*	*% F. Sand / Discontinuities*	*% Silt / Fractures / ft*	*% Clay / Drill Press (psi)*	***LAB RESULTS AND REMARKS***
														Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
50	921.8													*H_2S (ppm)* *LEL (%)* *Water Loss, WL (%)*
		Soft gray SHALE, highly weathered.												
52.4	919.4													Augers seated @52.4'
		Medium hard, gray SHALE, moderately weathered to highly weathered, contains occasional thin sandstone laminae (BEDFORD SHALE).		35% 34"	100%	1	2:18	TH	MW to HW	MH	J	>5 2 2	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
55		@ 52.4'-65.0', broken to slightly broken with Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe; e:Su; f:Pl; g:S-SR.										2 2 2 2		W = 1.0 Unit weight @ 58.5 = 160.1 pcf Packer Test 59' - 155.2'
		@ 59.1', a:40°; b:J; c:N;d:Cl; e:Pa; f:Pl.												
60		@ 60.8', a:40°; b:J; c:N;d:Cl; e:Pa; f:Pl.		40% 120"	80%	2	3:00	TH	MW to HW	MH	J	2 2 2 >5	300	Unconfined test @ 58.5' = 5305 psi
65		@ 65.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										>5 1		H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 66.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										3		
		@ 66.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										2		
		@ 66.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										2		
		@ 67.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										1		
		@ 67.1', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
		@ 68.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
		@ 68.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
70		@ 69.7'-70.4', a:90°; b:J; c:N; d:Fe; e:Sp; f:Pl.		70% 120"	100%	3	3:30	TH	MW to HW	MH	J	1 0	300	
		@ 73.9', a:0°; b:J; c:N;d:Cl; e:Sp; f:Pl.										1 0		H_2S = 0 ppm; LEL = 0%; WL = 0%
75														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-19
Driller: R Brungs	Location:	N 765297.3 E 1867707.9			Page 4 of 7
Geologist: L Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 750	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/26/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 11/29/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS: Piezometer Installed at Completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL/ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
75	896.8	Medium hard, gray SHALE, moderately weathered to highly weathered (BEDFORD SHALE) @ 75.9', a:0°; b:J; c:N;d:Cl; e:Sp; f:Pl. @ 76.3'-77.0', a:60°; b:J; c:N; d:Fe; e:Sp; f:Pl. @ 76.8'-77.5', a:70°; b:J; c:N; d:Fe; e:Sp; f:Pl. @ 77.8', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.											1 2 2 1		
80		@ 79.9', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.		63% 120"	100%	4	3:00	TH	MW to HW	MH	J	1 0	300	
		@ 83.2', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 83.9'-84.8', a:60°; b:J; c:N; d:Fe; e:Sp; f:Pl.										2 2		
85		@ 84.9'-85.2', a:85°; b:J; c:N; d:Fe; e:Sp; f:Pl.										1		H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 86.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										1		
		@ 88.0', a:60°; b:J; c:N; d:Fe; e:Su; f:Pl. @ 88.2', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 88.2'-89.2', a:60°; b:J; c:N; d:Fe; e:Sp; f:Pl.										0 3 1		
90		@ 90.0', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 90.7', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 90.8'-91.2', clay seam/decomposed shale. @ 91.5', red interbeds evident. @ 91.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 92.8', a:30°; b:J; c:N; d:Cl; e:Pa; f:Pl,g:slks. @ 93.8', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 93.9', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 94.3', a:10°; b:J; c:N; d:Cl; e:Pa; f:Pl.		80% 120"	100%	5	3:00	TH	MW to HW	MH	J	3 3 1 2 2	300	
95		@ 94.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 95.5', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.										2		H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 95.9'-96.4', a:90°; b:J; c:T; d:H; e:Fi; f:Pl (mechanically rebroken). @ 96.7'-97.7', very broken with mechanical breaks. @ 98.2', a:5°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 98.9', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 99.3', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.		52% 120"	100%	6	4:30	TH	MW to HW	MH	J	1 0 2 2	300	W = 3.8 Unit weight @ 97.7 = 161.8 pcf Sample @ 98.2' - 99.4' Unconfined test @ 97.7' = 5671 psi
100		@ 99.9', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.										2		

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		***LOG of BORING:***	FTB-19
Driller: R Brungs	*Location:*	N 765297.3 E 1867707.9			***Page 5 of 7***
Geologist: L Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: CME 750	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	11/26/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Dete Finished:*	11/29/2001

WATER LEVELS			
Dete	*Depth to Water*	*Bot. of Cesing*	*Bot. of Hole*
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS: Piezometer Installed at Completion

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*% Aggregate* / *Bedding*	*% C. Sand* / *Weathering*	*% M. Sand* / *Hardness*	*% F. Sand* / *Discontinuities*	*% Silt* / *Fractures / ft*	*% Clay* / *Drill Press (psi)*	***LAB RESULTS AND REMARKS***
								GRADATION						*Liquid Limit, LL* *Plasticity Index, PI* *Water Content, W (%)*
100	871.8													*H_2S (ppm)* *LEL (%)* *Weter Loss, WL (%)*
		Medium hard, gray and red SHALE, moderately weathered (BEDFORD SHALE). @ 100.2', a:20°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 101.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 102.3'-102.5', a:60°;b:J;c:N;d:Cl;e:Su;f:Pl. @ 102.5' - 102.7', decomposed layer.		52% 120"	100%	6	4:30	TH	MW to HW	MH	J	1 1 1	300	
103.1	868.7	@ 103.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										2		
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE). @ 103.1', a:35°; b:J; c:N; d:Cl; e:Sp; f:Pl. @103.4' - 105.2', decomposed very broken (contains possible mechanical breaks).										>5		
105												>5		H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 106.6', 2 breaks: a:0°; b:J; c:N; d:No; e:No; f:Pl. @ 107.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 107.1', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 107.2'-107.4', a:80°;b:J;c:N;d:Cl;e:Su;f:Pl. @ 109.1', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 109.7' & 109.9', a:35°; b:J; c:N; d:Cl; e:Su; f:Pl.										2 2 0 3		
110		@ 110.2' - 110.8', decomposed zone. @ 110.8' - 113.0', highly weathered to decomposed zone with clay seams. @ 111.4', 111.7', 111.9', 112.1', 112.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 112.9', a:25°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 113.0', a:20°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:slks.		50% 120"	98%	7	3:00	TH	MW to HW	MH	J	0 3 3 1 4	300	
115		@ 115.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 115.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 115.7', a:0°; b:J; c:N; d:Cl; e:Sp-Pa; f:Pl. @ 115.8', a:0°; b:J; c:N; d:Cl; e:Sp-Pa; f:Pl.									—	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
117.5	854.3	@ 117.2', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).												
120				98% 120"	100%	8	3:00	TH	MW	MH	—	0	300	
125														H_2S = 0 ppm; LEL = 0%; WL = 0%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-19
Driller: R Brungs	Location:	N 765297.3 E 1867707.9			Page 6 of 7
Geologist: L Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 750	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/26/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/29/2001

WATER LEVELS			
Dete	Depth to Weter	Bot. of Casing	Bot. of Hole
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS:
Piezometer Installed at Completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
125	846.8													
		Medium hard, gray SHALE, moderately weathered, contains occasional red beds (BEDFORD SHALE).												
130		@ 130.5'-131.4', gray siltstone laminae evident.		98% 120"	100%	9	5:00	TH	MW	MH	—	0	300	
135														H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 137.0', moderately weathered.												W = 3.5
140				100% 120"	100%	10	3:00	TH to VT	MW	MH	—	0	300	Unconfined test @ 142.9' = 6243 psi Unit weight @ 142.9 = 165.5 pcf
		@ 143.3'-143.5', 143.7'-143.75', 143.9'-144', 144.2'-144.3', hard, gray SILTSTONE beds.												Slake Durability Index 89.1 Type II
145		@ 145.0', medium hard to hard.												H_2S = 0 ppm; LEL = 0%; WL = 0%
				100% 120"	100%	11	3:00	VT to L	U to SW	MH to HW	—	0	300	Packer Test 145'-155' Slake Durability Index 93.2 Type III W = 2.4 Unit weight @ 147.7 = 159.9 pcf
150		@ 149.0'-150.0', gradational change from gray to black.												H_2S = 0 ppm; LEL = 0%; WL = 0%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-19
Driller: R Brungs	Location:	N 765297.3 E 1867707.9			Page 7 of 7
Geologist: L Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 750	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/26/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/29/2001

WATER LEVELS			
Dete	Depth to Water	Bot. of Cesing	Bot. of Hole
11/26/01	10'	53' (HSA)	53'
11/30/01	6.3'	147'	165.2'

WATER REMARKS:
Piezometer Installed at Completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
150	821.8	Hard, black SHALE, pyritic, fissile, unweathered (OHIO SHALE).		100% 120"	100%	11	3:00	VT to L	U	HW	—	0	300	Unconfined test @ 147.7' = 11327 psi Packer Test 152'-162' H_2S = 0 ppm; LEL = 0%; WL = 0%
155														
160				100% 120"	100%	12	NR	VT to L	U	HW	—	0	300	
		@ 162.2', pyritic nodule.												
		@ 163.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
165											—	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
165.2	806.6	Bottom of hole @ 165.2'												
170														
175														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer		LOG of BORING: FTB-20
Driller: K Conrad	Location:	N 768827.2 E 1868024.1		Page 1 of 8
Geologist: K Walden	Client:	City of Columbus	Job No.	9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt: 140 lbs.	Date Started: 10/30/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 11/1/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Weter Content, W (%)
														H_2S (ppm) LEL (%) Weter Loss, WL (%)
0	996.8													
0.3	996.5	Topsoil - 4"												
		Very stiff, light brown CLAYEY SILT (CL-ML), little fine to coarse sand, contains rootlets; damp.	SOIL	5 15 9	18"	1	4.5+							
3.0	993.8	@ 1.5', brown and gray.	SOIL	3 3 7	18"	2	4.5+							
		Very stiff to hard, brown SILTY CLAY (CL), little fine to coarse sand, little gravel; damp.	SOIL	3 5 10	18"	3	4.5+							LL = 38; PL = 21 W = 17.6 Specific Gravity = 2.81
5			SOIL	11 50/4	10"	4	3.75							
6.0	990.8		SOIL	50/5	5"	5								
		Hard, brown and gray SANDSTONE, moderately weathered, intensely fractured (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Sp; f:Pl; g:S-SR.	ROCK	0% 36"	92%	1	0:58	M to TK	MW	H	J	>5	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
10			ROCK									>5		
13.0	983.8													
		Hard, light gray SANDSTONE, fine grained, moderately weathered (BEREA SANDSTONE). Typical fractures @ 10'-20', a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Sp; f:Pl; g:S-SR.	ROCK	13% 120"	100%	2	1:09	M to TK	MW	H	J	5 5 4 4 2 4	300	
15		@ 15.7'-15.85', clay seam.												
20		@ 20.0', gray.										1		H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 20.7', a:0°; b:J; c:N; d:No; e:No; f:Pl; g:S.	ROCK	75% 60"	100%	3	2:03	M to TK	MW	H	J	1	300	Unit weight @ 20.8 = 141.1 pcf W = 0.2 Unconfined test @ 20.8' = 14622 psi
		@ 21.8', a:0°; b:J; c:N; d:No; e:No; f:Pl; g:S.										1		
		@ 23.0', dark gray argillaceous laminae.									—	0		
		@ 23.6'-24.0', a:90°; b:J; c:N; d:No; e:No; f:Pl.									J	1		
25		@ 24.3'-24.7', a:90°; b:J; c:T; d:H; e:Fi; f:Pl.										1		

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-20
Driller: K Conrad	Location:	N 768827.2 E 1868024.1			Page 2 of 8
Geologist: K Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 10/30/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/1/2001

WATER LEVELS			
Date	Depth to Watar	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezomatar Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Watar Content, W (%)
														H_2S (ppm) LEL (%) Watar Loss, WL (%)
25	971.8	Hard, gray SANDSTONE, fine grained, moderately weathered (BEREA SANDSTONE). @ 25.2', a:40°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 26.3', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 26.7', light gray.	SOIL	75% 60"	100%	3	2:03	M to TK	MW	H	J — J —	1 1 0 4 0	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
30		@ 30.8'-30.9', 3 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 30.9'-31.1', a:90°; b:J; c:N; d:Cl; e:Pa; f:Pl.												@ 30', WL = 100%
35		@ 34.0'-34.1', 3 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 35.8', thin clay seam. @ 37.6', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.		78% 120"	98%	5	1:24	M to TK	MW	H	J — J	3 0 1	300	
40		@ 38.2'-38.4', 4 fractures: a:0°-5°; b:J; c:N; d:Cl; e:Pa-Fi; f:Pl. @ 39.0' & 39.2', very thin clay seams. @ 39.3'-40.0', a:85°; b:J; c:N; d:Cl; e:Sp; f:Pl.										4 1		H_2S = 0 ppm; LEL = 0%; WL =100%
45		@ 40.9'-41.2', weathered and broken. Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Pa; f:Pl; g:S-SR. @ 41.6', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 41.9', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 44.4'-45.7', highly weathered and clayey.		47% 120"	96%	6	1:36	M to TK	MW	H	J —	>5 0	300	Unit weight @ 42.9 = 140.3 pcf Unconfined test @ 42.9' = 10002 psi W = 0.1
50		@ 46.7'-47.1', highly weathered and clayey. @ 48.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 48.1', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 49.6', clay seam.									J —	2 0		H_2S = 0 ppm; LEL = 0%; WL = 100%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer	LOG of BORING: FTB-20
Driller: K Conrad	Location:	N 768827.2 E 1868024.1	Page 3 of 8
Geologist: K Walden	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 10/30/2001
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished: 11/1/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
50	946.8	Medium hard to hard, dark gray SHALE with interbedded SANDSTONE, moderately weathered, thin to medium bedded (BEDFORD SHALE/BEREA SANDSTONE).									—	0		Core run contains numerous mechanical breaks.
		@ 51.2'-52.2', broken zone. Typical fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	>5		
55		@ 55.0'-56.2', broken zone. Typical fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.		18% 120"	97%	7	2:54	TH to M	MW	MH to H	—	0	300	
		@ 57.1', a:10°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	>5		
		@ 57.3', a:30°; b:J; c:N; d:Cl; e:Pa; f:Pl.										2		
60		@ 60.7', clay filled burrow structures.									—	0		H_2S = 0 ppm; LEL = 0%; WL = 100%
											—	0		Core run contains numerous mechanical breaks. @ 62', WL = 50%
65		@ 65.1'-65.3', a:90°; b:J; c:N; d:Cl; e:Sp; f:Pl.		28% 120"	100%	8	2:09	TH to M	MW	MH to H	J	1	300	
		@ 66.8'&66.9', a:0°; b:J; c:N; d:Cl; e:Pa;f:Pl.										2		
70		@ 70.4'-70.5', a:80°; b:J; c:N; d:Cl; e:Sp; f:Pl.									—	0		H_2S = 0 ppm; LEL=0% Probable gas due to 19.1% O_2 reading. WL = 70%
		@ 71.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		@ 70', WL = 100% Core run contains numerous mechanical breaks.
		@ 73.2', a:20°; b:J; c:N; d:Cl; e:Pa; f:Pl.		18% 120"	100%	9	2:51	TH to M	MW	MH to H	—	0	300	
		@ 73.4'-75.0', turbidite deposit.									J	2		W = 1.1
		@ 73.9', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										1		
75		@ 74.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.												Unconfined test @ 75.8' = 2270 psi

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-20
					Page 4 of 8
Driller: K Conrad	Location:	N 768827.2 E 1868024.1			Job No. 9821-6051.00
Gaologist: K Walden	Client:	City of Columbus			
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Startad: 10/30/2001
Size & Typa Core Barrel:	NQ_2 wireline		Hammar Drop:	30 in.	Date Finishad: 11/1/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezomatar Installad at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Contant, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
75	921.8	Medium hard to hard, dark gray SHALE with interbedded SANDSTONE, weathered, thin to medium bedded (BEDFORD SHALE/BEREA SANDSTONE). @ 75.2'&75.3', a:0°; b:J; c:N; d:Cl; e:Pa;f:Pl. @ 75.3'-75.6', a:80°; b:J; c:N; d:No; e:No;f:Pl. @ 76.4', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 77.2', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.		18% 120"	100%	9	2:51	TH to M	MW	MH to H	J — J	3 1 1 0 1	300	Unit weight @ 75.8 = 162.1 pcf Possible metar failure Probabla gas due to 19.1% O_2 reading. WL = 100%
80		@ 79.2', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 80.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 81.7', 2 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J J	1 2		Core run contains numerous mechanical braaks.
85				52% 120"	98%	10	2:12	TH to M	MW	MH to H	—	0	300	
90	906.8													
		Medium hard, gray SHALE, moderately weathered, contains occasional thin SANDSTONE beds (BEDFORD SHALE/BEREA SANDSTONE). @ 93.1', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 94.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									— J	0 1		@ 90' 17.2% O2 reading. H_2S = 0 ppm; LEL = 3%; WL = 100% Contains numarous mechanical breaks
95				70% 120"	100%	11	3:30	TH	MW	MH	J —	1 0	300	
100														No Gas Notad H_2S = 0 ppm; LEL = 0%; WL = 100%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-20
Driller: K Conrad	Location:	N 768827.2 E 1868024.1			Page 5 of 8
Geologist: K Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 10/30/2001
Size & Type Core Berrel: NQ_2 wireline			Hemmer Drop:	30 in.	Date Finished: 11/1/2001

WATER LEVELS			
Dete	Depth to Weter	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Weter Content, W (%) H_2S (ppm) LEL (%) Weter Loss, WL (%)
100	896.8	Medium hard gray SHALE, moderately weathered, contains occasional thin SANDSTONE beds (BEDFORD SHALE/BEREA SANDSTONE). @ 100.0'-100.6', broken with typical fractures: a:0°-5°; b:J; c:N; d:Cl; e:Pa; f:Pl.	SOIL								J	>5		
105			ROCK	93% 120"	100%	12	4:36	TH	MW	MH	—	0	300	
110														H_2S = 0 ppm; LEL = 0%; WL = 100%
		@113.4', thin occasional red bands evident.									—	0		
115		@ 115.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.		98% 120"	100%	13		TH	MW	MH			300	W = 3.2
											J	1		
											—	0		Unconfined test @ 119.9' = 6498 psi Unit weight @ 119.0 = 164.3 pcf H_2S = 0 ppm; LEL = 0%; WL = 100%
120		@ 120.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		
				94% 120"	100%	14	3:54	TH	MW	MH	—	0	300	
123.7	873.1	@ 123.7', a:5°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		
125		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).						TH	MW	MH	—	0		

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer		LOG of BORING: FTB-20
Driller: K Conrad	Location:	N 768827.2 E 1868024.1		Page 6 of 8
Geologist: K Walden	Client:	City of Columbus	Job No.	9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started:	10/30/2001
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished:	11/1/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / (in./%)	Sample No. / Run No.	Hand Penatrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
125	871.8	Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).										2		
		@ 125.0', 2 fractures: a:15°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		
		@ 126.8', a:20°; b:J; c:N; d:Cl; e:Su; f:Pl.										1		
		@ 127.8', a:15°; b:J; c:N; d:Cl; e:Su; f:Pl.		94% 120"	100%	14	3:54	TH	MW	MH		1	300	
											—	0		H_2S = 0 ppm; LEL = 0%; WL = 100%
130		@ 130.1'-130.8', broken with typical fractures: a:0°-5°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	>5		
		@ 132.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									—	0		
		@ 132.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	2		
														W = 0.2
											—	0		
135		@ 135.2', a:10°; b:J; c:N; d:No; e:No; f:Pl.												Unit weight @ 135.9 =
		@ 135.3', a:10°; b:J; c:N; d:No; e:No; f:Pl.		88% 120"	99%	15	4:03	TH	MW	MH	J	2	300	164.5 pcf
														Unconfined test @ 135.9' = 7511 psi
		@ 137.5', red and gray.									—	0		
														H_2S = 0 ppm;
140														LEL = 0%; WL = 100%
145														
				94% 120"	99%	16	4:18	TH	MW	MH	—	0	300	
		@ 147.4', a:10°; b:J; c:N; d:No; e:No; f:Pl.									J	1		
											—	0		
		@ 149.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		H_2S = 0 ppm;
150														LEL = 0%; WL = 100%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-20
					Page 7 of 8
Driller: K Conrad	Location:	N 768827.2 E 1868024.1			Job No. 9821-6051.00
Geologist: K Walden	Client:	City of Columbus			
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 10/30/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/1/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
150	846.8	Medium hard, gray and red SHALE, moderately weathered (BEDFORD SHALE).												
155		@ 155.8'-157.0', light gray silty layer. @ 157.5'-158.1', contains thin silty layers.		100% 120"	100%	17	3:42	TH	MW	MH	—	0	300	H_2S = 0 ppm; LEL = 0%; WL = 100%
160		@ 160.2'-161.1', contains thin silty layers. @ 162.7', dark gray.						TH	MW	MH	—	0		W = 2.1 Unit weight @ 163.9 = 156.0 pcf Slake Durability Index 96.0 Type II W = 0.7 Unconfined test @ 163.9' = 10093 psi
165.1	831.7	Hard black SHALE, unweathered to slightly weathered, pyritic, fissile (OHIO SHALE).		100% 120"	100%	18	2:51						300	W = 0.7 Slake Durability Index 97.8 Type II Unit weight @ 167.5 = 149.1 pcf Unconfined test @ 167.5' = 11014 psi
170		@ 166.3', large pyritized ammonite. @ 168.8', small pyritized gastropod.						VT	U to SW	H	—	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
175		@ 173.3' & 173.5, pyritic nodule.		100% 60"	100%	19	1:48	VT	U to SW	H	—	0	300	H_2S = 0 ppm; LEL = 0%; WL = 100%

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-20
Driller:	K Conrad	Location:	N 768827.2 E 1868024.1			Page 8 of 8
Geologist:	K Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 10/30/2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 11/1/2001

WATER LEVELS			
Date	Depth to Weter	Bot. of Casing	Bot. of Hole
10/30/01	DRY	7'	7'
10/31/10	12.4'	100'	100'
11/1/01	14.5'	165'	189'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
175	821.7	Hard black SHALE, unweathered to slightly weathered, pyritic, fissile (OHIO SHALE).		100% 120"	100%	20	2:12	VT	U to SW	H	—	0	300	
180		@ 180.7', highly pyritic layer.												
185		@ 184.4', highly pyritic layer.												H_2S = 0 ppm; LEL = 0%; WL = 100%
				100% 48"	100%	21	2:21	VT	U to SW	H	—	0	300	
189.0	807.8													H_2S = 0 ppm; LEL = 0%; WL = 100%
190		Bottom of hole @ 189'												
195														
200														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0			Page 1 of 8
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/8/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/6/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
0	996.8													Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
0.1	996.7	Topsoil - 2"	SOIL	2 4 4	18"	1	4.00							
		Stiff brown SILTY CLAY (CL), little fine to coarse sand, damp to moist. @ 1.5' - 3.0', medium stiff, gray.	SOIL	8 3 4	18"	2	0.75							
		@ 3.5' - 3.7', seepage.	SOIL	5 5 7	18"	3	1.00							
5		@ 4.5', brown and gray	SOIL	4 50/4	10"	4	2.25							
5.3	991.5													
		Medium hard, brown and reddish brown SANDSTONE, weathered to highly												
7.0	989.8	weathered.	SOIL	24 50/2	4"	5								Augers seated to 7'
		Medium hard to hard, brown SANDSTONE, moderately weathered, slightly broken to broken (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN-N;	ROCK	0% 36"	97%	1	1:05	TK	MW	MH to H	J	>5	300	
10		d:Fe; e:Su; f:Pl; g:S-SR.												H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 12.7', gray. @ 12.9'-13.1', clay seam. @ 13.1', a:0°; b:J; c:N; d:Fe; e:Su; f:Pl; g:Sr. @ 13.2' & 13.5', a:15°; b:J; c:T; d:Fe-H; e:Fi; f:Pl. @ 13.6', 13.8', 13.9', a:0°; b:J; c:N; d:Fe; e:Su;	ROCK	31% 120"	100%	2	1:00	TK	MW	MH to H	J	>5 2 1 1 2 — 0	300	Packer Test 10' - 60'
15		f:Pl; g:Sr. @ 14.3', 2 fractures a:0°; b:J;c:N; d:Fe; e:Su; f:Pl; g:Sr. @ 15.9', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl; g:Sr. @ 16.3', a:0°; b:J; c:N; d:Fe; e:Su; f:Pl; g:Sr. @ 16.8'-17.0', clay seam. @ 17.7', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 17.9', a:0°; b:J; c:N; d:Fe; e:Su; f:Pl; g:Sr.													H_2S = 0 ppm; LEL = 0%; WL = 0%
20		@ 23.1', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 23.5', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 24.1', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.	ROCK	62% 120"	100%	3	1:12	TK	MW	MH to H	— 0 J 2 1		300	
25														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0			Page 2 of 8
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/8/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
25	971.8	Medium hard to hard, gray SANDSTONE, moderately weathered, slightly broken (BEREA SANDSTONE). @ 25.1', 0.1' clay seam. @ 25.7', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 27.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 27.8', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 28.9', thin clay seam.	ROCK	62% 120"	100%	3	1:12	TK	MW	MH to H	J — J —	1 0 2 0	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
30		@ 30.5', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 31.8', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 32.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 33.7'-34.1', a:90°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 34.3', a:5°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 34.7'-35.5', turbidite flow deposit.	ROCK	83% 120"	100%	4	1:24	TK	MW	MH to H	J — J	1 1 1 1 2 0 1	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
40		@ 39.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 40.1'-40.6', a:90°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 40.7'-41.0', weathered zone.	ROCK								J	1		
45		@ 43.8'-45.0', weathered zone. @43.8', shale laminae and layers evident. @44.2', thin clay seam.	ROCK	43% 120"	99%	5	1:45	TK to TH	MW	MH to H	B	0	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
50														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer		LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0		Page 3 of 8
Geologist: K. Walden	Client:	City of Columbus		Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt: 140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 11/8/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
50	946.8	Medium hard to hard, gray SHALE, contains interbedded SANDSTONE laminae, moderately weathered (BEDFORD SHALE).												Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
		@ 52.2'-52.7', turbidite deposit.		18% 120"	100%	6	3:00	M to TH	MW	MH to H	B	0	300	Contains numerous mechanical fractures throughout run
55														
60														H_2S = 0 ppm; LEL = 0%; WL = 30%
		@ 61.0'-61.5', weathered to highly weathered with thin clay seams.												Contains numerous mechanical fractures throughout run
		@ 62.2'-62.7', SANDSTONE bed.		48% 120"	98%	7	2:30	M to TH	MW	MH to H	B	0	300	
65														
		@ 67.5'-67.8', a:80°; b:J;c:N;d:No;e:No; f:Pl.									J	1		
		@ 68.2'-69.0', weathered to highly weathered with thin clay seams.									—	0		
70														H_2S = 0 ppm; LEL = 0%; WL = 0%
		@ 72.8'-73.3', turbidite deposit.		44% 120"	99%	8	2:56	M to TH	MW	MH to H	—	0	300	Contains numerous mechanical fractures throughout run
75														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer	LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0	Page 4 of 8
Geologist: K. Walden	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished: 11/8/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
75	921.8	Medium hard, gray SHALE, contains SANDSTONE laminae, moderately weathered (BEDFORD SHALE). @ 75.2', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.		44% 120"	99%	8	2:56	M to TH	MW	MH	J	1	300	Contains numerous mechanical fractures throughout run
											—	0		
		@ 79.0', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.									J	1		H_2S = 0 ppm; LEL = 0%; WL = 0%
80											—	0		
				78% 120"	100%	9	3:06	M to TH	MW	MH	—	0	300	Contains numerous mechanical fractures throughout run
85														
90														H_2S = 0 ppm; LEL = 0%; WL =10%
				94% 120"	97%	10	—	M to TH	MW	MH to H	—	0	300	
95														
		@ 98.1', a:0°; b:J;c:N; d:Cl;e:Fi; f:Pl.									J	1		H_2S = 0 ppm; LEL = 0%; WL = 30%
100											—	0		

Dodson-Stilson		*Project:*	Big Walnut Sanitary Trunk Sewer	**LOG of BORING:**	FTB-21
Driller:	K. Conrad	*Location:*	N 769756.5 E 1868747.0		***Page 5 of 8***
Geologist:	K. Walden	*Client:*	City of Columbus	*Job No.*	9821-6051.00
Drill Equip:	CME 75	*Sampler:*	2" split spoon *Hammer Wt:* 140 lbs.	*Date Started:*	11/6/2001
Size & Type Core Barrel:	NQ_2 wireline	*Hammer Drop:*	30 in.	*Date Finished:*	11/8/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	***LAB RESULTS AND REMARKS***
																				Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
																				H_2S (ppm) *LEL (%)* *Weter Loss, WL (%)*
100	896.8																			
		Medium hard, gray SHALE, contains SANDSTONE laminae, moderately weathered (BEDFORD SHALE).		97% 120"	98%	11	2:45							M to TH	MW	MH to H	—	0	300	Packer Test 100'-170'
105																				
108.0	888.8																			
		Medium hard, gray SHALE, moderately weathered (BEDFORD SHALE).												M to TH	MW	MH to H				H_2S = 0 ppm; LEL = 0%; WL =30%
110		@110.0'-111.0', broken.		18" 0%	100%	12	10:00							M to TH	MW	MH to H	J SH	2	300	
		@111.0', red interbeds evident. @ 111.0', a:40°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 111.1', a:30°; b:Sh; c:N; d:No; e:No; f:Slk.															—	0		@111'-114', WL=100%
		@ 113.7', a:30°; b:Sh; c:N; d:No; e:No; f:Slk. @ 113.8', a:30°; b:Sh; c:N; d:No; e:No; f:Slk.															SH	2		
																	—	0		
115		@ 115.3', a:10°; b:Sh; c:N; d:No; e:No; f:Slk.		67% 120"	100%	13	3:34							M to TH	MW	MH to H	SH	1	300	
																	—	0		
120																				H_2S = 0 ppm; LEL = 0%; WL = 0%
121.9	874.9													M to TH	MW	MH to H				
		Medium hard, red SHALE, slightly weathered to moderately weathered (BEDFORD SHALE).		62% 120"	85%	14	4:04							TH	SW to MW	MH	—	0	300	
125																				

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer		LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0		Page 6 of 8
Geologist: K. Walden	Client:	City of Columbus		Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt: 140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 11/8/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
125	871.8	Medium hard, red SHALE, slightly to moderately weathered (BEDFORD SHALE).									—	0		
		@ 127.3', a:50°; b:Sh; c:N; d:No; e:No; f:Slk.	/	85% 120"	92%	15	3:56	TH	SW to MW	MH	J	1	300	
		@ 128.0', a:30°; b:Sh; c:N; d:No; e:No; f:Slk.									J	1		
130		@ 129.8', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.									J	1		H_2S = 0 ppm; LEL = 0%; WL = 50%
135		@ 134.9', thin clay seam.		91% 120"	95%	16	3:04	TH	SW to MW	MH	—	0	300	
		@ 136.7', thin clay seam.												
		@ 138.4', gray and red interbedded shale.												
		@ 138.6', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.									J	1		
140											—	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
145				100% 120"	100%	17	3:18	TH	SW to MW	MH	—	0	300	
150														H_2S = 0 ppm; LEL = 0%; WL = 0%

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-21
Driller: K. Conrad	Location:	N 769756.5 E 1868747.0			Page 7 of 8
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/6/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 11/8/2001

WATER LEVELS			
Date	Depth to Weter	Bot. of Casing	Bot. of Hole
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Weter Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
150	846.8	Medium hard, gray and red SHALE, moderately to slightly weathered (BEDFORD SHALE).	ROCK	100% 120"	100%	18	3:38	M to TH	SW to MW	MH	—	0	300	@152'-156', WL=100%
155		@158.3, very hard, gray SILTSTONE. @158.5, very hard, gray SILTSTONE.												H_2S = 0 ppm; LEL = 0%; WL = 0%
160														
164.4	832.4			100% 120"	100%	19	2:36	M to TH	SW	MH	—	0	300	Slake Durability Index 93.1 Type III W = 0.9 Unit weight @ 163.6 = 158.2 pcf Unconfined test @ 163.6' = 7511 psi W = 0.6
165		Hard, black SHALE, thinly bedded, fissile, slightly pyritic unweathered (OHIO SHALE).						TH	U	H	—	0		Slake Durability Index 95.7 Type III W = 0.6 Unit weight @ 165.0 = 151.7 pcf Unconfined test @ 165.0' = 10196 psi
170		@ 171.1' -172.1', a:90°; b:J; c:N; d:Ca; e:Sp; f:Pl; g:S-Sr.		90% 120"	100%	20	2:21	TH	U	H	— J —	0 1 0	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
175														

Dodson-Stilson		*Project:*	Big Walnut Sanitary Trunk Sewer			**LOG of BORING:**	FTB-21
Driller:	K. Conrad	*Location:*	N 769756.5 E 1868747.0				***Page 8 of 8***
Geologist:	K. Walden	*Client:*	City of Columbus			*Job No.*	9821-6051.00
Drill Equip:	CME 75	*Sampler:*	2" split spoon	*Hammer Wt:*	140 lbs.	*Date Started:*	11/6/2001
Size & Type Core Barrel:	NQ_2 wireline			*Hammer Drop:*	30 in.	*Date Finished:*	11/8/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
11/6/01	DRY	7'	7'
11/7/01	12.2'	—	60'
11/8/01	10.4'	160'	180'

WATER REMARKS:
No Piezometer installed at completion

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*% Aggregate* / *Bedding*	*% C. Sand* / *Weathering*	*% M. Sand* / *Hardness*	*% F. Sand* / *Discontinuities*	*% Silt* / *Fractures / ft*	*% Clay* / *Drill Press (psi)*	***LAB RESULTS AND REMARKS***
								GRADATION						*Liquid Limit, LL* *Plasticity Index, PI* *Water Content, W (%)*
175	821.8	Hard, black SHALE, thinly bedded, fissile, slightly pyritic unweathered (OHIO SHALE).	ROCK	90% 120"	100%	20	2:21	TH	U	H	—	0	300	*H_2S (ppm)* *LEL (%)* *Water Loss, WL (%)*
180	816.8													H_2S = 0 ppm; LEL = 0%; WL = 0%
		Bottom of hole @ 180.0'												
185														
190														
195														
200														

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			***Page 1 of 7***
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Bedding	Weathering	Hardness	Discontinuities	Fractures / ft	Drill Press (psi)	LAB RESULTS AND REMARKS
																				Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
0	991.2																			
0.4	990.8	Topsoil - 5"																		
		Stiff brown and gray SILTY CLAY (CL), some fine to coarse sand, trace to little gravel; damp.		2 3 12	13"	1A 1B														
4.0	987.2			50/3	3"	2														
5		Hard, light gray SANDSTONE, fine grained, moderately to highly weathered, broken to very broken (BEREA SANDSTONE). Typical fractures: a:0º-5º; b:J; c:VN-N; d:Fe; e:Su-Pa; f:Pl; g:S-SR.		0% 60"	100%	1	1:15							TK to M	MW to HW	H	J	>5	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
10		@ 10.9' - 12.4', very thin, dark gray micaceous argillaceous laminae. @ 11.5', broken. @ 11.7'-12.0', a:90º; b:J; c:T; d:H; e:Fi; f:Pl. @ 13.0', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 13.5'-13.7', a:90º; b:J; c:T; d:H; e:Fi; f:Pl.		% 108"	100%	2	1:20							TK to M	MW to HW	H	J	>5 >5 >5 3 2 3 3 3 2	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
15																				
20		@ 16.1'-16.5', a:90º; b:J; c:T; d:H; e:Fi; f:Pl. @ 19.3'; Typical fractures: a:0º-5º; b:J; c:VN-N; d:No; e:No; f:Pl; g:S-SR.		73% 120"	100%	3	1:00							TK to M	MW to HW	H	J	>5 3 >5 1 4 >5	300	
25																		4		

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			***Page 2 of 7***
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
25	966.2	Hard, light gray SANDSTONE, fine-grained, moderately to highly weathered, contains dark gray argillaceous laminae (BEREA SANDSTONE). Typical fractures: a:0º-5º; b:J; c:VN-N; d:No; e:No; f:Pl; g:S-SR. @ 25.5' - 25.9', clay seam. @ 28.5', a:0º; b:B; c:N; d:No; e:No; f:Pl. @ 28.5', thin clay seam.		73% 120"	100%	3	1:00	TK to M	MW to HW	H	--- J	0 0 3	300	H_2S = 0 ppm; LEL = 0%; WL = 0%
30		@ 30.5' - 30.7', thin decomposed seam. @ 32.3' - 32.6', clay seam. @ 33.5' - 33.7', clay seam. @ 34.1' - 34.3', turbidite deposit.		52% 120"	98%	4	0:56	TK to M	MW to HW	H	J	0 3 1 3 0 0	300	
35		@ 34.5' -34.3', clay seam. @ 35.5'-36', a:90º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 36.0' - 37.1', clay seam.										1 0 4 2		H_2S = 0 ppm; LEL = 0%; WL = 0%
40		@ 39.8', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 41.0', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 41.1', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 41.2', dark gray shale seam.						TK to M	MW to HW	H		3 1 2 0		
42.8	948.4	Medium hard to hard, dark gray SHALE, interbedded with light gray SANDSTONE, fine-grained, moderately weathered (BEDFORD SHALE).		39% 120"	92%	5	1:00	TH	MW	MH	J	0 1 1 2	300	Core is highly broken with mechanical breaks.
45		@ 45.4', thin clay seam. @ 45.8', 2 fractures: a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 46.1', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 47.6' - 48.0', light gray sandstone seam.										1 0		H_2S = 0 ppm; LEL = 0%; WL = 0%
50				42% 120"	95%	6	1:24	TH	MW	MH	---	0	300	

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			**Page 3 of 7**
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
50	941.2	Medium hard to hard dark gray SHALE, interbedded with light gray SANDSTONE, fine-grained, moderately weathered (BEDFORD SHALE).		42% 120"	95%	6	1:24	TH	MW	MH	B	0	300	Core is highly broken with mechanical breaks.
		@ 54.0' - 54.8', light gray SANDSTONE bed.												
55		@ 54.8', a:0º; b:J; c:N; d:Cl; e:Fi; f:Pl.									J	1		
		@ 54.8' - 55.4', light gray SILTSTONE bed.									B	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
60				28% 24"	71%	7	NR	TH	MW	MH	J	>5	300	
		@ 61'-61.7', a:70º; b:J; c:N; d:Cl; e:Su; f:Pl.	/									1		Core is highly broken with mechanical breaks.
												0		
		@ 63.0', a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	2		
		@ 63.8', a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl.										1		
		@ 64.2', a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl.												
65				28% 120"	92%	8	1:51	TH	MW	MH		0	300	
												1		
		@ 66.5', a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl.									B	0		
		@ 67.3', SANDSTONE interbeds not evident.												H_2S = 0 ppm; LEL = 0%; WL = 0%
70														
				37% 120"	92%	9	1:36	TH	MW	MH	B	0	300	Core is highly broken with mechanical breaks.
		@ 73.8', 0.1' clay/decomposed shale seam.												
75		@ 74.8', thin clay seam.												

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-22
Driller: L. Hull	Location:	N 770321.5 E 1869158.9			Page 4 of 7
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B-59	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/19/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 11/26/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
75	916.2	Medium hard dark gray SHALE, moderately weathered, occasional sandstone clast evident (BEDFORD SHALE).	SOIL								B	0		
		@ 76.1', thin clay seam.									B			
		@ 76.8', a:40º; b:J; c:N; d:Cl; e:Pa; f:Pl.		37% 120"	92%	9	1:36	TH	MW	MH	J	1	300	
											B	0		
80		@ 80.0', a:0º; b:J; c:N; d:Cl; e:Pa; f:Pl.												H_2S = 0 ppm; LEL = 0%; WL = 0%
			ROCK								J	1		Core is highly broken with mechanical breaks.
				46% 120"	95%	10	2:06	TH	MW	MH	B	0	300	
85		@ 86.0', a:60º; b:J; c:N; d:Cl; e:Sp; f:St.									J	1		
											J	1		
		@ 88.6', a:60º; b:J; c:N; d:Cl; e:Sp; f:St.									B	0		
											J	1		
90											B	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
														Core is highly broken with mechanical breaks.
				83% 120"	98%	11	2:06	TH	MW	MH	B	0	300	
95														
100														H_2S = 0 ppm; LEL = 0%; WL = 0%

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			**Page 5 of 7**
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
100	891.2													
		Medium hard, dark gray SHALE, moderately weathered, occasional SANDSTONE clast evident (BEDFORD SHALE).												Core is highly broken with mechanical breaks.
105				73% 120"	98%	12	1:18	TH	MW	MH	B	0	300	
		@ 107.6', a:30º; b:J; c:N; d:Cl; e:Pa; f:Pl.									B	1		
		@ 108'-108.5', a:80º; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	>5		
		@ 108.5' - 109.6', very broken (rock fragments) with possible loss.									J	>5		
		@ 109.6', a:30º; b:J; c:N; d:Cl; e:Pa; f:Pl.												
		@ 109.7', a:30º; b:J; c:N; d:Cl; e:Pa; f:Pl.												
110	881.2	@ 109.9', a:30º; b:J; c:N; d:Cl; e:Pa; f:Pl.									B	3		H_2S = 0 ppm; LEL = 0%; WL = 0%
		Medium hard, gray and red SHALE, moderately weathered (BEDFORD SHALE).									J	>5		
		@ 110'-110.9', very broken: a:0º-'5º; b:J; c:N; d:Cl; e:Fi; f:Pl.									B	0		
		@ 112.0' -112.3', clay seam.												
		@ 113.3', a:10º; b:J; c:N; d:No; e:No; f:Pl; g:S.									J	2		
		@ 113.7', a:10º; b:J; c:N; d:No; e:No; f:Pl; g:S.												
115		@ 114.5'-115', very broken: a:0º-'5º; b:J; c:N; d:Cl; e:Fi; f:Pl.		49% 120"	100%	13	1:36	TH	MW	MH	J	>5	300	
		@ 114.9', a:30º;b:J;c:N;d:Cl,e:Sp;f:Pl;g:Slks.									B	0		
		@ 115.8' -116.0', clay seam.												
116.4	874.8													
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).									J	2		
		@ 116.7', a:30º; b:J; c:N; d:Cl, e:Sp; f:Pl.									J	1		
		@ 116.8', a:0º; b:J; c:N; d:Cl, e:Sp; f:Pl.									---	0		
		@ 117.1', a:20º b:J; c:N; d:Cl, e:Sp; f:Pl.												
		@ 119.7', a:30º; b:J; c:N; d:Cl, e:Su; f:Pl.												H_2S = 0 ppm;
120		@ 119.9', a:30º; b:J; c:N; d:Cl, e:Su; f:Pl.									J	2		LEL = 0%; WL = 0%
											B	0		
		@ 122.3'-122.8', very broken: a:0º-'70º; b:J; c:N; d:Cl; e:Fi; f:Pl.		43% 120"	89%	14	2:06	TH	MW	MH	J	>5	300	
											B	0		
125														

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			***Page 6 of 7***
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
														H_2S (ppm) *LEL (%)* *Water Loss, WL (%)*
125	866.2													
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).									J	1		
		@ 126.9', a:50º; b:J; c:N; d:Cl, e:Su; f:Pl.									--	0		
		@ 128.3', a:30º; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Slks.		43% 120"	89%	14	2:06	TH	MW	MH	J SLK	2	300	
130		@ 128.6', a:50º; b:J; c:N; d:Cl, e:Pa; f:Pl.									B	0		H_2S = 0 ppm; LEL = 0%; WL = 0%
135				90% 120"	98%	15	1:38	TH	MW	MH	B	0	300	
137.5	853.7													
		Medium hard, red and gray SHALE, moderately weathered (BEDFORD SHALE).						TH	MW	MH				
		@ 139.0', a:0º; b:J; c:N; d:Cl, e:Sp; f:Pl.												H_2S = 0 ppm;
140											J	1		LEL = 0%; WL = 0%
141.0	850.2							TH	MW	MH				
		Medium hard gray SHALE, moderately weathered (BEDFORD SHALE).												
145				71% 120"	97%	16	1:56	TH	MW	MH	B	0	300	
		@ 147.7', a:0º; b:J; c:N; d:Cl, e:Sp; f:Pl.									J	1		
150											B	0		H_2S = 0 ppm; LEL = 0%; WL = 0%

Dodson-Stilson	**Project:**	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-22
Driller: L. Hull	**Location:**	N 770321.5 E 1869158.9			**Page 7 of 7**
Geologist: K. Walden	**Client:**	City of Columbus		**Job No.**	9821-6051.00
Drill Equip: Mobile B-59	**Sampler:**	2" split spoon	**Hammer Wt:** 140 lbs.	**Date Started:**	11/19/2001
Size & Type Core Barrel:	NQ_2 wireline		**Hammer Drop:** 30 in.	**Date Finished:**	11/26/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/19/01	DRY	4'	4'
11/20/01	9.0'	58'	58'
11/21/01	8.5'	90'	90'

WATER REMARKS:
No Piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Bedding	Weathering	Hardness	Discontinuities	Fractures / ft	Drill Press (psi)	LAB RESULTS AND REMARKS
																				Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
150	841.2	Medium hard gray SHALE, moderately weathered (BEDFORD SHALE). @ 150.2', a:20º; b:J; c:N; d:Cl, e:Sp; f:Pl. @ 150.6', a:0º; b:J; c:N; d:Cl, e:Sp; f:Pl.															J	2		Unit weight @ 155.4 = 161.6 pcf Slake Durability Index 91.9 Type I W = 0.6
155		@ 153.5' - 153.8', hard, gray SILTSTONE. @ 154.0' - 154.1', hard, gray SILTSTONE. @ 154.1' - 154.5', highly weathered.		92% 120"	100%	17	1:50	TH	MW	MH	---	0	300							Unconfined test @ 155.4' = 9153 psi W = 0.8 Unconfined test @ 159.2' = 4232 psi Unit weight @ 159.2 = 156.5 pcf Unconfined test @ 161.8' = 6498 psi Unconfined test @ 162.7' = 9728 psi H_2S = 0 ppm; LEL = 0%; WL = 0%
160		@ 158.6' - 160.5', gradational color change from gray to black.																		
160.5	830.7	Hard, black SHALE, slightly weathered to unweathered (OHIO SHALE).		100% 60"	100%	18	1:56	TH	SW to U	MH	---	0	300							Unit weight Index 149.9 pcf Slake Durability Index 96.5 Type I W = 0.6 Unit weight @ 162.7 = 148.7 pcf W = 0.6 H_2S = 0 ppm; LEL = 0%; WL = 0%
165	826.2																			
170		Bottom of hole @ 165.0'																		
175																				

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-23
Driller: M. Hull	*Location:*	N 770456.3 E 1869385.6			***Page 1 of 7***
Geologist: Taylor/Walden	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: Mobile B57	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	12/10/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	12/12/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	*SOIL / ROCK*	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	***LAB RESULTS AND REMARKS***
0	984.0																			
0.5	983.5	Topsoil - 6"																		
		Very stiff, brown SILTY CLAY (CL), trace fine to medium sand, contains organics and rootlets; damp.		4 10 8	14"	1	3.50													
				6 8 10	14"	2	3.00													
4.5	979.5			8 10 13	17"	3	4.5+													
5		Hard, brown SILTY CLAY (CL), little fine to coarse sand, little gravel; damp.		5 6 13	16"	4	4.5+													
6.0	978.0	@ 6.5', brown, gray, light brown and red																		
		Medium dense, light brown SILT (ML), trace rock fragments; damp.		4 12 15	18"	5														LL = 22; PL = 17 W = 13.8 Specific Gravity = 2.74 W_d = 118.7 pcf
		@ 7.5', some rock fragments.		6 12 22	18"	6														
9.0	975.0																			
10		Medium stiff, light brown and red CLAYEY SILT (CL-ML), some rock fragments; damp to moist.		7 8 8	18"	7														
11.5	972.5			14 30 32	12"	8														
12.2	971.8	Very dense, brown and red GRAVEL (GM), some silt; primarily rock fragments; moist.		18 28 35	18"	9														
		Medium stiff, brown CLAYEY SILT (CL-ML), some rock fragments; damp to moist.		15 50/5	11"	10														LL = 24; PL = 18 W = 13.1 Specific Gravity = 2.73
15				31 50/5	11"	11														
15.5	968.5																			
		Hard, brown and gray SANDSTONE, moderately weathered (BEREA SANDSTONE). @ 17.0', gray with occasional brown layers. Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Fi; f:Pl; g:S-SR. @ 15.8'-16.3', a:85°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Sr. @ 16.8'-18.0', a:80°; b:J; c:N; d:Fe; e:Su;		36% 55"	100%	1	1:07	TK to M	MW	H	J	4 4 5 2 1	350							
20		f:Pl; g:Sr (crossing cutting low angle fracts). @ 18.0'-18.1', clay layer. @ 18.3'-18.8', a:80°; b:J; c:N; d:No; e:No; f:Pl; g:Sr. @ 20.0'-20.1', a:80°; b:J; c:T; d:H; e:Py; f:Pl; g:Sr. @ 20.4'-20.8', a:70°; b:J; c:T; d:H; e:Fi; f:Pl; g:Sr. @ 21.2', 0.1' clay seam. @ 21.3', dark gray argillaceous laminae.		61% 102"	100%	2	1:46	TK to M	MW	H	—	4 0	350							
25		@ 22.2', 0.15' clay seam.																		

LAB RESULTS AND REMARKS
Liquid Limit, LL
Plasticity Index, PI
Water Content, W (%)
H_2S (ppm)
LEL (%)
Water Loss, WL (%)

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-23
Driller:	M. Hull	Location:	N 770456.3 E 1869385.6			Page 2 of 7
Geologist:	Taylor/Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	Mobile B57	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/10/2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/12/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
25	959.0													
		Hard, gray SANDSTONE, moderately weathered (BEREA SANDSTONE).										0		
		@ 25.9', 0.2' clay seam.		61% 102"	100%	2	1:46	TK to M	MW	H	J	1	350	
		@ 26.1' - 26.4', a:80°; b:J; c:N; d:Fe; e:Su; f:Pl; g:Sr.									J	>5		
		@ 27.5' - 28.5', broken zone with typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Fi; f:Pl; g:S-SR.		0% 18"	83%	3	—	TK to M	MW	H	—	0		
30		@ 30.0', sandstone laminae evident.												
		@ 30.4' - 31.0', turbidite deposit.												
		@ 32.6' - 33.7', turbidite deposit.		52% 120"	100%	4	1:54	TH	SW	MH to H	—	0	350	W = 5.5 Unconfined test @ 36.0' = 11338 psi Unit weight @ 36.0 = 146.2 pcf
40	944.0													H_2S = 0%; LEL = 0%; WL = 20%
		Medium hard to hard gray SHALE with SANDSTONE interbeds (BEDFORD SHALE/BEREA SANDSTONE).										3		
		@ 40.0'-40.7', a:70°; b:J; c:N; d:Cl; e:Sp; f:Pl; g:Sr.									J	3		
		@ 41.5'-42.0', a:85°; b:J; c:N; d:Cl; e:Sp; f:Pl; g:Sr.										2		
		@ 41.0'-43.0', slightly broken. Typical fractures: a:0°-5°; b:J; c:N; d:Cl; e:Sp; f:Pl; g:S-SR.		30% 120"	88%	5	3:15	TH	SW	MH to H	—	0	350	
45		@ 46.4'-47.2', sandstone bed.												
		@ 46.8'-47', a:85°; b:J; c:T; d:Cl; e:Fi; f:Pl; g:Sr.												
		@ 47.2'-47.5', clay seam with loss.												
		@ 49.0'-50.0', sandstone bed.												H_2S = 0%; LEL = 0%; WL = 0%
50														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-23
Driller: M. Hull	Location:	N 770456.3 E 1869385.6			Page 3 of 7
Geologist: Taylor/Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B57	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/10/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 12/12/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
50	934.0	Medium hard to hard, gray SHALE with SANDSTONE interbeds (BEDFORD SHALE/BEREA SANDSTONE). @ 50'-53', a:60°; b:J; c:N; d:No; e:No; f:St; g:R.									J	1		
55				45% 120"	99%	6	1:54	TH	SW	MH to H	—	0	350	
60														H_2S = 0%; LEL = 0%; WL = 0%
												3		
												0		
												3		
65				66% 120"	99%	7	1:45	TH	SW	MH to H	J	4	350	W = 3.8 Unit weight @ 65.6 = 1610 pcf Unconfined test @ 65.6' = 4969 psi
												1		
												0		
		@ 69.0', a:0°; b:J; c:N; d:No; e:No; f:Pl; g:Sr.										1		
70												1		H_2S = 0%; LEL = 0%; WL = 0%
				82% 120"	95%	8	1:50	TH	SW	MH to H	—	0	350	
		@ 73.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Sr.									J	1		LEL background = 2-3 O_2 = 18.1
		@ 74.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Sr.												H_2S = 0%;
75		@ 74.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Sr.										2		LEL =4%; WL = 0%

Dodson-Stilson		*Project:*	Big Walnut Sanitary Trunk Sewer			**LOG of BORING:**	FTB-23
Driller:	M. Hull	*Location:*	N 770456.3 E 1869385.6				***Page 4 of 7***
Geologist:	Taylor/Walden	*Client:*	City of Columbus			*Job No.*	9821-6051.00
Drill Equip:	Mobile B57	*Sampler:*	2" split spoon	*Hammer Wt:*	140 lbs.	*Date Started:*	12/10/2001
Size & Type Core Barrel:		NQ_2 wireline		*Hammer Drop:*	30 in.	*Date Finished:*	12/12/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	*SOIL / ROCK*	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	*LAB RESULTS AND REMARKS*
											GRADATION			
											% Aggregate	*% Silt*		*Liquid Limit, LL*
											% C. Sand	*% Clay*		*Plasticity Index, PI*
											% M. Sand			*Water Content, W (%)*
											% F. Sand			
75	909.0	Medium hard, gray SHALE, moderately weathered (BEDFORD SHALE). @ 75.6', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl; g:Sr.		82% 120"	95%	8	1:50	TH	SW	MH to H	J — J	1 0 1	350	LEL background = 2-3 O_2 = 18.1 H_2S = 0%; LEL = 4%; WL = 0%
80		@ 79.5', a:20°; b:J; c:N; d:No; e:No; f:Pl; g:Sr.												
85		@ 81.2' - 81.6', highly weathered. @ 81.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 81.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 84.0', highly weathered zone . @ 84.8'-85.5', a:80°; b:J; c:N; d:No; e:No; f:St; g:R (possible mechanical break).		92% 120"	100%	9	1:30	TH	SW	MH to H	— J — J	0 2 0 1	350	
90		@ 89.4'-90.0', a:80°; b:J; c:N; d:No; e:No; f:St; g:R (possible mechanical break). @ 90.3', 2 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 90.9'-91.1', silty layer.									— J	0 1		
95		@ 94.9', a:5°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 95.0' - 96.2', broken and highly weathered Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Fi; f:Pl; g:S-SR. @ 96.7', red interbeds.		73% 120"	96%	10	3:00	TH	SW	MH to H	J — J —	2 0 1 >5 0	350	Unit weight @ 93.7 = 162.3 pcf W = 3.9 Unit weight @ 94.3 = 162.3 pcf Unconfined test @ 94.3' = 7028 psi
100														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		***LOG of BORING:***	FTB-23
Driller: M. Hull	*Location:*	N 770456.3 E 1869385.6			***Page 5 of 7***
Geologist: Taylor/Walden	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: Mobile B57	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	12/10/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	12/12/2001

WATER LEVELS			
Dete	*Depth to Weter*	*Bot. of Cesing*	*Bot. of Hole*
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS: Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	*SOIL / ROCK*	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	***LAB RESULTS AND REMARKS***
																				Liquid Limit, LL *Plesticity Index, PI* *Weter Content, W (%)*
																				H_2S (ppm) *LEL (%)* *Water Loss, WL (%)*
100	884.0	Medium hard, gray SHALE, moderately weathered (BEDFORD SHALE). @ 100'-102.3', broken and highly weathered. Typical fractures: a:0°-60°; b:J; c:VN-N; d:Fe-Cl; e:Su-Fi; f:Pl; g:S-SR. @ 100.9', a:40°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Slks.										J	>5							
105				87% 120"	100%	11	1:54				—	0	350	TH	MW	MH				
110																				
111.2	872.8	@ 110.7', a:15°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Slks.									J	1		TH	MW	MH				
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE). @ 111.4', a:50°; b:J; c:N; d:No; e:No; f:St; g:Sr. @ 111.5', a:40°; b:J; c:N; d:No; e:No; f:Pl; g:Slks. @ 113.7', 2 fractures: a:35°; b:J; c:N; d:No; e:No; f:Pl; g:Sr. @ 115.0' - 115.3', highly broken zone. Typical fractures: a:30°-45°; b:J; c:VN-N; d:Fe-Cl; e:Su-Fi; f:Pl; g:S-SR. @ 116.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 117.1', a:40°; b:J; c:N; d:Cl; e:Sp; f:St. @ 117.2', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 117.9', a:5°; b:J; c:N; d:Cl; e:Pa; f:Pl.										J	2							
											—	0								
											J	2								
115				85% 120"	100%	12	2:21				—	0	350	TH	MW	MH				
											J	>5								
												1								
												3								
											—	0								
120		@ 120.0' - 129.0', broken zone. Typical fractures: a:0°-10°; b:J; c:VN-N; d:Cl; e:Su-Fi; f:Pl; g:S-SR.										4								
											J	3								
				28% 120"	96%	13	2:42					3	350	TH	MW	MH				
											—	0								Unconfined test @ 125.2' = 4994 psi
125		@ 124.0' - 124.2', highly weathered. @ 124.6', red and gray.									J	3								Unit weight @ 125.2 = 164 pcf

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-23
Driller: M. Hull	Location:	N 770456.3 E 1869385.6			Page 6 of 7
Geologist: Taylor/Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B57	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/10/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 12/12/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
125	859.0	Medium hard, red and gray SHALE, moderately weathered (BEDFORD SHALE).									J	2		
		@ 126.7' - 127.1', highly weathered.										5		
				28% 120"	96%	13	2:42	TH	MW	MH	—	0	350	W = 2.4
		@ 128.0' - 128.7', highly weathered with probably loss.									J	>5		
130												>5		
								TH	MW	MH	B	0		
135	849.0			91% 120"	95%	14	3:12						350	
		Medium hard, gray SHALE, moderately weathered (BEDFORD SHALE).						TH	MW	MH	B	0		
140														
											B	0		
		@ 144.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.												
145		@ 145.2', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Slks.		98% 120"	100%	15	1:56	TH	MW	MH	J	1	350	
		@ 145.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl; g:Slks.									J	2		
		@ 146.0'-146.2', highly weathered.												
		@ 146.2'-146.4', hard, gray SILTSTONE bed.									B	0		Unconfined test @ 155.5' = 9432 psi
150														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-23
Driller: M. Hull	Location:	N 770456.3 E 1869385.6			Page 7 of 7
Geologist: Taylor/Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B57	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/10/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 12/12/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/10/01	15.3'	16'	16'
12/11/01	3.4'	60'	60'

WATER REMARKS:
Piazometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
150	834.0													
		Medium hard gray SHALE, slightly weathered (BEDFORD SHALE). @ 150.4' - 153.0', silty.						TH	MW	MH	—	0		Unconfined tast @ 150.8' = 7572 psi Slake Durability Index 94.3 Type III Unit weight @ 150.8 = 159.7 pcf
153.0	831.0													
		Hard, black SHALE, unweathered, pyritic, fissile (OHIO SHALE).												Unconfined tast @ 152.1' = 5246 psi Slake Durability Index 94.5 Type III Unconfined test @ 155.5' = 9432 psi W = 0.6 Slake Durability Index 97.3 Type II W = 0.7 Unit waight @ 152.1 = 157 pcf Unit waight @ 155.5 = 149.5 pcf
155				98% 120"	100%	16	1:15	VT	U	H	—	0	350	
160		@ 160.6' large pyritic nodule.												H_2S = 0%; LEL = 0%; WL = 0%
165				100% 120"	100%	17	1:12	VT	U	H	—	0	350	
170	814.0													
		Bottom of hole @ 170.0'												
175														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-24
Driller: K. Conrad	*Location:*	N 765996.5 E 1867748.0			***Page 1 of 7***
Geologist: K. Walden	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: Mobile B-59	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	11/27/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	12/3/2001

WATER LEVELS

Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** *Blows per 6"*	*Recovery (in.)*	*Sample No.*	*Hand Penetrometer (tsf)*	*GRADATION* *% Aggregate*	*% C. Sand*	*% M. Sand*	*% F. Sand*	*% Silt*	*% Clay*	***LAB RESULTS AND REMARKS***
0	974.2												*Liquid Limit, LL*
		Topsoil - 24"	5 8 8	18"	1	4.0							*Plasticity Index, PI*
2.0	972.2	Hard, brown SILTY CLAY (CL), little fine to coarse sand, trace gravel, slightly organic,	4 6 7	18"	2	4.5+							*Water Content, W (%)*
3.2	971.0	contains intermixed topsoil; damp.	5 7 10	18"	3	4.5+							
5		Hard, brown and gray SILTY CLAY (CL), little fine to coarse sand, little gravel; dry to damp.	8 10 17	18"	4	4.5+							
		@ 6.0', brown and dark brown.	11 14 15	18"	5	4.5+							
7.5	966.7	Very stiff, gray SILTY CLAY (CL), little fine to medium sand; damp.	10 11 15	18"	6	3.5							@ 8.7', seepage.
9.0	965.2	@ 8.1' - 8.7', some fine to coarse sand, little gravel.	10 11 15	18"	7	—							
10		@ 8.7', sand seam; wet.											
10.5	963.7	Very stiff, gray SILT (ML), little fine to coarse sand, little gravel; damp.	4 7 16	18"	8								
12.0	962.2	Stiff, gray CLAYEY SILT (CL-ML), little fine to coarse sand, trace gravel; moist to wet.	4 11 19	18"	9								
15		Very stiff, gray SILTY CLAY (CL), little fine to coarse sand, little gravel; damp to moist. @ 13.5', hard. @ 14' - 15', some gravel; damp. @ 15.0', seepage.	14 20 24	18"	10								
16.5	957.7		8 27 34	18"	11								
17.2	957.0	Very dense, brown GRAVEL (GP), some fine to coarse sand, trace silty clay; wet.	25 41 50/5	17"	12A 12B								
18.0	956.2	Very stiff, gray SILT (ML), little fine to coarse sand, little gravel; damp.	23 50/5	11"	13								
20		Very dense, gray fine to coarse SAND (SC-SM), some clayey silt, some gravel; moist.											
21.0	953.2	Hard, gray SILTY CLAY (CL), some gravel, some fine to coarse sand; damp to moist.	18 46 51	15"	14	4.5+							
25			14 22 22	18"	15	4.5+							

ROCK *RQD (%) & Core Length (in.)* | *Recovery (in./%)* | *Run No.* | *Drill rate (min/ft)* | *Bedding* | *Weathering* | *Hardness* | *Discontinuities* | *Fractures / ft* | *Drill Press (psi)*

H_2S (ppm)
LEL (%)
Water Loss, WL (%)

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-24
Driller: K. Conrad	Location:	N 765996.5 E 1867748.0			Page 2 of 7
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B-59	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/27/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/3/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
25	949.2													Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
		Hard, gray SILTY CLAY (CL), some gravel, some fine to coarse sand; damp to moist.	SOIL	25 44 50/2	14"	16								
28.5	945.7													
29.3	944.9	Very dense, brown GRAVEL (GP), some fine to coarse sand, trace silty clay; wet.	SOIL	51 50/3	9"	17A 17B								
30 31.0	943.2	Very dense, light brown, fine to coarse SAND (SM), little silt, little gravel rock fragments; moist.	SOIL	50/5	5"	18								@ 31', 10" heave.
33.0	941.2	Very dense, brown, fine to medium SAND (SM), little to some silt; moist.	SOIL	16 36 50/5	17"	19								
35 35.5	938.7	Very dense, brown and red GRAVEL (GC), some fine to coarse sand, little silty clay; damp to moist.	SOIL	49 50/3	7"	20								@ 36', 9" heave.
37.5	936.7	Very dense, gray, fine to coarse SAND (SM), little to some silt; wet.	SOIL	16 37 37	18"	21								
40 43.0	931.2	Very dense, brown GRAVEL (GC), some fine to coarse sand, little silty clay; moist to wet.	SOIL	36 40 41	16"	22								@ 41', 5' heave; washed out with tricone.
44.0	930.2	Dense, dark brown, fine to medium SAND (SM), some silt; wet.	SOIL	19 43 46	18"	23A 23B								@ 43.5', 15" heave.
45		Very dense, brown and red GRAVEL (GC), some fine to coarse sand, little silty clay; moist to wet.	SOIL	28 35 36	16"	24								@ 46', 2.5' heave; washed out with tricone.
50			SOIL	30 54 50/3	15"	25								@ 48.5', 5' heave; washed out with tricone.

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer	LOG of BORING: FTB-24
Driller: K. Conrad	Location:	N 765996.5 E 1867748.0	Page 3 of 7
Geologist: K. Walden	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: Mobile B-59	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 11/27/2001
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished: 12/3/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS: No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL: Blows per 6"	Recovery (in.)	Sample No.	Hand Penetrometer (tsf)	GRADATION: % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	LAB RESULTS AND REMARKS
50	924.2												
		Very dense, brown and red GRAVEL (GC), some fine to coarse sand, little silty clay; moist to wet.	33 49 39	17	26								@ 53.5', 5' heave; washed out with tricone.
55													
57.0	917.2												
		Very dense, gray SILT (ML), little fine to coarse sand with silt seams; wet.	44 50/5	11"	27								@ 58.5', 7" heave.
60													
62.0	912.2												
		Very dense, gray, fine to medium SAND (SM), some to 'and' silt, trace rock fragments; wet.	50/3	3"	28								@ 63.5', 5' heave; washed out with tricone.
65													
68.0	906.2												
		Very dense, gray SILT (ML); damp to moist.	44 45 49	18"	29								@ 68.5', 4' heave washed out with tricone.
70													
72.0	902.2												
		Very dense, gray, fine to coarse SAND (SM), some silt, little gravel; moist.	50/4	4"	30								@ 73.5', 1.5' heave; washed out with tricone.
75													

ROCK: RQD (%) & Core Length (in.) | Recovery (in./%) | Run No. | Drill rate (min/ft) | Bedding | Weathering | Hardness | Discontinuities | Fractures / ft | Drill Press (psi)

LAB RESULTS AND REMARKS: Liquid Limit, LL; Plasticity Index, PI; Water Content, W (%); H_2S (ppm); LEL (%); Water Loss, WL (%)

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-24
Driller:	K. Conrad	Locetion:	N 765996.5 E 1867748.0			Page 4 of 7
Geologist:	K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	Mobile B-59	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/27/2001
Size & Type Core Berrel:	NQ_2 wireline			Hammer Drop:	30 in.	Dete Finished: 12/3/2001

WATER LEVELS			
Date	Depth to Weter	Bot. of Casing	Bot. of Hole
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Weter Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
75	899.2													
		Very stiff, gray SILTY CLAY (CL), little fine to coarse sand, little gravel; moist.	SOIL											
		PLEASE NOTE: Encountered spoon refusal in previous drive. Set up to core to confirm if rock or boulder.	SOIL	48% 60"	47%	1	2:49	(Encountered spoon refusal in previous drive. Set up to core to confirm if rock or boulder.)						
80		@ 80', brown.	SOIL	22% 60"	30%	2	2:00	(Encountered spoon refusal in previous drive. Set up to core to confirm if rock or boulder.)						
85			SOIL											
90			SOIL	12 27 31	18"	31	3.75							@ 88.5', 2.5' heeve; washed out.
		@ 93', gray, some gravel.	SOIL	24 50/4	10"	32	2.50							@ 93.5', 1.5' heeve; weshed out.
95			SOIL											
97.0	877.2													
		Stiff, gray CLAY (CH); damp to moist.	SOIL											
100			SOIL	12 17 50/2	14"	33	1.50							@ 98.5', 1.3' heeve; weshed out.

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-24
Driller: K. Conrad	Location:	N 765996.5 E 1867748.0			Page 5 of 7
Geologist: K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: Mobile B-59	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/27/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/3/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
100	874.2													
		Stiff, gray CLAY (CH); damp to moist.												
102.5	871.7													Augers seated on
103.5	870.7	@ 102.5', boulder @ 103', SAND, GRAVEL, and CLAY												boulder @102.5' Cleaned out hole.
105		Soft to medium hard, red SHALE, highly weathered, very broken with many possible mechanical breaks (BEDFORD SHALE). Typical fractures: a:0°-5°; b:J; c:VN-N; d:Cl; e:Sp-Fi; f:Pl; g:S.		0% 120"	18%	3	1:21	TH	HW	S to MH	J	>5	300	
110												4 >5		O_2 = 18.4% H_2S = 0 ppm; LEL = 0%; WL=0%
115				22% 60"	100%	4	1:00	TH	HW	S to MH	J	4 5 3 2 3	300	H_2S = 0 ppm; LEL = 0%; WL=0%
120		@ 118.6', thin clay seam. @ 119.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 121.4', a:60°; b:J; c:N; d:Cl; e:Su; f:Pl; g:R. @ 121.9'-122.8', near vertical mechanical fracture. @ 123.9', a:30°; b:J; c:N; d:No; e:No; f:Pl; g:Slks.		87% 120"	94%	5	1:36	TH	HW	S to MH	J	0 1 0 1 0 1 0	300	
125														

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-24
Driller:	K. Conrad	Location:	N 765996.5 E 1867748.0			Page 6 of 7
Geologist:	K. Walden	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	Mobile B-59	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 11/27/2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/3/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
125	849.2	Soft to medium hard, red SHALE, moderately to highly weathered (BEDFORD SHALE).		87% 120"	94%	5	1:36	TH	MW to HW	S to MH	—	0	300	Slight gas odor noted during drillling. H_2S = 0 ppm; LEL = 0%; WL=0%
		@ 129.5', gray and red interbedded.									—	0		
130		@ 131.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										1		
		@ 132.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 133.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 133.3'-133.7', a:80°; b:J; c:N; d:Cl; e:Sp; f:Pl.		56% 120"	100%	6	1:30	TH	HW	S to MH	J	1 2	300	
135		@ 134.2', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 134.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 134.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										3 1		
		@ 135.8', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 136.2', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 136.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										2 0		H_2S = 0 ppm; LEL = 0%; WL=0%
138.5	835.7	Medium hard, gray SHALE, moderately to highly weathered (BEDFORD SHALE).									J	2		
140		@ 138.5'-139.7', near vertical mechanical fracture. @ 139.9', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.		92% 120"	94%	7	1:15	TH	MW to HW	MH	B	0	300	
145		@ 147.2'-147.7', hard SILTSTONE beds.												Slight gas odor noted during drillling. H_2S = 0 ppm; LEL = 0%; WL=0%
150				100% 120"	100%	8	NR	TH	MW	MH	B	0	300	Unit weight @ 149.8 = 161.4 pcf

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-24
Driller: K. Conrad	*Location:*	N 765996.5 E 1867748.0			***Page 7 of 7***
Geologist: K. Walden	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: Mobile B-59	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Startad:*	11/27/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Data Finished:*	12/3/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
11/28/01	9'	41'	41'
11/29/01	6.2'	75'	75'
12/3/01	3.5'	130	158.5

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*% Aggregate* / *Bedding*	*% C. Sand* / *Weathering*	*% M. Sand* / *Hardness*	*% F. Sand* / *Discontinuities*	*% Silt* / *Fractures / ft*	*% Clay* / *Drill Press (psi)*	***LAB RESULTS AND REMARKS***
								GRADATION						*Liquid Limit, LL* *Plasticity Index, PI* *Water Contant, W (%)*
150	824.2													*H_2S (ppm)* *LEL (%)* *Water Loss, WL (%)*
		Medium hard, gray SHALE, moderately weathered (BEDFORD SHALE).						TH	MW	MH	B	0	300	Slake Durability Index 96.0 Type II W = 0.4 Slake Durability Index 93.2 Type III W = 0.4
		@ 153.1'-154.8', gradational color change from gray to black.		100% 120"	100%	8	NR							Unit weight @ 150.3 = 157.7 pcf
154.8	819.4													Slake Durability Index 97.0 Type II W = 0.4
155		Hard, black SHALE; pyritic, fissile, slightly weathered (OHIO SHALE).						VT	SW	H	B	0	300	Unit weight @ 156.3 = 150.1 pcf Slight gas odor noted during drillling. O_2 = 17.2 H_2S = 0 ppm;
160		@ 161.9'-164.0', brownish black.												LEL = 0%; WL=0% Unconfined test @ 149.8' = 10175 psi Unconfined test @ 153.0' = 7170 psi Unconfined test @ 156.3' = 10366 psi @ 160', WL = 60%
165				83% 120"	100%	9	1:56	VT	SW	H	B	0	300	Slight gas odor noted during drillling. O_2 = 16.0 H_2S = 0 ppm; LEL = 0%; WL = 60%
168.5	805.7													
		Bottom of hole @ 168.5'												
170														
175														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		***LOG of BORING:***	FTB-25
Driller: R. Brungs	*Location:*	N 766896.7 E 1867802.0			***Page 1 of 8***
Geologist: L. Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: CME 850	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	12/5/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	12/7/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
12/5/01	DRY	13.8'	13.8'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows par 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*% Aggregate* / *Bedding*	*% C. Sand* / *Weathering*	*% M. Sand* / *Hardness*	*% F. Sand* / *Discontinuities*	*% Silt* / *Fractures / ft*	*% Clay* / *Drill Press (psi)*	***LAB RESULTS AND REMARKS***
								GRADATION						*Liquid Limit, LL* *Plasticity Index, PI* *Water Content, W (%)*
0	985.3													
0.8	984.5	Topsoil - 9"												
		Hard, brown SILTY CLAY (CL), little fine to coarse sand, little gravel; damp.	SOIL	2 3 4	17"	1	4.5+							
4.0	981.3													
5		Soft, brown SANDSTONE, decomposed.	SOIL	3 19 50/5	17"	2								
			SOIL	50/5	5"	3								
			SOIL	50/5	5"	4								
10														
		@ 11', gray	SOIL	50/5	5"	5								
13.8	971.5													Augers seated @ 13.8'
15		Hard, light gray SANDSTONE, highly to moderately weathered, contains very thin argillaceous laminae (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe; e:Su; f:Pl; g:S-SR.	ROCK	71% 48"	100%	1	NR	TK	HW to MW	H	J	3 4 3 3	300	
		@ 17.8'-18.2', a:70°; b:J; c:N; d:Fe; e:Su; f:Pl.												WL = 0%
		@ 18.2'-18.7', a:90°; b:J; c:N; d:No; e:No; f:Pl.												
		@ 18.9', very thin clay seam.												
		@ 19.6', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.										1		Packer Test 19' - 47.8'
20												1		
		@ 21.0', a:0°; b:J; c:N; d:No; e:No; f:Pl.	ROCK	62% 120"	100%	2	2:00	TK	HW to MW	H	J	1	300	
		@ 21.6', 3 fractures: a:0°-90°; b:J; c:N; d:Fe; e:Su; f:Pl.										3		
		@ 22.1'-22.4', a:60°; b:J; c:T; d:H; e:Fi; f:Pl.										2		
		@ 22.6-22.8', a:90°; b:J; c:N; d:Cl; e:Fi; f:Pl.												
		@ 23.1' & 23.5', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										2		
25		@ 25.0', thin clay seam.										0		

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-25
Drillar: R. Brungs	Location:	N 766896.7 E 1867802.0			Page 2 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 850	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/7/2001

WATER LEVELS			
Date	Depth to Watar	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Watar Contant, W (%)
25	960.3													H_2S (ppm) LEL (%) Watar Loss, WL (%)
		Hard light gray SANDSTONE, highly to moderately weathered, contains very thin argillaceous laminae (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe; e:Su; f:Pl; g:S-SR.		62% 120"	100%	2	2:00	TK	HW to MW	H	J	2 1 2	300	
		@ 25.1', 2 fractures: a:5°; b:J; c:VN; d:Cl; e:Pa; f:Pl.												WL = 0%
		@ 26.5' & 27.0', thin clay seam.												
		@ 27.7', 2 fractures: a:0°; b:J; c:N; d:Cl;										0		
30		e:Pa; f:Pl.										0		
		@ 30.6', 2 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										2		
		@ 32.1', 32.2', 32.3', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.		83% 120"	100%	3	2:00	TK	HW to MW	H	J	1 3	400	
		@ 33.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										2		
		@ 33.9'-34.7', severely weathered												
35		containing several clay seams.										0		
		@ 36.1', a:0°; b:J; c:N; d:No; e:No; f:Pl.										1		
		@ 37.5'-37.8', broken zone.												WL = 0%
38.1	947.2	@ 37.9', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										1		
		Soft to hard, gray and dark gray SANDSTONE and SHALE, thin to medium interbedded, moderately to highly weathered (BEREA SANDSTONE).										4		
40		@ 38.2', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										1		
		@ 38.7', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.										1		
		@ 38.8', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.										0		
		@ 38.8' - 39.6', a:90°; b:J; c:N; d:Fe; e:Su; f:Pl (contains 3 horizontal pyrite bands).		38% 120"	100%	4	2:00	TK to TH	MW to HW	H to S	J	2	400	
		@ 41.4', a:0°; b:J; c:MW; d:Cl; e:Fi; f:Pl.										2		
		@ 43.0', 43.9', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.										1		
		@ 44.2' & 44.7', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.										5		
45		@ 45.3', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.										4		
		@ 46.1', 2 fractures: a:10°; b:J; c:N; d:H; e:Fi; f:Pl.										1		WL = 0%
		@ 46.2', a:45°; b:J; c:N; d:H; e:Fi; f:Pl.												
		@ 46.2', a:30°; b:J; c:MW; d:H; e:Fi; f:Pl.												
		@ 46.3', a:80°; b:J; c:N; d:Cl; e:Su; f:Pl.												
		@ 46.1' - 47.6', dark gray SHALE argillaceous.												
		@ 47.0'-47.6', a:80°; b:J; c:N; d:Cl; e:Sp; f:Pl.		40% 120"	100%	5	2:00	TK to TH	MW to HW	H to S	J	>5		
50		'@ 45.8'-50.3', a:0°-5°; b:J; c:VN-N; d:Cl; e:Sp-Pa; f:Pl; g:S-SR.										4		

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-25
Driller: R. Brungs	Location:	N 766896.7 E 1867802.0			Page 3 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 850	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/7/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL/ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
50	935.3	Soft to hard, gray and dark gray SHALE and SANDSTONE, thin to medium interbedded, moderately to highly weathered (BEDFORD SHALE). @ 51.5' - 52.3', a:0°-5°; b:J; c:VN-N; d:Cl; e:Sp-Pa; f:Pl; g:S-SR. @ 52.8' - 53.0', a:0°-5°; b:J; c:VN-N; d:Cl; e:Sp-Pa; f:Pl; g:S-SR. @ 54.5' - 55.2', Sandstone layer. '@ 54.6' - 54.9', a:0°-5°; b:J; c:VN-N; d:Cl; e:Sp-Pa; f:Pl; g:S-SR. @ 55.3' - 55.9', Sandstone layer.		40% 120"	100%	5	2:00	TK to TH	MW to HW	H to S	J	3 >5 >5 0 >5 0	400	H_2S (ppm) LEL (%) Water Loss, WL (%)
60		@ 59.5', a:80°; b:J; c:N; d:Cl; e:Su; f:Pl. @ 60.9', a:10°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 60.9'-61.1', a:80°; b:J; c:N; d:Cl; e:Sp; f:Pl.		50% 120"	100%	6	2:00	TK to TH	MW to HW	H to S	J	0 1 1 1 0	400	
65														
65.8	919.5	Medium hard, dark gray SHALE, moderately to highly weathered (BEDFORD SHALE). @ 66.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 67.1', a:30°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 68.1 & 68.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.						TH	MW to HW	MH	1	1 1		
70		@ 70.3', a:5°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 71.8', a:30°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 72.9', a:40°; b:J; c:MW; d:Cl; e:Sp; f:Pl; g:St @ 73.2'-73.7', a:80°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 73.2', 73.4', 73.7', a:5°;b:J;c:N;d:Cl;e:Pa;f:Pl @ 74.4', broken along bedding planes.		83% 120"	100%	7	3:00	TH	MW to HW	MH	J	2 0 1 1 1 1 0	400	
75														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer	LOG of BORING: FTB-25
Driller: R. Brungs	Location:	N 766896.7 E 1867802.0	Page 4 of 8
Geologist: L. Taylor	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 850	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel: NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 12/7/2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'

WATER REMARKS: Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
75	910.3	Medium hard dark gray SHALE, moderately to highly weathered (BEDFORD SHALE). @ 75.3', a:5°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 76.3', a:30°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 76.5', a:60°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 76.7', a:30°; b:J; c:N; d:Cl; e:Pa; f:Pl.		83% 120"	100%	7	3:00	TH	MW to HW	MH	J	1 3 0	400	H_2S = 0 ppm; LEL = 0%; WL = 0%
80				75% 120"	100%	8	4:00	TH	MW to HW	MH	B	—	400	
85														H_2S = 0 ppm; LEL = 0%; WL = 0%
90		@ 90.1'-91.4', a:70°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 91.4' & 91.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 92.3' & 92.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.		70% 120"	100%	9	4:00	TH	MW to HW	MH	J	0 1 2 2 0	400	Packer Test 88'-157.8'
95		@ 95.0'-95.1', a:45°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 96.2' & 96.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.										1 2 0		H_2S=0 ppm; LEL = 0%; WL = 0%
100		@ 99.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.		98% 120"	100%	10	3:30	TH	MW to HW	MH	J	0 1	400	

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-25
Driller: R. Brungs	Location:	N 766896.7 E 1867802.0			Page 5 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 850	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 12/7/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'	

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL/ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plesticity Index, PI Weter Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
100	885.3													
		Medium hard, gray SHALE, moderately to highly weathered (BEDFORD SHALE). @100.8' & 101', a:30°; b:J; c:N; d:Cl; e:Sp; f:Pl @101.2' &101.6'; a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl		98% 120"	100%	10	3:30	TH	MW to HW	MH	J — J —	1 3 0 1 0	400	H_2S=0 ppm; LEL=0% WL = 0%
105		@ 105.6', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 107.4'-108', a:70°; b:J; c:N; d:No; e:No; f:Pl. (Mechanical Break)												
110		@ 110.0', Red interbeds present. @ 110.7', 2 fractures: a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 112.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 113.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.		120" 85% 120"	110" 92%	11	3:00	TH	MW to HW	MH	B J B J	0 2 0 1 1	400	
115														
115.2	870.1	Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).						TH	MW	MH	B	0		H_2S=0 ppm; LEL = 0%; WL = 0%
		@118.4'-118.8', a:45°; b:J; c:N; d:Cl; e:Sp; f:Pl @ 119.4', a:30°; b:J; c:N; d:Cl; e:Sp; f:Pl.		97% 120"	100%	12	4:30	TH	MW	MH	J B J B	1 1 0 1 0	300	
120		@ 122.8', a:45°; b:J; c:N; d:Cl; e:Fi; f:Pl; g:St (possible zone of loss).												
125														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-25
Driller: R. Brungs	*Location:*	N 766896.7 E 1867802.0			***Page 6 of 8***
Geologist: L. Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051.00
Drill Equip: CME 850	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	12/5/2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	12/7/2001

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
12/5/01	DRY	13.8'	13.8'

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL *Plasticity Index, PI* *Water Content, W (%)*
125	860.3	Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).		97% 120"	100%	12	4:30	TH	MW	MH	B	—	400	Water loss ~125' H_2S=0 ppm; LEL = 0%; WL = 100%
130				100% 120"	100%	13	5:30	TH	MW	MH	B	—	450	
133.3	852.0													
135		Medium hard, gray SHALE, moderately weathered, contains occasional red interbeds (BEDFORD SHALE).						VT to TH	MW	MH	B	—		H_2S=0 ppm; LEL = 0%; WL = 0%
140		@ 140.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
145		@ 147.4', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl; g:St.		99% 120"	99%	14	4:30	VT to TH	MW	MH	B	—	450	H_2S=0 ppm; LEL = 0%; WL = 2%
											J	1		
150				100% 120"	100%	15	4:00	VT to TH	MW	MH	B	—	450	

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-25
Driller: R. Brungs	Location:	N 766896.7 E 1867802.0			Page 7 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 850	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: 12/7/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'	

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
150	835.3													
		Medium hard, gray SHALE, moderately weathered, contains occasional red interbeds (BEDFORD SHALE).									J	1		W = 2.8
		@ 150.6', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.												
		152.3' -152.4', 152.55' -152.75', hard, gray SILTSTONE beds.		100% 120"	100%	15	4:00	VT to TH	MW	MH	B	—	450	Slake Durability Index 96.5 Type II w = 0.5 Unit weight @ 155.9 = 159.7 pcf Packer Test 155'-177.8' Unconfined test @ 155.9' = 10658 psi H_2S=0 ppm; LEL = 0%; WL = 0%
155														
157.8	827.5													
		Hard, black SHALE, thinly laminated, unweathered, fissile (OHIO SHALE).												Slake Durability Index 97.4 Type I W = 2.7
160														
				100% 120"	100%	16	2:00	VT	H	U	B	0	450	Unit weight @ 162.4 = 148.9 pcf Unconfined test @ 162.4' = 12397 psi
165		@ 166.6', pyrite layer.												H_2S=0 ppm; LEL = 0%; WL = 0%
170														
				100% 120"	100%	17	2:00	VT	H	U	B	0	450	
		@ 173.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		
175											B	0		

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-25
Driller:	R. Brungs	Location:	N 766896.7 E 1867802.0			Page 8 of 8
Geologist:	L. Taylor	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip:	CME 850	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 12/5/2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 12/7/2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/5/01	DRY	13.8'	13.8'	

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Cley / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
175	810.3													
		Hard, black SHALE, thinly laminated, unweathered, fissile (OHIO SHALE). @ 176.2', small concretion @ 176.6', pyrite layer		100% 120"	100%	17	2:00	VT	H	U	B	0	450	
177.8	807.5													H_2S=0 ppm; LEL = 0%; WL = 0%
		Bottom of Boring -177.8'												
180														
185														
190														
195														
200														

H_2S (ppm)
LEL (%)
Water Loss, WL (%)

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-26
Driller:	M. Hull	Location:	N 767692.3 E 1867849.8			Page 1 of 8
Geologist:	L. Taylor	Client:	City of Columbus			Job No. 9821-6051
Drill Equip:	CME-859	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: Dec 20, 2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
0	991.5													
0.6	990.9	Topsoil - 7"												
		Stiff brown and gray SILTY CLAY (CL), little to some fine to coarse sand, little gravel; damp.	SOIL	2 3 7	10	1								
				3 5 10	18	2								
5	986.5													Auger seated @ 5'
		Hard, brown SANDSTONE, highly weathered, highly broken (BEREA SANDSTONE) Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe-Cl; e:Su-Pa; f:Pl; g:S-SR.	ROCK	38% 96"	100%	1	2:30	TH to M	HW	H	J	>5	300	
10		@ 10.1', a:45°; b:J; c:N; d:Fe; e:Su; f:Pl.												Packer test 10' - 63'
		@ 11.3' - 11.6', a:80°; b:J; c:N; d:Cl; e:Pa; f:Pl.												
		@ 12.2', gray, slightly broken. Typical fractures: a:0°-5°; b:J; c:VN-N; d:Fe; e:Su; f:Pl; g:S-SR.												WL = 0%
		@ 12.6', thin clay seam.		72% 120"	100%	2	2:30	TH to M	HW	H	J	1 1 2 2 1 1 2 2 1	350	
15														
		@ 16.4', very thin argillaceous laminae evident												
		@ 18.1', 0.1' clay seam @ 18.1' - 18.4', a:75°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
20		@ 20.5' - 20.8', a:75°; b:J; c:N; d:No; e:No; f:Pl												
		@ 23.1', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.												WL = 0%
		@23.2', 2 fractures: a:0°; b:J;c:N;d:Cl; e:Fi; f:Pl @ 24.1' - 24.4', thin clay seams. @ 24.9'-25', clay seams with 1 fracture: a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.		50% 120"	100%	3	2:30	TH to M	HW	H	J J	1 1	350	
25														

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		***LOG of BORING:***	FTB-26
Driller: M. Hull	*Locetion:*	N 767692.3 E 1867849.8			***Page 2 of 8***
Geologist: L. Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051
Drill Equip: CME-859	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Dete Started:*	Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	Dec 20, 2001

WATER LEVELS			
Dete	*Depth to Weter*	*Bot. of Cesing*	*Bot. of Hole*
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	*SOIL / ROCK*	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	***LAB RESULTS AND REMARKS***
																				Liquid Limit, LL *Plesticity Index, PI* *Water Content, W (%)*
25	966.5																			
		Hard, gray SANDSTONE, severely weathered, (BEREA SANDSTONE).															B	0		
		@ 26.4' - 27.1', a:85°; b:J; c:N; d:H; e:Fi; f:Pl. (mechanically rebroken).															J	1		
		@ 28.5', a:5°; b:J; c:N; d:Cl; e:Fi; f:Pl.		50%	100%	3	2:30							TH to M	HW	H			350	
		@ 28.7', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.		120"													J	3		
		@ 28.9', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.															J	1		
30		@ 29.4' - 30.0', a:90°; b:J; c:N; d:H; e:Fi; f:Pl. (mechanically rebroken).															B	0		
		@ 31.3', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.															J	2		
		@ 31.4', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.															J	1		WL = 0%
		@ 32.6', a:0°; b:J; c:N; d:Fe; e:Su; f:Pl.																		
		@ 33.3', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.															J	1		
35		@ 35.0' - 35.5', contorted bedding with mechanical breakage.															B	0		
		@ 36.5' - 36.8', 2 fractures: a:45°; b:J; c:N; d:Cl; e:Fi; f:Pl (contains sandstone clasts).															J	2		
		@ 37.0' - 37.4', a:90°; b:J; c:N; d:H; e:Fi; f:Pl. (mechanically rebroken).		60%	100%	4	2:18							TH to M	HW	H			350	
		@ 38.0', high angle dark gray laminae.		120"													B	0		
		@ 39.1', highly decomposed/clay layer																		
		@ 39.7' - 39.9', severely weathered zone.																		
40		@ 40.1', a:5°; b:J; c:N; d:Cl; e:Fi; f:Pl.															J	1		
																	B	0		
42.0	949.5																			
		Medium hard, gray SANDSTONE and SHALE interbedded, moderately weathered (BEREA SANDSTONE/BEDFORD SHALE).												VT M	MW	MH	J	3		WL = 0%
		@ 42.7', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.															B	0		
		@ 42.9', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.																		
45		@ 43.0', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl.																		
		@ 43.7' - 45.9', severely weathered layer.															J	1		
		@ 44.6' - 45.1', a:90°; b:J; c:N; d:H; e:Fi; f:Pl.												VT to M	MW	MH				
		@ 46.4', 0.1' severely weathered layer.		65%	100%	5	2:00												350	
		@ 47.6', very thin clay seam.		120"																
		@ 48.6' - 49.0', severely weathered layer.															B	0		
50																				

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-26
Driller: M. Hull	Location:	N 767692.3 E 1867849.8			Page 3 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051
Drill Equip: CME-859	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: Dec 20, 2001

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL/ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
								Bedding	Weathering	Hardness	Discontinuities	Fractures / ft	Drill Press (psi)	H_2S (ppm) LEL (%) Water Loss, WL (%)
50	941.5													
52.0	939.5	Medium hard, gray SANDSTONE and SHALE interbedded, moderately weathered (BEREA SANDSTONE/BEDFORD SHALE). @ 50.7', 2 clay seams.		65% 120"	100%	5 2:00		VT to M	MW	MH	B	0	350	
		Medium hard, gray SHALE and SANDSTONE interbedded, moderately weathered (BEREA SANDSTONE/BEDFORD SHALE).												WL = 0%
55				90% 120"	100%	6 2:00		VT to TK	MW	MH	B	0	400	
		@ 59.3', a:20°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
60		@ 60.0' - 60.3', sandstone layer. @ 60.5' - 61.1', sandstone layer.									B	0		
		@ 62.3', a:30°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 62.8', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	3		WL = 0%
65				87% 120"	100%	7 2:00		VT to TK	MW	MH	B	0	450	
		@ 68.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	2		
		@ 68.7', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
70		@ 69.3', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									B	0		
		@ 71.0' - 71.1', a:85°; b:J; c:N; d:Cl; e:Su; f:Pl.									J	3		
		@ 71.1', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 71.4', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 72.1' - 72.4', a:85°; b:J; c:N; d:Cl; e:Su; f:Pl.									J	1		H_2S = 0 ppm; LEL = 3%; WL = 0%
				90% 120"	100%	8 2:00		VT to M	MW	MH	B	0	450	
75														

Dodson-Stilson		Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-26
						Page 4 of 8
Driller:	M. Hull	Location:	N 767692.3 E 1867849.8			Job No. 9821-6051
Geologist:	L. Taylor	Client:	City of Columbus			Date Started: Dec 18, 2001
Drill Equip:	CME-859	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Finished: Dec 20, 2001
Size & Type Core Barrel:		NQ_2 wireline		Hammer Drop:	30 in.	

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
75	916.5													
		Medium hard, gray SHALE and SANDSTONE interbedded, moderately weathered (BEREA SANDSTONE/BEDFORD SHALE). @ 76.9', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.		90% 120"	100%	8	2:00	VT to M	MW	MH	B J	0 1	450	
80		@ 80.8', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 81.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 81.5', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 82.0', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									B J J J	0 2 1 1		Packer test 80' - 163' H_2S = 0 ppm; LEL = 3%; WL = 0%
83.0	908.5													
		Medium hard, gray SHALE, moderately weathered, fissile (BEDFORD SHALE). @ 84.0', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 85.1', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl. @ 85.2', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J B J	1 0 2		
85		@ 86.2', a:0°; b:J; c:N; d:Cl; e:Fi; f:Pl. @ 86.2' - 86.3', a:45°; b:J; c:N; d:Cl; e:Fi; f:Pl.		92% 120"	100%	9	2:00	VT to M	MW	MH	J B	2 0	450	
90														H_2S = 0 ppm; LEL = 3%; WL = 0%
		@ 94.5', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 94.6', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl. @ 95.3', a:0°; b:J; c:MW; d:Cl; e:Pa; f:Pl.									B J	0 2		
95		@ 96.4', a:0°; b:J; c:MW; d:Cl; e:Pa; f:Pl. @ 97.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.		100% 120"	100%	10	2:00	TH	MW	MH	J J J B	1 1 1 0	450	
100														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-26
Driller: M. Hull	Location:	N 767692.3 E 1867849.8			Page 5 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051
Drill Equip: CME-859	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: Dec 20, 2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
100	891.5													H_2S (ppm) LEL (%) Water Loss, WL (%)
		Medium hard, gray SHALE, moderately weathered, fissile (BEDFORD SHALE).	SOIL	100% 120"	100%	10	2:00	TH	MW	MH	B	—	450	
		@ 101.5' - 102.1', contorted bedding.									J	1		
		@ 102.0', a:35°; b:J; c:MW; d:Cl; e:Fi; f:Pl.									B	—		H_2S = 0 ppm; LEL = 4%; WL = 0%
		@ 103'-103.2', a:60°;b:J;c:N;d:Cl; e:Su;f:Pl;g:St.									J	1		
105											B	0		
		@ 105.5', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	2		
		@ 105.6', a:20°; b:J; c:N; d:Cl; e:Sp; f:Pl.		100% 120"	100%	11	2:00	TH	MW	MH	B	—	500	
		@ 108.4', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.									J	1		
110											B	—		H_2S = 0 ppm; LEL = 4%; WL = 0%
		@ 113.1', red interbeds evident.												
115														
117.4	874.1			98% 120"	98%	12	2:00	TH	MW	MH	B	—	500	
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).									J	1		
		@ 118.7', a:10°; b:J; c:N; d:Cl; e:Su; f:Pl.									J	1		
120		@ 119.9', a:10°; b:J; c:N; d:Cl; e:Su; f:Pl.									J	1		
		@ 120.2', a:5°; b:J; c:N; d:Cl; e:Su; f:Pl.									B	0		
		@ 122.6' - 123.0', grayish red.									J	1		H_2S = 0 ppm; LEL = 4%; WL = 0%
		@ 123.0', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.		98% 120"	98%	13	2:00	TH	MW	MH	B	—	500	
125														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer		LOG of BORING: FTB-26
Driller: M. Hull	Location:	N 767692.3 E 1867849.8		Page 6 of 8
Geologist: L. Taylor	Client:	City of Columbus		Job No. 9821-6051
Drill Equip: CME-859	Sampler:	2" split spoon	Hammer Wt: 140 lbs.	Date Started: Dec 18, 2001
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop: 30 in.	Date Finished: Dec 20, 2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
125	866.5													Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
		Medium hard, red SHALE, moderately weathered (BEDFORD SHALE).		100% 120"	100%	13	2:00	TH	MW	MH	B	0	500	
		@ 129.0', a:0°; b:J; c:MW; d:Cl; e:Pa; f:Pl.									J	1		
130											B	0		
		@ 132.5', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		H_2S = 0 ppm; LEL = 2%; WL = 0%
		@ 134.0', a:0°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	1		
		@ 134.1', a:30°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
135				100% 120"	100%	14	3:00	TH	MW	MH	B	—	500	
		@ 139.1', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
		@ 139.3', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.												
140		@ 139.6', a:5°; b:J; c:N; d:Cl; e:Sp; f:Pl.									J	3		Driller note: ~140.5' tried to plug off indicated by water pressure build up.
											—	0		
142.1	849.4										J	1		
		Medium hard, gray SHALE, moderately to slightly weathered, contains occasional red interbeds (BEDFORD SHALE).						TH	MW	MH	B	0		H_2S = 0 ppm; LEL = 1%; WL = 0%
		@ 142.2', a:0°; b:J; c:N; d:Cl; e:Pa; f:Pl.												
145				100% 120"	100%	15	3:00	TH	MW to SW	MH	B	—	500	
		@ 147.7', red beds disappear.												
150														

Dodson-Stilson	Project:	Big Walnut Sanitary Trunk Sewer			LOG of BORING: FTB-26
Driller: M. Hull	Location:	N 767692.3 E 1867849.8			Page 7 of 8
Geologist: L. Taylor	Client:	City of Columbus			Job No. 9821-6051
Drill Equip: CME-859	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	Date Finished: Dec 20, 2001

WATER LEVELS			
Date	Depth to Water	Bot. of Casing	Bot. of Hole
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed et completion.

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
150	841.5	Medium hard, gray SHALE, slightly weathered (BEDFORD SHALE).	SOIL	100% 120"	100%	15	3:00	TH	SW	MH	B	—	500	H_2S = 0 ppm; LEL = 1%; WL = 0%
155		@ 155.5' - 156.4', contains gray SILTSTONE beds.	SOIL	100% 120"	100%	16	3:00	TH	SW	MH	B	—	500	Slake Durability Index 94.9 Type III Unconfined test @ 161.8' = 12281 psi W = 0.8 Unit weight @ 161.8 = 157.2 pcf Packer test 160.5' - 182.5' H_2S = 0 ppm; LEL = 1%; WL = 0%
160		@ 160.5' - 162.0', color grades from gray to black.												
162	829.5	Hard, black SHALE, unweathered, fissile, pyritic (OHIO SHALE).						VT	H	U				
165			SOIL	100% 120"	100%	17	1:30	VT	H	U	B	—	500	Unit weight @ 165.1 = 150.6 pcf Unconfined test @ 165.1' = 11816 psi Sleke Durability Index 98.7 Type I W = 2.7
170														H_2S = 0 ppm; LEL = 1%; WL = 0%
175			SOIL	100% 124"	100%	18	1:30	VT	H	U	B	—	500	

Dodson-Stilson	*Project:*	Big Walnut Sanitary Trunk Sewer		**LOG of BORING:**	FTB-26
Driller: M. Hull	*Location:*	N 767692.3 E 1867849.8			***Page 8 of 8***
Geologist: L. Taylor	*Client:*	City of Columbus		*Job No.*	9821-6051
Drill Equip: CME-859	*Sampler:*	2" split spoon	*Hammer Wt:* 140 lbs.	*Date Started:*	Dec 18, 2001
Size & Type Core Barrel:	NQ_2 wireline		*Hammer Drop:* 30 in.	*Date Finished:*	Dec 20, 2001

WATER LEVELS			
Data	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
12/18/01	Dry	5' (HSA)	5'
12/19/01	13	7'	63'
12/20/01	11.5	123'	123'

WATER REMARKS:
No piezometer installed at completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** / ***ROCK***	*Blows per 6"* / *RQD (%) & Core Length (in.)*	*Recovery (in.)* / *Recovery (in./%)*	*Sample No.* / *Run No.*	*Hand Penetrometer (tsf)* / *Drill rate (min/ft)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	***LAB RESULTS AND REMARKS***
175	816.5													*Liquid Limit, LL*
		Hard, black SHALE, unweathered, fissile, pyritic (OHIO SHALE).										J	1	*Plasticity Index, PI*
		@ 175.8', a:0°; b:J; c:N; d:Cl; e:Su; f:Pl.		100% 124"	100%	18	1:30	VT	H	U	B	—	500	*Water Content, W (%)*
180														*H_2S (ppm)*
182.5	809.0													*LEL (%)*
														Watar Loss, WL (%)
														H_2S = 0 ppm; LEL = 1%; WL = 0%
		Bottom of Hole - 182.5												
185														
190														
195														
200														

Dodson-Stilson		***Project:***	Big Walnut Sewer			***LOG of BORING:*** FTB-30	
Driller:	R. Brungs	***Location:***	N 770461.4 E 1869375.6			***Page 1 of 2***	
Geologist:	N/A	***Client:***	City of Columbus			***Job No.***	9821-6051.00
Drill Equip:	CME-750	***Sampler:***	N/A	***Hammer Wt:***	N/A	***Date Started:***	6/8/1999
Size & Type Core Barrel:	N/A			***Hammer Drop:***	N/A	***Date Finished:***	6/8/1999

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
NOT RECORDED DURING DRILLING - BORING WAS			
DRILLED BY ROTARY WASH METHOD			

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** *Blows per 6"*	*Recovery (in.)*	*Sample No.*	*Hand Penetrometer (tsf)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	***LAB RESULTS AND REMARKS***
0	984.4												*Liquid Limit, LL*
		Drilled by rotary wash method without sampling to 39.0'											*Plasticity Index, PI*
		Note: Boring was drilled as an offset boring approximately 10 feet away from boring FTB-23 to be used in a hydrological invsetigation.											*Water Content, W (%)*
5		No samples were collected; hole was drilled using 3 7/8" tricone bit and rotary wash method. Samples collected from boring FTB-23.											
10													
14.0	970.4	**Auger refusal at 14.0 ft.**											
15		Top of Bedrock 15.5 ft in Boring FTB-23											
20		Hard, brown and gray SANDSTONE, moderately weathered, intensely fractured (BEREA SANDSTONE). (See Boring FTB-23 for detailed descripition of bedrock encoutnered).											
		Note: No core was obtained from boring; hole was drilled using 3 7/8" tricone and rotary wash method.											
25													

ROCK *RQD (%) & Core Length (in.)*	*Recovery (in./%)*	*Run No.*	*Drill rate (min/ft)*	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	*H_2S (ppm)* *LEL (%)* *Water Loss, WL (%)*

Dodson-Stilson		***Project:***	Big Walnut Sewer			***LOG of BORING:*** FTB-30	
Driller:	R. Brungs	***Location:***	N 770461.4 E 1869375.6			***Page 2 of 2***	
Geologist:	N/A	***Client:***	City of Columbus			***Job No.***	9821-6051.00
Drill Equip:	CME-750	***Sampler:***	N/A	***Hammer Wt:***	N/A	***Date Started:***	6/8/1999
Size & Type Core Barrel:	N/A			***Hammer Drop:***	N/A	***Date Finished:***	6/8/1999

WATER LEVELS			
Date	*Depth to Water*	*Bot. of Casing*	*Bot. of Hole*
NOT RECORDED DURING DRILLING - BORING WAS			
DRILLED BY ROTARY WASH METHOD			

WATER REMARKS:
Piezometer Installed at Completion.

Depth (ft)	*Elev. (ft)*	***DESCRIPTION***	***SOIL*** *Blows per 6"*	*Recovery (in.)*	*Sample No.*	*Hand Penetrometer (tsf)*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	***LAB RESULTS AND REMARKS***
25	959.4												*Liquid Limit, LL*
		Hard, brown and gray SANDSTONE, moderately weathered, intensely fractured (BEREA SANDSTONE). (See Boring FTB-23 for detailed descripition of bedrock encoutnered).											*Plasticity Index, PI*
		Note: No core was obtained from boring; hole was drilled using 3 7/8" tricone and rotary wash method.											*Water Content, W (%)*
30.0													
35													
39.0	891.4												
40		Bottom of Boring - 39.0 '											
45													
50													

ROCK *RQD (%) & Core Length (in.)*	*Recovery (in./%)*	*Run No.*	*Drill rate (min/ft)*	*Bedding*	*Weathering*	*Hardness*	*Discontinuities*	*Fractures / ft*	*Drill Press (psi)*	*H_2S (ppm)* *LEL (%)* *Water Loss, WL (%)*

Dodson-Stilson	Project:	Big Walnut Sewer			LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4			Page 1 of 8
Geologist: K. Smith	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
0	996.3													
0.5	995.8	Topsoil	SOIL	2 2 3	16	1	2.25							
		Very stiff brown SILTY CLAY (CL), little fine to coarse sand; moist.	SOIL	2 3 6	14	2	3.0							
		@ 3.0' - 4.5', shale fragments.	SOIL	4 7 7		3	3.5	19	4	5	9	28	35	LL = 44; PI = 26; W = 20.3%
5	991.3	Sandstone fragments	SOIL	9 50/4		4A 4B								W = 12.9%
5.2		Moderately hard to hard, bluish gray and brown, SANDSTONE, broken, moderately weathered (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN; d:Fe-No; e:Su-No; f:Pl; g:S-SR.	ROCK	0% 102"	86%	1	3:14	TH to TK	MW	MH	J	>5	300	Began coring @ 5.2'
		@ 11.5', becomes predominantly bluish gray.												Packer test ran from 12' - 22' H_2S = 0 ppm; LEL = 0% WL = slight loss
		@ 15.9' - 16.5', dark gray, argillaceous, SHALE, thinly laminated.		24% 120"	100%	2	2:02	TH to TK	MW	MH to H	---	0	300	
		@ 20.7', 0.02' clay seam.									J	1		
		@ 20.85', dark gray, argillaceous, SHALE, with clay.									---	0		H_2S = 0 ppm; LEL = 0%
		@ 21.45' - 21.77';a:90°;b:J;c:VN;d:H;e:Fi; f:Pl;g:SR.												WL = some loss
		@ 22.3', 0.1' clay seam.										0		
		@ 22.6', dark gray, argillaceous, SHALE, thinly laminated.												
		@ 24.35' - 24.50', deformed/wavy, laminae.										4		

Dodson-Stilson	Project:	Big Walnut Sewer			LOG of BORING: ATB-5
					Page 2 of 8
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4			Job No. 9821-6051.00
Geologist: K. Smith	Client:	City of Columbus			Date Started: 4/15/1999
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Finished: 4/20/1999
Size & Type Core Barrel:	NQ_2 wireline		Hammer Drop:	30 in.	

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling.			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
25	971.3	Moderately hard to hard, bluish gray and brown, SANDSTONE, broken, slightly weathered (BEREA SANDSTONE). Typical fractures: a:0°-5°; b:J; c:VN; d:Fe-No; e:Su-No; f:Pl; g:S-SR.		48% 120"	100%	3	2:48	TH to TK	SW	MH to H	J	3 2 4 1 2 0 5 1	300	Packer test ran from 25' - 35'
		@ 25.6', clay seam.												
		@ 26.2', clay seam.												
		@ 29.0', clay seam.												
30		@ 30.2', clay seam.												Unconfined compressive strength from 31.5' to 31.9': 15,568 psi
														H_2S = 0 ppm; LEL = 0% WL = 0%
		@ 33.8';a:45°;b:Sh;c:VN;d:No;e:No;f:Pl; g:Slk (underlain by deformation deposit).									SH	1		
35		@ 34.95' - 35.05', turbidite.		91% 120"	100%	4	3:12	TH to TK	SW	MH to H	---	0	300 to 350	
		@ ~35.5', becomes intact.												
40		@ 40.0' - 40.3', clay seam.												Packer test ran from 40' - 50'
														H_2S = 0 ppm; LEL = 0% WL = 0%
		@ 43.0' - 43.4', turbidite flow structure.												
		@ 44.15', clay seam.		48% 120"	98%	5	2:04	TH to TK	SW	MH to H	---	---	350	
45		@ 44.75', clay seam.												
		@ 46.5', clay seam.												
		@ 47.5', clay seam.												
49.6	946.7													
50		Interbedded shales/sandstone												

Dodson-Stilson	Project:	Big Walnut Sewer			LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4			Page 3 of 8
Geologist: K. Smith	Client:	City of Columbus			Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon	Hammer Wt:	140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel: NQ_2 wireline			Hammer Drop:	30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded Dunng Drilling.			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathenng	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
50	946.3	Interbedded moderately hard dark gray SHALE and light gray hard SANDSTONE (BEREA SANDSTONE/BEDFORD SHALE).		48% 120"	98%	5	2:04	L to TH	SW	MH	---	---	350	H_2S = 0 ppm; LEL = 0% WL = 0%
55		@ 54.45' - 54.92';a:90°;b:J;c:T;d:H;e:Fi; f:Pl. @ 54.5' - 54.9', sandstone lens.									J	1		
				37%* 120"	100%	6	3:10	L to TH	MW to SW	MH to H	---	0	350 to 400	*RQD is actually higher due to mechanical breakage along weak bedding planes
60		@ 60.0' - 60.25', sandstone lens. @ 60.9' - 61.2', sandstone lens. @ 61.76', small pyritic nodules. @ 61.7' - 62.4', sandstone lens.												Packer test ran from 60' - 70' H_2S = 0 ppm; LEL = 0% WL = 0%
65		@ 64.34' - 64.54';a:90°;b:J;c:T;d:No;e:No; f:Pl;g:S. @ 65.35' - 65.65';a:90°;b:J;c:T;d:No;e:No; f:Pl;g:S.									J	1 1		
		@ 67.35', 1" clay seam.		64%* 120"	100%	7	3:10	L to TH	MW to SW	MH to H	---	0	350 to 400	*RQD is actually higher due to mechanical breakage along weak bedding planes
70														H_2S = 0 ppm; LEL = 0% WL = 0%
				78%	100%	8	2:45	L	SW	MH to H	J	2 1		
75		@ 74.5';a:45°;b:J;c:N;d:Cl;e:Pa;f:Pl;g:S.												

Dodson-Stilson	Project:	Big Walnut Sewer	LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4	Page 4 of 8
Geologist: K. Smith	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel: NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%) H_2S (ppm) LEL (%) Water Loss, WL (%)
75	921.3	Interbedded, moderately hard, dark gray, SHALE and light gray, SANDSTONE (BEREA SANDSTONE/BEDFORD SHALE). Very broken throughout run, typical fractures: a:0°-10°;b:J;c:VN; d:Cl;e:Fi;f:Pl;g:S.		78% 120"	100%	8	2:45	L	SW	MH to H	J	2 3 1 1 1 2 1 2	350 to 400	
80		@ 81.45';a:10°;b:J;c:VN;d:Cl;e:Fi;f:Pl;g:S.												Packer test ran from 80' - 90'
		@ 83.7' - 84.5';a:90°;b:J;c:VN;d:Cl;e:Sp; f:St;g:R (cuts through additional fractures)												H_2S = 0 ppm; LEL = 0% WL = 0%
85		@ 84.6', brown siltstone laminae become evident.		76% 120"	100%	9	2:38	L	SW	MH to H	J —	>5 0	Est. 400	Down pressure gauge not working Slight H_2O loss at 85.5' No H_2O return at 87.0'
90		@ 88.25', pyrite nodules.												
95		@ 94.2';a:0°;b:J;c:N;d:Cl;e:Sp;f:Pl;g:S.		94% 120"	95%	10	5:00	L	SW	MH	J —	1 0	Est. 400	H_2S = 0 ppm; LEL = 0%
100														

Dodson-Stilson	Project:	Big Walnut Sewer	LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4	Page 5 of 8
Geologist: K. Smith	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel: NQ_2 wireline	Hammer Drop:	30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
100	896.3													H_2S (ppm) LEL (%) Water Loss, WL (%)
		Interbedded, moderately hard, dark gray, SHALE and light gray, SANDSTONE (BEREA SANDSTONE/BEDFORD SHALE).		94% 120"	95%	10	5:00	L	SW	MH	---	0	Est 400	Slight H_2O loss at 100.2'
103.7	892.6													H_2S = 0 ppm; LEL = 0%
105		Moderately hard, bluish gray, SHALE, unweathered, very thin bedded to laminated; (BEREA SANDSTONE/BEDFORD SHALE).												
		@ 107.6', becomes gray and red.		N/A 120"	N/A	11	4:50	VT to L	SW	MH	---	0	350 to 400	
		@ 109.45';a:0°;b:J;c:N;d:Cl;e:Pa;f:Pl;g:S.												
110		@ 109.65';a:0°;b:J;c:N;d:Cl;e:Pa;f:Pl;g:S.									J	2		
		@ 110.3' - 113.7', occasional contorted beds.									SH	1		Packer test ran from 110' - 168.7'
		@ 110.6' - 110.8', a:60°;b:Sh;c:N;d:No; e:No;f:Pl;g:Slk.									---	0		H_2S = 0 ppm; LEL = 0% WL = 0%
		@ 113.45' - 113.95', a:60°;b:Sh;c:N;d:No; e:No;f:Pl;g:Slk.									SH	1		
115		@ 114.7' - 115.4', highly fractured zone, a:0°;b:J;c:N;d:Cl,e:Pa-Fi;f:Pl;g:S.									J	>5		
				59% 120"	100%	12	5:00	L	SW	S to MH	---	0	350 to 400	
120		@ 119.5';a:20°;b:Sh;c:N;d:No;e:No;f:Pl; g:Slk.									SH	1		
											---	0		
		@ 121.7';a:0°;b:J;c:N;d:Cl;e:Pa;f:Pl;g:S.									J	1		
		@ 122.5';a:0°;b:J;c:N;d:Cl;e:Pa;f:Pl;g:S.										1		H_2S = 0 ppm; LEL = 0% WL = 20% - 30%
125				93%	98%	13	6:30	TH to M	U	MH	---	0		

Dodson-Stilson	Project:	Big Walnut Sewer	LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4	Page 6 of 8
Geologist: K. Smith	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
														H_2S (ppm) LEL (%) Water Loss, WL (%)
125	871.3	Moderately hard, red, SHALE, thin to unweathered (BEDFORD SHALE). @ 125.7';a:50°;b:Sh;c:N;d:No;e:No;f:Pl;g:Slk. @ 127.2', a:45°;b:Sh;c:N;d:No;e:No;f:Pl;g:Slk. @ 127.4', a:45°;b:Sh;c:N;d:No;e:No;f:Pl;g:Slk. @ 127.6', a:45°;b:Sh;c:N;d:No;e:No;f:Pl;g:Slk.	SOIL / ROCK	93% 120"	98%	13	6:30	TH to M	U	S to MH	SH	1 2 1	350 to 400	No H_2O return from 131.0' - 132.5' H_2S = 0 ppm, LEL = 0% WL = 10%
130											---	0		
135				99% 120"	100%	14	4:30	TH to M	SW to U	S to MH	---	0	350 to 400	
140		@ 140.0';a:0°;b:J;c:N;d:Cl;e:Pa-Fi;f:Pl;g:S. @ 140.1';a:0°;b:J;c:N;d:Cl;e:Pa-Fi;f:Pl;g:S. @ 140.25', color change to bluish gray and red interbedded.									J	2		All breaks mechanical except 140.0' & 141.0'
											---	0		H_2S = 0 ppm; LEL = 0% WL = 0%
145		@ 145.5', weathered zone. @ 147.9', color change to bluish gray.		97% 120"	97%	15	8:00	TH to M	U	MH	—	—	400 to 450	4" lost from slippage Slake durability test ran from 148.7' - 150.3'
150														

Dodson-Stilson	Project:	Big Walnut Sewer	LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4	Page 7 of 8
Geologist: K. Smith	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel:	NQ_2 wireline	Hammer Drop: 30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded Dunng Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev. (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	% Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
								GRADATION						Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
150	846.3	Moderately hard, red, SHALE, thin to unweathered (BEDFORD SHALE).		97% 120"	97%	15	8:00	TH to M	U	MH	---	---	400 to 450	Unconfined compressive strength from 149.2' to 149.6': 4,753 psi H_2S = 0 ppm; LEL = 0% WL = 0%
155		@ 157.8' - 158.0', hard brown siltstone with shale interbedds. @ 158.1' - 158.3', hard brown siltstone.		98% 120"	100%	16	5:15	TH to M	U	MH to H	---	---	Est. 400	Slipped 1.9' Run 17, 5' to recover
160		@ 16.0' - 161.9', hard brown siltstone with shale interbedds.												
162.0	834.3	Moderately hard to hard, black, SHALE, thin bedded, unweathered (OHIO SHALE).						L	U	MH to H	---	---	Est. 400	H_2S = 0 ppm; LEL = 0% WL = 0%
165		@ 165.5', becomes pyritic.		100% 60"	100%	17	5:00	L	U	MH to H	---	---	Est. 400	H_2S = 0 ppm; LEL = 0% WL = 0%
170		@ 168.5', 0.05' pyritic nodule. @ 172.0', pyritic nodule.		100% 60"	100%	18	5:04	L	U	MH to H	---	---	Est. 400	Packer test ran from 169' - 200.35' 18" slipped in hole, recovered on Run 19 H_2S = 0 ppm; LEL = 0% WL = 0%
175														Slake durability test ran from 173.7' - 175.3'

Dodson-Stilson	Project:	Big Walnut Sewer	LOG of BORING: ATB-5
Driller: K. Conrad	Location:	N 768385.8 E 1867732.4	Page 8 of 8
Geologist: K. Smith	Client:	City of Columbus	Job No. 9821-6051.00
Drill Equip: CME 75	Sampler:	2" split spoon Hammer Wt: 140 lbs.	Date Started: 4/15/1999
Size & Type Core Barrel: NQ_2 wireline		Hammer Drop: 30 in.	Date Finished: 4/20/1999

WATER LEVELS

Date	Depth to Water	Bot. of Casing	Bot. of Hole
No Water Levels Recorded During Drilling			

WATER REMARKS: Piezometer tip set at 169.8' - 199.8'
Groundwater depth - 171.3' (10/29/99)

Depth (ft)	Elev (ft)	DESCRIPTION	SOIL / ROCK	Blows per 6" / RQD (%) & Core Length (in.)	Recovery (in.) / Recovery (in./%)	Sample No. / Run No.	Hand Penetrometer (tsf) / Drill rate (min/ft)	GRADATION: % Aggregate / Bedding	% C. Sand / Weathering	% M. Sand / Hardness	% F. Sand / Discontinuities	% Silt / Fractures / ft	% Clay / Drill Press (psi)	LAB RESULTS AND REMARKS
														Liquid Limit, LL Plasticity Index, PI Water Content, W (%)
175	821.3	Moderately hard to hard, black, SHALE, thin bedded, pyritic, unweathered (OHIO SHALE). @ 176.0', pyritic nodule. @ 178.4', very thin, partial cone in cone structure. @ 178.4' - 178.95', contains pyritic laminae. @ 179.25', limestone laminae. @ 180.0', pyrite nodule. @ 180.3' - 180.37', pyritic/iron stone concretion. @ 181.9' - 182.1', pyritic nodule.		100% 60"	100%	19	5:12	L	U	MH to H	---	---	Est. 400	Unconfined compressive strength from 174.0' to 174.4': 10,708 psi H_2S = 0 ppm; LEL = 0% WL = 0%
180				98% 120"	98%	20	5:20	L	U	MH to H	---	---	Est. 400	Loss 2" to slip
185		@ 184.9', pyritic laminae. @ 186.05', pyritic nodule. @ 188.55', pyrite nodule with marcasite.												H_2S = 0 ppm; LEL = 0% WL = 0%
190		@ 189.7' , pyritic nodule. @ 190.7' , pyritic nodule.		100% 120"	100%	21	5:06	L	U	MH to H	---	---	Est. 400	Loss of 23" due to slip, recovered on Run 22
195		@ 195.05', limestone laminae. @ 195.95', pyritic nodule.												H_2S = 0 ppm; LEL = 0% WL = 0%
200.3	796.0	Bottom of Boring @ 200.35'		100% 20"	100%	22	5:40	L	U	MH to H	---	---		H_2S = 0 ppm; LEL = 0% WL = 0%

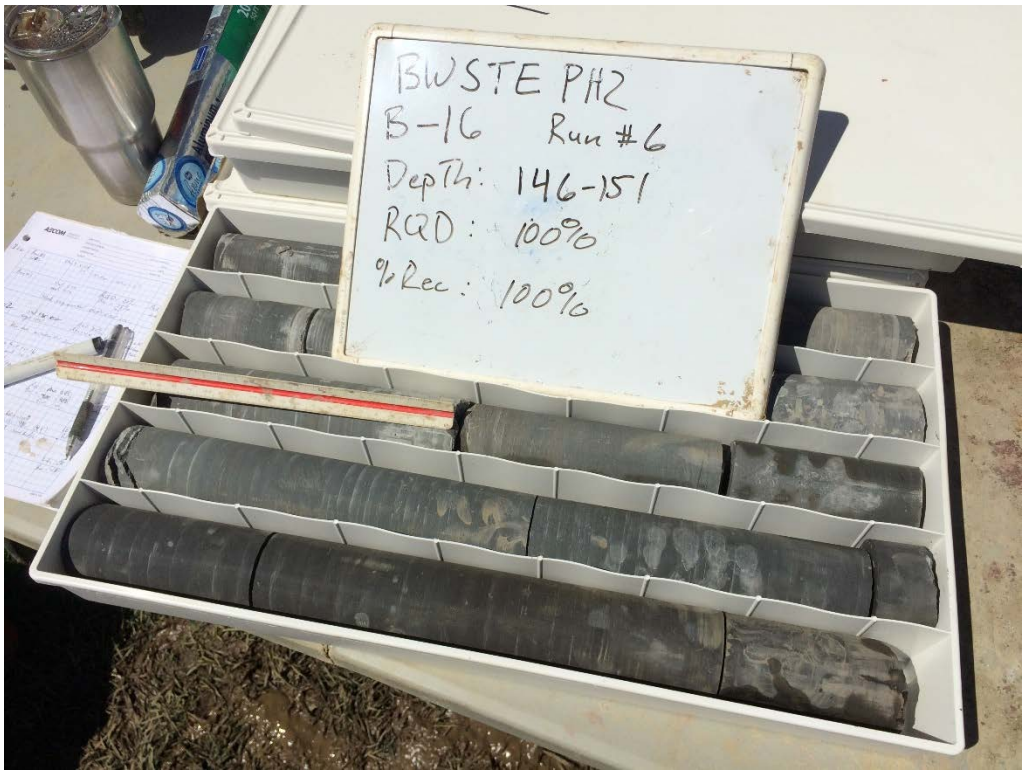
Appendix C BEDROCK CORE PHOTO LOGS

BORING B-16 ROCK CORE PHOTO LOG

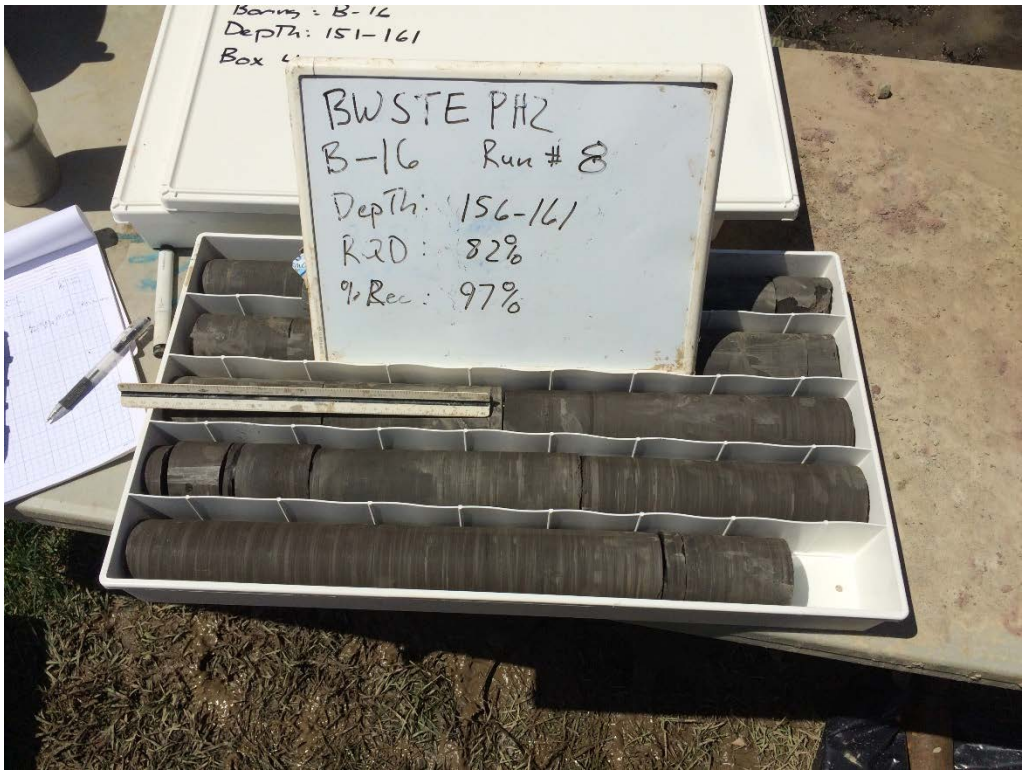

Box 2 of
BWSTE PH2
B-16 Run # 3
Depth: 131-136
RQD: 96%
% Rec: 100%

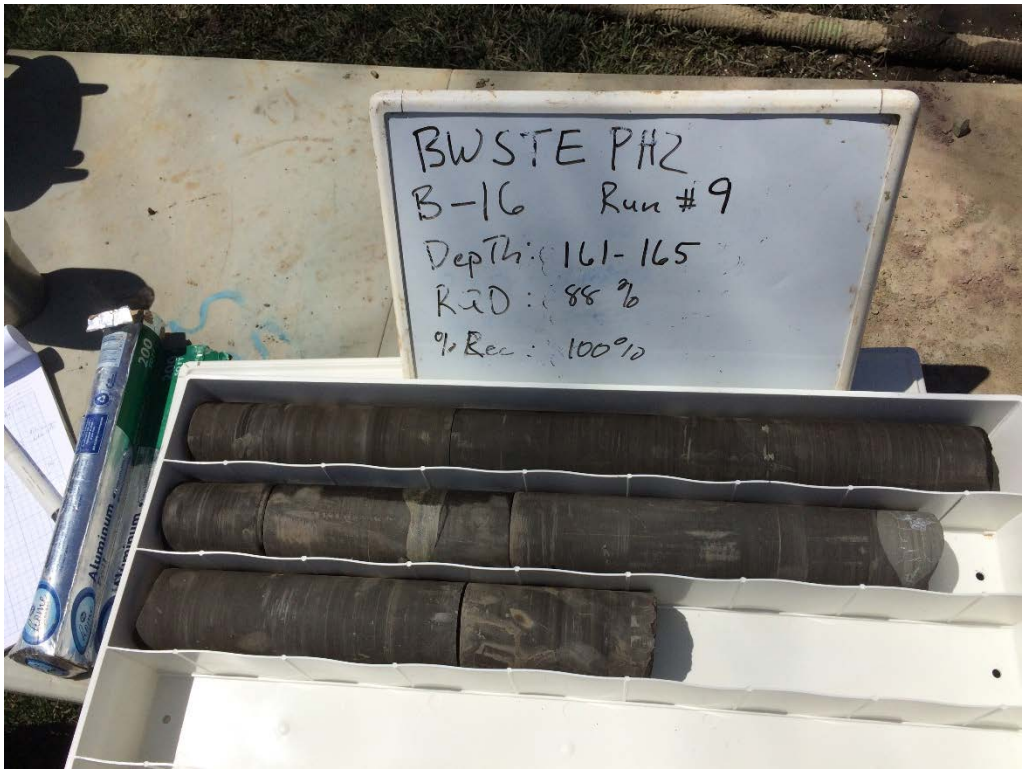

BWSTE PH2
B-16 Run # 4
Depth: 136-141
RQD: 98%
% Rec: 100%


BWSTE PH2
B-16 Run #5
Depth: 141-146
RQD: 100%
%Rec: 98%

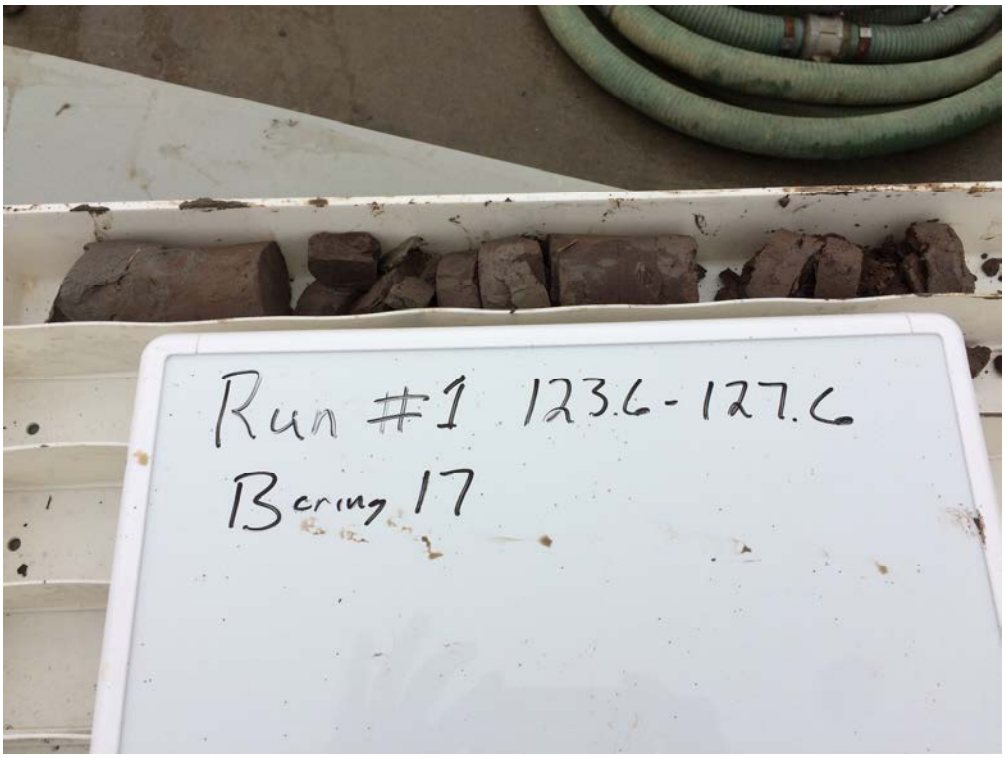

BWSTE PH2
B-16 Run #6
Depth: 146-151
RQD: 100%
%Rec: 100%


Project: BWSTE PHZ
Box 4
BWSTE PHZ
B-16 Run # 7
DepTh: 151-156
RQD: 100%
%Rec: 100%


DepTh: 151-161
BWSTE PHZ
B-16 Run # 8
DepTh: 156-161
RQD: 82%
%Rec: 97%

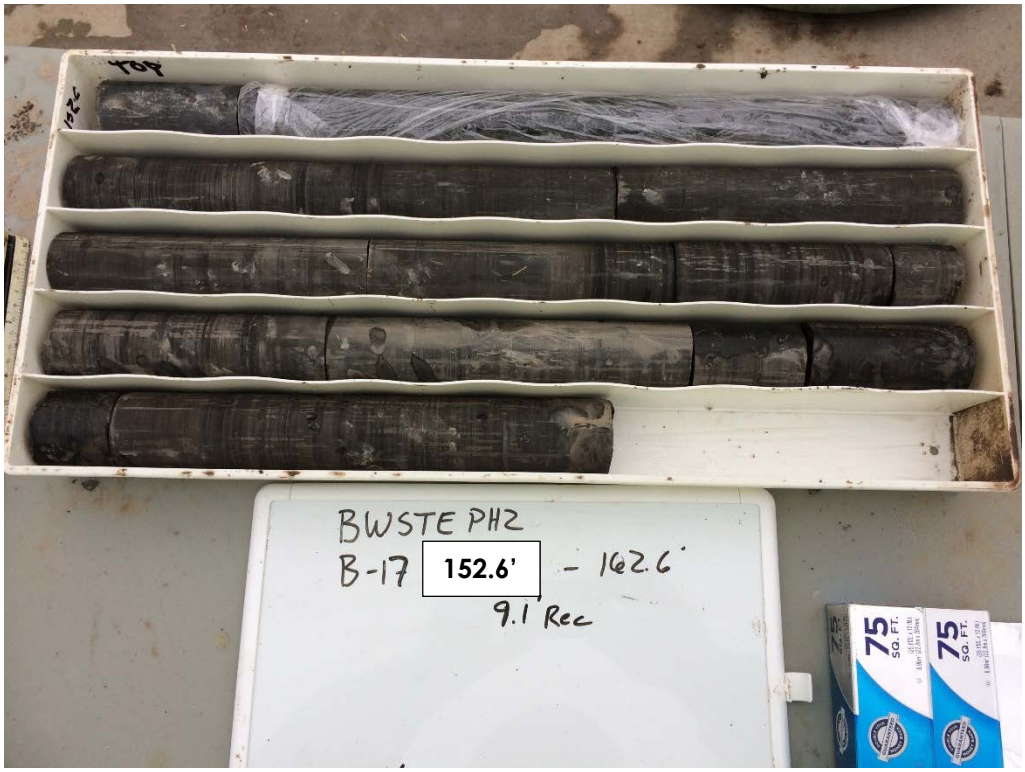

BWSTE PH2
B-16 Run #9
Depth: 161-165
RQD: 88 %
% Rec: 100%

BORING B-17 ROCK CORE PHOTO LOG




BWSTE PhaseII
Boring 17 132.6- 142.6'
9.5' Rec


TOP
BWSTE PH2
B-17 142.6-152.6
10' Rec

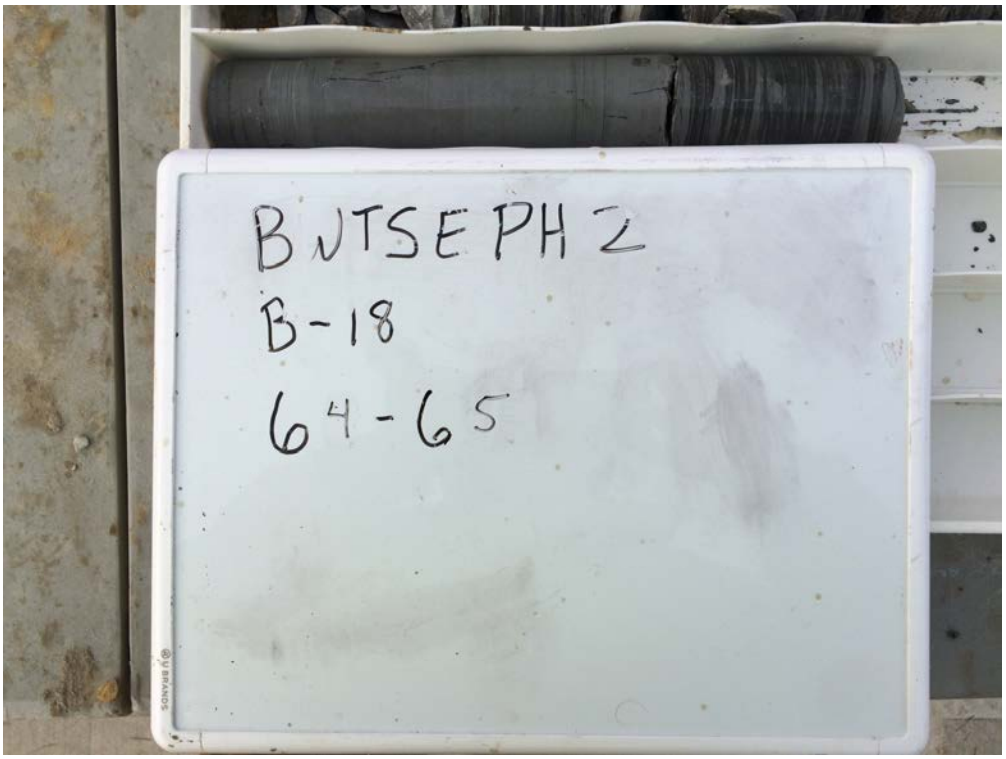

TOP
BWSTE PHZ
B-17 152.6' - 162.6'
9.1 Rec
75 SQ. FT.
75 SQ. FT.


Top
BWSTE PHZ
B-17 162.6 - 172.6
10' Rec


BW STE PH2
B-17
172.6' – 180.6'
7.5 10' Rec

Stantec

BORING B-18 ROCK CORE PHOTO LOG




BJTSEPH 2
B-18
65-70

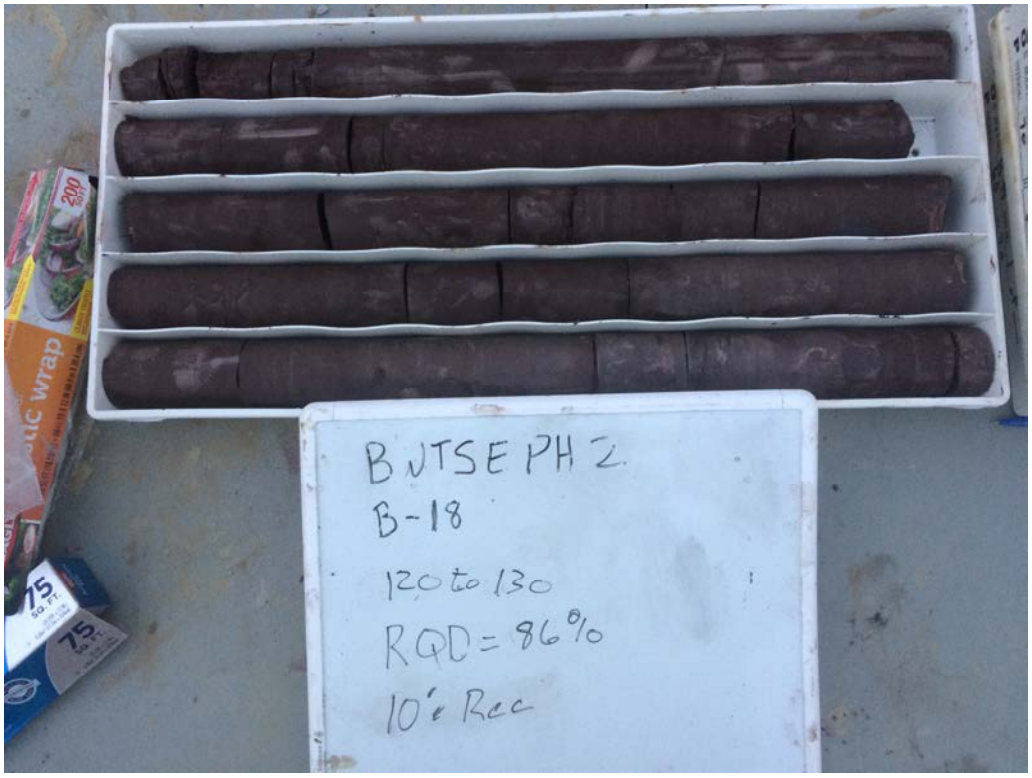

BJTSEPH 2
B-18
70-80'
ROD = 12%


BNTSEPH 2
B-18
80 to 90
RQD = 35%
10' Rec


BNTSEPH 2
B-18
90 to 100
RQD = 42.5
10' Rec


BNTSE PH 2.
B-18
100 – 110
RQD = 44%
9.9' Rec


BNTSE PH 2.
B-18
110 to 120
RQD = 65%
10'e Rec

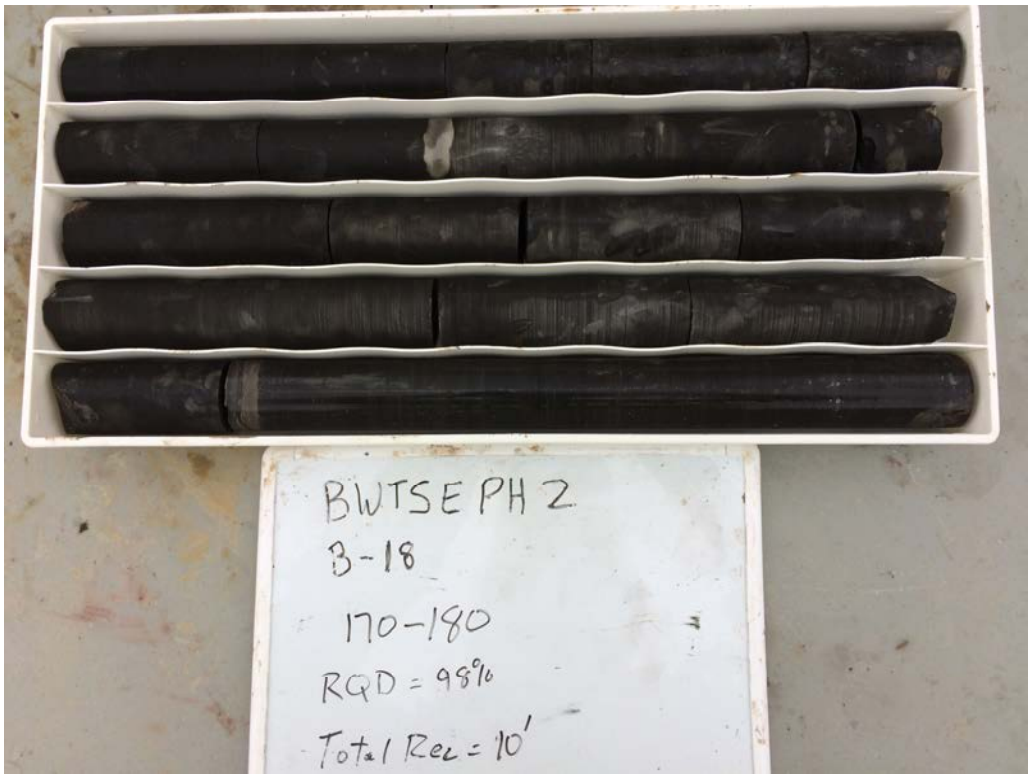

BWTSE PH 2
B-18
120 to 130
RQD = 86%
10' Rec


BWTSE PH 2
B-18
130 - 140' Run 10
RQD : 94%
Rec = 10'


BWTSE PH 2
B-18
140 - 150
Run 11
RQD = 95%
Total Rec = 10'


ALUMINUM FOIL
BWTSE PH 2
B-18
150 - 160
RQD = 97%

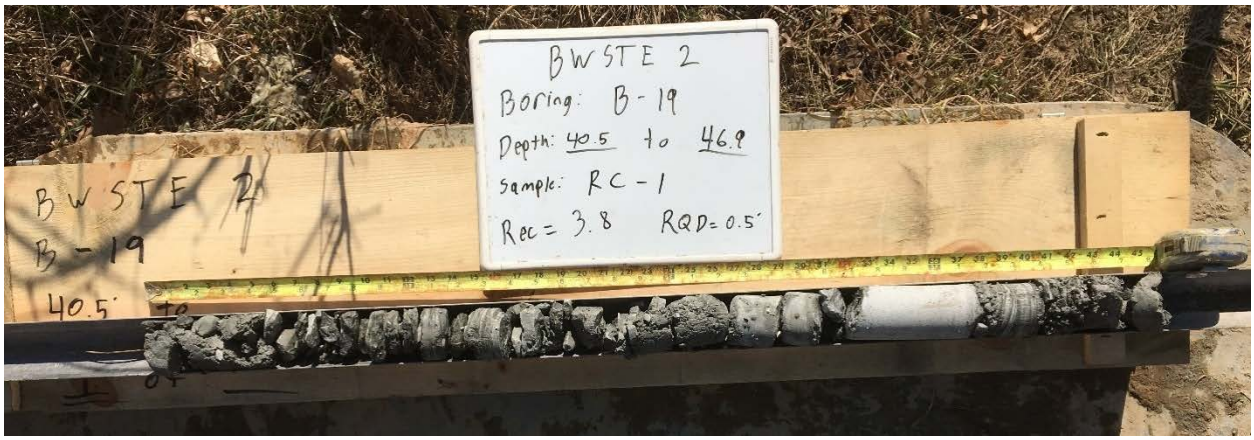

BWTSE PH 2
B-18
160-170
RQD = 100
Total Rec = 9.75

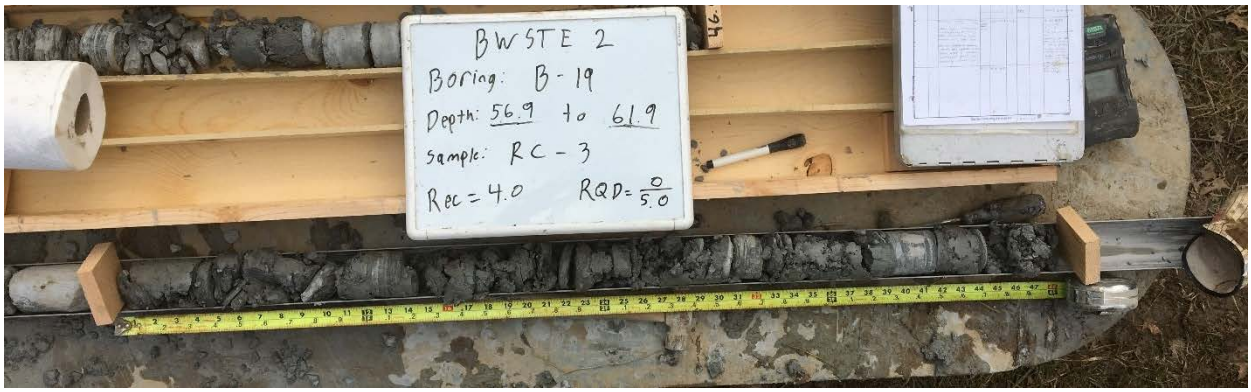

BWTSE PH 2
B-18
170-180
RQD = 98%
Total Rec = 10'

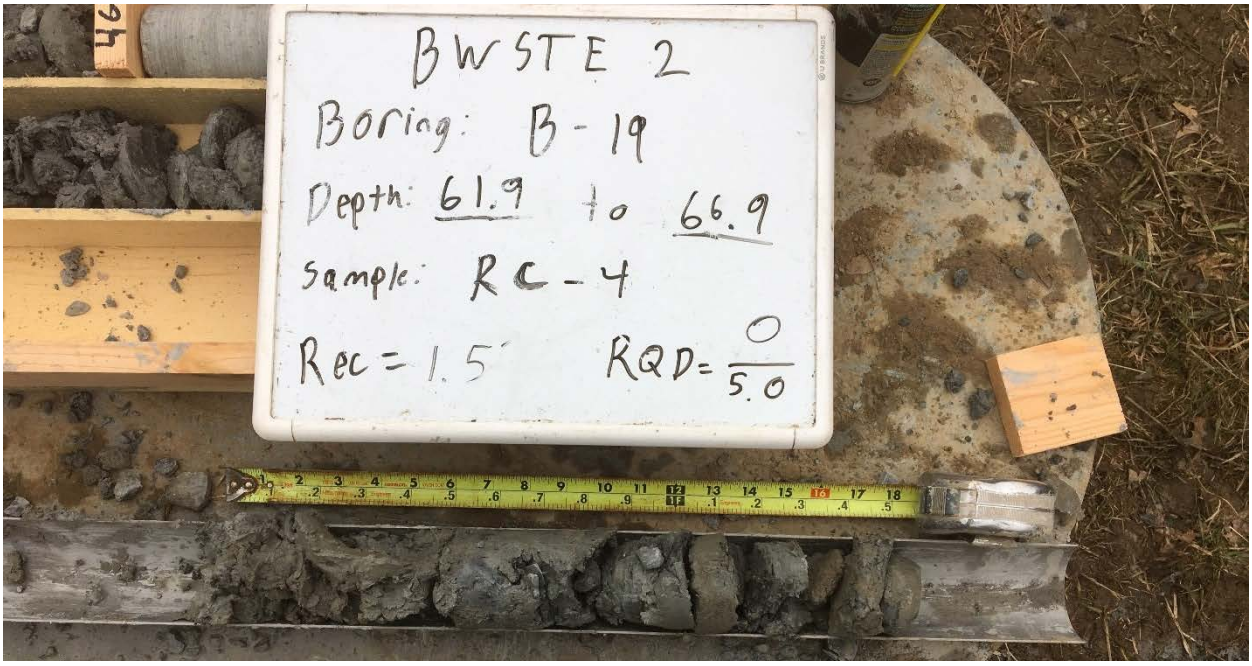

BWTSE PH 2
B-18
180-185
RQD = 100%
Total Rec = 5'

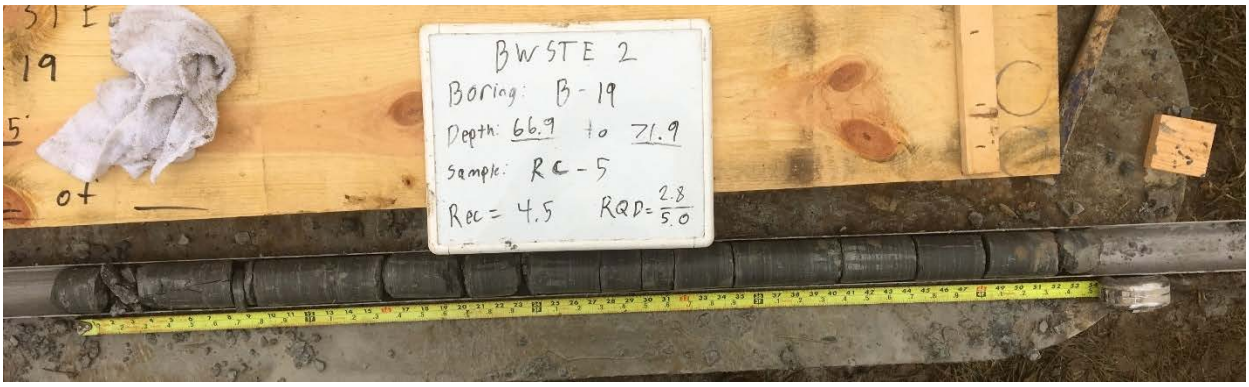
Stantec

BORING B-19 ROCK CORE PHOTO LOG

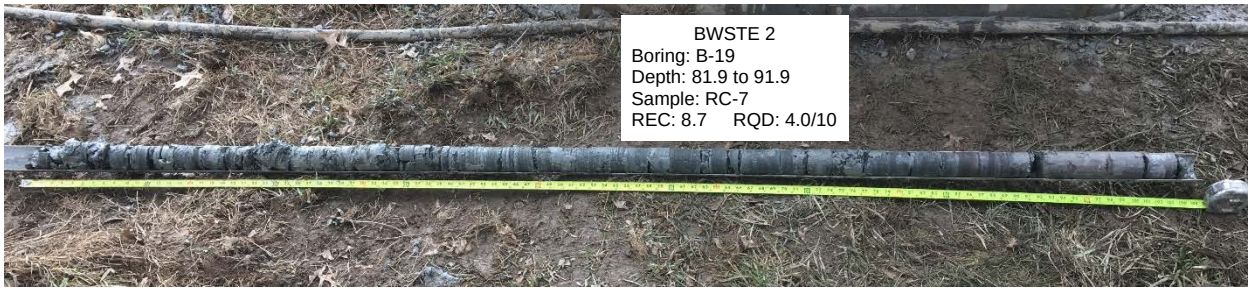





BWSTE 2
Boring: B-19
Depth: 61.9 to 66.9
Sample: RC-4
Rec = 1.5'
RQD = 0/5.0


BWSTE 2
Boring: B-19
Depth: 66.9 to 71.9
Sample: RC-5
Rec = 4.5
RQD = 2.8/5.0


BWSTE 2
Boring: B-19
Depth: 71.9 to 81.9
Sample: RC-6
REC: 9.6 RQD: 3.6/10

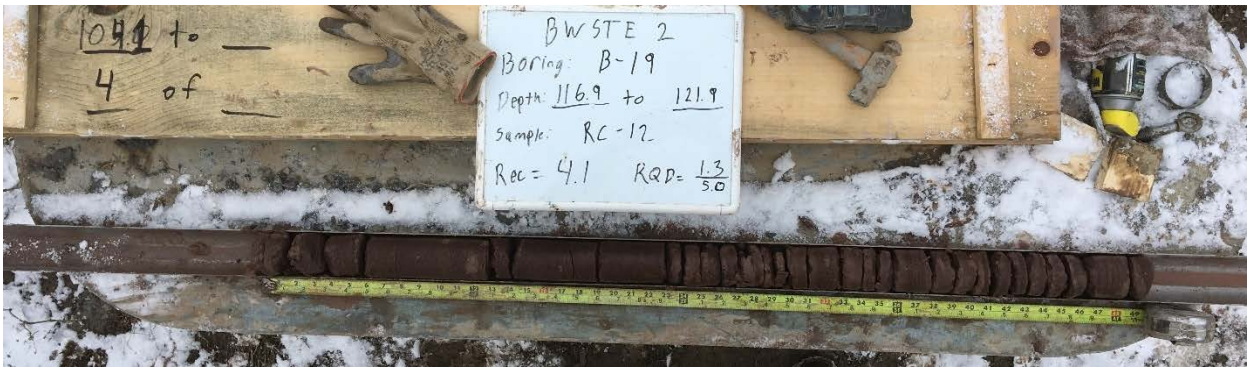

BWSTE 2
Boring: B-19
Depth: 81.9 to 91.9
Sample: RC-7
REC: 8.7 RQD: 4.0/10


BWSTE 2
Boring: B-19
Depth: 91.9 to 101.9
Sample: RC-8
Rec = 5.2' RQD = 2.0/10


BWSTE 2
Boring: B-19
Depth: 101.9 to 106.9
Sample: RC-9
Rec = 5.0 RQD = 0/5.0

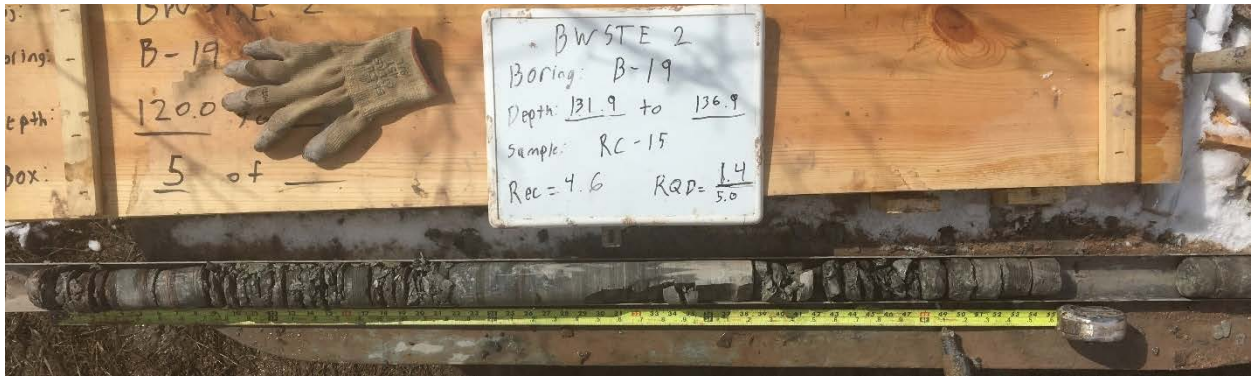

BWSTE 2
Boring: B-19
Depth: 106.9 to 111.9
Sample: RC-10
Rec = 4.6 RQD = 0/5.0


BWSTE 2
Boring: B-19
Depth: 111.9 to 116.9
Sample: RC-11
Rec = 4.6 RQD = 0.5/5.0


104.1 to
4 of
BWSTE 2
Boring: B-19
Depth: 116.9 to 121.9
Sample: RC-12
Rec = 4.1 RQD = 1.3/5.0

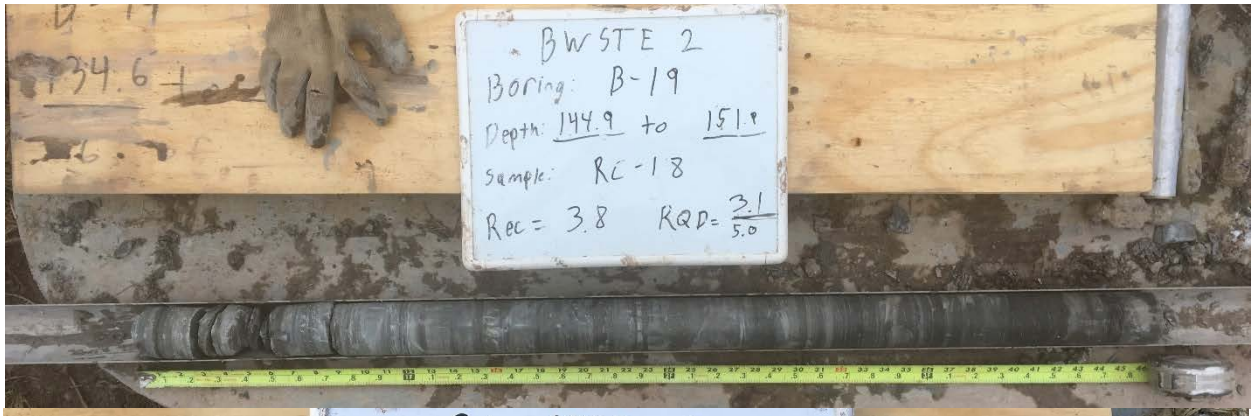

Depth:
Box:
120.0 to
5 of
BWSTE 2
Boring: B-19
Depth: 121.9 to 126.9
Sample: RC-13
Rec = 5.0' RQD = 0.7/5.0


BWSTE 2
Boring: B-19
Depth: 126.9 to 131.9
Sample: RC-14
Rec = 5.5 RQD = 1.9/5.0


B-19
120.0
5 of
BWSTE 2
Boring: B-19
Depth: 131.9 to 136.9
Sample: RC-15
Rec = 4.6 RQD = 1.4/5.0


BWSTE 2
Boring: B-19
Depth: 136.9 to 141.9
Sample: RC-16
Rec = 4.5 RQD = 2.1/5.0


B-19
134.6 to
BWSTE 2
Boring: B-19
Depth: 141.9 to 146.9
Sample: RC-17
Rec = 5.4 RQD = 1.9/5.0


BWSTE 2
Boring: B-19
Depth: 144.9 to 151.9
Sample: RC-18
Rec = 3.8 RQD = 3.1/5.0

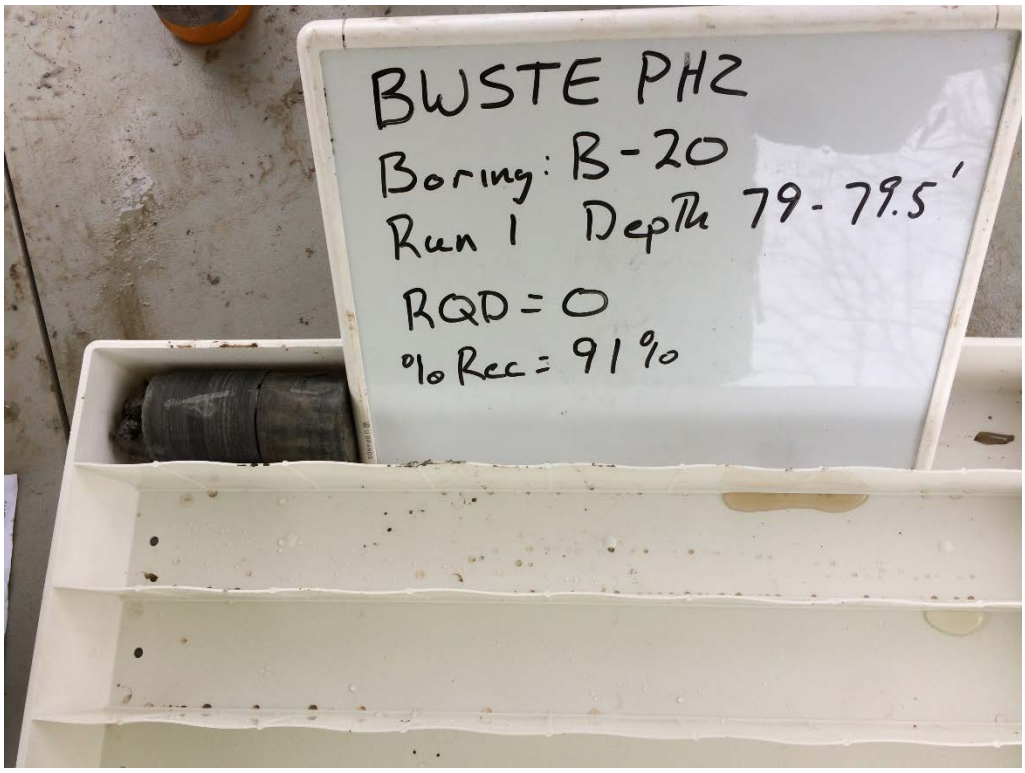

BWSTE 2
Boring: B-19
Depth: 144.9 to 151.9
Sample: RC-18
Rec = 3.8+0.7 = 4.5
RQD = 3.1+.3/5.0 = 3.4/5.0


BWSTE 2
Boring: B-19
Depth: 151.9 to 161.9
Sample: RC-19
REC: 10.2 RQD: 5.2/10


BWSTE 2
Boring: B-19
Depth: 161.9 to 171.9
Sample: RC-20
REC: 9.5 RQD: 9.1/10


BWSTE 2
Boring: B-19
Depth: 171.9 to 181.9
Sample: RC-21
Rec = 9.6 RQD = 64/10'
BWSTE 2
Boring: B-19
Depth: 171.9 to 181.9
Sample: RC-21
Rec = 9.6 RQD = 64/10'

BORING B-20 ROCK CORE PHOTO LOG




BWSTE PHZ
Boring: B-20
Run 3 Depth 84.5-89.5
RQD = 78%
%Rec = 92%


BWSTE PHZ
Boring: B-20
Run 4 Depth 89.5-94.5
RQD = 73%
%Rec = 100%


BWSTE PHZ
Boring: B-20
Run 5 Depth: 94.5-99.5
RQD = 60%
% Rec = 100%

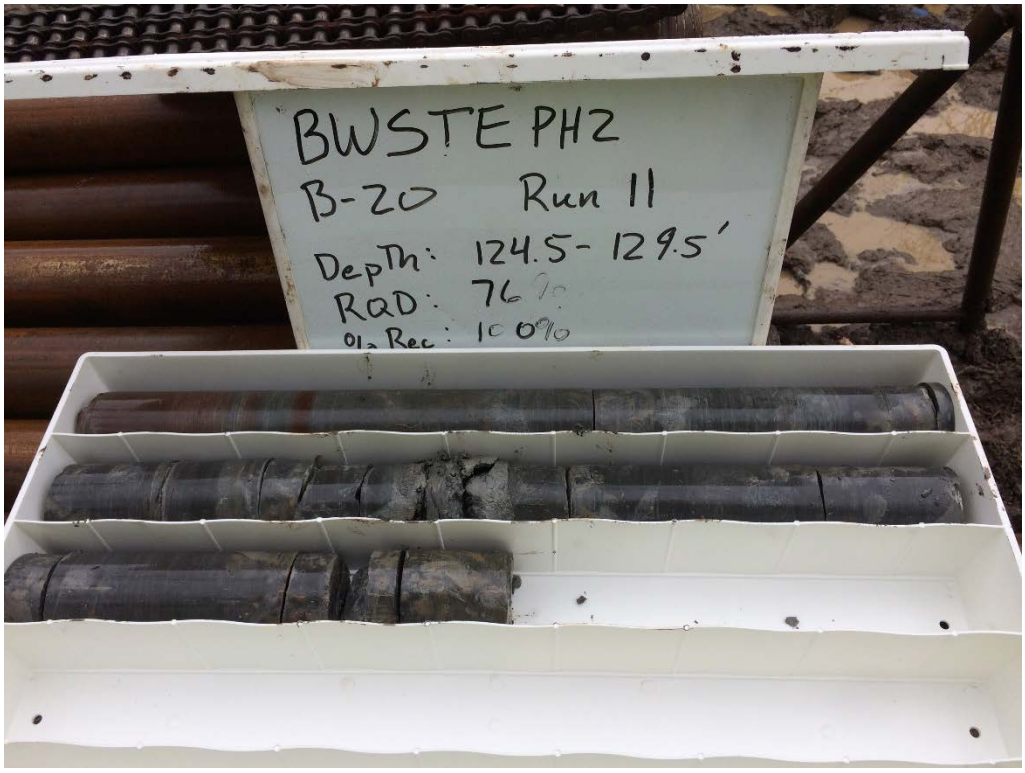

BWSTE PHZ
Boring: B-20
Run 6 Depth: 99.5-104.5
RQD = 99%
% Rec = 94%


BWSTE PH2
Boring: B-20
Run 7 Depth: 104.5-109.5
RQD = 60%
%Rec = 100%


BWSTE PH2
Boring: B-20
Run 8 Depth: 109.5-114.5
RQD = 76 %
%Rec = 94%


BWSTE PHZ
Boring: B-20
Run 9 Depth: 114.5-119.5
RQD = 50%
%Rec = 100%


BWSTE PHZ
Boring: B-20
Run 10 Depth: 119.5-124.5
RQD = 76%
%Rec = 99%

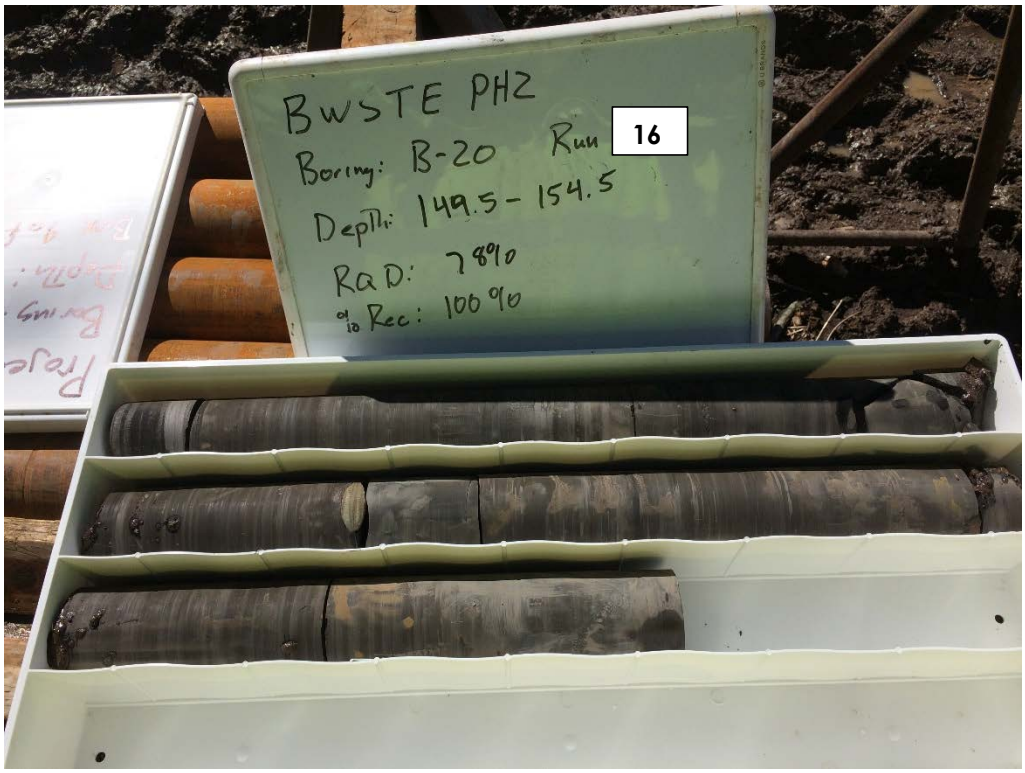

BWSTE PH2
B-20 Run 11
Depth: 124.5- 129.5'
RQD: 76%
% Rec: 100%


BWSTE PH2
Boring: B-20 Run 12
Depth: 129.5- 134.5
RQD: 65%
% Rec: 100%


BWSTE PH2
Boring: B-20 Run 13
Depth: 134.5 - 139.5
RQD: 75%
% Rec: 90 %


BWSTE PH2
Boring: B-20 Run 14
Depth: 139.5 - 144.5
RQD: 95%
% Rec: 100 %


BWSTE PH2
Boring: B-20 Run 15
Depth: 144.5 - 149.5
RQD: 83%
% Rec: 100%


BWSTE PH2
Boring: B-20 Run 16
Depth: 149.5 - 154.5
RQD: 78%
% Rec: 100%


BWSTE PHZ
Boring: B-20 Run 17
Depth: 154.5 - 159.5
RQD: 92%
% Rec: 98%

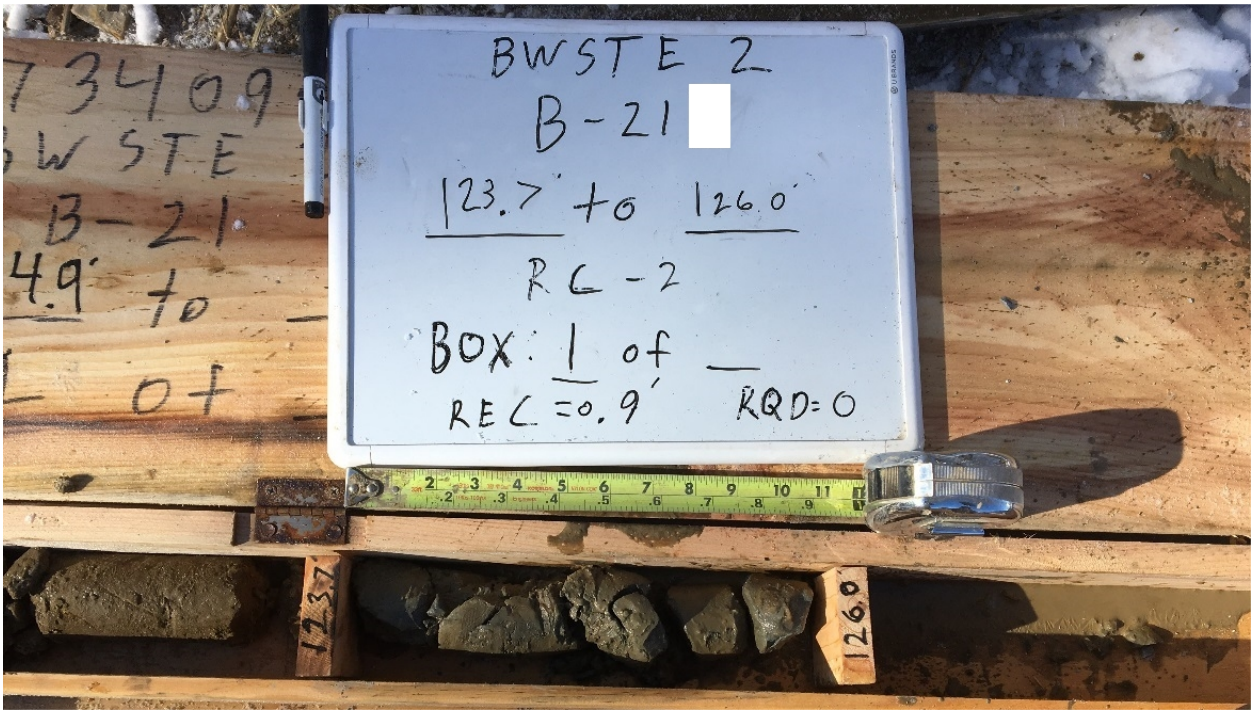

BWSTE PHZ
Boring: B-20 Run 18
Depth: 159.5 - 164.5
RQD: 93%
% Rec: 99%


BWSTE PH2
Boring: B-20 Run 19
Depth: 164.5 - 169.5
RQD: 78%
% Rec: 99%

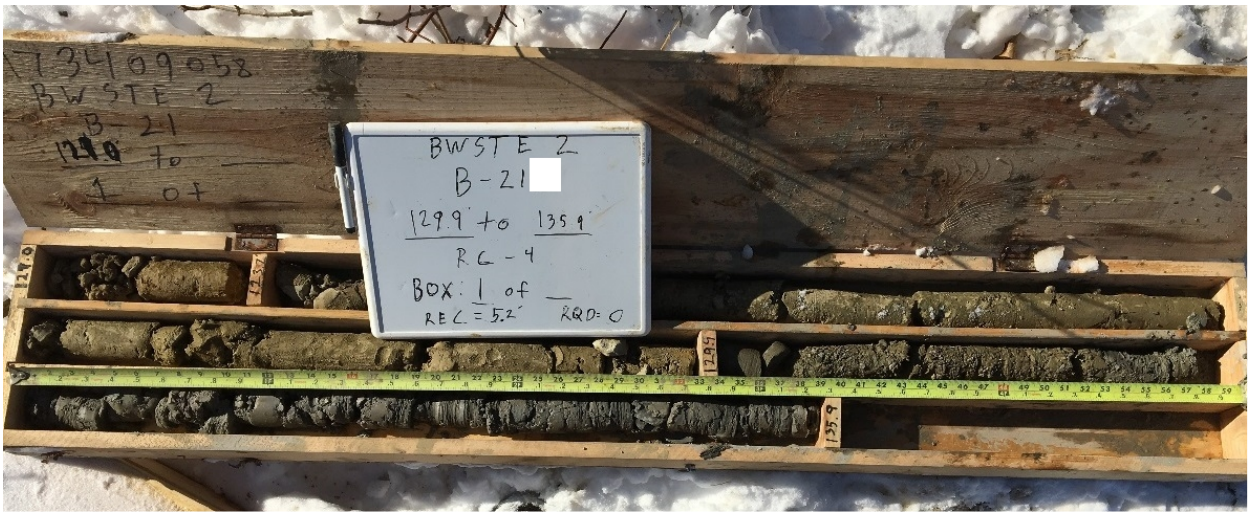

BWSTE PH2
Boring: B-20 Run 20
Depth: 169.5 - 174.5
RQD: 67%
% Rec: 97%


BWSTE PH2
Boring: B-20 Run 21
Depth: 174.5 - 178'
RQD: 67%
% Rec: 100 %

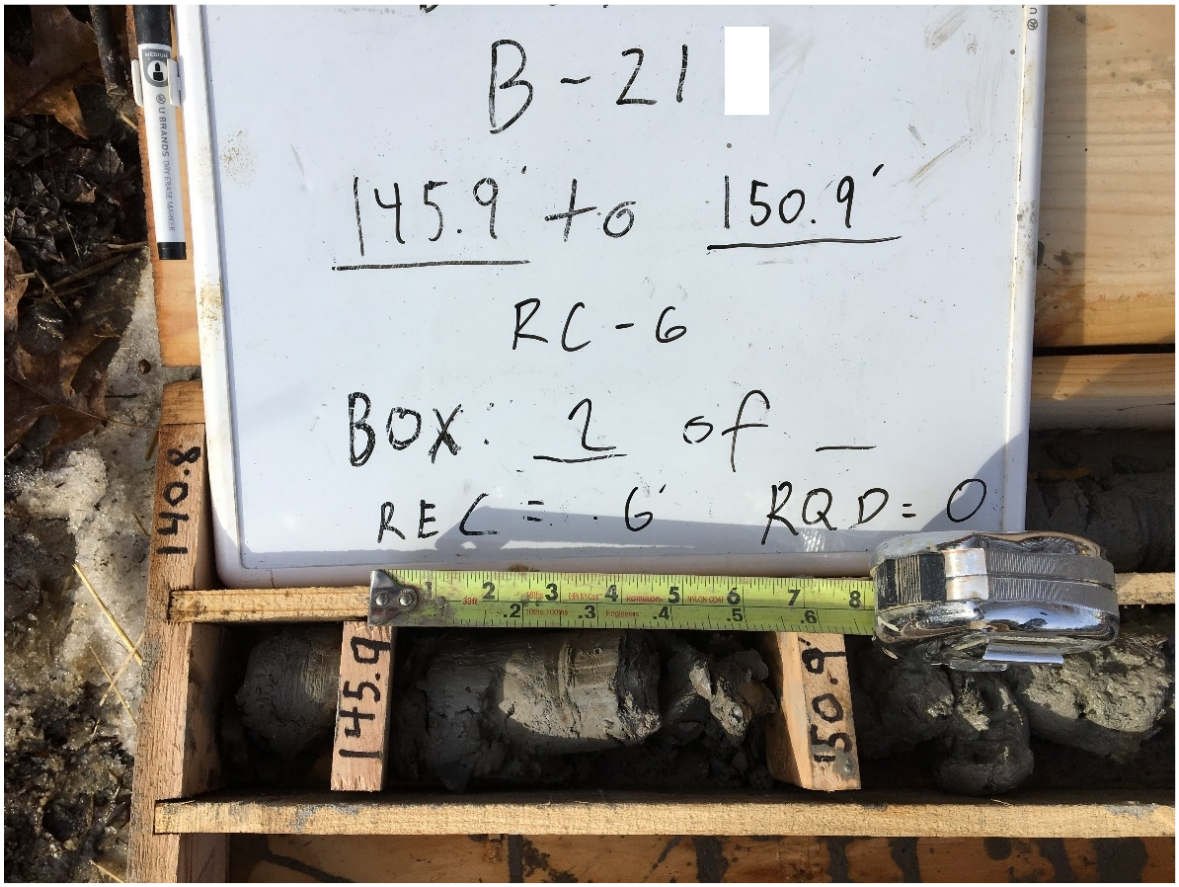
BORING B-21 ROCK CORE PHOTO LOG




BWSTE 2
B-21
126.0 to 129.9
RC-3
BOX: 1 of
REC=5.8
RQD=0


BWSTE 2
B-21
129.9 to 135.9
RC-4
BOX: 1 of
REC=5.2
RQD=0


BWSTE 2
B-21
135.9 to 145.9
RC-5
REC=6.9
RQD=0


B-21
145.9' to 150.9'
RC-6
BOX: 2 of _
REC = 6' RQD = 0
140.8
145.9
150.9


BWSTE 2
B-21
150.9' to 151.6'
RC-7
BOX: 2 of _
REC = 1.9' RQD = 0
150.9
151.6


BWSTE 2
B-21
151.6 to 155.9'
RC-8
BOX 2 of
REC=3.9 RQD=1.5


BWSTE 2
B-21
155.9 to 160.9'
RC-9
BOX 2 of
REC=2.3' RQD=0
160.9'


BWSTE 2
B-21
160.9 to 165.9'
RC-10
BOX 3 of
REC=5.0 RQD=34


1734 09058
BWSTE 2
B-21
160.9 to
3 of
BWSTE 2
B-21
165.9 to 170.9'
RC-11
BOX 3 of
REC=5.0 RQD=2.3


BWSTE 2
B-21
170.9 to 180.9'
RC-12
BOX 3&4 of 4
REC=10' RQD=85
BWSTE 2
B-21
170.9 to 180.9'
RC-12
BOX 3&4 of 4
REC=10' RQD=85

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BORING B-21B ROCK CORE PHOTO LOG


W-15-012
B-21 B
RC-4 173-178'


W-15-012
B-21 B
RC-4 173-178'


W-15-012
B-21 B
RC-5 : 178'-188'


W-15-012
B-21 B
RC-5 : 178'-188'


W-15-012
B-21 B
RC-6 188-198'

Stantec

BORING B-22 ROCK CORE PHOTO LOG


BWSTE 2
Boring: B-22
Depth: 141.4 to 146.4
Sample: RC-3
REC. 5.0 RQD: 0/50


BWSTE 2
Boring: B-22
Depth: 146.4 to 151.4
Sample: RC-4
REC. 3.5 RQD: 0/50


BWSTE2
B-22
151.4 to
BWSTE 2
Boring: B-22
Depth: 151.4 to 156.4
Sample: RC-5
REC. 4.5 RQD: 2.6/5.0


BWSTE2
B-22
151.4 to
2 of
BWSTE 2
Boring: B-22
Depth: 156.4 to 161.4
Sample: RC-6
REC. 5.2 RQD: 2.4/5.0


BWSTE2
B-22
151.4 to
2 of
BWSTE 2"
Boring: B-22
Depth: 161.4 to 166.4
Sample: RC-7
REC. 50"
RQD: 10/5


BWSTE 2
B-22
166.4 to
3 of
BWSTE 2"
Boring: B-22
Depth: 166.4 to 171.4
Sample: RC-8
REC. 4.3
RQD: 3.7/5
.7 Sample

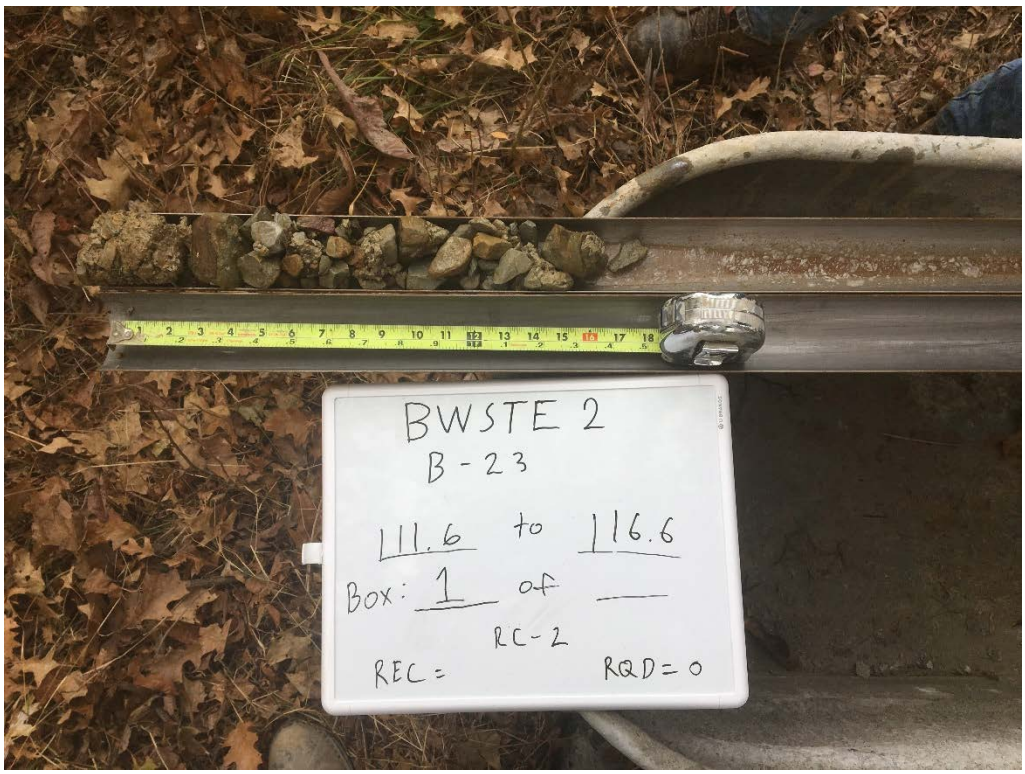

BWSTE 2
B-22
166.4 to
3 of
BWSTE 2
Boring: B-22
Depth: 171.4 to 176.4
Sample: RC-9
REC: 5.3 RQD: 31/50


BWSTE 2
B-22
166.4 to
3 of
BWSTE 2
Boring: B-22
Depth: 176.4 to 181.4
Sample: RC-10
REC: 4.6 RQD: 21/50


BWSTE 2
B-22
4 of
BWSTE 2
Boring: B-22
Depth: 181.4 to 186.4
Sample: RC-11
REC: 4.8 RQD- 19/50


BWSTE 2
B-22
4 of
BWSTE 2
Boring: B-22
Depth: 186.4 to 191.4
Sample: RC-12
REC: 4.6 RQD- 35/50

BORING B-23 ROCK CORE PHOTO LOG




BWSTE 2
B-23
116.6 to 121.6
Box: 1 of
RC-3
REC=29
RQD=0

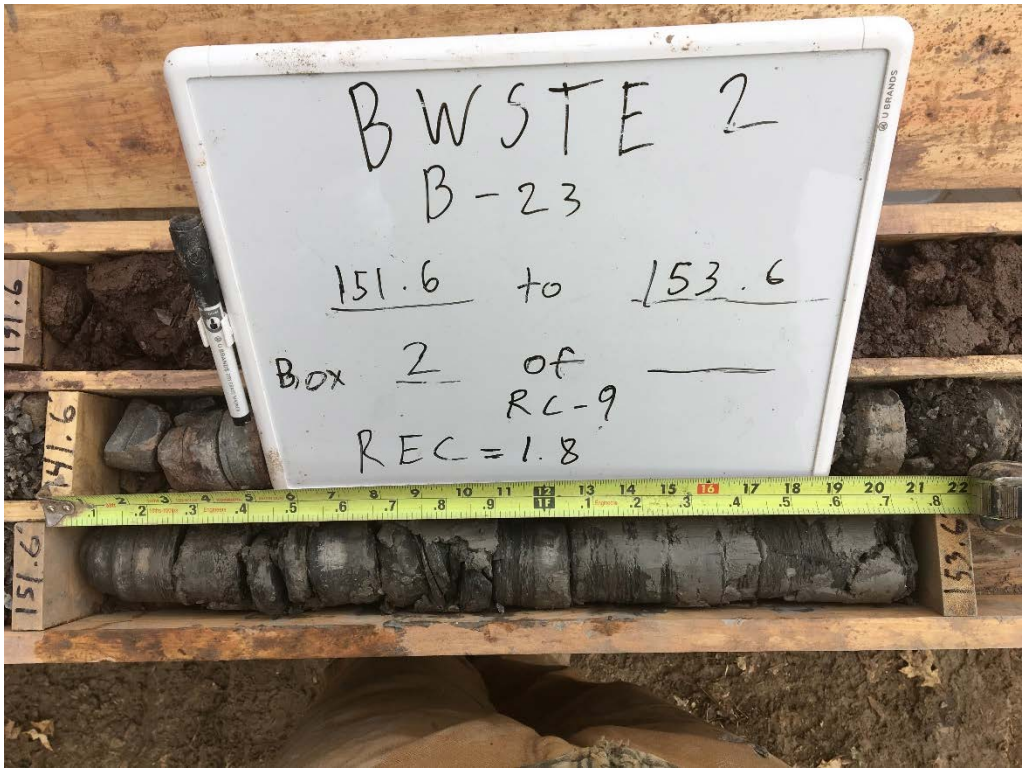

BWSTE 2
B-23
121.6 to 126.6
Box: 1 of
RC-4
REC=25
RQD=


BWSTE 2
B-23
126.6' to 131.6'
Box 1 of
RC-5
REC. = 7.5' RQD = 4.1


1734090S8
BWSTE 2
B-23
130.6 to
2 of
BWSTE 2
B-23
131.6 to 141.6
Box 2 of
RC-6
REC.=5.0'
RQD=


9058
BWSTE 2
B-23
141.6 to 146.6
Box 2 of
RC-7
REC: 3.4'
RQD=


BWSTE 2
B-23
146.6 to 151.6
Box 2 of
RC-8
REC=1.2'


BWSTE 2
B-23
151.6 to 153.6
Box 2 of
RC-9
REC = 1.8
151.6
153.6


BWSTE 2
B-23
153.6 to 156.6
Box 2&3 of
RC-10
REC = 2.7


173409058
BWSTE 2
155.2' to
B-23
3 of
BWSTE 2
B-23
156.6 to 161.6
Box 3 of
RC-11
REC = 5.0'


173409058
BWSTE 2
155.2' to
B-23
3 of
BWSTE 2
B-23
161.6 to
BOX: 3 of
RC-12
REC = 5.0'


BWSTE 2
B-23
166.6 to 171.6
BOX: 3 of 4
RC-13
REC = 5.0


173409058
BWSTE 2
B-23
170.3 to
4 of
BWSTE 2
B-23
171.6 to 176.6
BOX: 4 of
RC-14
REC = 5.0'


173409058
BWSTE 2
B-23
170.3
4
BWSTE 2
B-23
176.6 to 181.6
BOX: 4 of
RC-15
REC=4.8


BWSTE 2
B-23
181.6 to 186.6
BOX: 4&5 of 5
RC-16
REC=4.2'


BWSTE 2
B-23
186.6 to 191.6
BOX: 5 of 5
RC-17
REC = 4.9'

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BORING B-24 ROCK CORE PHOTO LOG


BWSTE 2
Boring: B-24
Depth: 101.4' to 106.4
Sample: RC-4
REC = 4.6 RQD = 1.1/5.0


BWSTE 2
Boring: B-24
Depth: 106.4' to 111.4
Sample: RC-5
REC = 5.0 RQD = 1.4/5.0
Proj: BWSTE
B-24
Depth: 105.4 to


BWSTE 2
Boring: B-24
Depth: 111.4' to 116.4
Sample: RC-6
REC = 5.0 RQD = 2.5/5.0
Proj: BWSTE 2
B-24
Depth: 105.4 to


Proj: BWSTE 2
Boring: B-24
Depth: 105.4 to
BWSTE 2
Boring: B-24
Depth: 116.4 to 121.4
Sample: RC-7
REC = 5.0 RQD = 1.0/5.0


Proj:
Boring:
BWSTE 2
B-24
BWSTE 2
Boring: B-24
Depth: 121.4 to 126.4
Sample: RC-8
REC = 5.0 RQD = 0.8/5.0


Proj:
Boring:
Depth:
Box
BWSTE 2
B-24
120.2 to
3 of
BWSTE 2
Boring: B-24
Depth: 126.4 to 131.4
Sample: RC-9
REC = 4.6 RQD = 1.3/5.0


BW ST E 2
B-24
120.2 to
3 of
BW ST E 2
Boring: B-24
Depth: 131.4 to 136.4
Sample: RC-10
REC = 3.2
RQD = 0/5.0


120.2
121.4
126.4
131.4
136.4
BW ST E 2
Boring: B-24
Depth: 136.4 to 141.4
Sample: RC-11
REC = 5.0
RQD = 32/5.0


BW STE 2
Boring: B-24
Depth: 141.4' to 146.4
Sample: RC-12
REC = 2.0 RQD = 0/5.0


BW STE 2
Boring: B-24
Depth: 146.4' to 151.4
Sample: RC-13
REC = 3.7 RQD = 1.1/5.0
151.4


BW STE 2
B-24
BW STE 2
Boring: B-24
Depth: 151.4 to 156.4
Sample: RC-14
REC = 5.0 RQD = 0.3/5.0


Proj: BW STE 2
Boring: B-24
BW STE 2
Boring: B-24
Depth: 156.4 to 161.4
Sample: RC-15
REC = 4.5 RQD = 1.6/5.0


Proj: BW STE 2
Boring: B-24
Depth:
BW STE 2
Boring: B-24
Depth: 161.4 to 166.4
Sample: RC-16
REC = 5.5 RQD = 4.8/5.0


Boring: B-24
Depth: 154.7 to
Box: 5 of
BW STE 2
Boring: B-24
Depth: 166.4 to 171.4
Sample: RC-17
REC = 5.0 RQD = 5.0/5.0


Boring: B-24
to
6 of
BW STE 2
Boring: B-24
Depth: 171.4 to 176.4
Sample: RC-18
REC = 5.0 RQD = 3.3/5.0


Boring
Depth
Box
B-24
169.0 to
6 of
BW ST E 2
Boring: B-24
Depth: 176.4 to 181.4
Sample: RC-19
REC = 5.0 RQD = 4.6/5.0


Depth
Box
169.0 to
6 of
BW ST E 2
Boring: B-24
Depth: 181.4 to 186.4
Sample: RC-20
REC = 4.9 RQD = 3.5/5.0


BW ST E 2
Boring: B-24
Depth: 186.4 to 191.4
Sample: RC-21
REC = 4.9 RQD = 4.1/5.0
191.4
196.4


BW ST E 2
Boring: B-24
Depth: 191.4 to 196.4
Sample: RC-22
REC = 4.9 RQD = 3.1/5.0
191.4
196.4

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BORING B-25 ROCK CORE PHOTO LOG


BWSTE 2
Boring: B-25
Depth: 27.1' to 37.1'
Sample: RC-3 "a"
REC = 9.4
RQD = 72/10
BWSTE 2
Boring: B-25
Depth: 27.1' to 37.1'
Sample: RC-3 "b"
REC = 9.4
RQD = 72/10


BWSTE 2
Boring: B-25
Depth: 37.1' to 47.1'
Sample: RC-4 "a"
REC = 8.9
RQD = 46/10
BWSTE 2
Boring: B-25
Depth: 27.1' to 47.1'
Sample: RC-4 "b"
REC = 8.9
RQD = 46/10


BWSTE 2
Boring B-25
Depth 47.1' to 57.1'
Sample: RC-5 "a"
REC = 7.3' RQD = 2.2/10
BWSTE 2
Boring B-25
Depth 47.1' to 57.1'
Sample: RC-5 "b"
REC = 7.3' RQD = 2.2/10


BWSTE 2
Boring B-25
Depth 57.1' to 62.1'
Sample: RC-6
REC = 4.2' RQD = 0.8/5.0


BWSTE 2
Boring B-25
Depth 62.1' to 67.1'
Sample: RC-7
REC = 3.2' RQD = 0/5.0


BWSTE 2
Boring B-25
Depth 67.1' to 77.1
Sample: RC-8 "a"
Rec = 8.7 RQD = 2.8/10
BWSTE 2
Boring B-25
Depth 67.1' to 77.1
Sample: RC-8 "b"
Rec = 8.7 RQD = 2.8/10


BWSTE 2
Boring B-25
Depth 77.1' to 82.1
Sample: RC-9
Rec = 3.6 RQD = 0.6/5.0


BWSTE 2
Boring B-25
Depth 82.1' to 87.1
Sample: RC-10
Rec = 4.3' RQD = 1.8/5.0


BWSTE 2
Boring: B-25
Depth: 87.1' to 97.1
Sample: RC-11"a"
REC = 10' RQD = 6.3/10
BWSTE 2
Boring: B-25
Depth: 87.1' to 97.1
Sample: RC-11"b"
REC = 10' RQD = 6.3/10


BWSTE 2
Boring: B-25
Depth: 97.1' to 107.1
Sample: RC-12"a"
REC = 9.9 RQD = 23/10
BWSTE 2
Boring: B-25
Depth: 97.1' to 107.1
Sample: RC-12"b"
REC = 9.9 RQD = 23/10


BWSTE 2
Boring: B-25
Depth: 107.1' to 117.1'
Sample: RC-13"a"
R PC = 9.4
RQD = 4.9/10
BWSTE 2
Boring: B-25
Depth: 107.1' to 117.1'
Sample: RC-13"b"
R PC = 9.4
RQD = 4.9/10


BWSTE 2
Boring: B-25
Depth: 117.1' to 127.1'
Sample: RC-14"a"
R PC = 9.4
RQD = 3.9/10
BWSTE 2
Boring: B-25
Depth: 117.1' to 127.1'
Sample: RC-14"b"
R PC = 9.4
RQD = 3.9/10


BWST 2
Boring B-25
Depth 127.1' to 137.1'
Sample RC-15" a"
Rec = 10' RQD = 8.3/10
BWST 2
Boring B-25
Depth 127.1' to 137.1'
Sample RC-15" b"
Rec = 10' RQD = 8.3/10


BWST 2
Boring B-25
Depth 137.1' to 147.1'
Sample RC-16" a"
Rec = 10 RQD = 0.9/10
BWST 2
Boring B-25
Depth 137.1' to 147.1'
Sample RC-16" b"
Rec = 10 RQD = 0.9/10


BWSTE 2
Boring B-25
Depth 147.1' to 157.1'
Sample RC-17" a"
REC = 9.0
RQD = 23/10
BWSTE 2
Boring B-25
Depth 147.1' to 157.1'
Sample RC-17" b"
REC = 9.0
RQD = 23/10


BWSTE 2
Boring B-25
Depth 157.1' to 167.1'
Sample RC-18" a"
REC = 9.4
RQD = 44/10
BWSTE 2
Boring B-25
Depth 157.1' to 167.1'
Sample RC-18" b"
REC = 9.4
RQD = 44/10


BWSTF 2
Boring B-25
Depth: 167.1 to 177.1
RC-19 "a"
Rec = 10.0'
RQD = 59/10
BWSTF 2
Boring B-25
Depth 167.1 to 177.1
RC-19 "b"
Rec = 10.0'
RQD = 59/10

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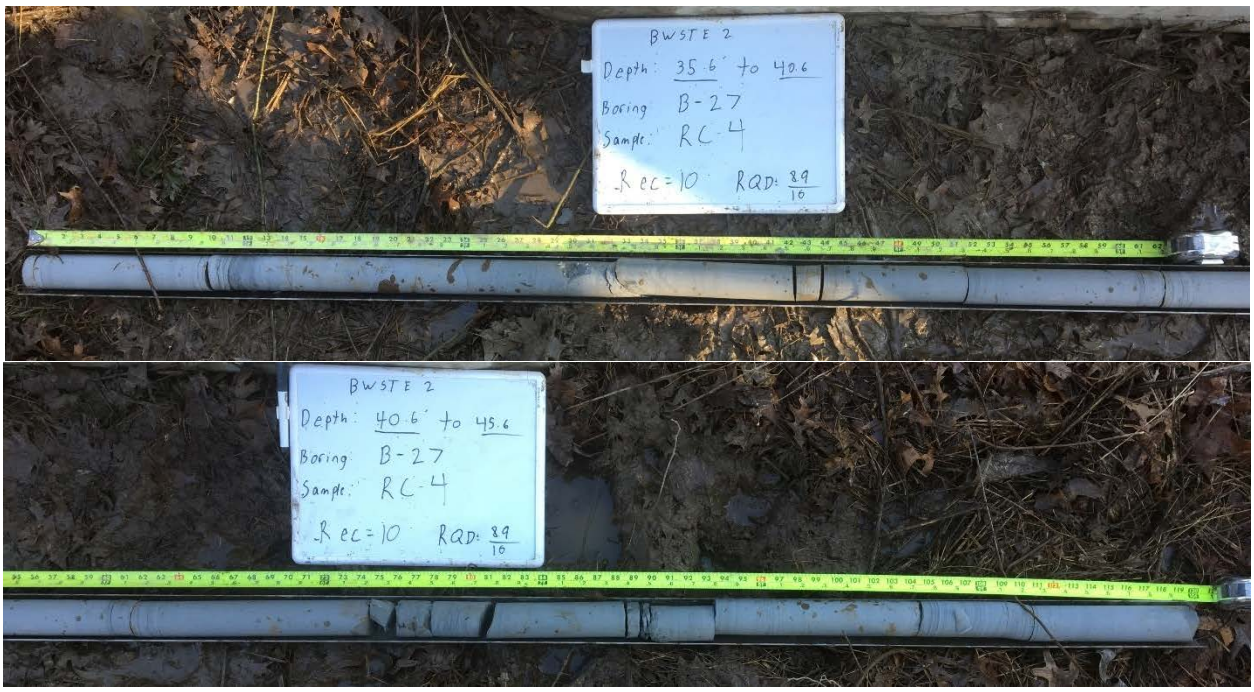
BORING B-27 ROCK CORE PHOTO LOG

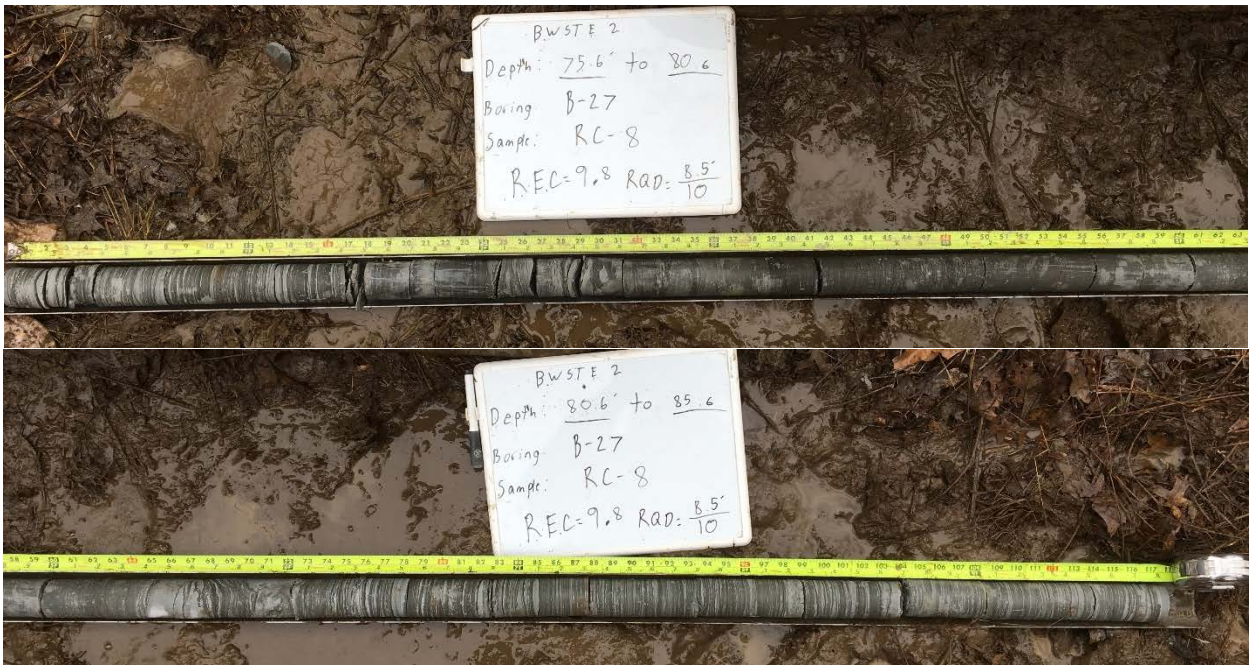

BWSTE 2
Boring: B-27
Depth: 25.6 to 30.6
Sample: RC-3
REC: 10.0 RQD:7.1/10
BWSTE 2
Depth: 30.6 to 35.6
Boring: B-27
Sample: RC-3
Rec=10 RQD: 71/10

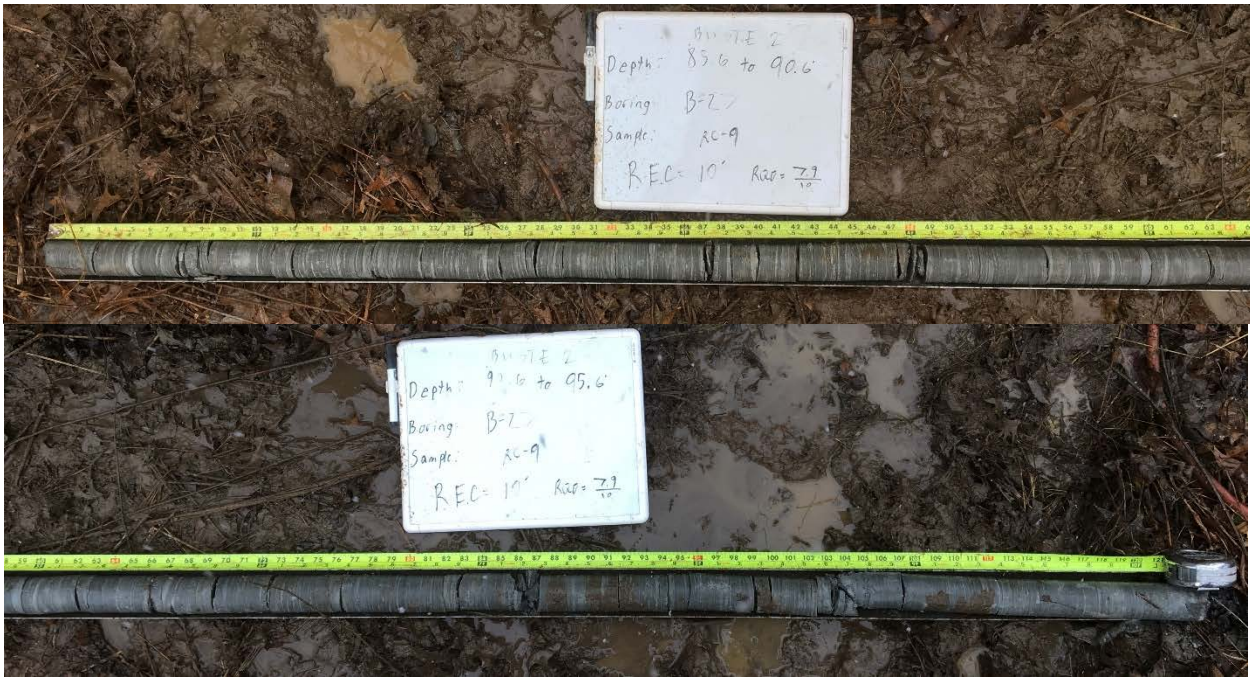

BWSTE 2
Depth: 35.6 to 40.6
Boring: B-27
Sample: RC-4
Rec=10 RQD: 89/10
BWSTE 2
Depth: 40.6 to 45.6
Boring: B-27
Sample: RC-4
Rec=10 RQD: 89/10

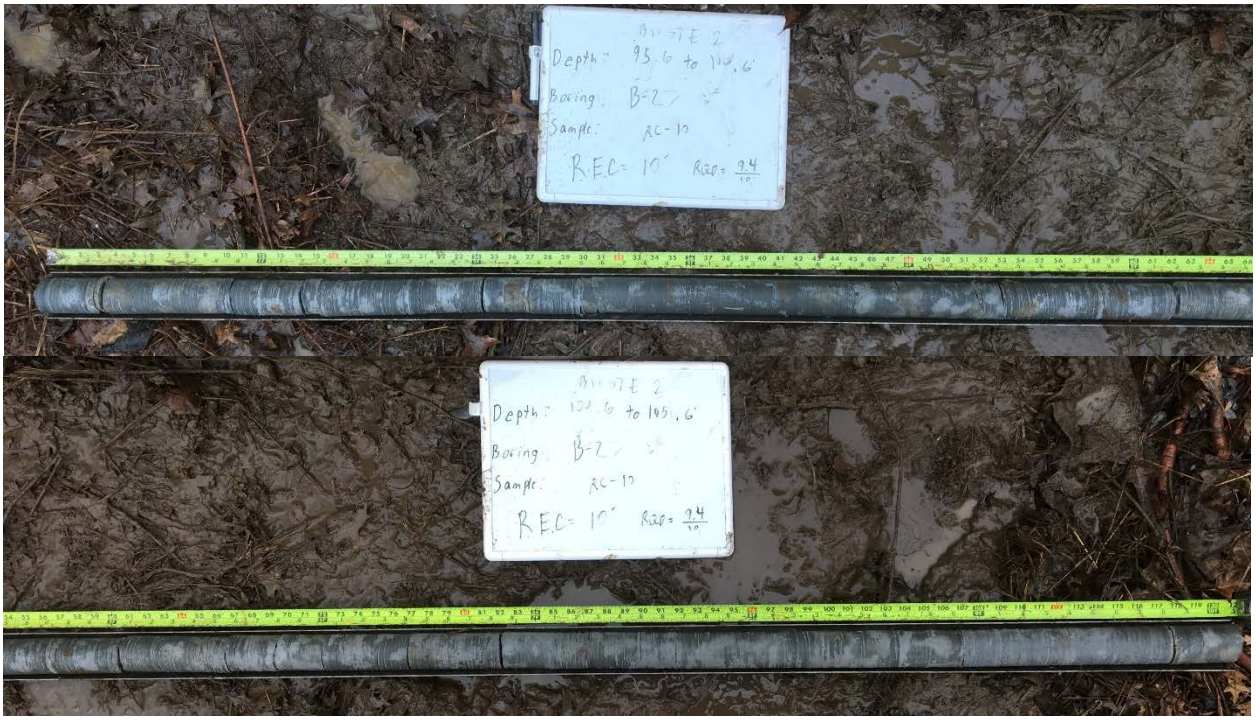

BWSTE 2
Depth: 45.6' to 50.6
Boring: B-27
Sample: RC-5
Rec=9.7 RQD: 5.3/10
BWSTE 2
Depth: 50.6' to 55.6
Boring: B-27
Sample: RC-5
Rec=9.7 RQD: 5.3/10

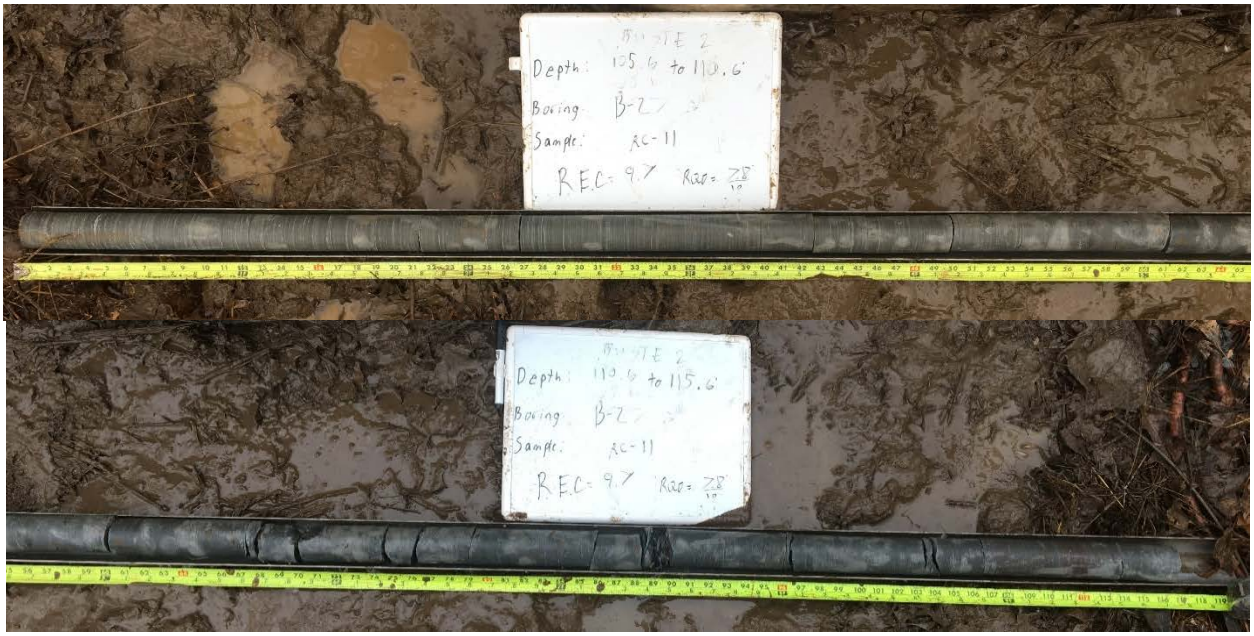

BWSTE 2
Depth: 55.6' to 60.6
Boring: B-27
Sample: RC-6
Rec=9.0' RQD: 2.0/10
Depth: 60.6' to 65.6
Boring: B-27
Sample: RC-6
Rec=9.0' RQD: 2.0/10


BWSTE 2
Depth: 65.6' to 70.6
Boring: B-27
Sample: RC-7
REC=10 RAD= 6.5/10
BWSTE 2
Depth: 70.6' to 75.6
Boring: B-27
Sample: RC-7
REC=10 RAD= 6.5/10


BWSTE 2
Depth: 75.6' to 80.6
Boring: B-27
Sample: RC-8
REC=9.8 RAD= 8.5/10
BWSTE 2
Depth: 80.6' to 85.6
Boring: B-27
Sample: RC-8
REC=9.8 RAD= 8.5/10


Depth: 85.6 to 90.6'
Boring: B-2
Sample: RC-9
R.E.C = 10' Rec = 7.9/10
Depth: 90.6 to 95.6'
Boring: B-2
Sample: RC-9
R.E.C = 10' Rec = 7.9/10


Depth: 95.6 to 100.6'
Boring: B-2
Sample: RC-10
R.E.C = 10' Rec = 9.4/10
Depth: 100.6 to 105.6'
Boring: B-2
Sample: RC-10
R.E.C = 10' Rec = 9.4/10


BW STE 2
Depth: 105.6 to 110.6'
Boring: B-7
Sample: RC-11
REC= 9.7 RQD= 7.8/10
BW STE 2
Depth: 110.6 to 115.6'
Boring: B-7
Sample: RC-11
REC= 9.7 RQD= 7.8/10


BW STE 2
Depth: 115.6 to 120.6
Boring: B-7
Sample: RC-12
REC=10 RQD=9.3/10
BW STE 2
Depth: 120.6 to 125.6
Boring: B-7
Sample: RC-12
REC=10 RQD=9.3/10


BW STE 2
Depth: 125.6 to 130.6
Boring: B-77
Sample: RC-13
REC=10 RQD=8.1/10
BW STE 2
Depth: 130.6 to 135.6
Boring: B-77
Sample: RC-13
REC=10 RQD=8.1/10


BW STE 2
Depth: 135.6 to 140.6
Boring: B-77
Sample: RC-14
REC=10 RQD=10/10
BW STE 2
Depth: 140.6 to 145.6
Boring: B-77
Sample: RC-14
REC=10 RQD=10/10


BW STE 2
Depth: 145.6 to 150.6
Boring: B-77
Sample: RC-15
REC=10 RQD=10/10
BW STE 2
Depth: 150.6 to 155.6
Boring: B-77
Sample: RC-15
REC=10 RQD=10/10

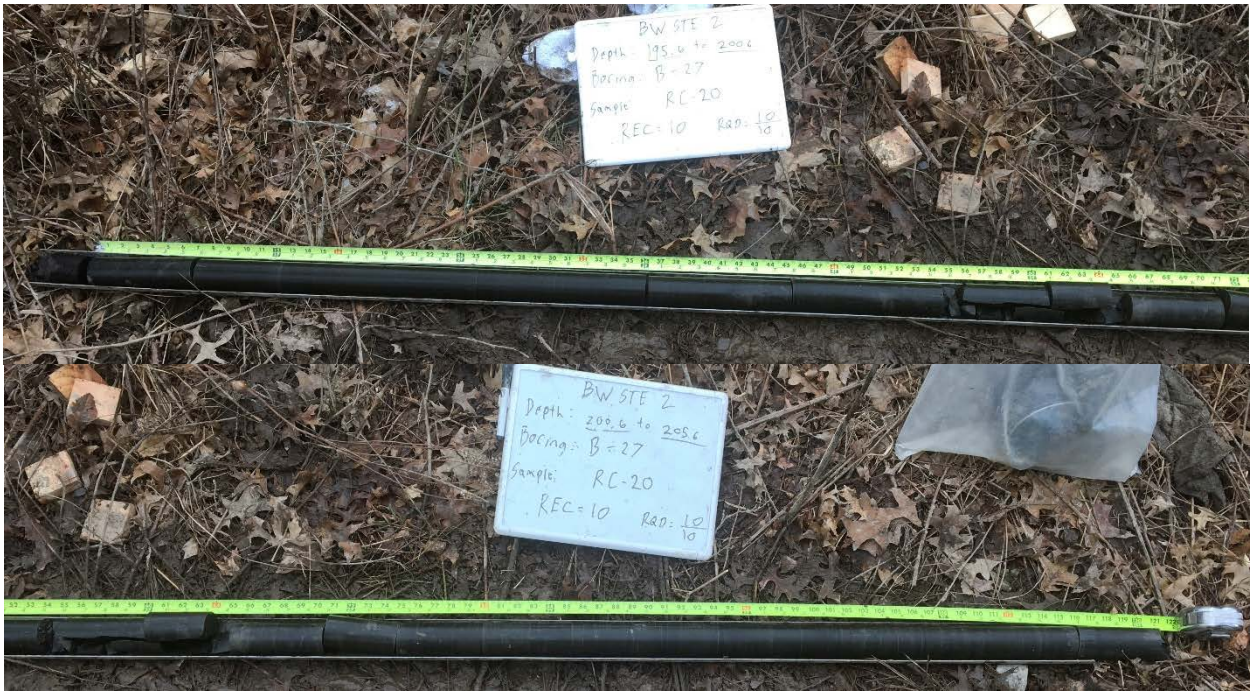

BW STE 2
Depth: 155.6 to 160.6
Boring: B-77
Sample: RC-16
REC=10 RQD=9/10
BW STE 2
Depth: 160.6 to 165.6
Boring: B-77
Sample: RC-16
REC=10 RQD=9/10


BWSTE 2
Depth: 165.6 to 170.6
Boring: B-27
Sample: RC-17
REC=10 RQD=10/10
BWSTE 2
Depth: 170.6 to 175.6
Boring: B-27
Sample: RC-17
REC=10 RQD=10/10


BWSTE 2
Depth: 175.6 to 180.6
Boring: B-27
Sample: RC-18
REC=10 RQD=9.8/10
BWSTE 2
Depth: 180.6 to 185.6
Boring: B-27
Sample: RC-18
REC=10 RQD=9.8/10


BW STE 2
Depth: 185.6 to 190.6
Boring: B-27
Sample: RC-19
REC=10 RQD: 9.3/10

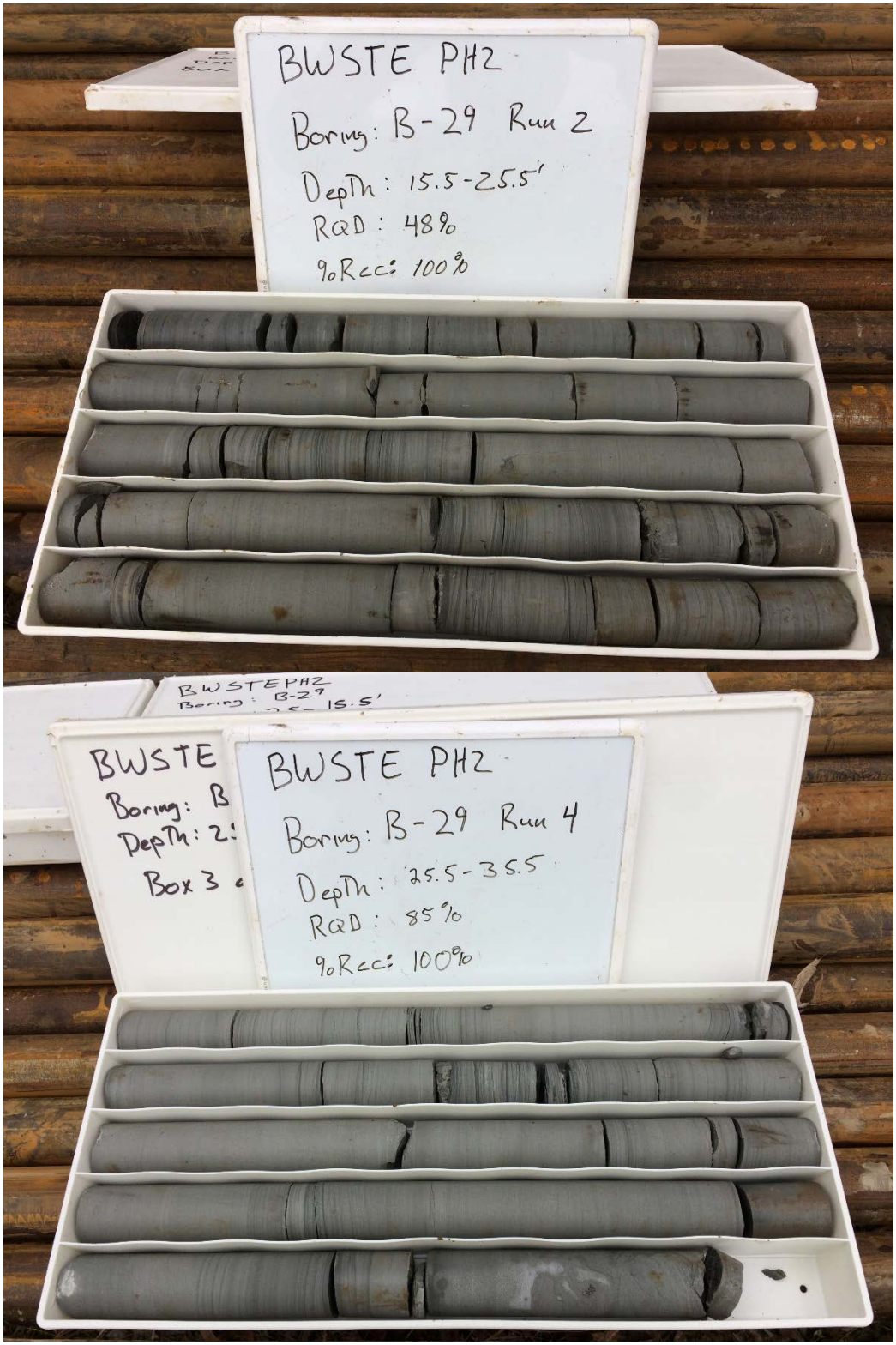
BW STE 2
Depth: 190.6 to 195.6
Boring: B-27
Sample: RC-19
REC=10 RQD: 9.3/10


BW STE 2
Depth: 195.6 to 200.6
Boring: B-27
Sample: RC-20
REC=10 RQD: 10/10

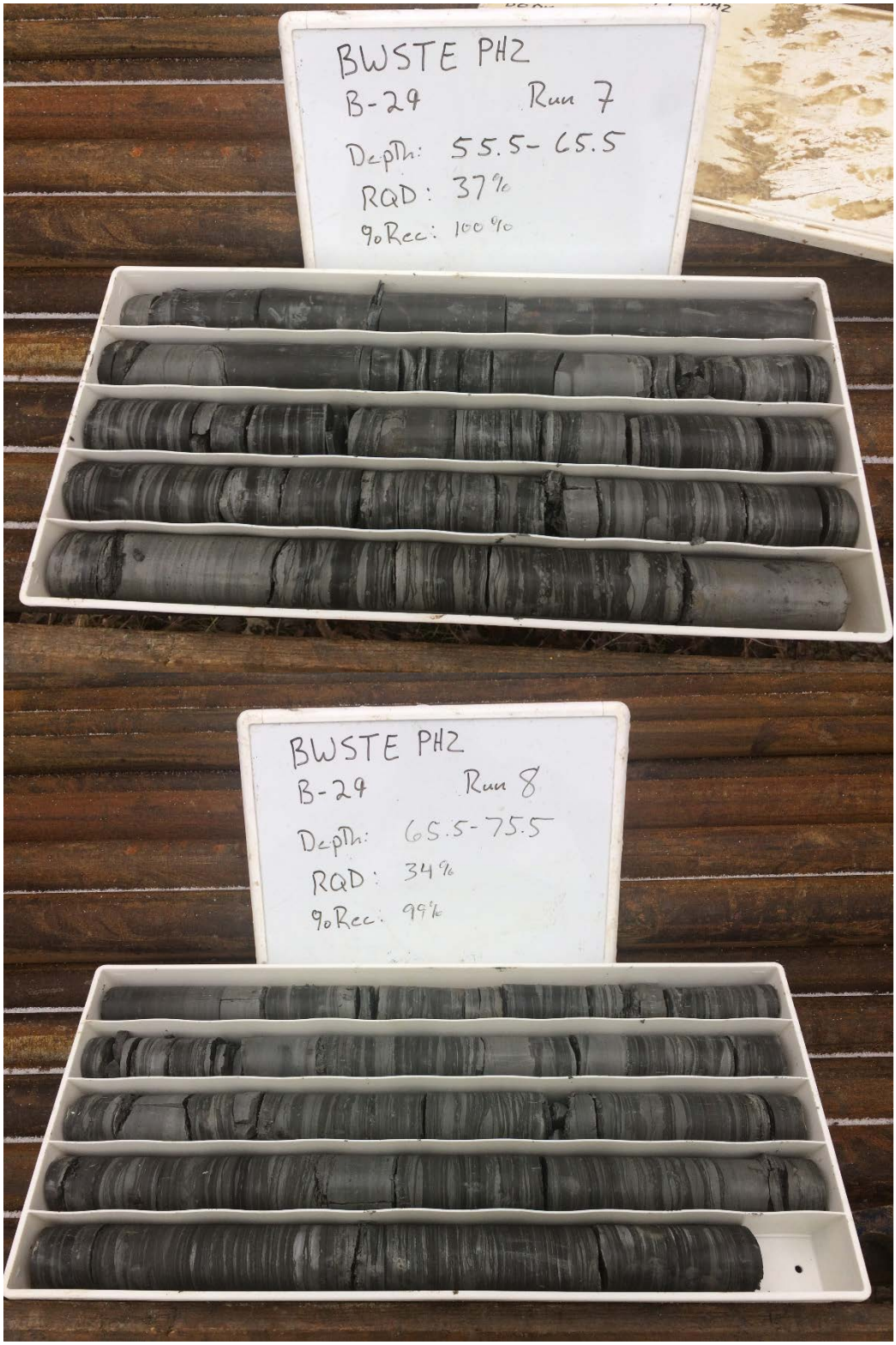
BW STE 2
Depth: 200.6 to 205.6
Boring: B-27
Sample: RC-20
REC=10 RQD: 10/10

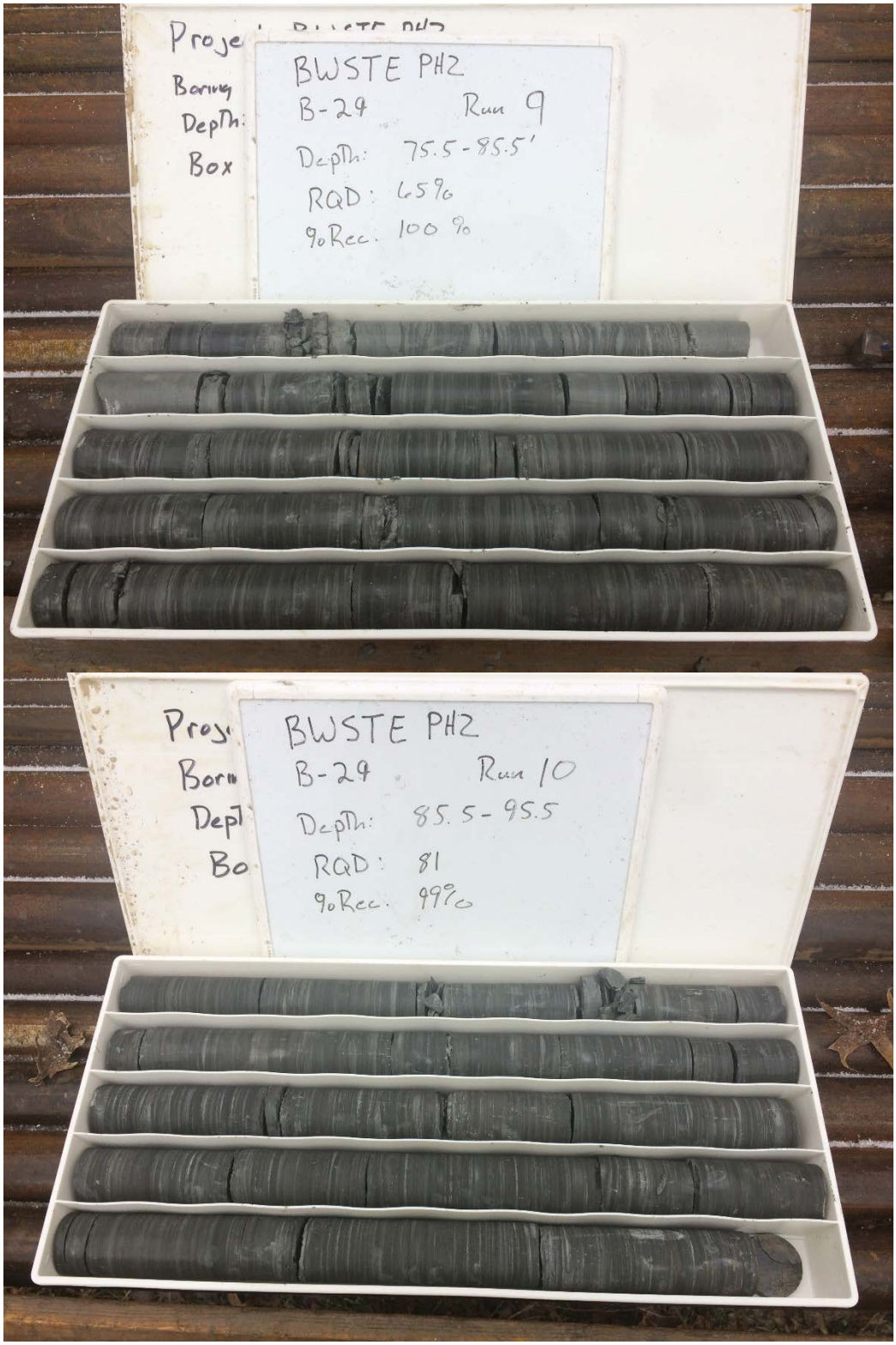
Stantec

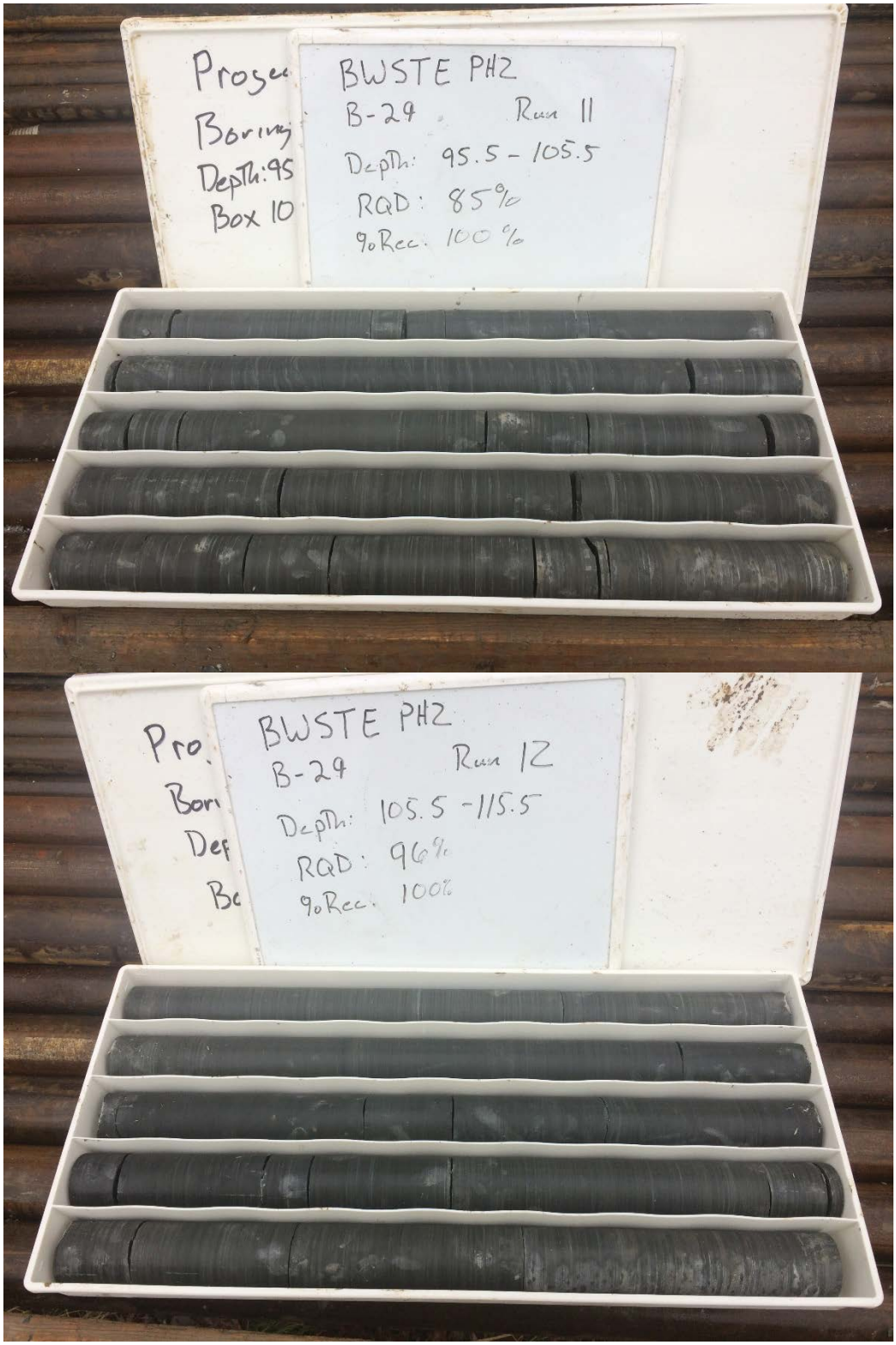
BORING B-29 ROCK CORE PHOTO LOG


BWSTE PH2
Boring: B-29 Run 2
Depth: 15.5-25.5'
RQD: 48%
%Recc: 100%
BWSTE PH2
Boring: B-29 Run 4
Depth: 25.5-35.5
RQD: 85%
%Recc: 100%


BWSTE PH2
Boring: B-29 Run 5
Depth: 35.5-45.5
RQD: 67%
%Rec: 100%
BWSTE PH2
Boring: B-29 Run 6
Depth: 45.5-55.5
RQD: 51%
%Rec: 95%


BWSTE PH2
B-24 Run 7
Depth: 55.5-65.5
RQD: 37%
%Rec: 100%
BWSTE PH2
B-24 Run 8
Depth: 65.5-75.5
RQD: 34%
%Rec: 99%


BWSTE PH2
B-29 Run 9
Depth: 75.5-85.5'
RQD: 65%
%Rec. 100 %
BWSTE PH2
B-29 Run 10
Depth: 85.5-95.5
RQD: 81
%Rec. 99%


Proje
Boring
Depth: 95
Box 10
BWSTE PHZ
B-29
Run 11
Depth: 95.5 - 105.5
RQD: 85%
%Rec. 100%
Pro
Bori
Dep
Bo
BWSTE PHZ
B-29
Run 12
Depth: 105.5 - 115.5
RQD: 96%
%Rec. 100%


BWSTE PH2
B-29 Run 13
Depth: 115.5 - 125.5
RQD: 98%
%Rec. 100%
BWSTE PH2
B-29 Run 14
Depth: 125.5 - 135.5
RQD: 87%
%Rec 99%


BWSTE PH2
B-29 Run 15
Depth: 135.5-145.5
RQD: 75 %
%Rec 100%
B-29 Run 16
Depth: 145.5-155.5
RQD: 100%
%Rec 100%


BWSTE PH2
B-29 Run 17
Depth: 155.5 - 165.5
RQD: 85%
%Rec 100%
BWSTE PH2
Boring B-29 Run 18
Depth: 165.5 - 175.5
RQD: 91%
%Rec: 99%


BLUSTE PH2
Boring B-29 Run 19
Depth: 175.5-185.5
RQD: 100 %
%Rec: 100 %
BLUSTE PH2
Boring B-29 Run 20
Depth: 185.5-195.5
RQD: 99%
%Rec: 100%


BLUSTE PHZ
Boring B-29 Run 21
Depth: 195.5-205.5
RQD: 99%
%Rec: 100%
BLUSTE PHZ
Boring B-29 Run 22
Depth: 205.5-207.5
RQD: 79%
%Rec: 100%

BORING B-31 ROCK CORE PHOTO LOG


BWSTE PHZ
Boring B-31
Run 3
Depth 14.7-24.7
RQD - 23%
%Rec. - 95%
Boring B-31
Run 4
Depth 24.7-34.7
RQD - 77%
%Rec. 99%


BWSTE PHZ
Boring B-31
Depth 34.7-44.7
RQD - 63%
%Rec. 90%
Run 5


BWSTEPHZ
B-31
Depth 44.7 - 49.7
RQD - 61%
%Rec 90%
Run 6


BWSTE PH2
B-31
Depth: 49.7-54.7'
RQD: 25%
% Rec: 100%
Run 7
BWSTE PH2
B-31 Run 8
Depth: 54.7-64.7
RQD: 50%
% Rec: 95%


BWSTE PHZ
B-31 Run 9
Depth: 64.7-74.7
RQD: 61%
% Rec: 98%
BWSTE PHZ
B-31 Run 10
Depth: 74.7 – 84.7
RQD: 65%
% Rec: 100%


BWSTE PHZ
B-31 Run 11
Depth: 84.7-94.7
RQD: 56%
BWSTE PHZ
B-31 Run 12
Depth: 94.7-104.7
RQD: 83
% Rec: 100%

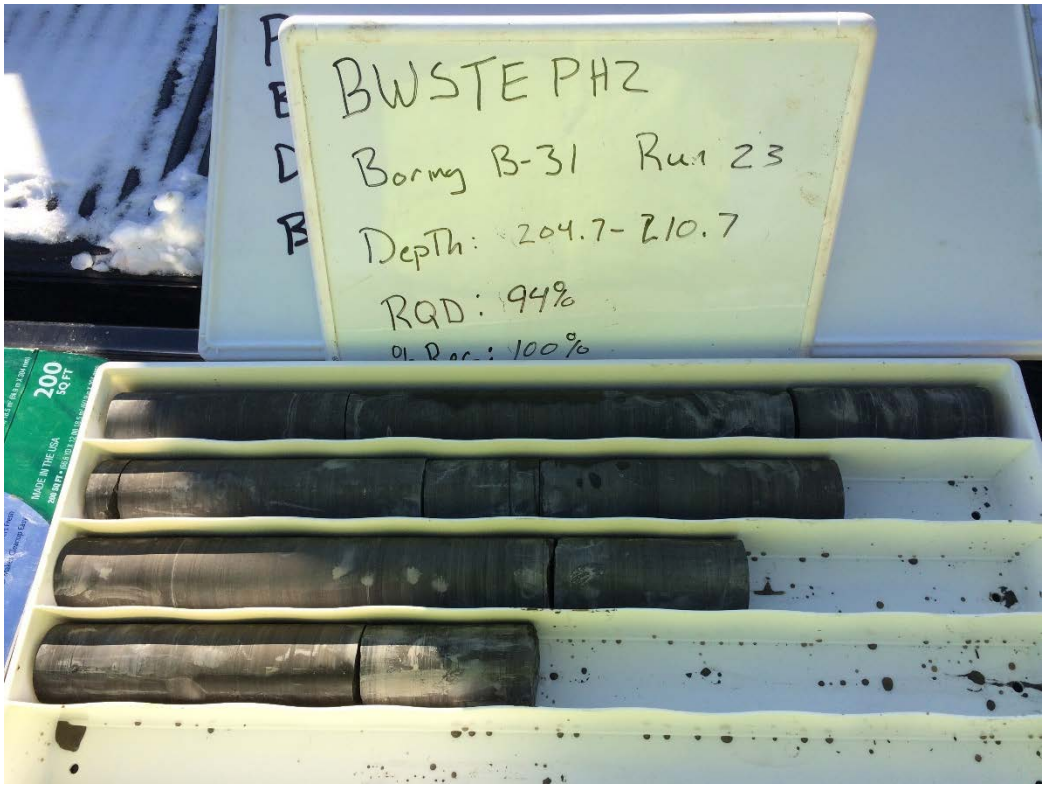

BWSTE PH2
B-31 Run 13
Depth: 104.7- 114.7
RQD: 85
% Rec: 100%
BWSTE PH2
B-31 Run 14
Depth: 114.7-124.7
RQD: 77%
% Rec: 98%


BWSTEPH2
B-31 Run 15
Depth: 124.7-134.7
RQD: 68%
% Rec: 99%
BWSTEPH2
B-31 Run 16
Depth: 134.7-144.7
RQD: 79%
% Rec: 100%


BWSTE PH2
B-31 Run 17
Depth: 144.7-154.7
RQD: 82%
% Rec: 99%
BWSTE PH2
B-31 Run 18
Depth: 154.7-164.7
RQD: 93%
% Rec: 99%


Project
Boring
Depth
Box
BWSTEPH2
B-31 Run 19
Depth: 164.7-174.7
RQD: 96%
% Rec: 100%
BWSTEPH2
B-31 Run 20
Depth: 174.7-184.7
RQD: 88%
% Rec: 100%


BWSTE PH2
B-31 Run 21
Depth: 184.7- 194.7
RQD: 88%
% Rec: 100%
BWSTE PH2
Borng B-31 Run 22
Depth: 194.7-204.7
RQD: 100%
% Rec: 99%


BWSTE PH2
Boring B-31 Run 23
DepTh: 204.7-210.7
RQD: 94%
100%

BORING B-33 ROCK CORE PHOTO LOG


BWSTE PH2
B-33
Depth - 20.5 - 30.5
RQD - 46
Rec 100 %


Project: RWTSF PH2
Boring
Depth
Box
BWTSE PH2
B-33
Depth: 30.5 - 40.5
RQD: 72%
%Rec: 100%


BWTSE PH2
B-33
Depth: 40.5 - 50.5
RQD: 50%
%Rec: 99% (9.9')


BWTSE PH2
B-33
Depth: 50.5 - 60.5
RQD: 50%
%Rec: 99% (9.9')


Boring:
Depth:
Box
BWTSE PH2
B-33
Depth: 60.5-70.5
RQD: 41%
%Rec: 99%


BWTSE PH2
B-33
Depth: 70.5-80.5
RQD: 50%
%Rec: 98%


BWTSE PH2
B-33
Depth: 80.5 - 90.5
RQD: 70%
%Rec: 100%


Project: BWTSE PH2
BWTSE PH2
B-33
Depth: 90.5 - 100.5
RQD: 85%
%Rec: 99%


BWTSE PH2
B-33
Depth: 100.5 - 110.5
RQD: 81%
%Rec: 100%


BWTSE PH2
B-33
Depth: 110.5-120.5
RQD: 79%
%Rec: 99%


BWSTE PH2
Boring 33
Depth: 120.5-130.5
RQD: 90%
% Rec: 98%


BWSTE PH2
Boring 33
Depth 130.5-140.5
RQD 83%
% Rec 99%


BWSTE PHZ
Boring 33
Depth 140.5 - 150.5
RQD 91%
% Rec 100%


BWSTE PHZ
Boring 33
Depth 150.5 - 160.5
RQD 86%
% Rec 100%


BWSTE PHZ
Boring 33
Depth 160.5 - 170.5
RQD 41%
% Rec 100%


Project: BWSTE PHZ
Boring: B-33
Depth: 170.5 - 180.5
Box 17 of
BWSTE PHZ
Boring 33
Depth 170.5 - 180.5
RQD 92%
% Rec 99%


BWSTE PHZ
Boring 33
Depth 180.5-190.5
RQD 94%
% Rec 100%


BWSTE PHZ
Boring 33
Depth 190.5- 200.5
RQD 100%
% Rec 100%


Project :
Boring : B-
Depth: 200.
Box 19
BWSTE PHZ
Boring 33
Depth 200.5-210.5
RQD 96%
% Rec 100%


BWSTE PHZ
Boring 33
Depth 210.5-213.5
RQD 100%
% Rec 100 %

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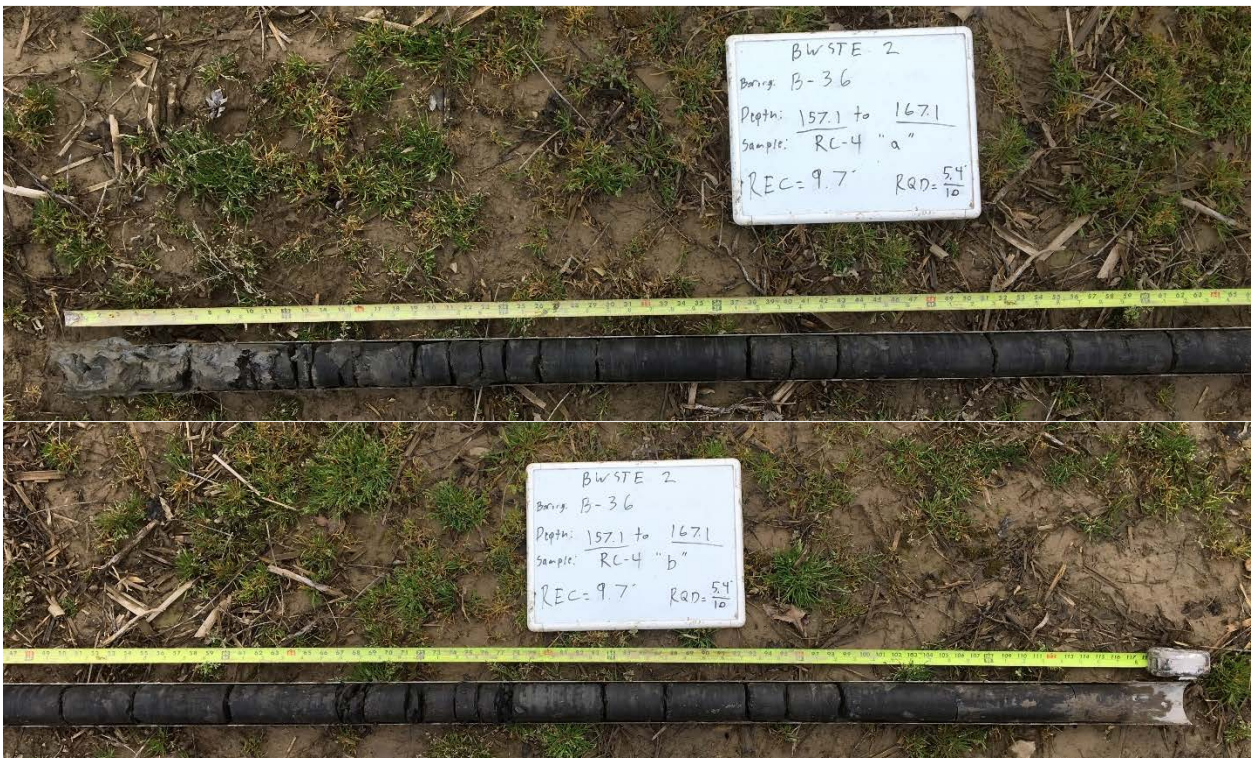
BORING B-36 ROCK CORE PHOTO LOG


BWSTE 2
Boring: B-36
Depth: 147.1 to 157.1
Sample: RC-3 "a"
REC= 9.3' RQD= 47/10
BWSTE 2
Boring: B-36
Depth: 147.1 to 157.1
Sample: RC-3 "b"
REC= 9.3' RQD= 47/10


BWSTE 2
Boring: B-36
Depth: 157.1 to 167.1
Sample: RC-4 "a"
REC= 9.7' RQD= 54/10
BWSTE 2
Boring: B-36
Depth: 157.1 to 167.1
Sample: RC-4 "b"
REC= 9.7' RQD= 54/10


BWSTE 2
Boring: B-36
Depth: 167.1 to 173.1
Sample: RC-5
REC= 6.0
RQD= 3.7/6.0

BORING B-38 ROCK CORE PHOTO LOG


BwSTE 2
Boring: B-38
Depth: 56.8' to 61.8'
Sample: RC-3
REC = 3.2'
RQD = 1.4/5.0


BwSTE 2
Boring: B-38
Depth: 61.8' to 66.8'
Sample: RC-4
REC = 2.5'
RQD = 0/5.0

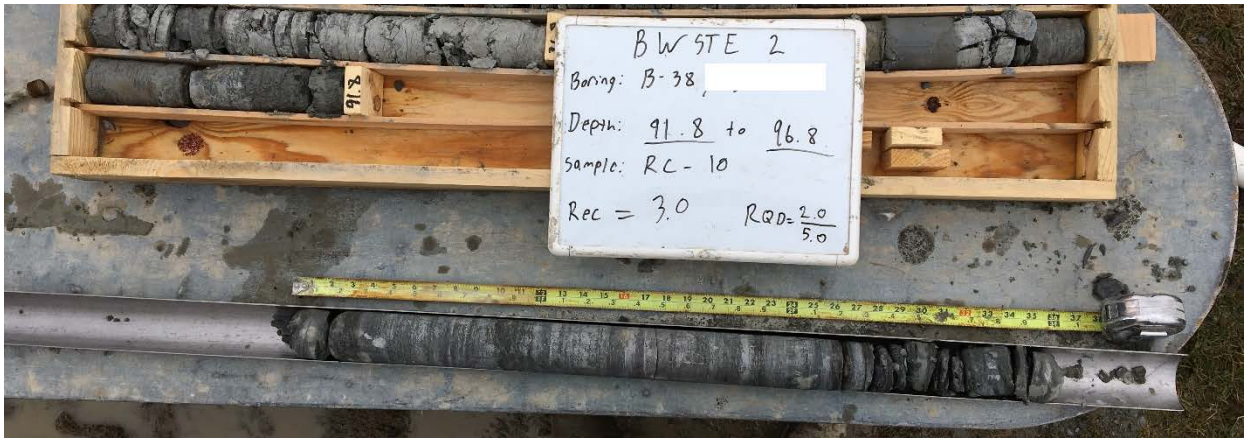

BwSTE 2
Boring: B-38
Depth: 66.8' to 71.8'
Sample: RC-5
REC = 2.4
RQD = 1.3/5.0


B-38/ SHAFT 1
to
1 of
BWSTE 2
Boring: B-38
Depth: 71.8' to 76.8'
Sample: RC-6
REC = 3.0
RQD = 1.8/5.0


BWSTE 2
Boring: B-38
Depth: 76.8' to 81.8'
Sample: RC-7
REC = 1.5
RQD = 1.3/5.0


B-38/ Shaft
76.8' to
2 of
BWSTE 2
Boring: B-38
Depth: 81.8' to 86.8'
Sample: RC-8
REC = 4.3
RQD = 0.4/5.0


BWSTE 2
Boring: B-38
Depth: 86.8 to 91.8
Sample: RC-9
Rec = 3.0
RQD= 0.9/5.0


91.8
BWSTE 2
Boring: B-38
Depth: 91.8 to 96.8
Sample: RC-10
Rec = 3.0
RQD= 2.0/5.0


BW STE 2
Boring: B-38
Depth: 96.8 to 106.8
Sample: RC-11 "a"
Rec = 8.8' RQD= 4.6/10
BW STE 2
Boring: B-38
Depth: 96.8 to 106.8
Sample: RC-11 "b"
Rec = 8.8' RQD= 4.6/10


BW STE 2
Boring: B-38
Depth: 106.8 to 116.8
Sample: RC-12 "a"
Rec = 9.4 RQD= 8.4/10
BW STE 2
Boring: B-38
Depth: 106.8 to 116.8
Sample: RC-12 "b"
Rec = 9.4 RQD= 8.4/10


BW STE 2
Boring: B-38
Depth: 116.8 to 126.8
Sample: RC-13 "a"
Rec = 6.4' RQD= 07/10
BW STE 2
Boring: B-38
Depth: 116.8 to 126.8
Sample: RC-13 "b"
Rec = 6.4' RQD= 07/10


BW STE 2
Boring: B-38
Depth: 126.8 to 136.8
Sample: RC-14 "a"
Rec = 9.3' RQD= 29/10
BW STE 2
Boring: B-38
Depth: 126.8 to 136.8
Sample: RC-14 "b"
Rec = 9.3' RQD= 29/10

Note: 149.0' to 152.7' Void; 152.7' to 158.0' Washed Out/Loss Core


BW SITE 2
Boring: B-38
Depth: 156.8' to 166.8
Sample: RC-17 "a"
Rec = 8.8 RQD: 2.4/8.8


Close up of recovered Control Density Fill (CDF) from 158.0' to 158.6'


BW SITE 2
Boring: B-38
Depth: 156.8' to 166.8
Sample: RC-17 "b"
Rec = 8.8 RQD: 2.4/8.8


BW SIZE 2
Boring: B-38
Depth: 166.8 to 176.8
Sample: RC-18 "a"
Rec = 9.0 RQD = 8.2/10
BW SIZE 2
Boring: B-38
Depth: 166.8 to 176.8
Sample: RC-18 "b"
Rec = 9.0 RQD = 8.2/10

BORING B-39 ROCK CORE PHOTO LOG


BWSTEPH2
B-39 Run 3
Depth: 140.5-145.5
RQD: 67%
%Rec: 100 %


BWSTE PH2
B-39 Run #4
Depth: 145.5- 147.5
RQD: 50%
% Rec: 63%


BWSTE PH2
B-39 Run#5
Depth: 147.5-150.5
RQD: 79%
%Rec: 100%

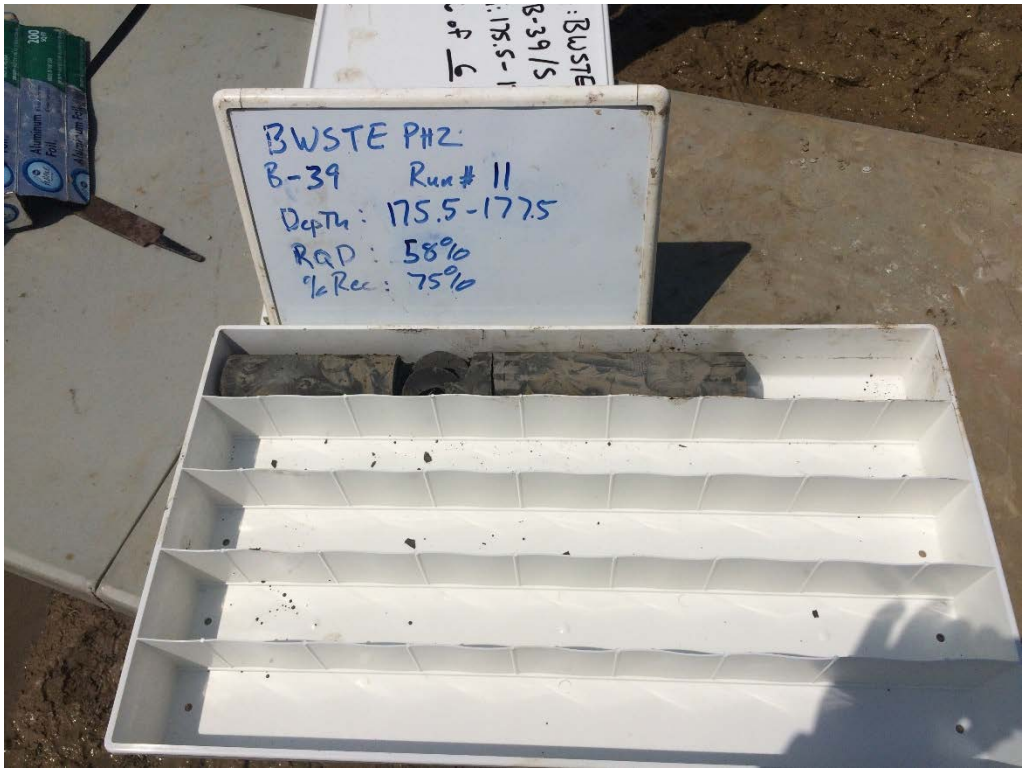

BWSTE PH2
B-39 Run#6
Depth: 150.5-155.5
RQD: 88%
%Rec: 100%


BWSTE PHZ
B-39 Run# 7
Depth: 155.5-160.5
RQD: 91%
%Rec: 97%


BWSTE PHZ
B-39 Run# 8
Depth: 160.5-165.5
RQD: 90%
%Rec: 100%


BWSTE PHZ
B-39 Run # 9
Depth: 165.5 – 170.5
RQD: 95%
%Rec: 100%

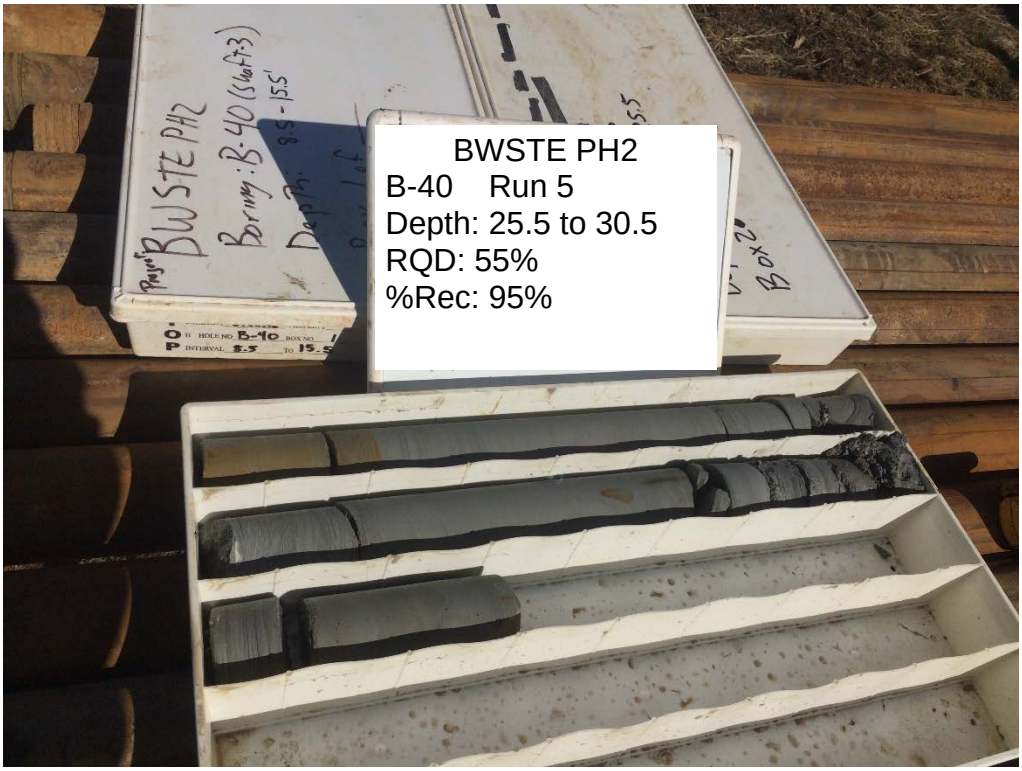

BWSTE PHZ
B-39 Run # 10
Depth: 170.5-175.5
RQD: 98%
%Rec: 97%


BWSTE PH2
B-39 Run # 11
Depth: 175.5-177.5
RQD: 58%
%Rec: 75%

BORING B-40 ROCK CORE PHOTO LOG


BWSTE PH2
B-40 Run 3
Depth: 15.5 - 20.5
RQD: 28%
%Rec: 100%


BWSTE PH2
B-40 Run 4
Depth: 20.5 - 25.5
RQD: 46%
%Rec: 100%


BWSTE PH2
B-40 Run 5
Depth: 25.5 to 30.5
RQD: 55%
%Rec: 95%


BWSTE PH2
B-40 Run 6
Depth: 30.5 - 35.5
RQD: 18%
%Rec: 96%


BWSTE PH2
B-40 Run 7
Depth: 35.5-40.5
RQD: 6%
%Rec 95%


BWSTE PH2
B-40 Run 8
Depth: 40.5-45.5
RQD: 27%
%Rec 100%


BWSTE PH2
B-40 Run 9
Depth: 45.5 - 50.5
RQD: 6%
%Rec 96%


BWSTE PH2
B-40 Run 10
Depth: 50.5 - 55.5
RQD: 0%
%Rec 97%


BWSTE PH2
B-40 Run 11
Depth: 55.5-60.5
RQD: 12%
%Rec 90%


BWSTE PH2
B-40 Run 12
Depth: 60.5-65.5
RQD: 0
%Rec 21%


BWSTE PH2
B-40 Run 13
Depth: 65.5- 70.5
RQD: 52%
%Rec 100%


BWSTE PH2
B-40 Run 14
Depth: 70.5- 75.5
RQD: 65%
%Rec 100%


BWSTE PH2
B-40 Run 15
Depth: 75.5-80.5
RQD: 62%
%Rec: 94%


BWSTE PH2
B-40 Run 16
Depth: 80.5-85.5
RQD: 85%


BWSTE PH2
B-40 Run 17
Depth: 85.5-90.5
RQD: 83%
%Rec 100%


BWSTE PH2
B-40 Run 18
Depth: 90.5-95.5
RQD: 76%


BWSTE PH2
B-40 Run 19
Depth: 95.5 - 100.5
RQD: 91%
%Rec: 100%
Project: BWSTE PH2
Boring: B-40/SHAFT-3
Depth: 90.5 - 100.5
Box 10 of


BWSTE PH2
B-40 Run 20
Depth: 100.5 - 105.5
RQD: 83
%Rec: 86


BWSTE PH2
B-40 Run 21
Depth: 105.5-110.5
RQD: 53
%Rec 86

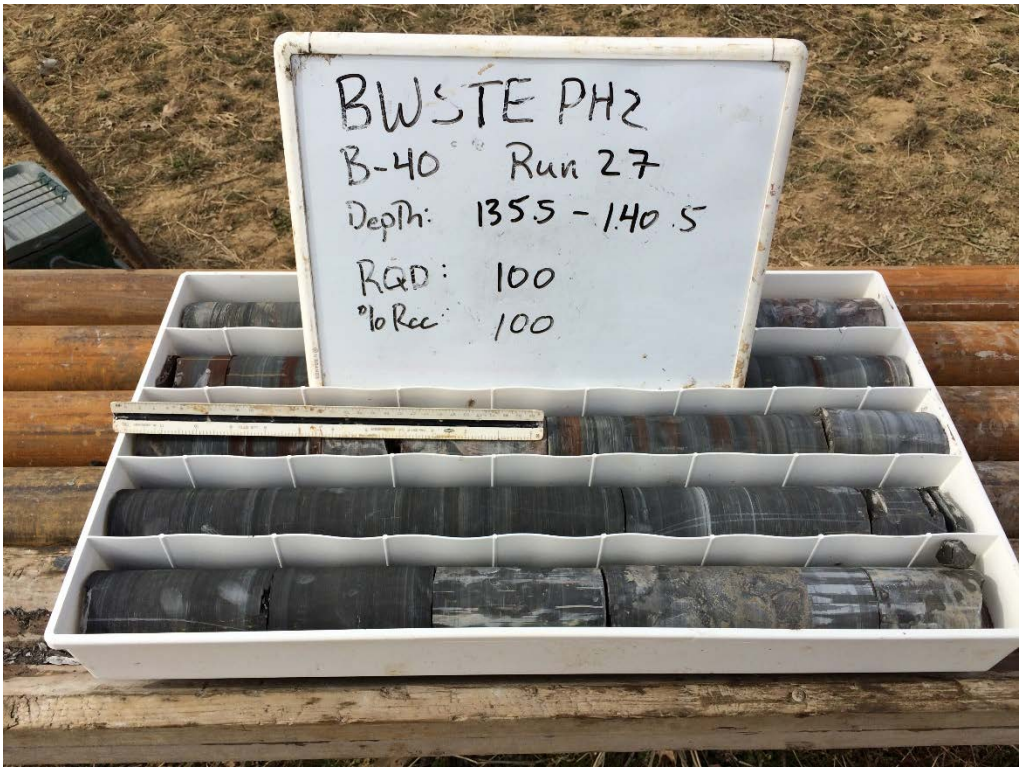

BWSTE PH2
B-40 Run 22
Depth: 110.5-115.5
RQD: 90
100


BWSTE PH2
B-40 Run 23
Depth: 115.5 - 120.5
RQD: 83
%Rec 98


BWSTE PH2
B-40 Run 24
Depth: 120.5 - 125.5
RQD: 73
98


BWSTE PH2
B-40 Run 25
Depth: 125.5 - 130.5
RQD: 79
%Rec 100


BWSTE PH2
B-40 Run 26
Depth: 130.5 - 135.5
RQD: 99
%Rec 100


BWSTE PH2
B-40 Run 27
Depth: 135.5 - 140.5
RQD: 100
%Rec 100


BWSTE PH2
Boring B-40 Run 28
Depth: 140.5 - 145.5
RQD: 100
%Rec: 100


BWSTE PHZ
Boring B-40 Run 29
Depth: 145.5-150.5
RQD: 90
%Rec: 96


BWSTE PHZ
Boring B-40 Run 30
Depth: 150.5-155.5
RQD: 100
%Rec: 100


BWSTE PHZ
Boring B-40 Run 31
Depth: 155.5-160.5
RQD: 99
%Rec: 97


BWSTE PHZ
Boring B-40 Run 32
Depth: 160.5 - 165.5
RQD: 73
%Rec: 98


BWSTE PHZ
Boring B-40 Run 33
Depth: 165.5-170.5
RQD: 75
%Rec: 100


BWSTE PHZ
Boring B-40 Run 34
Depth: 170.5-175.5
RQD: 100
%Rec: 100


BWSTE PHZ
Boring B-40 Run 35
Depth: 175.5-180.5
RQD: 100%
%Rec: 99%


BWSTE PHZ
Boring B-40 Run 36
Depth: 180.5-185.5
RQD: 100%
%Rec: 99%


BWSTE PHZ
Boring B-40 Run 37
Depth: 185.5-190.5
RQD: 100%
%Rec: 99%


BWSTE PHZ
Boring B-40 Run 38
Depth: 190.5-195.5
RQD: 100
%Rec: 100


Boring B-40 Run 39
Depth: 195.5 - 200.5
RQD: 100
% Rec: 99


BWSTE PHZ
Boring B-40 Run 40
Depth: 200.5 - 205.5
RQD: 78%
90%


BWSTE PH2
Boring B-40 Run 41
Depth: 205.5-210.5
RQD: 98
%Rec: 100

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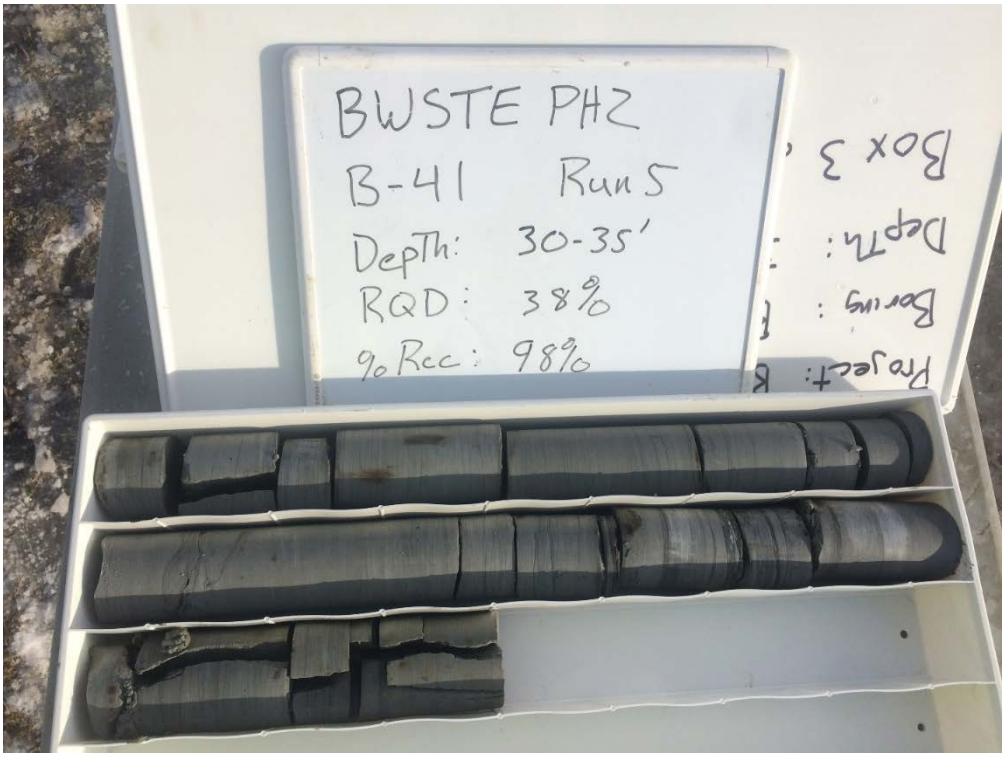
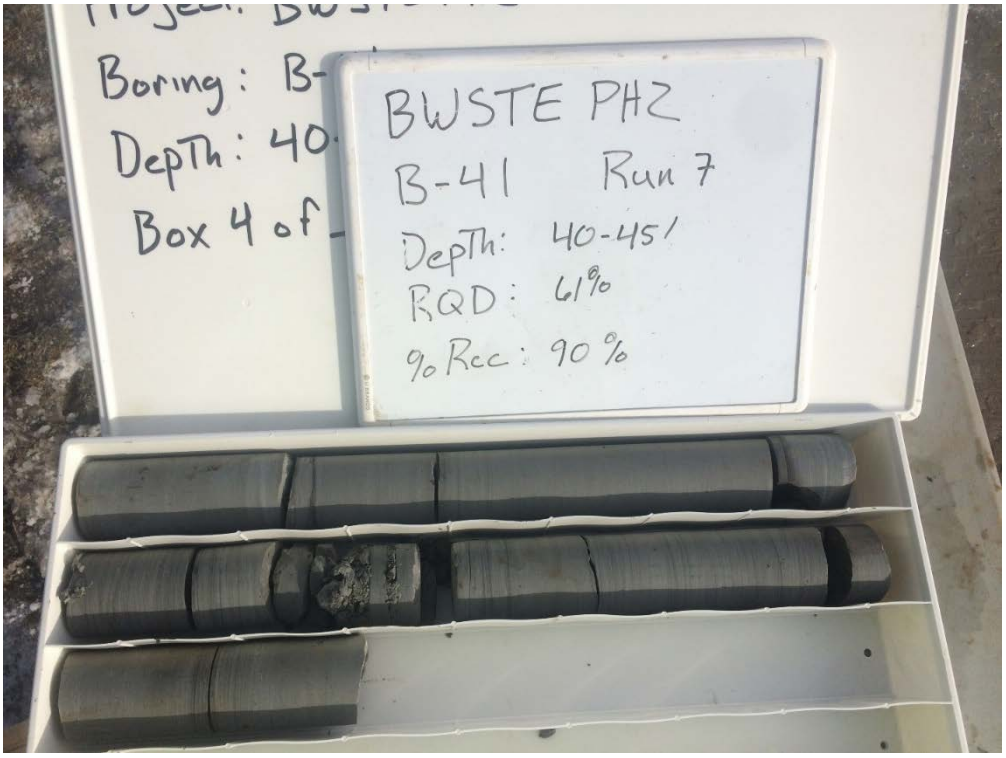
BORING B-41 ROCK CORE PHOTO LOG


BWSTE
B-41 Run-3
Depth: 20-25'
RQD: 61%
%Rec: 98%


BWSTE
B-41 Run-4
Depth: 25-30
RQD: 61%
%Rec: 90%


BWSTE PHZ
B-41 Run 5
Depth: 30-35'
RQD: 38%
% Rec: 98%


BWSTE PHZ
B-41 Run 6
Depth: 35'-40'
RQD: 60%
% Rec: 100%


Boring: B-
Depth: 40
Box 4 of
BWSTE PHZ
B-41 Run 7
Depth: 40-45'
RQD: 61%
% Rec: 90 %


BWSTE PHZ
B-41 Run 8
Depth: 45-50'
RQD: 55%
% Rec: 94 %


BWSTE PHZ
B-41 Run. 9
Depth: 50-55'
RQD: 21%
% Rec: 94%


BWSTE PHZ
B-41 Run. 10
Depth: 55-60'
RQD: 28%
% Rec: 100%


BWSTE PHZ
B-41 Run: 11
Depth: 60-65
RQD: 53%
% Rec: 99%


BWSTE PHZ
B-41 Run: 12
Depth: 65 - 70'
RQD: 30%
% Rec: 96%


BWSTE PHZ
B-41 Run 13
Depth: 70-75'
RQD: 65%
%Rec: 100%


BWSTE PHZ
B-41 Run 14
Depth: 75-80'
RQD: 71%
%Rec: 99%


BWSTE PHZ
B-41 Run 15
Depth: 80-85'
RQD: 83%
%Rec: 100%


BWSTE PHZ
B-41 Run 16
Depth: 85-90'
RQD: 93%
%Rec: 100%


BWSTE PHZ
B-41 Run 17
Depth: 90-95'
RQD: 63%
% Rec: 98%


BWSTE PHZ
B-41 Run 18
Depth: 95-100'
RQD: 80%
% Rec: 99%


BWSTE PHZ
B-41 Run: 19
Depth: 100-105'
RQD: 75%
% Rec: 100%


BWSTE PHZ
B-41 Run: 20
Depth: 105-110
RQD: 81%
% Rec: 94%


BWSTE PHZ
B-41 Run 21
Depth: 110-115
RQD: 71%
% Rec: 100%


BWSTE PHZ
B-41 Run 22
Depth: 115-120
RQD: 85%
% Rec: 92%


BWSTE PHZ
B-41 Run-23
Depth: 120-125
RQD: 80%
% Rec: 96%


BWSTE PHZ
B-41 Run-24
Depth: 125-130
RQD: 100%
% Rec: 100%


BWSTE PHZ
B-41 Run - 25
Depth: 130-135
RQD: 90%
% Rec: 99%


BWSTE PHZ
B-41 Run - 26
Depth: 135-140
RQD: 100%
% Rec: 94%


Boring:
Depth:
Box 14
BWSTEPH2
B-41 Run - 27
Depth: 140-145
RQD: 90%
% Rec: 100%


BWSTEPH2
B-41 Run - 28
Depth 145-150
RQD 94%
% Rec 100%


BWSTE PHZ
B-41 Run 29
Depth 150-155
RQD 100%
% Rec 75%


BWSTE PHZ
Boring B-41 Run. 30
Depth: 155-160
RQD: 78%
% Rec: 100%
plastic wrap
Aluminum Foil


BWSTE PHZ
Boring B-41 Run. 31
Depth 160-165
RQD: 100%
% Rec: 98%


BWSTE PHZ
Boring B-41 Run. 32
Depth 165-170
RQD: 100%
% Rec: 100%


BWSTE PHZ
Boring B-41 Run. 33
Depth 170 - 175
RQD: 100%
% Rec 96%


BWSTE PHZ
Boring B-41 Run. 34
Depth 175-180
RQD 97%
% Rec 100%


BWSTE PHZ
Boring B-41 Run 35
Depth 180 - 185
RQD 100%
% Rec 99 %


BWSTE PHZ
Boring B-41 Run 36
Depth 185 - 190
RQD 100%
% Rec 100 %

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BORING B-42 ROCK CORE PHOTO LOG


BWSTE PHZ
B-42 Run 3
DepTh: 20-30'
RQD: 80%
%Rec: 100%


BWSTE PHZ
B-42 Run 4
DepTh: 30-40'
RQD: 52%
%Rec: 99 %


BWSTE PHZ
B-42 Run 5
Depth: 40-50'
RQD: 66%
% Rec: 95%


BWSTE PHZ
B-42 Run 6
Depth: 50-60'
RQD: 17%
% Rec: 99%


BWSTE PHZ
B-42 Run 7
Depth: 60-70'
RQD: 56%
%Rec: 100%


BWSTE PHZ
B-42 Run 8
Depth: 70-80'
RQD: 34%
%Rec: 100%


BWSTE PH2
B-42 Run 9
Depth: 80-90'
RQD: 58%
% Rec: 100%


BWSTE PH2
B-42 Run 10
Depth: 90-100'
RQD: 72%
% Rec: 100%


BWSTE PH2
B-42 Run 11
Depth: 100-110
RQD: 95%
%Rec: 99%


BWSTE PH2
B-42 Run 12
Depth: 110-120
RQD: 100%
%Rec: 99%


BWSTE PH2
B-42 Run 13
Depth: 120-130
RQD: 92%
% Rec: 100%


BWSTE PH2
B-42 Run 14
Depth: 130-140'
RQD: 76%
% Rec: 100%

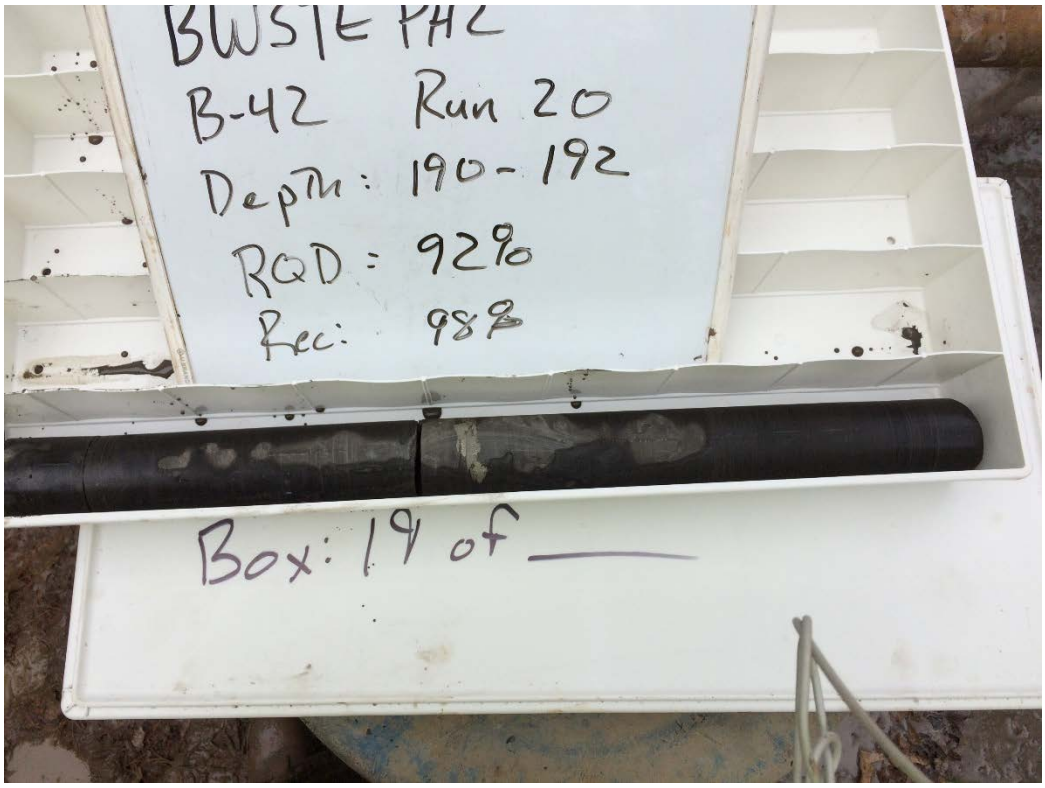

BWSTE PH2
B-42 Run 15
Depth: 140-150
RQD : 82%
% Rec: 100%


BWSTE PH2
B-42 Run 16
Depth: 150-160'
RQD: 71%
% Rec: 97%


BWSTE PH2
B-42 Run 17
Depth: 160-170
RQD: 94%
%Rec: 100%


BWSTE PH2
B-42 Run 18
Depth: 170-180
RQD: 98
Rec: 100%


BWSTE PH2
B-42 Run 19
Depth: 180-190
RQD = 89%
Rec: 98%


BWSTE PH2
B-42 Run 20
Depth: 190-192
RQD = 92%
Rec: 98%
Box: 19 of ___

BORING B-43 ROCK CORE PHOTO LOG


BWSTE 2
Boring: B-43
Sample: RC-3 "a"
Depth: 26.6 to 36.6
Rec = 9.5' RQD = 5.9/10


BWSTE 2
Boring: B-43
Sample: RC-3 "b"
Depth: 26.6 to 36.6
Rec = 9.5' RQD = 5.9/10


BWSTE 2
Boring: B-43
Sample: RC-4
Depth: 36.6 to 46.6
Rec = 6.7' RQD = 1.5/10

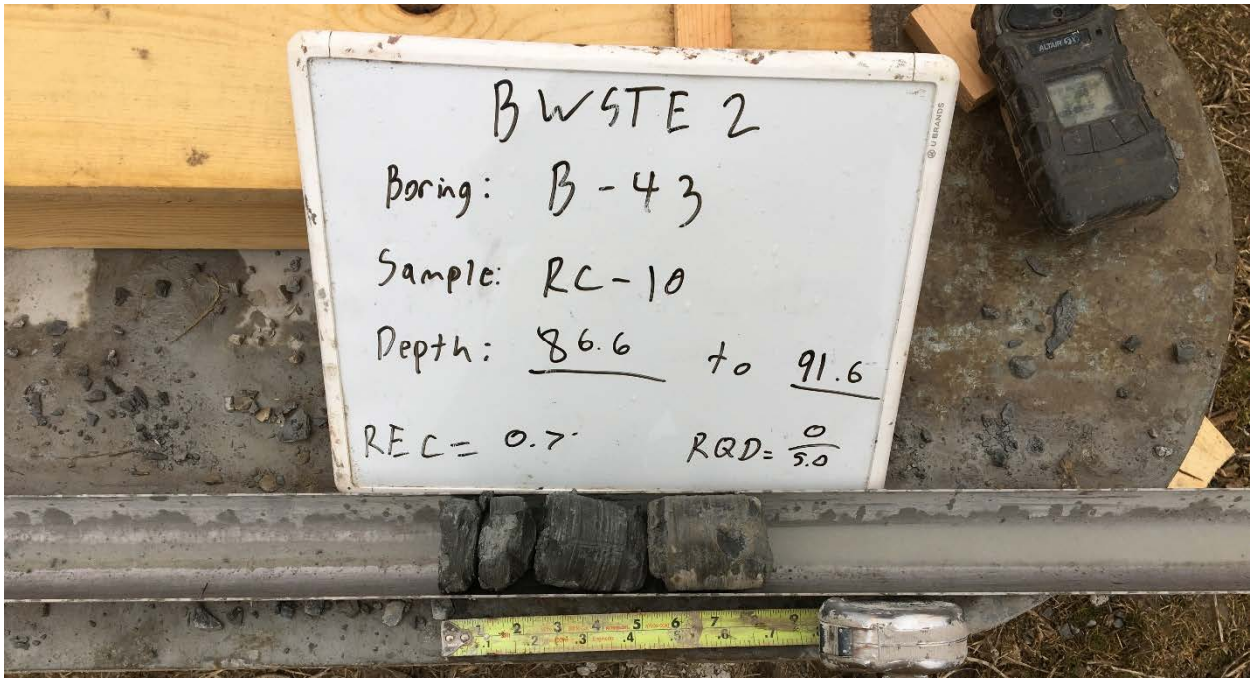

BWSTE 2
Boring: B-43
Sample: RC-5
Depth: 46.6 to 56.6
Rec = 5.0 RQD = 0.7/10


BWSTE 2
Boring: B-43
Sample: RC-6
Depth: 56.6 to 61.6
Rec = 3.3 RQD = 04/10


BWSTE 2
Boring: B-43
Sample: RC-7
Depth: 61.6 to 66.6'
Rec = 4.6' RQD = 04/5.0


BWSTE 2
Boring: B-43
Sample: RC-8 "a"
Depth: 66.6 to 76.6
Rec = 9.0 RQD = 6.8'/10
BWSTE 2
Boring: B-43
Sample: RC-8 "b"
Depth: 66.6 to 76.6
Rec = 9.0 RQD = 6.8'/10


BWSTE 2
Boring: B-43
Sample: RC-9 "a"
Depth: 76.6 to 86.6
REC = 8.5' RQD = 4'/10
BWSTE 2
Boring: B-43
Sample: RC-9 "b"
Depth: 76.6 to 86.6
REC = 8.5' RQD = 4'/10


BWSTE 2
Boring: B-43
Sample: RC-10
Depth: 86.6 to 91.6
REC= 0.7
RQD= 0/5.0


BWSTE 2
Boring: B-43
Sample: RC-11
Depth: 91.6 to 96.6
REC= 5.0
RQD= 4.3/5.0


BWSTE 2
Boring: B-43
Sample: RC-12
Depth: 96.6 to 101.6
REC= 2.3
RQD= 0.5/5.0


BWSTE 2
Boring: B-43
Sample: RC-13
Depth: 101.6 to 106.6
REC=5.0
RQD= 1.4/5.0


BWSTE 2
Boring: B-43
Sample: RC-14
Depth: 106.6 to 111.6
REC= 4.7
RQD= 0.5/5.0


BWSTE 2
Boring: B-43
Sample: RC-15
Depth: 111.6 to 116.6
REC= 4.6
RQD= 1.0/5.0


BWSTE 2
Boring: B-43
SAMPLE: RC-16 "a"
Depth: 116.6 to 126
REC= 9.3
RQD= 42/10
BWSTE 2
Boring: B-43
SAMPLE: RC-16 "b"
Depth: 116.6 to 126
REC= 9.3
RQD= 42/10


BWSTE 2
Boring: B-43
SAMPLE: RC-17 "a"
Depth: 126.6 to 136.6
REC= 10 RQD= 6.3/10
BWSTE 2
Boring: B-43
SAMPLE: RC-17 "b"
Depth: 126.6 to 136.6
REC= 10 RQD= 6.3/10


BWSTE 2
Boring: B-43
SAMPLE: RC-18 "a"
Depth: 136.6 to 146.6
REC= 9.9 RQD= 12/10
BWSTE 2
Boring: B-43
SAMPLE: RC-18 "b"
Depth: 136.6 to 146.6
REC= 9.9 RQD= 12/10


BWSTE 2
Boring: B-43
SAMPLE: RC-19 "a"
Depth: 146.6 to 156.6
REC = 9.3 RQD = 61/10
BWSTE 2
Boring: B-43
SAMPLE: RC-19 "b"
Depth: 146.6 to 156.6
REC = 9.3 RQD = 61/10


BWSTE 2
Boring: B-43
SAMPLE: RC-20 "a"
Depth: 156.6 to 166.6
REC = 10" RQD = 66/10
BWSTE 2
Boring: B-43
SAMPLE: RC-20 "b"
Depth: 156.6 to 166.6
REC = 10" RQD = 66/10


BWSTE 2
Boring: B-43
SAMPLE: RC-21 "a"
Depth: 166.6 to 176.6
REC = 9.8' RQD = 9.1/10
BWSTE 2
Boring: B-43
SAMPLE: RC-21 "b"
Depth: 166.6 to 176.6
REC = 9.8' RQD = 9.1/10


BWSTE 2
Boring: B-43
SAMPLE: RC-22 "a"
Depth: 176.6 to 186.6
REC = 10' RQD = 9.1/10
BWSTE 2
Boring: B-43
SAMPLE: RC-22 "b"
Depth: 176.6 to 186.6
REC = 10' RQD = 9.1/10

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BORING B-44 ROCK CORE PHOTO LOG


BWSTE PHZ
B-44 Run: 3
DepTh: 15-25'
RQD: 56%
% Rec: 96%


BWSTE PHZ
B-44 Run: 4
DepTh: 25'-35'
RQD: 56%
% Rec: 99%


BWSTE PHZ
B-44 Run: 5
Depth: 35-45'
RQD: 60%
% Rec: 90%


BWSTE PHZ
B-44 Run: 6
Depth: 45-55'
RQD: 27%
% Rec: 93%


BWSTE PHZ
B-44 Run: 7
Depth: 55-65'
RQD: 7%
% Rec: 92%


BWSTE PHZ
B-44 Run: 8
Depth: 65-75'
RQD: 42.5%
% Rec: 99%


BWSTE PHZ
B-44 Run: 9
Depth: 75-80'
RQD: 11%
% Rec: 100%


BWSTE PHZ
B-44 Run 10
Depth: 80-85'
RQD: 80%
% Rec: 93%


BWSTE PHZ
B-44 Run 11
Depth: 85-95
RQD: 72%
% Rec: 100%


BWSTE PHZ
B-44 Run 12
Depth: 95-105
RQD: 61%
% Rec: 100%


BWSTE PHZ
B-44 Run 13
Depth: 105-115
RQD: 86%
% Rec: 99%


BWSTE PHZ
B-44 Run 14
Depth: 115-125
RQD: 80%
% Rec: 99%


BWSTE PH2
B-44 Run 15
Depth: 125-135
RQD: 78%
% Rec: 100%


BWSTE PH2
B-44 Run 16
Depth: 135-145
RQD: 68%
% Rec: 99%


BWSTE PH2
B-44 Run 17
Depth: 145-155'
RQD: 44%
%Rec: 99%


BWSTE PH2
B-44 Run 18
Depth: 155-165'
RQD: 89%
100%


BWSTE PHZ
B-44 Run 19
Depth: 165-175'
RQD: 87%
%Rec: 100%


BWSTE PHZ
B-44 Run 20
Depth: 175-185'
RQD: 90%
%Rec: 97%


BWSTE PH2
B-44 Run 21
Depth: 185-192'
RQD: 92%
%Rec: 100%

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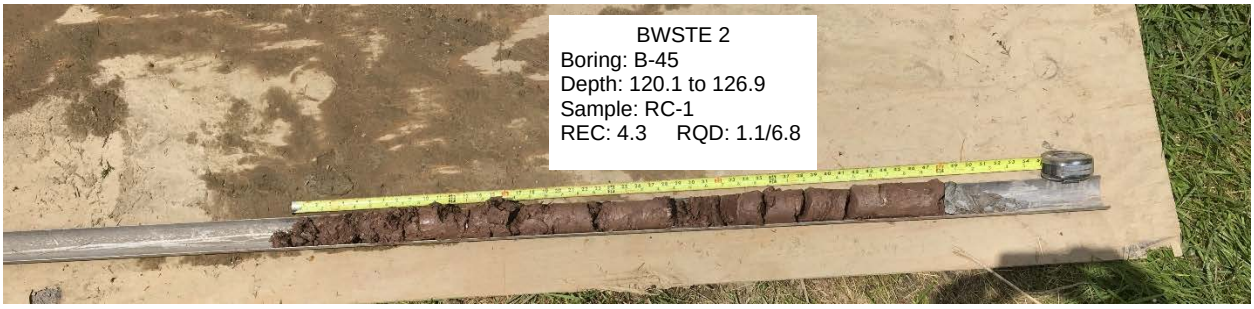
BORING B-45 ROCK CORE PHOTO LOG




BWSTE 2
Boring: B-45
Depth: 146.9 to 151.9
Sample: RC-5
REC: 5.0 RQD: 3.0/5.0


BWSTE 2
Boring: B-45
Depth: 151.9 to 161.9
Sample: RC-6 A
REC: 10.0 RQD: 5.6/10


BWSTE 2
Boring: B-45
Depth: 151.9 to 161.9
Sample: RC-6 B
REC: 10.0 RQD: 5.6/10


BWSTE 2
Boring: B-45
Depth: 161.9 to 171.9
Sample: RC-7 A
REC: 10.0 RQD: 7.5/10


BWSTE 2
Boring: B-45
Depth: 161.9 to 171.9
Sample: RC-7 B
REC: 10.0 RQD: 7.5/10

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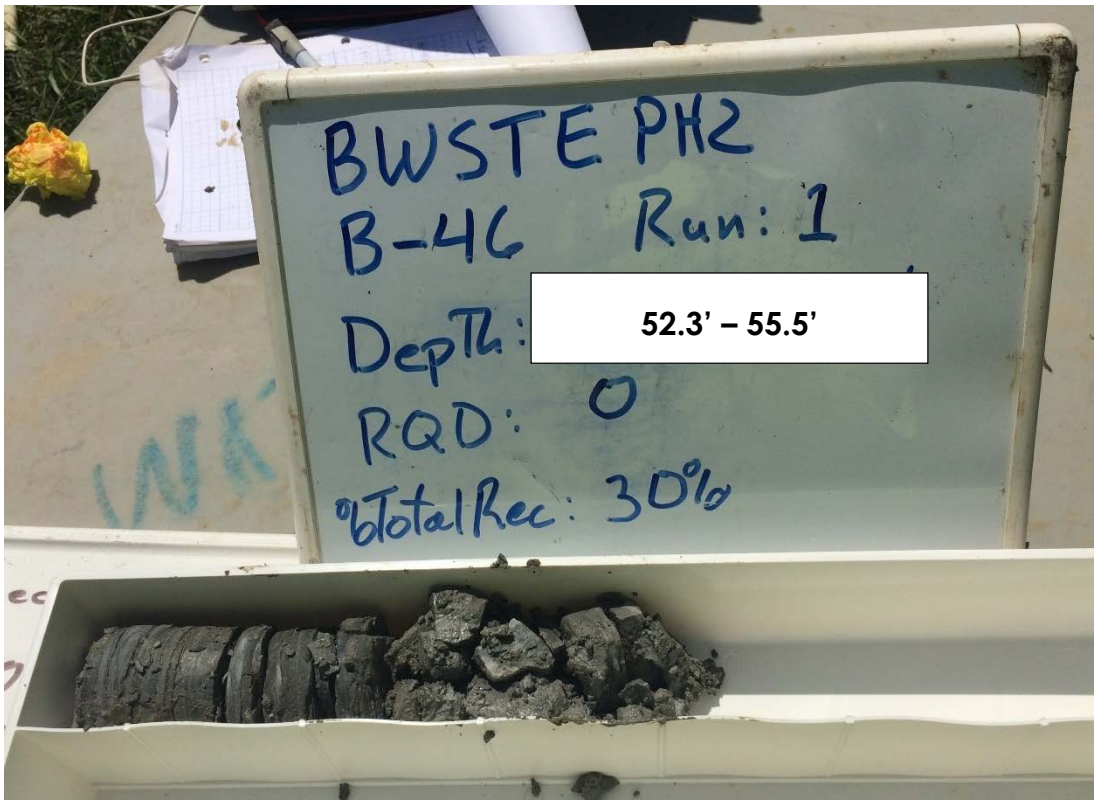
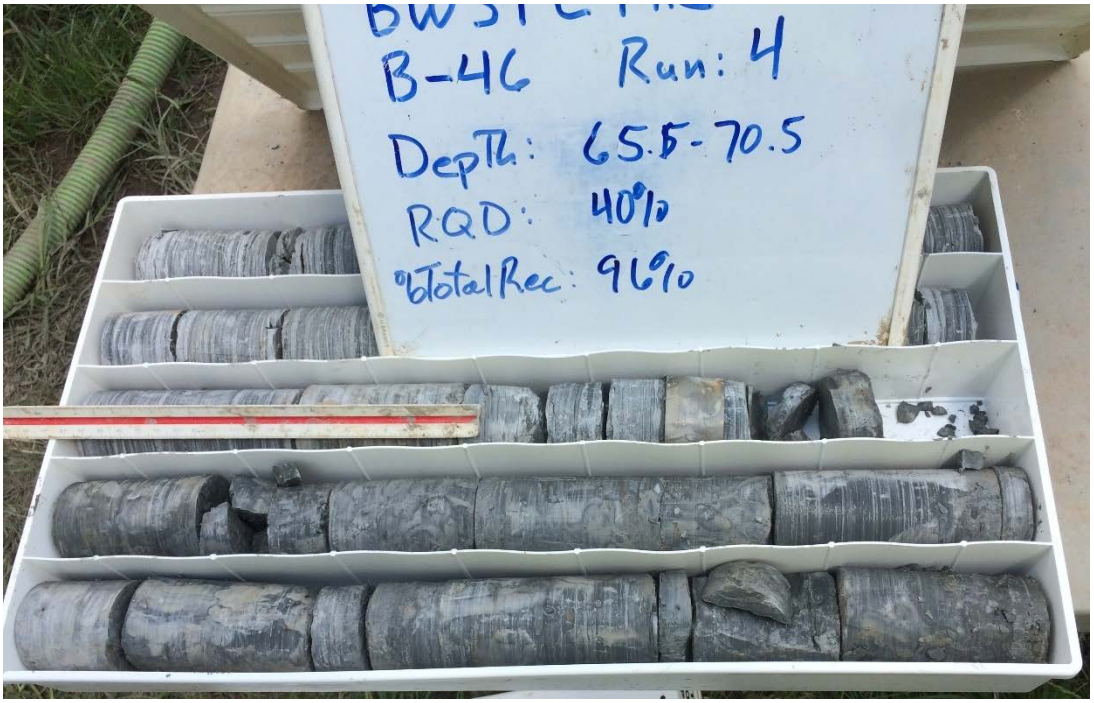
BORING B-46 ROCK CORE PHOTO LOG




BWSTE PH2
B-46 Run: 3
Depth: 60.5-65.5
RQD: 50%
%TotalRec: 96%


B-46 Run: 4
Depth: 65.5-70.5
RQD: 40%
%TotalRec: 96%

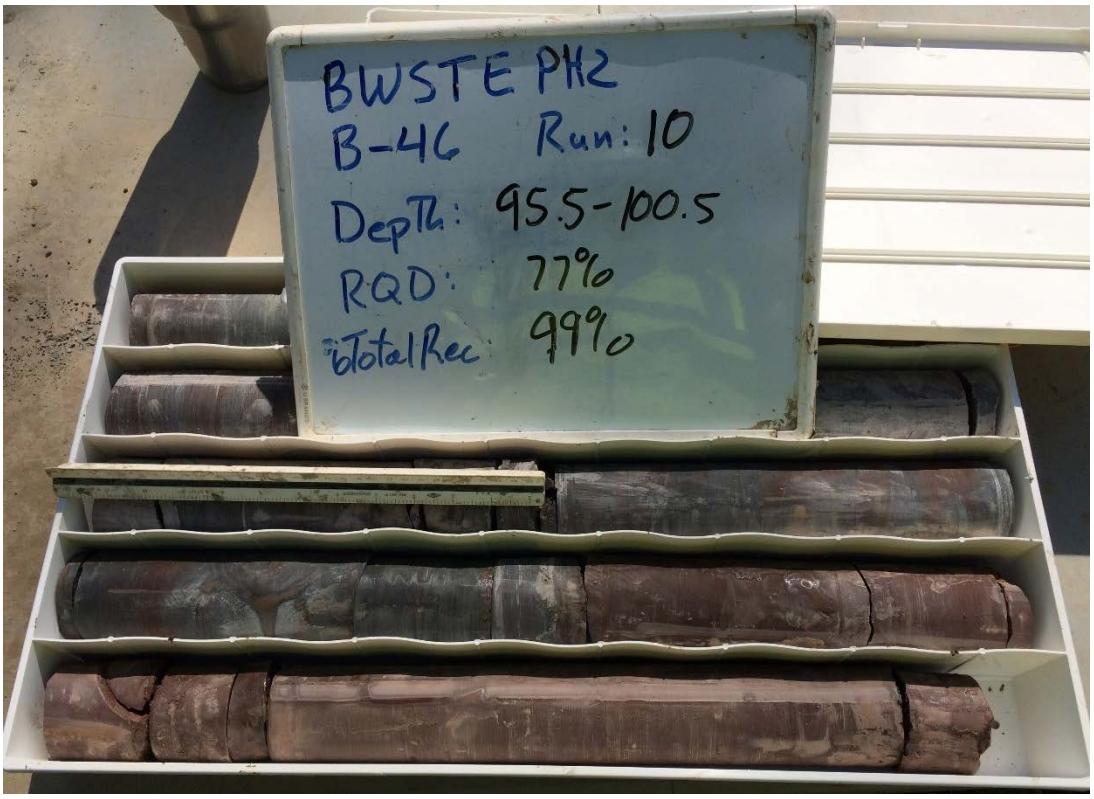

BWSTE FH2
B-46 Run: 5
Depth: 70.5 - 75.5
RQD: 65%
%TotalRec: 100%


BWSTE FH2
B-46 Run: 6
Depth: 75.5 - 80.5
RQD: 82%
%TotalRec: 96%


BWSTE FH2
B-46 Run: 7
Depth: 80.5-85.5
RQD: 77%
%Total Rec: 100%

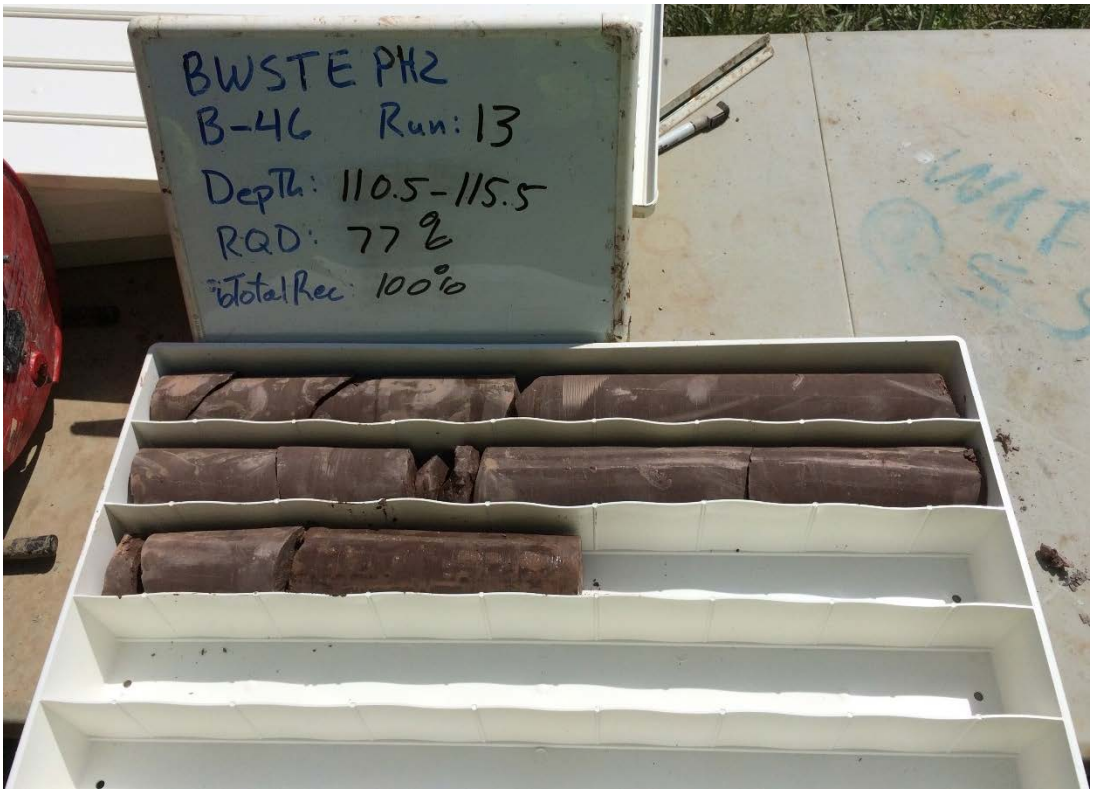

BWSTE FH2
B-46 Run: 8
Depth: 85.5-90.5
RQD: 98%
%Total Rec: 100%


BWSTE PH2
B-46 Run: 9
Depth: 90.5-95.5
RQD: 70%
%Total Rec 100%

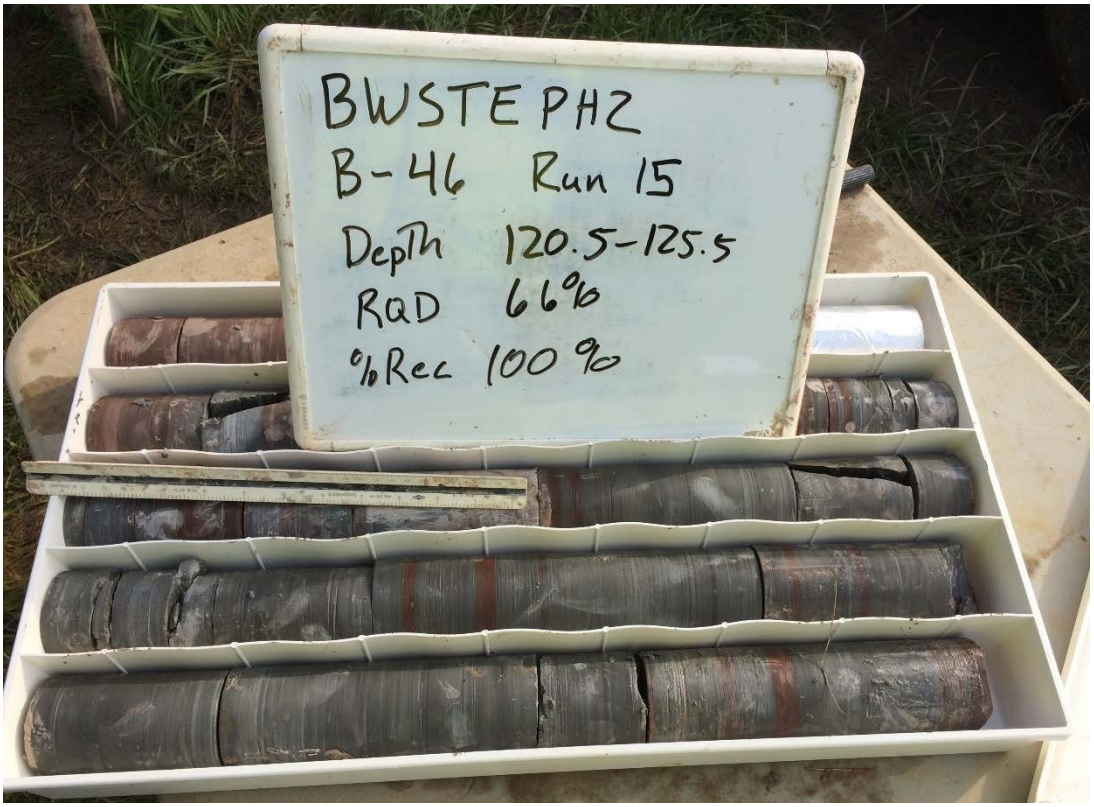

BWSTE PH2
B-46 Run: 10
Depth: 95.5-100.5
RQD: 77%
%Total Rec 99%

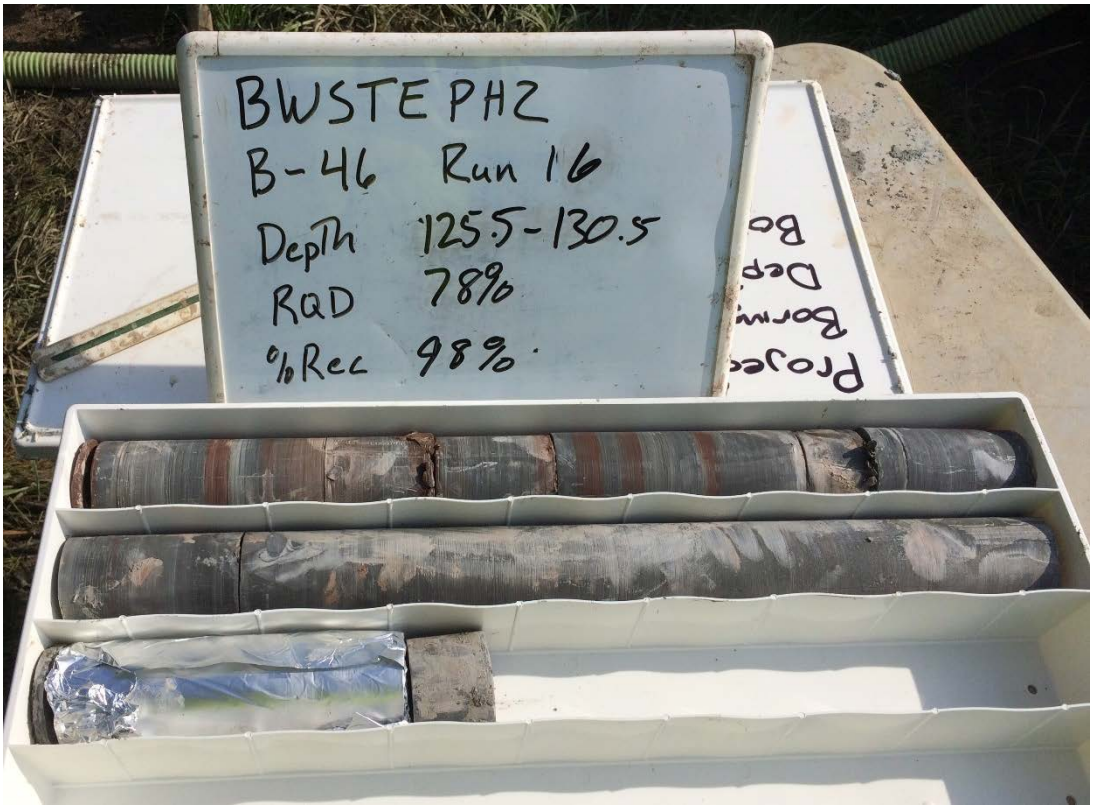

BWSTE PH2
B-46 Run: 11
Depth: 100.5 - 105.5
RQD: 45%
%TotalRec: 100%

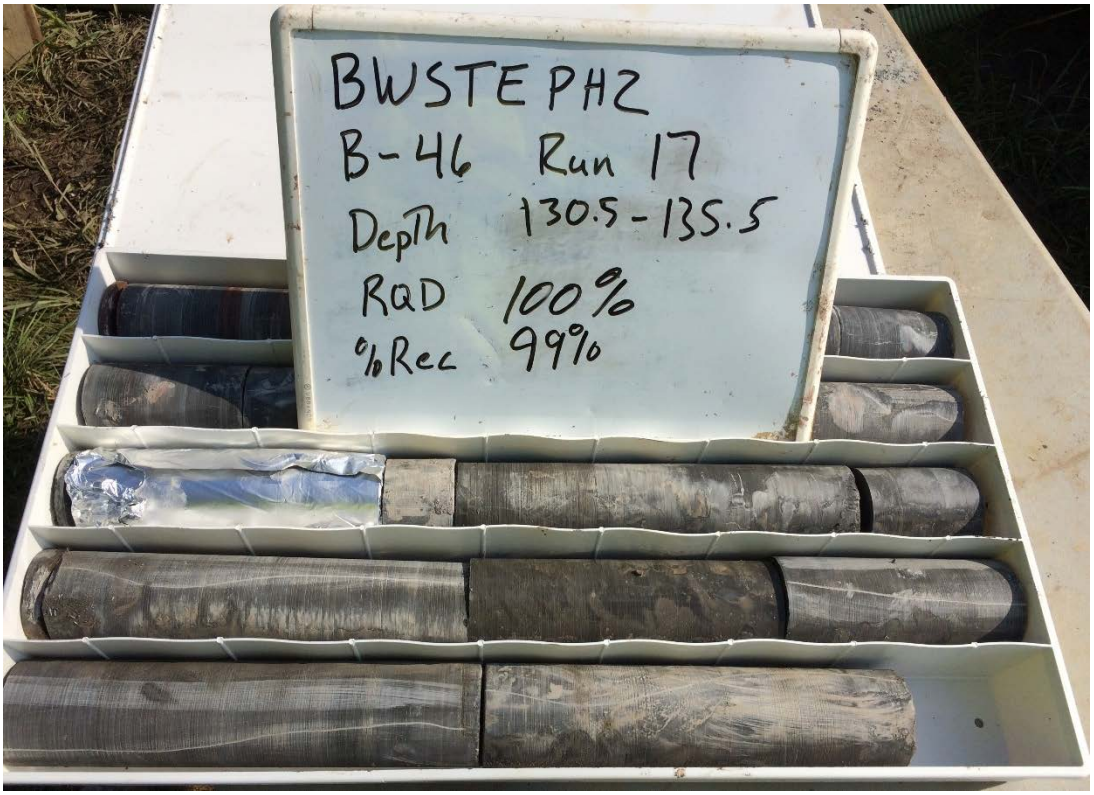

BWSTE PH2
B-46 Run: 12
Depth: 105.5 - 110.5
RQD: 87%
%TotalRec: 100%


BWSTE PH2
B-46 Run: 13
Depth: 110.5-115.5
RQD: 77 %
%TotalRec: 100%

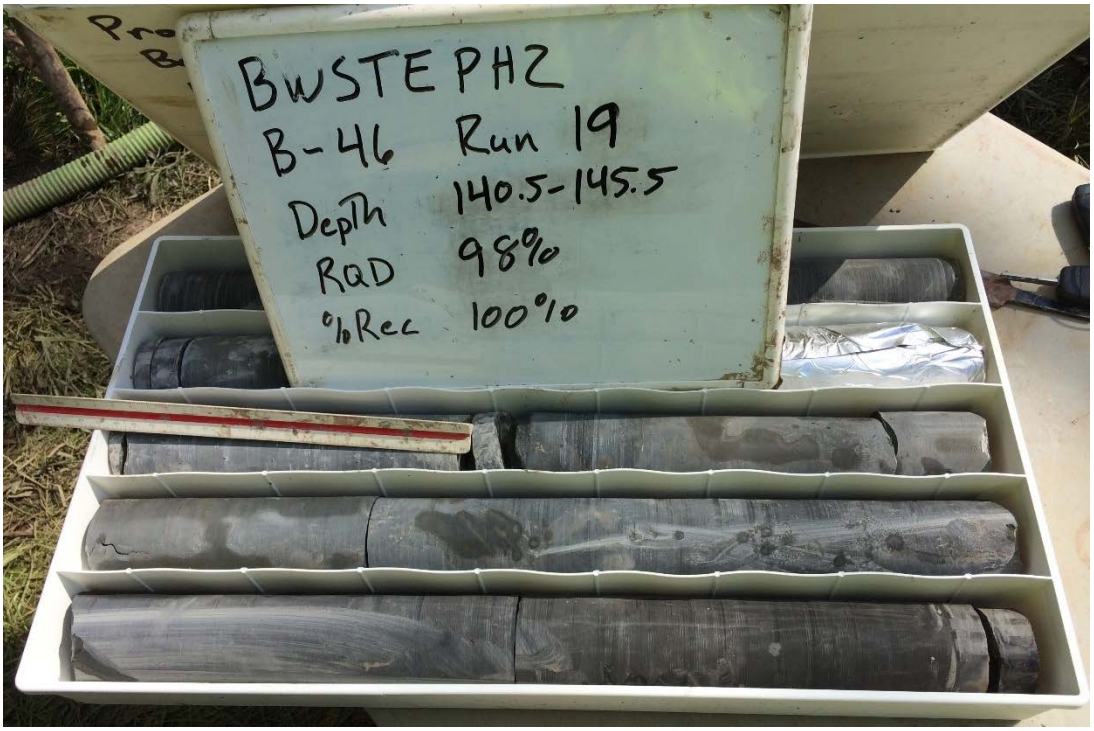

BWSTE PH2
B-46 Run 14
Depth 115.5-120.5
RQD 34%
%Rec 100%


BWSTE PHZ
B-46 Run 15
Depth 120.5-125.5
RQD 66%
%Rec 100%

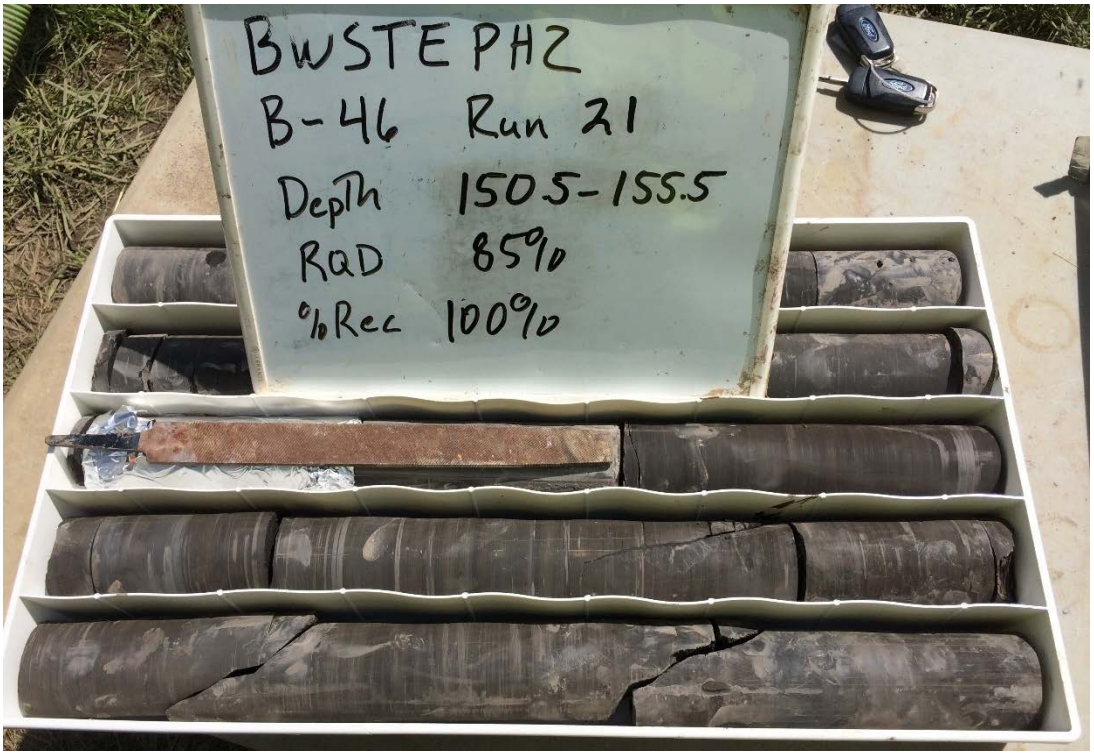

BWSTE PHZ
B-46 Run 16
Depth 125.5-130.5
RQD 78%
%Rec 98%

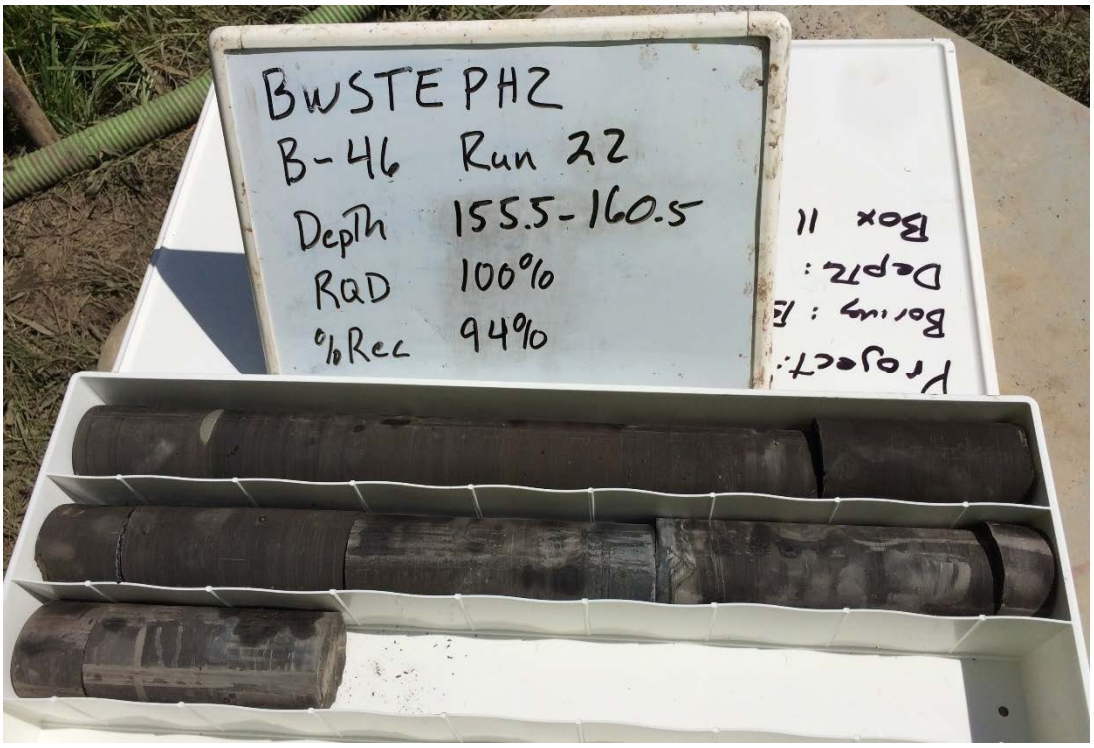

BWSTE PHZ
B-46 Run 17
Depth 130.5 - 135.5
RQD 100%
%Rec 99%

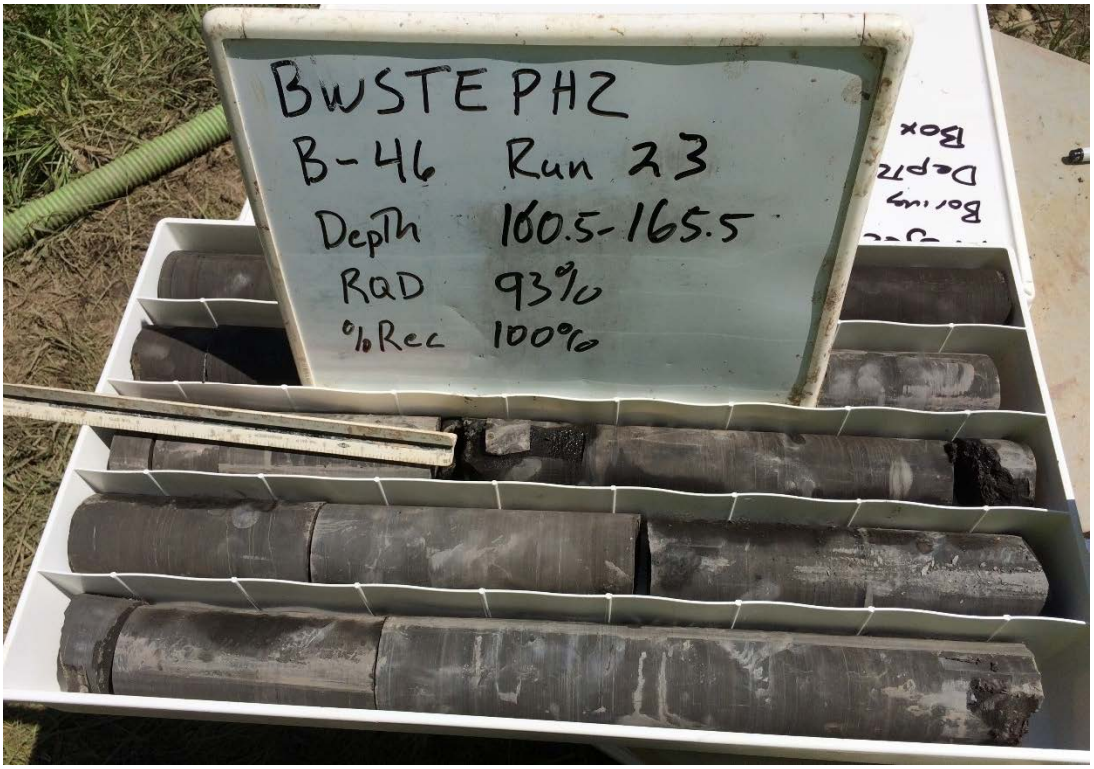

BWSTE PHZ
B-46 Run 18
Depth 135.5 - 140.5
RQD 93%
%Rec 99%


BWSTE PHZ
B-46 Run 19
Depth 140.5-145.5
RQD 98%
%Rec 100%


BWSTE PHZ
B-46 Run 20
Depth 145.5-150.5
RQD 100%
%Rec 100%


BWSTE PHZ
B-46 Run 21
Depth 150.5-155.5
RQD 85%
%Rec 100%


BWSTE PHZ
B-46 Run 22
Depth 155.5-160.5
RQD 100%
%Rec 94%


BWSTE PHZ
B-46 Run 23
Depth 160.5-165.5
RQD 93%
%Rec 100%


BWSTE PHZ
B-46 Run 24
Depth 165.5-170.5
RQD 100%
%Rec 100%

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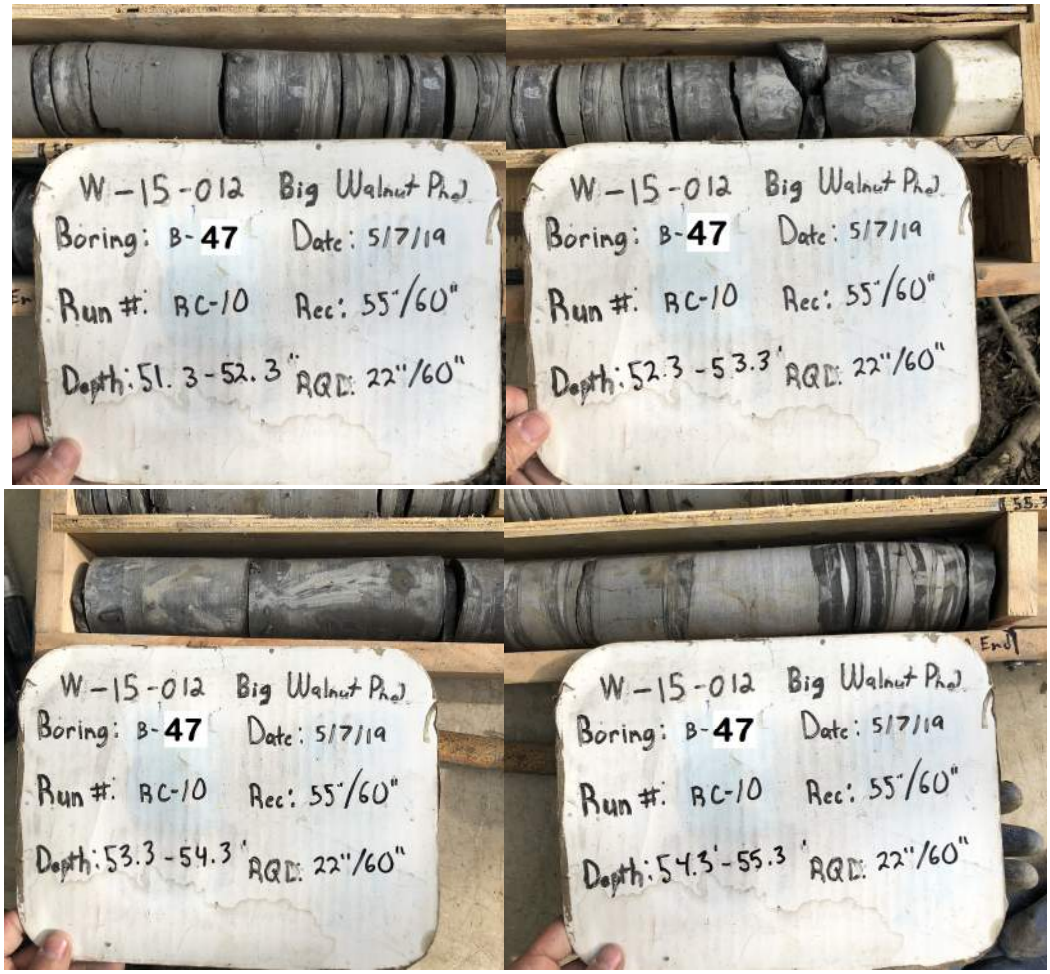
BORING B-47 ROCK CORE PHOTOS


W-15-012
B-47
HQ-5: 25.3-30.3
HQ-6: 30.3-35.3'

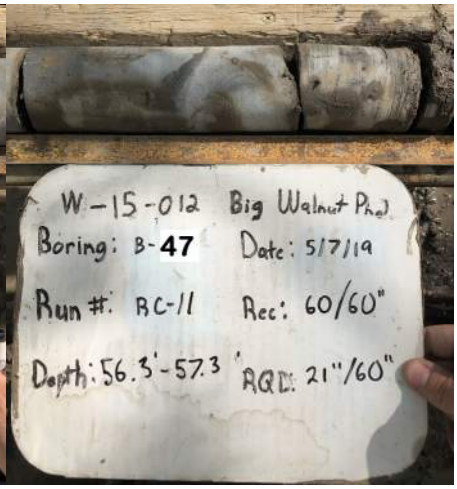
4


W-15-012
B-47
HQ-7: 35.3-40.3'
HQ-8: 40.3-45.3'


W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-9 Rec': 57"/60"
Depth: 45.3'-46.3' RQD: 36.5"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-9 Rec': 57"/60"
Depth: 46.3'-47.3' RQD: 36.5"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-9 Rec': 57"/60"
Depth: 47.3'-48.3' RQD: 36.5"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-9 Rec': 57"/60"
Depth: 49.3'-49.3' RQD: 36.5"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-9 Rec': 57"/60"
Depth: 49.3'-50.3' RQD: 36.5"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-10 Rec': 55"/60"
Depth: 50.3-51.3' RQD: 22"/60"

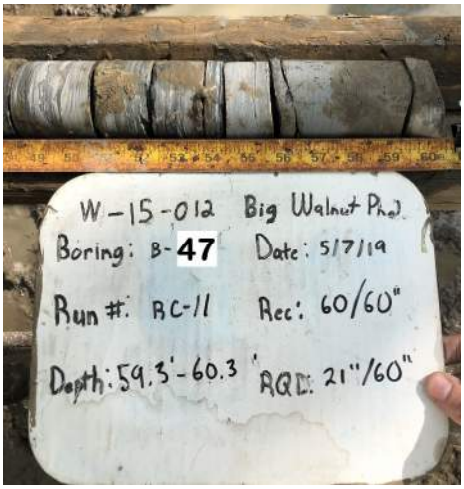

W-15-012 Big Walnut Pho
Boring: B-47 Date: 5/7/19
Run #: RC-10 Rec: 55"/60"
Depth: 51.3-52.3' RQD: 22"/60"
W-15-012 Big Walnut Pho
Boring: B-47 Date: 5/7/19
Run #: RC-10 Rec: 55"/60"
Depth: 52.3-53.3' RQD: 22"/60"
W-15-012 Big Walnut Pho
Boring: B-47 Date: 5/7/19
Run #: RC-10 Rec: 55"/60"
Depth: 53.3-54.3' RQD: 22"/60"
W-15-012 Big Walnut Pho
Boring: B-47 Date: 5/7/19
Run #: RC-10 Rec: 55"/60"
Depth: 54.3'-55.3' RQD: 22"/60"
End


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: BC-11 Rec: 60/60"
Depth: 55.3'-56.3' RQD: 21"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: BC-11 Rec: 60/60"
Depth: 56.3'-57.3' RQD: 21"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: BC-11 Rec: 60/60"
Depth: 57.3'-58.3' RQD: 21"/60"

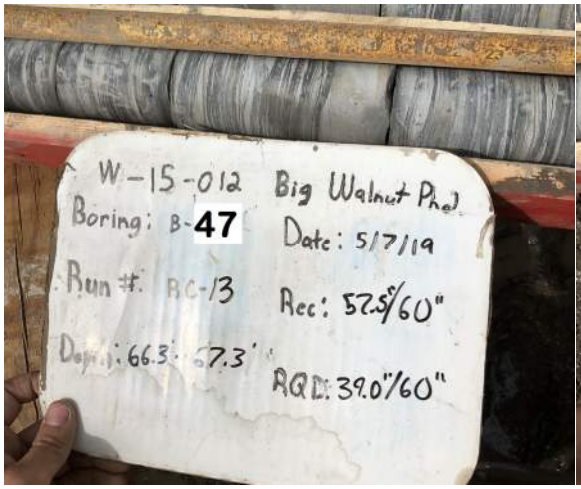

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: BC-11 Rec: 60/60"
Depth: 58.3'-59.3' RQD: 21"/60"

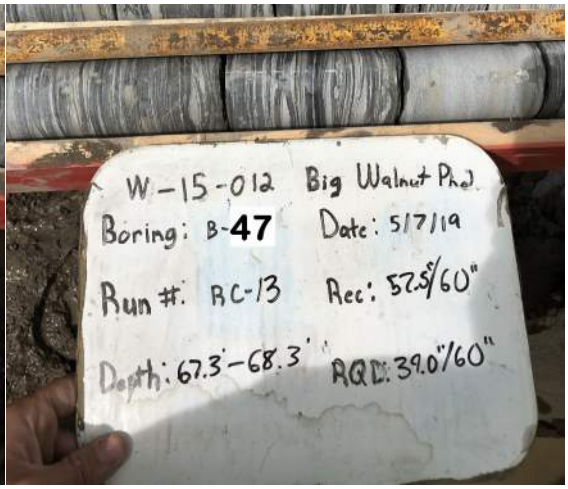

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: BC-11 Rec: 60/60"
Depth: 59.3'-60.3' RQD: 21"/60"

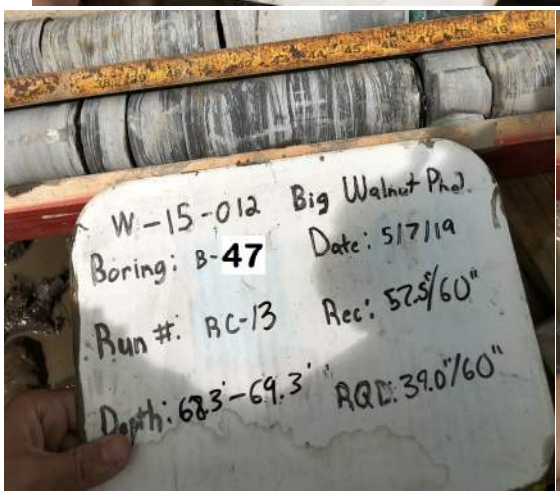

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-12 Rec: 57.5"/60"
Depth: 60.3-61.3' RQD: 39.5"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-12 Rec: 57.5"/60"
Depth: 61.3-62.3' RQD: 39.5"/60"

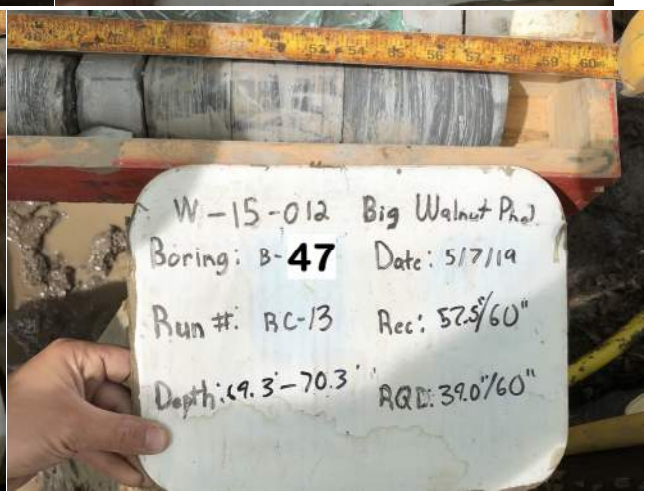

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-12 Rec: 57.5"/60"
Depth: 62.3-63.3' RQD: 39.5"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-12 Rec: 57.5"/60"
Depth: 63.3-64.3' RQD: 39.5"/60"

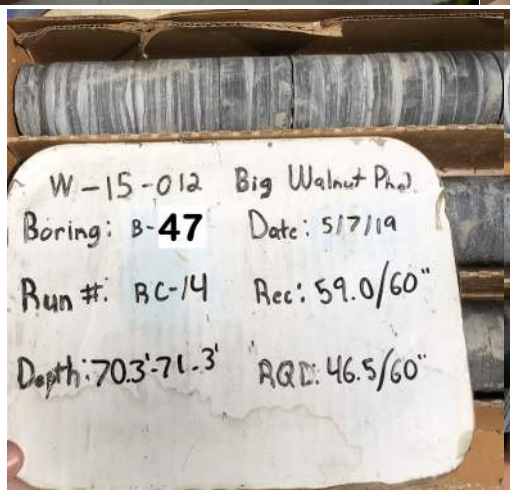

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-12 Rec: 57.5"/60"
Depth: 64.3-65.3' RQD: 39.5"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-13 Rec: 57.5"/60"
Depth: 65.3-66.3' RQD: 39.0"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-13 Rec: 57.5/60"
Depth: 66.3'-67.3' RQD: 39.0"/60"

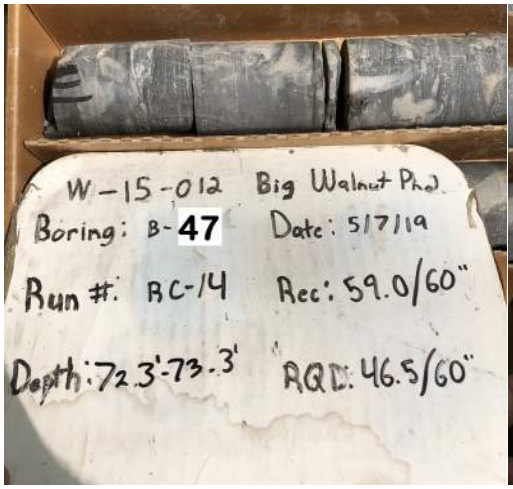

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-13 Rec: 57.5/60"
Depth: 67.3'-68.3' RQD: 39.0"/60"

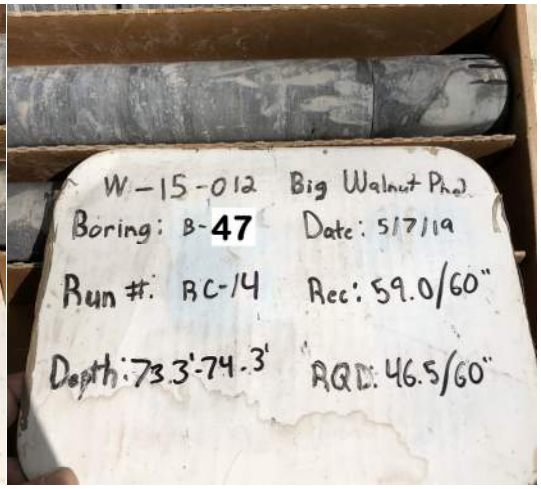

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-13 Rec: 57.5/60"
Depth: 68.3'-69.3' RQD: 39.0"/60"

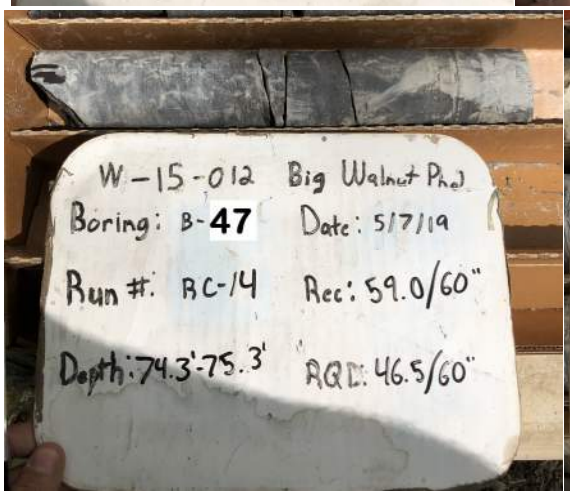

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-13 Rec: 57.5/60"
Depth: 69.3'-70.3' RQD: 39.0"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-14 Rec: 59.0/60"
Depth: 70.3'-71.3' RQD: 46.5/60"

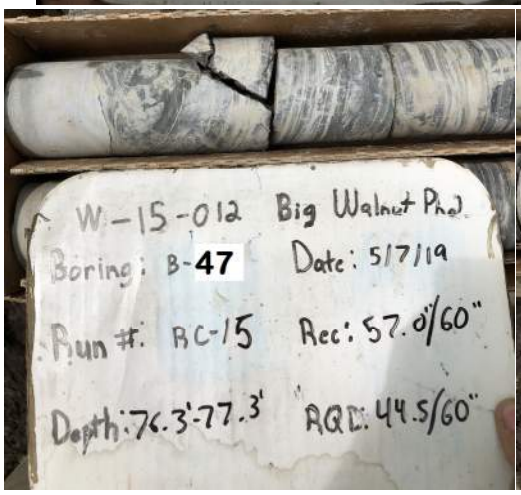

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-14 Rec: 59.0/60"
Depth: 71.3'-72.3' RQD: 46.5/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-14 Rec: 59.0/60"
Depth: 72.3'-73.3' RQD: 46.5/60"

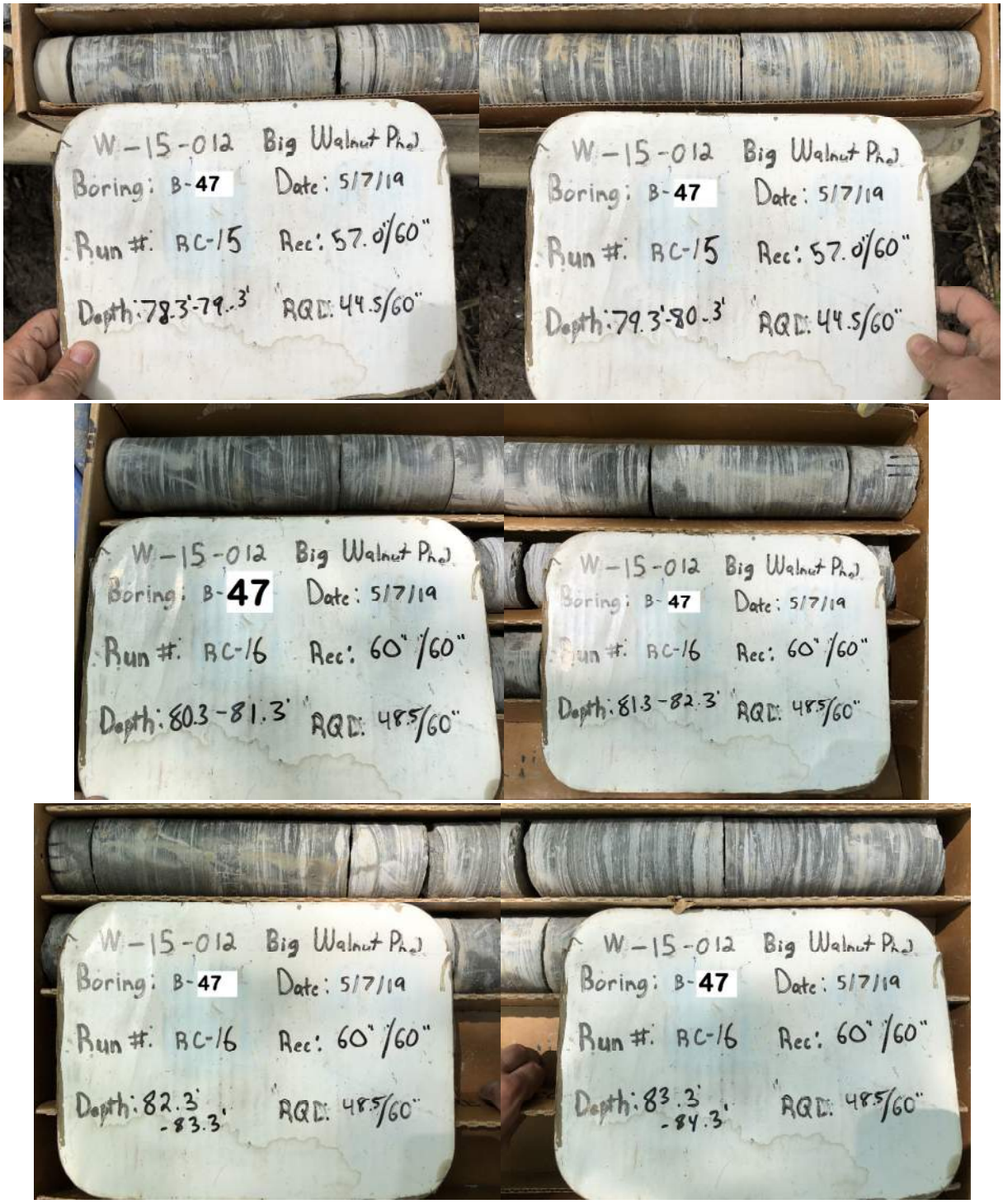

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-14 Rec: 59.0/60"
Depth: 73.3'-74.3' RQD: 46.5/60"

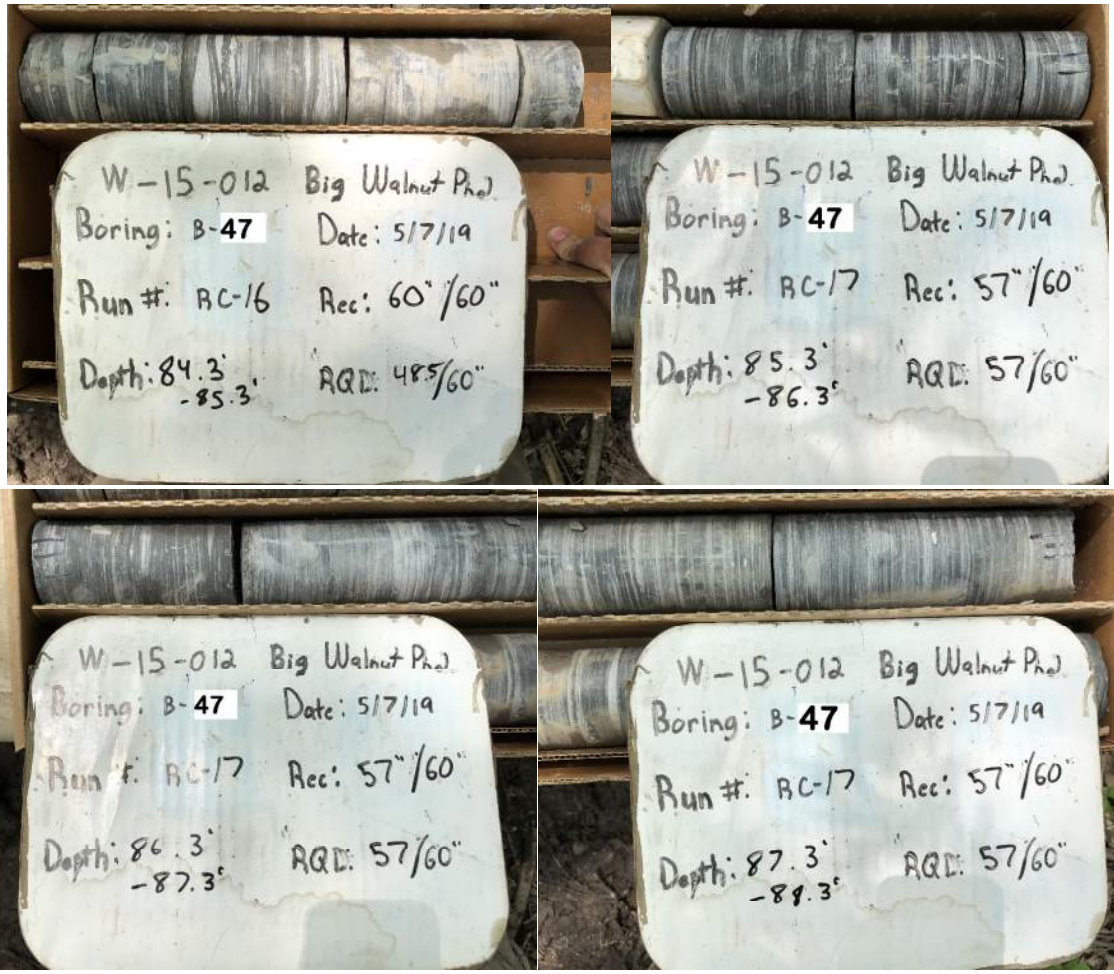

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-14 Rec: 59.0/60"
Depth: 74.3'-75.3' RQD: 46.5/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-15 Rec: 57.0/60"
Depth: 75.3'-76.3' RQD: 44.5/60"

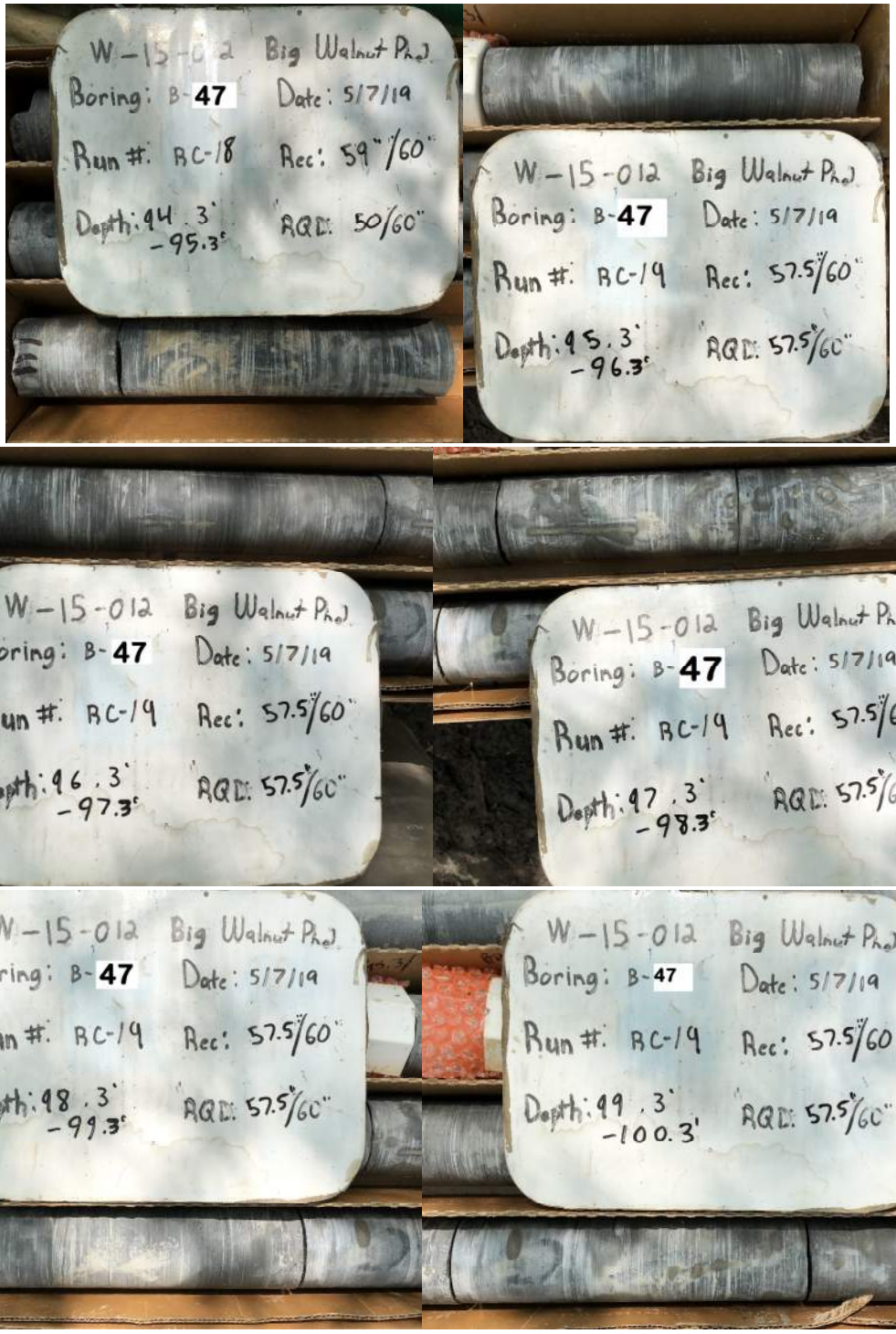

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-15 Rec: 57.0/60"
Depth: 76.3'-77.3' RQD: 44.5/60"

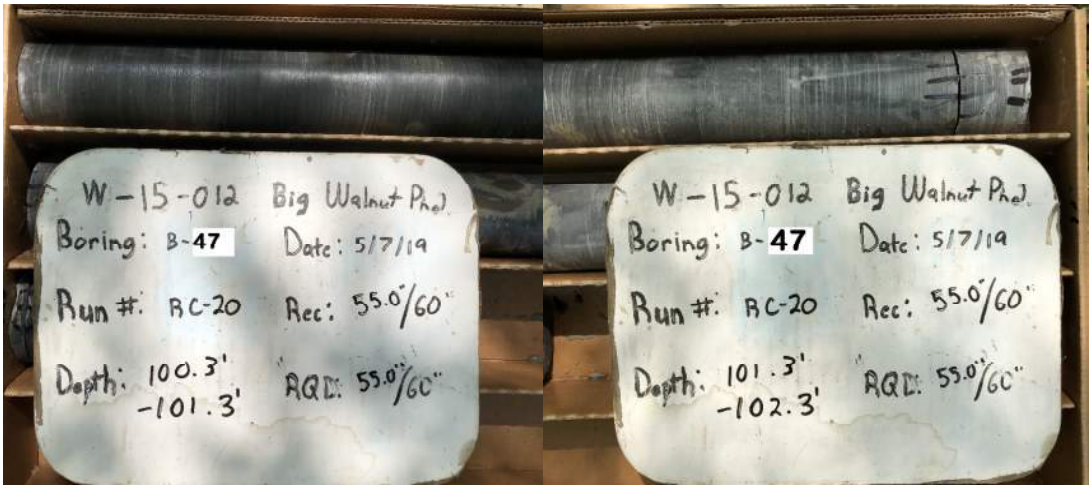

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-15 Rec: 57.0/60"
Depth: 77.3'-78.3' RQD: 44.5/60"

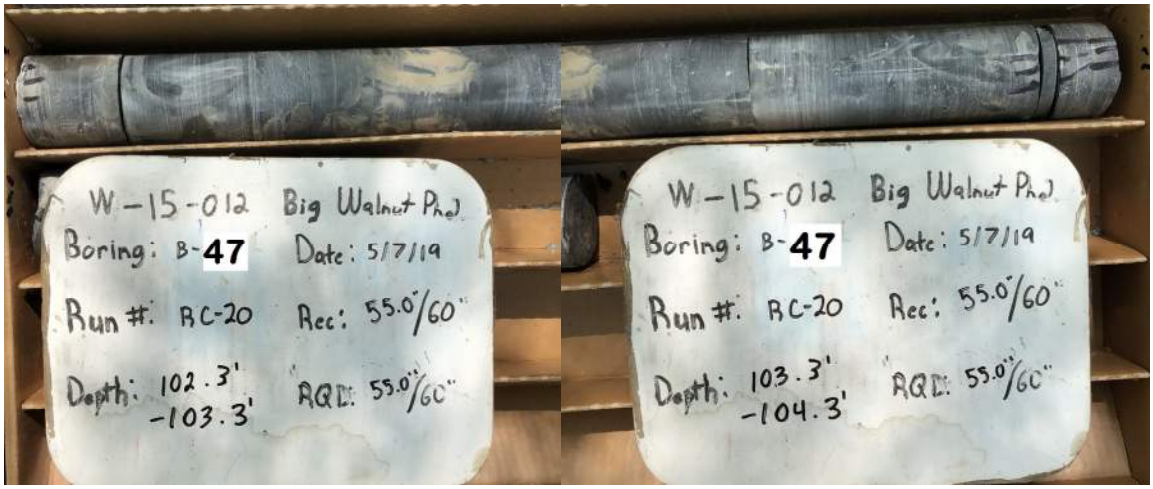

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-15 Rec: 57.0/60"
Depth: 78.3-79.3' RQD: 44.5/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-15 Rec: 57.0/60"
Depth: 79.3-80.3' RQD: 44.5/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-16 Rec: 60"/60"
Depth: 80.3-81.3' RQD: 48.5/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-16 Rec: 60"/60"
Depth: 81.3-82.3' RQD: 48.5/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-16 Rec: 60"/60"
Depth: 82.3-83.3' RQD: 48.5/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-16 Rec: 60"/60"
Depth: 83.3-84.3' RQD: 48.5/60"

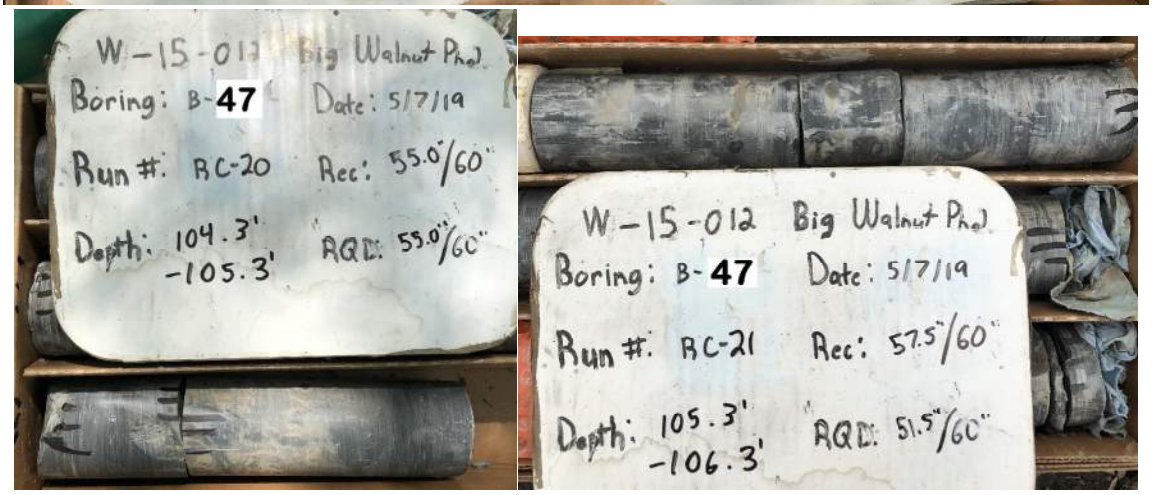

W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-16 Rec: 60"/60"
Depth: 84.3' - 85.3' RQD: 485/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-17 Rec: 57"/60"
Depth: 85.3' - 86.3' RQD: 57/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-17 Rec: 57"/60"
Depth: 86.3' - 87.3' RQD: 57/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-17 Rec: 57"/60"
Depth: 87.3' - 88.3' RQD: 57/60"

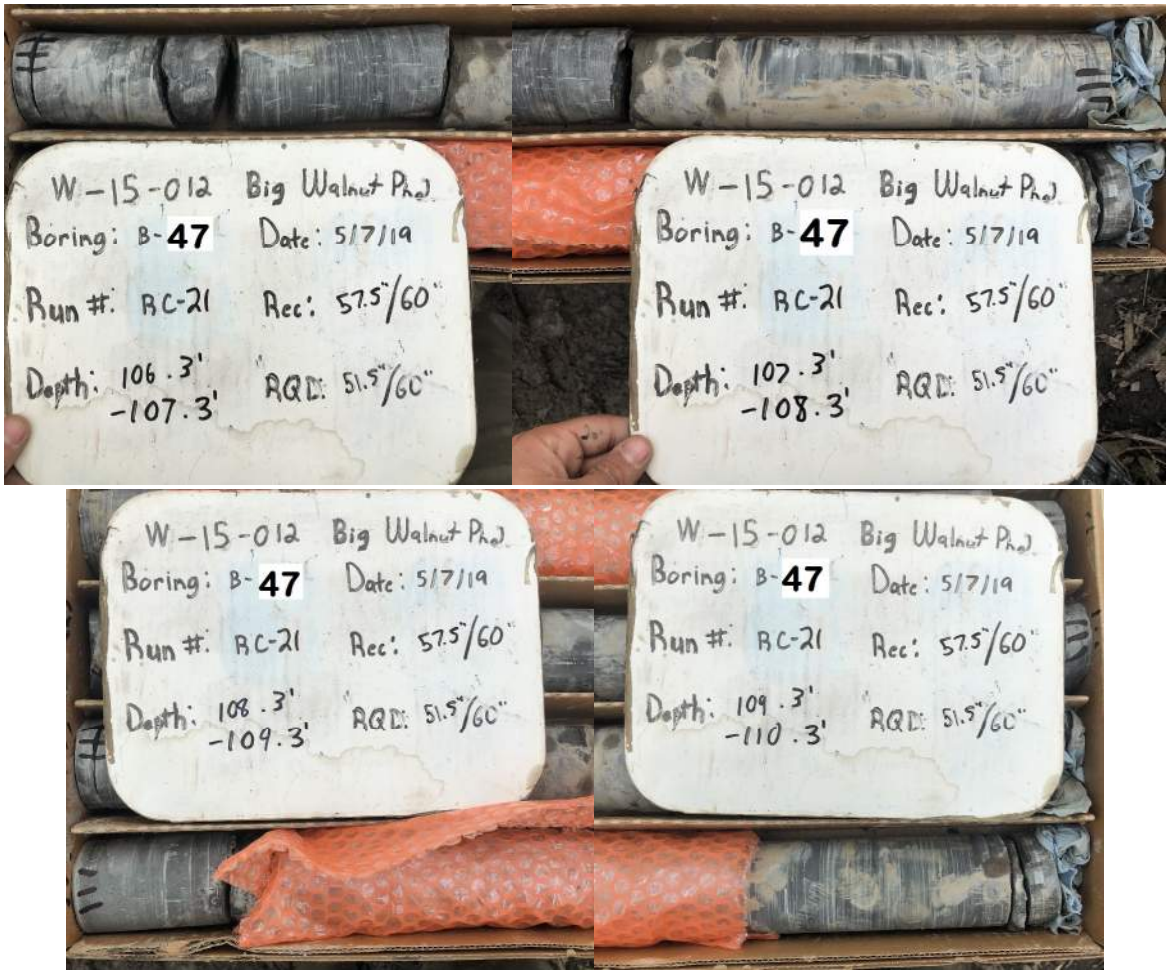

W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-17 Rec: 57"/60"
Depth: 88.3' - 89.3' RQD: 57/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-17 Rec: 57"/60"
Depth: 89.3' - 90.3' RQD: 57/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-18 Rec: 59"/60"
Depth: 90.3' - 91.3' RQD: 50/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-18 Rec: 59"/60"
Depth: 91.3' - 92.3' RQD: 50/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-18 Rec: 59"/60"
Depth: 92.3' - 93.3' RQD: 50/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-18 Rec: 59"/60"
Depth: 93.3' - 94.3' RQD: 50/60"

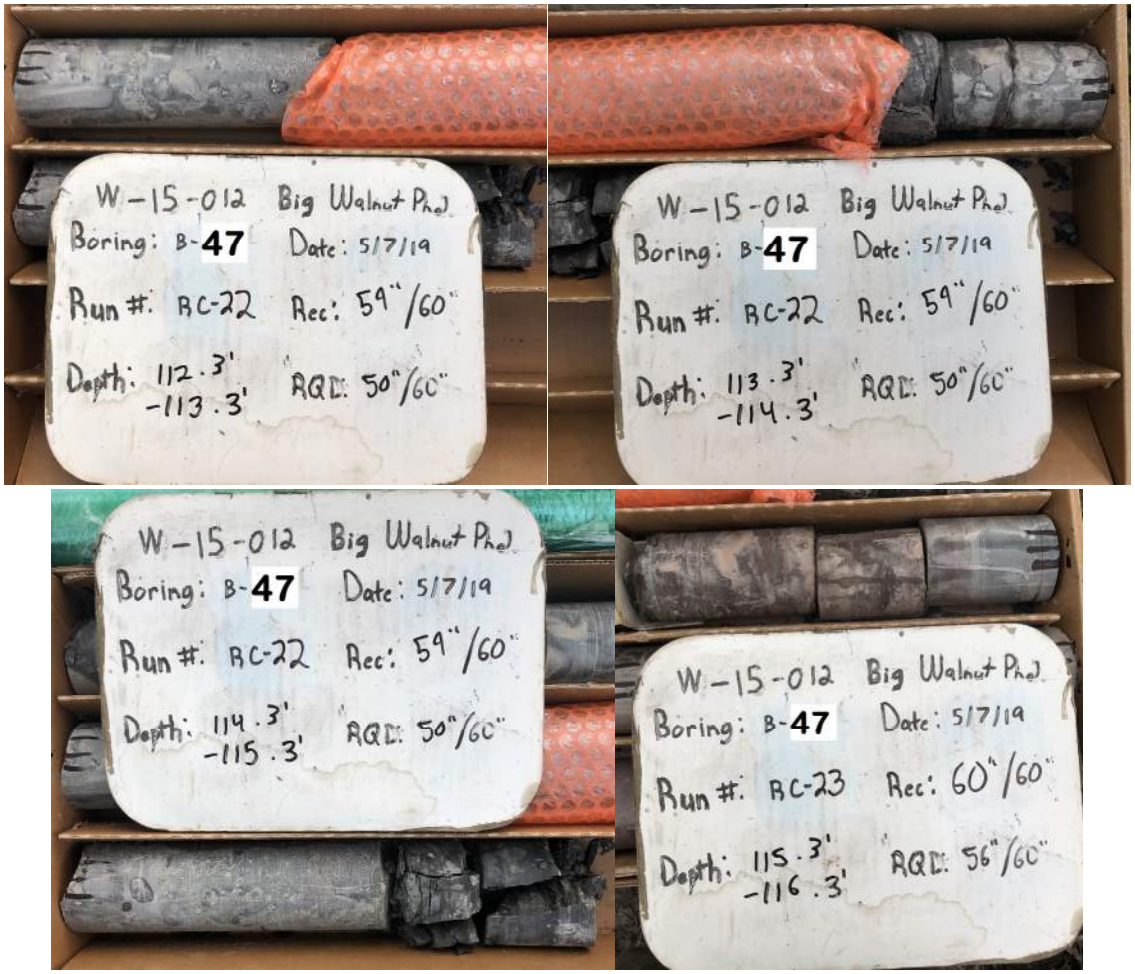

W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-18 Rec: 59"/60"
Depth: 94.3' - 95.3' RQD: 50/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-19 Rec: 57.5"/60"
Depth: 95.3' - 96.3' RQD: 57.5"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-19 Rec: 57.5"/60"
Depth: 96.3' - 97.3' RQD: 57.5"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-19 Rec: 57.5"/60"
Depth: 97.3' - 98.3' RQD: 57.5"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-19 Rec: 57.5"/60"
Depth: 98.3' - 99.3' RQD: 57.5"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/7/19
Run #: RC-19 Rec: 57.5"/60"
Depth: 99.3' - 100.3' RQD: 57.5"/60"

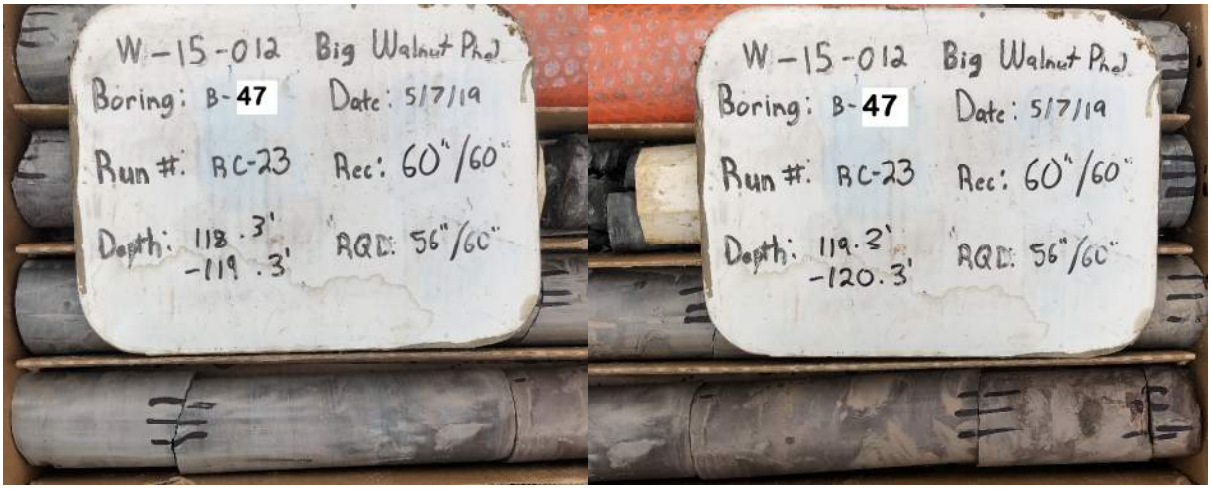

W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-20 Rec: 55.0"/60"
Depth: 100.3' -101.3' RQD: 55.0"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-20 Rec: 55.0"/60"
Depth: 101.3' -102.3' RQD: 55.0"/60"

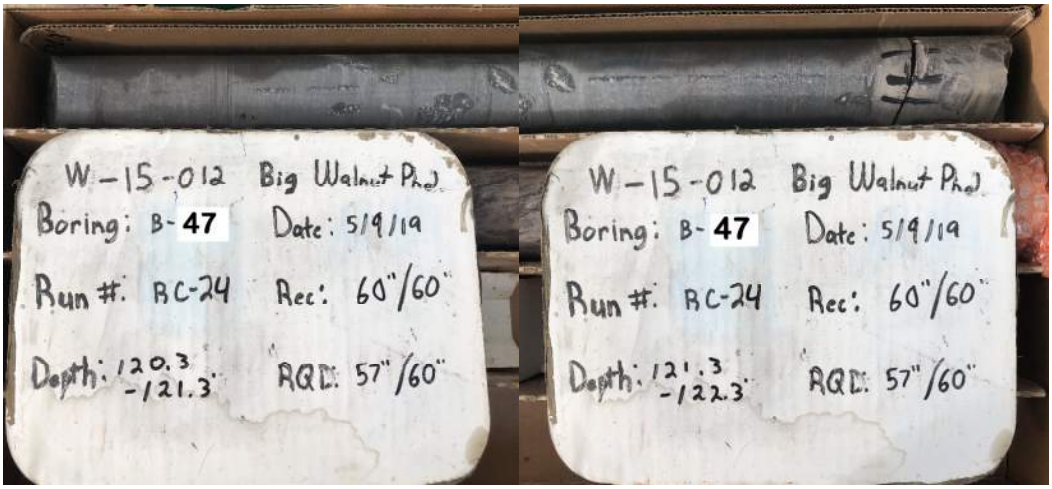

W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-20 Rec: 55.0"/60"
Depth: 102.3' -103.3' RQD: 55.0"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-20 Rec: 55.0"/60"
Depth: 103.3' -104.3' RQD: 55.0"/60"

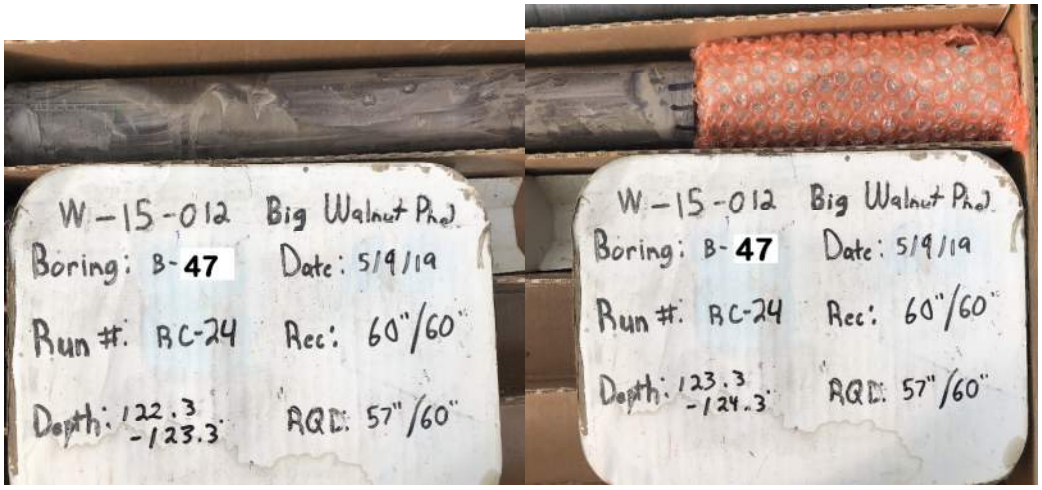

W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-20 Rec: 55.0"/60"
Depth: 104.3' -105.3' RQD: 55.0"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/7/19
Run #: RC-21 Rec: 57.5"/60"
Depth: 105.3' -106.3' RQD: 51.5"/60"


W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-21 Rec: 57.5"/60"
Depth: 106.3' -107.3' RQD: 51.5"/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-21 Rec: 57.5"/60"
Depth: 107.3' -108.3' RQD: 51.5"/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-21 Rec: 57.5"/60"
Depth: 108.3' -109.3' RQD: 51.5"/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-21 Rec: 57.5"/60"
Depth: 109.3' -110.3' RQD: 51.5"/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-22 Rec: 59"/60"
Depth: 110.3' -111.3' RQD: 50"/60"
W-15-012 Big Walnut Phase 1
Boring: B-47 Date: 5/7/19
Run #: RC-22 Rec: 59"/60"
Depth: 111.3' -112.3' RQD: 50"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-22 Rec: 59"/60"
Depth: 112.3' -113.3' RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-22 Rec: 59"/60"
Depth: 113.3' -114.3' RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-22 Rec: 59"/60"
Depth: 114.3' -115.3' RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-23 Rec: 60"/60"
Depth: 115.3' -116.3' RQD: 56"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-23 Rec: 60"/60"
Depth: 116.3' -117.3' RQD: 56"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-23 Rec: 60"/60"
Depth: 117.3' -118.3' RQD: 56"/60"

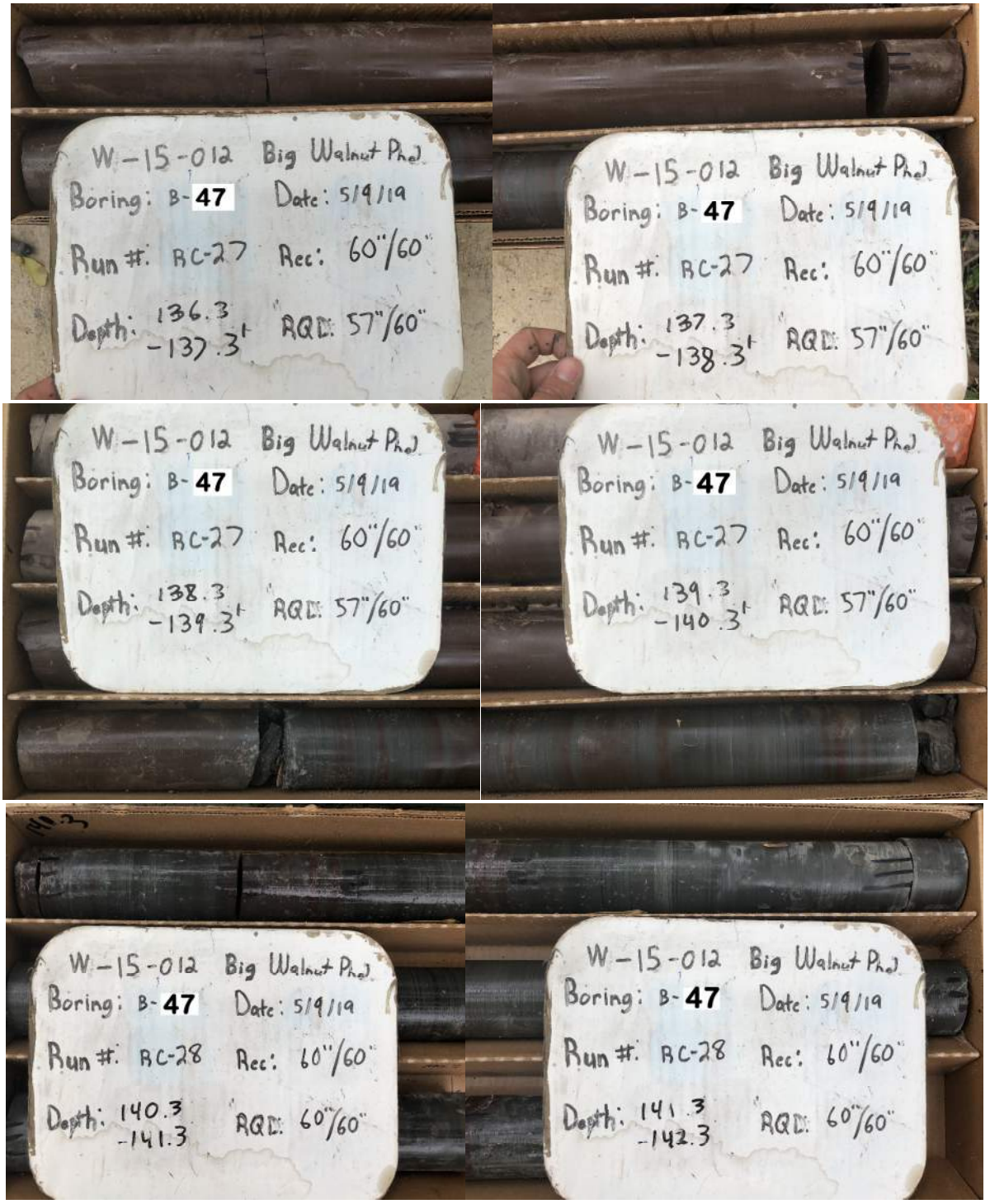

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-23 Rec: 60"/60"
Depth: 118.3' RQD: 56"/60"
-119.3'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/7/19
Run #: RC-23 Rec: 60"/60"
Depth: 119.3' RQD: 56"/60"
-120.3'


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-24 Rec: 60"/60"
Depth: 120.3 RQD: 57"/60"
-121.3'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-24 Rec: 60"/60"
Depth: 121.3 RQD: 57"/60"
-122.3'


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-24 Rec: 60"/60"
Depth: 122.3 RQD: 57"/60"
-123.3'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-24 Rec: 60"/60"
Depth: 123.3 RQD: 57"/60"
-124.3'

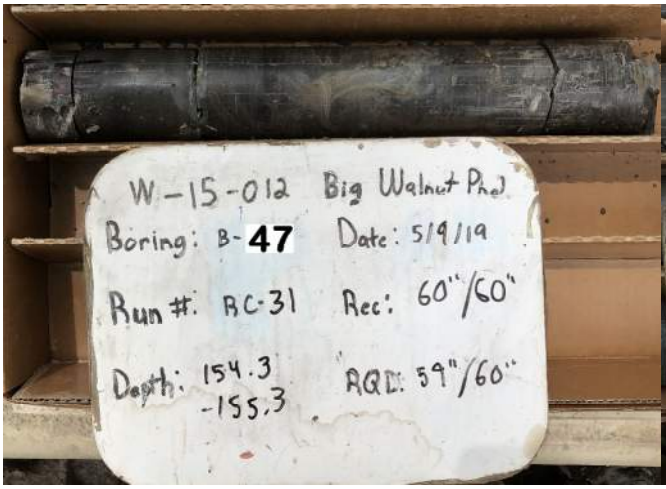

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-24 Rec: 60"/60"
Depth: 124.3 -125.3 RQD: 57"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-2 Rec: 57"/60"
Depth: 125.3 -126.3 RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-2 Rec: 57"/60"
Depth: 126.3 -127.3 RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-2 Rec: 57"/60"
Depth: 127.3 -128.3 RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-2 Rec: 57"/60"
Depth: 128.3 -129.3 RQD: 50"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-2 Rec: 57"/60"
Depth: 129.3 -130.3 RQD: 50"/60"


W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-26 Rec: 52"/60"
Depth: 130.3 -131.3' RQD: 52"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-26 Rec: 52"/60"
Depth: 131.3 -132.3' RQD: 52"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-26 Rec: 52"/60"
Depth: 132.3 -133.3' RQD: 52"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-26 Rec: 52"/60"
Depth: 133.3 -134.3' RQD: 52"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-26 Rec: 52"/60"
Depth: 134.3 -135.3' RQD: 52"/60"
W-15-012 Big Walnut Proj.
Boring: B-47 Date: 5/9/19
Run #: RC-27 Rec: 60"/60"
Depth: 135.3 -136.3' RQD: 57"/60"

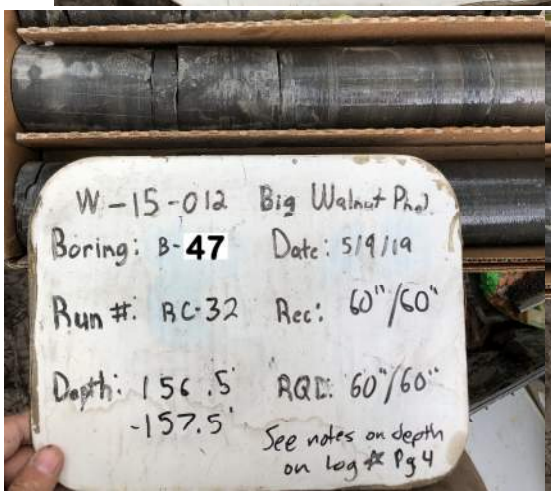

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-27 Rec: 60"/60"
Depth: 136.3 -137.3' RQD: 57"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-27 Rec: 60"/60"
Depth: 137.3 -138.3' RQD: 57"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-27 Rec: 60"/60"
Depth: 138.3 -139.3' RQD: 57"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-27 Rec: 60"/60"
Depth: 139.3 -140.3' RQD: 57"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-28 Rec: 60"/60"
Depth: 140.3 -141.3 RQD: 60"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-28 Rec: 60"/60"
Depth: 141.3 -142.3 RQD: 60"/60"

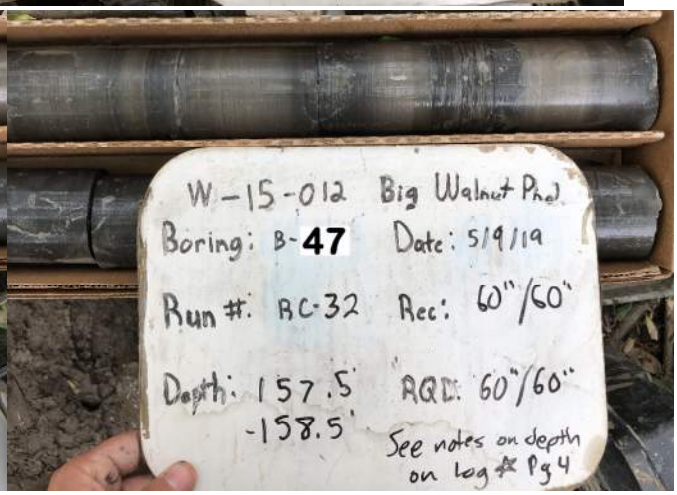

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-28 Rec: 60"/60"
Depth: 142.3 -143.3 RQD: 60"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-28 Rec: 60"/60"
Depth: 143.3 -144.3 RQD: 60"/60"
145.3'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-28 Rec: 60"/60"
Depth: 144.3 -145.3 RQD: 60"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-29 Rec: 32"/36"
Depth: 145.3 -146.3 RQD: 32"/36"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-29 Rec: 32"/36"
Depth: 146.3 -147.3 RQD: 32"/36"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-29 Rec: 32"/36"
Depth: 147.3 -148.3 RQD: 32"/36"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-30 Rec: 24"/24"
Depth: 148.3 -149.3 RQD: 24"/24"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-30 Rec: 24"/24"
Depth: 149.3 -150.3 RQD: 24"/24"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-31 Rec: 60"/60"
Depth: 150.3 -151.3 RQD: 59"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-31 Rec: 60"/60"
Depth: 151.3 -152.3 RQD: 59"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-31 Rec: 60"/60"
Depth: 152.3 -153.3 RQD: 59"/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-31 Rec: 60"/60"
Depth: 153.3 -154.3 RQD: 59"/60"

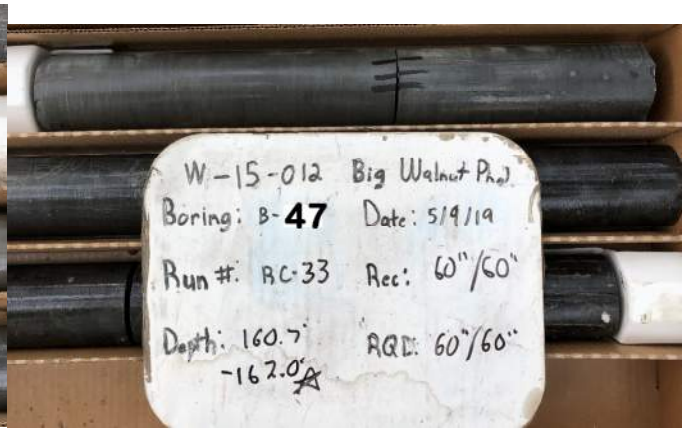

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-31 Rec: 60"/60"
Depth: 154.3 -155.3 RQD: 59"/60"

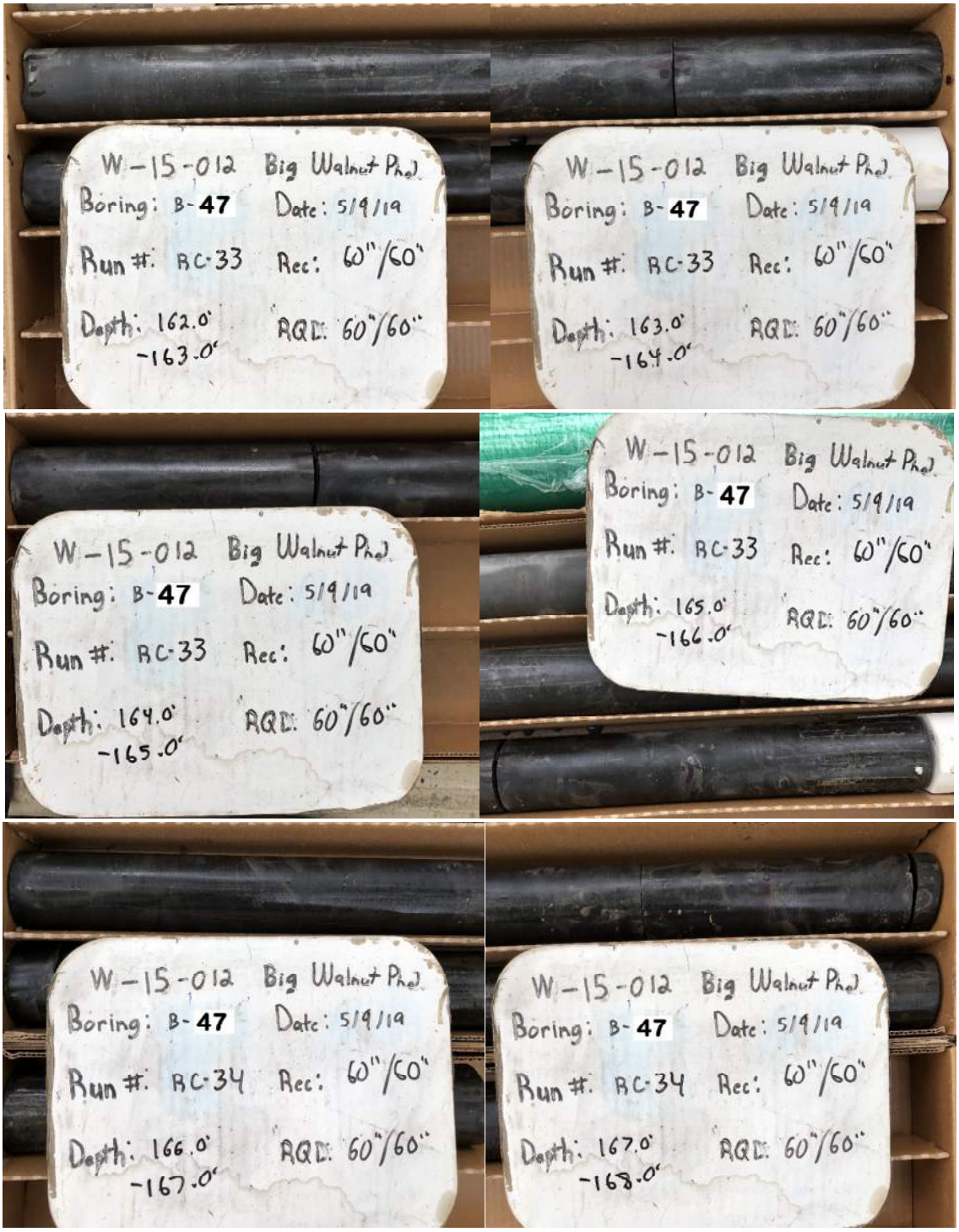

W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-32 Rec: 60"/60"
Depth: 155.5 -156.5 RQD: 60"/60"
See notes on depth on log ☆ Pg 4


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-32 Rec: 60"/60"
Depth: 156.5 -157.5 RQD: 60"/60"
See notes on depth on log ☆ Pg 4


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-32 Rec: 60"/60"
Depth: 157.5 -158.5 RQD: 60"/60"
See notes on depth on log ☆ Pg 4


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-32 Rec: 60"/60"
Depth: 158.5 -159.5 RQD: 60"/60"
See notes on depth on log ☆ Pg 4


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-33 Rec: 60"/60"
Depth: 160.7 -162.0☆ RQD: 60"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-33 Rec: 60"/60"
Depth: 162.0' RQD: 60"/60"
-163.0'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-33 Rec: 60"/60"
Depth: 163.0' RQD: 60"/60"
-164.0'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-33 Rec: 60"/60"
Depth: 164.0' RQD: 60"/60"
-165.0'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-33 Rec: 60"/60"
Depth: 165.0' RQD: 60"/60"
-166.0'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-34 Rec: 60"/60"
Depth: 166.0' RQD: 60"/60"
-167.0'
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/9/19
Run #: RC-34 Rec: 60"/60"
Depth: 167.0' RQD: 60"/60"
-168.0'


W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-34 Rec: 60"/60"
Depth: 168.0' RQD: 60"/60"
-169.0'
W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-34 Rec: 60"/60"
Depth: 169.0' RQD: 60"/60"
-170.0'
W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-34 Rec: 60"/60"
Depth: 170.0' RQD: 60"/60"
-171.0'
W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-35 Rec: 54.5"/60"
Depth: 172.0' RQD: 53"/60"
-173.0'
W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-35 Rec: 54.5"/60"
Depth: 173.0' RQD: 53"/60"
-174.0'
W-15-012 Big Walnut Ph2
Boring: B-47 Date: 5/9/19
Run #: RC-35 Rec: 54.5"/60"
Depth: 174.0' RQD: 53"/60"
-175.0'


W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/9/19
Run #: RC-35 Rec: 54.5"/60"
Depth: 175.0' - 176.0' RQD: 53"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/10/19
Run #: RC-36 Rec: 59"/60"
Depth: 176.0' - 177.0' RQD: 59"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/10/19
Run #: RC-36 Rec: 59"/60"
Depth: 177.0' - 178.0' RQD: 59"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/10/19
Run #: RC-36 Rec: 59"/60"
Depth: 178.0' - 179.0' RQD: 59"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/10/19
Run #: RC-36 Rec: 59"/60"
Depth: 179.0' - 180.0' RQD: 59"/60"
W-15-012 Big Walnut Proj
Boring: B-47 Date: 5/10/19
Run #: RC-36 Rec: 59"/60"
Depth: 180.0' - 181.0' RQD: 59"/60"


W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/10/19
Run #: RC-37 Rec: 60"/60"
Depth: 181.0'-182.0' RQD: 57/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/10/19
Run #: RC-37 Rec: 60"/60"
Depth: 182.0'-183.0' RQD: 57/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/10/19
Run #: RC-37 Rec: 60"/60"
Depth: 183.0'-184.0' RQD: 57/60"
W-15-012 Big Walnut Phase
Boring: B-47 Date: 5/10/19
Run #: RC-37 Rec: 60"/60"
Depth: 184.0'-185.0' RQD: 57/60"

Appendix D PACKER TESTING RESULTS

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 2, 2018
Water Pressure Testing
Boring B-16

Ground Elevation:	972.96	ft
Groundwater Depth:	3.8	ft
Groundwater Elev:	969.16	ft
Gage Height:	4	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.2					
123	849.96	10	15	18.4	0.00	1	3406.2	0.0	0.0000			0.00E+00
133	839.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	18.40	0.00E+00
							3406.2					
123	849.96	10	30	33.4	0.00	1	3406.2	0.0	0.0000			0.00E+00
133	839.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	33.40	0.00E+00
							3406.2					
123	849.96	10	45	48.4	0.00	1	3406.2	0.0	0.0000			0.00E+00
133	839.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	48.40	0.00E+00
							3406.2					
123	849.96	10	30	33.4	0.00	1	3406.2	0.0	0.0000			0.00E+00
133	839.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	33.40	0.00E+00
							3406.2					
123	849.96	10	15	18.4	0.00	1	3406.2	0.0	0.0000			0.00E+00
133	839.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	18.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double Packer System Used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 2, 2018
Water Pressure Testing
Boring B-16

Ground Elevation:	972.96	ft
Groundwater Depth:	2.8	ft
Groundwater Elev:	970.16	ft
Gage Height:	4	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.1					
133	839.96	10	15	17.9	0.00	1	3406.1	0.0	0.0000			0.00E+00
143	829.96					2	3406.1	0.0	0.0000			0.00E+00
						5	3406.1	0.0	0.0000			0.00E+00
						10	3406.1	0.0	0.0000			0.00E+00
						15	3406.1	0.0	0.0000	0.00E+00	17.90	0.00E+00
							3406.1					
133	839.96	10	30	32.9	0.00	1	3406.1	0.0	0.0000			0.00E+00
143	829.96					2	3406.1	0.0	0.0000			0.00E+00
						5	3406.1	0.0	0.0000			0.00E+00
						10	3406.1	0.0	0.0000			0.00E+00
						15	3406.1	0.0	0.0000	0.00E+00	32.90	0.00E+00
							3406.2					
133	839.96	10	45	47.9	0.00	1	3406.2	0.0	0.0000			0.00E+00
143	829.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	47.90	0.00E+00
							3406.2					
133	839.96	10	30	32.9	0.00	1	3406.2	0.0	0.0000			0.00E+00
143	829.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	32.90	0.00E+00
							3406.2					
133	839.96	10	15	17.9	0.00	1	3406.2	0.0	0.0000			0.00E+00
143	829.96					2	3406.2	0.0	0.0000			0.00E+00
						5	3406.2	0.0	0.0000			0.00E+00
						10	3406.2	0.0	0.0000			0.00E+00
						15	3406.2	0.0	0.0000	0.00E+00	17.90	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double Packer System Used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.96 ft
	May 2, 2018	Groundwater Depth:	2.9 ft
	Water Pressure Testing	Groundwater Elev:	970.06 ft
	Boring B-16	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.0					
143	829.96	10	15	18.0	0.00	1	3406.0	0.0	0.0000			0.00E+00
153	819.96					2	3406.0	0.0	0.0000			0.00E+00
						5	3406.0	0.0	0.0000			0.00E+00
						10	3406.0	0.0	0.0000			0.00E+00
						15	3406.0	0.0	0.0000	0.00E+00	18.00	0.00E+00
							3406.0					
143	829.96	10	30	33.0	0.00	1	3406.0	0.0	0.0000			0.00E+00
153	819.96					2	3406.0	0.0	0.0000			0.00E+00
						5	3406.0	0.0	0.0000			0.00E+00
						10	3406.0	0.0	0.0000			0.00E+00
						15	3406.0	0.0	0.0000	0.00E+00	33.00	0.00E+00
							3406.0					
143	829.96	10	45	48.0	0.00	1	3406.0	0.0	0.0000			0.00E+00
153	819.96					2	3406.0	0.0	0.0000			0.00E+00
						5	3406.0	0.0	0.0000			0.00E+00
						10	3406.0	0.0	0.0000			0.00E+00
						15	3406.0	0.0	0.0000	0.00E+00	48.00	0.00E+00
							3406.0					
143	829.96	10	30	33.0	0.00	1	3406.0	0.0	0.0000			0.00E+00
153	819.96					2	3406.0	0.0	0.0000			0.00E+00
						5	3406.0	0.0	0.0000			0.00E+00
						10	3406.0	0.0	0.0000			0.00E+00
						15	3406.0	0.0	0.0000	0.00E+00	33.00	0.00E+00
							3406.0					
143	829.96	10	15	18.0	0.00	1	3406.0	0.0	0.0000			0.00E+00
153	819.96					2	3406.0	0.0	0.0000			0.00E+00
						5	3406.0	0.0	0.0000			0.00E+00
						10	3406.0	0.0	0.0000			0.00E+00
						15	3406.0	0.0	0.0000	0.00E+00	18.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double Packer System Used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 1, 2018
Water Pressure Testing
Boring B-16

Ground Elevation:	972.96	ft
Groundwater Depth:	1.5	ft
Groundwater Elev:	971.46	ft
Gage Height:	4	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3400.0					
152	820.96	10	15	17.4	0.00	1	3400.0	0.0	0.0000			0.00E+00
162	810.96					2	3400.0	0.0	0.0000			0.00E+00
						5	3400.0	0.0	0.0000			0.00E+00
						10	3400.0	0.0	0.0000			0.00E+00
						15	3400.0	0.0	0.0000	0.00E+00	17.40	0.00E+00
							3400.2					
152	820.96	10	30	32.4	0.00	1	3400.2	0.0	0.0000			0.00E+00
162	810.96					2	3400.2	0.0	0.0000			0.00E+00
						5	3400.2	0.0	0.0000			0.00E+00
						10	3400.2	0.0	0.0000			0.00E+00
						15	3400.2	0.0	0.0000	0.00E+00	32.40	0.00E+00
							3400.7					
152	820.96	10	45	47.4	0.39	1	3400.8	0.1	0.0013			1.41E-07
162	810.96					2	3401.1	0.3	0.0040			4.22E-07
						5	3402.1	0.3	0.0045			4.69E-07
						10	3403.7	0.3	0.0043			4.50E-07
						15	3405.6	0.4	0.0051	3.83E-03	47.01	5.34E-07
							3405.6					
152	820.96	10	30	32.4	0.39	1	3405.7	0.1	0.0013			2.06E-07
162	810.96					2	3405.9	0.2	0.0027			4.12E-07
						5	3405.9	0.0	0.0000			0.00E+00
						10	3405.9	0.0	0.0000			0.00E+00
						15	3405.9	0.0	0.0000	8.02E-04	32.01	0.00E+00
							3405.9					
152	820.96	10	15	17.4	0.00	1	3405.9	0.0	0.0000			0.00E+00
162	810.96					2	3405.9	0.0	0.0000			0.00E+00
						5	3405.9	0.0	0.0000			0.00E+00
						10	3405.9	0.0	0.0000			0.00E+00
						15	3405.9	0.0	0.0000	0.00E+00	17.40	0.00E+00
											Average of Valid Stages:	**1.05E-07**

Note: Double Packer System Used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	975.05	ft
December 11, 2017	Groundwater Depth:	1.2	ft
Water Pressure Testing	Groundwater Elev:	973.85	ft
Boring B-17	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							189.20					
126.5	848.55	10	15	17.3	2.54	1	190.70	1.5	0.0201			6.46E-06
136.5	838.55					2	191.40	0.7	0.0094			3.02E-06
						5	193.60	0.7	0.0098			3.16E-06
						10	197.60	0.8	0.0107			3.45E-06
						15	201.50	0.8	0.0104	1.21E-02	14.76	3.36E-06
							201.50					
126.5	848.55	10	30	32.3	1.14	1	202.20	0.7	0.0094			1.53E-06
136.5	838.55					2	203.10	0.9	0.0120			1.97E-06
						5	205.10	0.7	0.0089			1.46E-06
						10	208.80	0.7	0.0099			1.62E-06
						15	212.40	0.7	0.0096	9.96E-03	31.16	1.58E-06
							212.40					
126.5	848.55	10	45	47.3	1.14	1	213.10	0.7	0.0094			1.04E-06
136.5	838.55					2	213.80	0.7	0.0094			1.04E-06
						5	215.90	0.7	0.0094			1.04E-06
						10	219.40	0.7	0.0094			1.04E-06
						15	222.90	0.7	0.0094	9.36E-03	46.16	1.04E-06
							222.90					
126.5	848.55	10	30	32.3	1.00	1	223.50	0.6	0.0080			1.31E-06
136.5	838.55					2	224.10	0.6	0.0080			1.31E-06
						5	225.90	0.6	0.0080			1.31E-06
						10	229.10	0.6	0.0086			1.40E-06
						15	231.90	0.6	0.0075	8.02E-03	31.30	1.23E-06
							231.90					
126.5	848.55	10	15	17.3	1.00	1	232.50	0.6	0.0080			2.48E-06
136.5	838.55					2	233.30	0.8	0.0107			3.31E-06
						5	235.40	0.7	0.0094			2.90E-06
						10	239.50	0.8	0.0110			3.39E-06
						15	243.20	0.7	0.0099	9.79E-03	16.30	3.06E-06
											Average of Valid Stages:	**2.18E-06**

Note: Possible leak in line above packer, below flow meter, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	975.05	ft
December 11, 2017	Groundwater Depth:	0.95	ft
Water Pressure Testing	Groundwater Elev:	974.10	ft
Boring B-17	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							163.40					
136.5	838.55	10	15	17.1	1.29	1	164.20	0.8	0.0107			3.36E-06
146.5	828.55					2	164.60	0.4	0.0053			1.68E-06
						5	165.90	0.4	0.0058			1.82E-06
						10	166.20	0.1	0.0008			2.52E-07
						15	166.20	0.0	0.0000	4.53E-03	15.81	0.00E+00
							167.70					
136.5	838.55	10	30	32.1	0.73	1	168.10	0.4	0.0053			8.75E-07
146.5	828.55					2	168.50	0.4	0.0053			8.75E-07
						5	169.60	0.4	0.0049			8.02E-07
						10	171.90	0.5	0.0061			1.01E-06
						15	172.80	0.2	0.0024	4.83E-03	31.37	3.94E-07
							172.80					
136.5	838.55	10	45	47.1	1.00	1	173.40	0.6	0.0080			8.94E-07
146.5	828.55					2	173.90	0.5	0.0067			7.45E-07
						5	175.10	0.4	0.0053			5.96E-07
						10	177.80	0.5	0.0072			8.05E-07
						15	179.20	0.3	0.0037	6.20E-03	46.10	4.17E-07
							179.50					
136.5	838.55	10	30	32.1	0.73	1	179.90	0.4	0.0053			8.75E-07
146.5	828.55					2	180.20	0.3	0.0040			6.56E-07
						5	181.20	0.3	0.0045			7.29E-07
						10	182.80	0.3	0.0043			7.00E-07
						15	184.40	0.3	0.0043	4.47E-03	31.37	7.00E-07
							184.40					
136.5	838.55	10	15	17.1	0.50	1	184.60	0.2	0.0027			8.23E-07
146.5	828.55					2	185.00	0.4	0.0053			1.65E-06
						5	185.80	0.3	0.0036			1.10E-06
						10	187.40	0.3	0.0043			1.32E-06
						15	188.60	0.2	0.0032	3.81E-03	16.60	9.87E-07
											Average of Valid Stages:	**9.62E-07**

Note: Possible leak in line above packer, below flow meter, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	975.05	ft
December 11, 2017	Groundwater Depth:	1.2	ft
Water Pressure Testing	Groundwater Elev:	973.85	ft
Boring B-17	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							125.50					
146.6	828.45	10	15	17.3	1.00	1	126.10	0.6	0.0080			2.48E-06
156.6	818.45					2	126.50	0.4	0.0053			1.66E-06
						5	127.50	0.3	0.0045			1.38E-06
						10	129.40	0.4	0.0051			1.57E-06
						15	130.70	0.3	0.0035	5.28E-03	16.30	1.08E-06
							130.70					
146.6	828.45	10	30	32.3	1.00	1	131.30	0.6	0.0080			1.31E-06
156.6	818.45					2	131.80	0.5	0.0067			1.09E-06
						5	133.50	0.6	0.0076			1.24E-06
						10	136.80	0.7	0.0088			1.44E-06
						15	139.50	0.5	0.0072	7.66E-03	31.30	1.18E-06
							139.50					
146.6	828.45	10	45	47.3	0.86	1	140.00	0.5	0.0067			7.43E-07
156.6	818.45					2	140.40	0.4	0.0053			5.94E-07
						5	142.20	0.6	0.0080			8.91E-07
						10	144.90	0.5	0.0072			8.02E-07
						15	147.50	0.5	0.0070	6.84E-03	46.44	7.72E-07
							147.50					
146.6	828.45	10	30	32.3	1.96	1	148.70	1.2	0.0160			2.66E-06
156.6	818.45					2	149.20	0.5	0.0067			1.11E-06
						5	150.10	0.3	0.0040			6.65E-07
						10	152.10	0.4	0.0053			8.87E-07
						15	154.40	0.5	0.0061	7.65E-03	30.34	1.02E-06
							154.40					
146.6	828.45	10	15	17.3	1.14	1	155.10	0.7	0.0094			2.91E-06
156.6	818.45					2	155.70	0.6	0.0080			2.49E-06
						5	157.20	0.5	0.0067			2.08E-06
						10	159.70	0.5	0.0067			2.08E-06
						15	162.30	0.5	0.0070	7.54E-03	16.16	2.16E-06
											Average of Valid Stages:	**1.45E-06**

Note: Possible leak in line above packer, below flow meter, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	975.05	ft
December 11, 2017	Groundwater Depth:	1.2	ft
Water Pressure Testing	Groundwater Elev:	973.85	ft
Boring B-17	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							56.70					
156.6	818.45	8.9	15	17.3	1.61	1	57.70	1.0	0.0150			4.61E-06
165.5	809.55					2	58.20	0.5	0.0075			2.31E-06
						5	59.80	0.5	0.0080			2.46E-06
						10	62.20	0.5	0.0072			2.21E-06
						15	64.50	0.5	0.0069	8.93E-03	15.69	2.12E-06
							64.50					
156.6	818.45	8.9	30	32.3	1.61	1	65.50	1.0	0.0150			2.42E-06
165.5	809.55					2	66.10	0.6	0.0090			1.45E-06
						5	68.10	0.7	0.0100			1.61E-06
						10	71.40	0.7	0.0099			1.60E-06
						15	75.00	0.7	0.0108	1.10E-02	30.69	1.74E-06
							82.10					
156.6	818.45	8.9	45	47.3	1.45	1	83.00	0.9	0.0135			1.47E-06
165.5	809.55					2	84.10	1.1	0.0165			1.80E-06
						5	87.30	1.1	0.0160			1.75E-06
						10	92.10	1.0	0.0144			1.57E-06
						15	97.20	1.0	0.0153	1.52E-02	45.85	1.67E-06
							97.20					
156.6	818.45	8.9	30	32.3	2.95	1	98.90	1.7	0.0255			4.19E-06
165.5	809.55					2	100.50	1.6	0.0240			3.94E-06
						5	103.80	1.1	0.0165			2.71E-06
						10	108.70	1.0	0.0147			2.41E-06
						15	113.50	1.0	0.0144	1.90E-02	29.35	2.37E-06
							113.50					
156.6	818.45	8.9	15	17.3	2.34	1	114.90	1.4	0.0210			6.58E-06
165.5	809.55					2	115.80	0.9	0.0135			4.23E-06
						5	118.20	0.8	0.0120			3.76E-06
						10	121.60	0.7	0.0102			3.20E-06
						15	125.20	0.7	0.0108	1.35E-02	14.96	3.38E-06
											Average of Valid Stages:	**2.70E-06**

Note: Possible leak in line above packer, below flow meter, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	975.05	ft
December 11, 2017	Groundwater Depth:	1.2	ft
Water Pressure Testing	Groundwater Elev:	973.85	ft
Boring B-17	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							24.50					
166.5	808.55	10	15	17.3	4.37	1	26.80	2.3	0.0307			1.04E-05
176.5	798.55					2	27.50	0.7	0.0094			3.17E-06
						5	29.40	0.6	0.0085			2.87E-06
						10	32.70	0.7	0.0088			2.99E-06
						15	35.80	0.6	0.0083	1.31E-02	12.93	2.81E-06
							35.80					
166.5	808.55	10	30	32.3	0.50	1	36.00	0.2	0.0027			4.35E-07
176.5	798.55					2	37.40	1.4	0.0187			3.04E-06
						5	38.90	0.5	0.0067			1.09E-06
						10	41.80	0.6	0.0078			1.26E-06
						15	44.50	0.5	0.0072	8.61E-03	31.80	1.17E-06
							44.50					
166.5	808.55	10	45	47.3	1.78	1	45.60	1.1	0.0147			1.65E-06
176.5	798.55					2	46.70	1.1	0.0147			1.65E-06
						5	47.70	0.3	0.0045			4.99E-07
						10	49.40	0.3	0.0045			5.09E-07
						15	51.20	0.4	0.0048	8.65E-03	45.52	5.39E-07
							51.20					
166.5	808.55	10	30	32.3	0.50	1	51.40	0.2	0.0027			4.35E-07
176.5	798.55					2	51.70	0.3	0.0040			6.52E-07
						5	52.40	0.2	0.0031			5.07E-07
						10	53.40	0.2	0.0027			4.35E-07
						15	54.00	0.1	0.0016	2.82E-03	31.80	2.61E-07
							54.00					
166.5	808.55	10	15	17.3	0.39	1	54.10	0.1	0.0013			4.08E-07
176.5	798.55					2	54.20	0.1	0.0013			4.08E-07
						5	54.80	0.2	0.0027			8.15E-07
						10	55.60	0.2	0.0021			6.52E-07
						15	56.80	0.2	0.0032	2.14E-03	16.91	9.78E-07
											Average of Valid Stages:	**1.59E-06**

Note: Possible leak in line above packer, below flow meter, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.58	ft
December, 2017	Groundwater Depth:	9.1	ft
Water Pressure Testing	Groundwater Elev:	972.48	ft
Boring B-18	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							252.9					
131	850.58	10	15	20.7	0.00	1	252.9	0.0	0.0000			0.00E+00
141	840.58					2	252.9	0.0	0.0000			0.00E+00
						5	252.9	0.0	0.0000			0.00E+00
						10	252.9	0.0	0.0000			0.00E+00
						15	252.9	0.0	0.0000	0.00E+00	20.70	0.00E+00
							252.9					
131	850.58	10	30	35.7	0.00	1	252.9	0.0	0.0000			0.00E+00
141	840.58					2	252.9	0.0	0.0000			0.00E+00
						5	252.9	0.0	0.0000			0.00E+00
						10	252.9	0.0	0.0000			0.00E+00
						15	252.9	0.0	0.0000	0.00E+00	35.70	0.00E+00
							252.9					
131	850.58	10	45	50.7	0.00	1	252.9	0.0	0.0000			0.00E+00
141	840.58					2	252.9	0.0	0.0000			0.00E+00
						5	253.0	0.0	0.0004			4.58E-08
						10	253.0	0.0	0.0000			0.00E+00
						15	253.0	0.0	0.0000	8.91E-05	50.70	0.00E+00
							253.0					
131	850.58	10	30	35.7	0.00	1	253.0	0.0	0.0000			0.00E+00
141	840.58					2	253.0	0.0	0.0000			0.00E+00
						5	253.0	0.0	0.0000			0.00E+00
						10	253.0	0.0	0.0000			0.00E+00
						15	253.0	0.0	0.0000	0.00E+00	35.70	0.00E+00
							253.0					
131	850.58	10	15	20.7	0.00	1	253.0	0.0	0.0000			0.00E+00
141	840.58					2	253.0	0.0	0.0000			0.00E+00
						5	253.0	0.0	0.0000			0.00E+00
						10	253.0	0.0	0.0000			0.00E+00
						15	253.0	0.0	0.0000	0.00E+00	20.70	0.00E+00
											Average of Valid Stages:	**1.83E-09**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.58	ft
December, 2017	Groundwater Depth:	8.95	ft
Water Pressure Testing	Groundwater Elev:	972.63	ft
Boring B-18	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							252.4					
141	840.58	10	15	20.6	0.00	1	252.4	0.0	0.0000			0.00E+00
151	830.58					2	252.4	0.0	0.0000			0.00E+00
						5	252.5	0.0	0.0004			1.13E-07
						10	252.5	0.0	0.0000			0.00E+00
						15	252.5	0.0	0.0000	8.91E-05	20.60	0.00E+00
							252.5					
141	840.58	10	30	35.6	0.00	1	252.5	0.0	0.0000			0.00E+00
151	830.58					2	252.5	0.0	0.0000			0.00E+00
						5	252.5	0.0	0.0000			0.00E+00
						10	252.5	0.0	0.0000			0.00E+00
						15	252.5	0.0	0.0000	0.00E+00	35.60	0.00E+00
							252.5					
141	840.58	10	45	50.6	0.00	1	252.5	0.0	0.0000			0.00E+00
151	830.58					2	252.5	0.0	0.0000			0.00E+00
						5	252.5	0.0	0.0000			0.00E+00
						10	252.5	0.0	0.0000			0.00E+00
						15	252.5	0.0	0.0000	0.00E+00	50.60	0.00E+00
							252.5					
141	840.58	10	30	35.6	0.00	1	252.5	0.0	0.0000			0.00E+00
151	830.58					2	252.5	0.0	0.0000			0.00E+00
						5	252.5	0.0	0.0000			0.00E+00
						10	252.5	0.0	0.0000			0.00E+00
						15	252.5	0.0	0.0000	0.00E+00	35.60	0.00E+00
							252.5					
141	840.58	10	15	20.6	0.00	1	252.5	0.0	0.0000			0.00E+00
151	830.58					2	252.5	0.0	0.0000			0.00E+00
						5	252.5	0.0	0.0000			0.00E+00
						10	252.5	0.0	0.0000			0.00E+00
						15	252.5	0.0	0.0000	0.00E+00	20.60	0.00E+00
											Average of Valid Stages:	**4.50E-09**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.58	ft
December, 2017	Groundwater Depth:	9.05	ft
Water Pressure Testing	Groundwater Elev:	972.53	ft
Boring B-18	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							251.8					
151	830.58	10	15	20.7	0.00	1	251.8	0.0	0.0000			0.00E+00
161	820.58					2	251.8	0.0	0.0000			0.00E+00
						5	251.8	0.0	0.0000			0.00E+00
						10	251.8	0.0	0.0000			0.00E+00
						15	251.8	0.0	0.0000	0.00E+00	20.70	0.00E+00
							251.8					
151	830.58	10	30	35.7	0.00	1	251.8	0.0	0.0000			0.00E+00
161	820.58					2	251.8	0.0	0.0000			0.00E+00
						5	251.8	0.0	0.0000			0.00E+00
						10	251.8	0.0	0.0000			0.00E+00
						15	251.8	0.0	0.0000	0.00E+00	35.70	0.00E+00
							251.8					
151	830.58	10	45	50.7	0.00	1	251.8	0.0	0.0000			0.00E+00
161	820.58					2	251.8	0.0	0.0000			0.00E+00
						5	251.8	0.0	0.0000			0.00E+00
						10	251.8	0.0	0.0000			0.00E+00
						15	251.8	0.0	0.0000	0.00E+00	50.70	0.00E+00
							251.8					
151	830.58	10	30	35.7	0.00	1	251.8	0.0	0.0000			0.00E+00
161	820.58					2	251.8	0.0	0.0000			0.00E+00
						5	251.8	0.0	0.0000			0.00E+00
						10	251.8	0.0	0.0000			0.00E+00
						15	251.8	0.0	0.0000	0.00E+00	35.70	0.00E+00
							251.8					
151	830.58	10	15	20.7	0.00	1	251.8	0.0	0.0000			0.00E+00
161	820.58					2	251.8	0.0	0.0000			0.00E+00
						5	251.8	0.0	0.0000			0.00E+00
						10	251.8	0.0	0.0000			0.00E+00
						15	251.8	0.0	0.0000	0.00E+00	20.70	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.58	ft
December, 2017	Groundwater Depth:	9.05	ft
Water Pressure Testing	Groundwater Elev:	972.53	ft
Boring B-18	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							244.7					
161	820.58	10	15	20.7	0.39	1	244.8	0.1	0.0013			3.40E-07
171	810.58					2	244.9	0.1	0.0013			3.40E-07
						5	244.9	0.0	0.0000			0.00E+00
						10	244.9	0.0	0.0000			0.00E+00
						15	244.9	0.0	0.0000	5.35E-04	20.31	0.00E+00
							244.9					
161	820.58	10	30	35.7	0.50	1	245.1	0.2	0.0027			3.93E-07
171	810.58					2	245.1	0.0	0.0000			0.00E+00
						5	245.1	0.0	0.0000			0.00E+00
						10	245.1	0.0	0.0000			0.00E+00
						15	245.1	0.0	0.0000	5.35E-04	35.20	0.00E+00
							245.1					
161	820.58	10	45	50.7	1.14	1	245.8	0.7	0.0094			9.72E-07
171	810.58					2	246.6	0.8	0.0107			1.11E-06
						5	247.1	0.2	0.0022			2.31E-07
						10	248.0	0.2	0.0024			2.50E-07
						15	248.6	0.1	0.0016	5.26E-03	49.56	1.67E-07
							248.6					
161	820.58	10	30	35.7	0.00	1	248.6	0.0	0.0000			0.00E+00
171	810.58					2	248.6	0.0	0.0000			0.00E+00
						5	248.7	0.0	0.0004			6.51E-08
						10	249.4	0.1	0.0019			2.73E-07
						15	250.0	0.1	0.0016	7.84E-04	35.70	2.34E-07
							250.1					
161	820.58	10	15	20.7	0.39	1	250.2	0.1	0.0013			3.40E-07
171	810.58					2	250.3	0.1	0.0013			3.40E-07
						5	250.5	0.1	0.0009			2.27E-07
						10	250.9	0.1	0.0011			2.72E-07
						15	251.1	0.0	0.0005	1.03E-03	20.31	1.36E-07
											Average of Valid Stages:	**2.28E-07**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.58	ft
December, 2017	Groundwater Depth:	8.9	ft
Water Pressure Testing	Groundwater Elev:	972.68	ft
Boring B-18	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							240.5					
171	810.58	10	15	20.6	0.73	1	240.9	0.4	0.0053			1.37E-06
181	800.58					2	241.0	0.1	0.0013			3.44E-07
						5	241.1	0.0	0.0004			1.15E-07
						10	241.1	0.0	0.0000			0.00E+00
						15	241.1	0.0	0.0000	1.43E-03	19.87	0.00E+00
							241.1					
171	810.58	10	30	35.6	0.00	1	241.1	0.0	0.0000			0.00E+00
181	800.58					2	241.1	0.0	0.0000			0.00E+00
						5	241.1	0.0	0.0000			0.00E+00
						10	241.1	0.0	0.0000			0.00E+00
						15	241.1	0.0	0.0000	0.00E+00	35.60	0.00E+00
							241.1					
171	810.58	10	45	50.6	0.00	1	241.1	0.0	0.0000			0.00E+00
181	800.58					2	241.1	0.0	0.0000			0.00E+00
						5	241.1	0.0	0.0000			0.00E+00
						10	241.1	0.0	0.0000			0.00E+00
						15	241.1	0.0	0.0000	0.00E+00	50.60	0.00E+00
							241.1					
171	810.58	10	30	35.6	0.00	1	241.1	0.0	0.0000			0.00E+00
181	800.58					2	241.1	0.0	0.0000			0.00E+00
						5	241.1	0.0	0.0000			0.00E+00
						10	241.1	0.0	0.0000			0.00E+00
						15	241.1	0.0	0.0000	0.00E+00	35.60	0.00E+00
							241.1					
171	810.58	10	15	20.6	0.00	1	241.1	0.0	0.0000			0.00E+00
181	800.58					2	241.1	0.0	0.0000			0.00E+00
						5	241.1	0.0	0.0000			0.00E+00
						10	241.1	0.0	0.0000			0.00E+00
						15	241.1	0.0	0.0000	0.00E+00	20.60	0.00E+00
											Average of Valid Stages:	**7.33E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.15	ft
March 8, 2018	Groundwater Depth:	2.1	ft
Water Pressure Testing	Groundwater Elev:	977.05	ft
Boring B-19	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5885.6					
131.9	847.25	10	15	17.6	0.00	1	5885.6	0.0	0.0000			0.00E+00
141.9	837.25					2	5885.6	0.0	0.0000			0.00E+00
						5	5885.6	0.0	0.0000			0.00E+00
						10	5885.6	0.0	0.0000			0.00E+00
						15	5885.6	0.0	0.0000	0.00E+00	17.60	0.00E+00
							5885.6					
131.9	847.25	10	30	32.6	0.00	1	5885.6	0.0	0.0000			0.00E+00
141.9	837.25					2	5885.6	0.0	0.0000			0.00E+00
						5	5885.6	0.0	0.0000			0.00E+00
						10	5885.6	0.0	0.0000			0.00E+00
						15	5885.6	0.0	0.0000	0.00E+00	32.60	0.00E+00
							5885.6					
131.9	847.25	10	45	47.6	0.00	1	5885.6	0.0	0.0000			0.00E+00
141.9	837.25					2	5885.6	0.0	0.0000			0.00E+00
						5	5885.6	0.0	0.0000			0.00E+00
						10	5885.6	0.0	0.0000			0.00E+00
						15	5885.6	0.0	0.0000	0.00E+00	47.60	0.00E+00
							5885.6					
131.9	847.25	10	30	32.6	0.00	1	5885.6	0.0	0.0000			0.00E+00
141.9	837.25					2	5885.6	0.0	0.0000			0.00E+00
						5	5885.6	0.0	0.0000			0.00E+00
						10	5885.6	0.0	0.0000			0.00E+00
						15	5885.6	0.0	0.0000	0.00E+00	32.60	0.00E+00
							5885.6					
131.9	847.25	10	15	17.6	0.00	1	5885.6	0.0	0.0000			0.00E+00
141.9	837.25					2	5885.6	0.0	0.0000			0.00E+00
						5	5885.6	0.0	0.0000			0.00E+00
						10	5885.6	0.0	0.0000			0.00E+00
						15	5885.6	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.15	ft
March 8, 2018	Groundwater Depth:	4.1	ft
Water Pressure Testing	Groundwater Elev:	975.05	ft
Boring B-19	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5893.2					
141.9	837.25	10	15	18.5	0.00	1	5893.2	0.0	0.0000			0.00E+00
151.9	827.25					2	5893.2	0.0	0.0000			0.00E+00
						5	5893.2	0.0	0.0000			0.00E+00
						10	5893.2	0.0	0.0000			0.00E+00
						15	5893.2	0.0	0.0000	0.00E+00	18.50	0.00E+00
							5893.5					
141.9	837.25	10	30	33.5	0.00	1	5893.5	0.0	0.0000			0.00E+00
151.9	827.25					2	5893.5	0.0	0.0000			0.00E+00
						5	5893.5	0.0	0.0000			0.00E+00
						10	5893.5	0.0	0.0000			0.00E+00
						15	5893.5	0.0	0.0000	0.00E+00	33.50	0.00E+00
							5893.5					
141.9	837.25	10	45	48.5	0.00	1	5893.5	0.0	0.0000			0.00E+00
151.9	827.25					2	5893.5	0.0	0.0000			0.00E+00
						5	5893.5	0.0	0.0000			0.00E+00
						10	5893.5	0.0	0.0000			0.00E+00
						15	5893.5	0.0	0.0000	0.00E+00	48.50	0.00E+00
							5893.5					
141.9	837.25	10	30	33.5	0.00	1	5893.5	0.0	0.0000			0.00E+00
151.9	827.25					2	5893.5	0.0	0.0000			0.00E+00
						5	5893.5	0.0	0.0000			0.00E+00
						10	5893.5	0.0	0.0000			0.00E+00
						15	5893.5	0.0	0.0000	0.00E+00	33.50	0.00E+00
							5893.4					
141.9	837.25	10	15	18.5	0.00	1	5893.4	0.0	0.0000			0.00E+00
151.9	827.25					2	5893.4	0.0	0.0000			0.00E+00
						5	5893.4	0.0	0.0000			0.00E+00
						10	5893.4	0.0	0.0000			0.00E+00
						15	5893.4	0.0	0.0000	0.00E+00	18.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.15	ft
March 12, 2018	Groundwater Depth:	1.2	ft
Water Pressure Testing	Groundwater Elev:	977.95	ft
Boring B-19	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5906.0					
151.9	827.25	9.8	15	17.3	0.00	1	5906.0	0.0	0.0000			0.00E+00
161.7	817.45					2	5906.0	0.0	0.0000			0.00E+00
						5	5906.0	0.0	0.0000			0.00E+00
						10	5906.0	0.0	0.0000			0.00E+00
						15	5906.0	0.0	0.0000	0.00E+00	17.30	0.00E+00
							5906.0					
151.9	827.25	9.8	30	32.3	0.00	1	5906.0	0.0	0.0000			0.00E+00
161.7	817.45					2	5906.0	0.0	0.0000			0.00E+00
						5	5906.0	0.0	0.0000			0.00E+00
						10	5906.0	0.0	0.0000			0.00E+00
						15	5906.0	0.0	0.0000	0.00E+00	32.30	0.00E+00
							5906.0					
151.9	827.25	9.8	45	47.3	0.00	1	5906.0	0.0	0.0000			0.00E+00
161.7	817.45					2	5906.0	0.0	0.0000			0.00E+00
						5	5906.0	0.0	0.0000			0.00E+00
						10	5906.0	0.0	0.0000			0.00E+00
						15	5906.0	0.0	0.0000	0.00E+00	47.30	0.00E+00
							5906.0					
151.9	827.25	9.8	30	32.3	0.00	1	5906.0	0.0	0.0000			0.00E+00
161.7	817.45					2	5906.0	0.0	0.0000			0.00E+00
						5	5906.0	0.0	0.0000			0.00E+00
						10	5906.0	0.0	0.0000			0.00E+00
						15	5906.0	0.0	0.0000	0.00E+00	32.30	0.00E+00
							5906.0					
151.9	827.25	9.8	15	17.3	0.00	1	5906.0	0.0	0.0000			0.00E+00
161.7	817.45					2	5906.0	0.0	0.0000			0.00E+00
						5	5906.0	0.0	0.0000			0.00E+00
						10	5906.0	0.0	0.0000			0.00E+00
						15	5906.0	0.0	0.0000	0.00E+00	17.30	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.15	ft
March 12, 2018	Groundwater Depth:	2.7	ft
Water Pressure Testing	Groundwater Elev:	976.45	ft
Boring B-19	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5907.6					
161.9	817.25	10	15	17.9	0.00	1	5907.6	0.0	0.0000			0.00E+00
171.9	807.25					2	5907.6	0.0	0.0000			0.00E+00
						5	5907.6	0.0	0.0000			0.00E+00
						10	5907.6	0.0	0.0000			0.00E+00
						15	5907.6	0.0	0.0000	0.00E+00	17.90	0.00E+00
							5907.6					
161.9	817.25	10	30	32.9	0.00	1	5907.6	0.0	0.0000			0.00E+00
171.9	807.25					2	5907.6	0.0	0.0000			0.00E+00
						5	5907.6	0.0	0.0000			0.00E+00
						10	5907.6	0.0	0.0000			0.00E+00
						15	5907.6	0.0	0.0000	0.00E+00	32.90	0.00E+00
							5907.7					
161.9	817.25	10	45	47.9	0.00	1	5907.7	0.0	0.0000			0.00E+00
171.9	807.25					2	5907.7	0.0	0.0000			0.00E+00
						5	5907.7	0.0	0.0000			0.00E+00
						10	5907.7	0.0	0.0000			0.00E+00
						15	5907.7	0.0	0.0000	0.00E+00	47.90	0.00E+00
							5907.6					
161.9	817.25	10	30	32.9	0.00	1	5907.6	0.0	0.0000			0.00E+00
171.9	807.25					2	5907.6	0.0	0.0000			0.00E+00
						5	5907.6	0.0	0.0000			0.00E+00
						10	5907.6	0.0	0.0000			0.00E+00
						15	5907.6	0.0	0.0000	0.00E+00	32.90	0.00E+00
							5907.6					
161.9	817.25	10	15	17.9	0.00	1	5907.6	0.0	0.0000			0.00E+00
171.9	807.25					2	5907.6	0.0	0.0000			0.00E+00
						5	5907.6	0.0	0.0000			0.00E+00
						10	5907.6	0.0	0.0000			0.00E+00
						15	5907.6	0.0	0.0000	0.00E+00	17.90	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.15	ft
March 13, 2018	Groundwater Depth:	2.4	ft
Water Pressure Testing	Groundwater Elev:	976.75	ft
Boring B-19	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5908.0					
171.9	807.25	10	15	17.8	0.00	1	5908.0	0.0	0.0000			0.00E+00
181.9	797.25					2	5908.0	0.0	0.0000			0.00E+00
						5	5908.0	0.0	0.0000			0.00E+00
						10	5908.0	0.0	0.0000			0.00E+00
						15	5908.0	0.0	0.0000	0.00E+00	17.80	0.00E+00
							5908.0					
171.9	807.25	10	30	32.8	0.00	1	5908.0	0.0	0.0000			0.00E+00
181.9	797.25					2	5908.0	0.0	0.0000			0.00E+00
						5	5908.0	0.0	0.0000			0.00E+00
						10	5908.0	0.0	0.0000			0.00E+00
						15	5908.0	0.0	0.0000	0.00E+00	32.80	0.00E+00
							5908.0					
171.9	807.25	10	45	47.8	0.00	1	5908.0	0.0	0.0000			0.00E+00
181.9	797.25					2	5908.0	0.0	0.0000			0.00E+00
						5	5908.0	0.0	0.0000			0.00E+00
						10	5908.0	0.0	0.0000			0.00E+00
						15	5908.0	0.0	0.0000	0.00E+00	47.80	0.00E+00
							5908.0					
171.9	807.25	10	30	32.8	0.00	1	5908.0	0.0	0.0000			0.00E+00
181.9	797.25					2	5908.0	0.0	0.0000			0.00E+00
						5	5908.0	0.0	0.0000			0.00E+00
						10	5908.0	0.0	0.0000			0.00E+00
						15	5908.0	0.0	0.0000	0.00E+00	32.80	0.00E+00
							5907.9					
171.9	807.25	10	15	17.8	0.00	1	5907.9	0.0	0.0000			0.00E+00
181.9	797.25					2	5907.9	0.0	0.0000			0.00E+00
						5	5907.9	0.0	0.0000			0.00E+00
						10	5907.9	0.0	0.0000			0.00E+00
						15	5907.9	0.0	0.0000	0.00E+00	17.80	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	971.23	ft
February 28, 2018	Groundwater Depth:	-3	ft
Water Pressure Testing	Groundwater Elev:	974.23	ft
Boring B-20	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							45.74					
125	846.23	10	15	15.4	0.00	1	45.74	0.0	0.0000			0.00E+00
135	836.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	15.40	0.00E+00
							45.74					
125	846.23	10	30	30.4	0.00	1	45.74	0.0	0.0000			0.00E+00
135	836.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	30.40	0.00E+00
							45.74					
125	846.23	10	45	45.4	0.00	1	45.74	0.0	0.0000			0.00E+00
135	836.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	45.40	0.00E+00
							45.74					
125	846.23	10	30	30.4	0.00	1	45.74	0.0	0.0000			0.00E+00
135	836.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	30.40	0.00E+00
							45.74					
125	846.23	10	15	15.4	0.00	1	45.74	0.0	0.0000			0.00E+00
135	836.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	15.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Artesian conditions in boring, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	971.23	ft
February 28, 2018	Groundwater Depth:	-3	ft
Water Pressure Testing	Groundwater Elev:	974.23	ft
Boring B-20	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							45.71					
135	836.23	10	15	15.4	0.30	1	45.73	0.0	0.0003			8.67E-08
145	826.23					2	45.73	0.0	0.0000			0.00E+00
						5	45.73	0.0	0.0000			0.00E+00
						10	45.73	0.0	0.0000			0.00E+00
						15	45.73	0.0	0.0000	5.35E-05	15.10	0.00E+00
							45.74					
135	836.23	10	30	30.4	0.00	1	45.74	0.0	0.0000			0.00E+00
145	826.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	30.40	0.00E+00
							45.74					
135	836.23	10	45	45.4	0.00	1	45.74	0.0	0.0000			0.00E+00
145	826.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	45.40	0.00E+00
							45.74					
135	836.23	10	30	30.4	0.00	1	45.74	0.0	0.0000			0.00E+00
145	826.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	30.40	0.00E+00
							45.74					
135	836.23	10	15	15.4	0.00	1	45.74	0.0	0.0000			0.00E+00
145	826.23					2	45.74	0.0	0.0000			0.00E+00
						5	45.74	0.0	0.0000			0.00E+00
						10	45.74	0.0	0.0000			0.00E+00
						15	45.74	0.0	0.0000	0.00E+00	15.40	0.00E+00
											Average of Valid Stages:	**3.47E-09**

Note: Artesian conditions in boring, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	971.23	ft
February 28, 2018	Groundwater Depth:	-3	ft
Water Pressure Testing	Groundwater Elev:	974.23	ft
Boring B-20	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							39.61					
145	826.23	10	15	15.4	0.00	1	39.61	0.0	0.0000			0.00E+00
155	816.23					2	39.61	0.0	0.0000			0.00E+00
						5	39.61	0.0	0.0000			0.00E+00
						10	39.61	0.0	0.0000			0.00E+00
						15	39.61	0.0	0.0000	0.00E+00	15.40	0.00E+00
							39.65					
145	826.23	10	30	30.4	0.38	1	39.74	0.1	0.0012			1.97E-07
155	816.23					2	39.87	0.1	0.0017			2.85E-07
						5	40.21	0.1	0.0015			2.48E-07
						10	40.72	0.1	0.0014			2.24E-07
						15	41.28	0.1	0.0015	1.46E-03	30.02	2.46E-07
							41.45					
145	826.23	10	45	45.4	0.40	1	41.56	0.1	0.0015			1.61E-07
155	816.23					2	41.70	0.1	0.0019			2.05E-07
						5	42.12	0.1	0.0019			2.05E-07
						10	42.71	0.1	0.0016			1.73E-07
						15	43.33	0.1	0.0017	1.69E-03	45.00	1.82E-07
							43.41					
145	826.23	10	30	30.4	0.39	1	43.51	0.1	0.0013			2.19E-07
155	816.23					2	43.61	0.1	0.0013			2.19E-07
						5	43.91	0.1	0.0013			2.19E-07
						10	44.37	0.1	0.0012			2.02E-07
						15	44.85	0.1	0.0013	1.30E-03	30.01	2.11E-07
							44.90					
145	826.23	10	15	15.4	0.40	1	45.01	0.1	0.0015			4.78E-07
155	816.23					2	45.10	0.1	0.0012			3.91E-07
						5	45.15	0.0	0.0002			7.25E-08
						10	45.39	0.0	0.0006			2.09E-07
						15	45.65	0.1	0.0007	8.47E-04	15.00	2.26E-07

Average of Valid Stages: **1.83E-07**

Note: Artesian conditions in boring, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	971.23	ft
February 28, 2018	Groundwater Depth:	-2.95	ft
Water Pressure Testing	Groundwater Elev:	974.18	ft
Boring B-20	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							39.6					
155	816.23	10	15	15.5	0.00	1	39.6	0.0	0.0000			0.00E+00
165	806.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	15.50	0.00E+00
							39.6					
155	816.23	10	30	30.5	0.00	1	39.6	0.0	0.0000			0.00E+00
165	806.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	30.50	0.00E+00
							39.6					
155	816.23	10	45	45.5	0.00	1	39.6	0.0	0.0000			0.00E+00
165	806.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	45.50	0.00E+00
							39.6					
155	816.23	10	30	30.5	0.00	1	39.6	0.0	0.0000			0.00E+00
165	806.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	30.50	0.00E+00
							39.6					
155	816.23	10	15	15.5	0.00	1	39.6	0.0	0.0000			0.00E+00
165	806.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	15.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Artesian conditions in boring, Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	971.23	ft
February 28, 2018	Groundwater Depth:	-2.95	ft
Water Pressure Testing	Groundwater Elev:	974.18	ft
Boring B-20	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							39.6					
165	806.23	10	15	15.5	0.00	1	39.6	0.0	0.0000			0.00E+00
175	796.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	15.50	0.00E+00
							39.6					
165	806.23	10	30	30.5	0.00	1	39.6	0.0	0.0000			0.00E+00
175	796.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	30.50	0.00E+00
							39.6					
165	806.23	10	45	45.5	0.00	1	39.6	0.0	0.0000			0.00E+00
175	796.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	45.50	0.00E+00
							39.6					
165	806.23	10	30	30.5	0.00	1	39.6	0.0	0.0000			0.00E+00
175	796.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	30.50	0.00E+00
							39.6					
165	806.23	10	15	15.5	0.00	1	39.6	0.0	0.0000			0.00E+00
175	796.23					2	39.6	0.0	0.0000			0.00E+00
						5	39.6	0.0	0.0000			0.00E+00
						10	39.6	0.0	0.0000			0.00E+00
						15	39.6	0.0	0.0000	0.00E+00	15.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Artesian conditions in boring, Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	982.25 ft
	January 23, 2018	Groundwater Depth:	10.7 ft
	Water Pressure Testing	Groundwater Elev:	971.55 ft
	Boring B-21	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5509.4					
155.9	826.35	5	15	21.4	0.00	1	5509.4	0.0	0.0000			0.00E+00
160.9	821.35					2	5509.4	0.0	0.0000			0.00E+00
						5	5509.4	0.0	0.0000			0.00E+00
						10	5509.4	0.0	0.0000			0.00E+00
						15	5509.4	0.0	0.0000	0.00E+00	21.40	0.00E+00
							5509.9					
155.9	826.35	5	30	36.4	0.00	1	5509.9	0.0	0.0000			0.00E+00
160.9	821.35					2	5509.9	0.0	0.0000			0.00E+00
						5	5509.9	0.0	0.0000			0.00E+00
						10	5509.9	0.0	0.0000			0.00E+00
						15	5509.9	0.0	0.0000	0.00E+00	36.40	0.00E+00
							5510.0					
155.9	826.35	5	45	51.4	0.00	1	5510.0	0.0	0.0000			0.00E+00
160.9	821.35					2	5510.0	0.0	0.0000			0.00E+00
						5	5510.0	0.0	0.0000			0.00E+00
						10	5510.0	0.0	0.0000			0.00E+00
						15	5510.0	0.0	0.0000	0.00E+00	51.40	0.00E+00
							5509.9					
155.9	826.35	5	30	36.4	0.00	1	5509.9	0.0	0.0000			0.00E+00
160.9	821.35					2	5509.9	0.0	0.0000			0.00E+00
						5	5509.9	0.0	0.0000			0.00E+00
						10	5509.9	0.0	0.0000			0.00E+00
						15	5509.9	0.0	0.0000	0.00E+00	36.40	0.00E+00
							5509.7					
155.9	826.35	5	15	21.4	0.00	1	5509.7	0.0	0.0000			0.00E+00
160.9	821.35					2	5509.7	0.0	0.0000			0.00E+00
						5	5509.7	0.0	0.0000			0.00E+00
						10	5509.7	0.0	0.0000			0.00E+00
						15	5509.7	0.0	0.0000	0.00E+00	21.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	982.25 ft
	January 23, 2018	Groundwater Depth:	10 ft
	Water Pressure Testing	Groundwater Elev:	972.25 ft
	Boring B-21	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5510.2					
160.9	821.35	10	15	21.1	0.00	1	5510.2	0.0	0.0000			0.00E+00
170.9	811.35					2	5510.2	0.0	0.0000			0.00E+00
						5	5510.2	0.0	0.0000			0.00E+00
						10	5510.2	0.0	0.0000			0.00E+00
						15	5510.2	0.0	0.0000	0.00E+00	21.10	0.00E+00
							5513.2					
160.9	821.35	10	30	36.1	12.92	1	5518.0	4.8	0.0642			1.06E-05
170.9	811.35					2	5522.6	4.6	0.0615			1.01E-05
						5	5535.7	4.4	0.0584			9.63E-06
						10	5557.3	4.3	0.0578			9.53E-06
						15	5579.1	4.4	0.0583	6.00E-02	23.18	9.62E-06
							5601.1					
160.9	821.35	10	45	51.1	13.35	1	5606.0	4.9	0.0655			7.27E-06
170.9	811.35					2	5609.1	3.1	0.0414			4.60E-06
						5	5609.6	0.2	0.0022			2.47E-07
						10	5610.0	0.1	0.0011			1.19E-07
						15	5610.5	0.1	0.0013	2.23E-02	37.75	1.48E-07
							5610.6					
160.9	821.35	10	30	36.1	0.00	1	5610.6	0.0	0.0000			0.00E+00
170.9	811.35					2	5610.9	0.3	0.0040			5.59E-07
						5	5613.0	0.7	0.0094			1.30E-06
						10	5614.2	0.2	0.0032			4.47E-07
						15	5614.2	0.0	0.0000	3.32E-03	36.10	0.00E+00
							5614.3					
160.9	821.35	10	15	21.1	0.00	1	5614.3	0.0	0.0000			0.00E+00
170.9	811.35					2	5614.3	0.0	0.0000			0.00E+00
						5	5614.3	0.0	0.0000			0.00E+00
						10	5614.3	0.0	0.0000			0.00E+00
						15	5614.3	0.0	0.0000	0.00E+00	21.10	0.00E+00

Note: Single packer system used. Betweeen pressure increase from 30 to 45 psi, pressure guage appeared to malfunction, but was remedied prior to starting 45 psi test sequence.

Average of Valid Stages: 2.57E-06

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	982.25 ft
	January 23, 2018	Groundwater Depth:	5.2 ft
	Water Pressure Testing	Groundwater Elev:	977.05 ft
	Boring B-21	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5617.5					
170.9	811.35	10	15	19.0	0.00	1	5617.5	0.0	0.0000			0.00E+00
180.9	801.35					2	5617.5	0.0	0.0000			0.00E+00
						5	5617.5	0.0	0.0000			0.00E+00
						10	5617.5	0.0	0.0000			0.00E+00
						15	5617.5	0.0	0.0000	0.00E+00	19.00	0.00E+00
							5617.6					
170.9	811.35	10	30	34.0	0.00	1	5617.6	0.0	0.0000			0.00E+00
180.9	801.35					2	5617.6	0.0	0.0000			0.00E+00
						5	5617.6	0.0	0.0000			0.00E+00
						10	5617.6	0.0	0.0000			0.00E+00
						15	5617.6	0.0	0.0000	0.00E+00	34.00	0.00E+00
							5617.7					
170.9	811.35	10	45	49.0	0.00	1	5617.7	0.0	0.0000			0.00E+00
180.9	801.35					2	5617.7	0.0	0.0000			0.00E+00
						5	5617.9	0.1	0.0009			9.15E-08
						10	5618.0	0.0	0.0003			2.74E-08
						15	5618.4	0.1	0.0011	4.46E-04	49.00	1.10E-07
							5618.3					
170.9	811.35	10	30	34.0	0.00	1	5618.3	0.0	0.0000			0.00E+00
180.9	801.35					2	5618.3	0.0	0.0000			0.00E+00
						5	5618.3	0.0	0.0000			0.00E+00
						10	5618.3	0.0	0.0000			0.00E+00
						15	5618.3	0.0	0.0000	0.00E+00	34.00	0.00E+00
							5618.2					
170.9	811.35	10	15	19.0	0.00	1	5618.2	0.0	0.0000			0.00E+00
180.9	801.35					2	5618.2	0.0	0.0000			0.00E+00
						5	5618.2	0.0	0.0000			0.00E+00
						10	5618.2	0.0	0.0000			0.00E+00
						15	5618.2	0.0	0.0000	0.00E+00	19.00	0.00E+00
											Average of Valid Stages:	**9.15E-09**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.12	ft
February 13, 2018	Groundwater Depth:	15.2	ft
Water Pressure Testing	Groundwater Elev:	968.92	ft
Boring B-22	Gage Height:	2.5	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5810.0					
139	845.12	12.4	15	22.7	0.00	1	5810.0	0.0	0.0000			0.00E+00
151.4	832.72					2	5810.0	0.0	0.0000			0.00E+00
						5	5810.0	0.0	0.0000			0.00E+00
						10	5810.0	0.0	0.0000			0.00E+00
						15	5810.0	0.0	0.0000	0.00E+00	22.70	0.00E+00
							5810.1					
139	845.12	12.4	30	37.7	0.00	1	5810.1	0.0	0.0000			0.00E+00
151.4	832.72					2	5810.1	0.0	0.0000			0.00E+00
						5	5810.1	0.0	0.0000			0.00E+00
						10	5810.1	0.0	0.0000			0.00E+00
						15	5810.1	0.0	0.0000	0.00E+00	37.70	0.00E+00
							5810.1					
139	845.12	12.4	45	52.7	0.00	1	5810.1	0.0	0.0000			0.00E+00
151.4	832.72					2	5810.1	0.0	0.0000			0.00E+00
						5	5810.1	0.0	0.0000			0.00E+00
						10	5810.1	0.0	0.0000			0.00E+00
						15	5810.1	0.0	0.0000	0.00E+00	52.70	0.00E+00
							5810.0					
139	845.12	12.4	30	37.7	0.00	1	5810.0	0.0	0.0000			0.00E+00
151.4	832.72					2	5810.0	0.0	0.0000			0.00E+00
						5	5810.0	0.0	0.0000			0.00E+00
						10	5810.0	0.0	0.0000			0.00E+00
						15	5810.0	0.0	0.0000	0.00E+00	37.70	0.00E+00
							5809.9					
139	845.12	12.4	15	22.7	0.00	1	5809.9	0.0	0.0000			0.00E+00
151.4	832.72					2	5809.9	0.0	0.0000			0.00E+00
						5	5809.9	0.0	0.0000			0.00E+00
						10	5809.9	0.0	0.0000			0.00E+00
						15	5809.9	0.0	0.0000	0.00E+00	22.70	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
February 13, 2018
Water Pressure Testing
Boring B-22

Ground Elevation: 984.12 ft
Groundwater Depth: 16.5 ft
Groundwater Elev: 967.62 ft
Gage Height: 2.5 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5814.3					
151.4	832.72	10	15	23.2	0.00	1	5814.3	0.0	0.0000			0.00E+00
161.4	822.72					2	5814.3	0.0	0.0000			0.00E+00
						5	5814.3	0.0	0.0000			0.00E+00
						10	5814.3	0.0	0.0000			0.00E+00
						15	5814.3	0.0	0.0000	0.00E+00	23.20	0.00E+00
							5814.3					
151.4	832.72	10	30	38.2	0.00	1	5814.3	0.0	0.0000			0.00E+00
161.4	822.72					2	5814.3	0.0	0.0000			0.00E+00
						5	5814.3	0.0	0.0000			0.00E+00
						10	5814.3	0.0	0.0000			0.00E+00
						15	5814.3	0.0	0.0000	0.00E+00	38.20	0.00E+00
							5814.3					
151.4	832.72	10	45	53.2	0.00	1	5814.3	0.0	0.0000			0.00E+00
161.4	822.72					2	5814.3	0.0	0.0000			0.00E+00
						5	5814.3	0.0	0.0000			0.00E+00
						10	5814.3	0.0	0.0000			0.00E+00
						15	5814.3	0.0	0.0000	0.00E+00	53.20	0.00E+00
							5814.2					
151.4	832.72	10	30	38.2	0.00	1	5814.2	0.0	0.0000			0.00E+00
161.4	822.72					2	5814.2	0.0	0.0000			0.00E+00
						5	5814.2	0.0	0.0000			0.00E+00
						10	5814.2	0.0	0.0000			0.00E+00
						15	5814.2	0.0	0.0000	0.00E+00	38.20	0.00E+00
							5814.2					
151.4	832.72	10	15	23.2	0.00	1	5814.2	0.0	0.0000			0.00E+00
161.4	822.72					2	5814.2	0.0	0.0000			0.00E+00
						5	5814.2	0.0	0.0000			0.00E+00
						10	5814.2	0.0	0.0000			0.00E+00
						15	5814.2	0.0	0.0000	0.00E+00	23.20	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.12	ft
February 14, 2018	Groundwater Depth:	17.6	ft
Water Pressure Testing	Groundwater Elev:	966.52	ft
Boring B-22	Gage Height:	2.5	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5819.7					
161.4	822.72	10	15	23.7	0.00	1	5819.7	0.0	0.0000			0.00E+00
171.4	812.72					2	5819.7	0.0	0.0000			0.00E+00
						5	5819.7	0.0	0.0000			0.00E+00
						10	5819.7	0.0	0.0000			0.00E+00
						15	5819.7	0.0	0.0000	0.00E+00	23.70	0.00E+00
							5819.7					
161.4	822.72	10	30	38.7	0.00	1	5819.7	0.0	0.0000			0.00E+00
171.4	812.72					2	5819.7	0.0	0.0000			0.00E+00
						5	5819.7	0.0	0.0000			0.00E+00
						10	5819.7	0.0	0.0000			0.00E+00
						15	5819.7	0.0	0.0000	0.00E+00	38.70	0.00E+00
							5819.7					
161.4	822.72	10	45	53.7	0.00	1	5819.7	0.0	0.0000			0.00E+00
171.4	812.72					2	5819.7	0.0	0.0000			0.00E+00
						5	5819.7	0.0	0.0000			0.00E+00
						10	5819.7	0.0	0.0000			0.00E+00
						15	5819.7	0.0	0.0000	0.00E+00	53.70	0.00E+00
							5819.7					
161.4	822.72	10	30	38.7	0.00	1	5819.7	0.0	0.0000			0.00E+00
171.4	812.72					2	5819.7	0.0	0.0000			0.00E+00
						5	5819.7	0.0	0.0000			0.00E+00
						10	5819.7	0.0	0.0000			0.00E+00
						15	5819.7	0.0	0.0000	0.00E+00	38.70	0.00E+00
							5817.6					
161.4	822.72	10	15	23.7	0.00	1	5817.6	0.0	0.0000			0.00E+00
171.4	812.72					2	5817.6	0.0	0.0000			0.00E+00
						5	5817.6	0.0	0.0000			0.00E+00
						10	5817.6	0.0	0.0000			0.00E+00
						15	5817.6	0.0	0.0000	0.00E+00	23.70	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.12	ft
February 14, 2018	Groundwater Depth:	19.2	ft
Water Pressure Testing	Groundwater Elev:	964.92	ft
Boring B-22	Gage Height:	2.5	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5829.8					
171.4	812.72	10	15	24.4	0.00	1	5829.8	0.0	0.0000			0.00E+00
181.4	802.72					2	5829.8	0.0	0.0000			0.00E+00
						5	5829.8	0.0	0.0000			0.00E+00
						10	5829.8	0.0	0.0000			0.00E+00
						15	5829.9	0.0	0.0003	5.35E-05	24.40	5.21E-08
							5830.0					
171.4	812.72	10	30	39.4	0.00	1	5830.0	0.0	0.0000			0.00E+00
181.4	802.72					2	5830.0	0.0	0.0000			0.00E+00
						5	5830.0	0.0	0.0000			0.00E+00
						10	5830.0	0.0	0.0000			0.00E+00
						15	5830.0	0.0	0.0000	0.00E+00	39.40	0.00E+00
							5830.0					
171.4	812.72	10	45	54.4	0.00	1	5830.0	0.0	0.0000			0.00E+00
181.4	802.72					2	5830.0	0.0	0.0000			0.00E+00
						5	5830.0	0.0	0.0000			0.00E+00
						10	5830.0	0.0	0.0000			0.00E+00
						15	5830.0	0.0	0.0000	0.00E+00	54.40	0.00E+00
							5830.0					
171.4	812.72	10	30	39.4	0.00	1	5830.0	0.0	0.0000			0.00E+00
181.4	802.72					2	5830.0	0.0	0.0000			0.00E+00
						5	5830.0	0.0	0.0000			0.00E+00
						10	5830.0	0.0	0.0000			0.00E+00
						15	5830.0	0.0	0.0000	0.00E+00	39.40	0.00E+00
							5829.9					
171.4	812.72	10	15	24.4	0.00	1	5829.9	0.0	0.0000			0.00E+00
181.4	802.72					2	5829.9	0.0	0.0000			0.00E+00
						5	5829.9	0.0	0.0000			0.00E+00
						10	5829.9	0.0	0.0000			0.00E+00
						15	5829.9	0.0	0.0000	0.00E+00	24.40	0.00E+00
											Average of Valid Stages:	**2.09E-09**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
February 15, 2018
Water Pressure Testing
Boring B-22

Ground Elevation:	984.12	ft
Groundwater Depth:	24.4	ft
Groundwater Elev:	959.72	ft
Gage Height:	2.5	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5840.8					
181.4	802.72	10	15	26.6	0.00	1	5840.8	0.0	0.0000			0.00E+00
191.4	792.72					2	5840.8	0.0	0.0000			0.00E+00
						5	5840.8	0.0	0.0000			0.00E+00
						10	5840.8	0.0	0.0000			0.00E+00
						15	5840.8	0.0	0.0000	0.00E+00	26.60	0.00E+00
							5840.8					
181.4	802.72	10	30	41.6	0.00	1	5840.8	0.0	0.0000			0.00E+00
191.4	792.72					2	5840.8	0.0	0.0000			0.00E+00
						5	5840.9	0.0	0.0004			5.09E-08
						10	5840.9	0.0	0.0000			0.00E+00
						15	5840.9	0.0	0.0000	8.91E-05	41.60	0.00E+00
							5840.9					
181.4	802.72	10	45	56.6	0.00	1	5840.9	0.0	0.0000			0.00E+00
191.4	792.72					2	5840.9	0.0	0.0000			0.00E+00
						5	5840.9	0.0	0.0000			0.00E+00
						10	5840.9	0.0	0.0000			0.00E+00
						15	5840.9	0.0	0.0000	0.00E+00	56.60	0.00E+00
							5840.9					
181.4	802.72	10	30	41.6	0.00	1	5840.9	0.0	0.0000			0.00E+00
191.4	792.72					2	5840.9	0.0	0.0000			0.00E+00
						5	5840.9	0.0	0.0000			0.00E+00
						10	5840.9	0.0	0.0000			0.00E+00
						15	5840.9	0.0	0.0000	0.00E+00	41.60	0.00E+00
							5840.8					
181.4	802.72	10	15	26.6	0.00	1	5840.8	0.0	0.0000			0.00E+00
191.4	792.72					2	5840.8	0.0	0.0000			0.00E+00
						5	5840.8	0.0	0.0000			0.00E+00
						10	5840.8	0.0	0.0000			0.00E+00
						15	5840.8	0.0	0.0000	0.00E+00	26.60	0.00E+00
											Average of Valid Stages:	**2.04E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
	December 13, 2017	Groundwater Depth:	10.4	ft
	Water Pressure Testing	Groundwater Elev:	975.96	ft
	Boring B-23	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
153.6	832.76	5	15	21.2	0.00	1		0.0	0.0000			0.00E+00
158.6	827.76					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	21.20	0.00E+00
153.6	832.76	5	30	36.2	0.00	1		0.0	0.0000			0.00E+00
158.6	827.76					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	36.20	0.00E+00
153.6	832.76	5	45	51.2	0.00	1		0.0	0.0000			0.00E+00
158.6	827.76					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	51.20	0.00E+00
153.6	832.76	5	30	36.2	0.00	1		0.0	0.0000			0.00E+00
158.6	827.76					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	36.20	0.00E+00
153.6	832.76	5	15	21.2	0.00	1		0.0	0.0000			0.00E+00
158.6	827.76					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	21.20	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used, Unable to seal packers in bedrock, no test

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
December 13, 2017	Groundwater Depth:	14.2	ft
Water Pressure Testing	Groundwater Elev:	972.16	ft
Boring B-23	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5199.50					
158.6	827.76	5	15	22.9	0.00	1	5199.50	0.0	0.0000			0.00E+00
163.6	822.76					2	5199.50	0.0	0.0000			0.00E+00
						5	5199.50	0.0	0.0000			0.00E+00
						10	5199.50	0.0	0.0000			0.00E+00
						15	5199.50	0.0	0.0000	0.00E+00	22.90	0.00E+00
							5199.60					
158.6	827.76	5	30	37.9	0.00	1	5199.60	0.0	0.0000			0.00E+00
163.6	822.76					2	5199.60	0.0	0.0000			0.00E+00
						5	5199.60	0.0	0.0000			0.00E+00
						10	5199.60	0.0	0.0000			0.00E+00
						15	5199.60	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5199.80					
158.6	827.76	5	45	52.9	0.00	1	5199.80	0.0	0.0000			0.00E+00
163.6	822.76					2	5199.80	0.0	0.0000			0.00E+00
						5	5199.80	0.0	0.0000			0.00E+00
						10	5199.80	0.0	0.0000			0.00E+00
						15	5199.80	0.0	0.0000	0.00E+00	52.90	0.00E+00
							5199.60					
158.6	827.76	5	30	37.9	0.00	1	5199.60	0.0	0.0000			0.00E+00
163.6	822.76					2	5199.60	0.0	0.0000			0.00E+00
						5	5199.60	0.0	0.0000			0.00E+00
						10	5199.60	0.0	0.0000			0.00E+00
						15	5199.60	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5199.50					
158.6	827.76	5	15	22.9	0.00	1	5199.50	0.0	0.0000			0.00E+00
163.6	822.76					2	5199.50	0.0	0.0000			0.00E+00
						5	5199.50	0.0	0.0000			0.00E+00
						10	5199.50	0.0	0.0000			0.00E+00
						15	5199.50	0.0	0.0000	0.00E+00	22.90	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36 ft
	December 13, 2017	Groundwater Depth:	14.2 ft
	Water Pressure Testing	Groundwater Elev:	972.16 ft
	Boring B-23	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5086.90					
163.6	822.76	5	15	22.9	0.00	1	5086.90	0.0	0.0000			0.00E+00
168.6	817.76					2	5086.90	0.0	0.0000			0.00E+00
						5	5086.90	0.0	0.0000			0.00E+00
						10	5086.90	0.0	0.0000			0.00E+00
						15	5086.90	0.0	0.0000	0.00E+00	22.90	0.00E+00
							5087.50					
163.6	822.76	5	30	37.9	0.00	1	5087.50	0.0	0.0000			0.00E+00
168.6	817.76					2	5087.50	0.0	0.0000			0.00E+00
						5	5087.50	0.0	0.0000			0.00E+00
						10	5087.50	0.0	0.0000			0.00E+00
						15	5087.50	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5122.80					
163.6	822.76	5	45	52.9	0.00	1	5122.80	0.0	0.0000			0.00E+00
168.6	817.76					2	5122.80	0.0	0.0000			0.00E+00
						5	5122.80	0.0	0.0000			0.00E+00
						10	5122.80	0.0	0.0000			0.00E+00
						15	5122.80	0.0	0.0000	0.00E+00	52.90	0.00E+00
							5122.70					
163.6	822.76	5	30	37.9	0.00	1	5122.70	0.0	0.0000			0.00E+00
168.6	817.76					2	5122.70	0.0	0.0000			0.00E+00
						5	5122.70	0.0	0.0000			0.00E+00
						10	5122.70	0.0	0.0000			0.00E+00
						15	5122.70	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5122.60					
163.6	822.76	5	15	22.9	0.00	1	5122.60	0.0	0.0000			0.00E+00
168.6	817.76					2	5122.60	0.0	0.0000			0.00E+00
						5	5122.60	0.0	0.0000			0.00E+00
						10	5122.60	0.0	0.0000			0.00E+00
						15	5122.60	0.0	0.0000	0.00E+00	22.90	0.00E+00

Note: Double packer system used, packer deflated at 45 psi, reinflated and started test again at that pressure

Average of Valid Stages: 0.00E+00

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
	December 13, 2017	Groundwater Depth:	21.4	ft
	Water Pressure Testing	Groundwater Elev:	964.96	ft
	Boring B-23	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							4924.30					
168.6	817.76	5	15	26.0	0.00	1	4924.30	0.0	0.0000			0.00E+00
173.6	812.76					2	4924.30	0.0	0.0000			0.00E+00
						5	4924.30	0.0	0.0000			0.00E+00
						10	4924.30	0.0	0.0000			0.00E+00
						15	4924.30	0.0	0.0000	0.00E+00	26.00	0.00E+00
							4925.10					
168.6	817.76	5	30	41.0	0.00	1	4925.10	0.0	0.0000			0.00E+00
173.6	812.76					2	4925.10	0.0	0.0000			0.00E+00
						5	4925.10	0.0	0.0000			0.00E+00
						10	4925.10	0.0	0.0000			0.00E+00
						15	4925.10	0.0	0.0000	0.00E+00	41.00	0.00E+00
							4925.80					
168.6	817.76	5	45	56.0	0.00	1	4925.80	0.0	0.0000			0.00E+00
173.6	812.76					2	4925.80	0.0	0.0000			0.00E+00
						5	4925.80	0.0	0.0000			0.00E+00
						10	4925.80	0.0	0.0000			0.00E+00
						15	4925.80	0.0	0.0000	0.00E+00	56.00	0.00E+00
							4941.90					
168.6	817.76	5	30	41.0	0.00	1	4941.90	0.0	0.0000			0.00E+00
173.6	812.76					2	4941.90	0.0	0.0000			0.00E+00
						5	4941.90	0.0	0.0000			0.00E+00
						10	4941.90	0.0	0.0000			0.00E+00
						15	4941.90	0.0	0.0000	0.00E+00	41.00	0.00E+00
							4941.80					
168.6	817.76	5	15	26.0	0.00	1	4941.80	0.0	0.0000			0.00E+00
173.6	812.76					2	4941.80	0.0	0.0000			0.00E+00
						5	4941.80	0.0	0.0000			0.00E+00
						10	4941.80	0.0	0.0000			0.00E+00
						15	4941.80	0.0	0.0000	0.00E+00	26.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
December 13, 2017	Groundwater Depth:	21.4	ft
Water Pressure Testing	Groundwater Elev:	964.96	ft
Boring B-23	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							4902.00					
173.6	812.76	5	15	26.0	0.00	1	4902.00	0.0	0.0000			0.00E+00
178.6	807.76					2	4902.00	0.0	0.0000			0.00E+00
						5	4902.00	0.0	0.0000			0.00E+00
						10	4901.50	-0.1	-0.0027			-4.47E-07
						15	4900.80	-0.1	-0.0037	-1.28E-03	26.00	-6.25E-07
							4901.50					
173.6	812.76	5	30	41.0	0.00	1	4901.50	0.0	0.0000			0.00E+00
178.6	807.76					2	4901.50	0.0	0.0000			0.00E+00
						5	4901.50	0.0	0.0000			0.00E+00
						10	4901.50	0.0	0.0000			0.00E+00
						15	4901.50	0.0	0.0000	0.00E+00	41.00	0.00E+00
							4902.00					
173.6	812.76	5	45	56.0	0.00	1	4902.00	0.0	0.0000			0.00E+00
178.6	807.76					2	4902.00	0.0	0.0000			0.00E+00
						5	4902.00	0.0	0.0000			0.00E+00
						10	4902.00	0.0	0.0000			0.00E+00
						15	4902.00	0.0	0.0000	0.00E+00	56.00	0.00E+00
							4901.00					
173.6	812.76	5	30	41.0	0.19	1	4900.90	-0.1	-0.0027			-2.84E-07
178.6	807.76					2	4900.90	0.0	0.0000			0.00E+00
						5	4900.90	0.0	0.0000			0.00E+00
						10	4900.90	0.0	0.0000			0.00E+00
						15	4900.90	0.0	0.0000	-5.35E-04	40.81	0.00E+00
							4900.20					
173.6	812.76	5	15	26.0	0.00	1	4900.20	0.0	0.0000			0.00E+00
178.6	807.76					2	4900.20	0.0	0.0000			0.00E+00
						5	4900.20	0.0	0.0000			0.00E+00
						10	4900.20	0.0	0.0000			0.00E+00
						15	4900.20	0.0	0.0000	0.00E+00	26.00	0.00E+00
											Average of Valid Stages:	**-5.42E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
December 13, 2017	Groundwater Depth:	21.4	ft
Water Pressure Testing	Groundwater Elev:	964.96	ft
Boring B-23	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							4907.40					
178.6	807.76	5	15	26.0	0.50	1	4907.60	0.2	0.0053			9.00E-07
183.6	802.76					2	4908.30	0.7	0.0187			3.15E-06
						5	4908.90	0.2	0.0053			9.00E-07
						10	4908.90	0.0	0.0000			0.00E+00
						15	4908.90	0.0	0.0000	5.88E-03	25.50	0.00E+00
							4909.00					
178.6	807.76	5	30	41.0	0.39	1	4909.10	0.1	0.0027			2.84E-07
183.6	802.76					2	4909.10	0.0	0.0000			0.00E+00
						5	4909.10	0.0	0.0000			0.00E+00
						10	4909.10	0.0	0.0000			0.00E+00
						15	4909.10	0.0	0.0000	5.35E-04	40.61	0.00E+00
							4909.10					
178.6	807.76	5	45	56.0	0.00	1	4909.10	0.0	0.0000			0.00E+00
183.6	802.76					2	4909.10	0.0	0.0000			0.00E+00
						5	4909.10	0.0	0.0000			0.00E+00
						10	4909.10	0.0	0.0000			0.00E+00
						15	4909.10	0.0	0.0000	0.00E+00	56.00	0.00E+00
							4909.10					
178.6	807.76	5	30	41.0	0.00	1	4909.10	0.0	0.0000			0.00E+00
183.6	802.76					2	4909.10	0.0	0.0000			0.00E+00
						5	4909.10	0.0	0.0000			0.00E+00
						10	4909.10	0.0	0.0000			0.00E+00
						15	4909.10	0.0	0.0000	0.00E+00	41.00	0.00E+00
							4908.90					
178.6	807.76	5	15	26.0	0.00	1	4908.90	0.0	0.0000			0.00E+00
183.6	802.76					2	4908.90	0.0	0.0000			0.00E+00
						5	4908.90	0.0	0.0000			0.00E+00
						10	4908.90	0.0	0.0000			0.00E+00
						15	4908.90	0.0	0.0000	0.00E+00	26.00	0.00E+00
											Average of Valid Stages:	**2.09E-07**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	986.36	ft
December 13, 2017	Groundwater Depth:	21.4	ft
Water Pressure Testing	Groundwater Elev:	964.96	ft
Boring B-23	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							4891.50					
183.6	802.76	5	15	26.0	0.00	1	4891.50	0.0	0.0000			0.00E+00
188.6	797.76					2	4891.50	0.0	0.0000			0.00E+00
						5	4891.50	0.0	0.0000			0.00E+00
						10	4891.50	0.0	0.0000			0.00E+00
						15	4891.50	0.0	0.0000	0.00E+00	26.00	0.00E+00
							4891.60					
183.6	802.76	5	30	41.0	0.39	1	4891.70	0.1	0.0027			2.84E-07
188.6	797.76					2	4891.70	0.0	0.0000			0.00E+00
						5	4891.70	0.0	0.0000			0.00E+00
						10	4891.70	0.0	0.0000			0.00E+00
						15	4891.70	0.0	0.0000	5.35E-04	40.61	0.00E+00
							4891.80					
183.6	802.76	5	45	56.0	0.00	1	4891.80	0.0	0.0000			0.00E+00
188.6	797.76					2	4891.80	0.0	0.0000			0.00E+00
						5	4891.80	0.0	0.0000			0.00E+00
						10	4891.80	0.0	0.0000			0.00E+00
						15	4891.80	0.0	0.0000	0.00E+00	56.00	0.00E+00
							4891.70					
183.6	802.76	5	30	41.0	0.00	1	4891.70	0.0	0.0000			0.00E+00
188.6	797.76					2	4891.70	0.0	0.0000			0.00E+00
						5	4891.70	0.0	0.0000			0.00E+00
						10	4891.70	0.0	0.0000			0.00E+00
						15	4891.70	0.0	0.0000	0.00E+00	41.00	0.00E+00
							4891.70					
183.6	802.76	5	15	26.0	0.00	1	4891.70	0.0	0.0000			0.00E+00
188.6	797.76					2	4891.70	0.0	0.0000			0.00E+00
						5	4891.70	0.0	0.0000			0.00E+00
						10	4891.70	0.0	0.0000			0.00E+00
						15	4891.70	0.0	0.0000	0.00E+00	26.00	0.00E+00
											Average of Valid Stages:	**1.14E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
February 28, 2018
Water Pressure Testing
Boring B-24

Ground Elevation: 989.58 ft
Groundwater Depth: 14.3 ft
Groundwater Elev: 975.28 ft
Gage Height: 4 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5843.7					
146.4	843.18	10	15	22.9	0.00	1	5843.7	0.0	0.0000			0.00E+00
156.4	833.18					2	5843.7	0.0	0.0000			0.00E+00
						5	5843.7	0.0	0.0000			0.00E+00
						10	5843.7	0.0	0.0000			0.00E+00
						15	5843.7	0.0	0.0000	0.00E+00	22.90	0.00E+00
							5843.7					
146.4	843.18	10	30	37.9	0.00	1	5843.7	0.0	0.0000			0.00E+00
156.4	833.18					2	5843.7	0.0	0.0000			0.00E+00
						5	5843.7	0.0	0.0000			0.00E+00
						10	5843.7	0.0	0.0000			0.00E+00
						15	5843.7	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5843.7					
146.4	843.18	10	45	52.9	0.00	1	5843.7	0.0	0.0000			0.00E+00
156.4	833.18					2	5843.7	0.0	0.0000			0.00E+00
						5	5843.7	0.0	0.0000			0.00E+00
						10	5843.7	0.0	0.0000			0.00E+00
						15	5843.7	0.0	0.0000	0.00E+00	52.90	0.00E+00
							5843.7					
146.4	843.18	10	30	37.9	0.00	1	5843.7	0.0	0.0000			0.00E+00
156.4	833.18					2	5843.7	0.0	0.0000			0.00E+00
						5	5843.7	0.0	0.0000			0.00E+00
						10	5843.7	0.0	0.0000			0.00E+00
						15	5843.7	0.0	0.0000	0.00E+00	37.90	0.00E+00
							5843.7					
146.4	843.18	10	15	22.9	0.00	1	5843.7	0.0	0.0000			0.00E+00
156.4	833.18					2	5843.7	0.0	0.0000			0.00E+00
						5	5843.7	0.0	0.0000			0.00E+00
						10	5843.7	0.0	0.0000			0.00E+00
						15	5843.7	0.0	0.0000	0.00E+00	22.90	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	989.58	ft
February 28, 2018	Groundwater Depth:	33.9	ft
Water Pressure Testing	Groundwater Elev:	955.68	ft
Boring B-24	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5850.5					
156.4	833.18	10	15	31.4	0.00	1	5850.5	0.0	0.0000			0.00E+00
166.4	823.18					2	5850.5	0.0	0.0000			0.00E+00
						5	5850.5	0.0	0.0000			0.00E+00
						10	5850.5	0.0	0.0000			0.00E+00
						15	5850.5	0.0	0.0000	0.00E+00	31.40	0.00E+00
							5851.3					
156.4	833.18	10	30	46.4	0.00	1	5851.3	0.0	0.0000			0.00E+00
166.4	823.18					2	5851.3	0.0	0.0000			0.00E+00
						5	5851.3	0.0	0.0000			0.00E+00
						10	5851.3	0.0	0.0000			0.00E+00
						15	5851.3	0.0	0.0000	0.00E+00	46.40	0.00E+00
							5851.7					
156.4	833.18	10	45	61.4	0.00	1	5851.7	0.0	0.0000			0.00E+00
166.4	823.18					2	5851.7	0.0	0.0000			0.00E+00
						5	5851.7	0.0	0.0000			0.00E+00
						10	5851.7	0.0	0.0000			0.00E+00
						15	5851.7	0.0	0.0000	0.00E+00	61.40	0.00E+00
							5851.7					
156.4	833.18	10	30	46.4	0.00	1	5851.7	0.0	0.0000			0.00E+00
166.4	823.18					2	5851.7	0.0	0.0000			0.00E+00
						5	5851.7	0.0	0.0000			0.00E+00
						10	5851.7	0.0	0.0000			0.00E+00
						15	5851.7	0.0	0.0000	0.00E+00	46.40	0.00E+00
							5851.6					
156.4	833.18	10	15	31.4	0.00	1	5851.6	0.0	0.0000			0.00E+00
166.4	823.18					2	5851.6	0.0	0.0000			0.00E+00
						5	5851.6	0.0	0.0000			0.00E+00
						10	5851.6	0.0	0.0000			0.00E+00
						15	5851.6	0.0	0.0000	0.00E+00	31.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	989.58 ft
	February 28, 2018	Groundwater Depth:	24.4 ft
	Water Pressure Testing	Groundwater Elev:	965.18 ft
	Boring B-24	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5863.2					
166.4	823.18	10	15	27.3	0.00	1	5863.2	0.0	0.0000			0.00E+00
176.4	813.18					2	5863.2	0.0	0.0000			0.00E+00
						5	5863.2	0.0	0.0000			0.00E+00
						10	5863.2	0.0	0.0000			0.00E+00
						15	5863.2	0.0	0.0000	0.00E+00	27.30	0.00E+00
							5863.3					
166.4	823.18	10	30	42.3	0.00	1	5863.3	0.0	0.0000			0.00E+00
176.4	813.18					2	5863.3	0.0	0.0000			0.00E+00
						5	5863.3	0.0	0.0000			0.00E+00
						10	5863.3	0.0	0.0000			0.00E+00
						15	5863.3	0.0	0.0000	0.00E+00	42.30	0.00E+00
							5863.3					
166.4	823.18	10	45	57.3	0.00	1	5863.3	0.0	0.0000			0.00E+00
176.4	813.18					2	5863.3	0.0	0.0000			0.00E+00
						5	5863.3	0.0	0.0000			0.00E+00
						10	5863.3	0.0	0.0000			0.00E+00
						15	5863.3	0.0	0.0000	0.00E+00	57.30	0.00E+00
							5863.3					
166.4	823.18	10	30	42.3	0.00	1	5863.3	0.0	0.0000			0.00E+00
176.4	813.18					2	5863.3	0.0	0.0000			0.00E+00
						5	5863.3	0.0	0.0000			0.00E+00
						10	5863.3	0.0	0.0000			0.00E+00
						15	5863.3	0.0	0.0000	0.00E+00	42.30	0.00E+00
							5863.3					
166.4	823.18	10	15	27.3	0.00	1	5863.3	0.0	0.0000			0.00E+00
176.4	813.18					2	5863.3	0.0	0.0000			0.00E+00
						5	5863.3	0.0	0.0000			0.00E+00
						10	5863.3	0.0	0.0000			0.00E+00
						15	5863.3	0.0	0.0000	0.00E+00	27.30	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	989.58 ft
	March 1, 2018	Groundwater Depth:	37 ft
	Water Pressure Testing	Groundwater Elev:	952.58 ft
	Boring B-24	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5871.6					
176.4	813.18	10	15	32.8	0.00	1	5871.6	0.0	0.0000			0.00E+00
186.4	803.18					2	5871.6	0.0	0.0000			0.00E+00
						5	5871.6	0.0	0.0000			0.00E+00
						10	5871.6	0.0	0.0000			0.00E+00
						15	5871.6	0.0	0.0000	0.00E+00	32.80	0.00E+00
							5872.0					
176.4	813.18	10	30	47.8	0.00	1	5872.0	0.0	0.0000			0.00E+00
186.4	803.18					2	5872.0	0.0	0.0000			0.00E+00
						5	5872.0	0.0	0.0000			0.00E+00
						10	5872.0	0.0	0.0000			0.00E+00
						15	5872.0	0.0	0.0000	0.00E+00	47.80	0.00E+00
							5872.2					
176.4	813.18	10	45	62.8	0.00	1	5872.2	0.0	0.0000			0.00E+00
186.4	803.18					2	5872.2	0.0	0.0000			0.00E+00
						5	5872.2	0.0	0.0000			0.00E+00
						10	5872.2	0.0	0.0000			0.00E+00
						15	5872.2	0.0	0.0000	0.00E+00	62.80	0.00E+00
							5872.0					
176.4	813.18	10	30	47.8	0.00	1	5872.0	0.0	0.0000			0.00E+00
186.4	803.18					2	5872.0	0.0	0.0000			0.00E+00
						5	5872.0	0.0	0.0000			0.00E+00
						10	5872.0	0.0	0.0000			0.00E+00
						15	5872.0	0.0	0.0000	0.00E+00	47.80	0.00E+00
							5871.9					
176.4	813.18	10	15	32.8	0.00	1	5871.9	0.0	0.0000			0.00E+00
186.4	803.18					2	5871.9	0.0	0.0000			0.00E+00
						5	5871.9	0.0	0.0000			0.00E+00
						10	5871.9	0.0	0.0000			0.00E+00
						15	5871.9	0.0	0.0000	0.00E+00	32.80	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	989.58 ft
	March 1, 2018	Groundwater Depth:	35.4 ft
	Water Pressure Testing	Groundwater Elev:	954.18 ft
	Boring B-24	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5881.2					
186.4	803.18	10	15	32.1	0.00	1	5881.2	0.0	0.0000			0.00E+00
196.4	793.18					2	5881.2	0.0	0.0000			0.00E+00
						5	5881.2	0.0	0.0000			0.00E+00
						10	5881.2	0.0	0.0000			0.00E+00
						15	5881.2	0.0	0.0000	0.00E+00	32.10	0.00E+00
							5881.8					
186.4	803.18	10	30	47.1	0.00	1	5881.8	0.0	0.0000			0.00E+00
196.4	793.18					2	5881.8	0.0	0.0000			0.00E+00
						5	5881.8	0.0	0.0000			0.00E+00
						10	5881.8	0.0	0.0000			0.00E+00
						15	5881.8	0.0	0.0000	0.00E+00	47.10	0.00E+00
							5881.9					
186.4	803.18	10	45	62.1	0.00	1	5881.9	0.0	0.0000			0.00E+00
196.4	793.18					2	5881.9	0.0	0.0000			0.00E+00
						5	5881.9	0.0	0.0000			0.00E+00
						10	5881.9	0.0	0.0000			0.00E+00
						15	5881.9	0.0	0.0000	0.00E+00	62.10	0.00E+00
							5881.8					
186.4	803.18	10	30	47.1	0.00	1	5881.8	0.0	0.0000			0.00E+00
196.4	793.18					2	5881.8	0.0	0.0000			0.00E+00
						5	5881.8	0.0	0.0000			0.00E+00
						10	5881.8	0.0	0.0000			0.00E+00
						15	5881.8	0.0	0.0000	0.00E+00	47.10	0.00E+00
							5881.6					
186.4	803.18	10	15	32.1	0.00	1	5881.6	0.0	0.0000			0.00E+00
196.4	793.18					2	5881.6	0.0	0.0000			0.00E+00
						5	5881.6	0.0	0.0000			0.00E+00
						10	5881.6	0.0	0.0000			0.00E+00
						15	5881.6	0.0	0.0000	0.00E+00	32.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 15, 2018	Groundwater Depth:	1.4 ft
	Water Pressure Testing	Groundwater Elev:	993.56 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13733.5					
75	919.96	12.1	15	17.3	0.44	1	13733.7	0.1	0.0017			4.80E-07
87.1	907.86					2	13734.0	0.3	0.0033			9.59E-07
						5	13734.6	0.2	0.0025			7.20E-07
						10	13734.9	0.0	0.0005			1.44E-07
						15	13734.9	0.0	0.0000	1.59E-03	16.86	0.00E+00
							13734.9					
75	919.96	12.1	30	32.3	0.36	1	13735.0	0.1	0.0008			1.28E-07
87.1	907.86					2	13735.0	0.0	0.0000			0.00E+00
						5	13735.2	0.0	0.0006			8.52E-08
						10	13735.2	0.0	0.0002			2.56E-08
						15	13735.4	0.0	0.0003	3.75E-04	31.94	5.11E-08
							13735.4					
75	919.96	12.1	45	47.3	0.44	1	13735.5	0.1	0.0017			1.74E-07
87.1	907.86					2	13735.6	0.1	0.0008			8.72E-08
						5	13735.9	0.1	0.0011			1.16E-07
						10	13736.4	0.1	0.0012			1.22E-07
						15	13736.5	0.0	0.0002	9.81E-04	46.86	1.74E-08
							13736.9					
75	919.96	12.1	30	32.3	0.00	1	13736.9	0.0	0.0000			0.00E+00
87.1	907.86					2	13737.0	0.1	0.0008			1.27E-07
						5	13737.2	0.0	0.0006			8.48E-08
						10	13737.5	0.1	0.0007			1.02E-07
						15	13737.7	0.0	0.0005	5.07E-04	32.30	7.63E-08
							13737.7					
75	919.96	12.1	15	17.3	0.00	1	13737.7	0.0	0.0000			0.00E+00
87.1	907.86					2	13737.7	0.0	0.0000			0.00E+00
						5	13737.7	0.0	0.0000			0.00E+00
						10	13737.8	0.0	0.0002			4.74E-08
						15	13737.8	0.0	0.0002	6.61E-05	17.30	4.74E-08
											Average of Valid Stages:	**1.44E-07**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96	ft
May 15, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	993.86	ft
Boring B-25	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13740.1					
87.1	907.86	10	15	17.2	0.61	1	13740.4	0.3	0.0040			1.12E-06
97.1	897.86					2	13740.5	0.1	0.0020			5.62E-07
						5	13740.5	0.0	0.0000			0.00E+00
						10	13740.5	0.0	0.0000			0.00E+00
						15	13740.7	0.0	0.0004	1.28E-03	16.59	1.12E-07
							13740.8					
87.1	907.86	10	30	32.2	0.00	1	13740.8	0.0	0.0000			0.00E+00
97.1	897.86					2	13740.8	0.0	0.0000			0.00E+00
						5	13740.8	0.0	0.0003			4.92E-08
						10	13741.1	0.0	0.0006			8.86E-08
						15	13741.4	0.1	0.0010	3.87E-04	32.20	1.48E-07
							13741.5					
87.1	907.86	10	45	47.2	0.44	1	13741.7	0.1	0.0020			2.02E-07
97.1	897.86					2	13741.8	0.1	0.0020			2.02E-07
						5	13742.2	0.1	0.0017			1.69E-07
						10	13742.9	0.1	0.0020			2.02E-07
						15	13743.6	0.1	0.0018	1.89E-03	46.76	1.82E-07
							13743.6					
87.1	907.86	10	30	32.2	0.36	1	13743.7	0.1	0.0010			1.48E-07
97.1	897.86					2	13743.8	0.1	0.0010			1.48E-07
						5	13744.1	0.1	0.0013			1.98E-07
						10	13744.5	0.1	0.0012			1.78E-07
						15	13744.9	0.1	0.0012	1.15E-03	31.84	1.78E-07
							13744.9					
87.1	907.86	10	15	17.2	0.00	1	13744.9	0.0	0.0000			0.00E+00
97.1	897.86					2	13744.9	0.0	0.0000			0.00E+00
						5	13745.0	0.0	0.0003			9.22E-08
						10	13745.2	0.0	0.0004			1.11E-07
						15	13745.3	0.0	0.0004	2.27E-04	17.20	1.11E-07
											Average of Valid Stages:	**1.68E-07**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 16, 2018	Groundwater Depth:	1.3 ft
	Water Pressure Testing	Groundwater Elev:	993.66 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13746.7					
97.1	897.86	10	15	17.3	0.00	1	13746.7	0.0	0.0000			0.00E+00
107.1	887.86					2	13746.7	0.0	0.0000			0.00E+00
						5	13746.7	0.0	0.0000			0.00E+00
						10	13746.7	0.0	0.0000			0.00E+00
						15	13746.7	0.0	0.0000	0.00E+00	17.30	0.00E+00
							13747.0					
97.1	897.86	10	30	32.3	0.00	1	13747.0	0.0	0.0000			0.00E+00
107.1	887.86					2	13747.0	0.0	0.0000			0.00E+00
						5	13747.0	0.0	0.0000			0.00E+00
						10	13747.0	0.0	0.0000			0.00E+00
						15	13747.1	0.0	0.0002	4.00E-05	32.30	2.95E-08
							13747.3					
97.1	897.86	10	45	47.3	0.36	1	13747.3	0.1	0.0010			1.01E-07
107.1	887.86					2	13747.4	0.1	0.0010			1.01E-07
						5	13747.6	0.1	0.0010			1.01E-07
						10	13747.9	0.1	0.0008			8.08E-08
						15	13748.2	0.0	0.0006	8.80E-04	46.94	6.06E-08
							13748.1					
97.1	897.86	10	30	32.3	0.00	1	13748.1	0.0	0.0000			0.00E+00
107.1	887.86					2	13748.1	0.0	0.0000			0.00E+00
						5	13748.3	0.1	0.0010			1.47E-07
						10	13748.5	0.0	0.0006			8.84E-08
						15	13748.8	0.1	0.0008	4.80E-04	32.30	1.18E-07
							13748.7					
97.1	897.86	10	15	17.3	0.00	1	13748.7	0.0	0.0000			0.00E+00
107.1	887.86					2	13748.7	0.0	0.0000			0.00E+00
						5	13748.8	0.0	0.0003			9.17E-08
						10	13748.8	0.0	0.0000			0.00E+00
						15	13748.8	0.0	0.0002	1.07E-04	17.30	5.50E-08
											Average of Valid Stages:	**3.90E-08**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96	ft
May 16, 2018	Groundwater Depth:	1.5	ft
Water Pressure Testing	Groundwater Elev:	993.46	ft
Boring B-25	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13749.4					
107.1	887.86	10	15	17.4	0.00	1	13749.4	0.0	0.0000			0.00E+00
117.1	877.86					2	13749.4	0.0	0.0000			0.00E+00
						5	13749.4	0.0	0.0000			0.00E+00
						10	13749.4	0.0	0.0000			0.00E+00
						15	13749.4	0.0	0.0000	0.00E+00	17.40	0.00E+00
							13749.5					
107.1	887.86	10	30	32.4	0.00	1	13749.5	0.0	0.0000			0.00E+00
117.1	877.86					2	13749.5	0.0	0.0000			0.00E+00
						5	13749.5	0.0	0.0000			0.00E+00
						10	13749.6	0.0	0.0002			2.94E-08
						15	13749.6	0.0	0.0000	4.00E-05	32.40	0.00E+00
							13749.7					
107.1	887.86	10	45	47.4	0.00	1	13749.7	0.0	0.0000			0.00E+00
117.1	877.86					2	13749.7	0.0	0.0000			0.00E+00
						5	13749.7	0.0	0.0000			0.00E+00
						10	13749.7	0.0	0.0002			2.01E-08
						15	13749.7	0.0	0.0000	4.00E-05	47.40	0.00E+00
							13749.7					
107.1	887.86	10	30	32.4	0.00	1	13749.7	0.0	0.0000			0.00E+00
117.1	877.86					2	13749.7	0.0	0.0000			0.00E+00
						5	13749.7	0.0	0.0000			0.00E+00
						10	13749.7	0.0	0.0000			0.00E+00
						15	13749.7	0.0	0.0000	0.00E+00	32.40	0.00E+00
							13749.7					
107.1	887.86	10	15	17.4	0.00	1	13749.7	0.0	0.0000			0.00E+00
117.1	877.86					2	13749.7	0.0	0.0000			0.00E+00
						5	13749.7	0.0	0.0000			0.00E+00
						10	13749.7	0.0	0.0000			0.00E+00
						15	13749.7	0.0	0.0000	0.00E+00	17.40	0.00E+00
											Average of Valid Stages:	**1.98E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 16, 2018	Groundwater Depth:	0 ft
	Water Pressure Testing	Groundwater Elev:	994.96 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13751.0					
117.1	877.86	10	15	16.7	0.00	1	13751.0	0.0	0.0000			0.00E+00
127.1	867.86					2	13751.0	0.0	0.0000			0.00E+00
						5	13751.0	0.0	0.0000			0.00E+00
						10	13751.0	0.0	0.0000			0.00E+00
						15	13751.1	0.0	0.0002	4.00E-05	16.70	5.69E-08
							13751.2					
117.1	877.86	10	30	31.7	0.00	1	13751.2	0.0	0.0000			0.00E+00
127.1	867.86					2	13751.2	0.0	0.0000			0.00E+00
						5	13751.2	0.0	0.0000			0.00E+00
						10	13751.3	0.0	0.0002			3.00E-08
						15	13751.4	0.0	0.0002	8.00E-05	31.70	3.00E-08
							13751.5					
117.1	877.86	10	45	46.7	0.00	1	13751.5	0.0	0.0000			0.00E+00
127.1	867.86					2	13751.5	0.0	0.0000			0.00E+00
						5	13751.6	0.0	0.0003			3.39E-08
						10	13751.7	0.0	0.0002			2.04E-08
						15	13751.8	0.0	0.0002	1.47E-04	46.70	2.04E-08
							13751.7					
117.1	877.86	10	30	31.7	0.00	1	13751.7	0.0	0.0000			0.00E+00
127.1	867.86					2	13751.7	0.0	0.0000			0.00E+00
						5	13751.7	0.0	0.0000			0.00E+00
						10	13751.8	0.0	0.0002			3.00E-08
						15	13751.8	0.0	0.0000	4.00E-05	31.70	0.00E+00
							13751.7					
117.1	877.86	10	15	16.7	0.00	1	13751.7	0.0	0.0000			0.00E+00
127.1	867.86					2	13751.7	0.0	0.0000			0.00E+00
						5	13751.7	0.0	0.0000			0.00E+00
						10	13751.7	0.0	0.0000			0.00E+00
						15	13751.7	0.0	0.0000	0.00E+00	16.70	0.00E+00

Average of Valid Stages: **8.86E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 17, 2018	Groundwater Depth:	1.4 ft
	Water Pressure Testing	Groundwater Elev:	993.56 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13752.7					
127.1	867.86	10	15	17.3	0.00	1	13752.7	0.0	0.0000			0.00E+00
137.1	857.86					2	13752.7	0.0	0.0000			0.00E+00
						5	13752.7	0.0	0.0000			0.00E+00
						10	13752.7	0.0	0.0000			0.00E+00
						15	13752.7	0.0	0.0000	0.00E+00	17.30	0.00E+00
							13753.0					
127.1	867.86	10	30	32.3	0.00	1	13753.0	0.0	0.0000			0.00E+00
137.1	857.86					2	13753.0	0.0	0.0000			0.00E+00
						5	13753.0	0.0	0.0000			0.00E+00
						10	13753.1	0.0	0.0002			2.94E-08
						15	13753.2	0.0	0.0002	8.00E-05	32.30	2.94E-08
							13753.3					
127.1	867.86	10	45	47.3	0.00	1	13753.3	0.0	0.0000			0.00E+00
137.1	857.86					2	13753.3	0.1	0.0010			1.01E-07
						5	13753.3	0.0	0.0000			0.00E+00
						10	13753.3	0.0	0.0000			0.00E+00
						15	13753.3	0.0	0.0000	2.00E-04	47.30	0.00E+00
							13753.3					
127.1	867.86	10	30	32.3	0.00	1	13753.3	0.0	0.0000			0.00E+00
137.1	857.86					2	13753.3	0.0	0.0000			0.00E+00
						5	13753.3	0.0	0.0000			0.00E+00
						10	13753.3	0.0	0.0000			0.00E+00
						15	13753.3	0.0	0.0000	0.00E+00	32.30	0.00E+00
							13753.3					
127.1	867.86	10	15	17.3	0.00	1	13753.3	0.0	0.0000			0.00E+00
137.1	857.86					2	13753.3	0.0	0.0000			0.00E+00
						5	13753.3	0.0	0.0000			0.00E+00
						10	13753.3	0.0	0.0000			0.00E+00
						15	13753.3	0.0	0.0000	0.00E+00	17.30	0.00E+00

Average of Valid Stages: **6.37E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 17, 2018	Groundwater Depth:	0 ft
	Water Pressure Testing	Groundwater Elev:	994.96 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13790.1					
137.1	857.86	10	15	16.7	0.44	1	13790.2	0.1	0.0020			5.75E-07
147.1	847.86					2	13790.4	0.2	0.0030			8.63E-07
						5	13791.0	0.2	0.0023			6.71E-07
						10	13791.6	0.1	0.0018			5.18E-07
						15	13791.6	0.0	0.0000	1.83E-03	16.26	0.00E+00
							13791.7					
137.1	857.86	10	30	31.7	0.00	1	13791.7	0.0	0.0000			0.00E+00
147.1	847.86					2	13791.7	0.0	0.0000			0.00E+00
						5	13791.8	0.0	0.0003			5.00E-08
						10	13791.8	0.0	0.0002			3.00E-08
						15	13791.9	0.0	0.0002	1.47E-04	31.70	3.00E-08
							13791.9					
137.1	857.86	10	45	46.7	0.44	1	13792.1	0.1	0.0020			2.04E-07
147.1	847.86					2	13792.3	0.2	0.0030			3.07E-07
						5	13793.0	0.2	0.0030			3.07E-07
						10	13793.9	0.2	0.0026			2.66E-07
						15	13794.9	0.2	0.0026	2.64E-03	46.26	2.66E-07
							13794.9					
137.1	857.86	10	30	31.7	0.44	1	13795.1	0.1	0.0020			3.02E-07
147.1	847.86					2	13795.2	0.1	0.0020			3.02E-07
						5	13795.7	0.1	0.0020			3.02E-07
						10	13796.3	0.1	0.0016			2.41E-07
						15	13796.9	0.1	0.0018	1.88E-03	31.26	2.72E-07
							13796.9					
137.1	857.86	10	15	16.7	0.00	1	13796.9	0.0	0.0000			0.00E+00
147.1	847.86					2	13796.9	0.0	0.0000			0.00E+00
						5	13797.1	0.0	0.0007			1.90E-07
						10	13797.3	0.0	0.0006			1.71E-07
						15	13797.5	0.0	0.0004	3.33E-04	16.70	1.14E-07
											Average of Valid Stages:	**2.39E-07**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 17, 2018	Groundwater Depth:	1.3 ft
	Water Pressure Testing	Groundwater Elev:	993.66 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13800.0					
147.1	847.86	10	15	17.3	0.00	1	13800.0	0.0	0.0000			0.00E+00
157.1	837.86					2	13800.0	0.0	0.0000			0.00E+00
						5	13800.0	0.0	0.0000			0.00E+00
						10	13800.0	0.0	0.0000			0.00E+00
						15	13800.0	0.0	0.0000	0.00E+00	17.30	0.00E+00
							13800.0					
147.1	847.86	10	30	32.3	0.00	1	13800.0	0.0	0.0000			0.00E+00
157.1	837.86					2	13800.0	0.0	0.0000			0.00E+00
						5	13800.0	0.0	0.0000			0.00E+00
						10	13800.0	0.0	0.0000			0.00E+00
						15	13800.0	0.0	0.0000	0.00E+00	32.30	0.00E+00
							13800.0					
147.1	847.86	10	45	47.3	0.00	1	13800.0	0.0	0.0000			0.00E+00
157.1	837.86					2	13800.0	0.0	0.0000			0.00E+00
						5	13800.0	0.0	0.0000			0.00E+00
						10	13800.0	0.0	0.0000			0.00E+00
						15	13800.0	0.0	0.0000	0.00E+00	47.30	0.00E+00
							13800.0					
147.1	847.86	10	30	32.3	0.00	1	13800.0	0.0	0.0000			0.00E+00
157.1	837.86					2	13800.0	0.0	0.0000			0.00E+00
						5	13800.2	0.1	0.0010			1.47E-07
						10	13800.5	0.0	0.0006			8.84E-08
						15	13800.8	0.1	0.0010	5.20E-04	32.30	1.47E-07
							13800.8					
147.1	847.86	10	15	17.3	0.00	1	13800.8	0.0	0.0000			0.00E+00
157.1	837.86					2	13800.8	0.0	0.0000			0.00E+00
						5	13800.8	0.0	0.0000			0.00E+00
						10	13800.8	0.0	0.0000			0.00E+00
						15	13800.8	0.0	0.0000	0.00E+00	17.30	0.00E+00
											Average of Valid Stages:	**1.53E-08**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 18, 2018	Groundwater Depth:	5.1 ft
	Water Pressure Testing	Groundwater Elev:	989.86 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13802.0					
157.1	837.86	10	15	18.9	0.44	1	13802.2	0.1	0.0020			5.08E-07
167.1	827.86					2	13802.2	0.1	0.0010			2.54E-07
						5	13802.2	0.0	0.0000			0.00E+00
						10	13802.2	0.0	0.0000			0.00E+00
						15	13802.2	0.0	0.0000	6.00E-04	18.46	0.00E+00
							13802.4					
157.1	837.86	10	30	33.9	0.00	1	13802.4	0.0	0.0000			0.00E+00
167.1	827.86					2	13802.4	0.0	0.0000			0.00E+00
						5	13802.4	0.0	0.0000			0.00E+00
						10	13802.4	0.0	0.0000			0.00E+00
						15	13802.4	0.0	0.0000	0.00E+00	33.90	0.00E+00
							13802.5					
157.1	837.86	10	45	48.9	0.00	1	13802.5	0.0	0.0000			0.00E+00
167.1	827.86					2	13802.5	0.0	0.0000			0.00E+00
						5	13802.5	0.0	0.0000			0.00E+00
						10	13802.5	0.0	0.0002			1.94E-08
						15	13802.6	0.0	0.0002	8.00E-05	48.90	1.94E-08
							13802.6					
157.1	837.86	10	30	33.9	0.00	1	13802.6	0.0	0.0000			0.00E+00
167.1	827.86					2	13802.6	0.0	0.0000			0.00E+00
						5	13802.6	0.0	0.0000			0.00E+00
						10	13802.6	0.0	0.0000			0.00E+00
						15	13802.6	0.0	0.0000	0.00E+00	33.90	0.00E+00
							13802.6					
157.1	837.86	10	15	18.9	0.00	1	13802.6	0.0	0.0000			0.00E+00
167.1	827.86					2	13802.6	0.0	0.0000			0.00E+00
						5	13802.6	0.0	0.0000			0.00E+00
						10	13802.6	0.0	0.0000			0.00E+00
						15	13802.6	0.0	0.0000	0.00E+00	18.90	0.00E+00
											Average of Valid Stages:	**3.20E-08**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 18, 2018
Water Pressure Testing
Boring B-25

Ground Elevation:	994.96	ft
Groundwater Depth:	5.1	ft
Groundwater Elev:	989.86	ft
Gage Height:	4	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13803.4					
167.1	827.86	10	15	18.9	0.36	1	13803.4	0.1	0.0010			2.53E-07
177.1	817.86					2	13803.4	0.0	0.0000			0.00E+00
						5	13803.4	0.0	0.0000			0.00E+00
						10	13803.4	0.0	0.0000			0.00E+00
						15	13803.4	0.0	0.0000	2.00E-04	18.54	0.00E+00
							13814.7					
167.1	827.86	10	30	33.9	0.00	1	13814.7	0.0	0.0000			0.00E+00
177.1	817.86					2	13814.7	0.0	0.0000			0.00E+00
						5	13814.7	0.0	0.0000			0.00E+00
						10	13814.7	0.0	0.0002			2.80E-08
						15	13814.8	0.0	0.0002	8.00E-05	33.90	2.80E-08
							13814.8					
167.1	827.86	10	45	48.9	0.00	1	13814.8	0.0	0.0000			0.00E+00
177.1	817.86					2	13814.9	0.1	0.0010			9.72E-08
						5	13815.0	0.0	0.0003			3.24E-08
						10	13815.1	0.0	0.0004			3.89E-08
						15	13815.3	0.0	0.0004	4.27E-04	48.90	3.89E-08
							13815.3					
167.1	827.86	10	30	33.9	0.00	1	13815.3	0.0	0.0000			0.00E+00
177.1	817.86					2	13815.3	0.0	0.0000			0.00E+00
						5	13815.3	0.0	0.0000			0.00E+00
						10	13815.3	0.0	0.0000			0.00E+00
						15	13815.3	0.0	0.0002	4.00E-05	33.90	2.80E-08
							13815.3					
167.1	827.86	10	15	18.9	0.00	1	13815.3	0.0	0.0000			0.00E+00
177.1	817.86					2	13815.3	0.0	0.0000			0.00E+00
						5	13815.3	0.0	-0.0003			-8.37E-08
						10	13815.4	0.0	0.0004			1.00E-07
						15	13815.4	0.0	0.0000	1.33E-05	18.90	0.00E+00
											Average of Valid Stages:	**2.25E-08**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	994.96 ft
	May 18, 2018	Groundwater Depth:	1.3 ft
	Water Pressure Testing	Groundwater Elev:	993.66 ft
	Boring B-25	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (cuft)	Flow Rate (cuftpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
177.1	817.86	10	15	17.3	0.00	1		0.0	0.0000			0.00E+00
187.1	807.86					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	17.30	0.00E+00
177.1	817.86	10	30	32.3	0.00	1		0.0	0.0000			0.00E+00
187.1	807.86					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	32.30	0.00E+00
177.1	817.86	10	45	47.3	0.00	1		0.0	0.0000			0.00E+00
187.1	807.86					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	47.30	0.00E+00
177.1	817.86	10	30	32.3	0.00	1		0.0	0.0000			0.00E+00
187.1	807.86					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	32.30	0.00E+00
177.1	817.86	10	15	17.3	0.00	1		0.0	0.0000			0.00E+00
187.1	807.86					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	17.30	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: No Packer Test was needed

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.22	ft
January 31, 2018	Groundwater Depth:	3.1	ft
Water Pressure Testing	Groundwater Elev:	998.12	ft
Boring B-27	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5819.0					
155	846.22	10.6	15	18.1	0.00	1	5819.0	0.0	0.0000			0.00E+00
165.6	835.62					2	5819.0	0.0	0.0000			0.00E+00
						5	5819.0	0.0	0.0000			0.00E+00
						10	5819.0	0.0	0.0000			0.00E+00
						15	5819.0	0.0	0.0000	0.00E+00	18.10	0.00E+00
							5818.6					
155	846.22	10.6	30	33.1	0.00	1	5818.6	0.0	0.0000			0.00E+00
165.6	835.62					2	5818.6	0.0	0.0000			0.00E+00
						5	5818.6	0.0	0.0000			0.00E+00
						10	5818.6	0.0	0.0000			0.00E+00
						15	5818.6	0.0	0.0000	0.00E+00	33.10	0.00E+00
							5818.6					
155	846.22	10.6	45	48.1	0.00	1	5818.6	0.0	0.0000			0.00E+00
165.6	835.62					2	5818.6	0.0	0.0000			0.00E+00
						5	5818.6	0.0	0.0000			0.00E+00
						10	5818.6	0.0	0.0000			0.00E+00
						15	5818.6	0.0	0.0000	0.00E+00	48.10	0.00E+00
							5818.6					
155	846.22	10.6	30	33.1	0.00	1	5818.6	0.0	0.0000			0.00E+00
165.6	835.62					2	5818.6	0.0	0.0000			0.00E+00
						5	5818.6	0.0	0.0000			0.00E+00
						10	5818.6	0.0	0.0000			0.00E+00
						15	5818.6	0.0	0.0000	0.00E+00	33.10	0.00E+00
							5818.6					
155	846.22	10.6	15	18.1	0.00	1	5818.6	0.0	0.0000			0.00E+00
165.6	835.62					2	5818.6	0.0	0.0000			0.00E+00
						5	5818.6	0.0	0.0000			0.00E+00
						10	5818.6	0.0	0.0000			0.00E+00
						15	5818.6	0.0	0.0000	0.00E+00	18.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.22	ft
January 31, 2018	Groundwater Depth:	3.7	ft
Water Pressure Testing	Groundwater Elev:	997.52	ft
Boring B-27	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5819.5					
165	836.22	10.6	15	18.3	0.00	1	5819.5	0.0	0.0000			0.00E+00
175.6	825.62					2	5819.5	0.0	0.0000			0.00E+00
						5	5819.5	0.0	0.0000			0.00E+00
						10	5819.5	0.0	0.0000			0.00E+00
						15	5819.5	0.0	0.0000	0.00E+00	18.30	0.00E+00
							5819.8					
165	836.22	10.6	30	33.3	0.00	1	5819.8	0.0	0.0000			0.00E+00
175.6	825.62					2	5819.8	0.0	0.0000			0.00E+00
						5	5819.8	0.0	0.0000			0.00E+00
						10	5819.8	0.0	0.0000			0.00E+00
						15	5819.8	0.0	0.0000	0.00E+00	33.30	0.00E+00
							5820.1					
165	836.22	10.6	45	48.3	0.00	1	5820.1	0.0	0.0000			0.00E+00
175.6	825.62					2	5820.1	0.0	0.0000			0.00E+00
						5	5820.1	0.0	0.0000			0.00E+00
						10	5820.1	0.0	0.0000			0.00E+00
						15	5820.1	0.0	0.0000	0.00E+00	48.30	0.00E+00
							5820.1					
165	836.22	10.6	30	33.3	0.00	1	5820.1	0.0	0.0000			0.00E+00
175.6	825.62					2	5820.1	0.0	0.0000			0.00E+00
						5	5820.1	0.0	0.0000			0.00E+00
						10	5820.1	0.0	0.0000			0.00E+00
						15	5820.1	0.0	0.0000	0.00E+00	33.30	0.00E+00
							5820.1					
165	836.22	10.6	15	18.3	0.00	1	5820.1	0.0	0.0000			0.00E+00
175.6	825.62					2	5820.1	0.0	0.0000			0.00E+00
						5	5820.1	0.0	0.0000			0.00E+00
						10	5820.1	0.0	0.0000			0.00E+00
						15	5820.1	0.0	0.0000	0.00E+00	18.30	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.22 ft
	January 31, 2018	Groundwater Depth:	2.5 ft
	Water Pressure Testing	Groundwater Elev:	998.72 ft
	Boring B-27	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5820.5					
175	826.22	10.6	15	17.8	0.00	1	5820.5	0.0	0.0000			0.00E+00
185.6	815.62					2	5820.5	0.0	0.0000			0.00E+00
						5	5820.6	0.0	0.0004			1.20E-07
						10	5820.6	0.0	0.0000			0.00E+00
						15	5820.6	0.0	0.0000	8.41E-05	17.80	0.00E+00
							5820.6					
175	826.22	10.6	30	32.8	0.00	1	5820.6	0.0	0.0000			0.00E+00
185.6	815.62					2	5820.6	0.0	0.0000			0.00E+00
						5	5820.7	0.0	0.0004			6.53E-08
						10	5820.7	0.0	0.0000			0.00E+00
						15	5820.7	0.0	0.0000	8.41E-05	32.80	0.00E+00
							5821.0					
175	826.22	10.6	45	47.8	0.00	1	5821.0	0.0	0.0000			0.00E+00
185.6	815.62					2	5821.0	0.0	0.0000			0.00E+00
						5	5821.0	0.0	0.0000			0.00E+00
						10	5821.0	0.0	0.0000			0.00E+00
						15	5821.0	0.0	0.0000	0.00E+00	47.80	0.00E+00
							5821.1					
175	826.22	10.6	30	32.8	0.00	1	5821.1	0.0	0.0000			0.00E+00
185.6	815.62					2	5821.1	0.0	0.0000			0.00E+00
						5	5821.1	0.0	0.0000			0.00E+00
						10	5821.1	0.0	0.0000			0.00E+00
						15	5821.1	0.0	0.0000	0.00E+00	32.80	0.00E+00
							5821.1					
175	826.22	10.6	15	17.8	0.00	1	5821.1	0.0	0.0000			0.00E+00
185.6	815.62					2	5821.1	0.0	0.0000			0.00E+00
						5	5821.1	0.0	0.0000			0.00E+00
						10	5821.1	0.0	0.0000			0.00E+00
						15	5821.1	0.0	0.0000	0.00E+00	17.80	0.00E+00
											Average of Valid Stages:	**7.43E-09**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.22	ft
February 1, 2018	Groundwater Depth:	3.1	ft
Water Pressure Testing	Groundwater Elev:	998.12	ft
Boring B-27	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5824.5					
185	816.22	10.6	15	18.1	0.00	1	5824.5	0.0	0.0000			0.00E+00
195.6	805.62					2	5824.5	0.0	0.0000			0.00E+00
						5	5824.5	0.0	0.0000			0.00E+00
						10	5824.5	0.0	0.0000			0.00E+00
						15	5824.5	0.0	0.0000	0.00E+00	18.10	0.00E+00
							5824.5					
185	816.22	10.6	30	33.1	0.00	1	5824.5	0.0	0.0000			0.00E+00
195.6	805.62					2	5824.5	0.0	0.0000			0.00E+00
						5	5824.5	0.0	0.0000			0.00E+00
						10	5824.5	0.0	0.0000			0.00E+00
						15	5824.5	0.0	0.0000	0.00E+00	33.10	0.00E+00
							5824.5					
185	816.22	10.6	45	48.1	0.00	1	5824.5	0.0	0.0000			0.00E+00
195.6	805.62					2	5824.5	0.0	0.0000			0.00E+00
						5	5824.5	0.0	0.0000			0.00E+00
						10	5824.5	0.0	0.0000			0.00E+00
						15	5824.5	0.0	0.0000	0.00E+00	48.10	0.00E+00
							5824.5					
185	816.22	10.6	30	33.1	0.00	1	5824.5	0.0	0.0000			0.00E+00
195.6	805.62					2	5824.5	0.0	0.0000			0.00E+00
						5	5824.5	0.0	0.0000			0.00E+00
						10	5824.5	0.0	0.0000			0.00E+00
						15	5824.4	0.0	-0.0003	-5.04E-05	33.10	-3.89E-08
							5824.4					
185	816.22	10.6	15	18.1	0.00	1	5824.4	0.0	0.0000			0.00E+00
195.6	805.62					2	5824.4	0.0	0.0000			0.00E+00
						5	5824.4	0.0	0.0000			0.00E+00
						10	5824.4	0.0	0.0000			0.00E+00
						15	5824.4	0.0	0.0000	0.00E+00	18.10	0.00E+00
											Average of Valid Stages:	**-1.56E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.22 ft
	February 1, 2018	Groundwater Depth:	3 ft
	Water Pressure Testing	Groundwater Elev:	998.22 ft
	Boring B-27	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5805.3					
195	806.22	10.6	15	18.0	0.00	1	5805.3	0.0	0.0000			0.00E+00
205.6	795.62					2	5805.3	0.0	0.0000			0.00E+00
						5	5805.3	0.0	0.0000			0.00E+00
						10	5805.3	0.0	0.0000			0.00E+00
						15	5805.3	0.0	0.0000	0.00E+00	18.00	0.00E+00
							5805.3					
195	806.22	10.6	30	33.0	0.00	1	5805.3	0.0	0.0000			0.00E+00
205.6	795.62					2	5805.3	0.0	0.0000			0.00E+00
						5	5805.3	0.0	0.0000			0.00E+00
						10	5805.3	0.0	0.0000			0.00E+00
						15	5805.3	0.0	0.0000	0.00E+00	33.00	0.00E+00
							5805.3					
195	806.22	10.6	45	48.0	0.00	1	5805.3	0.0	0.0000			0.00E+00
205.6	795.62					2	5805.3	0.0	0.0000			0.00E+00
						5	5805.3	0.0	0.0000			0.00E+00
						10	5805.3	0.0	0.0000			0.00E+00
						15	5805.3	0.0	0.0000	0.00E+00	48.00	0.00E+00
							5805.3					
195	806.22	10.6	30	33.0	0.00	1	5805.3	0.0	0.0000			0.00E+00
205.6	795.62					2	5805.3	0.0	0.0000			0.00E+00
						5	5805.3	0.0	0.0000			0.00E+00
						10	5805.3	0.0	0.0000			0.00E+00
						15	5805.3	0.0	0.0000	0.00E+00	33.00	0.00E+00
							5805.3					
195	806.22	10.6	15	18.0	0.00	1	5805.3	0.0	0.0000			0.00E+00
205.6	795.62					2	5805.3	0.0	0.0000			0.00E+00
						5	5805.3	0.0	0.0000			0.00E+00
						10	5805.3	0.0	0.0000			0.00E+00
						15	5805.3	0.0	0.0000	0.00E+00	18.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.23 ft
	January 26, 2018	Groundwater Depth:	1.65 ft
	Water Pressure Testing	Groundwater Elev:	999.58 ft
	Boring B-29	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.5					
154.5	846.73	10	15	17.4	0.00	1	265.5	0.0	0.0000			0.00E+00
164.5	836.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	17.40	0.00E+00
							265.5					
154.5	846.73	10	30	32.4	0.00	1	265.5	0.0	0.0000			0.00E+00
164.5	836.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	32.40	0.00E+00
							265.5					
154.5	846.73	10	45	47.4	0.00	1	265.5	0.0	0.0000			0.00E+00
164.5	836.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	47.40	0.00E+00
							265.5					
154.5	846.73	10	30	32.4	0.00	1	265.5	0.0	0.0000			0.00E+00
164.5	836.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	32.40	0.00E+00
							265.5					
154.5	846.73	10	15	17.4	0.00	1	265.5	0.0	0.0000			0.00E+00
164.5	836.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	17.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.23	ft
	January 26, 2018	Groundwater Depth:	1.7	ft
	Water Pressure Testing	Groundwater Elev:	999.53	ft
	Boring B-29	Gage Height:	4	ft
		Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.4					
164.5	836.73	10	15	17.5	0.00	1	265.4	0.0	0.0000			0.00E+00
174.5	826.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	17.50	0.00E+00
							265.4					
164.5	836.73	10	30	32.5	0.00	1	265.4	0.0	0.0000			0.00E+00
174.5	826.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.5					
164.5	836.73	10	45	47.5	0.00	1	265.5	0.0	0.0000			0.00E+00
174.5	826.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	47.50	0.00E+00
							265.5					
164.5	836.73	10	30	32.5	0.00	1	265.5	0.0	0.0000			0.00E+00
174.5	826.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.5					
164.5	836.73	10	15	17.5	0.00	1	265.5	0.0	0.0000			0.00E+00
174.5	826.73					2	265.5	0.0	0.0000			0.00E+00
						5	265.5	0.0	0.0000			0.00E+00
						10	265.5	0.0	0.0000			0.00E+00
						15	265.5	0.0	0.0000	0.00E+00	17.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.23	ft
January 26, 2018	Groundwater Depth:	1.7	ft
Water Pressure Testing	Groundwater Elev:	999.53	ft
Boring B-29	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.3					
174.5	826.73	10	15	17.5	0.00	1	265.3	0.0	0.0000			0.00E+00
184.5	816.73					2	265.3	0.0	0.0000			0.00E+00
						5	265.3	0.0	0.0000			0.00E+00
						10	265.3	0.0	0.0000			0.00E+00
						15	265.3	0.0	0.0000	0.00E+00	17.50	0.00E+00
							265.4					
174.5	826.73	10	30	32.5	0.00	1	265.4	0.0	0.0000			0.00E+00
184.5	816.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.4					
174.5	826.73	10	45	47.5	0.00	1	265.4	0.0	0.0000			0.00E+00
184.5	816.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	47.50	0.00E+00
							265.4					
174.5	826.73	10	30	32.5	0.00	1	265.4	0.0	0.0000			0.00E+00
184.5	816.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.4					
174.5	826.73	10	15	17.5	0.00	1	265.4	0.0	0.0000			0.00E+00
184.5	816.73					2	265.4	0.0	0.0000			0.00E+00
						5	265.4	0.0	0.0000			0.00E+00
						10	265.4	0.0	0.0000			0.00E+00
						15	265.4	0.0	0.0000	0.00E+00	17.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.23 ft
	January 26, 2018	Groundwater Depth:	1.7 ft
	Water Pressure Testing	Groundwater Elev:	999.53 ft
	Boring B-29	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.2					
184.5	816.73	10	15	17.5	0.00	1	265.2	0.0	0.0000			0.00E+00
194.5	806.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	17.50	0.00E+00
							265.2					
184.5	816.73	10	30	32.5	0.00	1	265.2	0.0	0.0000			0.00E+00
194.5	806.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.2					
184.5	816.73	10	45	47.5	0.00	1	265.2	0.0	0.0000			0.00E+00
194.5	806.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	47.50	0.00E+00
							265.2					
184.5	816.73	10	30	32.5	0.00	1	265.2	0.0	0.0000			0.00E+00
194.5	806.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.2					
184.5	816.73	10	15	17.5	0.00	1	265.2	0.0	0.0000			0.00E+00
194.5	806.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	17.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1001.23 ft
	January 26, 2018	Groundwater Depth:	1.7 ft
	Water Pressure Testing	Groundwater Elev:	999.53 ft
	Boring B-29	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.1					
194.5	806.73	10	15	17.5	0.00	1	265.1	0.0	0.0000			0.00E+00
204.5	796.73					2	265.1	0.0	0.0000			0.00E+00
						5	265.1	0.0	0.0000			0.00E+00
						10	265.1	0.0	0.0000			0.00E+00
						15	265.1	0.0	0.0000	0.00E+00	17.50	0.00E+00
							265.1					
194.5	806.73	10	30	32.5	0.00	1	265.1	0.0	0.0000			0.00E+00
204.5	796.73					2	265.1	0.0	0.0000			0.00E+00
						5	265.1	0.0	0.0000			0.00E+00
						10	265.1	0.0	0.0000			0.00E+00
						15	265.1	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.2					
194.5	806.73	10	45	47.5	0.00	1	265.2	0.0	0.0000			0.00E+00
204.5	796.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	47.50	0.00E+00
							265.2					
194.5	806.73	10	30	32.5	0.00	1	265.2	0.0	0.0000			0.00E+00
204.5	796.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	32.50	0.00E+00
							265.2					
194.5	806.73	10	15	17.5	0.00	1	265.2	0.0	0.0000			0.00E+00
204.5	796.73					2	265.2	0.0	0.0000			0.00E+00
						5	265.2	0.0	0.0000			0.00E+00
						10	265.2	0.0	0.0000			0.00E+00
						15	265.2	0.0	0.0000	0.00E+00	17.50	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1004.68	ft
January 22, 2018	Groundwater Depth:	1.55	ft
Water Pressure Testing	Groundwater Elev:	1003.13	ft
Boring B-31	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							267.4					
157.8	846.88	10	15	17.4	0.00	1	267.4	0.0	0.0000			0.00E+00
167.8	836.88					2	267.4	0.0	0.0000			0.00E+00
						5	267.4	0.0	0.0000			0.00E+00
						10	267.4	0.0	0.0000			0.00E+00
						15	267.4	0.0	0.0000	0.00E+00	17.40	0.00E+00
							267.4					
157.8	846.88	10	30	32.4	0.00	1	267.4	0.0	0.0000			0.00E+00
167.8	836.88					2	267.4	0.0	0.0000			0.00E+00
						5	267.4	0.0	0.0000			0.00E+00
						10	267.4	0.0	0.0000			0.00E+00
						15	267.4	0.0	0.0000	0.00E+00	32.40	0.00E+00
							267.4					
157.8	846.88	10	45	47.4	0.00	1	267.4	0.0	0.0000			0.00E+00
167.8	836.88					2	267.4	0.0	0.0000			0.00E+00
						5	267.4	0.0	0.0000			0.00E+00
						10	267.4	0.0	0.0000			0.00E+00
						15	267.4	0.0	0.0000	0.00E+00	47.40	0.00E+00
							267.4					
157.8	846.88	10	30	32.4	0.00	1	267.4	0.0	0.0000			0.00E+00
167.8	836.88					2	267.4	0.0	0.0000			0.00E+00
						5	267.4	0.0	0.0000			0.00E+00
						10	267.4	0.0	0.0000			0.00E+00
						15	267.4	0.0	0.0000	0.00E+00	32.40	0.00E+00
							267.4					
157.8	846.88	10	15	17.4	0.00	1	267.4	0.0	0.0000			0.00E+00
167.8	836.88					2	267.4	0.0	0.0000			0.00E+00
						5	267.4	0.0	0.0000			0.00E+00
						10	267.4	0.0	0.0000			0.00E+00
						15	267.4	0.0	0.0000	0.00E+00	17.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1004.68 ft
	January 22, 2018	Groundwater Depth:	1.5 ft
	Water Pressure Testing	Groundwater Elev:	1003.18 ft
	Boring B-31	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.8					
167.8	836.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
177.8	826.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00
							256.8					
167.8	836.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
177.8	826.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
167.8	836.88	10	45	47.4	0.00	1	256.8	0.0	0.0000			0.00E+00
177.8	826.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	47.40	0.00E+00
							256.8					
167.8	836.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
177.8	826.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
167.8	836.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
177.8	826.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1004.68 ft
	January 22, 2018	Groundwater Depth:	1.6 ft
	Water Pressure Testing	Groundwater Elev:	1003.08 ft
	Boring B-31	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.8					
177.8	826.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
187.8	816.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00
							256.8					
177.8	826.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
187.8	816.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
177.8	826.88	10	45	47.4	0.00	1	256.8	0.0	0.0000			0.00E+00
187.8	816.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	47.40	0.00E+00
							256.8					
177.8	826.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
187.8	816.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
177.8	826.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
187.8	816.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1004.68	ft
January 11, 2018	Groundwater Depth:	1.45	ft
Water Pressure Testing	Groundwater Elev:	1003.23	ft
Boring B-31	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.8					
187.8	816.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
197.8	806.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00
							256.8					
187.8	816.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
197.8	806.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
187.8	816.88	10	45	47.4	0.00	1	256.8	0.0	0.0000			0.00E+00
197.8	806.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	47.40	0.00E+00
							256.8					
187.8	816.88	10	30	32.4	0.00	1	256.8	0.0	0.0000			0.00E+00
197.8	806.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.40	0.00E+00
							256.8					
187.8	816.88	10	15	17.4	0.00	1	256.8	0.0	0.0000			0.00E+00
197.8	806.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.40	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1004.68	ft
January 11, 2018	Groundwater Depth:	1.25	ft
Water Pressure Testing	Groundwater Elev:	1003.43	ft
Boring B-31	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.7					
197.8	806.88	10	15	17.3	0.39	1	256.8	0.1	0.0013			4.07E-07
207.8	796.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	2.67E-04	16.91	0.00E+00
							256.8					
197.8	806.88	10	30	32.3	0.00	1	256.8	0.0	0.0000			0.00E+00
207.8	796.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.30	0.00E+00
							256.8					
197.8	806.88	10	45	47.3	0.00	1	256.8	0.0	0.0000			0.00E+00
207.8	796.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	47.30	0.00E+00
							256.8					
197.8	806.88	10	30	32.3	0.00	1	256.8	0.0	0.0000			0.00E+00
207.8	796.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	32.30	0.00E+00
							256.8					
197.8	806.88	10	15	17.3	0.00	1	256.8	0.0	0.0000			0.00E+00
207.8	796.88					2	256.8	0.0	0.0000			0.00E+00
						5	256.8	0.0	0.0000			0.00E+00
						10	256.8	0.0	0.0000			0.00E+00
						15	256.8	0.0	0.0000	0.00E+00	17.30	0.00E+00
											Average of Valid Stages:	**1.63E-08**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1009.72 ft
	January 11, 2018	Groundwater Depth:	9.8 ft
	Water Pressure Testing	Groundwater Elev:	999.92 ft
	Boring B-33	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.6					
160	849.72	10	15	21.0	0.00	1	256.6	0.0	0.0000			0.00E+00
170	839.72					2	256.6	0.0	0.0000			0.00E+00
						5	256.6	0.0	0.0000			0.00E+00
						10	256.6	0.0	0.0000			0.00E+00
						15	256.6	0.0	0.0000	0.00E+00	21.00	0.00E+00
							256.9					
160	849.72	10	30	36.0	0.00	1	256.9	0.0	0.0000			0.00E+00
170	839.72					2	256.9	0.0	0.0000			0.00E+00
						5	256.9	0.0	0.0000			0.00E+00
						10	256.9	0.0	0.0000			0.00E+00
						15	256.9	0.0	0.0000	0.00E+00	36.00	0.00E+00
							256.9					
160	849.72	10	45	51.0	0.00	1	256.9	0.0	0.0000			0.00E+00
170	839.72					2	256.9	0.0	0.0000			0.00E+00
						5	256.9	0.0	0.0000			0.00E+00
						10	256.9	0.0	0.0000			0.00E+00
						15	256.9	0.0	0.0000	0.00E+00	51.00	0.00E+00
							256.9					
160	849.72	10	30	36.0	0.00	1	256.9	0.0	0.0000			0.00E+00
170	839.72					2	256.9	0.0	0.0000			0.00E+00
						5	256.9	0.0	0.0000			0.00E+00
						10	256.9	0.0	0.0000			0.00E+00
						15	256.9	0.0	0.0000	0.00E+00	36.00	0.00E+00
							256.9					
160	849.72	10	15	21.0	0.00	1	256.9	0.0	0.0000			0.00E+00
170	839.72					2	256.9	0.0	0.0000			0.00E+00
						5	256.9	0.0	0.0000			0.00E+00
						10	256.9	0.0	0.0000			0.00E+00
						15	256.9	0.0	0.0000	0.00E+00	21.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	1009.72 ft
	January 11, 2018	Groundwater Depth:	9.7 ft
	Water Pressure Testing	Groundwater Elev:	1000.02 ft
	Boring B-33	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							256.0					
170	839.72	10	15	20.9	0.00	1	256.0	0.0	0.0000			0.00E+00
180	829.72					2	256.0	0.0	0.0000			0.00E+00
						5	256.0	0.0	0.0000			0.00E+00
						10	256.0	0.0	0.0000			0.00E+00
						15	256.0	0.0	0.0000	0.00E+00	20.90	0.00E+00
							256.1					
170	839.72	10	30	35.9	0.00	1	256.1	0.0	0.0000			0.00E+00
180	829.72					2	256.2	0.1	0.0013			1.94E-07
						5	256.2	0.0	0.0000			0.00E+00
						10	256.2	0.0	0.0000			0.00E+00
						15	256.2	0.0	0.0000	2.67E-04	35.90	0.00E+00
							256.3					
170	839.72	10	45	50.9	0.00	1	256.3	0.0	0.0000			0.00E+00
180	829.72					2	256.3	0.0	0.0000			0.00E+00
						5	256.3	0.0	0.0000			0.00E+00
						10	256.3	0.0	0.0000			0.00E+00
						15	256.3	0.0	0.0000	0.00E+00	50.90	0.00E+00
							256.3					
170	839.72	10	30	35.9	0.00	1	256.3	0.0	0.0000			0.00E+00
180	829.72					2	256.3	0.0	0.0000			0.00E+00
						5	256.3	0.0	0.0000			0.00E+00
						10	256.3	0.0	0.0000			0.00E+00
						15	256.3	0.0	0.0000	0.00E+00	35.90	0.00E+00
							256.3					
170	839.72	10	15	20.9	0.00	1	256.3	0.0	0.0000			0.00E+00
180	829.72					2	256.3	0.0	0.0000			0.00E+00
						5	256.3	0.0	0.0000			0.00E+00
						10	256.3	0.0	0.0000			0.00E+00
						15	256.3	0.0	0.0000	0.00E+00	20.90	0.00E+00
											Average of Valid Stages:	**7.75E-09**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1009.72	ft
January 11, 2018	Groundwater Depth:	9.7	ft
Water Pressure Testing	Groundwater Elev:	1000.02	ft
Boring B-33	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							255.3					
180	829.72	10	15	20.9	0.39	1	255.4	0.1	0.0013			3.35E-07
190	819.72					2	255.4	0.0	0.0000			0.00E+00
						5	255.4	0.0	0.0000			0.00E+00
						10	255.4	0.0	0.0000			0.00E+00
						15	255.4	0.0	0.0000	2.67E-04	20.51	0.00E+00
							255.4					
180	829.72	10	30	35.9	0.00	1	255.4	0.0	0.0000			0.00E+00
190	819.72					2	255.4	0.0	0.0000			0.00E+00
						5	255.4	0.0	0.0000			0.00E+00
						10	255.4	0.0	0.0000			0.00E+00
						15	255.4	0.0	0.0000	0.00E+00	35.90	0.00E+00
							255.4					
180	829.72	10	45	50.9	0.39	1	255.5	0.1	0.0013			1.37E-07
190	819.72					2	255.5	0.0	0.0000			0.00E+00
						5	255.5	0.0	0.0000			0.00E+00
						10	255.5	0.0	0.0000			0.00E+00
						15	255.5	0.0	0.0000	2.67E-04	50.51	0.00E+00
							255.5					
180	829.72	10	30	35.9	0.00	1	255.5	0.0	0.0000			0.00E+00
190	819.72					2	255.5	0.0	0.0000			0.00E+00
						5	255.5	0.0	0.0000			0.00E+00
						10	255.5	0.0	0.0000			0.00E+00
						15	255.5	0.0	0.0000	0.00E+00	35.90	0.00E+00
							255.5					
180	829.72	10	15	20.9	0.00	1	255.5	0.0	0.0000			0.00E+00
190	819.72					2	255.5	0.0	0.0000			0.00E+00
						5	255.5	0.0	0.0000			0.00E+00
						10	255.5	0.0	0.0000			0.00E+00
						15	255.5	0.0	0.0000	0.00E+00	20.90	0.00E+00
											Average of Valid Stages:	**1.89E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1009.72	ft
January 11, 2018	Groundwater Depth:	9.7	ft
Water Pressure Testing	Groundwater Elev:	1000.02	ft
Boring B-33	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							254.4					
190	819.72	10	15	20.9	0.00	1	254.4	0.0	0.0000			0.00E+00
200	809.72					2	254.4	0.0	0.0000			0.00E+00
						5	254.4	0.0	0.0000			0.00E+00
						10	254.4	0.0	0.0000			0.00E+00
						15	254.4	0.0	0.0000	0.00E+00	20.90	0.00E+00
							254.4					
190	819.72	10	30	35.9	0.39	1	254.5	0.1	0.0013			1.95E-07
200	809.72					2	254.5	0.0	0.0000			0.00E+00
						5	254.5	0.0	0.0000			0.00E+00
						10	254.5	0.0	0.0000			0.00E+00
						15	254.5	0.0	0.0000	2.67E-04	35.51	0.00E+00
							254.5					
190	819.72	10	45	50.9	0.39	1	254.6	0.1	0.0013			1.37E-07
200	809.72					2	254.6	0.0	0.0000			0.00E+00
						5	254.6	0.0	0.0000			0.00E+00
						10	254.6	0.0	0.0000			0.00E+00
						15	254.6	0.0	0.0000	2.67E-04	50.51	0.00E+00
							254.6					
190	819.72	10	30	35.9	0.00	1	254.6	0.0	0.0000			0.00E+00
200	809.72					2	254.6	0.0	0.0000			0.00E+00
						5	254.6	0.0	0.0000			0.00E+00
						10	254.6	0.0	0.0000			0.00E+00
						15	254.6	0.0	0.0000	0.00E+00	35.90	0.00E+00
							254.6					
190	819.72	10	15	20.9	0.00	1	254.6	0.0	0.0000			0.00E+00
200	809.72					2	254.6	0.0	0.0000			0.00E+00
						5	254.6	0.0	0.0000			0.00E+00
						10	254.6	0.0	0.0000			0.00E+00
						15	254.6	0.0	0.0000	0.00E+00	20.90	0.00E+00
											Average of Valid Stages:	**1.33E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	1009.72	ft
January 11, 2018	Groundwater Depth:	9.7	ft
Water Pressure Testing	Groundwater Elev:	1000.02	ft
Boring B-33	Gage Height:	4	ft
	Hole Diameter:	3	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							253.7					
200	809.72	10	15	20.9	0.00	1	253.7	0.0	0.0000			0.00E+00
210	799.72					2	253.7	0.0	0.0000			0.00E+00
						5	253.7	0.0	0.0000			0.00E+00
						10	253.7	0.0	0.0000			0.00E+00
						15	253.7	0.0	0.0000	0.00E+00	20.90	0.00E+00
							253.7					
200	809.72	10	30	35.9	0.39	1	253.8	0.1	0.0013			1.95E-07
210	799.72					2	253.9	0.1	0.0013			1.95E-07
						5	253.9	0.0	0.0000			0.00E+00
						10	253.9	0.0	0.0000			0.00E+00
						15	253.9	0.0	0.0000	5.35E-04	35.51	0.00E+00
							254.0					
200	809.72	10	45	50.9	0.00	1	254.0	0.0	0.0000			0.00E+00
210	799.72					2	254.0	0.0	0.0000			0.00E+00
						5	254.0	0.0	0.0000			0.00E+00
						10	254.0	0.0	0.0000			0.00E+00
						15	254.0	0.0	0.0000	0.00E+00	50.90	0.00E+00
							254.0					
200	809.72	10	30	35.9	0.00	1	254.0	0.0	0.0000			0.00E+00
210	799.72					2	254.0	0.0	0.0000			0.00E+00
						5	254.0	0.0	0.0000			0.00E+00
						10	254.0	0.0	0.0000			0.00E+00
						15	254.0	0.0	0.0000	0.00E+00	35.90	0.00E+00
							254.0					
200	809.72	10	15	20.9	0.00	1	254.0	0.0	0.0000			0.00E+00
210	799.72					2	254.0	0.0	0.0000			0.00E+00
						5	254.0	0.0	0.0000			0.00E+00
						10	254.0	0.0	0.0000			0.00E+00
						15	254.0	0.0	0.0000	0.00E+00	20.90	0.00E+00
											Average of Valid Stages:	**1.56E-08**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	980.00 ft
	April 25, 2018	Groundwater Depth:	0 ft
	Water Pressure Testing	Groundwater Elev:	980.00 ft
	Boring B-36	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1817.9					
137	843.00	10.1	15	16.7	0.00	1	1817.9	0.0	0.0000			0.00E+00
147.1	832.90					2	1817.9	0.0	0.0000			0.00E+00
						5	1818.0	0.0	0.0004			1.26E-07
						10	1818.1	0.0	0.0003			7.55E-08
						15	1818.1	0.0	0.0000	1.41E-04	16.70	0.00E+00
							1818.1					
137	843.00	10.1	30	31.7	0.00	1	1818.1	0.0	0.0000			0.00E+00
147.1	832.90					2	1818.1	0.0	0.0000			0.00E+00
						5	1818.1	0.0	0.0000			0.00E+00
						10	1818.1	0.0	0.0000			0.00E+00
						15	1818.1	0.0	0.0000	0.00E+00	31.70	0.00E+00
							1818.1					
137	843.00	10.1	45	46.7	0.39	1	1818.2	0.1	0.0013			1.36E-07
147.1	832.90					2	1818.2	0.0	0.0000			0.00E+00
						5	1818.2	0.0	0.0000			0.00E+00
						10	1818.2	0.0	0.0000			0.00E+00
						15	1818.3	0.0	0.0003	3.18E-04	46.31	2.71E-08
							1818.3					
137	843.00	10.1	30	31.7	0.00	1	1818.3	0.0	0.0000			0.00E+00
147.1	832.90					2	1818.3	0.0	0.0000			0.00E+00
						5	1818.3	0.0	0.0000			0.00E+00
						10	1818.3	0.0	0.0000			0.00E+00
						15	1818.3	0.0	0.0000	0.00E+00	31.70	0.00E+00
							1818.3					
137	843.00	10.1	15	16.7	0.00	1	1818.3	0.0	0.0000			0.00E+00
147.1	832.90					2	1818.3	0.0	0.0000			0.00E+00
						5	1818.3	0.0	0.0000			0.00E+00
						10	1818.3	0.0	0.0000			0.00E+00
						15	1818.3	0.0	0.0000	0.00E+00	16.70	0.00E+00
											Average of Valid Stages:	**1.46E-08**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	980.00 ft
	April 26, 2018	Groundwater Depth:	0.7 ft
	Water Pressure Testing	Groundwater Elev:	979.30 ft
	Boring B-36	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1819.4					
147.1	832.90	10	15	17.0	0.00	1	1819.4	0.0	0.0000			0.00E+00
157.1	822.90					2	1819.4	0.0	0.0000			0.00E+00
						5	1819.4	0.0	0.0000			0.00E+00
						10	1819.4	0.0	0.0000			0.00E+00
						15	1819.4	0.0	0.0000	0.00E+00	17.00	0.00E+00
							1819.4					
147.1	832.90	10	30	32.0	0.00	1	1819.4	0.0	0.0000			0.00E+00
157.1	822.90					2	1819.4	0.0	0.0000			0.00E+00
						5	1819.4	0.0	0.0000			0.00E+00
						10	1819.4	0.0	0.0000			0.00E+00
						15	1819.4	0.0	0.0000	0.00E+00	32.00	0.00E+00
							1819.4					
147.1	832.90	10	45	47.0	0.00	1	1819.4	0.0	0.0000			0.00E+00
157.1	822.90					2	1819.4	0.0	0.0000			0.00E+00
						5	1819.4	0.0	0.0000			0.00E+00
						10	1819.4	0.0	0.0000			0.00E+00
						15	1819.4	0.0	0.0000	0.00E+00	47.00	0.00E+00
							1819.4					
147.1	832.90	10	30	32.0	0.00	1	1819.4	0.0	0.0000			0.00E+00
157.1	822.90					2	1819.4	0.0	0.0000			0.00E+00
						5	1819.4	0.0	0.0000			0.00E+00
						10	1819.4	0.0	0.0000			0.00E+00
						15	1819.4	0.0	0.0000	0.00E+00	32.00	0.00E+00
							1819.4					
147.1	832.90	10	15	17.0	0.00	1	1819.4	0.0	0.0000			0.00E+00
157.1	822.90					2	1819.4	0.0	0.0000			0.00E+00
						5	1819.4	0.0	0.0000			0.00E+00
						10	1819.4	0.0	0.0000			0.00E+00
						15	1819.4	0.0	0.0000	0.00E+00	17.00	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	980.00 ft
	April 26, 2018	Groundwater Depth:	16.1 ft
	Water Pressure Testing	Groundwater Elev:	963.90 ft
	Boring B-36	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1819.9					
157.1	822.90	10	15	23.7	0.00	1	1819.9	0.0	0.0000			0.00E+00
167.1	812.90					2	1819.9	0.0	0.0000			0.00E+00
						5	1820.1	0.1	0.0009			1.79E-07
						10	1820.1	0.0	0.0000			0.00E+00
						15	1820.1	0.0	0.0000	1.78E-04	23.70	0.00E+00
							1820.2					
157.1	822.90	10	30	38.7	0.00	1	1820.2	0.0	0.0000			0.00E+00
167.1	812.90					2	1820.2	0.0	0.0000			0.00E+00
						5	1820.2	0.0	0.0000			0.00E+00
						10	1820.2	0.0	0.0000			0.00E+00
						15	1820.2	0.0	0.0000	0.00E+00	38.70	0.00E+00
							1820.3					
157.1	822.90	10	45	53.7	0.00	1	1820.3	0.0	0.0000			0.00E+00
167.1	812.90					2	1820.3	0.0	0.0000			0.00E+00
						5	1820.3	0.0	0.0000			0.00E+00
						10	1820.3	0.0	0.0000			0.00E+00
						15	1820.3	0.0	0.0000	0.00E+00	53.70	0.00E+00
							1820.3					
157.1	822.90	10	30	38.7	0.00	1	1820.3	0.0	0.0000			0.00E+00
167.1	812.90					2	1820.3	0.0	0.0000			0.00E+00
						5	1820.3	0.0	0.0000			0.00E+00
						10	1820.3	0.0	0.0000			0.00E+00
						15	1820.3	0.0	0.0000	0.00E+00	38.70	0.00E+00
							1820.2					
157.1	822.90	10	15	23.7	0.00	1	1820.2	0.0	0.0000			0.00E+00
167.1	812.90					2	1820.2	0.0	0.0000			0.00E+00
						5	1820.2	0.0	0.0000			0.00E+00
						10	1820.1	0.0	-0.0003			-5.37E-08
						15	1820.1	0.0	0.0000	-5.35E-05	23.70	0.00E+00
											Average of Valid Stages:	**5.01E-09**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	980.00 ft
	April 26, 2018	Groundwater Depth:	14.4 ft
	Water Pressure Testing	Groundwater Elev:	965.60 ft
	Boring B-36	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1820.6					
167.1	812.90	6	15	23.0	0.00	1	1820.6	0.0	0.0000			0.00E+00
173.1	806.90					2	1820.6	0.0	0.0000			0.00E+00
						5	1820.6	0.0	0.0000			0.00E+00
						10	1820.6	0.0	0.0000			0.00E+00
						15	1820.7	0.0	0.0004	8.91E-05	23.00	8.20E-08
							1820.8					
167.1	812.90	6	30	38.0	0.00	1	1820.8	0.0	0.0000			0.00E+00
173.1	806.90					2	1820.8	0.0	0.0000			0.00E+00
						5	1820.8	0.0	0.0000			0.00E+00
						10	1820.9	0.0	0.0004			4.96E-08
						15	1820.9	0.0	0.0000	8.91E-05	38.00	0.00E+00
							1820.9					
167.1	812.90	6	45	53.0	0.00	1	1820.9	0.0	0.0000			0.00E+00
173.1	806.90					2	1820.9	0.0	0.0000			0.00E+00
						5	1820.9	0.0	0.0000			0.00E+00
						10	1820.9	0.0	0.0000			0.00E+00
						15	1820.9	0.0	0.0000	0.00E+00	53.00	0.00E+00
							1820.9					
167.1	812.90	6	30	38.0	0.00	1	1820.9	0.0	0.0000			0.00E+00
173.1	806.90					2	1820.9	0.0	0.0000			0.00E+00
						5	1820.9	0.0	0.0000			0.00E+00
						10	1820.9	0.0	0.0000			0.00E+00
						15	1820.9	0.0	0.0000	0.00E+00	38.00	0.00E+00
							1820.9					
167.1	812.90	6	15	23.0	0.00	1	1820.9	0.0	0.0000			0.00E+00
173.1	806.90					2	1820.9	0.0	0.0000			0.00E+00
						5	1820.9	0.0	0.0000			0.00E+00
						10	1820.9	0.0	0.0000			0.00E+00
						15	1820.9	0.0	0.0000	0.00E+00	23.00	0.00E+00

Average of Valid Stages: **5.26E-09**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	993.73	ft
February 16, 2018	Groundwater Depth:	10.75	ft
Water Pressure Testing	Groundwater Elev:	982.98	ft
Boring B-41	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							267.3					
137	856.73	10	15	21.4	0.00	1	267.3	0.0	0.0000			0.00E+00
147	846.73					2	267.3	0.0	0.0000			0.00E+00
						5	267.3	0.0	0.0000			0.00E+00
						10	267.3	0.0	0.0000			0.00E+00
						15	267.3	0.0	0.0000	0.00E+00	21.40	0.00E+00
							267.7					
137	856.73	10	30	36.4	0.00	1	267.7	0.0	0.0000			0.00E+00
147	846.73					2	267.7	0.0	0.0000			0.00E+00
						5	267.7	0.0	0.0000			0.00E+00
						10	267.7	0.0	0.0000			0.00E+00
						15	267.7	0.0	0.0000	0.00E+00	36.40	0.00E+00
							267.8					
137	856.73	10	45	51.4	0.00	1	267.8	0.0	0.0000			0.00E+00
147	846.73					2	267.8	0.0	0.0000			0.00E+00
						5	267.8	0.0	0.0000			0.00E+00
						10	267.8	0.0	0.0000			0.00E+00
						15	267.8	0.0	0.0000	0.00E+00	51.40	0.00E+00
							267.8					
137	856.73	10	30	36.4	0.00	1	267.8	0.0	0.0000			0.00E+00
147	846.73					2	267.8	0.0	0.0000			0.00E+00
						5	267.8	0.0	0.0000			0.00E+00
						10	267.8	0.0	0.0000			0.00E+00
						15	267.8	0.0	0.0000	0.00E+00	36.40	0.00E+00
							267.8					
137	856.73	10	15	21.4	0.00	1	267.8	0.0	0.0000			0.00E+00
147	846.73					2	267.8	0.0	0.0000			0.00E+00
						5	267.8	0.0	0.0000			0.00E+00
						10	267.8	0.0	0.0000			0.00E+00
						15	267.8	0.0	0.0000	0.00E+00	21.40	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	993.73 ft
	February 16, 2018	Groundwater Depth:	11.5 ft
	Water Pressure Testing	Groundwater Elev:	982.23 ft
	Boring B-41	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							267.0					
147	846.73	10	15	21.7	0.00	1	267.0	0.0	0.0000			0.00E+00
157	836.73					2	267.0	0.0	0.0000			0.00E+00
						5	267.0	0.0	0.0000			0.00E+00
						10	267.0	0.0	0.0000			0.00E+00
						15	267.0	0.0	0.0000	0.00E+00	21.70	0.00E+00
							267.1					
147	846.73	10	30	36.7	0.00	1	267.1	0.0	0.0000			0.00E+00
157	836.73					2	267.1	0.0	0.0000			0.00E+00
						5	267.1	0.0	0.0000			0.00E+00
						10	267.1	0.0	0.0000			0.00E+00
						15	267.1	0.0	0.0000	0.00E+00	36.70	0.00E+00
							267.2					
147	846.73	10	45	51.7	0.00	1	267.2	0.0	0.0000			0.00E+00
157	836.73					2	267.2	0.0	0.0000			0.00E+00
						5	267.2	0.0	0.0000			0.00E+00
						10	267.2	0.0	0.0000			0.00E+00
						15	267.2	0.0	0.0000	0.00E+00	51.70	0.00E+00
							267.2					
147	846.73	10	30	36.7	0.00	1	267.2	0.0	0.0000			0.00E+00
157	836.73					2	267.2	0.0	0.0000			0.00E+00
						5	267.2	0.0	0.0000			0.00E+00
						10	267.2	0.0	0.0000			0.00E+00
						15	267.2	0.0	0.0000	0.00E+00	36.70	0.00E+00
							267.2					
147	846.73	10	15	21.7	0.00	1	267.2	0.0	0.0000			0.00E+00
157	836.73					2	267.2	0.0	0.0000			0.00E+00
						5	267.2	0.0	0.0000			0.00E+00
						10	267.2	0.0	0.0000			0.00E+00
						15	267.2	0.0	0.0000	0.00E+00	21.70	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	993.73 ft
	February 16, 2018	Groundwater Depth:	11.23 ft
	Water Pressure Testing	Groundwater Elev:	982.50 ft
	Boring B-41	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							266.5					
157	836.73	10	15	21.6	0.00	1	266.5	0.0	0.0000			0.00E+00
167	826.73					2	266.5	0.0	0.0000			0.00E+00
						5	266.5	0.0	0.0000			0.00E+00
						10	266.5	0.0	0.0000			0.00E+00
						15	266.5	0.0	0.0000	0.00E+00	21.60	0.00E+00
							266.7					
157	836.73	10	30	36.6	0.00	1	266.7	0.0	0.0000			0.00E+00
167	826.73					2	266.7	0.0	0.0000			0.00E+00
						5	266.7	0.0	0.0000			0.00E+00
						10	266.7	0.0	0.0000			0.00E+00
						15	266.7	0.0	0.0000	0.00E+00	36.60	0.00E+00
							266.8					
157	836.73	10	45	51.6	0.00	1	266.8	0.0	0.0000			0.00E+00
167	826.73					2	266.8	0.0	0.0000			0.00E+00
						5	266.8	0.0	0.0000			0.00E+00
						10	266.8	0.0	0.0000			0.00E+00
						15	266.8	0.0	0.0000	0.00E+00	51.60	0.00E+00
							266.8					
157	836.73	10	30	36.6	0.00	1	266.8	0.0	0.0000			0.00E+00
167	826.73					2	266.8	0.0	0.0000			0.00E+00
						5	266.8	0.0	0.0000			0.00E+00
						10	266.8	0.0	0.0000			0.00E+00
						15	266.8	0.0	0.0000	0.00E+00	36.60	0.00E+00
							266.8					
157	836.73	10	15	21.6	0.00	1	266.8	0.0	0.0000			0.00E+00
167	826.73					2	266.8	0.0	0.0000			0.00E+00
						5	266.8	0.0	0.0000			0.00E+00
						10	266.8	0.0	0.0000			0.00E+00
						15	266.8	0.0	0.0000	0.00E+00	21.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	993.73 ft
	February 16, 2018	Groundwater Depth:	12.15 ft
	Water Pressure Testing	Groundwater Elev:	981.58 ft
	Boring B-41	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							266.1					
167	826.73	10	15	22.0	0.00	1	266.1	0.0	0.0000			0.00E+00
177	816.73					2	266.1	0.0	0.0000			0.00E+00
						5	266.1	0.0	0.0000			0.00E+00
						10	266.1	0.0	0.0000			0.00E+00
						15	266.1	0.0	0.0000	0.00E+00	22.00	0.00E+00
							266.2					
167	826.73	10	30	37.0	0.00	1	266.2	0.0	0.0000			0.00E+00
177	816.73					2	266.2	0.0	0.0000			0.00E+00
						5	266.2	0.0	0.0000			0.00E+00
						10	266.2	0.0	0.0000			0.00E+00
						15	266.2	0.0	0.0000	0.00E+00	37.00	0.00E+00
							266.2					
167	826.73	10	45	52.0	0.00	1	266.2	0.0	0.0000			0.00E+00
177	816.73					2	266.2	0.0	0.0000			0.00E+00
						5	266.2	0.0	0.0000			0.00E+00
						10	266.2	0.0	0.0000			0.00E+00
						15	266.2	0.0	0.0000	0.00E+00	52.00	0.00E+00
							266.2					
167	826.73	10	30	37.0	0.00	1	266.2	0.0	0.0000			0.00E+00
177	816.73					2	266.2	0.0	0.0000			0.00E+00
						5	266.2	0.0	0.0000			0.00E+00
						10	266.2	0.0	0.0000			0.00E+00
						15	266.2	0.0	0.0000	0.00E+00	37.00	0.00E+00
							266.2					
167	826.73	10	15	22.0	0.00	1	266.2	0.0	0.0000			0.00E+00
177	816.73					2	266.2	0.0	0.0000			0.00E+00
						5	266.2	0.0	0.0000			0.00E+00
						10	266.2	0.0	0.0000			0.00E+00
						15	266.2	0.0	0.0000	0.00E+00	22.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	993.73	ft
February 16, 2018	Groundwater Depth:	12.2	ft
Water Pressure Testing	Groundwater Elev:	981.53	ft
Boring B-41	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							265.7					
177	816.73	10	15	22.0	0.00	1	265.7	0.0	0.0000			0.00E+00
187	806.73					2	265.7	0.0	0.0000			0.00E+00
						5	265.7	0.0	0.0000			0.00E+00
						10	265.7	0.0	0.0000			0.00E+00
						15	265.7	0.0	0.0000	0.00E+00	22.00	0.00E+00
							265.8					
177	816.73	10	30	37.0	0.00	1	265.8	0.0	0.0000			0.00E+00
187	806.73					2	265.8	0.0	0.0000			0.00E+00
						5	265.8	0.0	0.0000			0.00E+00
						10	265.8	0.0	0.0000			0.00E+00
						15	265.8	0.0	0.0000	0.00E+00	37.00	0.00E+00
							265.8					
177	816.73	10	45	52.0	0.39	1	265.9	0.1	0.0013			1.28E-07
187	806.73					2	265.9	0.0	0.0000			0.00E+00
						5	265.9	0.0	0.0000			0.00E+00
						10	265.9	0.0	0.0000			0.00E+00
						15	265.9	0.0	0.0000	2.67E-04	51.61	0.00E+00
							265.9					
177	816.73	10	30	37.0	0.00	1	265.9	0.0	0.0000			0.00E+00
187	806.73					2	265.9	0.0	0.0000			0.00E+00
						5	265.9	0.0	0.0000			0.00E+00
						10	265.9	0.0	0.0000			0.00E+00
						15	265.9	0.0	0.0000	0.00E+00	37.00	0.00E+00
							265.9					
177	816.73	10	15	22.0	0.00	1	265.9	0.0	0.0000			0.00E+00
187	806.73					2	265.9	0.0	0.0000			0.00E+00
						5	265.9	0.0	0.0000			0.00E+00
						10	265.9	0.0	0.0000			0.00E+00
						15	265.9	0.0	0.0000	0.00E+00	22.00	0.00E+00
											Average of Valid Stages:	**5.12E-09**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	995.53 ft
	March 21, 2018	Groundwater Depth:	7.8 ft
	Water Pressure Testing	Groundwater Elev:	987.73 ft
	Boring B-42	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							120.0					
138.5	857.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
148.5	847.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			1.15E-08
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	8.91E-06	20.10	0.00E+00
							120.0					
138.5	857.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
148.5	847.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
138.5	857.03	10	45	50.1	0.00	1	120.0	0.0	0.0000			0.00E+00
148.5	847.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	50.10	0.00E+00
							120.0					
138.5	857.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
148.5	847.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
138.5	857.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
148.5	847.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.10	0.00E+00

Average of Valid Stages: **4.62E-10**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	995.53 ft
	March 21, 2018	Groundwater Depth:	7.8 ft
	Water Pressure Testing	Groundwater Elev:	987.73 ft
	Boring B-42	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							120.0					
148.5	847.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
158.5	837.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.10	0.00E+00
							120.0					
148.5	847.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
158.5	837.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
148.5	847.03	10	45	50.1	0.00	1	120.0	0.0	0.0000			0.00E+00
158.5	837.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	50.10	0.00E+00
							120.0					
148.5	847.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
158.5	837.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
148.5	847.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
158.5	837.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.10	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	995.53 ft
	March 21, 2018	Groundwater Depth:	7.8 ft
	Water Pressure Testing	Groundwater Elev:	987.73 ft
	Boring B-42	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							120.0					
158.5	837.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
168.5	827.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.10	0.00E+00
							120.0					
158.5	837.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
168.5	827.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
158.5	837.03	10	45	50.1	0.00	1	120.0	0.0	0.0000			0.00E+00
168.5	827.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	50.10	0.00E+00
							120.0					
158.5	837.03	10	30	35.1	0.00	1	120.0	0.0	0.0000			0.00E+00
168.5	827.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.10	0.00E+00
							120.0					
158.5	837.03	10	15	20.1	0.00	1	120.0	0.0	0.0000			0.00E+00
168.5	827.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.10	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	995.53 ft
	March 21, 2018	Groundwater Depth:	7.9 ft
	Water Pressure Testing	Groundwater Elev:	987.63 ft
	Boring B-42	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							119.9					
168.5	827.03	10	15	20.2	0.00	1	119.9	0.0	0.0000			0.00E+00
178.5	817.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	20.20	0.00E+00
							119.9					
168.5	827.03	10	30	35.2	0.00	1	119.9	0.0	0.0000			0.00E+00
178.5	817.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	35.20	0.00E+00
							120.0					
168.5	827.03	10	45	50.2	0.00	1	120.0	0.0	0.0000			0.00E+00
178.5	817.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	50.20	0.00E+00
							120.0					
168.5	827.03	10	30	35.2	0.00	1	120.0	0.0	0.0000			0.00E+00
178.5	817.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	35.20	0.00E+00
							120.0					
168.5	827.03	10	15	20.2	0.00	1	120.0	0.0	0.0000			0.00E+00
178.5	817.03					2	120.0	0.0	0.0000			0.00E+00
						5	120.0	0.0	0.0000			0.00E+00
						10	120.0	0.0	0.0000			0.00E+00
						15	120.0	0.0	0.0000	0.00E+00	20.20	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	995.53 ft
	March 21, 2018	Groundwater Depth:	7.9 ft
	Water Pressure Testing	Groundwater Elev:	987.63 ft
	Boring B-42	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							119.9					
178.5	817.03	10	15	20.2	0.00	1	119.9	0.0	0.0000			0.00E+00
188.5	807.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	20.20	0.00E+00
							119.9					
178.5	817.03	10	30	35.2	0.00	1	119.9	0.0	0.0000			0.00E+00
188.5	807.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	35.20	0.00E+00
							119.9					
178.5	817.03	10	45	50.2	0.00	1	119.9	0.0	0.0000			0.00E+00
188.5	807.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	50.20	0.00E+00
							119.9					
178.5	817.03	10	30	35.2	0.00	1	119.9	0.0	0.0000			0.00E+00
188.5	807.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	35.20	0.00E+00
							119.9					
178.5	817.03	10	15	20.2	0.00	1	119.9	0.0	0.0000			0.00E+00
188.5	807.03					2	119.9	0.0	0.0000			0.00E+00
						5	119.9	0.0	0.0000			0.00E+00
						10	119.9	0.0	0.0000			0.00E+00
						15	119.9	0.0	0.0000	0.00E+00	20.20	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
March 22, 2018
Water Pressure Testing
Boring B-43

Ground Elevation: 990.64 ft
Groundwater Depth: 4.8 ft
Groundwater Elev: 985.84 ft
Gage Height: 4 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5917.2					
126.6	864.04	5	15	18.8	0.00	1	5917.2	0.0	0.0000			0.00E+00
131.6	859.04					2	5917.2	0.0	0.0000			0.00E+00
						5	5917.2	0.0	0.0000			0.00E+00
						10	5917.2	0.0	0.0000			0.00E+00
						15	5917.2	0.0	0.0000	0.00E+00	18.80	0.00E+00
							5917.2					
126.6	864.04	5	30	33.8	0.00	1	5917.2	0.0	0.0000			0.00E+00
131.6	859.04					2	5917.2	0.0	0.0000			0.00E+00
						5	5917.2	0.0	0.0000			0.00E+00
						10	5917.2	0.0	0.0000			0.00E+00
						15	5917.2	0.0	0.0000	0.00E+00	33.80	0.00E+00
							5917.2					
126.6	864.04	5	45	48.8	0.00	1	5917.2	0.0	0.0000			0.00E+00
131.6	859.04					2	5917.2	0.0	0.0000			0.00E+00
						5	5917.2	0.0	0.0000			0.00E+00
						10	5917.2	0.0	0.0000			0.00E+00
						15	5917.2	0.0	0.0000	0.00E+00	48.80	0.00E+00
							5917.2					
126.6	864.04	5	30	33.8	0.00	1	5917.2	0.0	0.0000			0.00E+00
131.6	859.04					2	5917.2	0.0	0.0000			0.00E+00
						5	5917.2	0.0	0.0000			0.00E+00
						10	5917.2	0.0	0.0000			0.00E+00
						15	5917.2	0.0	0.0000	0.00E+00	33.80	0.00E+00
							5917.2					
126.6	864.04	5	15	18.8	0.00	1	5917.2	0.0	0.0000			0.00E+00
131.6	859.04					2	5917.2	0.0	0.0000			0.00E+00
						5	5917.2	0.0	0.0000			0.00E+00
						10	5917.2	0.0	0.0000			0.00E+00
						15	5917.2	0.0	0.0000	0.00E+00	18.80	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
March 22, 2018
Water Pressure Testing
Boring B-43

Ground Elevation: 990.64 ft
Groundwater Depth: 4.9 ft
Groundwater Elev: 985.74 ft
Gage Height: 4 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5916.2					
131.6	859.04	5	15	18.9	0.00	1	5916.2	0.0	0.0000			0.00E+00
136.6	854.04					2	5916.2	0.0	0.0000			0.00E+00
						5	5916.2	0.0	0.0000			0.00E+00
						10	5916.2	0.0	0.0000			0.00E+00
						15	5916.2	0.0	0.0000	0.00E+00	18.90	0.00E+00
							5916.3					
131.6	859.04	5	30	33.9	0.00	1	5916.3	0.0	0.0000			0.00E+00
136.6	854.04					2	5916.3	0.0	0.0000			0.00E+00
						5	5916.3	0.0	0.0000			0.00E+00
						10	5916.3	0.0	0.0000			0.00E+00
						15	5916.3	0.0	0.0000	0.00E+00	33.90	0.00E+00
							5916.3					
131.6	859.04	5	45	48.9	0.00	1	5916.3	0.0	0.0000			0.00E+00
136.6	854.04					2	5916.3	0.0	0.0000			0.00E+00
						5	5916.3	0.0	0.0000			0.00E+00
						10	5916.3	0.0	0.0000			0.00E+00
						15	5916.3	0.0	0.0000	0.00E+00	48.90	0.00E+00
							5916.3					
131.6	859.04	5	30	33.9	0.00	1	5916.3	0.0	0.0000			0.00E+00
136.6	854.04					2	5916.3	0.0	0.0000			0.00E+00
						5	5916.3	0.0	0.0000			0.00E+00
						10	5916.3	0.0	0.0000			0.00E+00
						15	5916.3	0.0	0.0000	0.00E+00	33.90	0.00E+00
							5916.3					
131.6	859.04	5	15	18.9	0.00	1	5916.3	0.0	0.0000			0.00E+00
136.6	854.04					2	5916.3	0.0	0.0000			0.00E+00
						5	5916.3	0.0	0.0000			0.00E+00
						10	5916.3	0.0	0.0000			0.00E+00
						15	5916.3	0.0	0.0000	0.00E+00	18.90	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	990.64 ft
	March 21, 2018	Groundwater Depth:	2.3 ft
	Water Pressure Testing	Groundwater Elev:	988.34 ft
	Boring B-43	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5905.0					
136.6	854.04	10	15	17.7	0.00	1	5905.0	0.0	0.0000			0.00E+00
146.6	844.04					2	5905.0	0.0	0.0000			0.00E+00
						5	5905.0	0.0	0.0000			0.00E+00
						10	5905.0	0.0	0.0000			0.00E+00
						15	5905.0	0.0	0.0000	0.00E+00	17.70	0.00E+00
							5905.0					
136.6	854.04	10	30	32.7	0.00	1	5905.0	0.0	0.0000			0.00E+00
146.6	844.04					2	5905.0	0.0	0.0000			0.00E+00
						5	5905.0	0.0	0.0000			0.00E+00
						10	5905.0	0.0	0.0000			0.00E+00
						15	5905.0	0.0	0.0000	0.00E+00	32.70	0.00E+00
							5905.0					
136.6	854.04	10	45	47.7	0.00	1	5905.0	0.0	0.0000			0.00E+00
146.6	844.04					2	5905.0	0.0	0.0000			0.00E+00
						5	5905.0	0.0	0.0000			0.00E+00
						10	5905.0	0.0	0.0000			0.00E+00
						15	5905.0	0.0	0.0000	0.00E+00	47.70	0.00E+00
							5905.0					
136.6	854.04	10	30	32.7	0.00	1	5905.0	0.0	0.0000			0.00E+00
146.6	844.04					2	5905.0	0.0	0.0000			0.00E+00
						5	5905.0	0.0	0.0000			0.00E+00
						10	5905.0	0.0	0.0000			0.00E+00
						15	5905.0	0.0	0.0000	0.00E+00	32.70	0.00E+00
							5905.0					
136.6	854.04	10	15	17.7	0.00	1	5905.0	0.0	0.0000			0.00E+00
146.6	844.04					2	5905.0	0.0	0.0000			0.00E+00
						5	5905.0	0.0	0.0000			0.00E+00
						10	5905.0	0.0	0.0000			0.00E+00
						15	5905.0	0.0	0.0000	0.00E+00	17.70	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	990.64	ft
March 21, 2018	Groundwater Depth:	4	ft
Water Pressure Testing	Groundwater Elev:	986.64	ft
Boring B-43	Gage Height:	4	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5917.0					
146.6	844.04	10	15	18.5	0.00	1	5917.0	0.0	0.0000			0.00E+00
156.6	834.04					2	5917.0	0.0	0.0000			0.00E+00
						5	5917.0	0.0	0.0000			0.00E+00
						10	5917.0	0.0	0.0000			0.00E+00
						15	5917.0	0.0	0.0000	0.00E+00	18.50	0.00E+00
							5917.0					
146.6	844.04	10	30	33.5	0.00	1	5917.0	0.0	0.0000			0.00E+00
156.6	834.04					2	5917.0	0.0	0.0000			0.00E+00
						5	5917.0	0.0	0.0000			0.00E+00
						10	5917.0	0.0	0.0000			0.00E+00
						15	5917.0	0.0	0.0000	0.00E+00	33.50	0.00E+00
							5917.1					
146.6	844.04	10	45	48.5	0.00	1	5917.1	0.0	0.0000			0.00E+00
156.6	834.04					2	5917.1	0.0	0.0000			0.00E+00
						5	5917.1	0.0	0.0000			0.00E+00
						10	5917.1	0.0	0.0000			0.00E+00
						15	5917.1	0.0	0.0000	0.00E+00	48.50	0.00E+00
							5917.1					
146.6	844.04	10	30	33.5	0.00	1	5917.1	0.0	0.0000			0.00E+00
156.6	834.04					2	5917.1	0.0	0.0000			0.00E+00
						5	5917.1	0.0	0.0000			0.00E+00
						10	5917.1	0.0	0.0000			0.00E+00
						15	5917.1	0.0	0.0000	0.00E+00	33.50	0.00E+00
							5917.1					
146.6	844.04	10	15	18.5	0.00	1	5917.1	0.0	0.0000			0.00E+00
156.6	834.04					2	5917.1	0.0	0.0000			0.00E+00
						5	5917.1	0.0	0.0000			0.00E+00
						10	5917.1	0.0	0.0000			0.00E+00
						15	5917.1	0.0	0.0000	0.00E+00	18.50	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	990.64 ft
	March 21, 2018	Groundwater Depth:	3.7 ft
	Water Pressure Testing	Groundwater Elev:	986.94 ft
	Boring B-43	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5919.4					
156.6	834.04	10	15	18.3	0.00	1	5919.4	0.0	0.0000			0.00E+00
166.6	824.04					2	5919.4	0.0	0.0000			0.00E+00
						5	5919.4	0.0	0.0000			0.00E+00
						10	5919.4	0.0	0.0000			0.00E+00
						15	5919.4	0.0	0.0000	0.00E+00	18.30	0.00E+00
							5919.4					
156.6	834.04	10	30	33.3	0.00	1	5919.4	0.0	0.0000			0.00E+00
166.6	824.04					2	5919.4	0.0	0.0000			0.00E+00
						5	5919.4	0.0	0.0000			0.00E+00
						10	5919.4	0.0	0.0000			0.00E+00
						15	5919.4	0.0	0.0000	0.00E+00	33.30	0.00E+00
							5919.5					
156.6	834.04	10	45	48.3	0.00	1	5919.5	0.0	0.0000			0.00E+00
166.6	824.04					2	5919.5	0.0	0.0000			0.00E+00
						5	5919.5	0.0	0.0000			0.00E+00
						10	5919.5	0.0	0.0000			0.00E+00
						15	5919.5	0.0	0.0000	0.00E+00	48.30	0.00E+00
							5919.5					
156.6	834.04	10	30	33.3	0.00	1	5919.5	0.0	0.0000			0.00E+00
166.6	824.04					2	5919.5	0.0	0.0000			0.00E+00
						5	5919.5	0.0	0.0000			0.00E+00
						10	5919.5	0.0	0.0000			0.00E+00
						15	5919.5	0.0	0.0000	0.00E+00	33.30	0.00E+00
							5919.5					
156.6	834.04	10	15	18.3	0.00	1	5919.5	0.0	0.0000			0.00E+00
166.6	824.04					2	5919.5	0.0	0.0000			0.00E+00
						5	5919.5	0.0	0.0000			0.00E+00
						10	5919.5	0.0	0.0000			0.00E+00
						15	5919.5	0.0	0.0000	0.00E+00	18.30	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	990.64 ft
	March 22, 2018	Groundwater Depth:	5.3 ft
	Water Pressure Testing	Groundwater Elev:	985.34 ft
	Boring B-43	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5913.4					
166.6	824.04	10	15	19.0	0.00	1	5913.4	0.0	0.0000			0.00E+00
176.6	814.04					2	5913.4	0.0	0.0000			0.00E+00
						5	5913.4	0.0	0.0000			0.00E+00
						10	5913.4	0.0	0.0000			0.00E+00
						15	5913.4	0.0	0.0000	0.00E+00	19.00	0.00E+00
							5913.4					
166.6	824.04	10	30	34.0	0.00	1	5913.4	0.0	0.0000			0.00E+00
176.6	814.04					2	5913.4	0.0	0.0000			0.00E+00
						5	5913.4	0.0	0.0000			0.00E+00
						10	5913.4	0.0	0.0000			0.00E+00
						15	5913.4	0.0	0.0000	0.00E+00	34.00	0.00E+00
							5913.4					
166.6	824.04	10	45	49.0	0.00	1	5913.4	0.0	0.0000			0.00E+00
176.6	814.04					2	5913.4	0.0	0.0000			0.00E+00
						5	5913.4	0.0	0.0000			0.00E+00
						10	5913.4	0.0	0.0000			0.00E+00
						15	5913.4	0.0	0.0000	0.00E+00	49.00	0.00E+00
							5913.4					
166.6	824.04	10	30	34.0	0.00	1	5913.4	0.0	0.0000			0.00E+00
176.6	814.04					2	5913.4	0.0	0.0000			0.00E+00
						5	5913.4	0.0	0.0000			0.00E+00
						10	5913.4	0.0	0.0000			0.00E+00
						15	5913.4	0.0	0.0000	0.00E+00	34.00	0.00E+00
							5913.4					
166.6	824.04	10	15	19.0	0.00	1	5913.4	0.0	0.0000			0.00E+00
176.6	814.04					2	5913.4	0.0	0.0000			0.00E+00
						5	5913.4	0.0	0.0000			0.00E+00
						10	5913.4	0.0	0.0000			0.00E+00
						15	5913.4	0.0	0.0000	0.00E+00	19.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	990.64	ft
	March 22, 2018	Groundwater Depth:	0.5	ft
	Water Pressure Testing	Groundwater Elev:	990.14	ft
	Boring B-43	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5915.2					
176.6	814.04	10	15	16.9	0.00	1	5915.2	0.0	0.0000			0.00E+00
186.6	804.04					2	5915.2	0.0	0.0000			0.00E+00
						5	5915.2	0.0	0.0000			0.00E+00
						10	5915.2	0.0	0.0000			0.00E+00
						15	5915.2	0.0	0.0000	0.00E+00	16.90	0.00E+00
							5915.2					
176.6	814.04	10	30	31.9	0.00	1	5915.2	0.0	0.0000			0.00E+00
186.6	804.04					2	5915.2	0.0	0.0000			0.00E+00
						5	5915.2	0.0	0.0000			0.00E+00
						10	5915.2	0.0	0.0000			0.00E+00
						15	5915.2	0.0	0.0000	0.00E+00	31.90	0.00E+00
							5915.2					
176.6	814.04	10	45	46.9	0.00	1	5915.2	0.0	0.0000			0.00E+00
186.6	804.04					2	5915.2	0.0	0.0000			0.00E+00
						5	5915.2	0.0	0.0000			0.00E+00
						10	5915.2	0.0	0.0000			0.00E+00
						15	5915.2	0.0	0.0000	0.00E+00	46.90	0.00E+00
							5915.2					
176.6	814.04	10	30	31.9	0.00	1	5915.2	0.0	0.0000			0.00E+00
186.6	804.04					2	5915.2	0.0	0.0000			0.00E+00
						5	5915.2	0.0	0.0000			0.00E+00
						10	5915.2	0.0	0.0000			0.00E+00
						15	5915.2	0.0	0.0000	0.00E+00	31.90	0.00E+00
							5915.2					
176.6	814.04	10	15	16.9	0.00	1	5915.2	0.0	0.0000			0.00E+00
186.6	804.04					2	5915.2	0.0	0.0000			0.00E+00
						5	5915.2	0.0	0.0000			0.00E+00
						10	5915.2	0.0	0.0000			0.00E+00
						15	5915.2	0.0	0.0000	0.00E+00	16.90	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	996.08 ft
	March 15, 2018	Groundwater Depth:	7.3 ft
	Water Pressure Testing	Groundwater Elev:	988.78 ft
	Boring B-44	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1190.8					
139	857.08	10	15	19.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
149	847.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			1.17E-08
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	8.91E-06	19.90	0.00E+00
							1190.8					
139	857.08	10	30	34.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
149	847.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.90	0.00E+00
							1190.8					
139	857.08	10	45	49.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
149	847.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.9	0.0	0.0000			2.79E-09
						15	1190.9	0.0	0.0000	5.35E-06	49.90	0.00E+00
							1190.9					
139	857.08	10	30	34.9	0.00	1	1190.9	0.0	0.0000			0.00E+00
149	847.08					2	1190.9	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			-6.65E-09
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	-8.91E-06	34.90	0.00E+00
							1190.8					
139	857.08	10	15	19.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
149	847.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.90	0.00E+00
											Average of Valid Stages:	**3.12E-10**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	996.08 ft
	March 14, 2018	Groundwater Depth:	7.3 ft
	Water Pressure Testing	Groundwater Elev:	988.78 ft
	Boring B-44	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1190.8					
149	847.08	10	15	19.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
159	837.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.90	0.00E+00
							1190.8					
149	847.08	10	30	34.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
159	837.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.90	0.00E+00
							1190.8					
149	847.08	10	45	49.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
159	837.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			4.65E-09
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	8.91E-06	49.90	0.00E+00
							1190.8					
149	847.08	10	30	34.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
159	837.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.90	0.00E+00
							1190.8					
149	847.08	10	15	19.9	0.00	1	1190.8	0.0	0.0000			0.00E+00
159	837.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.90	0.00E+00
											Average of Valid Stages:	**1.86E-10**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	996.08 ft
	March 14, 2018	Groundwater Depth:	7.2 ft
	Water Pressure Testing	Groundwater Elev:	988.88 ft
	Boring B-44	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1190.8					
159	837.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
169	827.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
							1190.8					
159	837.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
169	827.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
159	837.08	10	45	49.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
169	827.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	49.80	0.00E+00
							1190.8					
159	837.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
169	827.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
159	837.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
169	827.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	996.08 ft
	March 14, 2018	Groundwater Depth:	7.2 ft
	Water Pressure Testing	Groundwater Elev:	988.88 ft
	Boring B-44	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1190.8					
169	827.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
179	817.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
							1190.8					
169	827.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
179	817.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
169	827.08	10	45	49.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
179	817.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	49.80	0.00E+00
							1190.8					
169	827.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
179	817.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
169	827.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
179	817.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	996.08 ft
	March 14, 2018	Groundwater Depth:	7.2 ft
	Water Pressure Testing	Groundwater Elev:	988.88 ft
	Boring B-44	Gage Height:	4 ft
		Hole Diameter:	3 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1190.8					
179	817.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
189	807.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
							1190.8					
179	817.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
189	807.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
179	817.08	10	45	49.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
189	807.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			2.79E-09
						15	1190.8	0.0	0.0001	1.60E-05	49.80	5.59E-09
							1190.8					
179	817.08	10	30	34.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
189	807.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	34.80	0.00E+00
							1190.8					
179	817.08	10	15	19.8	0.00	1	1190.8	0.0	0.0000			0.00E+00
189	807.08					2	1190.8	0.0	0.0000			0.00E+00
						5	1190.8	0.0	0.0000			0.00E+00
						10	1190.8	0.0	0.0000			0.00E+00
						15	1190.8	0.0	0.0000	0.00E+00	19.80	0.00E+00
											Average of Valid Stages:	**3.35E-10**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.51 ft
	May 7, 2018	Groundwater Depth:	14.8 ft
	Water Pressure Testing	Groundwater Elev:	964.71 ft
	Boring B-45	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13626.1					
123	856.51	8.9	15	23.1	0.80	1	13626.5	0.4	0.0067			1.37E-06
131.9	847.61					2	13627.1	0.6	0.0090			1.83E-06
						5	13628.0	0.3	0.0045			9.13E-07
						10	13628.0	0.0	0.0000			0.00E+00
						15	13628.1	0.0	0.0002	4.09E-03	22.30	4.57E-08
							13628.1					
123	856.51	8.9	30	38.1	0.00	1	13628.1	0.0	0.0000			0.00E+00
131.9	847.61					2	13628.1	0.0	0.0000			0.00E+00
						5	13628.2	0.0	0.0004			4.55E-08
						10	13628.2	0.0	0.0000			0.00E+00
						15	13628.2	0.0	0.0002	1.20E-04	38.10	2.73E-08
							13628.2					
123	856.51	8.9	45	53.1	0.36	1	13628.3	0.1	0.0011			9.82E-08
131.9	847.61					2	13628.3	0.0	0.0000			0.00E+00
						5	13628.5	0.0	0.0007			6.55E-08
						10	13628.7	0.0	0.0007			5.89E-08
						15	13628.9	0.0	0.0007	6.44E-04	52.74	5.89E-08
							13628.9					
123	856.51	8.9	30	38.1	0.00	1	13628.9	0.0	0.0000			0.00E+00
131.9	847.61					2	13628.9	0.0	0.0000			0.00E+00
						5	13629.0	0.0	0.0004			4.55E-08
						10	13629.0	0.0	0.0000			0.00E+00
						15	13629.0	0.0	0.0000	7.49E-05	38.10	0.00E+00
							13629.0					
123	856.51	8.9	15	23.1	0.00	1	13629.0	0.0	0.0000			0.00E+00
131.9	847.61					2	13629.0	0.0	0.0000			0.00E+00
						5	13629.0	0.0	0.0000			0.00E+00
						10	13629.0	0.0	0.0000			0.00E+00
						15	13629.0	0.0	0.0000	0.00E+00	23.10	0.00E+00
											Average of Valid Stages:	**1.82E-07**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.51 ft
	May 8, 2018	Groundwater Depth:	16.7 ft
	Water Pressure Testing	Groundwater Elev:	962.81 ft
	Boring B-45	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13686.5					
131.9	847.61	10	15	24.0	1.21	1	13687.3	0.7	0.0100			2.03E-06
141.9	837.61					2	13688.2	0.9	0.0120			2.44E-06
						5	13689.9	0.6	0.0077			1.56E-06
						10	13690.5	0.1	0.0016			3.25E-07
						15	13691.0	0.1	0.0014	6.53E-03	22.79	2.84E-07
							13691.4					
131.9	847.61	10	30	39.0	0.44	1	13691.6	0.1	0.0020			2.45E-07
141.9	837.61					2	13691.7	0.1	0.0010			1.23E-07
						5	13692.1	0.1	0.0020			2.45E-07
						10	13692.7	0.1	0.0016			1.96E-07
						15	13693.4	0.1	0.0018	1.68E-03	38.56	2.21E-07
							13693.7					
131.9	847.61	10	45	54.0	0.44	1	13693.8	0.1	0.0020			1.77E-07
141.9	837.61					2	13694.1	0.2	0.0030			2.65E-07
						5	13694.7	0.2	0.0030			2.65E-07
						10	13695.8	0.2	0.0028			2.48E-07
						15	13697.0	0.2	0.0032	2.80E-03	53.56	2.83E-07
							13696.9					
131.9	847.61	10	30	39.0	0.44	1	13697.1	0.1	0.0020			2.45E-07
141.9	837.61					2	13697.4	0.3	0.0040			4.91E-07
						5	13697.8	0.1	0.0020			2.45E-07
						10	13698.5	0.1	0.0018			2.21E-07
						15	13699.3	0.2	0.0022	2.40E-03	38.56	2.70E-07
							13699.2					
131.9	847.61	10	15	24.0	0.36	1	13699.2	0.1	0.0010			2.00E-07
141.9	837.61					2	13699.3	0.1	0.0010			2.00E-07
						5	13699.5	0.1	0.0010			2.00E-07
						10	13699.7	0.0	0.0006			1.20E-07
						15	13700.0	0.1	0.0008	8.80E-04	23.64	1.60E-07
											Average of Valid Stages:	**4.50E-07**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 8, 2018
Water Pressure Testing
Boring B-45

Ground Elevation: 979.51 ft
Groundwater Depth: 22.5 ft
Groundwater Elev: 957.01 ft
Gage Height: 4 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13705.9					
141.9	837.61	10	15	26.5	0.70	1	13706.3	0.4	0.0050			9.09E-07
151.9	827.61					2	13705.9	-0.4	-0.0050			-9.09E-07
						5	13707.6	0.6	0.0077			1.39E-06
						10	13707.8	0.0	0.0004			7.27E-08
						15	13707.8	0.0	0.0000	1.61E-03	25.80	0.00E+00
							13707.8					
141.9	837.61	10	30	41.5	0.36	1	13707.9	0.1	0.0010			1.15E-07
151.9	827.61					2	13707.9	0.0	0.0000			0.00E+00
						5	13708.0	0.0	0.0003			3.84E-08
						10	13708.2	0.0	0.0006			6.91E-08
						15	13708.4	0.0	0.0004	4.67E-04	41.14	4.61E-08
							13708.4					
141.9	837.61	10	45	56.5	0.44	1	13708.6	0.1	0.0020			1.69E-07
151.9	827.61					2	13708.7	0.1	0.0020			1.69E-07
						5	13709.0	0.1	0.0013			1.13E-07
						10	13709.4	0.1	0.0010			8.45E-08
						15	13709.9	0.1	0.0014	1.55E-03	56.06	1.18E-07
							13710.0					
141.9	837.61	10	30	41.5	0.36	1	13710.1	0.1	0.0010			1.15E-07
151.9	827.61					2	13710.2	0.1	0.0020			2.30E-07
						5	13710.4	0.0	0.0007			7.68E-08
						10	13710.7	0.1	0.0008			9.21E-08
						15	13710.8	0.0	0.0004	9.73E-04	41.14	4.61E-08
							13710.8					
141.9	837.61	10	15	26.5	0.36	1	13710.9	0.1	0.0010			1.81E-07
151.9	827.61					2	13710.9	0.0	0.0000			0.00E+00
						5	13711.0	0.0	0.0003			6.03E-08
						10	13711.0	0.0	0.0002			3.62E-08
						15	13711.1	0.0	0.0002	3.47E-04	26.14	3.62E-08
											Average of Valid Stages:	**1.31E-07**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.51 ft
	May 8, 2018	Groundwater Depth:	22.4 ft
	Water Pressure Testing	Groundwater Elev:	957.11 ft
	Boring B-45	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13716.7					
151.9	827.61	10	15	26.4	0.36	1	13716.7	0.1	0.0010			1.81E-07
161.9	817.61					2	13716.8	0.1	0.0010			1.81E-07
						5	13717.1	0.1	0.0013			2.41E-07
						10	13717.3	0.0	0.0006			1.09E-07
						15	13717.6	0.0	0.0006	9.07E-04	26.04	1.09E-07
							13719.7					
151.9	827.61	10	30	41.4	0.36	1	13719.8	0.1	0.0010			1.15E-07
161.9	817.61					2	13719.9	0.1	0.0020			2.31E-07
						5	13720.5	0.2	0.0027			3.07E-07
						10	13721.2	0.1	0.0018			2.08E-07
						15	13721.9	0.1	0.0018	1.85E-03	41.04	2.08E-07
							13722.2					
151.9	827.61	10	45	56.4	0.00	1	13722.2	0.0	0.0000			0.00E+00
161.9	817.61					2	13722.3	0.1	0.0020			1.69E-07
						5	13722.3	0.0	0.0000			0.00E+00
						10	13722.5	0.0	0.0004			3.37E-08
						15	13722.6	0.0	0.0004	5.60E-04	56.40	3.37E-08
							13722.5					
151.9	827.61	10	30	41.4	0.00	1	13722.5	0.0	0.0000			0.00E+00
161.9	817.61					2	13722.5	0.0	0.0000			0.00E+00
						5	13722.5	0.0	0.0000			0.00E+00
						10	13722.5	0.0	0.0000			0.00E+00
						15	13722.6	0.0	0.0002	4.00E-05	41.40	2.30E-08
							13722.2					
151.9	827.61	10	15	26.4	0.00	1	13722.2	0.0	0.0000			0.00E+00
161.9	817.61					2	13722.2	0.0	0.0000			0.00E+00
						5	13722.3	0.0	0.0003			6.00E-08
						10	13722.3	0.0	0.0002			3.60E-08
						15	13722.4	0.0	0.0002	1.47E-04	26.40	3.60E-08
											Average of Valid Stages:	**9.12E-08**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	979.51 ft
	May 9, 2018	Groundwater Depth:	20.8 ft
	Water Pressure Testing	Groundwater Elev:	958.71 ft
	Boring B-45	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							13726.6					
161.9	817.61	10	15	25.7	0.00	1	13726.6	0.0	0.0000			0.00E+00
171.9	807.61					2	13726.6	0.0	0.0000			0.00E+00
						5	13726.6	0.0	0.0000			0.00E+00
						10	13726.6	0.0	0.0000			0.00E+00
						15	13726.6	0.0	0.0000	0.00E+00	25.70	0.00E+00
							13727.7					
161.9	817.61	10	30	40.7	0.21	1	13727.7	-0.1	-0.0010			-1.17E-07
171.9	807.61					2	13727.7	0.0	0.0000			0.00E+00
						5	13727.7	0.0	0.0003			3.90E-08
						10	13727.8	0.0	0.0002			2.34E-08
						15	13728.0	0.0	0.0004	-1.33E-05	40.49	4.68E-08
							13728.4					
161.9	817.61	10	45	55.7	0.00	1	13728.4	0.0	0.0000			0.00E+00
171.9	807.61					2	13728.5	0.1	0.0010			8.54E-08
						5	13728.7	0.1	0.0010			8.54E-08
						10	13728.8	0.0	0.0004			3.41E-08
						15	13729.1	0.0	0.0006	6.00E-04	55.70	5.12E-08
							13728.9					
161.9	817.61	10	30	40.7	0.00	1	13728.9	0.0	0.0000			0.00E+00
171.9	807.61					2	13729.0	0.1	0.0010			1.17E-07
						5	13729.1	0.0	0.0007			7.79E-08
						10	13729.1	0.0	0.0000			0.00E+00
						15	13729.2	0.0	0.0002	3.73E-04	40.70	2.34E-08
							13729.1					
161.9	817.61	10	15	25.7	0.00	1	13729.1	0.0	0.0000			0.00E+00
171.9	807.61					2	13729.1	0.1	0.0010			1.85E-07
						5	13729.1	0.0	0.0000			0.00E+00
						10	13729.1	0.0	0.0000			0.00E+00
						15	13729.1	0.0	0.0000	2.00E-04	25.70	0.00E+00
											Average of Valid Stages:	**2.60E-08**

Note: Single packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 14, 2018	Groundwater Depth:	-1.4 ft
	Water Pressure Testing	Groundwater Elev:	974.65 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3408.0					
77.5	895.75	10	15	16.1	0.61	1	3408.3	0.3	0.0040			1.26E-06
87.5	885.75					2	3408.4	0.1	0.0013			4.18E-07
						5	3408.4	0.0	0.0000			0.00E+00
						10	3408.4	0.0	0.0000			0.00E+00
						15	3408.4	0.0	0.0000	1.07E-03	15.49	0.00E+00
							3408.5					
77.5	895.75	10	30	31.1	1.14	1	3409.2	0.7	0.0094			1.52E-06
87.5	885.75					2	3409.9	0.7	0.0094			1.52E-06
						5	3411.6	0.6	0.0076			1.23E-06
						10	3414.0	0.5	0.0064			1.04E-06
						15	3415.9	0.4	0.0051	7.56E-03	29.96	8.23E-07
							3415.9					
77.5	895.75	10	45	46.1	0.00	1	3415.9	0.0	0.0000			0.00E+00
87.5	885.75					2	3415.9	0.0	0.0000			0.00E+00
						5	3415.9	0.0	0.0000			0.00E+00
						10	3415.9	0.0	0.0000			0.00E+00
						15	3415.9	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3415.9					
77.5	895.75	10	30	31.1	0.00	1	3415.9	0.0	0.0000			0.00E+00
87.5	885.75					2	3415.9	0.0	0.0000			0.00E+00
						5	3415.9	0.0	0.0000			0.00E+00
						10	3415.9	0.0	0.0000			0.00E+00
						15	3415.9	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3415.9					
77.5	895.75	10	15	16.1	0.00	1	3415.9	0.0	0.0000			0.00E+00
87.5	885.75					2	3415.9	0.0	0.0000			0.00E+00
						5	3415.9	0.0	0.0000			0.00E+00
						10	3415.9	0.0	0.0000			0.00E+00
						15	3415.9	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**3.12E-07**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 14, 2018	Groundwater Depth:	-1.4 ft
	Water Pressure Testing	Groundwater Elev:	974.65 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3407.5					
87.5	885.75	10	15	16.1	0.00	1	3407.5	0.0	0.0000			0.00E+00
97.5	875.75					2	3407.5	0.0	0.0000			0.00E+00
						5	3407.5	0.0	0.0000			0.00E+00
						10	3407.5	0.0	0.0000			0.00E+00
						15	3407.5	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3407.5					
87.5	885.75	10	30	31.1	0.00	1	3407.5	0.0	0.0000			0.00E+00
97.5	875.75					2	3407.5	0.0	0.0000			0.00E+00
						5	3407.5	0.0	0.0000			0.00E+00
						10	3407.5	0.0	0.0000			0.00E+00
						15	3407.5	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.5					
87.5	885.75	10	45	46.1	0.00	1	3407.5	0.0	0.0000			0.00E+00
97.5	875.75					2	3407.5	0.0	0.0000			0.00E+00
						5	3407.5	0.0	0.0000			0.00E+00
						10	3407.5	0.0	0.0000			0.00E+00
						15	3407.5	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3407.5					
87.5	885.75	10	30	31.1	0.00	1	3407.5	0.0	0.0000			0.00E+00
97.5	875.75					2	3407.5	0.0	0.0000			0.00E+00
						5	3407.5	0.0	0.0000			0.00E+00
						10	3407.5	0.0	0.0000			0.00E+00
						15	3407.5	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.5					
87.5	885.75	10	15	16.1	0.00	1	3407.5	0.0	0.0000			0.00E+00
97.5	875.75					2	3407.5	0.0	0.0000			0.00E+00
						5	3407.5	0.0	0.0000			0.00E+00
						10	3407.5	0.0	0.0000			0.00E+00
						15	3407.5	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 14, 2018	Groundwater Depth:	-1.3 ft
	Water Pressure Testing	Groundwater Elev:	974.55 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3407.6					
97.5	875.75	10	15	16.2	0.00	1	3407.6	0.0	0.0000			0.00E+00
107.5	865.75					2	3407.6	0.0	0.0000			0.00E+00
						5	3407.6	0.0	0.0000			0.00E+00
						10	3407.6	0.0	0.0000			0.00E+00
						15	3407.6	0.0	0.0000	0.00E+00	16.20	0.00E+00
							3407.6					
97.5	875.75	10	30	31.2	0.00	1	3407.6	0.0	0.0000			0.00E+00
107.5	865.75					2	3407.6	0.0	0.0000			0.00E+00
						5	3407.6	0.0	0.0000			0.00E+00
						10	3407.6	0.0	0.0000			0.00E+00
						15	3407.6	0.0	0.0000	0.00E+00	31.20	0.00E+00
							3407.6					
97.5	875.75	10	45	46.2	0.00	1	3407.6	0.0	0.0000			0.00E+00
107.5	865.75					2	3407.6	0.0	0.0000			0.00E+00
						5	3407.6	0.0	0.0000			0.00E+00
						10	3407.6	0.0	0.0000			0.00E+00
						15	3407.6	0.0	0.0000	0.00E+00	46.20	0.00E+00
							3407.6					
97.5	875.75	10	30	31.2	0.00	1	3407.6	0.0	0.0000			0.00E+00
107.5	865.75					2	3407.6	0.0	0.0000			0.00E+00
						5	3407.6	0.0	0.0000			0.00E+00
						10	3407.6	0.0	0.0000			0.00E+00
						15	3407.6	0.0	0.0000	0.00E+00	31.20	0.00E+00
							3407.6					
97.5	875.75	10	15	16.2	0.00	1	3407.6	0.0	0.0000			0.00E+00
107.5	865.75					2	3407.6	0.0	0.0000			0.00E+00
						5	3407.6	0.0	0.0000			0.00E+00
						10	3407.6	0.0	0.0000			0.00E+00
						15	3407.6	0.0	0.0000	0.00E+00	16.20	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25	ft
	May 11, 2018	Groundwater Depth:	-1.4	ft
	Water Pressure Testing	Groundwater Elev:	974.65	ft
	Boring B-46	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3407.2					
107.5	865.75	10	15	16.1	0.00	1	3407.2	0.0	0.0000			0.00E+00
117.5	855.75					2	3407.2	0.0	0.0000			0.00E+00
						5	3407.2	0.0	0.0000			0.00E+00
						10	3407.2	0.0	0.0000			0.00E+00
						15	3407.2	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3407.2					
107.5	865.75	10	30	31.1	0.00	1	3407.2	0.0	0.0000			0.00E+00
117.5	855.75					2	3407.2	0.0	0.0000			0.00E+00
						5	3407.2	0.0	0.0000			0.00E+00
						10	3407.2	0.0	0.0000			0.00E+00
						15	3407.2	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.2					
107.5	865.75	10	45	46.1	0.00	1	3407.2	0.0	0.0000			0.00E+00
117.5	855.75					2	3407.2	0.0	0.0000			0.00E+00
						5	3407.2	0.0	0.0000			0.00E+00
						10	3407.2	0.0	0.0000			0.00E+00
						15	3407.2	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3407.2					
107.5	865.75	10	30	31.1	0.00	1	3407.2	0.0	0.0000			0.00E+00
117.5	855.75					2	3407.2	0.0	0.0000			0.00E+00
						5	3407.2	0.0	0.0000			0.00E+00
						10	3407.2	0.0	0.0000			0.00E+00
						15	3407.2	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.2					
107.5	865.75	10	15	16.1	0.00	1	3407.2	0.0	0.0000			0.00E+00
117.5	855.75					2	3407.2	0.0	0.0000			0.00E+00
						5	3407.2	0.0	0.0000			0.00E+00
						10	3407.2	0.0	0.0000			0.00E+00
						15	3407.2	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25	ft
	May 11, 2018	Groundwater Depth:	-1.4	ft
	Water Pressure Testing	Groundwater Elev:	974.65	ft
	Boring B-46	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3407.1					
117.5	855.75	10	15	16.1	0.00	1	3407.1	0.0	0.0000			0.00E+00
127.5	845.75					2	3407.1	0.0	0.0000			0.00E+00
						5	3407.1	0.0	0.0000			0.00E+00
						10	3407.1	0.0	0.0000			0.00E+00
						15	3407.1	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3407.1					
117.5	855.75	10	30	31.1	0.00	1	3407.1	0.0	0.0000			0.00E+00
127.5	845.75					2	3407.1	0.0	0.0000			0.00E+00
						5	3407.1	0.0	0.0000			0.00E+00
						10	3407.1	0.0	0.0000			0.00E+00
						15	3407.1	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.1					
117.5	855.75	10	45	46.1	0.00	1	3407.1	0.0	0.0000			0.00E+00
127.5	845.75					2	3407.1	0.0	0.0000			0.00E+00
						5	3407.1	0.0	0.0000			0.00E+00
						10	3407.1	0.0	0.0000			0.00E+00
						15	3407.1	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3407.1					
117.5	855.75	10	30	31.1	0.00	1	3407.1	0.0	0.0000			0.00E+00
127.5	845.75					2	3407.1	0.0	0.0000			0.00E+00
						5	3407.1	0.0	0.0000			0.00E+00
						10	3407.1	0.0	0.0000			0.00E+00
						15	3407.1	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3407.1					
117.5	855.75	10	15	16.1	0.00	1	3407.1	0.0	0.0000			0.00E+00
127.5	845.75					2	3407.1	0.0	0.0000			0.00E+00
						5	3407.1	0.0	0.0000			0.00E+00
						10	3407.1	0.0	0.0000			0.00E+00
						15	3407.1	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 11, 2018	Groundwater Depth:	-1.4 ft
	Water Pressure Testing	Groundwater Elev:	974.65 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.7					
127.5	845.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
137.5	835.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3406.7					
127.5	845.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
137.5	835.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
127.5	845.75	10	45	46.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
137.5	835.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3406.7					
127.5	845.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
137.5	835.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
127.5	845.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
137.5	835.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 11, 2018	Groundwater Depth:	-1.4 ft
	Water Pressure Testing	Groundwater Elev:	974.65 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.7					
137.5	835.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
147.5	825.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3406.7					
137.5	835.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
147.5	825.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
137.5	835.75	10	45	46.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
147.5	825.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3406.7					
137.5	835.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
147.5	825.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
137.5	835.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
147.5	825.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25	ft
	May 11, 2018	Groundwater Depth:	-1.4	ft
	Water Pressure Testing	Groundwater Elev:	974.65	ft
	Boring B-46	Gage Height:	4	ft
		Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.7					
147.5	825.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
157.5	815.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00
							3406.7					
147.5	825.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
157.5	815.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
147.5	825.75	10	45	46.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
157.5	815.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	46.10	0.00E+00
							3406.7					
147.5	825.75	10	30	31.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
157.5	815.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.10	0.00E+00
							3406.7					
147.5	825.75	10	15	16.1	0.00	1	3406.7	0.0	0.0000			0.00E+00
157.5	815.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.10	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058	Big Walnut Sanitary Trunk Extension	Ground Elevation:	973.25 ft
	May 11, 2018	Groundwater Depth:	-1.2 ft
	Water Pressure Testing	Groundwater Elev:	974.45 ft
	Boring B-46	Gage Height:	4 ft
		Hole Diameter:	3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3406.6					
157.5	815.75	10	15	16.2	0.00	1	3406.6	0.0	0.0000			0.00E+00
167.5	805.75					2	3406.6	0.0	0.0000			0.00E+00
						5	3406.6	0.0	0.0000			0.00E+00
						10	3406.6	0.0	0.0000			0.00E+00
						15	3406.6	0.0	0.0000	0.00E+00	16.20	0.00E+00
							3406.7					
157.5	815.75	10	30	31.2	0.00	1	3406.7	0.0	0.0000			0.00E+00
167.5	805.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.20	0.00E+00
							3406.7					
157.5	815.75	10	45	46.2	0.00	1	3406.7	0.0	0.0000			0.00E+00
167.5	805.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	46.20	0.00E+00
							3406.7					
157.5	815.75	10	30	31.2	0.00	1	3406.7	0.0	0.0000			0.00E+00
167.5	805.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	31.20	0.00E+00
							3406.7					
157.5	815.75	10	15	16.2	0.00	1	3406.7	0.0	0.0000			0.00E+00
167.5	805.75					2	3406.7	0.0	0.0000			0.00E+00
						5	3406.7	0.0	0.0000			0.00E+00
						10	3406.7	0.0	0.0000			0.00E+00
						15	3406.7	0.0	0.0000	0.00E+00	16.20	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 17, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	2	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
12.9	968.20	10	5	7.5	0.00	1		0.7	0.0098			6.45E-06
22.9	958.20					2		0.8	0.0111			7.33E-06
						5		0.8	0.0102			6.72E-06
						10		0.8	0.0106			6.98E-06
						15		0.7	0.0094	1.02E-02	7.50	6.19E-06
12.9	968.20	10	7.5	10.0	0.00	1		0.8	0.0103			5.10E-06
22.9	958.20					2		0.8	0.0103			5.10E-06
						5		0.8	0.0112			5.57E-06
						10		0.8	0.0100			4.97E-06
						15		0.8	0.0102	1.04E-02	10.00	5.04E-06
12.9	968.20	10	10	12.5	0.00	1		1.3	0.0172			6.84E-06
22.9	958.20					2		1.1	0.0146			5.78E-06
						5		1.1	0.0144			5.73E-06
						10		1.1	0.0150			5.94E-06
						15		1.0	0.0138	1.50E-02	12.50	5.46E-06
12.9	968.20	10	7.5	10.0	0.00	1		0.8	0.0106			5.24E-06
22.9	958.20					2		1.0	0.0131			6.50E-06
						5		0.9	0.0115			5.70E-06
						10		1.0	0.0134			6.63E-06
						15		1.0	0.0132	1.24E-02	10.00	6.56E-06
12.9	968.20	10	5	7.5	0.00	1		0.7	0.0092			6.10E-06
22.9	958.20					2		0.6	0.0076			5.04E-06
						5		0.5	0.0072			4.77E-06
						10		0.6	0.0086			5.65E-06
						15		0.7	0.0091	8.34E-03	7.50	6.01E-06
											Average of Valid Stages:	**5.90E-06**

Note: Double Packer System

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 17, 2019
Water Pressure Testing
Boring B-47

Ground Elevation: 981.10 ft
Groundwater Depth: 3.8 ft
Groundwater Elev: 977.30 ft
Gage Height: 1 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
22.9	958.20	10	8	10.1	0.28	1		13.1	0.1751			8.73E-05
32.9	948.20					2		14.0	0.1872			9.33E-05
						5		14.0	0.1872			9.33E-05
						10						0.00E+00
						15				1.83E-01	9.82	0.00E+00
22.9	958.20	10	12	14.1	0.38	1		16.2	0.2166			7.73E-05
32.9	948.20					2		15.7	0.2099			7.49E-05
						5		19.1	0.2553			9.11E-05
						10						0.00E+00
						15				2.27E-01	13.72	0.00E+00
22.9	958.20	10	16	18.1	0.45	1		17.9	0.2393			6.64E-05
32.9	948.20					2		17.6	0.2353			6.53E-05
						5		17.6	0.2353			6.53E-05
						10		17.6	0.2350			6.52E-05
						15		17.5	0.2340	2.36E-01	17.65	6.49E-05
22.9	958.20	10	12	14.1	0.44	1		17.8	0.2380			8.51E-05
32.9	948.20					2		14.1	0.1885			6.74E-05
						5		15.4	0.2063			7.37E-05
						10		15.9	0.2126			7.60E-05
						15		15.8	0.2118	2.11E-01	13.66	7.57E-05
22.9	958.20	10	8	10.1	0.30	1		14.0	0.1872			9.34E-05
32.9	948.20					2		14.0	0.1872			9.34E-05
						5		13.7	0.1832			9.14E-05
						10						0.00E+00
						15				1.86E-01	9.80	0.00E+00

Average of Valid Stages: **6.00E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 17, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
32.9	948.20	10	11	13.1	0.31	1		14.1	0.1885			7.23E-05
42.9	938.20					2		14.5	0.1939			7.43E-05
						5		14.1	0.1889			7.24E-05
						10						0.00E+00
						15				1.90E-01	12.79	0.00E+00
32.9	948.20	10	16.5	18.6	0.38	1		16.2	0.2166			5.84E-05
42.9	938.20					2		16.2	0.2166			5.84E-05
						5		16.0	0.2139			5.77E-05
						10						0.00E+00
						15				2.16E-01	18.22	0.00E+00
32.9	948.20	10	22	24.1	0.47	1		18.5	0.2473			5.14E-05
42.9	938.20					2		18.2	0.2433			5.06E-05
						5		18.3	0.2447			5.09E-05
						10						0.00E+00
						15				2.45E-01	23.63	0.00E+00
32.9	948.20	10	16.5	18.6	0.39	1		16.4	0.2193			5.91E-05
42.9	938.20					2		16.1	0.2152			5.80E-05
						5		16.2	0.2170			5.85E-05
						10						0.00E+00
						15				2.17E-01	18.21	0.00E+00
32.9	948.20	10	11	13.1	0.31	1		14.1	0.1885			7.23E-05
42.9	938.20					2		13.8	0.1845			7.07E-05
						5		14.0	0.1868			7.16E-05
						10						0.00E+00
						15				1.87E-01	12.79	0.00E+00
										Average of Valid Stages:		**3.75E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 17, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
42.9	938.20	10	13.5	15.6	0.00	1		0.8	0.0102			3.24E-06
52.9	928.20					2		0.6	0.0082			2.60E-06
						5		0.7	0.0098			3.11E-06
						10						0.00E+00
						15				9.36E-03	15.60	0.00E+00
42.9	938.20	10	22	24.1	0.00	1		1.1	0.0143			2.95E-06
52.9	928.20					2		1.1	0.0146			3.00E-06
						5		1.1	0.0146			3.00E-06
						10						0.00E+00
						15				1.45E-02	24.10	0.00E+00
42.9	938.20	10	27	29.1	0.00	1		1.2	0.0162			2.76E-06
52.9	928.20					2		1.3	0.0170			2.90E-06
						5		1.3	0.0175			2.99E-06
						10						0.00E+00
						15				1.69E-02	29.10	0.00E+00
42.9	938.20	10	22	24.1	0.00	1		1.0	0.0134			2.76E-06
52.9	928.20					2		1.0	0.0131			2.70E-06
						5		0.9	0.0126			2.59E-06
						10						0.00E+00
						15				1.30E-02	24.10	0.00E+00
42.9	938.20	10	13.5	15.6	0.00	1		0.8	0.0110			3.49E-06
52.9	928.20					2		0.8	0.0112			3.58E-06
						5		0.8	0.0106			3.37E-06
						10						0.00E+00
						15				1.09E-02	15.60	0.00E+00
										Average of Valid Stages:		**1.80E-06**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 17, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
52.9	928.20	10	16.5	18.6	0.00	1		0.2	0.0021			5.72E-07
62.9	918.20					2		0.1	0.0017			4.64E-07
						5		0.0	0.0004			1.07E-07
						10						0.00E+00
						15				1.43E-03	18.60	0.00E+00
52.9	928.20	10	25	27.1	0.00	1		0.1	0.0011			1.96E-07
62.9	918.20					2		0.1	0.0009			1.72E-07
						5		0.1	0.0009			1.72E-07
						10						0.00E+00
						15				9.80E-04	27.10	0.00E+00
52.9	928.20	10	33	35.1	0.00	1		0.1	0.0013			1.89E-07
62.9	918.20					2		0.1	0.0013			1.89E-07
						5		0.1	0.0015			2.08E-07
						10						0.00E+00
						15				1.38E-03	35.10	0.00E+00
52.9	928.20	10	25	27.1	0.00	1		0.0	0.0005			9.80E-08
62.9	918.20					2		0.1	0.0009			1.72E-07
						5		0.1	0.0009			1.72E-07
						10						0.00E+00
						15				8.02E-04	27.10	0.00E+00
52.9	928.20	10	16.5	18.6	0.00	1		0.0	0.0004			1.07E-07
62.9	918.20					2		0.1	0.0007			1.79E-07
						5		0.1	0.0007			1.79E-07
						10						0.00E+00
						15				5.79E-04	18.60	0.00E+00
											Average of Valid Stages:	**1.27E-07**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 17, 2019
Water Pressure Testing
Boring B-47

Ground Elevation: 981.10 ft
Groundwater Depth: 3.8 ft
Groundwater Elev: 977.30 ft
Gage Height: 1 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
62.9	918.20	10	19.5	21.6	0.00	1		0.2	0.0032			7.38E-07
72.9	908.20					2		0.3	0.0040			9.23E-07
						5		0.3	0.0044			1.01E-06
						10		0.3	0.0040			9.23E-07
						15		0.3	0.0039	3.90E-03	21.60	8.92E-07
62.9	918.20	10	29	31.1	0.00	1		0.5	0.0068			1.09E-06
72.9	908.20					2		0.3	0.0045			7.26E-07
						5		0.5	0.0061			9.82E-07
						10		0.4	0.0056			8.97E-07
						15				5.78E-03	31.10	0.00E+00
62.9	918.20	10	33	35.1	0.00	1		0.3	0.0044			6.24E-07
72.9	908.20					2		0.3	0.0044			6.24E-07
						5		0.3	0.0041			5.87E-07
						10						0.00E+00
						15				4.32E-03	35.10	0.00E+00
62.9	918.20	10	29	31.1	0.00	1		0.3	0.0039			6.19E-07
72.9	908.20					2		0.2	0.0031			4.91E-07
						5		0.3	0.0035			5.55E-07
						10						0.00E+00
						15				3.48E-03	31.10	0.00E+00
62.9	918.20	10	19.5	21.6	0.00	1		0.2	0.0023			5.23E-07
72.9	908.20					2		0.2	0.0020			4.61E-07
						5		0.2	0.0024			5.54E-07
						10						0.00E+00
						15				2.23E-03	21.60	0.00E+00

Average of Valid Stages: **5.29E-07**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 16, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
72.9	908.20	10	22	24.1	0.00	1		0.3	0.0043			8.82E-07
82.9	898.20					2		0.3	0.0035			7.17E-07
						5		0.3	0.0037			7.72E-07
						10						0.00E+00
						15				3.83E-03	24.10	0.00E+00
72.9	908.20	10	33	35.1	0.00	1		0.4	0.0053			7.57E-07
82.9	898.20					2		0.3	0.0041			5.87E-07
						5		0.3	0.0041			5.87E-07
						10		0.3	0.0039			5.49E-07
						15				4.38E-03	35.10	0.00E+00
72.9	908.20	10	45.5	47.6	0.00	1		0.4	0.0053			5.58E-07
82.9	898.20					2		0.4	0.0056			5.86E-07
						5		0.4	0.0055			5.72E-07
						10						0.00E+00
						15				5.48E-03	47.60	0.00E+00
72.9	908.20	10	33	35.1	0.00	1		0.2	0.0023			3.22E-07
82.9	898.20					2		0.2	0.0028			3.97E-07
						5		0.3	0.0033			4.73E-07
						10						0.00E+00
						15				2.81E-03	35.10	0.00E+00
72.9	908.20	10	22	24.1	0.00	1		0.1	0.0012			2.48E-07
82.9	898.20					2		0.1	0.0016			3.31E-07
						5		0.1	0.0015			3.03E-07
						10						0.00E+00
						15				1.43E-03	24.10	0.00E+00
										Average of Valid Stages:		**3.46E-07**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 16, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
82.9	898.20	10	25	27.1	0.00	1		0.3	0.0043			7.84E-07
92.9	888.20					2		0.3	0.0040			7.35E-07
						5		0.3	0.0040			7.35E-07
						10						0.00E+00
						15				4.10E-03	27.10	0.00E+00
82.9	898.20	10	37.5	39.6	0.00	1		0.2	0.0023			2.85E-07
92.9	888.20					2		0.2	0.0021			2.68E-07
						5		0.2	0.0023			2.85E-07
						10						0.00E+00
						15				2.23E-03	39.60	0.00E+00
82.9	898.20	10	50	52.1	0.00	1		0.3	0.0036			3.44E-07
92.9	888.20					2		0.3	0.0036			3.44E-07
						5		0.3	0.0035			3.31E-07
						10						0.00E+00
						15				3.57E-03	52.10	0.00E+00
82.9	898.20	10	37.5	39.6	0.00	1		0.2	0.0027			3.35E-07
92.9	888.20					2		0.2	0.0028			3.52E-07
						5		0.2	0.0029			3.69E-07
						10						0.00E+00
						15				2.81E-03	39.60	0.00E+00
82.9	898.20	10	25	27.1	0.00	1		0.0	0.0003			4.90E-08
92.9	888.20					2		0.0	0.0001			2.45E-08
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				1.34E-04	27.10	0.00E+00
										Average of Valid Stages:		**2.10E-07**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 16, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
92.9	888.20	10	28	30.1	0.00	1		0.1	0.0019			3.09E-07
102.9	878.20					2		0.1	0.0016			2.65E-07
						5		0.1	0.0011			1.77E-07
						10		0.1	0.0012			1.99E-07
						15		0.1	0.0009	1.34E-03	30.10	1.54E-07
92.9	888.20	10	42	44.1	0.00	1		0.1	0.0015			1.66E-07
102.9	878.20					2		0.1	0.0013			1.51E-07
						5		0.1	0.0011			1.20E-07
						10		0.1	0.0011			1.20E-07
						15		0.1	0.0011	1.20E-03	44.10	1.20E-07
92.9	888.20	10	56	58.1	0.00	1		0.2	0.0021			1.83E-07
102.9	878.20					2		0.0	0.0005			4.57E-08
						5		0.3	0.0041			3.54E-07
						10		0.4	0.0051			4.34E-07
						15		0.3	0.0033	3.05E-03	58.10	2.86E-07
92.9	888.20	10	42	44.1	0.00	1		0.0	0.0001			1.51E-08
102.9	878.20					2		0.0	0.0005			6.02E-08
						5		0.1	0.0007			7.53E-08
						10						0.00E+00
						15				4.46E-04	44.10	0.00E+00
92.9	888.20	10	28	30.1	0.00	1		0.0	0.0003			4.41E-08
102.9	878.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				8.91E-05	30.10	0.00E+00
										Average of Valid Stages:		**1.31E-07**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 15, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
102.9	878.20	10	15	17.1	0.00	1	0.0	0.0	0.0001			3.89E-08
112.9	868.20					2	0.0	0.0	0.0000			0.00E+00
						5	0.0	0.0	0.0000			0.00E+00
						10						0.00E+00
						15				4.46E-05	17.10	0.00E+00
102.9	878.20	10	30	32.1	0.00	1	2.4	2.4	0.0321			4.97E-06
112.9	868.20					2	2.5	2.5	0.0334			5.17E-06
						5	2.3	2.3	0.0311			4.82E-06
						10	2.2	2.2	0.0297			4.59E-06
						15				3.16E-02	32.10	0.00E+00
102.9	878.20	10	45	47.1	0.21	1	10.1	10.1	0.1350			1.43E-05
112.9	868.20					2	9.6	9.6	0.1283			1.36E-05
						5	9.7	9.7	0.1301			1.37E-05
						10						0.00E+00
						15				1.31E-01	46.89	0.00E+00
102.9	878.20	10	30	32.1	0.00	1			0.0000			0.00E+00
112.9	868.20					2			0.0000			0.00E+00
						5			0.0000			0.00E+00
						10			0.0000			0.00E+00
						15			0.0000	0.00E+00	32.10	0.00E+00
102.9	878.20	10	15	17.1	0.00	1			0.0000			0.00E+00
112.9	868.20					2			0.0000			0.00E+00
						5			0.0000			0.00E+00
						10			0.0000			0.00E+00
						15			0.0000	0.00E+00	17.10	0.00E+00
											Average of Valid Stages:	**2.45E-06**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 15, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
112.9	868.20	10	15	17.1	0.00	1	0.4	0.4	0.0052			1.52E-06
122.9	858.20					2	0.4	0.4	0.0051			1.48E-06
						5	0.2	0.2	0.0031			8.94E-07
						10	0.3	0.3	0.0033			9.72E-07
						15	0.2	0.2	0.0029	3.93E-03	17.10	8.55E-07
112.9	868.20	10	30	32.1	0.15	1	4.8	4.8	0.0642			9.95E-06
122.9	858.20					2	5.4	5.4	0.0722			1.12E-05
						5	4.4	4.4	0.0584			9.06E-06
						10	4.6	4.6	0.0620			9.62E-06
						15	4.6	4.6	0.0612	6.36E-02	31.95	9.50E-06
112.9	868.20	10	45	47.1	0.21	1	10.5	10.5	0.1404			1.48E-05
122.9	858.20					2	10.3	10.3	0.1377			1.45E-05
						5	10.3	10.3	0.1381			1.46E-05
						10	10.3	10.3	0.1374			1.45E-05
						15				1.38E-01	46.89	0.00E+00
112.9	868.20	10	30	32.1	0.15	1	4.8	4.8	0.0642			9.95E-06
122.9	858.20					2	4.6	4.6	0.0615			9.54E-06
						5	4.7	4.7	0.0624			9.68E-06
						10	4.7	4.7	0.0634			9.83E-06
						15				6.29E-02	31.95	0.00E+00
112.9	868.20	10	15	17.1	0.00	1	0.0	0.0	0.0000			0.00E+00
122.9	858.20					2	0.0	0.0	0.0000			0.00E+00
						5						0.00E+00
						10						0.00E+00
						15				0.00E+00	17.10	0.00E+00
											Average of Valid Stages:	**6.10E-06**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 15, 2019
Water Pressure Testing
Boring B-47

Ground Elevation:	981.10	ft
Groundwater Depth:	3.8	ft
Groundwater Elev:	977.30	ft
Gage Height:	1	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
122.9	858.20	10	15	17.1	0.00	1		0.0	0.0000			0.00E+00
132.9	848.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				0.00E+00	17.10	0.00E+00
122.9	858.20	10	30	32.1	0.17	1		7.8	0.1043			1.62E-05
132.9	848.20					2		7.7	0.1029			1.60E-05
						5		7.9	0.1060			1.64E-05
						10		7.7	0.1035			1.61E-05
						15		7.6	0.1011	1.04E-01	31.93	1.57E-05
122.9	858.20	10	45	47.1	0.24	1		11.6	0.1551			1.64E-05
132.9	848.20					2		11.5	0.1537			1.62E-05
						5		11.6	0.1547			1.63E-05
						10		11.6	0.1553			1.64E-05
						15		11.6	0.1545	1.55E-01	46.86	1.63E-05
122.9	858.20	10	30	32.1	0.17	1		7.7	0.1029			1.60E-05
132.9	848.20					2		7.2	0.0963			1.49E-05
						5		7.3	0.0980			1.52E-05
						10		6.5	0.0864			1.34E-05
						15		6.8	0.0914	9.50E-02	31.93	1.42E-05
122.9	858.20	10	15	17.1	0.00	1		0.1	0.0013			3.89E-07
132.9	848.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				4.46E-04	17.10	0.00E+00
											Average of Valid Stages:	**9.44E-06**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 15, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
132.9	848.20	10	15	17.1	0.00	1		0.0	0.0000			0.00E+00
142.9	838.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				0.00E+00	17.10	0.00E+00
132.9	848.20	10	30	32.1	0.00	1		1.7	0.0227			3.52E-06
142.9	838.20					2		3.0	0.0401			6.21E-06
						5		9.6	0.1283			1.99E-05
						10		8.9	0.1190			1.84E-05
						15		8.9	0.1190	8.58E-02	32.10	1.84E-05
132.9	848.20	10	45	47.1	0.28	1		13.1	0.1751			1.85E-05
142.9	838.20					2		12.6	0.1684			1.78E-05
						5		12.7	0.1698			1.79E-05
						10		12.5	0.1666			1.76E-05
						15		12.4	0.1660	1.69E-01	46.82	1.76E-05
132.9	848.20	10	30	32.1	0.18	1		8.7	0.1163			1.80E-05
142.9	838.20					2		9.0	0.1203			1.87E-05
						5		10.3	0.1373			2.13E-05
						10		8.7	0.1160			1.80E-05
						15		8.6	0.1150	1.21E-01	31.92	1.78E-05
132.9	848.20	10	15	17.1	0.00	1		1.5	0.0201			5.83E-06
142.9	838.20					2		1.0	0.0134			3.89E-06
						5		1.0	0.0134			3.89E-06
						10		0.5	0.0072			2.10E-06
						15		0.1	0.0009	1.10E-02	17.10	2.72E-07
											Average of Valid Stages:	**1.06E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 14, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
142.9	838.20	10	15	17.1	0.00	1		0.0	0.0000			0.00E+00
152.9	828.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				0.00E+00	17.10	0.00E+00
142.9	838.20	10	30	32.1	0.17	1		7.5	0.1003			1.56E-05
152.9	828.20					2		7.6	0.1016			1.58E-05
						5		7.7	0.1029			1.60E-05
						10		7.8	0.1043			1.62E-05
						15		8.3	0.1115	1.04E-01	31.93	1.73E-05
142.9	838.20	10	45	47.1	0.25	1		12.1	0.1618			1.71E-05
152.9	828.20					2		12.4	0.1658			1.75E-05
						5		12.2	0.1635			1.73E-05
						10		11.7	0.1564			1.65E-05
						15		12.9	0.1725	1.64E-01	46.85	1.82E-05
142.9	838.20	10	30	32.1	0.15	1		5.0	0.0668			1.04E-05
152.9	828.20					2		4.9	0.0655			1.02E-05
						5		5.1	0.0682			1.06E-05
						10		5.0	0.0671			1.04E-05
						15		4.9	0.0660	6.67E-02	31.95	1.02E-05
142.9	838.20	10	15	17.1	0.00	1		0.0	0.0000			0.00E+00
152.9	828.20					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10						0.00E+00
						15				0.00E+00	17.10	0.00E+00
											Average of Valid Stages:	**8.77E-06**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 14, 2019	Groundwater Depth:	3.8	ft
Water Pressure Testing	Groundwater Elev:	977.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
152.9	828.20	10	15	17.1	0.15	1		4.6	0.0615			1.79E-05
162.9	818.20					2		5.2	0.0695			2.03E-05
						5		6.0	0.0799			2.33E-05
						10		6.2	0.0830			2.42E-05
						15		5.6	0.0754	7.39E-02	16.95	2.20E-05
152.9	828.20	10	30	32.1	0.21	1		10.5	0.1404			2.18E-05
162.9	818.20					2		9.4	0.1257			1.95E-05
						5		10.0	0.1337			2.07E-05
						10		10.0	0.1337			2.07E-05
						15		9.9	0.1321	1.33E-01	31.89	2.05E-05
152.9	828.20	10	45	47.1	0.27	1		12.7	0.1698			1.79E-05
162.9	818.20					2		12.8	0.1711			1.81E-05
						5		13.0	0.1734			1.83E-05
						10		13.2	0.1765			1.87E-05
						15		13.1	0.1754	1.73E-01	46.83	1.85E-05
152.9	828.20	10	30	32.1	0.21	1		10.5	0.1404			2.18E-05
162.9	818.20					2		10.2	0.1364			2.12E-05
						5		10.1	0.1350			2.10E-05
						10		10.1	0.1353			2.10E-05
						15		10.0	0.1337	1.36E-01	31.89	2.07E-05
152.9	828.20	10	15	17.1	0.16	1		6.8	0.0909			2.65E-05
162.9	818.20					2		4.8	0.0642			1.87E-05
						5		5.7	0.0766			2.24E-05
						10		5.2	0.0695			2.03E-05
						15		5.3	0.0711	7.45E-02	16.94	2.08E-05
											Average of Valid Stages:	**2.07E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
May 13, 2019
Water Pressure Testing
Boring B-47

Ground Elevation:	981.10	ft
Groundwater Depth:	3.8	ft
Groundwater Elev:	977.30	ft
Gage Height:	1	ft
Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
162.9	818.20	10	15	17.1	0.19	1		9.3	0.1243			3.63E-05
172.9	808.20					2		9.2	0.1230			3.59E-05
						5		9.2	0.1230			3.59E-05
						10		9.2	0.1235			3.61E-05
						15		9.2	0.1227	1.23E-01	16.91	3.58E-05
162.9	818.20	10	30	32.1	0.27	1		12.7	0.1698			2.64E-05
172.9	808.20					2		17.6	0.2353			3.65E-05
						5		10.7	0.1434			2.23E-05
						10		12.4	0.1660			2.58E-05
						15		12.4	0.1658	1.76E-01	31.83	2.57E-05
162.9	818.20	10	45	47.1	0.34	1		15.0	0.2005			2.12E-05
172.9	808.20					2		14.8	0.1979			2.09E-05
						5		14.9	0.1988			2.10E-05
						10		14.9	0.1995			2.11E-05
						15		14.9	0.1989	1.99E-01	46.77	2.10E-05
162.9	818.20	10	30	32.1	0.26	1		12.6	0.1684			2.62E-05
172.9	808.20					2		12.8	0.1711			2.66E-05
						5		12.3	0.1648			2.56E-05
						10		12.5	0.1668			2.59E-05
						15		12.4	0.1660	1.67E-01	31.84	2.58E-05
162.9	818.20	10	15	17.1	0.53	1		19.7	0.2634			7.76E-05
172.9	808.20					2		9.1	0.1217			3.58E-05
						5		12.3	0.1648			4.86E-05
						10		12.5	0.1668			4.92E-05
						15		12.4	0.1660	1.77E-01	16.57	4.89E-05
											Average of Valid Stages:	**3.25E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	981.10	ft
May 13, 2019	Groundwater Depth:	4.8	ft
Water Pressure Testing	Groundwater Elev:	976.30	ft
Boring B-47	Gage Height:	1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
172.9	808.20	10	15	17.5	0.19	1		8.9	0.1183			3.37E-05
182.9	798.20					2		8.9	0.1194			3.40E-05
						5		8.7	0.1164			3.32E-05
						10		8.7	0.1164			3.32E-05
						15		8.8	0.1170	1.18E-01	17.31	3.33E-05
172.9	808.20	10	30	32.5	0.26	1		12.5	0.1666			2.55E-05
182.9	798.20					2		12.0	0.1607			2.46E-05
						5		11.8	0.1576			2.42E-05
						10		12.2	0.1632			2.50E-05
						15		11.4	0.1529	1.60E-01	32.24	2.34E-05
172.9	808.20	10	45	47.5	1.26	1		30.7	0.4104			4.34E-05
182.9	798.20					2		14.0	0.1872			1.98E-05
						5		14.5	0.1939			2.05E-05
						10		14.4	0.1928			2.04E-05
						15		14.2	0.1904	2.35E-01	46.24	2.01E-05
172.9	808.20	10	30	32.5	0.23	1		11.4	0.1524			2.33E-05
182.9	798.20					2		13.0	0.1738			2.66E-05
						5		11.7	0.1564			2.40E-05
						10		11.9	0.1588			2.43E-05
						15		10.7	0.1430	1.57E-01	32.27	2.19E-05
172.9	808.20	10	15	17.5	0.19	1		8.9	0.1183			3.37E-05
182.9	798.20					2		8.7	0.1156			3.29E-05
						5		8.9	0.1186			3.38E-05
						10		8.7	0.1166			3.32E-05
						15		8.7	0.1168	1.17E-01	17.31	3.33E-05
										Average of Valid Stages:		**2.81E-05**

Note:

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 28, 2018	Groundwater Depth:	2.5	ft
Water Pressure Testing	Groundwater Elev:	969.85	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							5994.5					
47	925.35	9.8	15	18.2	0.00	1	5994.5	0.0	0.0000			0.00E+00
56.8	915.55					2	5994.5	0.0	0.0000			0.00E+00
						5	5994.5	0.0	0.0000			0.00E+00
						10	5994.5	0.0	0.0000			0.00E+00
						15	5994.5	0.0	0.0000	0.00E+00	18.20	0.00E+00
							5994.5					
47	925.35	9.8	30	33.2	0.00	1	5994.5	0.0	0.0000			0.00E+00
56.8	915.55					2	5994.5	0.0	0.0000			0.00E+00
						5	5994.5	0.0	0.0000			0.00E+00
						10	5994.5	0.0	0.0000			0.00E+00
						15	5994.5	0.0	0.0000	0.00E+00	33.20	0.00E+00
							5994.6					
47	925.35	9.8	45	48.2	0.00	1	5994.6	0.0	0.0000			0.00E+00
56.8	915.55					2	5994.6	0.0	0.0000			0.00E+00
						5	5994.6	0.0	0.0000			0.00E+00
						10	5997.2	0.5	0.0071			6.97E-07
						15	6002.1	1.0	0.0134	4.09E-03	48.20	1.31E-06
							6003.0					
47	925.35	9.8	30	33.2	8.63	1	6006.7	3.7	0.0505			8.11E-06
56.8	915.55					2	6010.8	4.1	0.0559			8.99E-06
						5	6021.3	3.5	0.0477			7.67E-06
						10	6038.2	3.4	0.0461			7.41E-06
						15	6055.0	3.4	0.0458	4.92E-02	24.57	7.37E-06
							6055.5					
47	925.35	9.8	15	18.2	0.39	1	6055.6	0.1	0.0014			3.58E-07
56.8	915.55					2	6055.8	0.2	0.0027			7.16E-07
						5	6056.4	0.2	0.0027			7.16E-07
						10	6057.3	0.2	0.0025			6.45E-07
						15	6058.2	0.2	0.0025	2.35E-03	17.81	6.45E-07
											Average of Valid Stages:	**1.79E-06**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 28, 2018	Groundwater Depth:	2.3	ft
Water Pressure Testing	Groundwater Elev:	970.05	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6060.0					
56.8	915.55	10	15	18.1	0.00	1	6060.0	0.0	0.0000			0.00E+00
66.8	905.55					2	6060.0	0.0	0.0000			0.00E+00
						5	6060.0	0.0	0.0000			0.00E+00
						10	6060.0	0.0	0.0000			0.00E+00
						15	6060.0	0.0	0.0000	0.00E+00	18.10	0.00E+00
							6060.0					
56.8	915.55	10	30	33.1	0.00	1	6060.0	0.0	0.0000			0.00E+00
66.8	905.55					2	6060.0	0.0	0.0000			0.00E+00
						5	6060.0	0.0	0.0000			0.00E+00
						10	6060.0	0.0	0.0000			0.00E+00
						15	6060.0	0.0	0.0000	0.00E+00	33.10	0.00E+00
							6060.0					
56.8	915.55	10	45	48.1	0.00	1	6060.0	0.0	0.0000			0.00E+00
66.8	905.55					2	6060.0	0.0	0.0000			0.00E+00
						5	6060.0	0.0	0.0000			0.00E+00
						10	6060.0	0.0	0.0000			0.00E+00
						15	6060.0	0.0	0.0000	0.00E+00	48.10	0.00E+00
							6060.0					
56.8	915.55	10	30	33.1	0.00	1	6060.0	0.0	0.0000			0.00E+00
66.8	905.55					2	6060.0	0.0	0.0000			0.00E+00
						5	6060.0	0.0	0.0000			0.00E+00
						10	6060.0	0.0	0.0000			0.00E+00
						15	6060.0	0.0	0.0000	0.00E+00	33.10	0.00E+00
							6060.0					
56.8	915.55	10	15	18.1	0.00	1	6060.0	0.0	0.0000			0.00E+00
66.8	905.55					2	6060.0	0.0	0.0000			0.00E+00
						5	6060.0	0.0	0.0000			0.00E+00
						10	6060.0	0.0	0.0000			0.00E+00
						15	6060.0	0.0	0.0000	0.00E+00	18.10	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 29, 2018	Groundwater Depth:	4.5	ft
Water Pressure Testing	Groundwater Elev:	967.85	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6062.1					
66.8	905.55	10	15	19.1	0.00	1	6062.1	0.0	0.0000			0.00E+00
76.8	895.55					2	6062.1	0.0	0.0000			0.00E+00
						5	6062.1	0.0	0.0000			0.00E+00
						10	6062.1	0.0	0.0000			0.00E+00
						15	6062.1	0.0	0.0000	0.00E+00	19.10	0.00E+00
							6062.1					
66.8	905.55	10	30	34.1	0.00	1	6062.1	0.0	0.0000			0.00E+00
76.8	895.55					2	6062.1	0.0	0.0000			0.00E+00
						5	6062.1	0.0	0.0000			0.00E+00
						10	6062.1	0.0	0.0000			0.00E+00
						15	6062.1	0.0	0.0000	0.00E+00	34.10	0.00E+00
							6062.1					
66.8	905.55	10	45	49.1	0.00	1	6062.1	0.0	0.0000			0.00E+00
76.8	895.55					2	6062.1	0.0	0.0000			0.00E+00
						5	6062.1	0.0	0.0000			0.00E+00
						10	6062.1	0.0	0.0000			0.00E+00
						15	6062.1	0.0	0.0000	0.00E+00	49.10	0.00E+00
							6062.1					
66.8	905.55	10	30	34.1	0.00	1	6062.1	0.0	0.0000			0.00E+00
76.8	895.55					2	6062.1	0.0	0.0000			0.00E+00
						5	6062.1	0.0	0.0000			0.00E+00
						10	6062.1	0.0	0.0000			0.00E+00
						15	6062.1	0.0	0.0000	0.00E+00	34.10	0.00E+00
							6062.1					
66.8	905.55	10	15	19.1	0.00	1	6062.1	0.0	0.0000			0.00E+00
76.8	895.55					2	6062.1	0.0	0.0000			0.00E+00
						5	6062.1	0.0	0.0000			0.00E+00
						10	6062.1	0.0	0.0000			0.00E+00
						15	6062.1	0.0	0.0000	0.00E+00	19.10	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 29, 2018	Groundwater Depth:	5.4	ft
Water Pressure Testing	Groundwater Elev:	966.95	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6064.2					
76.8	895.55	10	15	19.5	0.00	1	6064.2	0.0	0.0000			0.00E+00
86.8	885.55					2	6064.2	0.0	0.0000			0.00E+00
						5	6064.2	0.0	0.0000			0.00E+00
						10	6064.2	0.0	0.0000			0.00E+00
						15	6064.2	0.0	0.0000	0.00E+00	19.50	0.00E+00
							6064.2					
76.8	895.55	10	30	34.5	0.00	1	6064.2	0.0	0.0000			0.00E+00
86.8	885.55					2	6064.2	0.0	0.0000			0.00E+00
						5	6064.2	0.0	0.0000			0.00E+00
						10	6064.2	0.0	0.0000			0.00E+00
						15	6064.2	0.0	0.0000	0.00E+00	34.50	0.00E+00
							6064.2					
76.8	895.55	10	45	49.5	0.00	1	6064.2	0.0	0.0000			0.00E+00
86.8	885.55					2	6064.2	0.0	0.0000			0.00E+00
						5	6064.2	0.0	0.0000			0.00E+00
						10	6064.2	0.0	0.0000			0.00E+00
						15	6064.2	0.0	0.0000	0.00E+00	49.50	0.00E+00
							6064.2					
76.8	895.55	10	30	34.5	0.00	1	6064.2	0.0	0.0000			0.00E+00
86.8	885.55					2	6064.2	0.0	0.0000			0.00E+00
						5	6064.2	0.0	0.0000			0.00E+00
						10	6064.2	0.0	0.0000			0.00E+00
						15	6064.2	0.0	0.0000	0.00E+00	34.50	0.00E+00
							6064.2					
76.8	895.55	10	15	19.5	0.00	1	6064.2	0.0	0.0000			0.00E+00
86.8	885.55					2	6064.2	0.0	0.0000			0.00E+00
						5	6064.2	0.0	0.0000			0.00E+00
						10	6064.2	0.0	0.0000			0.00E+00
						15	6064.2	0.0	0.0000	0.00E+00	19.50	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 29, 2018	Groundwater Depth:	9.4	ft
Water Pressure Testing	Groundwater Elev:	962.95	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6075.9					
86.8	885.55	10	15	21.2	0.00	1	6075.9	0.0	0.0000			0.00E+00
96.8	875.55					2	6075.9	0.0	0.0000			0.00E+00
						5	6075.9	0.0	0.0000			0.00E+00
						10	6075.9	0.0	0.0000			0.00E+00
						15	6075.9	0.0	0.0000	0.00E+00	21.20	0.00E+00
							6075.9					
86.8	885.55	10	30	36.2	0.00	1	6075.9	0.0	0.0000			0.00E+00
96.8	875.55					2	6075.9	0.0	0.0000			0.00E+00
						5	6075.9	0.0	0.0000			0.00E+00
						10	6075.9	0.0	0.0000			0.00E+00
						15	6075.9	0.0	0.0000	0.00E+00	36.20	0.00E+00
							6075.9					
86.8	885.55	10	45	51.2	0.00	1	6075.9	0.0	0.0000			0.00E+00
96.8	875.55					2	6075.9	0.0	0.0000			0.00E+00
						5	6075.9	0.0	0.0000			0.00E+00
						10	6075.9	0.0	0.0000			0.00E+00
						15	6075.9	0.0	0.0000	0.00E+00	51.20	0.00E+00
							6075.9					
86.8	885.55	10	30	36.2	0.00	1	6075.9	0.0	0.0000			0.00E+00
96.8	875.55					2	6075.9	0.0	0.0000			0.00E+00
						5	6075.9	0.0	0.0000			0.00E+00
						10	6075.9	0.0	0.0000			0.00E+00
						15	6075.9	0.0	0.0000	0.00E+00	36.20	0.00E+00
							6075.9					
86.8	885.55	10	15	21.2	0.00	1	6075.9	0.0	0.0000			0.00E+00
96.8	875.55					2	6075.9	0.0	0.0000			0.00E+00
						5	6075.9	0.0	0.0000			0.00E+00
						10	6075.9	0.0	0.0000			0.00E+00
						15	6075.9	0.0	0.0000	0.00E+00	21.20	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
March 29, 2018	Groundwater Depth:	6.1	ft
Water Pressure Testing	Groundwater Elev:	966.25	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6067.4					
96.8	875.55	10	15	19.8	0.00	1	6067.4	0.0	0.0000			0.00E+00
106.8	865.55					2	6067.4	0.0	0.0000			0.00E+00
						5	6067.4	0.0	0.0000			0.00E+00
						10	6067.4	0.0	0.0000			0.00E+00
						15	6067.4	0.0	0.0000	0.00E+00	19.80	0.00E+00
							6067.4					
96.8	875.55	10	30	34.8	0.00	1	6067.4	0.0	0.0000			0.00E+00
106.8	865.55					2	6067.4	0.0	0.0000			0.00E+00
						5	6067.4	0.0	0.0000			0.00E+00
						10	6067.4	0.0	0.0000			0.00E+00
						15	6067.4	0.0	0.0000	0.00E+00	34.80	0.00E+00
							6067.4					
96.8	875.55	10	45	49.8	0.00	1	6067.4	0.0	0.0000			0.00E+00
106.8	865.55					2	6067.4	0.0	0.0000			0.00E+00
						5	6067.4	0.0	0.0000			0.00E+00
						10	6067.4	0.0	0.0000			0.00E+00
						15	6067.4	0.0	0.0000	0.00E+00	49.80	0.00E+00
							6067.4					
96.8	875.55	10	30	34.8	0.00	1	6067.4	0.0	0.0000			0.00E+00
106.8	865.55					2	6067.4	0.0	0.0000			0.00E+00
						5	6067.4	0.0	0.0000			0.00E+00
						10	6067.4	0.0	0.0000			0.00E+00
						15	6067.4	0.0	0.0000	0.00E+00	34.80	0.00E+00
							6067.4					
96.8	875.55	10	15	19.8	0.00	1	6067.4	0.0	0.0000			0.00E+00
106.8	865.55					2	6067.4	0.0	0.0000			0.00E+00
						5	6067.4	0.0	0.0000			0.00E+00
						10	6067.4	0.0	0.0000			0.00E+00
						15	6067.4	0.0	0.0000	0.00E+00	19.80	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 4, 2018	Groundwater Depth:	5.7	ft
Water Pressure Testing	Groundwater Elev:	966.65	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6069.0					
106.8	865.55	10	15	19.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
116.8	855.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	19.60	0.00E+00
							6069.0					
106.8	865.55	10	30	34.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
116.8	855.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	34.60	0.00E+00
							6069.0					
106.8	865.55	10	45	49.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
116.8	855.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	49.60	0.00E+00
							6069.0					
106.8	865.55	10	30	34.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
116.8	855.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	34.60	0.00E+00
							6069.0					
106.8	865.55	10	15	19.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
116.8	855.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	19.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 5, 2018	Groundwater Depth:	4.1	ft
Water Pressure Testing	Groundwater Elev:	968.25	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6069.8					
116.8	855.55	10	15	18.9	0.00	1	6069.8	0.0	0.0000			0.00E+00
126.8	845.55					2	6069.8	0.0	0.0000			0.00E+00
						5	6069.8	0.0	0.0000			0.00E+00
						10	6069.8	0.0	0.0000			0.00E+00
						15	6069.8	0.0	0.0000	0.00E+00	18.90	0.00E+00
							6069.8					
116.8	855.55	10	30	33.9	0.00	1	6069.8	0.0	0.0000			0.00E+00
126.8	845.55					2	6069.8	0.0	0.0000			0.00E+00
						5	6069.8	0.0	0.0000			0.00E+00
						10	6069.8	0.0	0.0000			0.00E+00
						15	6069.8	0.0	0.0000	0.00E+00	33.90	0.00E+00
							6069.8					
116.8	855.55	10	45	48.9	0.00	1	6069.8	0.0	0.0000			0.00E+00
126.8	845.55					2	6069.8	0.0	0.0000			0.00E+00
						5	6069.8	0.0	0.0000			0.00E+00
						10	6069.8	0.0	0.0000			0.00E+00
						15	6069.8	0.0	0.0000	0.00E+00	48.90	0.00E+00
							6069.8					
116.8	855.55	10	30	33.9	0.00	1	6069.8	0.0	0.0000			0.00E+00
126.8	845.55					2	6069.8	0.0	0.0000			0.00E+00
						5	6069.8	0.0	0.0000			0.00E+00
						10	6069.8	0.0	0.0000			0.00E+00
						15	6069.8	0.0	0.0000	0.00E+00	33.90	0.00E+00
							6069.8					
116.8	855.55	10	15	18.9	0.00	1	6069.8	0.0	0.0000			0.00E+00
126.8	845.55					2	6069.8	0.0	0.0000			0.00E+00
						5	6069.8	0.0	0.0000			0.00E+00
						10	6069.8	0.0	0.0000			0.00E+00
						15	6069.8	0.0	0.0000	0.00E+00	18.90	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 5, 2018	Groundwater Depth:	3.3	ft
Water Pressure Testing	Groundwater Elev:	969.05	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6069.9					
126.8	845.55	10	15	18.6	0.00	1	6069.9	0.0	0.0000			0.00E+00
136.8	835.55					2	6069.9	0.0	0.0000			0.00E+00
						5	6069.9	0.0	0.0000			0.00E+00
						10	6069.9	0.0	0.0000			0.00E+00
						15	6069.9	0.0	0.0000	0.00E+00	18.60	0.00E+00
							6069.9					
126.8	845.55	10	30	33.6	0.00	1	6069.9	0.0	0.0000			0.00E+00
136.8	835.55					2	6069.9	0.0	0.0000			0.00E+00
						5	6069.9	0.0	0.0000			0.00E+00
						10	6069.9	0.0	0.0000			0.00E+00
						15	6069.9	0.0	0.0000	0.00E+00	33.60	0.00E+00
							6069.9					
126.8	845.55	10	45	48.6	0.00	1	6069.9	0.0	0.0000			0.00E+00
136.8	835.55					2	6069.9	0.0	0.0000			0.00E+00
						5	6069.9	0.0	0.0000			0.00E+00
						10	6069.9	0.0	0.0000			0.00E+00
						15	6069.9	0.0	0.0000	0.00E+00	48.60	0.00E+00
							6069.9					
126.8	845.55	10	30	33.6	0.00	1	6069.9	0.0	0.0000			0.00E+00
136.8	835.55					2	6069.9	0.0	0.0000			0.00E+00
						5	6069.9	0.0	0.0000			0.00E+00
						10	6069.9	0.0	0.0000			0.00E+00
						15	6069.9	0.0	0.0000	0.00E+00	33.60	0.00E+00
							6069.9					
126.8	845.55	10	15	18.6	0.00	1	6069.9	0.0	0.0000			0.00E+00
136.8	835.55					2	6069.9	0.0	0.0000			0.00E+00
						5	6069.9	0.0	0.0000			0.00E+00
						10	6069.9	0.0	0.0000			0.00E+00
						15	6069.9	0.0	0.0000	0.00E+00	18.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 5, 2018	Groundwater Depth:	5.1	ft
Water Pressure Testing	Groundwater Elev:	967.25	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6069.4					
136.8	835.55	10	15	19.3	0.00	1	6069.4	0.0	0.0000			0.00E+00
146.8	825.55					2	6069.4	0.0	0.0000			0.00E+00
						5	6069.4	0.0	0.0000			0.00E+00
						10	6069.4	0.0	0.0000			0.00E+00
						15	6069.4	0.0	0.0000	0.00E+00	19.30	0.00E+00
							6069.4					
136.8	835.55	10	30	34.3	0.00	1	6069.4	0.0	0.0000			0.00E+00
146.8	825.55					2	6069.4	0.0	0.0000			0.00E+00
						5	6069.4	0.0	0.0000			0.00E+00
						10	6069.4	0.0	0.0000			0.00E+00
						15	6069.4	0.0	0.0000	0.00E+00	34.30	0.00E+00
							6069.4					
136.8	835.55	10	45	49.3	0.00	1	6069.4	0.0	0.0000			0.00E+00
146.8	825.55					2	6069.4	0.0	0.0000			0.00E+00
						5	6069.4	0.0	0.0000			0.00E+00
						10	6069.4	0.0	0.0000			0.00E+00
						15	6069.4	0.0	0.0000	0.00E+00	49.30	0.00E+00
							6069.4					
136.8	835.55	10	30	34.3	0.00	1	6069.4	0.0	0.0000			0.00E+00
146.8	825.55					2	6069.4	0.0	0.0000			0.00E+00
						5	6069.4	0.0	0.0000			0.00E+00
						10	6069.4	0.0	0.0000			0.00E+00
						15	6069.4	0.0	0.0000	0.00E+00	34.30	0.00E+00
							6069.4					
136.8	835.55	10	15	19.3	0.00	1	6069.4	0.0	0.0000			0.00E+00
146.8	825.55					2	6069.4	0.0	0.0000			0.00E+00
						5	6069.4	0.0	0.0000			0.00E+00
						10	6069.4	0.0	0.0000			0.00E+00
						15	6069.4	0.0	0.0000	0.00E+00	19.30	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 9, 2018	Groundwater Depth:	3.1	ft
Water Pressure Testing	Groundwater Elev:	969.25	ft
Boring Shaft 1	Gage Height:	5.1	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6069.0					
162	810.35	4.8	15	18.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
166.8	805.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	18.60	0.00E+00
							6069.0					
162	810.35	4.8	30	33.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
166.8	805.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	33.60	0.00E+00
							6069.0					
162	810.35	4.8	45	48.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
166.8	805.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	48.60	0.00E+00
							6069.0					
162	810.35	4.8	30	33.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
166.8	805.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	33.60	0.00E+00
							6069.0					
162	810.35	4.8	15	18.6	0.00	1	6069.0	0.0	0.0000			0.00E+00
166.8	805.55					2	6069.0	0.0	0.0000			0.00E+00
						5	6069.0	0.0	0.0000			0.00E+00
						10	6069.0	0.0	0.0000			0.00E+00
						15	6069.0	0.0	0.0000	0.00E+00	18.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	972.35	ft
April 9, 2018	Groundwater Depth:	2.1	ft
Water Pressure Testing	Groundwater Elev:	970.25	ft
Boring Shaft 1	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							6068.8					
166.8	805.55	10	15	18.0	0.00	1	6068.8	0.0	0.0000			0.00E+00
176.8	795.55					2	6068.8	0.0	0.0000			0.00E+00
						5	6068.8	0.0	0.0000			0.00E+00
						10	6068.8	0.0	0.0000			0.00E+00
						15	6068.8	0.0	0.0000	0.00E+00	18.00	0.00E+00
							6068.8					
166.8	805.55	10	30	33.0	0.00	1	6068.8	0.0	0.0000			0.00E+00
176.8	795.55					2	6068.8	0.0	0.0000			0.00E+00
						5	6068.8	0.0	0.0000			0.00E+00
						10	6068.8	0.0	0.0000			0.00E+00
						15	6068.8	0.0	0.0000	0.00E+00	33.00	0.00E+00
							6068.8					
166.8	805.55	10	45	48.0	0.00	1	6068.8	0.0	0.0000			0.00E+00
176.8	795.55					2	6068.8	0.0	0.0000			0.00E+00
						5	6068.8	0.0	0.0000			0.00E+00
						10	6068.8	0.0	0.0000			0.00E+00
						15	6068.8	0.0	0.0000	0.00E+00	48.00	0.00E+00
							6068.8					
166.8	805.55	10	30	33.0	0.00	1	6068.8	0.0	0.0000			0.00E+00
176.8	795.55					2	6068.8	0.0	0.0000			0.00E+00
						5	6068.8	0.0	0.0000			0.00E+00
						10	6068.8	0.0	0.0000			0.00E+00
						15	6068.8	0.0	0.0000	0.00E+00	33.00	0.00E+00
							6068.8					
166.8	805.55	10	15	18.0	0.00	1	6068.8	0.0	0.0000			0.00E+00
176.8	795.55					2	6068.8	0.0	0.0000			0.00E+00
						5	6068.8	0.0	0.0000			0.00E+00
						10	6068.8	0.0	0.0000			0.00E+00
						15	6068.8	0.0	0.0000	0.00E+00	18.00	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Single packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.67	ft	
April 19, 2018	Groundwater Depth:	8.35	ft	increasing during test
Water Pressure Testing	Groundwater Elev:	976.32	ft	
Boring Shaft 2	Gage Height:	4.9	ft	
	Hole Diameter:	3.78	inches	

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3310.0					
134	850.67	10	15	20.7	21.19	1	3316.5	6.5	0.0869			3.73E-05
144	840.67					2	3323.0	6.5	0.0869			3.73E-05
						5	3338.5	5.2	0.0691			2.97E-05
						10	3361.8	4.7	0.0623			2.67E-05
						15	3378.3	3.3	0.0441	6.99E-02	-0.49	1.89E-05
							3381.5					
134	850.67	10	30	35.7	28.22	1	3389.2	7.7	0.1029			2.17E-05
144	840.67					2	3397.5	8.3	0.1110			2.34E-05
						5	END of TEST	0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	1.07E-01	7.48	0.00E+00
134	850.67	10	45	50.7	0.00	1		0.0	0.0000			0.00E+00
144	840.67					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	50.70	0.00E+00
134	850.67	10	30	35.7	0.00	1		0.0	0.0000			0.00E+00
144	840.67					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	35.70	0.00E+00
134	850.67	10	15	20.7	0.00	1		0.0	0.0000			0.00E+00
144	840.67					2		0.0	0.0000			0.00E+00
						5		0.0	0.0000			0.00E+00
						10		0.0	0.0000			0.00E+00
						15		0.0	0.0000	0.00E+00	20.70	0.00E+00
											Average of Valid Stages:	**7.81E-06**

Note: Double packer system used,water began flowing out of boring around casing, test was stopped

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.67	ft
April 19, 2018	Groundwater Depth:	8.33	ft
Water Pressure Testing	Groundwater Elev:	976.34	ft
Boring Shaft 2	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3307.1					
144	840.67	10	15	20.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
154	830.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	20.70	0.00E+00
							3307.1					
144	840.67	10	30	35.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
154	830.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	35.70	0.00E+00
							3307.1					
144	840.67	10	45	50.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
154	830.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	50.70	0.00E+00
							3307.1					
144	840.67	10	30	35.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
154	830.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	35.70	0.00E+00
							3307.1					
144	840.67	10	15	20.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
154	830.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	20.70	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.67	ft
April 19, 2018	Groundwater Depth:	8.35	ft
Water Pressure Testing	Groundwater Elev:	976.32	ft
Boring Shaft 2	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3307.1					
154	830.67	10	15	20.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
164	820.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	20.70	0.00E+00
							3307.1					
154	830.67	10	30	35.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
164	820.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	35.70	0.00E+00
							3307.1					
154	830.67	10	45	50.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
164	820.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	50.70	0.00E+00
							3307.1					
154	830.67	10	30	35.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
164	820.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	35.70	0.00E+00
							3307.1					
154	830.67	10	15	20.7	0.00	1	3307.1	0.0	0.0000			0.00E+00
164	820.67					2	3307.1	0.0	0.0000			0.00E+00
						5	3307.1	0.0	0.0000			0.00E+00
						10	3307.1	0.0	0.0000			0.00E+00
						15	3307.1	0.0	0.0000	0.00E+00	20.70	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	984.67	ft
April 18, 2018	Groundwater Depth:	6.2	ft
Water Pressure Testing	Groundwater Elev:	978.47	ft
Boring Shaft 2	Gage Height:	4.9	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							3307.0					
164	820.67	10	15	19.8	0.00	1	3307.0	0.0	0.0000			0.00E+00
174	810.67					2	3307.0	0.0	0.0000			0.00E+00
						5	3307.0	0.0	0.0000			0.00E+00
						10	3307.0	0.0	0.0000			0.00E+00
						15	3307.0	0.0	0.0000	0.00E+00	19.80	0.00E+00
							3307.0					
164	820.67	10	30	34.8	0.00	1	3307.0	0.0	0.0000			0.00E+00
174	810.67					2	3307.0	0.0	0.0000			0.00E+00
						5	3307.0	0.0	0.0000			0.00E+00
						10	3307.0	0.0	0.0000			0.00E+00
						15	3307.0	0.0	0.0000	0.00E+00	34.80	0.00E+00
							3307.0					
164	820.67	10	45	49.8	0.00	1	3307.0	0.0	0.0000			0.00E+00
174	810.67					2	3307.0	0.0	0.0000			0.00E+00
						5	3307.0	0.0	0.0000			0.00E+00
						10	3307.0	0.0	0.0000			0.00E+00
						15	3307.0	0.0	0.0000	0.00E+00	49.80	0.00E+00
							3307.0					
164	820.67	10	30	34.8	0.00	1	3307.0	0.0	0.0000			0.00E+00
174	810.67					2	3307.0	0.0	0.0000			0.00E+00
						5	3307.0	0.0	0.0000			0.00E+00
						10	3307.0	0.0	0.0000			0.00E+00
						15	3307.0	0.0	0.0000	0.00E+00	34.80	0.00E+00
							3307.0					
164	820.67	10	15	19.8	0.00	1	3307.0	0.0	0.0000			0.00E+00
174	810.67					2	3307.0	0.0	0.0000			0.00E+00
						5	3307.0	0.0	0.0000			0.00E+00
						10	3307.0	0.0	0.0000			0.00E+00
						15	3307.0	0.0	0.0000	0.00E+00	19.80	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
April 2, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1303.7					
33	965.10	10	15	17.6	3.17	1	1305.5	1.8	0.0241			7.38E-06
43	955.10					2	1306.9	1.4	0.0187			5.74E-06
						5	1311.8	1.6	0.0218			6.70E-06
						10	1319.4	1.5	0.0203			6.23E-06
						15	1327.1	1.5	0.0206	2.11E-02	14.43	6.32E-06
							1332.1					
33	965.10	10	30	32.6	9.72	1	1336.1	4.0	0.0535			9.37E-06
43	955.10					2	1339.5	3.4	0.0455			7.96E-06
						5	1350.5	3.7	0.0490			8.58E-06
						10	1377.8	5.5	0.0730			1.28E-05
						15	1385.7	1.6	0.0211	4.84E-02	22.88	3.70E-06
							1391.0					
33	965.10	10	45	47.6	25.77	1	1398.3	7.3	0.0976			1.33E-05
43	955.10					2	1404.9	6.6	0.0882			1.20E-05
						5	1424.6	6.6	0.0878			1.20E-05
						10	1457.6	6.6	0.0882			1.20E-05
						15	1490.8	6.6	0.0888	9.01E-02	21.83	1.21E-05
							1494.2					
33	965.10	10	30	32.6	21.74	1	1500.8	6.6	0.0882			1.89E-05
43	955.10					2	1506.3	5.5	0.0735			1.58E-05
						5	1522.2	5.3	0.0709			1.52E-05
						10	1548.8	5.3	0.0711			1.53E-05
						15	1569.2	4.1	0.0545	7.17E-02	10.86	1.17E-05
							1571.8					
33	965.10	10	15	17.6	8.63	1	1575.5	3.7	0.0495			1.78E-05
43	955.10					2	1578.5	3.0	0.0401			1.44E-05
						5	1588.7	3.4	0.0455			1.63E-05
						10	1605.8	3.4	0.0457			1.64E-05
						15	1622.4	3.3	0.0444	4.50E-02	8.97	1.59E-05
										Average of Valid Stages:		**1.18E-05**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
April 2, 2018
Water Pressure Testing
Boring Shaft 3

Ground Elevation: 998.10 ft
Groundwater Depth: 1.1 ft
Groundwater Elev: 997.00 ft
Gage Height: 4.8 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1244.5					
43	955.10	10	15	17.6	0.39	1	1244.6	0.1	0.0013			3.82E-07
53	945.10					2	1244.6	0.0	0.0000			0.00E+00
						5	1244.8	0.1	0.0009			2.54E-07
						10	1244.8	0.0	0.0000			0.00E+00
						15	1244.9	0.0	0.0003	4.99E-04	17.21	7.63E-08
							1245.4					
43	955.10	10	30	32.6	1.00	1	1246.0	0.6	0.0080			1.24E-06
53	945.10					2	1246.4	0.4	0.0053			8.26E-07
						5	1248.2	0.6	0.0080			1.24E-06
						10	1251.0	0.6	0.0075			1.16E-06
						15	1254.3	0.7	0.0088	7.54E-03	31.60	1.36E-06
							1255.6					
43	955.10	10	45	47.6	2.54	1	1257.1	1.5	0.0201			2.14E-06
53	945.10					2	1258.4	1.3	0.0174			1.86E-06
						5	1263.5	1.7	0.0227			2.43E-06
						10	1271.1	1.5	0.0203			2.17E-06
						15	1279.1	1.6	0.0214	2.04E-02	45.06	2.29E-06
							1279.8					
43	955.10	10	30	32.6	2.54	1	1281.3	1.5	0.0201			3.16E-06
53	945.10					2	1282.8	1.5	0.0201			3.16E-06
						5	1286.2	1.1	0.0152			2.39E-06
						10	1291.5	1.1	0.0142			2.24E-06
						15	1296.8	1.1	0.0142	1.67E-02	30.06	2.24E-06
							1297.2					
43	955.10	10	15	17.6	0.39	1	1297.3	0.1	0.0013			3.82E-07
53	945.10					2	1297.4	0.1	0.0013			3.82E-07
						5	1297.8	0.1	0.0018			5.09E-07
						10	1298.6	0.2	0.0021			6.11E-07
						15	1299.0	0.1	0.0011	1.53E-03	17.21	3.05E-07
											Average of Valid Stages:	**1.31E-06**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
April 2, 2018
Water Pressure Testing
Boring Shaft 3

Ground Elevation: 998.10 ft
Groundwater Depth: 1.1 ft
Groundwater Elev: 997.00 ft
Gage Height: 4.8 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1245.1					
53	945.10	10	15	17.6	0.00	1	1245.1	0.0	0.0000			0.00E+00
63	935.10					2	1245.1	0.0	0.0000			0.00E+00
						5	1245.1	0.0	0.0000			0.00E+00
						10	1245.1	0.0	0.0000			0.00E+00
						15	1245.1	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1245.2					
53	945.10	10	30	32.6	0.00	1	1245.2	0.0	0.0000			0.00E+00
63	935.10					2	1245.2	0.0	0.0000			0.00E+00
						5	1245.2	0.0	0.0000			0.00E+00
						10	1245.2	0.0	0.0000			0.00E+00
						15	1245.2	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1245.2					
53	945.10	10	45	47.6	0.00	1	1245.2	0.0	0.0000			0.00E+00
63	935.10					2	1245.2	0.0	0.0000			0.00E+00
						5	1245.2	0.0	0.0000			0.00E+00
						10	1245.2	0.0	0.0000			0.00E+00
						15	1245.2	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1245.2					
53	945.10	10	30	32.6	0.00	1	1245.2	0.0	0.0000			0.00E+00
63	935.10					2	1245.2	0.0	0.0000			0.00E+00
						5	1245.2	0.0	0.0000			0.00E+00
						10	1245.2	0.0	0.0000			0.00E+00
						15	1245.2	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1245.2					
53	945.10	10	15	17.6	0.00	1	1245.2	0.0	0.0000			0.00E+00
63	935.10					2	1245.2	0.0	0.0000			0.00E+00
						5	1245.2	0.0	0.0000			0.00E+00
						10	1245.2	0.0	0.0000			0.00E+00
						15	1245.2	0.0	0.0000	0.00E+00	17.60	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
April 2, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1244.3					
63	935.10	10	15	17.6	0.39	1	1244.4	0.1	0.0013			3.82E-07
73	925.10					2	1244.4	0.0	0.0000			0.00E+00
						5	1244.4	0.0	0.0000			0.00E+00
						10	1244.4	0.0	0.0000			0.00E+00
						15	1244.4	0.0	0.0000	2.67E-04	17.21	0.00E+00
							1244.4					
63	935.10	10	30	32.6	0.00	1	1244.4	0.0	0.0000			0.00E+00
73	925.10					2	1244.4	0.0	0.0000			0.00E+00
						5	1244.4	0.0	0.0000			0.00E+00
						10	1244.4	0.0	0.0000			0.00E+00
						15	1244.4	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1244.5					
63	935.10	10	45	47.6	0.61	1	1244.8	0.3	0.0040			4.21E-07
73	925.10					2	1244.8	0.0	0.0000			0.00E+00
						5	1244.8	0.0	0.0000			0.00E+00
						10	1244.8	0.0	0.0000			0.00E+00
						15	1244.8	0.0	0.0000	8.02E-04	46.99	0.00E+00
							1244.8					
63	935.10	10	30	32.6	0.00	1	1244.8	0.0	0.0000			0.00E+00
73	925.10					2	1244.8	0.0	0.0000			0.00E+00
						5	1244.8	0.0	0.0000			0.00E+00
						10	1244.8	0.0	0.0000			0.00E+00
						15	1244.8	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1244.8					
63	935.10	10	15	17.6	0.00	1	1244.8	0.0	0.0000			0.00E+00
73	925.10					2	1244.8	0.0	0.0000			0.00E+00
						5	1244.8	0.0	0.0000			0.00E+00
						10	1244.8	0.0	0.0000			0.00E+00
						15	1244.8	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**3.21E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 30, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1208.0					
73	925.10	10	15	17.6	0.39	1	1208.1	0.1	0.0013			3.82E-07
83	915.10					2	1208.1	0.0	0.0000			0.00E+00
						5	1208.2	0.0	0.0004			1.27E-07
						10	1208.3	0.0	0.0003			7.63E-08
						15	1208.3	0.0	0.0000	4.10E-04	17.21	0.00E+00
							1208.6					
73	925.10	10	30	32.6	0.73	1	1209.0	0.4	0.0053			8.24E-07
83	915.10					2	1209.6	0.6	0.0080			1.24E-06
						5	1211.5	0.6	0.0085			1.30E-06
						10	1214.7	0.6	0.0086			1.32E-06
						15	1217.1	0.5	0.0064	7.36E-03	31.87	9.88E-07
							1217.7					
73	925.10	10	45	47.6	2.15	1	1219.0	1.3	0.0174			1.85E-06
83	915.10					2	1220.3	1.3	0.0174			1.85E-06
						5	1223.5	1.1	0.0143			1.52E-06
						10	1228.7	1.0	0.0139			1.48E-06
						15	1234.0	1.1	0.0142	1.54E-02	45.45	1.51E-06
							1234.8					
73	925.10	10	30	32.6	0.86	1	1235.3	0.5	0.0067			1.03E-06
83	915.10					2	1236.0	0.7	0.0094			1.44E-06
						5	1237.7	0.6	0.0076			1.17E-06
						10	1240.7	0.6	0.0080			1.24E-06
						15	1243.1	0.5	0.0064	7.61E-03	31.74	9.90E-07
							1243.1					
73	925.10	10	15	17.6	0.50	1	1243.3	0.2	0.0027			7.65E-07
83	915.10					2	1243.6	0.3	0.0040			1.15E-06
						5	1243.8	0.1	0.0009			2.55E-07
						10	1243.9	0.0	0.0003			7.65E-08
						15	1244.0	0.0	0.0003	1.62E-03	17.10	7.65E-08
											Average of Valid Stages:	**9.06E-07**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 30, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.7					
83	915.10	10	15	17.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
93	905.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.7					
83	915.10	10	30	32.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
93	905.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.8	0.0	0.0004			6.80E-08
						10	1206.8	0.0	0.0000			0.00E+00
						15	1206.8	0.0	0.0000	8.91E-05	32.60	0.00E+00
							1206.8					
83	915.10	10	45	47.6	0.00	1	1206.8	0.0	0.0000			0.00E+00
93	905.10					2	1206.9	0.1	0.0013			1.40E-07
						5	1207.0	0.0	0.0004			4.65E-08
						10	1207.2	0.0	0.0005			5.58E-08
						15	1207.4	0.0	0.0005	5.70E-04	47.60	5.58E-08
							1207.4					
83	915.10	10	30	32.6	0.00	1	1207.4	0.0	0.0000			0.00E+00
93	905.10					2	1207.4	0.0	0.0000			0.00E+00
						5	1207.4	0.0	0.0000			0.00E+00
						10	1207.4	0.0	0.0000			0.00E+00
						15	1207.4	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1207.4					
83	915.10	10	15	17.6	0.00	1	1207.4	0.0	0.0000			0.00E+00
93	905.10					2	1207.4	0.0	0.0000			0.00E+00
						5	1207.4	0.0	0.0000			0.00E+00
						10	1207.4	0.0	0.0000			0.00E+00
						15	1207.4	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**1.46E-08**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 30, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.6					
93	905.10	10	15	17.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
103	895.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0004			1.26E-07
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	8.91E-05	17.60	0.00E+00
							1206.7					
93	905.10	10	30	32.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
103	895.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.7					
93	905.10	10	45	47.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
103	895.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.7					
93	905.10	10	30	32.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
103	895.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.7					
93	905.10	10	15	17.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
103	895.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**5.04E-09**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 30, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.6					
103	895.10	10	15	17.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
113	885.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.6					
103	895.10	10	30	32.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
113	885.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.6					
103	895.10	10	45	47.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
113	885.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.6					
103	895.10	10	30	32.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
113	885.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.6					
103	895.10	10	15	17.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
113	885.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 30, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.6					
113	885.10	10	15	17.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
123	875.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.6					
113	885.10	10	30	32.6	0.00	1	1206.6	0.0	0.0000			0.00E+00
123	875.10					2	1206.6	0.0	0.0000			0.00E+00
						5	1206.6	0.0	0.0000			0.00E+00
						10	1206.6	0.0	0.0000			0.00E+00
						15	1206.6	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.6					
113	885.10	10	45	47.6	0.39	1	1206.7	0.1	0.0013			1.40E-07
123	875.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	2.67E-04	47.21	0.00E+00
							1206.7					
113	885.10	10	30	32.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
123	875.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.7					
113	885.10	10	15	17.6	0.00	1	1206.7	0.0	0.0000			0.00E+00
123	875.10					2	1206.7	0.0	0.0000			0.00E+00
						5	1206.7	0.0	0.0000			0.00E+00
						10	1206.7	0.0	0.0000			0.00E+00
						15	1206.7	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**5.60E-09**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 29, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.3					
123	875.10	10	15	17.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
133	865.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.3					
123	875.10	10	30	32.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
133	865.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
123	875.10	10	45	47.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
133	865.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.3					
123	875.10	10	30	32.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
133	865.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
123	875.10	10	15	17.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
133	865.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	17.60	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension
March 29, 2018
Water Pressure Testing
Boring Shaft 3

Ground Elevation: 998.10 ft
Groundwater Depth: 1.1 ft
Groundwater Elev: 997.00 ft
Gage Height: 4.8 ft
Hole Diameter: 3.78 inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.3					
133	865.10	10	15	17.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
143	855.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.3					
133	865.10	10	30	32.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
143	855.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
133	865.10	10	45	47.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
143	855.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.3					
133	865.10	10	30	32.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
143	855.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
133	865.10	10	15	17.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
143	855.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	17.60	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 29, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.2					
143	855.10	10	15	17.6	0.00	1	1206.2	0.0	0.0000			0.00E+00
153	845.10					2	1206.2	0.0	0.0000			0.00E+00
						5	1206.2	0.0	0.0000			0.00E+00
						10	1206.2	0.0	0.0000			0.00E+00
						15	1206.2	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.2					
143	855.10	10	30	32.6	0.00	1	1206.2	0.0	0.0000			0.00E+00
153	845.10					2	1206.2	0.0	0.0000			0.00E+00
						5	1206.2	0.0	0.0000			0.00E+00
						10	1206.2	0.0	0.0000			0.00E+00
						15	1206.2	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
143	855.10	10	45	47.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
153	845.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.3					
143	855.10	10	30	32.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
153	845.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.3					
143	855.10	10	15	17.6	0.00	1	1206.3	0.0	0.0000			0.00E+00
153	845.10					2	1206.3	0.0	0.0000			0.00E+00
						5	1206.3	0.0	0.0000			0.00E+00
						10	1206.3	0.0	0.0000			0.00E+00
						15	1206.3	0.0	0.0000	0.00E+00	17.60	0.00E+00
										Average of Valid Stages:		**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 29, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.1					
153	845.10	10	15	17.6	0.00	1	1206.1	0.0	0.0000			0.00E+00
163	835.10					2	1206.1	0.0	0.0000			0.00E+00
						5	1206.1	0.0	0.0000			0.00E+00
						10	1206.1	0.0	0.0000			0.00E+00
						15	1206.1	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.1					
153	845.10	10	30	32.6	0.00	1	1206.1	0.0	0.0000			0.00E+00
163	835.10					2	1206.1	0.0	0.0000			0.00E+00
						5	1206.1	0.0	0.0000			0.00E+00
						10	1206.1	0.0	0.0000			0.00E+00
						15	1206.1	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.2					
153	845.10	10	45	47.6	0.00	1	1206.2	0.0	0.0000			0.00E+00
163	835.10					2	1206.2	0.0	0.0000			0.00E+00
						5	1206.2	0.0	0.0000			0.00E+00
						10	1206.2	0.0	0.0000			0.00E+00
						15	1206.2	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.2					
153	845.10	10	30	32.6	0.00	1	1206.2	0.0	0.0000			0.00E+00
163	835.10					2	1206.2	0.0	0.0000			0.00E+00
						5	1206.2	0.0	0.0000			0.00E+00
						10	1206.2	0.0	0.0000			0.00E+00
						15	1206.2	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.2					
153	845.10	10	15	17.6	0.00	1	1206.2	0.0	0.0000			0.00E+00
163	835.10					2	1206.2	0.0	0.0000			0.00E+00
						5	1206.2	0.0	0.0000			0.00E+00
						10	1206.2	0.0	0.0000			0.00E+00
						15	1206.2	0.0	0.0000	0.00E+00	17.60	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 29, 2018	Groundwater Depth:	1.1	ft
Water Pressure Testing	Groundwater Elev:	997.00	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.0					
163	835.10	10	15	17.6	0.00	1	1206.0	0.0	0.0000			0.00E+00
173	825.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	17.60	0.00E+00
							1206.0					
163	835.10	10	30	32.6	0.00	1	1206.0	0.0	0.0000			0.00E+00
173	825.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.0					
163	835.10	10	45	47.6	0.00	1	1206.0	0.0	0.0000			0.00E+00
173	825.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	47.60	0.00E+00
							1206.0					
163	835.10	10	30	32.6	0.00	1	1206.0	0.0	0.0000			0.00E+00
173	825.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	32.60	0.00E+00
							1206.0					
163	835.10	10	15	17.6	0.00	1	1206.0	0.0	0.0000			0.00E+00
173	825.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	17.60	0.00E+00
											Average of Valid Stages:	**0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 28, 2018	Groundwater Depth:	0.5	ft
Water Pressure Testing	Groundwater Elev:	997.60	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1206.0					
173	825.10	10	15	17.3	0.00	1	1206.0	0.0	0.0000			0.00E+00
183	815.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	17.30	0.00E+00
							1206.0					
173	825.10	10	30	32.3	0.00	1	1206.0	0.0	0.0000			0.00E+00
183	815.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1206.0					
173	825.10	10	45	47.3	0.00	1	1206.0	0.0	0.0000			0.00E+00
183	815.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	47.30	0.00E+00
							1206.0					
173	825.10	10	30	32.3	0.00	1	1206.0	0.0	0.0000			0.00E+00
183	815.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1206.0					
173	825.10	10	15	17.3	0.00	1	1206.0	0.0	0.0000			0.00E+00
183	815.10					2	1206.0	0.0	0.0000			0.00E+00
						5	1206.0	0.0	0.0000			0.00E+00
						10	1206.0	0.0	0.0000			0.00E+00
						15	1206.0	0.0	0.0000	0.00E+00	17.30	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 28, 2018	Groundwater Depth:	0.5	ft
Water Pressure Testing	Groundwater Elev:	997.60	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1205.8					
183	815.10	10	15	17.3	0.00	1	1205.8	0.0	0.0000			0.00E+00
193	805.10					2	1205.8	0.0	0.0000			0.00E+00
						5	1205.8	0.0	0.0000			0.00E+00
						10	1205.8	0.0	0.0000			0.00E+00
						15	1205.8	0.0	0.0000	0.00E+00	17.30	0.00E+00
							1205.8					
183	815.10	10	30	32.3	0.00	1	1205.8	0.0	0.0000			0.00E+00
193	805.10					2	1205.8	0.0	0.0000			0.00E+00
						5	1205.8	0.0	0.0000			0.00E+00
						10	1205.8	0.0	0.0000			0.00E+00
						15	1205.8	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1205.9					
183	815.10	10	45	47.3	0.00	1	1205.9	0.0	0.0000			0.00E+00
193	805.10					2	1205.9	0.0	0.0000			0.00E+00
						5	1205.9	0.0	0.0000			0.00E+00
						10	1205.9	0.0	0.0000			0.00E+00
						15	1205.9	0.0	0.0000	0.00E+00	47.30	0.00E+00
							1205.9					
183	815.10	10	30	32.3	0.00	1	1205.9	0.0	0.0000			0.00E+00
193	805.10					2	1205.9	0.0	0.0000			0.00E+00
						5	1205.9	0.0	0.0000			0.00E+00
						10	1205.9	0.0	0.0000			0.00E+00
						15	1205.9	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1205.9					
183	815.10	10	15	17.3	0.00	1	1205.9	0.0	0.0000			0.00E+00
193	805.10					2	1205.9	0.0	0.0000			0.00E+00
						5	1205.9	0.0	0.0000			0.00E+00
						10	1205.9	0.0	0.0000			0.00E+00
						15	1205.9	0.0	0.0000	0.00E+00	17.30	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

BWSTE Phase 2

173409058 Big Walnut Sanitary Trunk Extension	Ground Elevation:	998.10	ft
March 28, 2018	Groundwater Depth:	0.5	ft
Water Pressure Testing	Groundwater Elev:	997.60	ft
Boring Shaft 3	Gage Height:	4.8	ft
	Hole Diameter:	3.78	inches

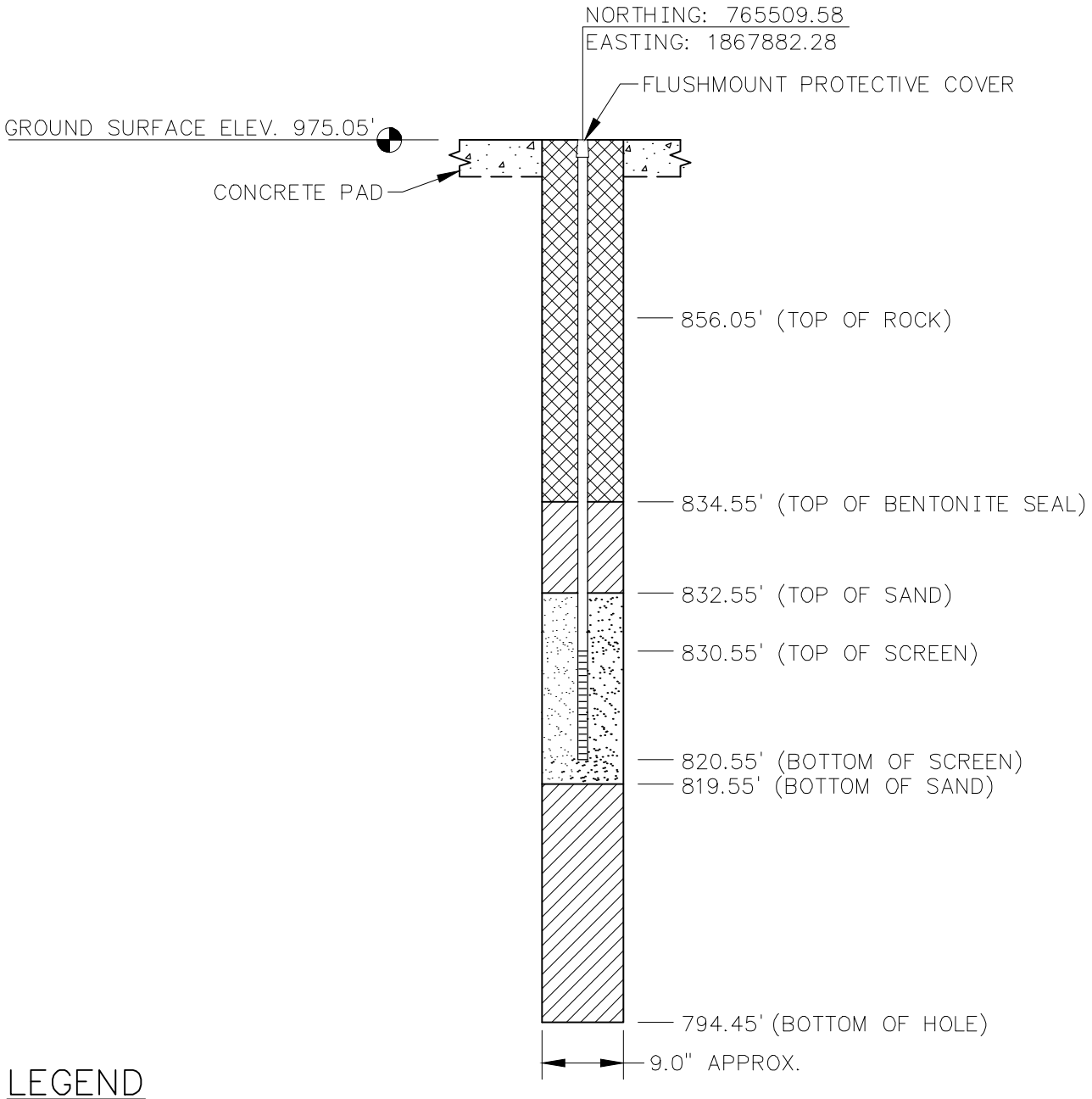
Water Pressure

Depth (ft)	Elevation (MSL)	Test Length (ft)	Gage (psi)	Test (psi)	Losses due flow	Time Step (min)	Flowmeter (gal)	Flow Rate (gpm)	Take (cuft/ft)	Average Take (cuft/ft)	Net Pressure	Hydraulic Conductivity, K (ft/sec)
							1205.6					
193	805.10	10	15	17.3	0.00	1	1205.6	0.0	0.0000			0.00E+00
203	795.10					2	1205.6	0.0	0.0000			0.00E+00
						5	1205.6	0.0	0.0000			0.00E+00
						10	1205.6	0.0	0.0000			0.00E+00
						15	1205.6	0.0	0.0000	0.00E+00	17.30	0.00E+00
							1205.6					
193	805.10	10	30	32.3	0.00	1	1205.6	0.0	0.0000			0.00E+00
203	795.10					2	1205.6	0.0	0.0000			0.00E+00
						5	1205.6	0.0	0.0000			0.00E+00
						10	1205.6	0.0	0.0000			0.00E+00
						15	1205.6	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1205.6					
193	805.10	10	45	47.3	0.00	1	1205.6	0.0	0.0000			0.00E+00
203	795.10					2	1205.6	0.0	0.0000			0.00E+00
						5	1205.6	0.0	0.0000			0.00E+00
						10	1205.6	0.0	0.0000			0.00E+00
						15	1205.6	0.0	0.0000	0.00E+00	47.30	0.00E+00
							1205.6					
193	805.10	10	30	32.3	0.00	1	1205.6	0.0	0.0000			0.00E+00
203	795.10					2	1205.6	0.0	0.0000			0.00E+00
						5	1205.6	0.0	0.0000			0.00E+00
						10	1205.6	0.0	0.0000			0.00E+00
						15	1205.6	0.0	0.0000	0.00E+00	32.30	0.00E+00
							1205.6					
193	805.10	10	15	17.3	0.00	1	1205.6	0.0	0.0000			0.00E+00
203	795.10					2	1205.6	0.0	0.0000			0.00E+00
						5	1205.6	0.0	0.0000			0.00E+00
						10	1205.6	0.0	0.0000			0.00E+00
						15	1205.6	0.0	0.0000	0.00E+00	17.30	0.00E+00

Average of Valid Stages: **0.00E+00**

Note: Double packer system used

Appendix E MONITORING WELL LOGS



LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

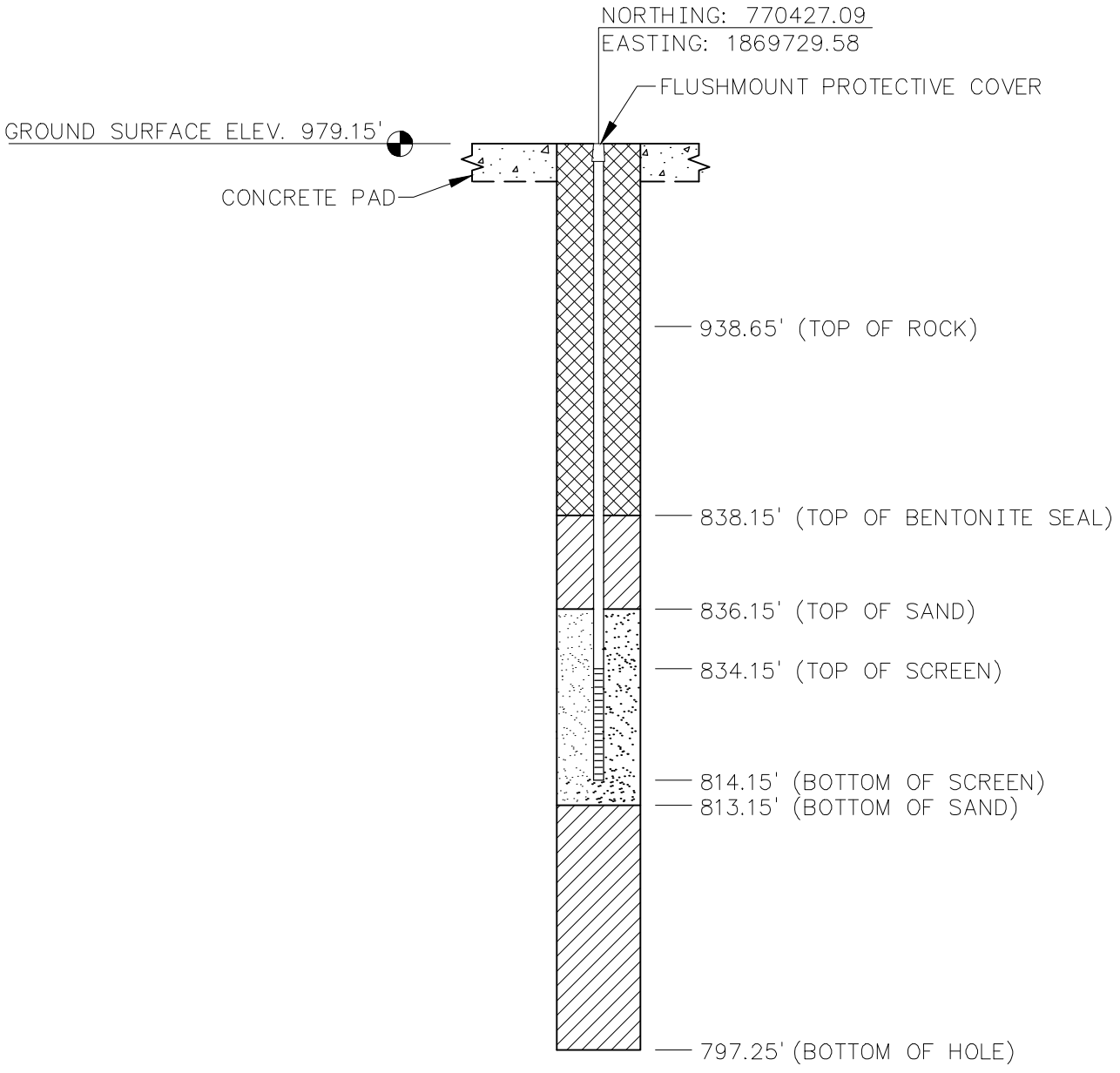
1. PIEZOMETER INSTALLED ON 12/11/2017.
2. PIEZOMETER IS 1–INCH SCH. 40 PVC WITH 10–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B17.DWG

PIEZOMETER B-17
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

Stantec Consulting Services Inc.
1500 Lakeshore Dr. Suite 100
Columbus, Ohio
43204-3800
614 486-4383
www.stantec.com

DRAWN BY	MSJ	DATE OCT., 2018	REVISED		SHEET
CHECKED BY	JMM	PROJ. NO. 173409058	1.	3.	1 of 1
CHECKED BY	JMM	SCALE NTS	2.	4.	



LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 03/13/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B19.DWG

PIEZOMETER B-19
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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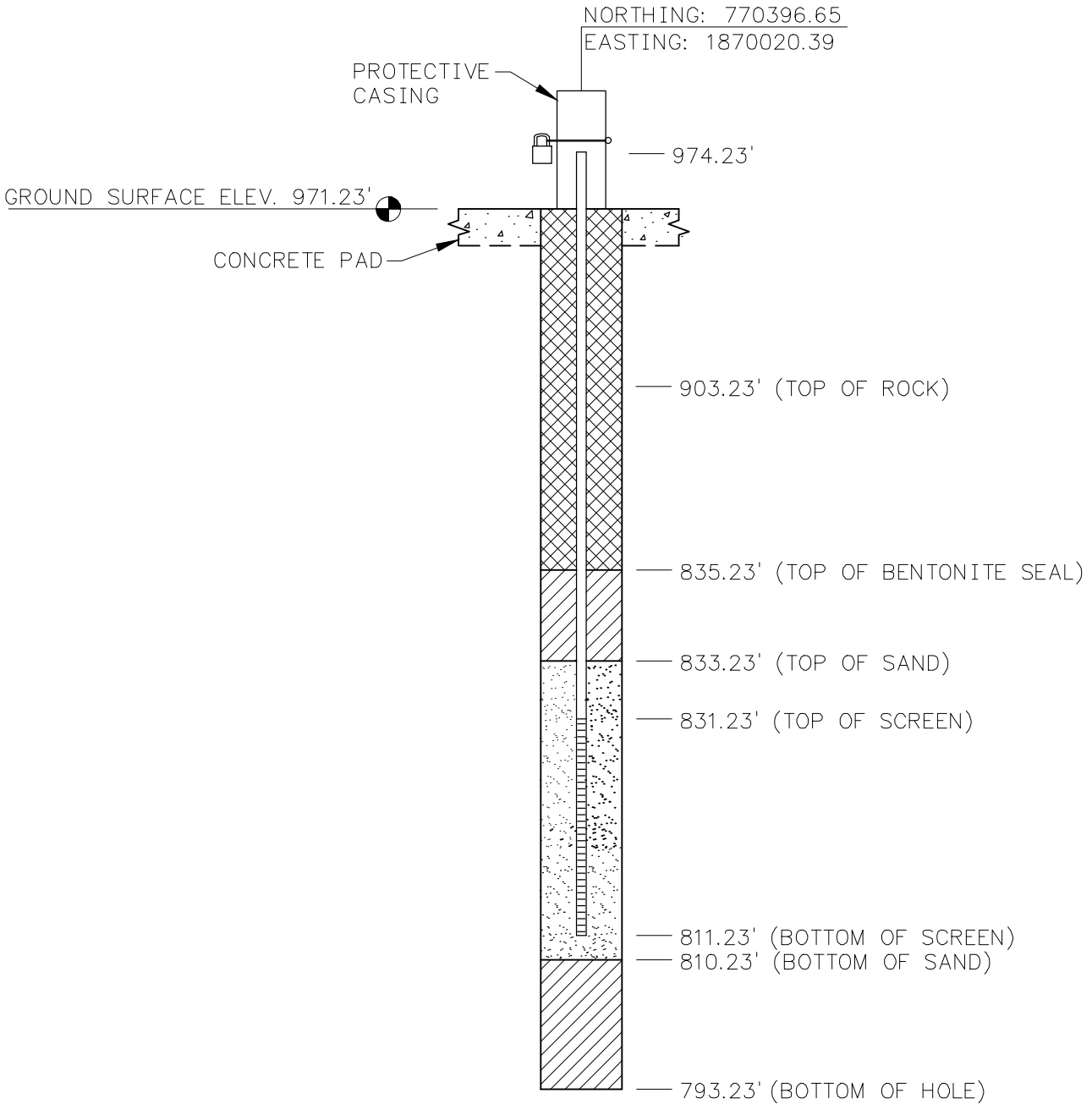

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 03/05/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B20.DWG

PIEZOMETER B-20
BIG WALNUT SEWER TUNNEL
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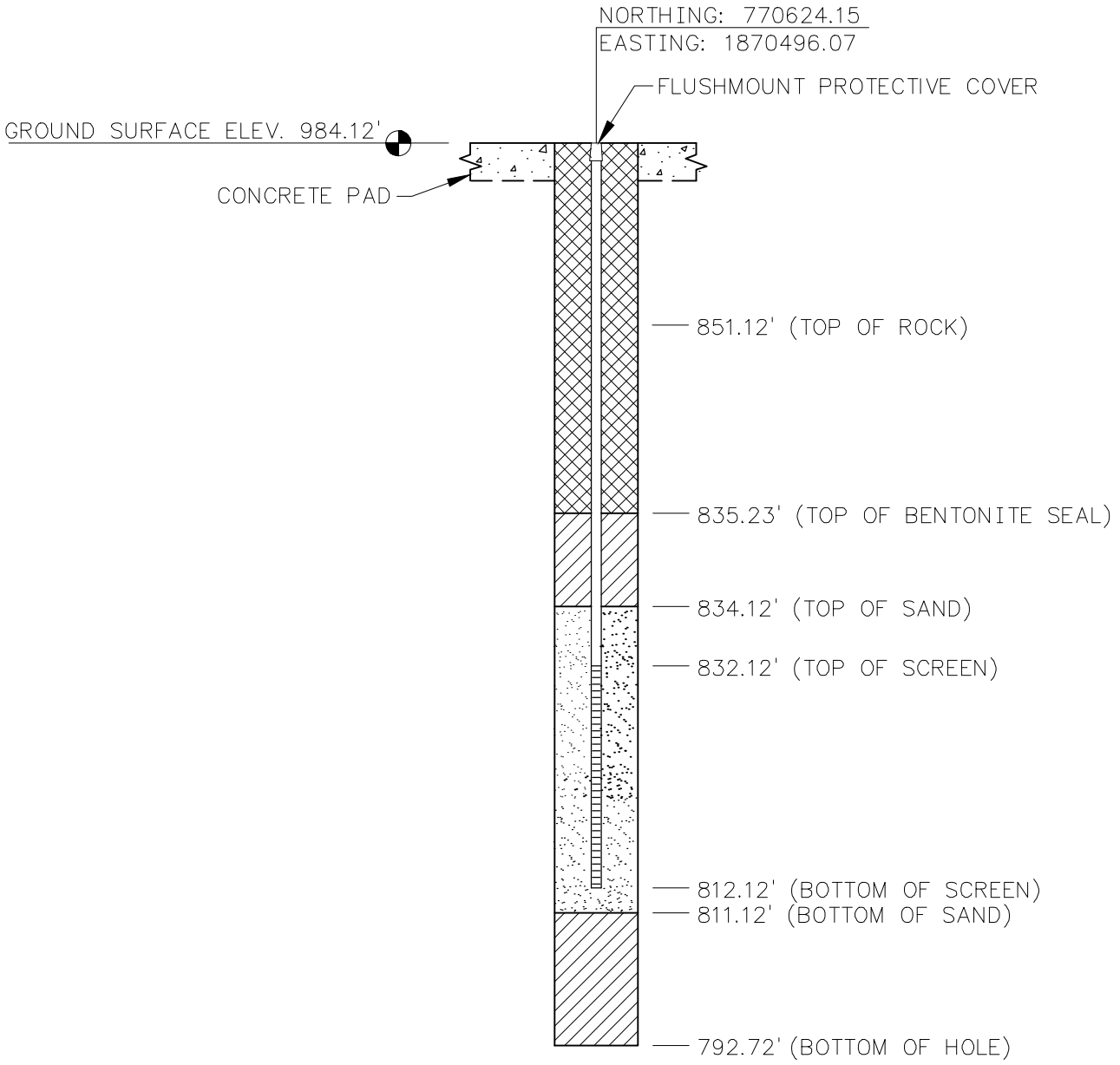

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 02/16/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B22.DWG

PIEZOMETER B-22
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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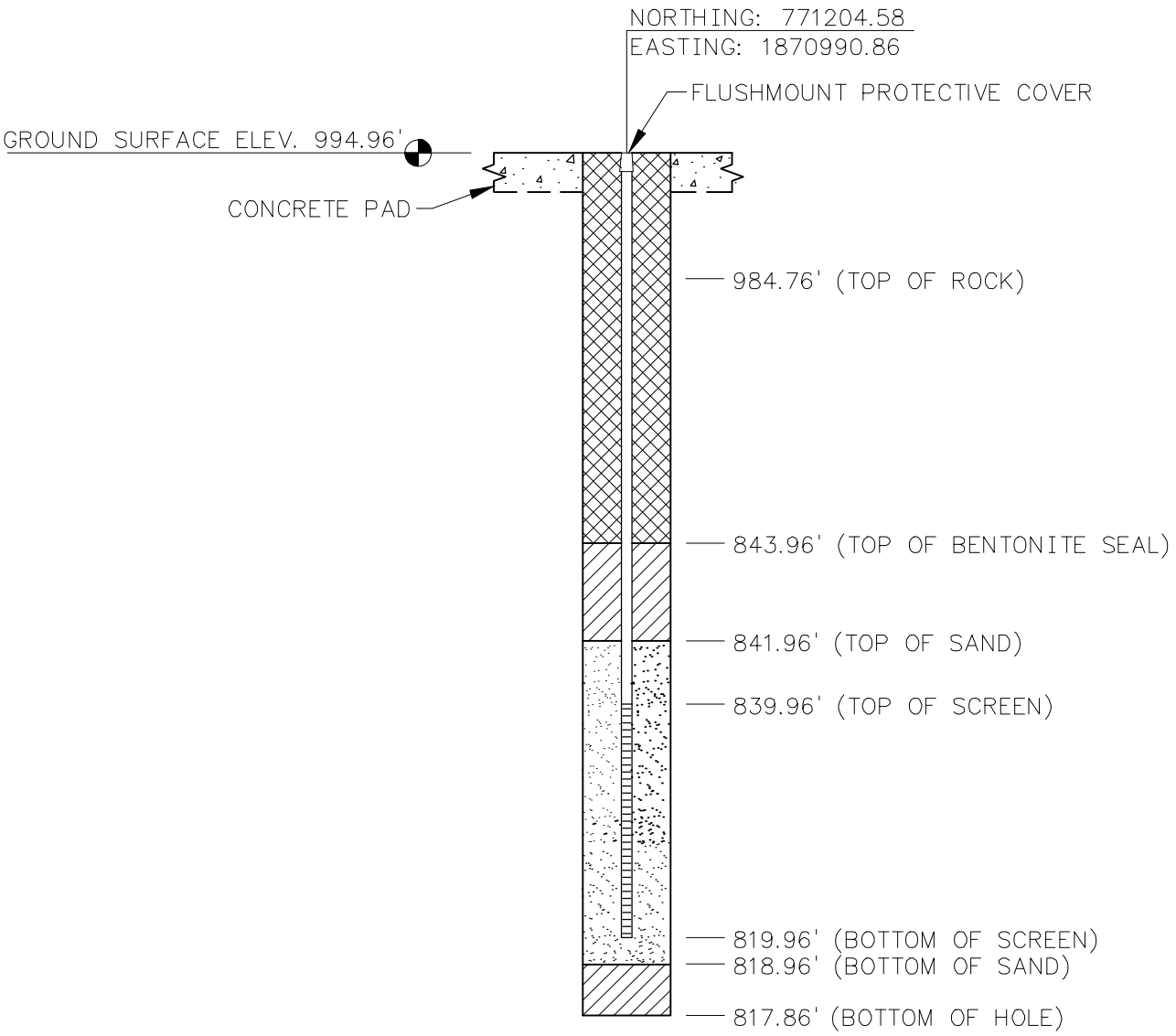

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 05/22/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B25.DWG

PIEZOMETER B-25
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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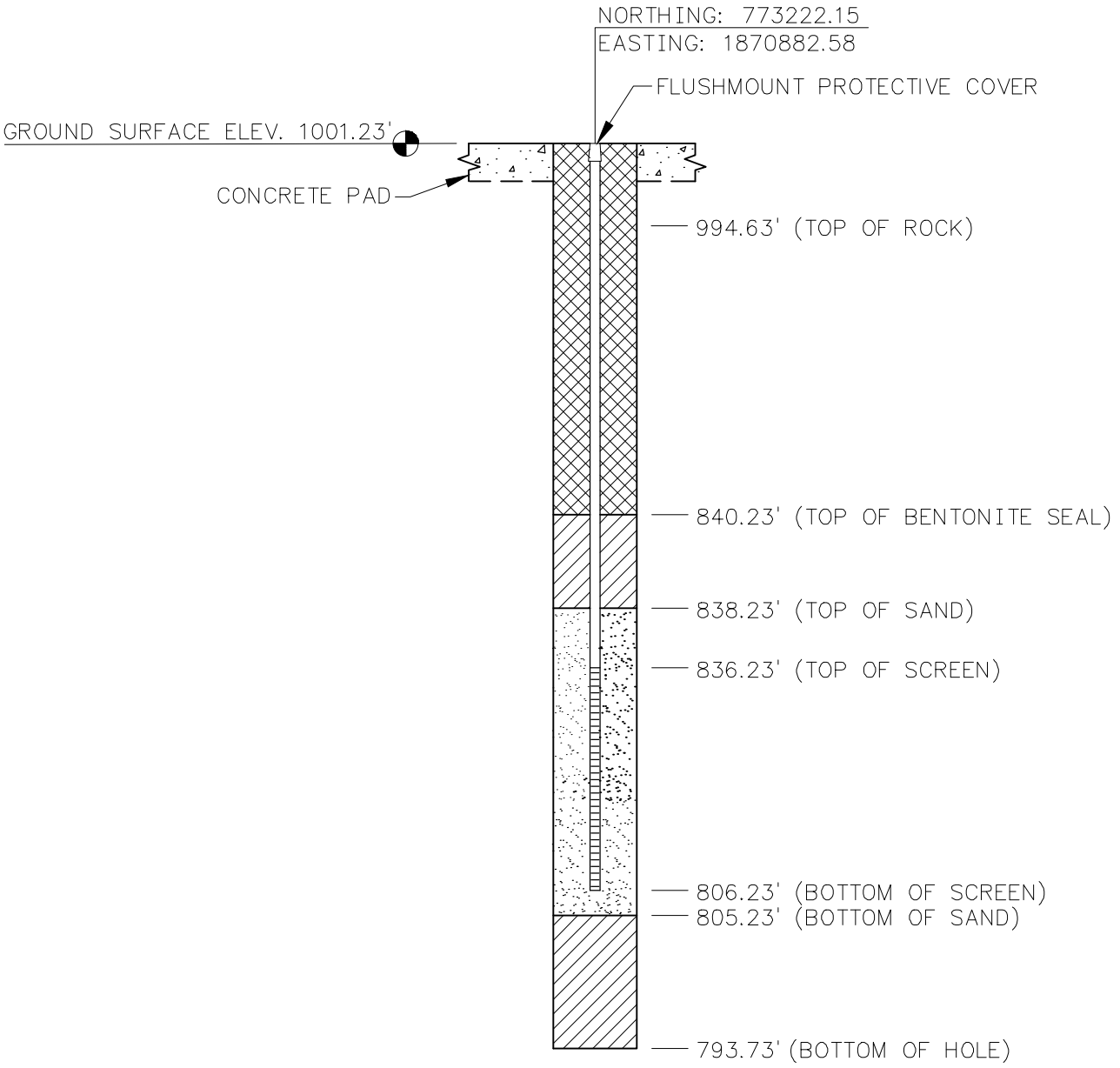
CHECKED BY	JMM	SCALE	NTS	2.	4.	



LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 01/29/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 30–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B29.DWG

PIEZOMETER B-29
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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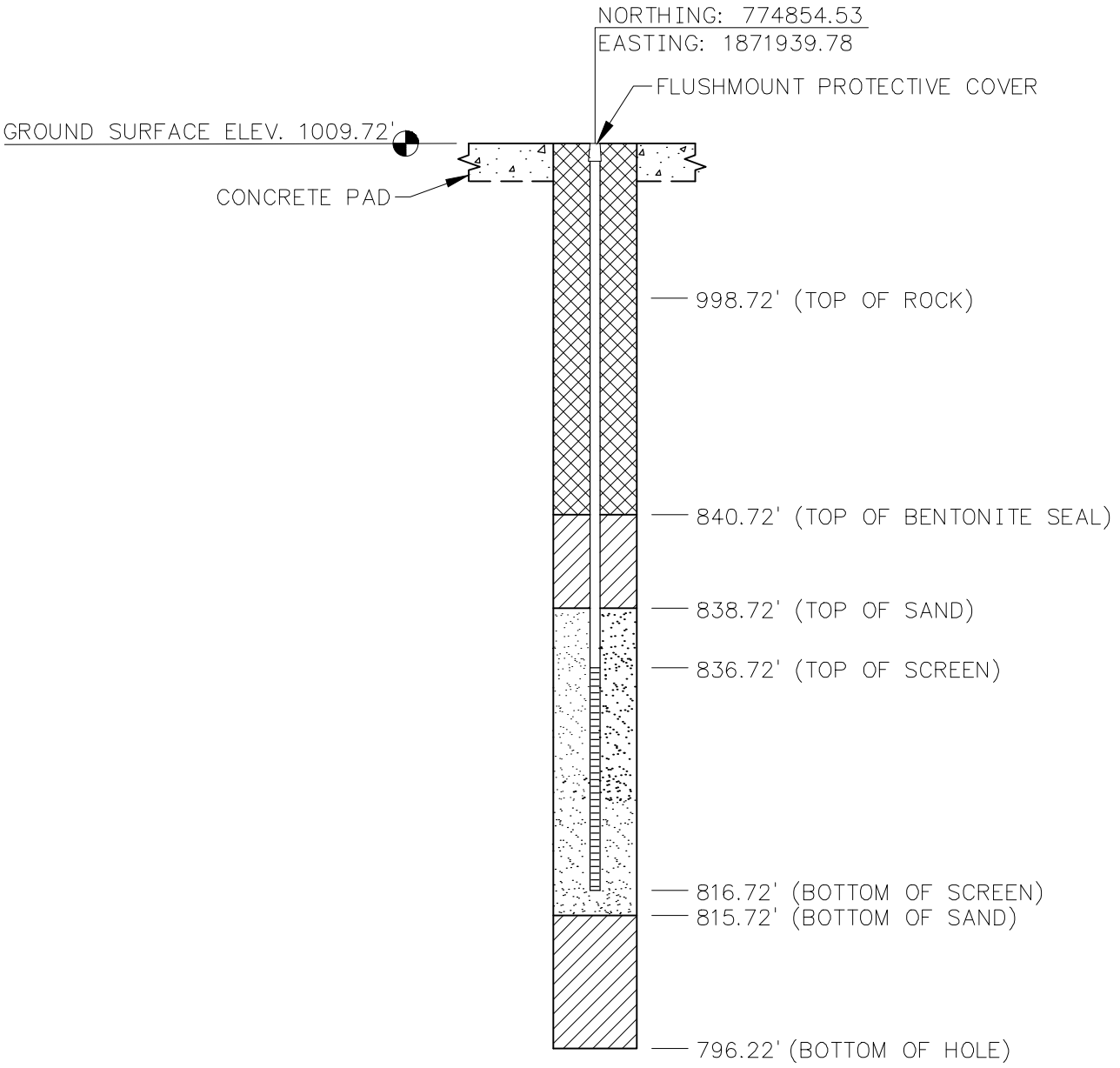

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 01/15/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B33.DWG

PIEZOMETER B-33
BIG WALNUT SEWER TUNNEL
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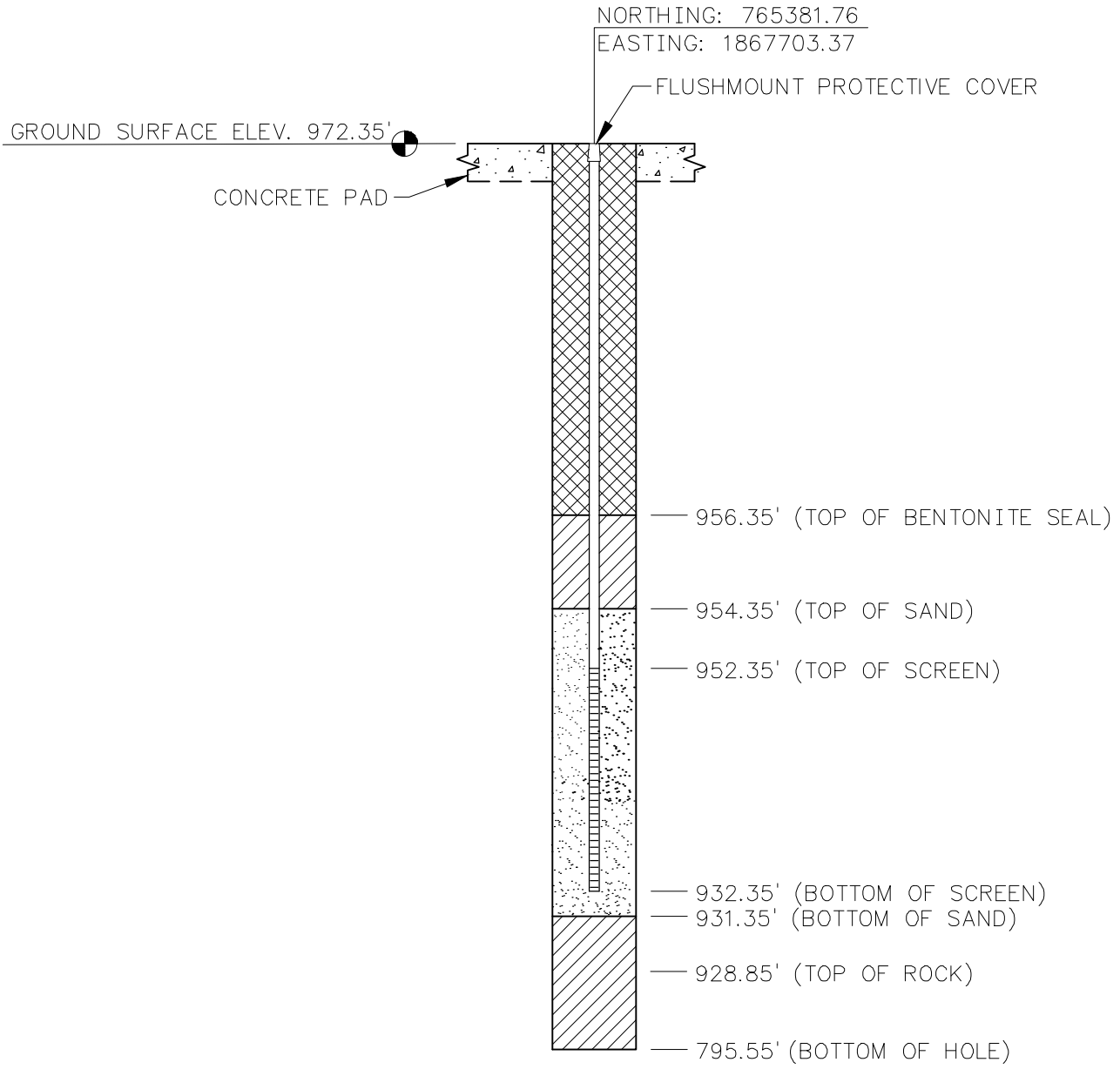

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 04/20/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 10/17/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B38.DWG

PIEZOMETER B-38/SHAFT 1
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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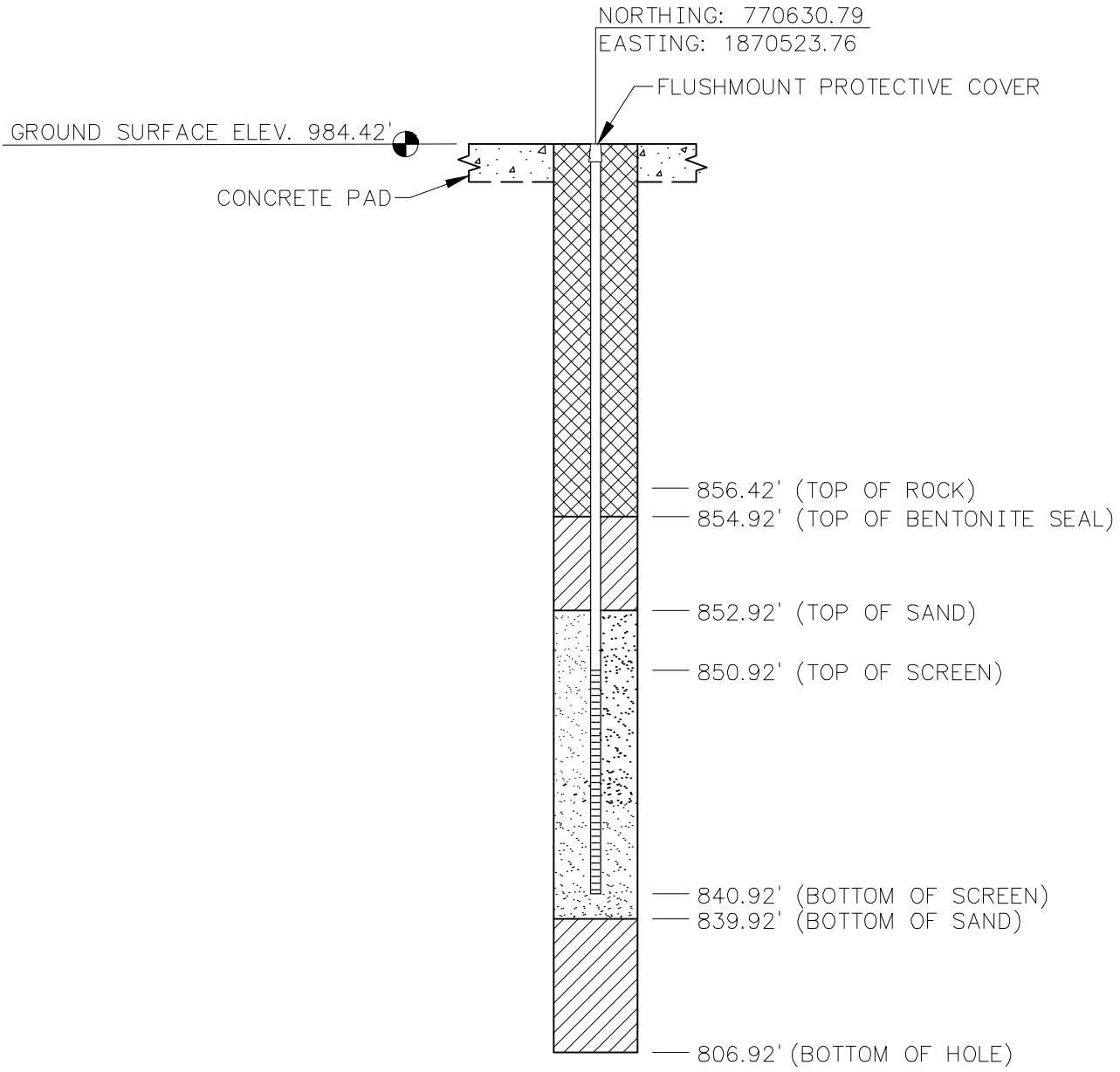

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 04/18/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 10–FOOT LONG SCREEN.

PLOT DATE: 06/15/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058–MWELL–LOG_B39.DWG

PIEZOMETER B-39/SHAFT 2
BIG WALNUT SEWER TUNNEL
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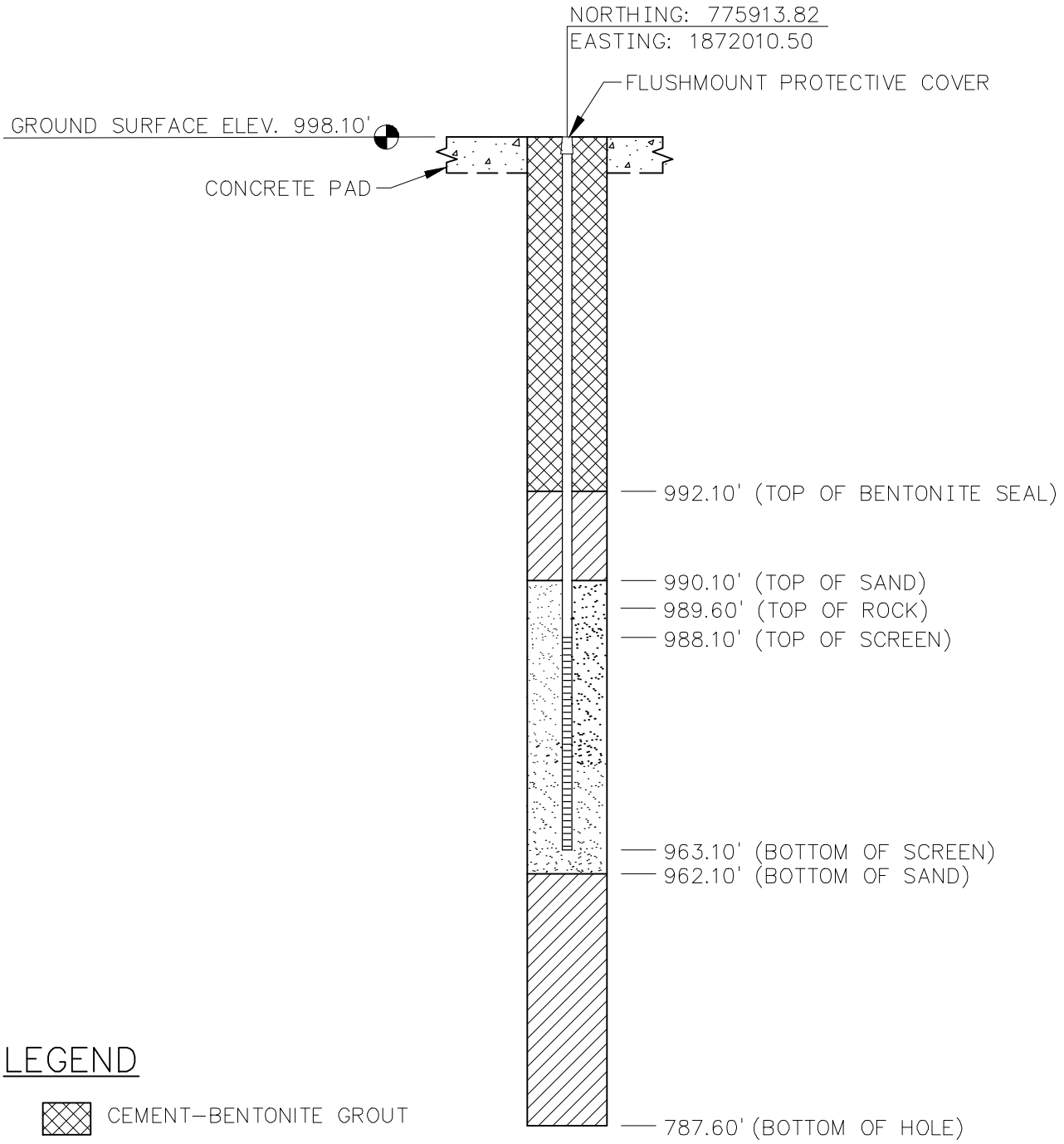

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 04/10/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 25–FOOT LONG SCREEN.

PLOT DATE: 06/15/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B40.DWG

PIEZOMETER B-40/SHAFT 3
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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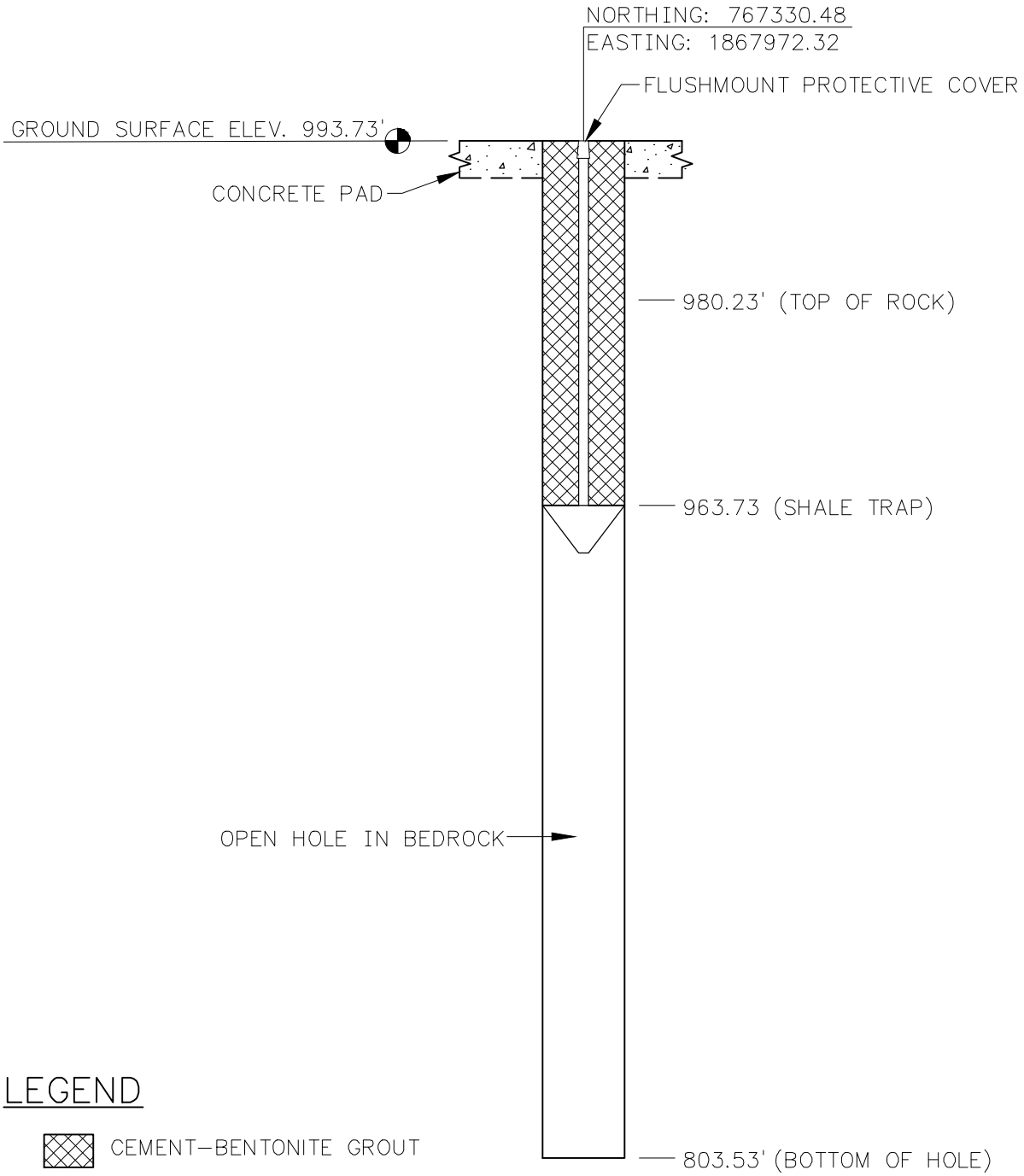

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 02/20/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH SHALE TRAP.

PLOT DATE: 06/15/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B41.DWG

PIEZOMETER B-41
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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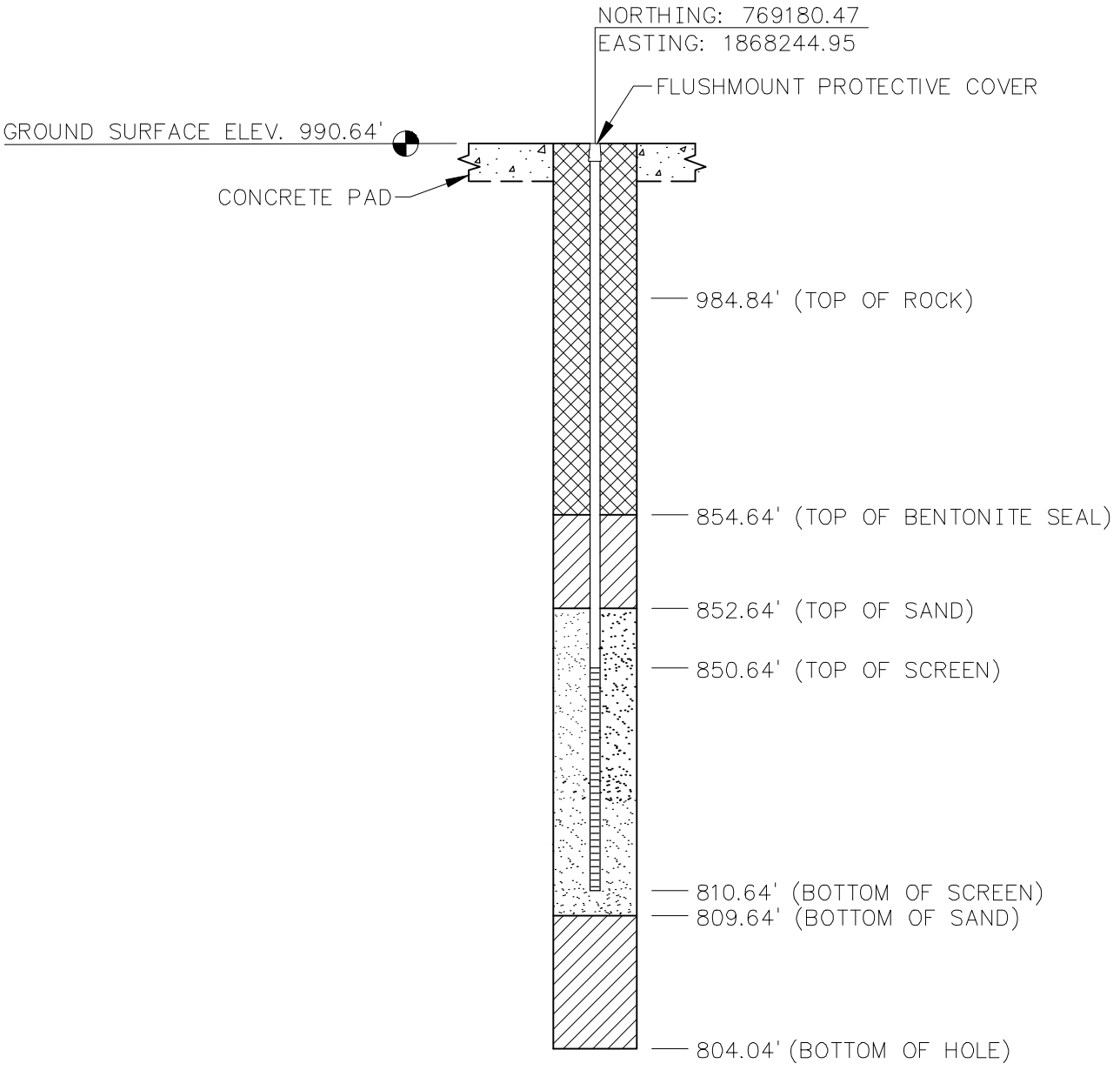

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 03/23/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 20–FOOT LONG SCREEN.

PLOT DATE: 06/15/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058-MWELL-LOG_B43.DWG

PIEZOMETER B-43
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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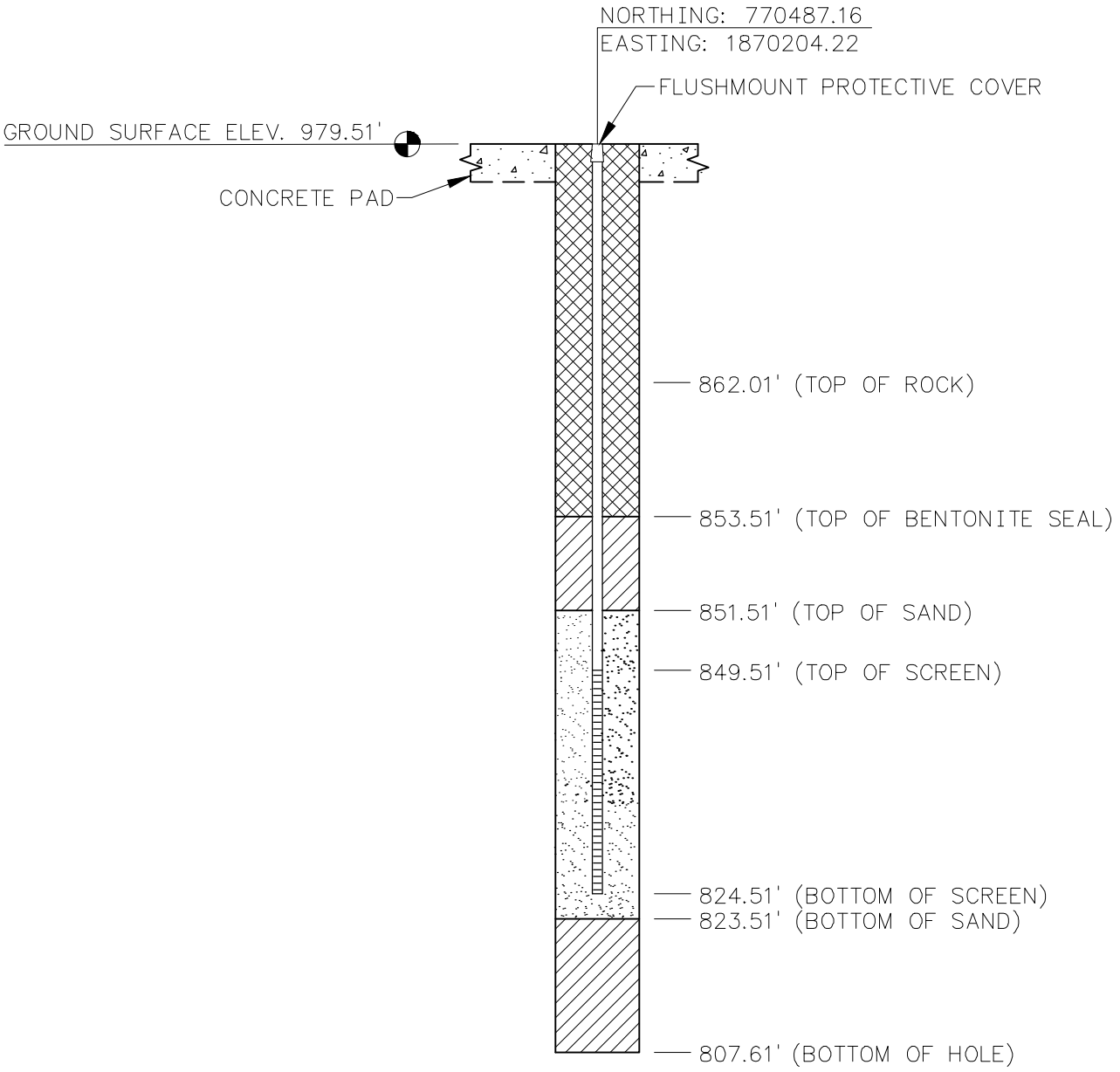

LEGEND

- CEMENT–BENTONITE GROUT
- BENTONITE SEAL
- SAND FILTER

NOTES:

1. PIEZOMETER INSTALLED ON 5/10/2018.
2. PIEZOMETER IS 2–INCH SCH. 40 PVC WITH 25–FOOT LONG SCREEN.

PLOT DATE: 06/15/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\09058–MWELL–LOG_B45.DWG

PIEZOMETER B-45
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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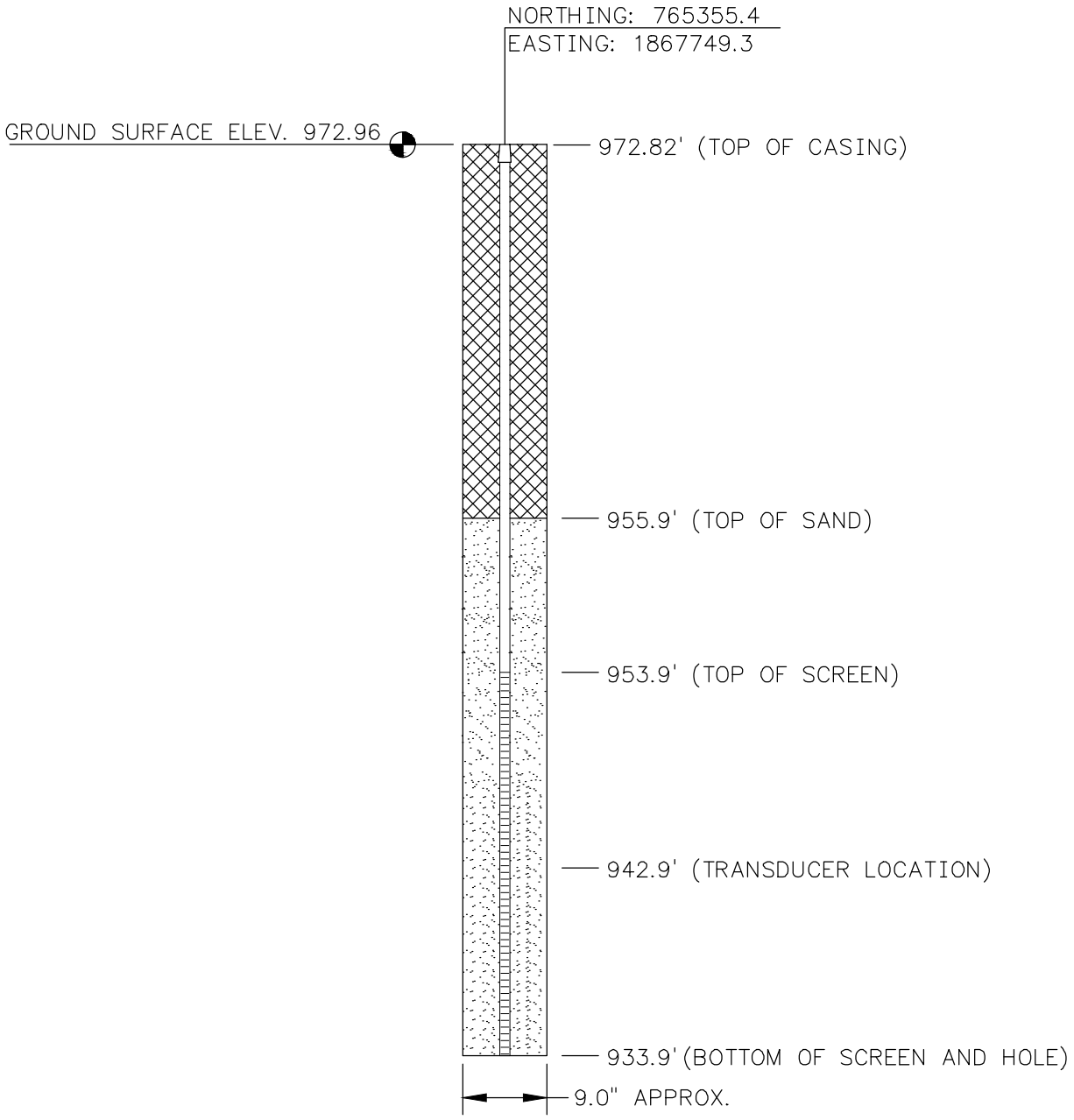

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 06/22/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_01.DWG

OBSERVATION WELL-OW-01
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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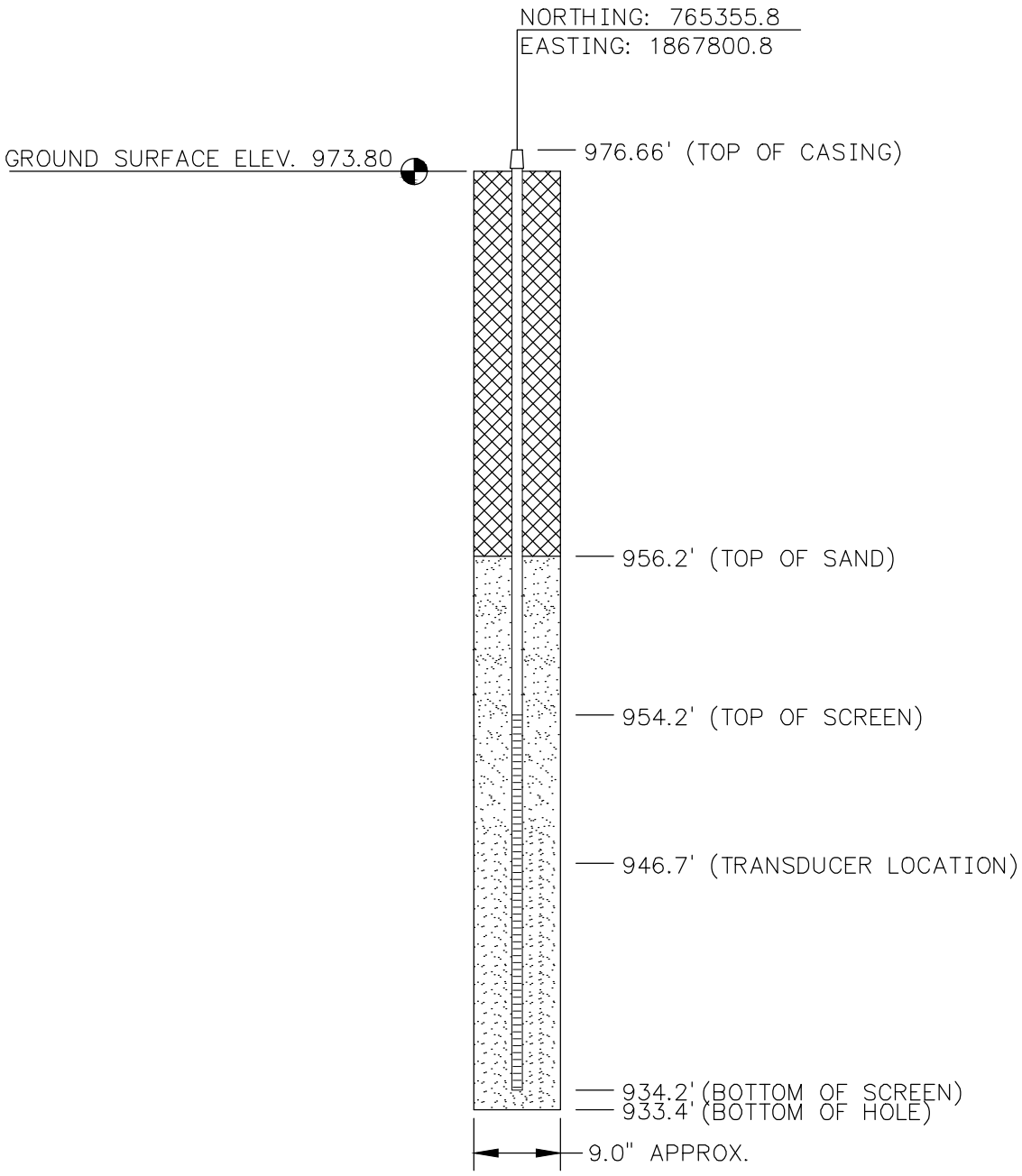

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 06/20/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/16/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_02.DWG

OBSERVATION WELL-OW-02
BIG WALNUT SEWER TUNNEL
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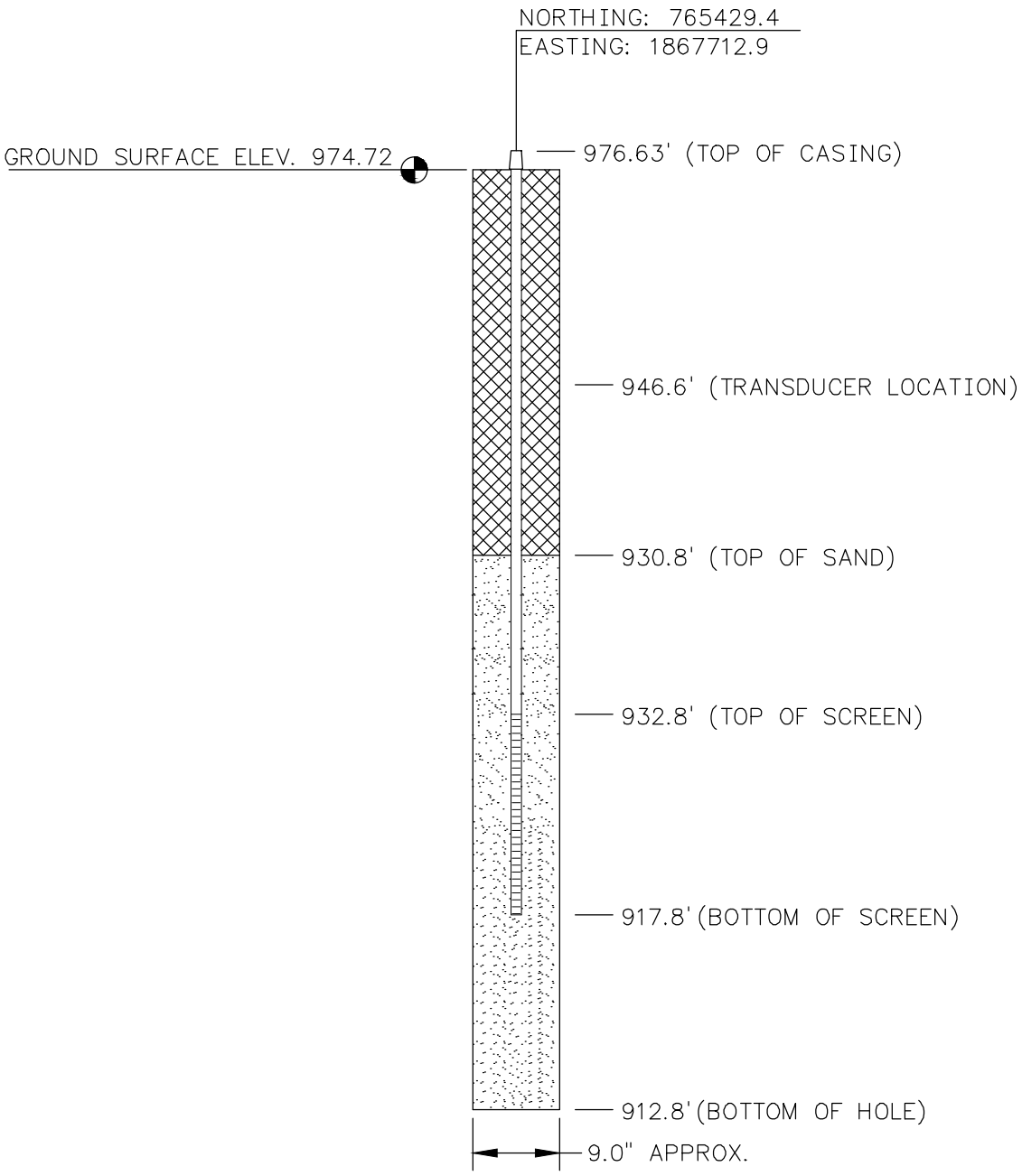

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 06/27/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_03.DWG

OBSERVATION WELL-OW-03
BIG WALNUT SEWER TUNNEL
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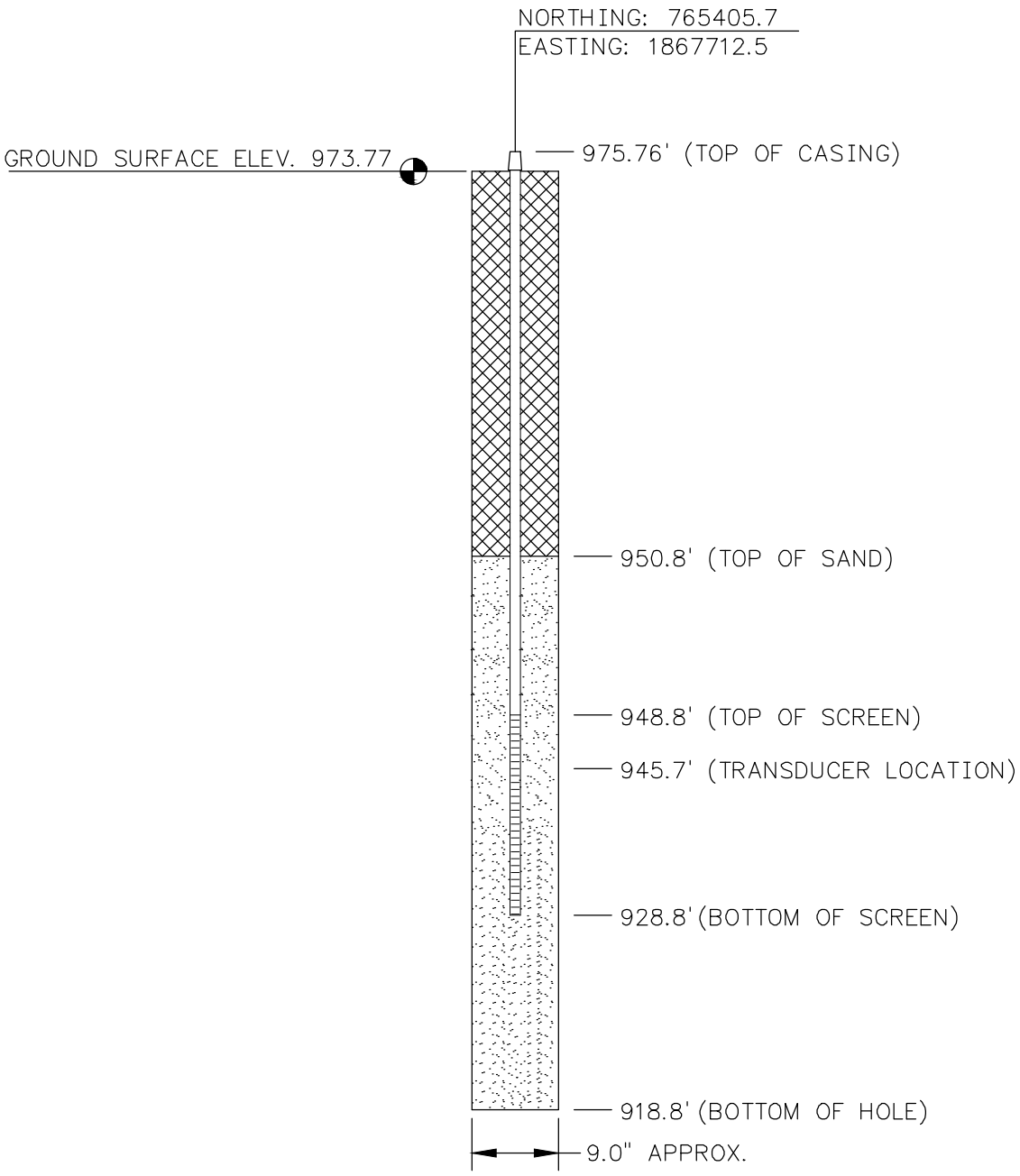

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 06/28/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
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OBSERVATION WELL-OW-04
BIG WALNUT SEWER TUNNEL
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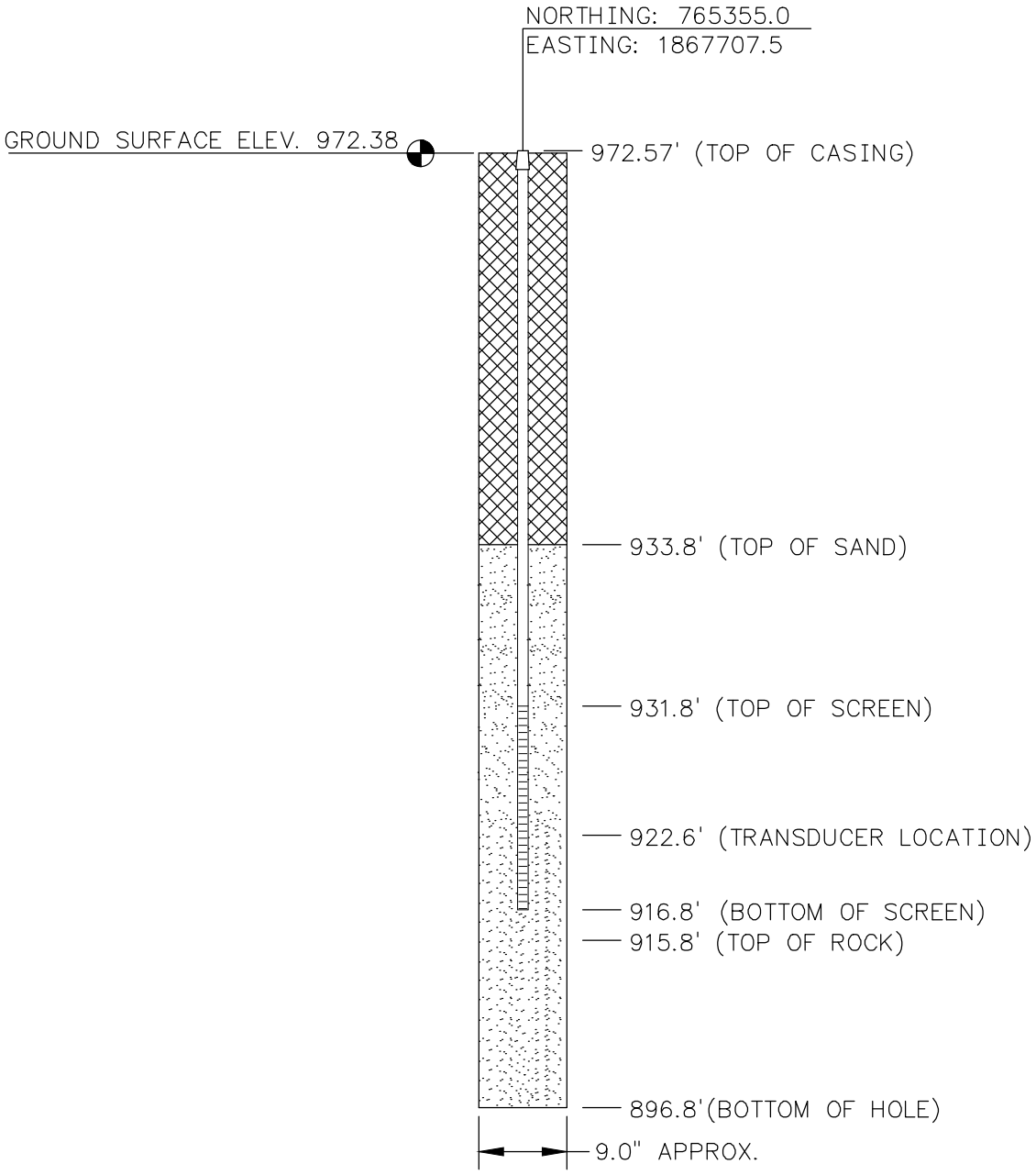

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 06/26/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_05.DWG

OBSERVATION WELL-OW-05
BIG WALNUT SEWER TUNNEL
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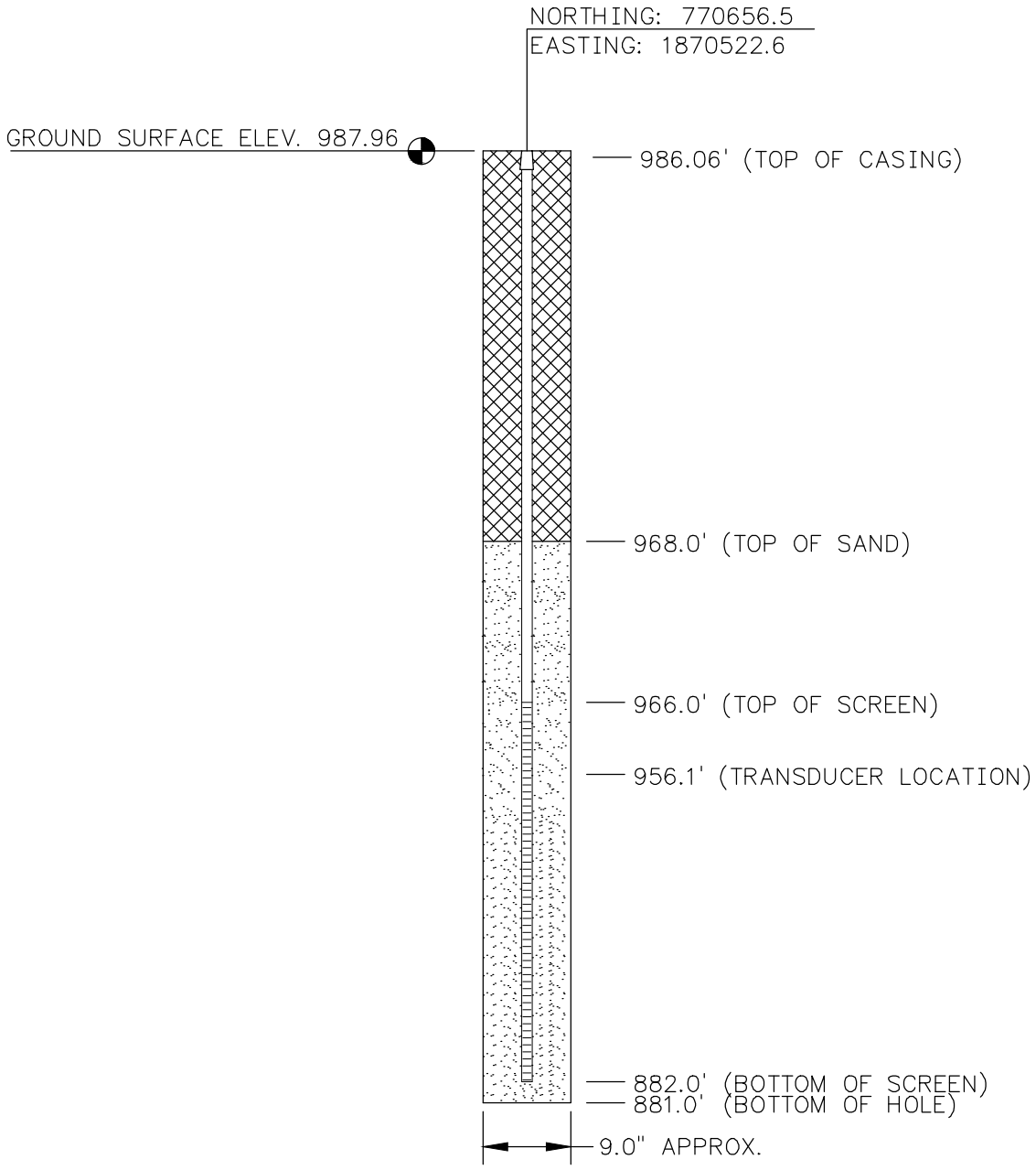

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 07/18/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_06.DWG

OBSERVATION WELL-OW-06
BIG WALNUT SEWER TUNNEL
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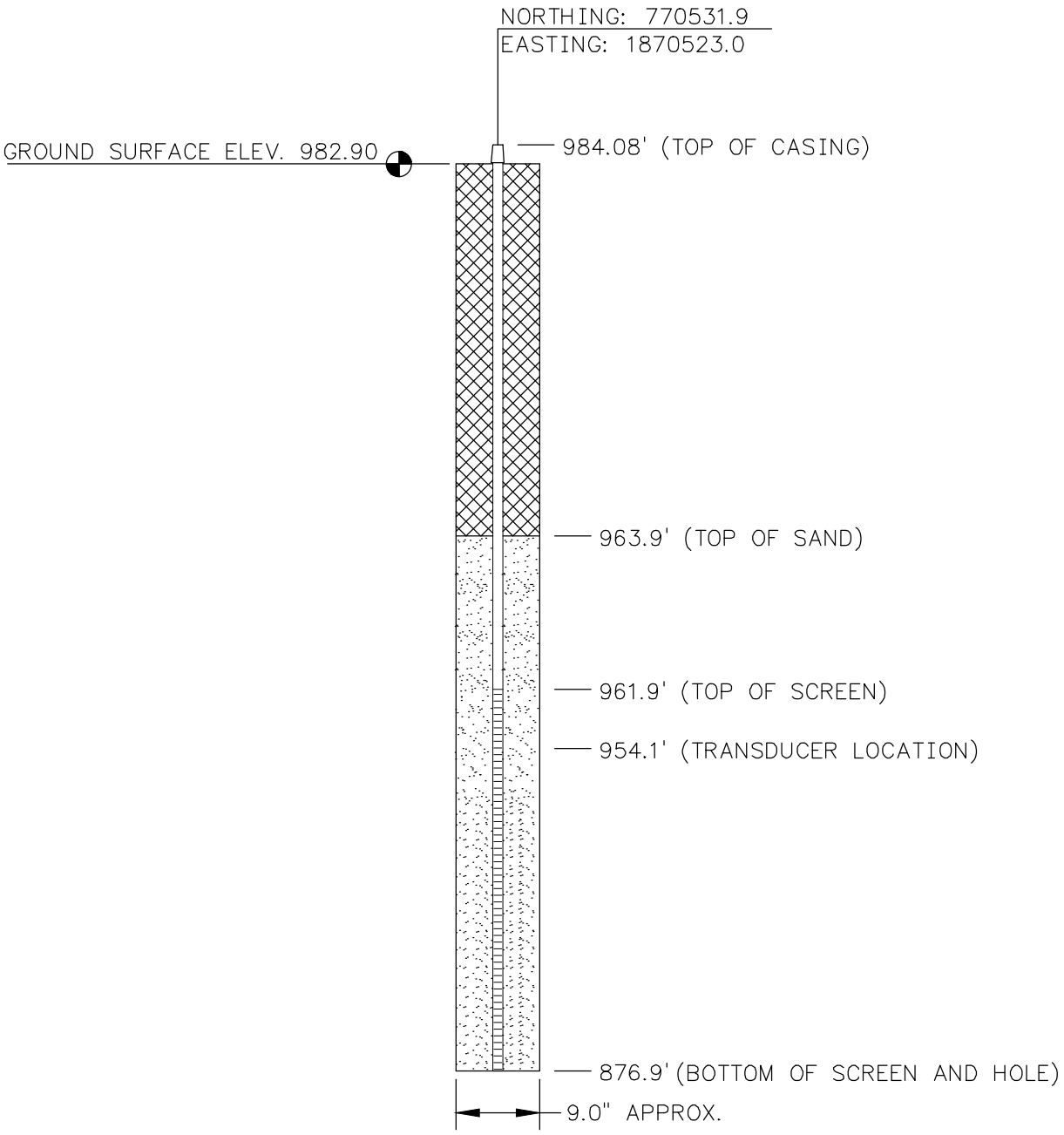

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 07/12/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_07.DWG

OBSERVATION WELL-OW-07
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

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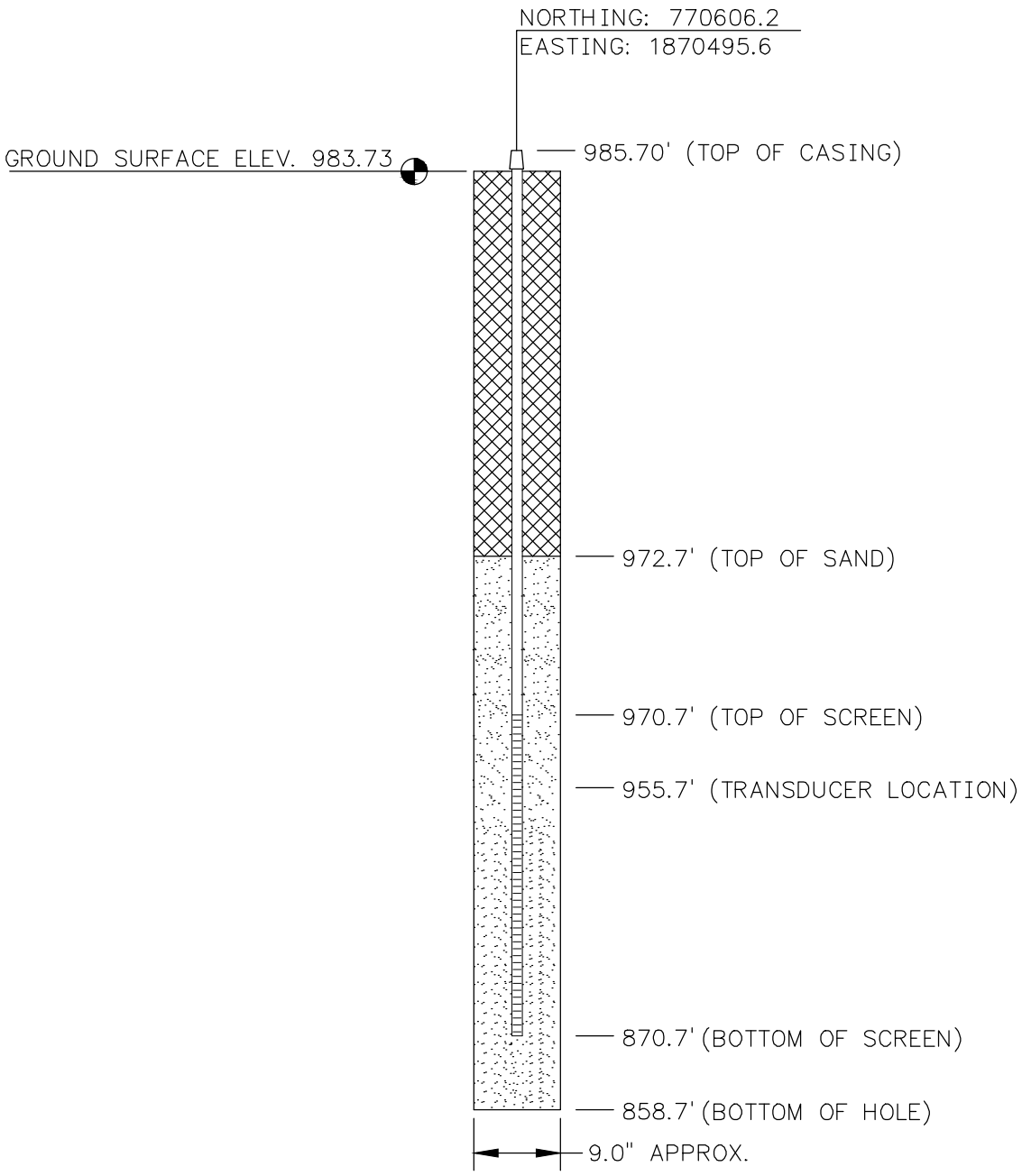

LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 08/01/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_08.DWG

OBSERVATION WELL-OW-08
BIG WALNUT SEWER TUNNEL
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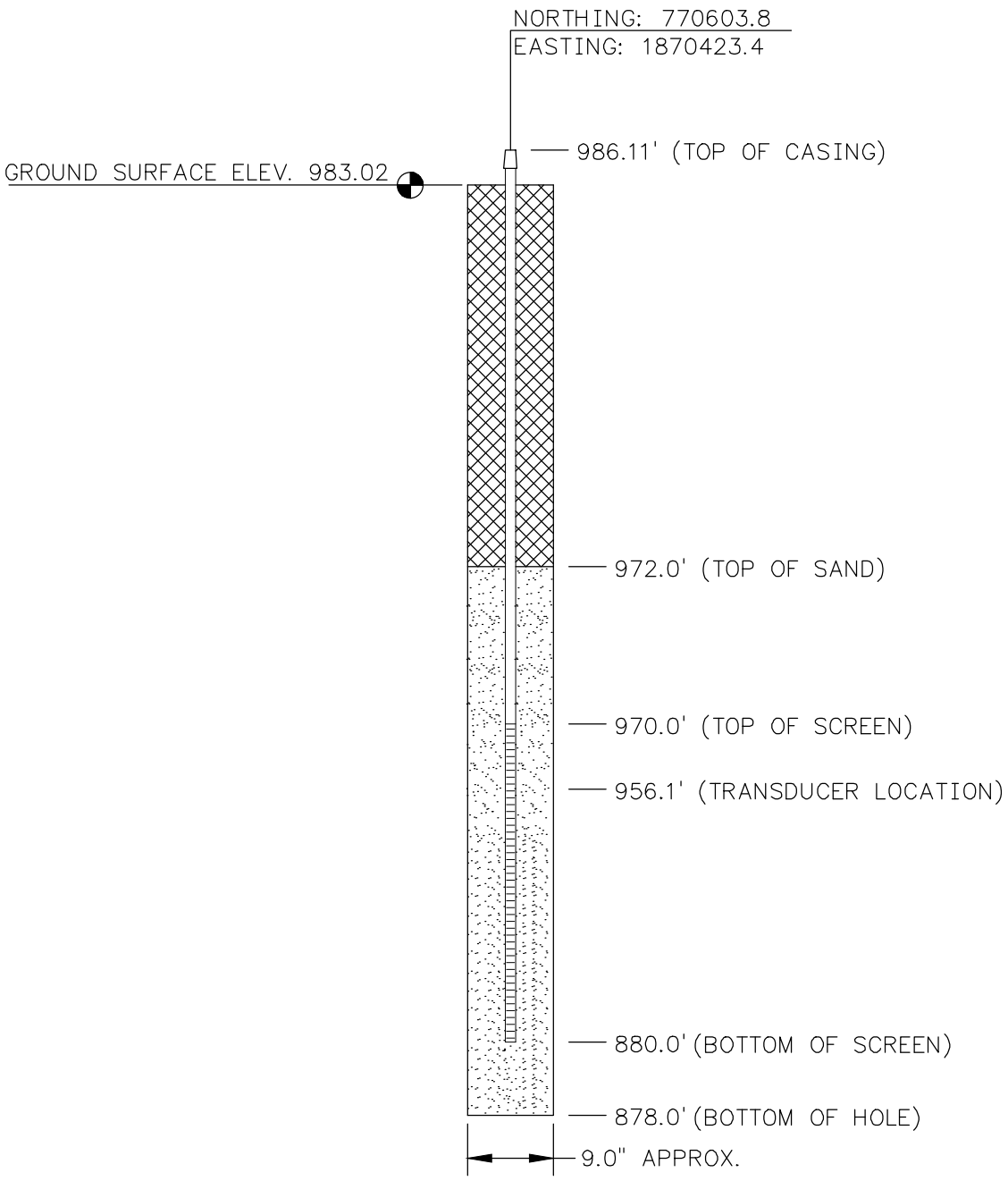
CHECKED BY	JMM	SCALE	NTS	2.	4.	



LEGEND

- BENTONITE PELLETS
- SAND FILTER

NOTE:

1. WELL INSTALLED ON 07/24/2018 BY RESOURCE INT. INC.

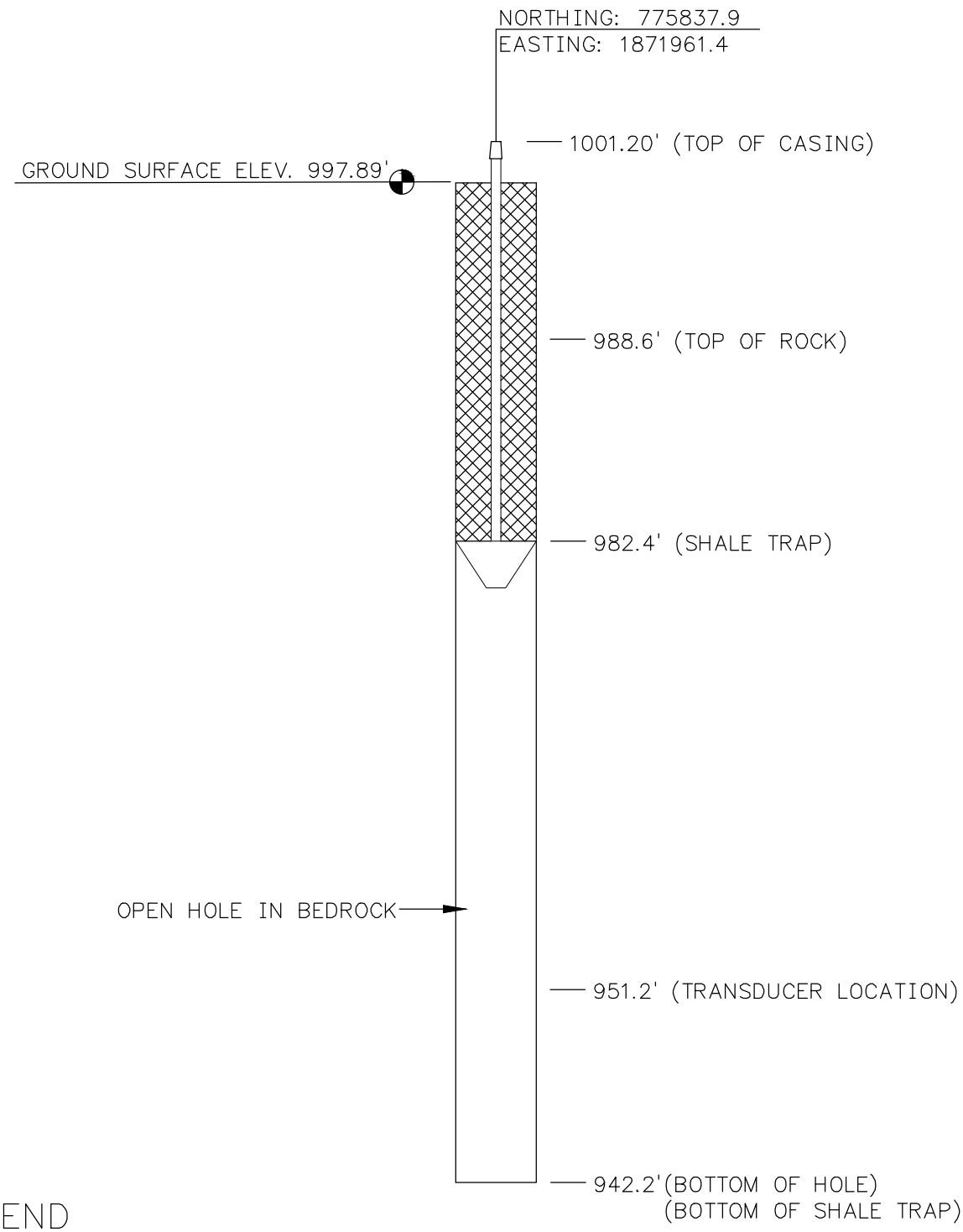
PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_09.DWG

OBSERVATION WELL-OW-09
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

Stantec

Stantec Consulting Services Inc.
1500 Lakeshore Dr. Suite 100
Columbus, Ohio
43204-3800
614 486-4383
www.stantec.com

DRAWN BY	MSJ	DATE	OCT., 2018	REVISED		SHEET
CHECKED BY	JMM	PROJ. NO.	173409058	1.	3.	1 of 1
CHECKED BY	JMM	SCALE	NTS	2.	4.	



LEGEND

BENTONITE PELLETS

NOTE:

1. WELL INSTALLED ON 07/05/2018 BY RESOURCE INT. INC.

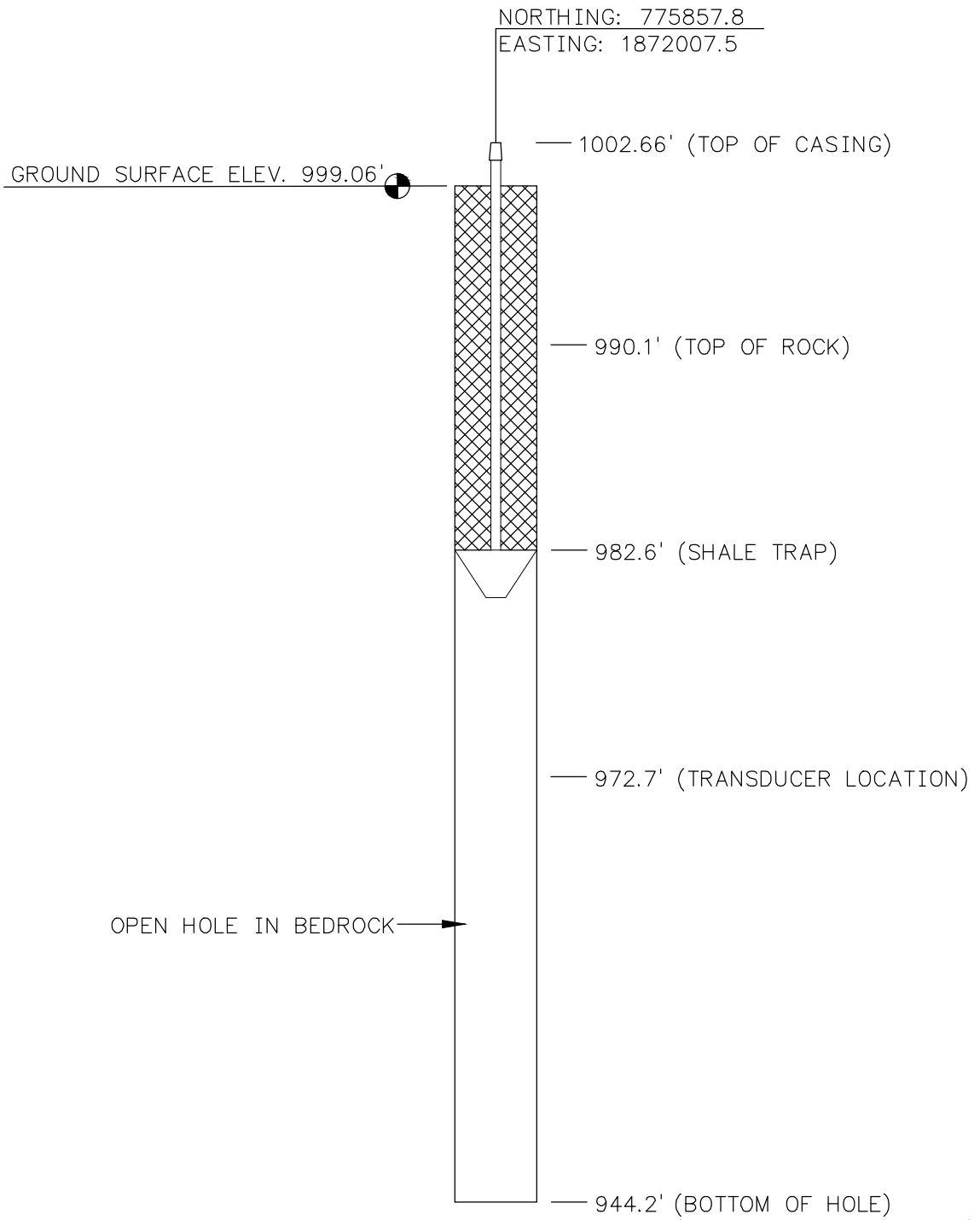
PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_10.DWG

OBSERVATION WELL OW-10
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

Stantec

Stantec Consulting Services Inc.
1500 Lakeshore Dr. Suite 100
Columbus, Ohio
43204-3800
614 486-4383
www.stantec.com

				REVISED		SHEET
DRAWN BY	MSJ	DATE	OCT., 2018			
CHECKED BY	JMM	PROJ. NO.	173409058	1.	3.	1 of 1
CHECKED BY	JMM	SCALE	NTS	2.	4.	



LEGEND

BENTONITE PELLETS

NOTE:

1. WELL INSTALLED ON 07/03/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_11.DWG

OBSERVATION WELL OW-11
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

Stantec

Stantec Consulting Services Inc.
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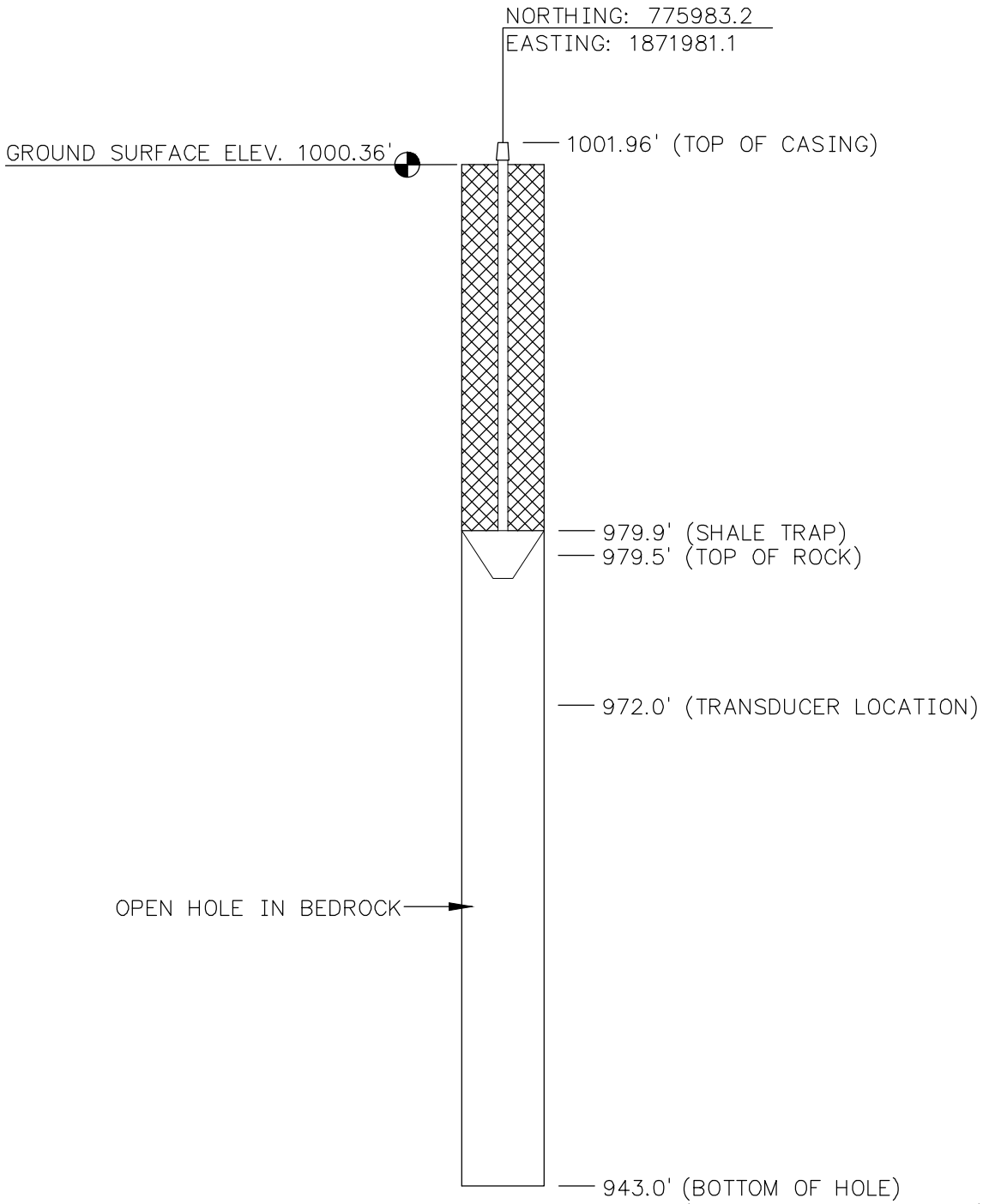
614 486-4383
www.stantec.com

DRAWN BY	MSJ	DATE	OCT., 2018	REVISED		SHEET
CHECKED BY	JMM	PROJ. NO.	173409058	1.	3.	1 of 1
CHECKED BY	JMM	SCALE	NTS	2.	4.	



LEGEND

BENTONITE PELLETS

NOTE:

1. WELL INSTALLED ON 07/09/2018 BY RESOURCE INT. INC.

PLOT DATE: 10/19/2018 USER: JENNINGS, MATTHEW
U:\1734\173409058\OW\09058-OW_12.DWG

OBSERVATION WELL OW-12
BIG WALNUT SEWER TUNNEL
WESTERVILLE, OHIO

Stantec

Stantec Consulting Services Inc.
1500 Lakeshore Dr. Suite 100
Columbus, Ohio
43204-3800
614 486-4383
www.stantec.com

				REVISED		SHEET
DRAWN BY	MSJ	DATE	OCT., 2018			
CHECKED BY	JMM	PROJ. NO.	173409058	1.	3.	1 of 1
CHECKED BY	JMM	SCALE	NTS	2.	4.	

Appendix F MONITORING WELL DATA READINGS

BWSTE Ph2 Monitoring Well Data

Boring No.	Depth of Water Below Top of Casing															
	2018									2019						
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
B-17	49.66	38.96	0.00	1.35	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface		Surface
B-19	see notes	5.84	129.40	33.28	14.50	9.80	8.81	0.50	0.10	Surface	Surface	Surface	Surface	Surface		Surface
B-20	see notes	5.50	3.00	1.15	2.14	Surface	0.50	Surface	Surface	Frozen	Surface	Surface	Surface	Surface		Surface
B-22	2.82	7.35	15.94	7.85	7.28	8.00	4.49	6.78	8.95	9.20	5.85	6.50	6.00	6.55		6.05
B-29	91.13	69.87	62.60	61.11	60.50	52.65	45.95	43.45	43.45	40.50	40.30	40.55	37.60	20.10		27.00
B-33	see notes	11.35	16.73	20.56	dry	8.41	14.8	Surface	5.40	11.40	Surface	Surface	Surface	Surface		Surface
B-38	NC	6.33	3.56	3.65	9.38	2.90	3.10	2.46	2.90	3.00	2.40	2.55	1.90	3.05		2.65
B-39	NC	see notes	5.68	7.44	7.95	8.10	8.20	7.35	7.90	3.20	7.20	7.20	Surface	7.30		5.80
B-40	NC	3.17	1.96	8.52	2.85	1.80	1.50	1.09	1.50	1.50	1.40	1.40	0.60	2.00		1.60
B-41	12.04	13.41	13.54	13.94	14.54	14.10	13.64	12.55	12.90	13.00	12.45	12.40	11.90	12.75		13.00
B-43	137.01	102.58	85.52	83.92	63.41	57.49	52.95	45.81	42.90	40.50	36.75	34.95	29.95	28.10		26.00
B-45	NC	4.23	NR	NR	4.75	4.50	4.50	2.94	4.50	3.70	3.85	4.80	1.85	6.40		3.50

NC = Well not completed at time of monthly reading

NR = No well readings recorded

Notes

B-19 was inaccessible at time of monthly reading

June 2019 readings not collected

B-33 April reading ponded water was present around well

B-20 November standpipe casing frozen to top

B-29 November full of water in casing

B-43 November water in casing/flushmount

B-45 November water in casing/flushmount

B-20 December standpipe casing frozen to top

B-20 February casing full of water

B-29 February gas built up in well riser

B-39 February water in casing

B-19 March water in pro-casing

B-29 March gas build up in well

B-43 March water in pro-casing

B-29 April gas build up in well LEL:XXX, O_2: 5% - 7.3%, CO: 2000 PPM, H_2S: 5 to 6 ppm

B-29 May gas build up in well LEL: 78%, CO: 15 PPM, O2: 20.8%

June 2019 readings not collected

BWSTE Ph2 Monitoring Well Data

Boring No.	Depth of Water Below Top of Casing											
	2018					2019						
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
OW-1	4.45	3.60	3.75	3.10	3.40	3.40	2.85	3.00	2.35	3.45		3.10
OW-2	7.50	7.20	7.36	6.45	3.50	7.30	6.70	6.85	6.10	7.25		6.95
OW-3	8.06	7.20	7.34	6.70	7.20	7.25	6.60	6.70	6.10	7.30		6.90
OW-4	7.20	6.30	6.46	5.84	6.30	6.40	6.75	5.90	5.25	6.40		6.05
OW-5	4.35	3.40	3.21	2.91	8.40	3.70	3.50	3.20	2.55	3.70		3.35
OW-6	12.36	11.30	11.40	10.34	10.70	10.80	9.85	10.15	9.70	10.40		10.20
OW-7	10.80	9.00	9.15	8.05	7.20	4.60	7.60	7.85	7.40	8.05		7.85
OW-8	12.50	11.50	11.63	10.65	11.00	11.00	10.20	10.40	10.00	10.65		10.45
OW-9	13.50	11.40	11.52	10.45	10.80	10.00	10.00	8.75	9.90	10.55		10.30
OW-10	5.80	4.90	4.80	3.95	4.40	4.50	4.20	4.20	4.10	4.90		4.50
OW-11	7.09	6.20	5.80	5.14	5.30	6.40	5.00	5.00	4.60	5.75		5.50
OW-12	6.60	5.40	5.15	4.50	5.00	5.20	4.70	4.70	4.55	5.50		5.05

Notes

OW-1 February well hit by mower

OW-1 March well open - destroyed by mower

OW-1 May well open - no cap

June 2019 readings not collected

Appendix G SLUG TEST RESULTS

Stantec

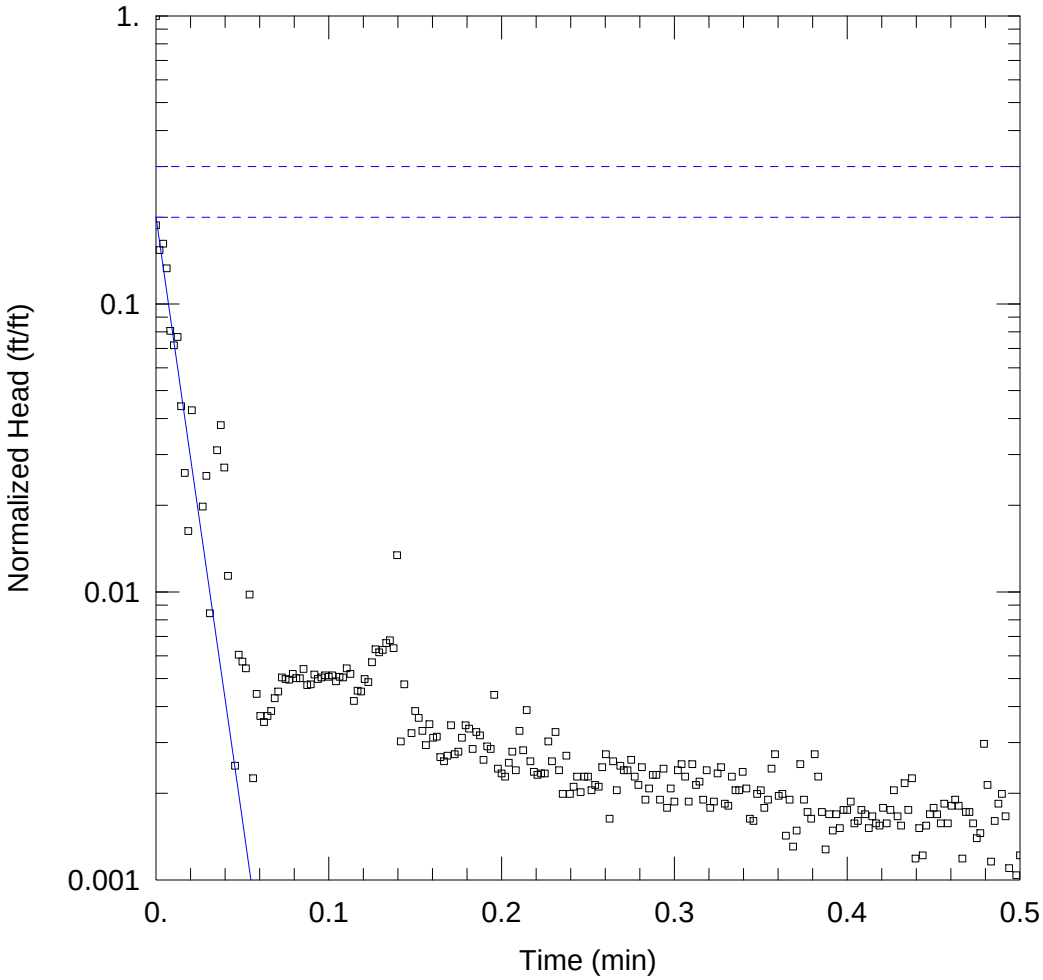
Table 1: Summary of Slug Test Setup

Well	Static Water Elevation (ft)	Piezometer Elevation (ft)	Screened Well Zone (ft)	Aquifer Type	Aquifer Material	Estimated Aquifer Thickness (ft)	K_v/K_h
Shaft 1	969.65	949.8	952.35 – 932.35	Confined	Glacial Till	20	1
Shaft 2	981.72	966.09	851.17 – 841.17	Confined	Shale	24	0.1
Shaft 3	989.2	974.73	988.1 – 963.1	Confined	Sandstone	87	1

Table 2: Summary of Slug Test Results

Location	Test Number	Slug Type	K (ft/s)	T (ft^2/s)	S (ft^{-1})
Shaft 1	1	Insert[1]	1.13E-03	4.15E-02	1.00E-01
	2	Removal	6.65E-03	1.01E-01	1.00E-10
	3	Insert[1]	6.95E-04	1.40E-02	1.00E-10
	4	Removal	3.96E-04	1.50E-02	5.36E-11
Shaft 2	1	Insert	7.34E-08	7.03E-07	1.00E-03
	2	Removal	5.31E-08	4.71E-07	1.00E-03
Shaft 3	1	Insert[1]	7.12E-05	1.80E-03	1.00E-01
	2	Removal	8.69E-05	2.23E-03	1.00E-01
	3	Insert[1]	6.58E-05	1.91E-03	3.67E-02
	4	Removal	4.49E-05	7.76E-04	1.00E-01

[1]Insert portion of testing for Shaft 1 and Shaft 3 showed scatter in results due to rapid recovery while inserting slug.



SHAFT 1 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_1_Test 1 .aqt
Date: 05/11/18 Time: 10:54:52

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 1 Slug Insert

AQUIFER DATA

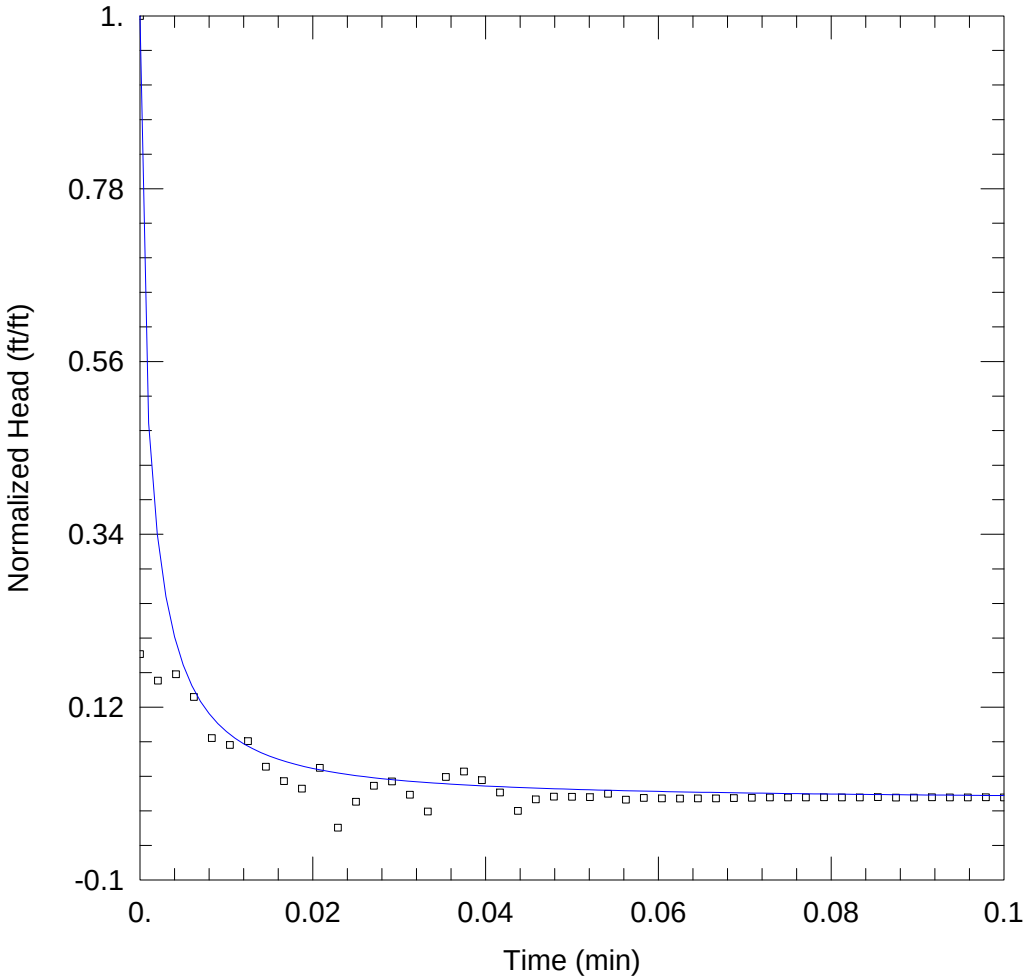
Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 3.37 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.001128 ft/sec
y0 = 0.6758 ft



SHAFT 1 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_1_Test 1 aqt
Date: 05/11/18 Time: 10:58:18

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 1 Slug Insert

AQUIFER DATA

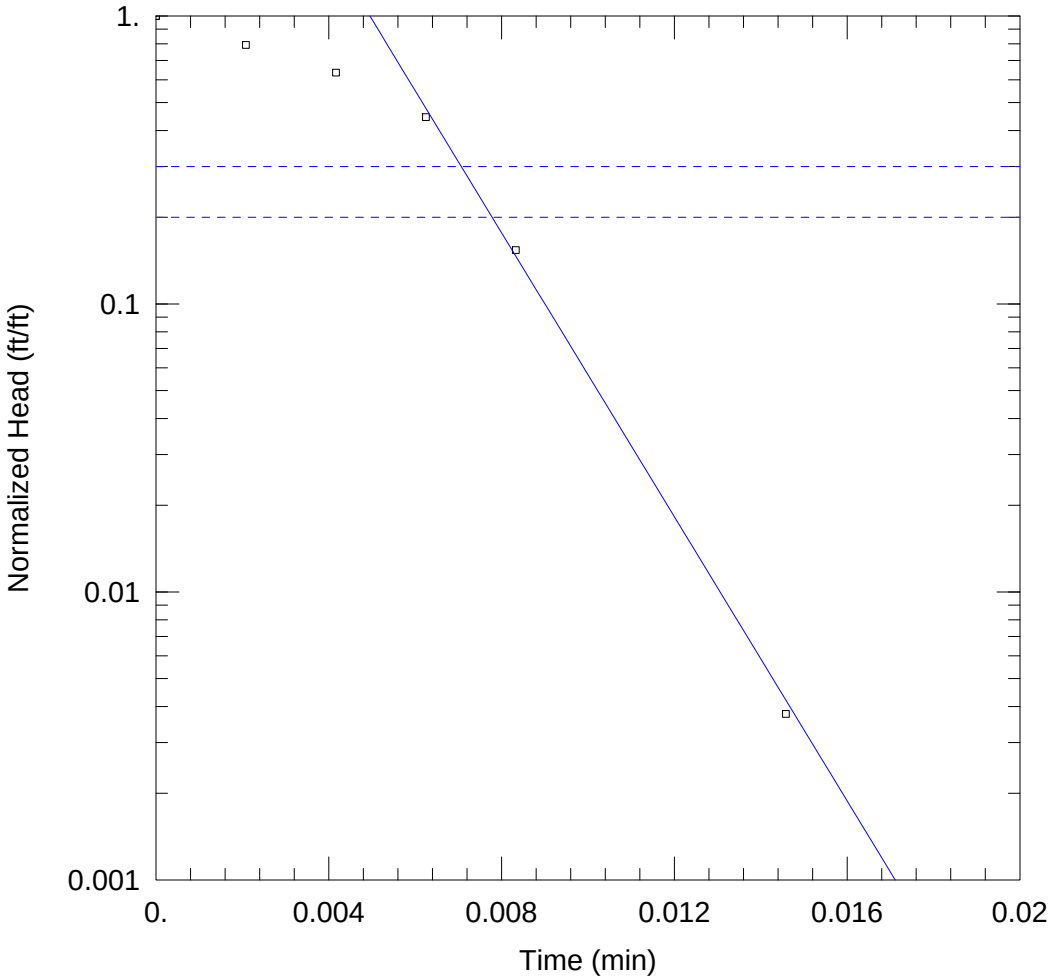
Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 3.37 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.04146 ft^2/sec
S = 0.1



SHAFT 1 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Shaft_1_Test_2.aqt
Date: 05/11/18 Time: 08:29:20

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 2 Slug Removal
Test Date: 11/01/2017

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 1.

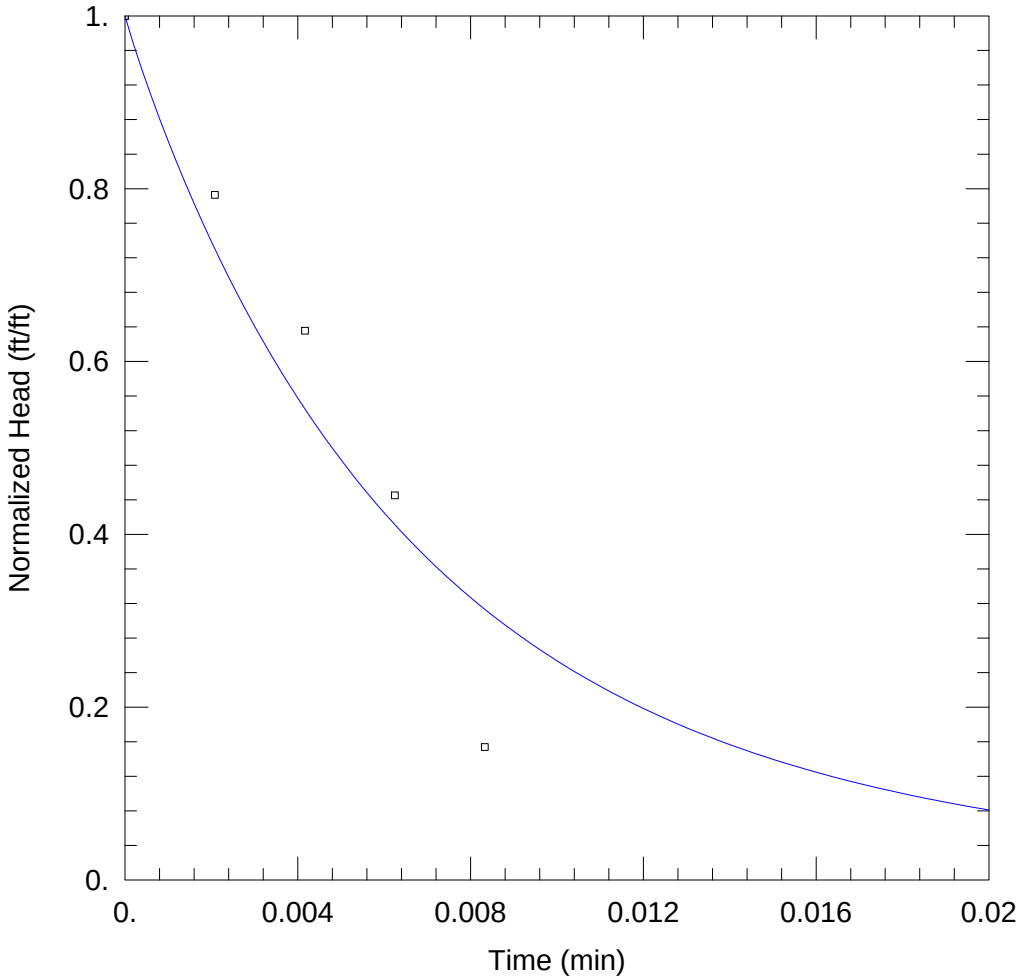
WELL DATA (Shaft 1)

Initial Displacement: 1.167 ft Static Water Column Height: 37.3 ft
Total Well Penetration Depth: 20. ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.006648 ft/sec y0 = 19.43 ft



SHAFT 1 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Shaft_1_Test 2 .aqt
Date: 05/11/18 Time: 08:35:45

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 2 Slug Removal
Test Date: 11/01/2017

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 1.

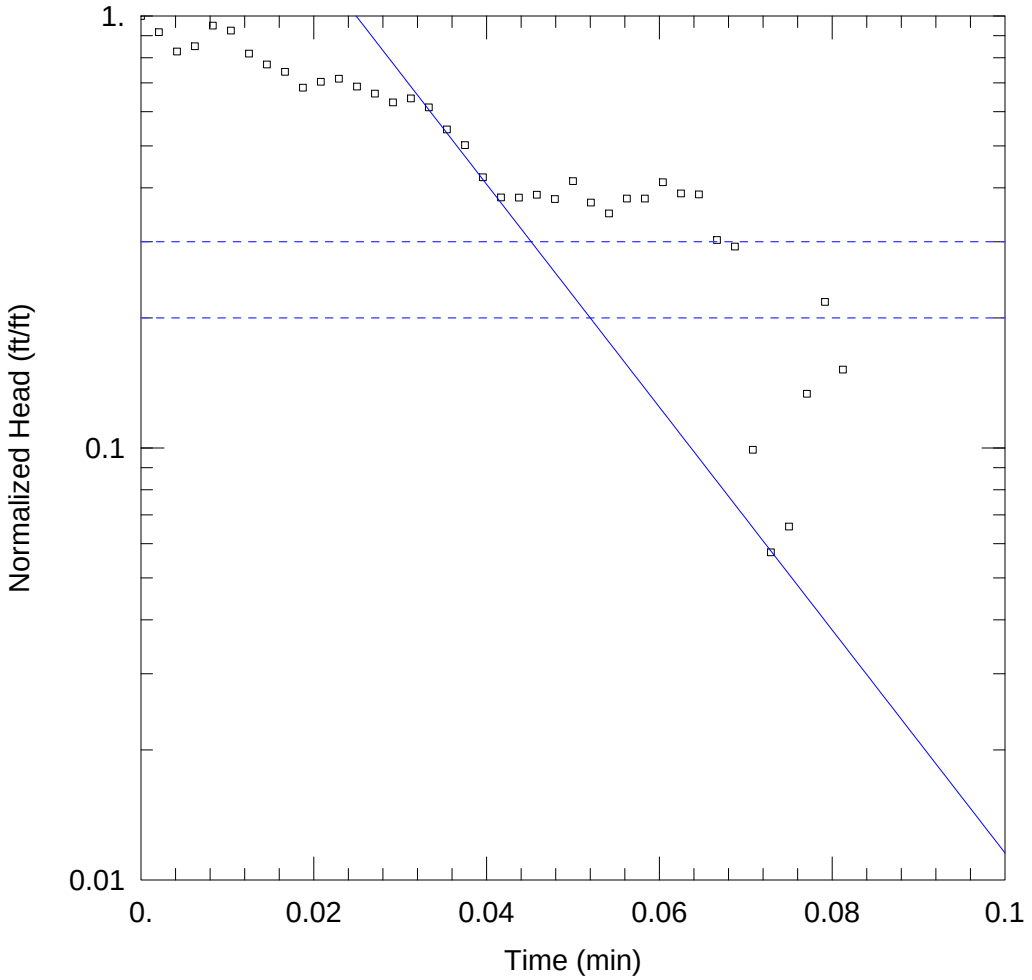
WELL DATA (Shaft 1)

Initial Displacement: 1.167 ft Static Water Column Height: 37.3 ft
Total Well Penetration Depth: 20. ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.1008 ft^2/sec S = 1.0E-10



SHAFT 1 TEST 3

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\New folder\Shaft_1_Test3 .aqt
Date: 05/11/18 Time: 08:50:20

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 3 Slug Insert

AQUIFER DATA

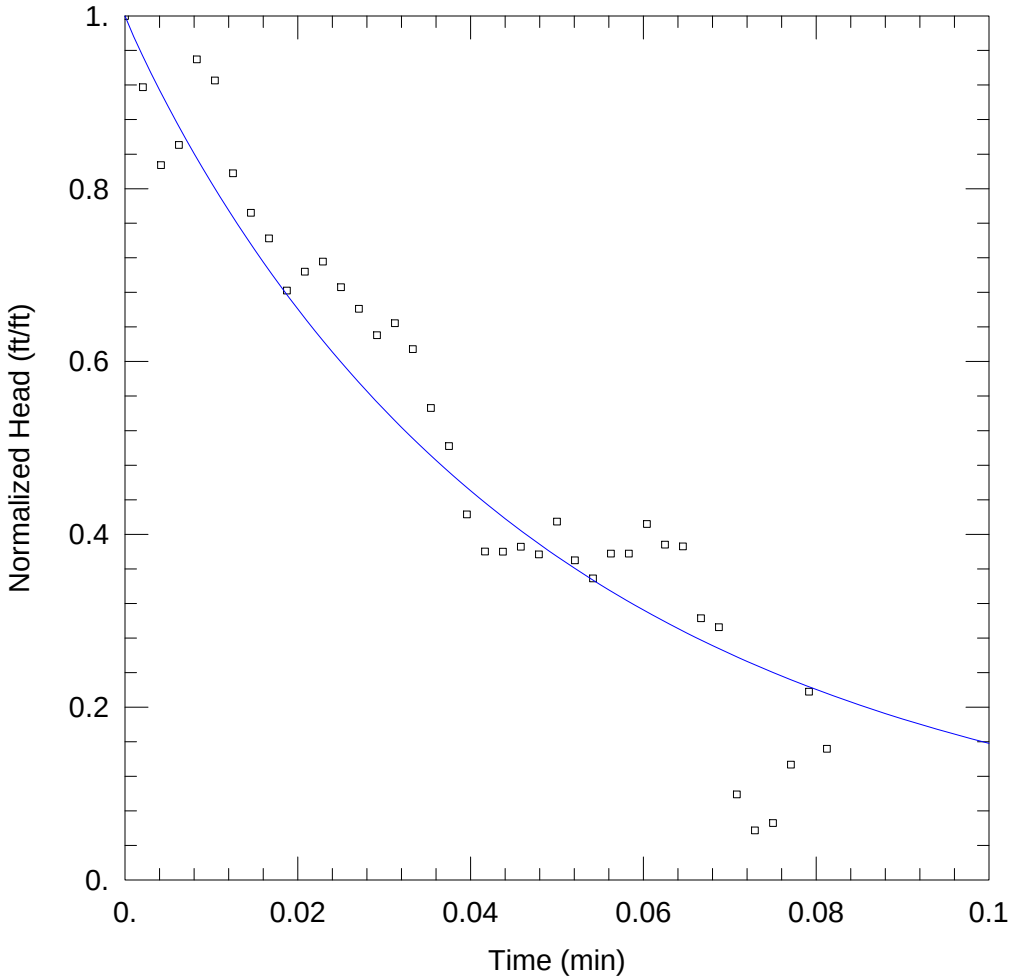
Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 1.13 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0006952 ft/sec
y0 = 4.958 ft



SHAFT 1 TEST 3

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\New folder\Shaft_1_Test_3 aqt
Date: 05/11/18 Time: 08:49:11

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 3 Slug Insert

AQUIFER DATA

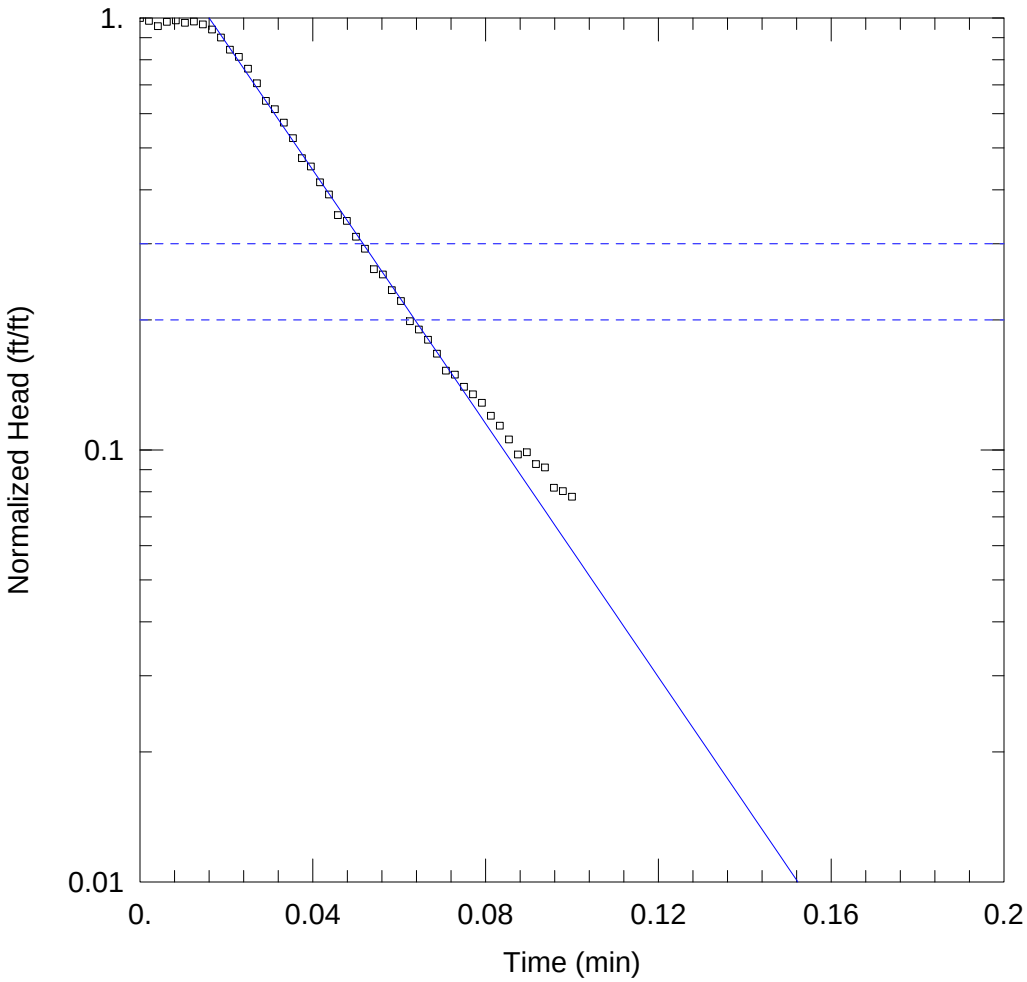
Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 1.13 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.01403 ft^2/sec
S = 1.0E-10



SHAFT 1 TEST 4

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_1_Test_4 aqt
Date: 05/11/18 Time: 08:57:51

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 4 Slug Removal

AQUIFER DATA

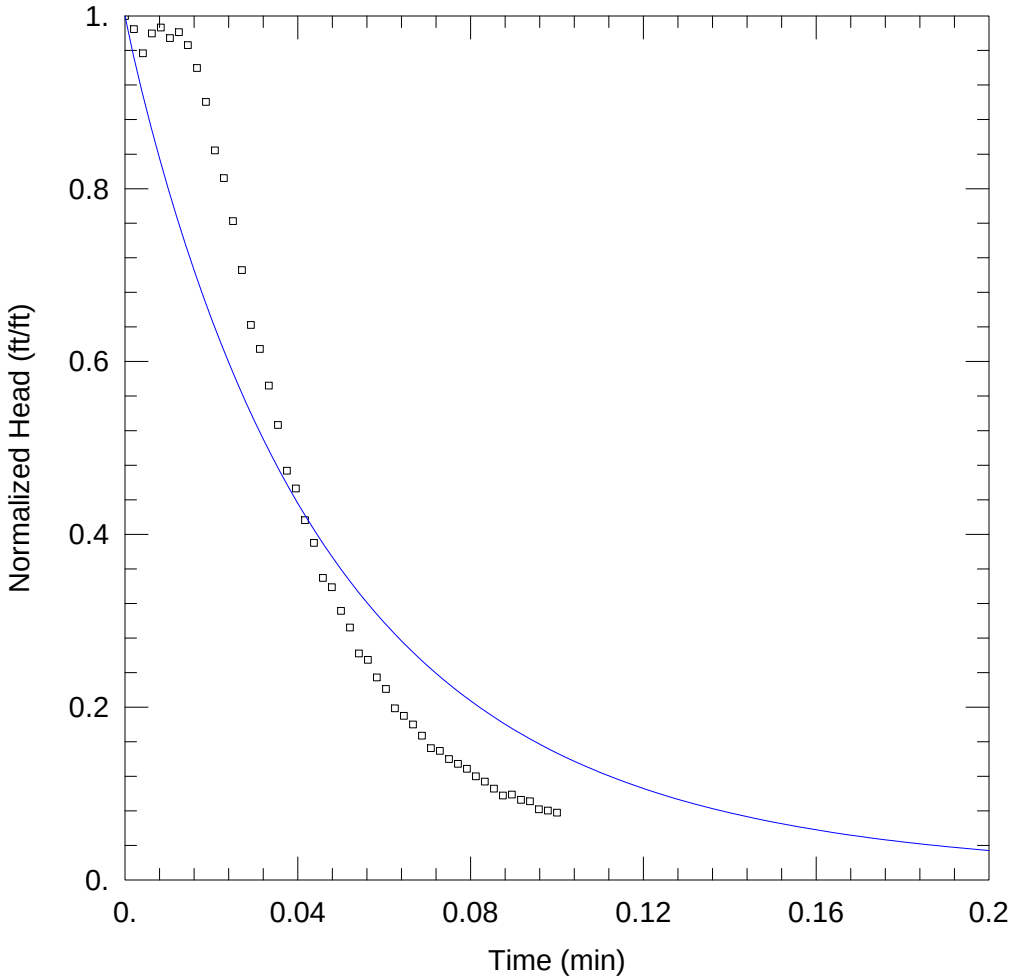
Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 0.63 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0003955 ft/sec
y0 = 1.083 ft



SHAFT 1 TEST 4

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_1_Test_4 aqt
Date: 05/11/18 Time: 08:56:25

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 1 Test 4 Slug Removal

AQUIFER DATA

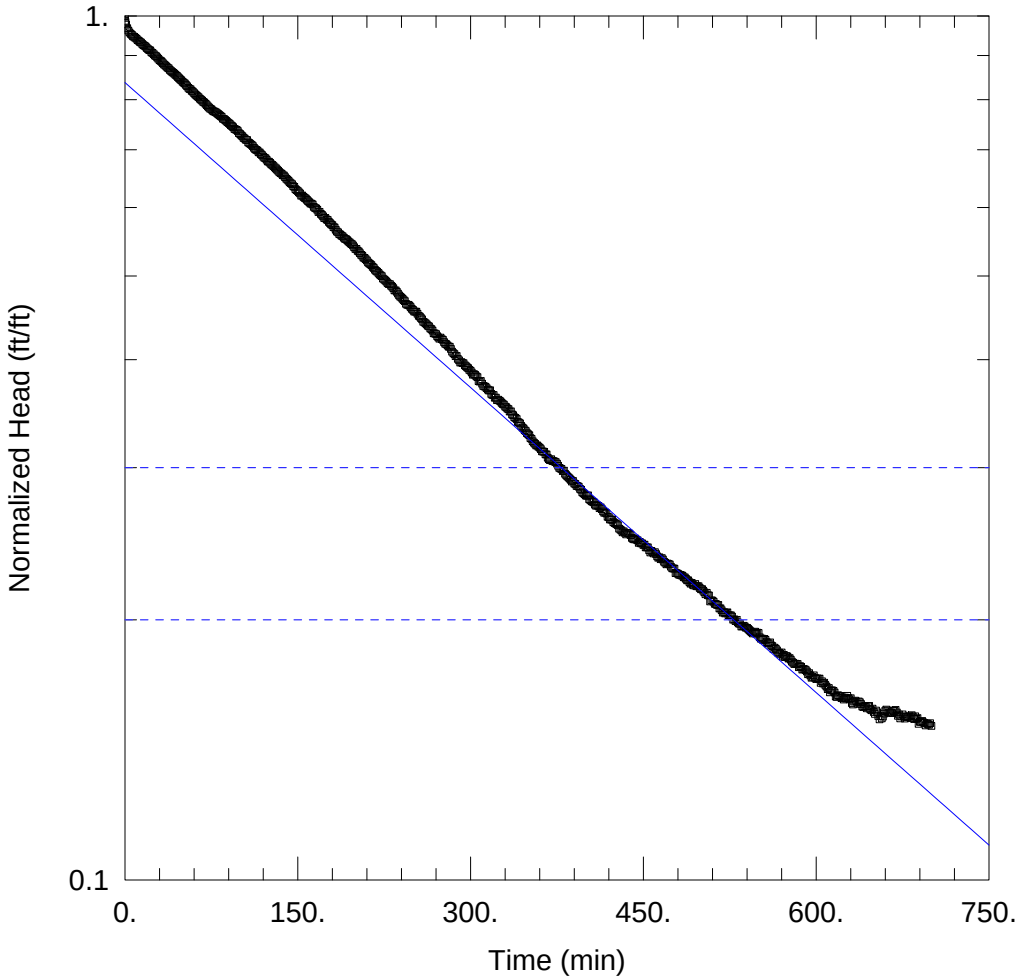
Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 1)

Initial Displacement: 0.63 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 37.3 ft
Screen Length: 20. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.01504 ft^2/sec
S = 5.362E-11



SHAFT 2 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_2_Test_1.aqt
Date: 05/11/18 Time: 09:15:28

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 2 Test 1

AQUIFER DATA

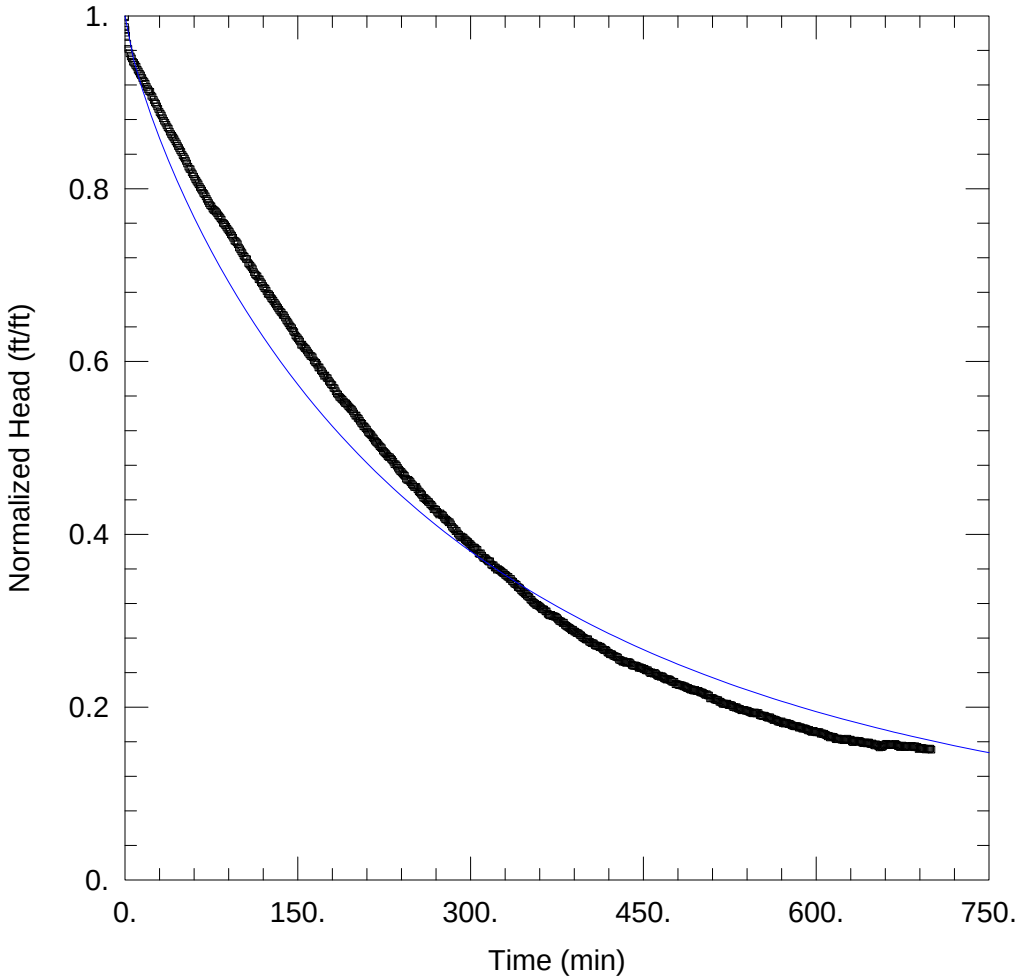
Saturated Thickness: 24. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (Shaft 2)

Initial Displacement: 1.55 ft
Total Well Penetration Depth: 22.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 22.5 ft
Screen Length: 10. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.335E-8 ft/sec
y0 = 1.298 ft



SHAFT 2 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_2_Test_1.aqt
Date: 05/11/18 Time: 09:24:13

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 2 Test 1

AQUIFER DATA

Saturated Thickness: 24. ft Anisotropy Ratio (Kz/Kr): 0.1

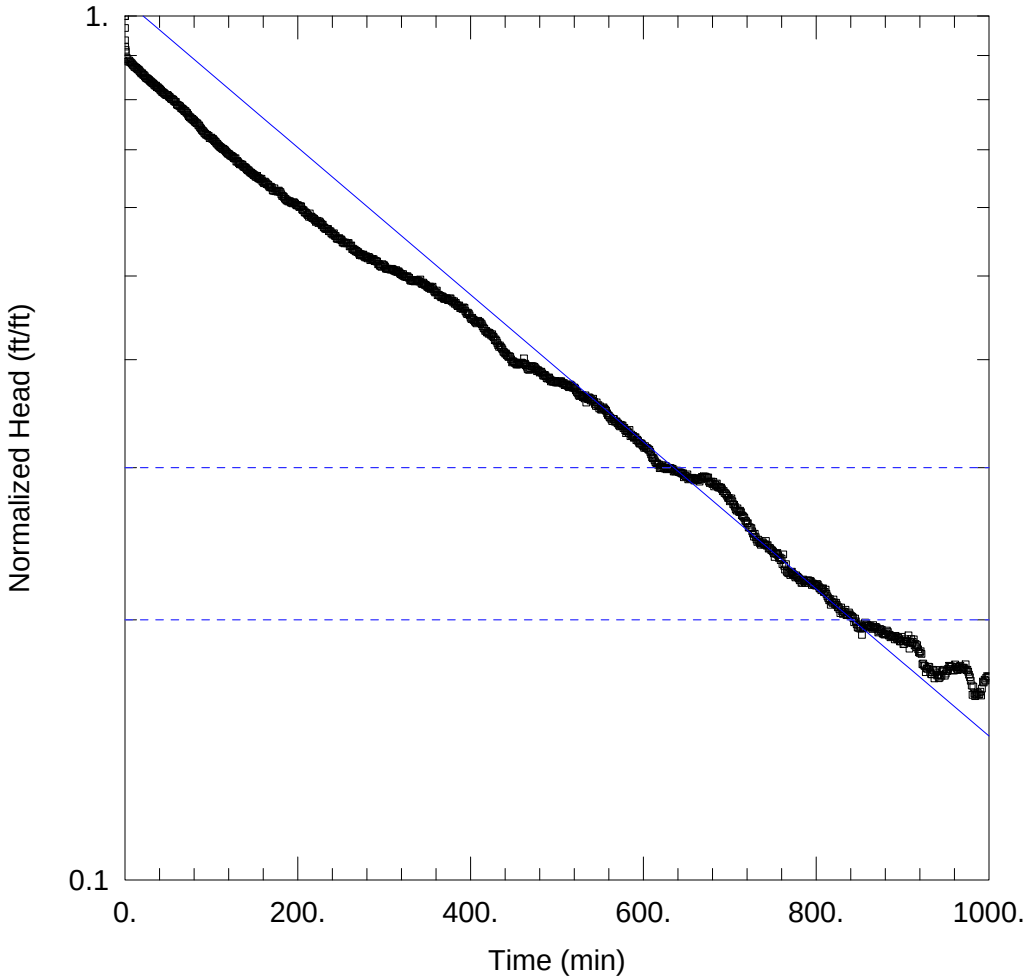
WELL DATA (Shaft 2)

Initial Displacement: 1.55 ft Static Water Column Height: 22.5 ft
Total Well Penetration Depth: 22.5 ft Screen Length: 10. ft
Casing Radius: 0.0833 ft Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Bredehoeft-Papadopulos

T = 7.03E-7 ft^2/sec S = 0.001



SHAFT 2 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_2_Test_2.aqt
Date: 05/11/18 Time: 09:31:15

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 2 Test 2

AQUIFER DATA

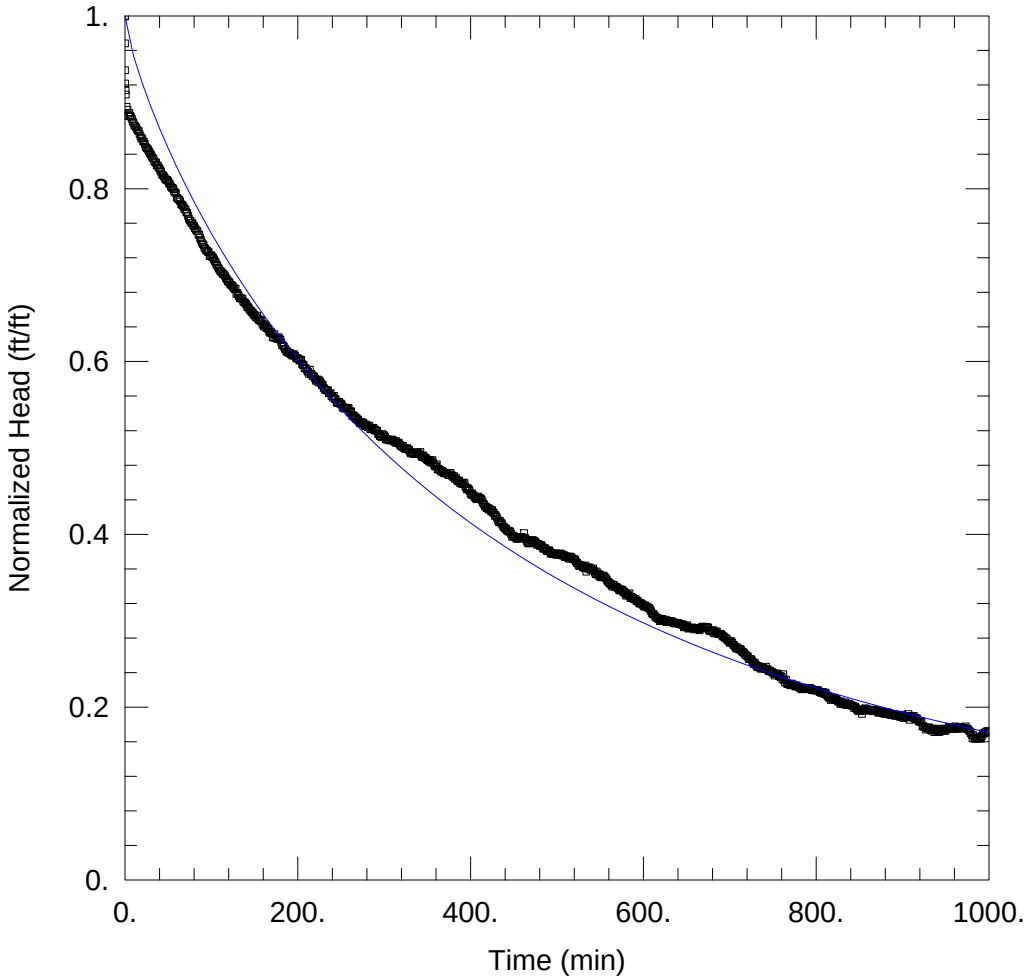
Saturated Thickness: 24. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (Shaft 2)

Initial Displacement: 1.29 ft
Total Well Penetration Depth: 22.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 22.5 ft
Screen Length: 10. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 5.307E-8 ft/sec
y0 = 1.344 ft



SHAFT 2 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_2_Test_2.aqt
Date: 05/11/18 Time: 09:29:59

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 2 Test 2

AQUIFER DATA

Saturated Thickness: 24. ft Anisotropy Ratio (Kz/Kr): 0.1

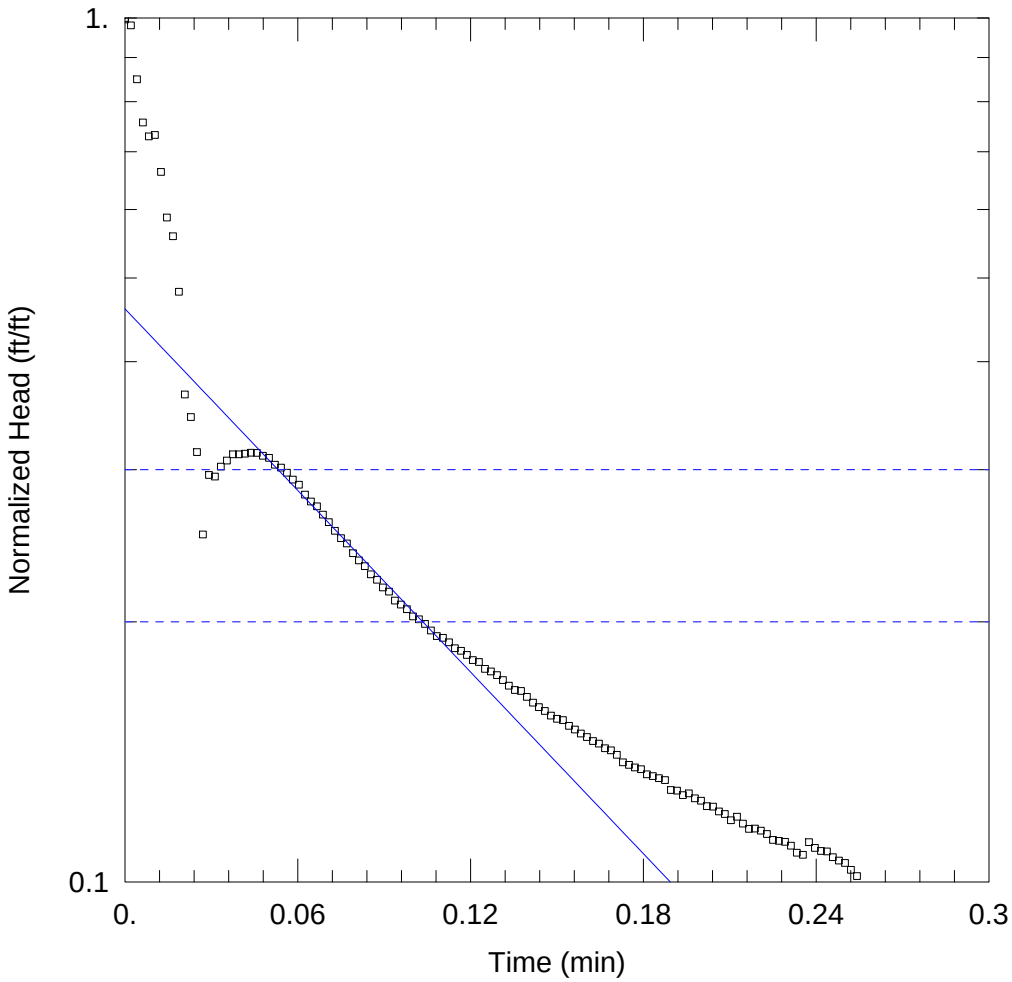
WELL DATA (Shaft 2)

Initial Displacement: 1.29 ft
Total Well Penetration Depth: 22.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 22.5 ft
Screen Length: 10. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 4.705E-7 ft^2/sec
S = 0.001



SHAFT 3 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_1.aqt
Date: 05/11/18 Time: 09:50:30

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 1

AQUIFER DATA

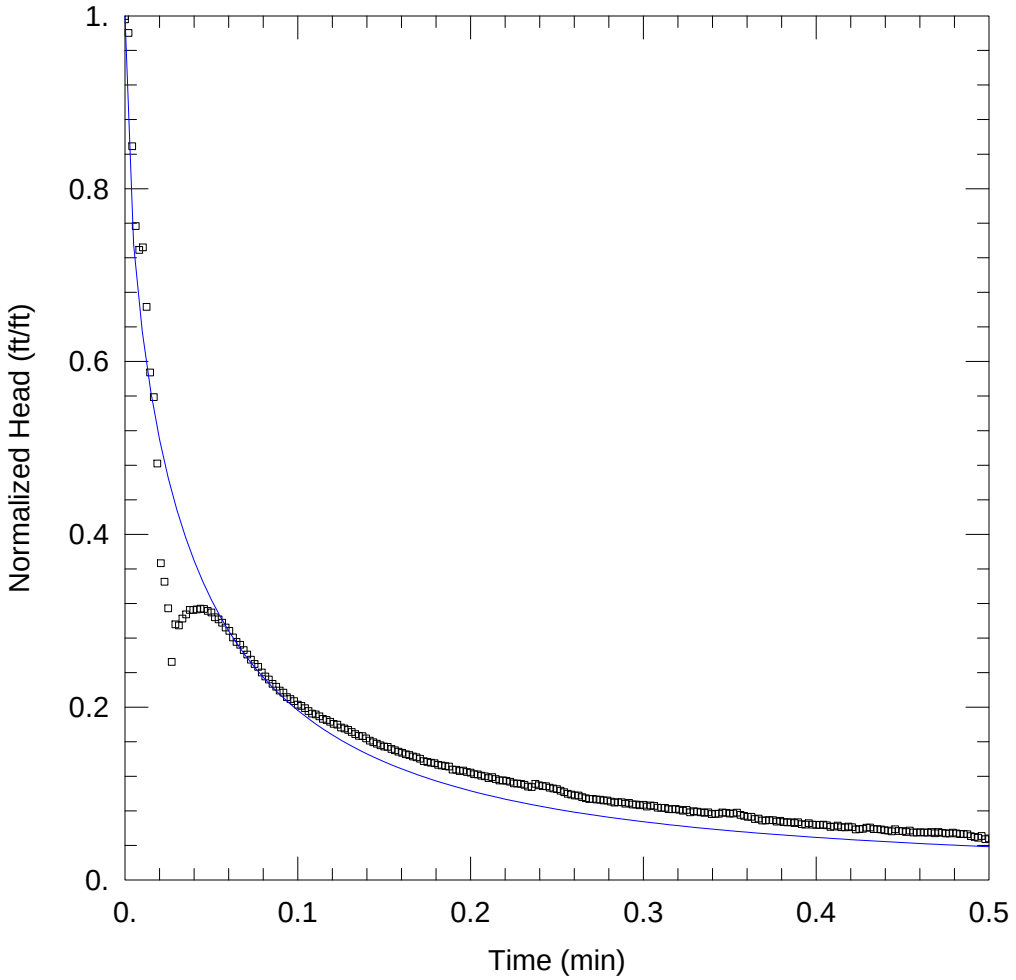
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 1.35 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.122E-5 ft/sec
y0 = 0.6217 ft



SHAFT 3 TEST 1

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_1.aqt
Date: 05/11/18 Time: 09:48:36

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 1

AQUIFER DATA

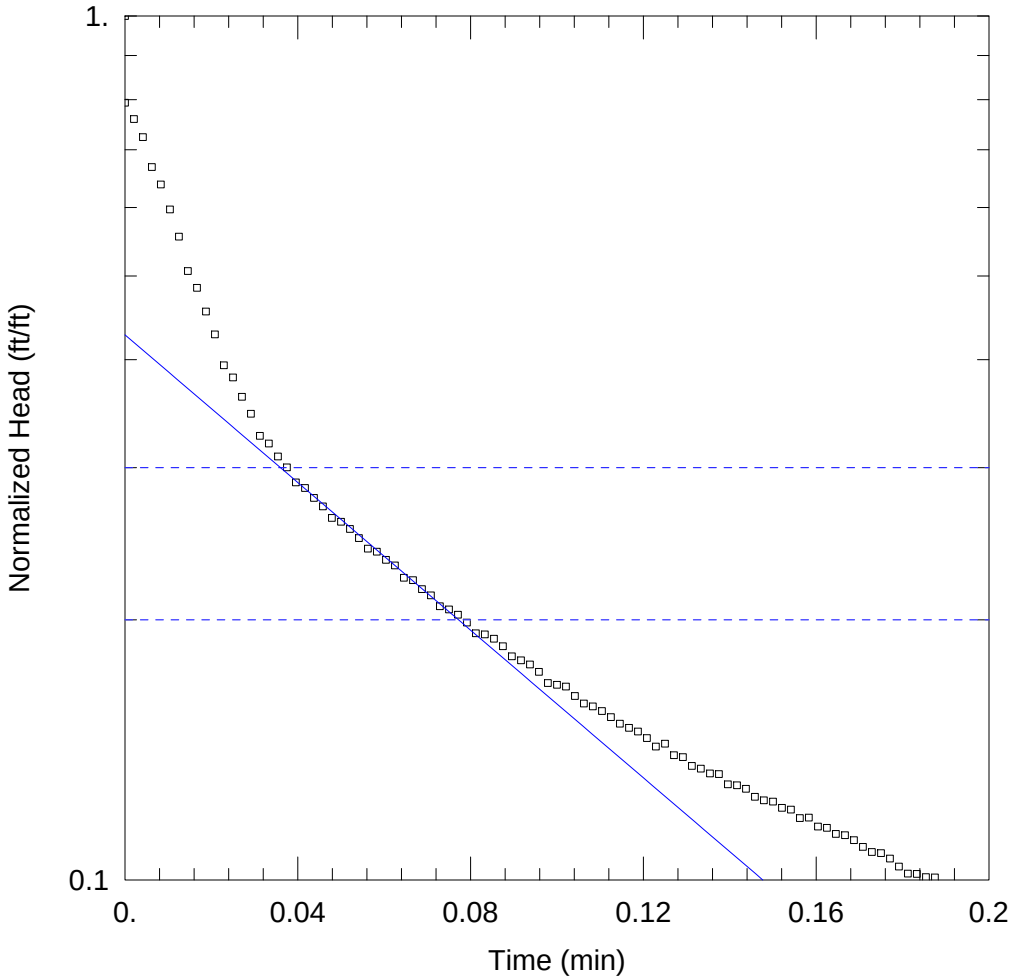
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 1.35 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.001795 ft^2/sec
S = 0.1



SHAFT 3 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_2.aqt
Date: 05/11/18 Time: 10:02:13

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 2

AQUIFER DATA

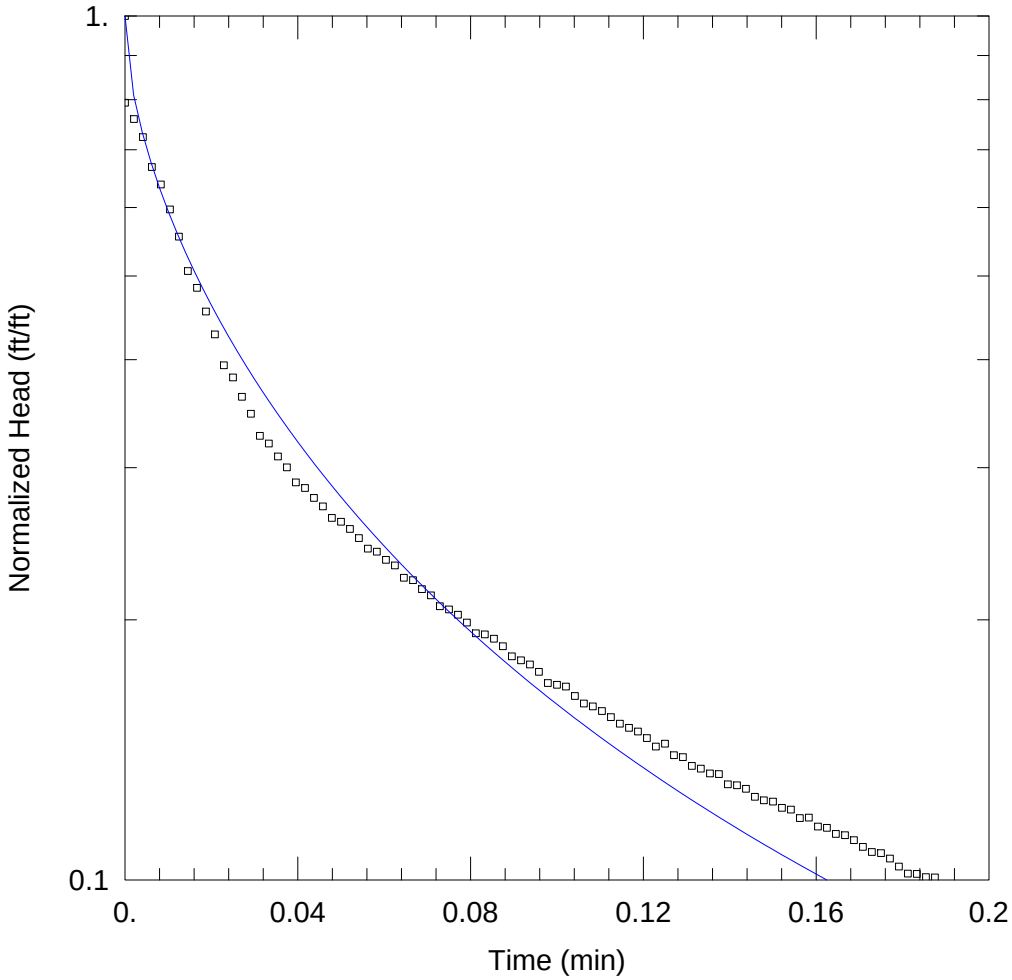
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 1.35 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 8.686E-5 ft/sec
y0 = 0.5771 ft



SHAFT 3 TEST 2

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_2.aqt
Date: 05/11/18 Time: 10:03:12

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 2

AQUIFER DATA

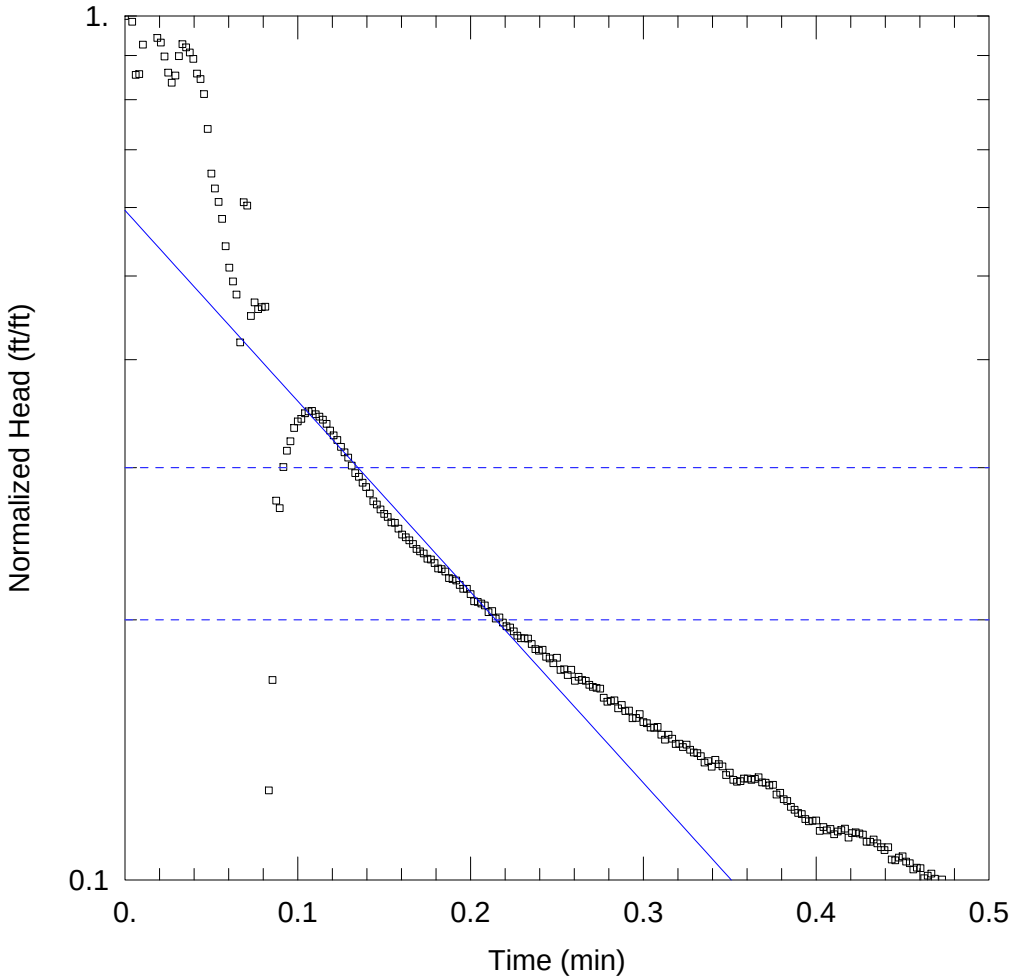
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 1.35 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.002278 ft^2/sec
S = 0.1



SHAFT 3 TEST 3

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_3.aqt
Date: 05/11/18 Time: 10:34:44

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 3

AQUIFER DATA

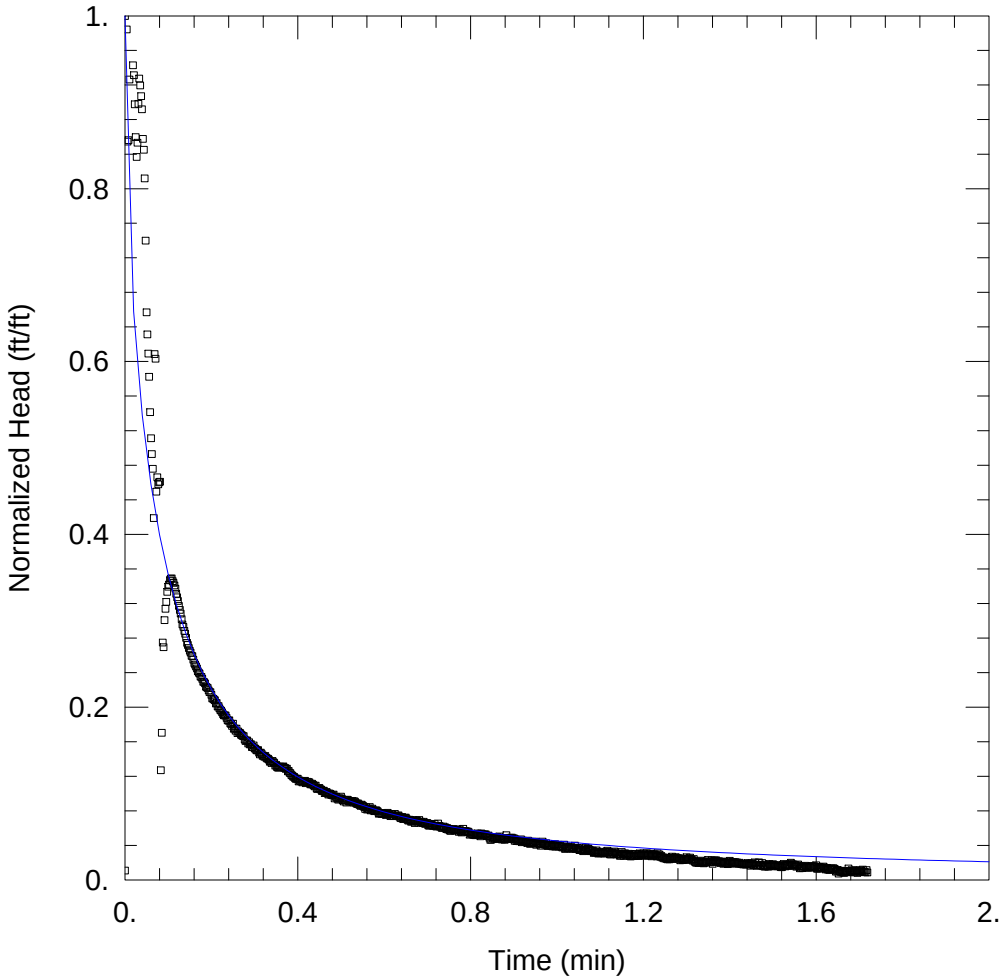
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 0.88 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 4.49E-5 ft/sec
y0 = 0.5241 ft



SHAFT 3 TEST 3

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_3.aqt
Date: 05/11/18 Time: 10:33:16

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 3

AQUIFER DATA

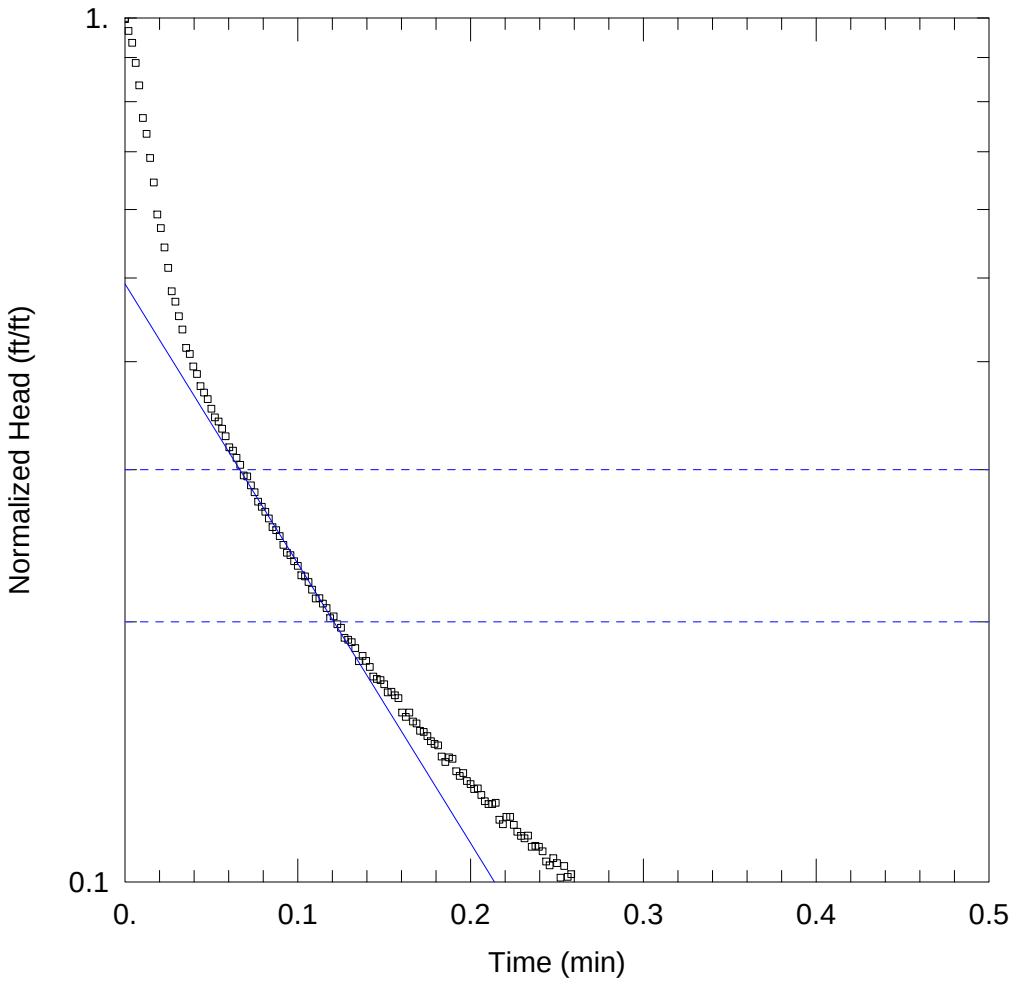
Saturated Thickness: 87. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 0.88 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 0.000776 ft^2/sec
S = 0.1



SHAFT 3 TEST 4

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_4.aqt
Date: 05/11/18 Time: 10:42:12

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 4

AQUIFER DATA

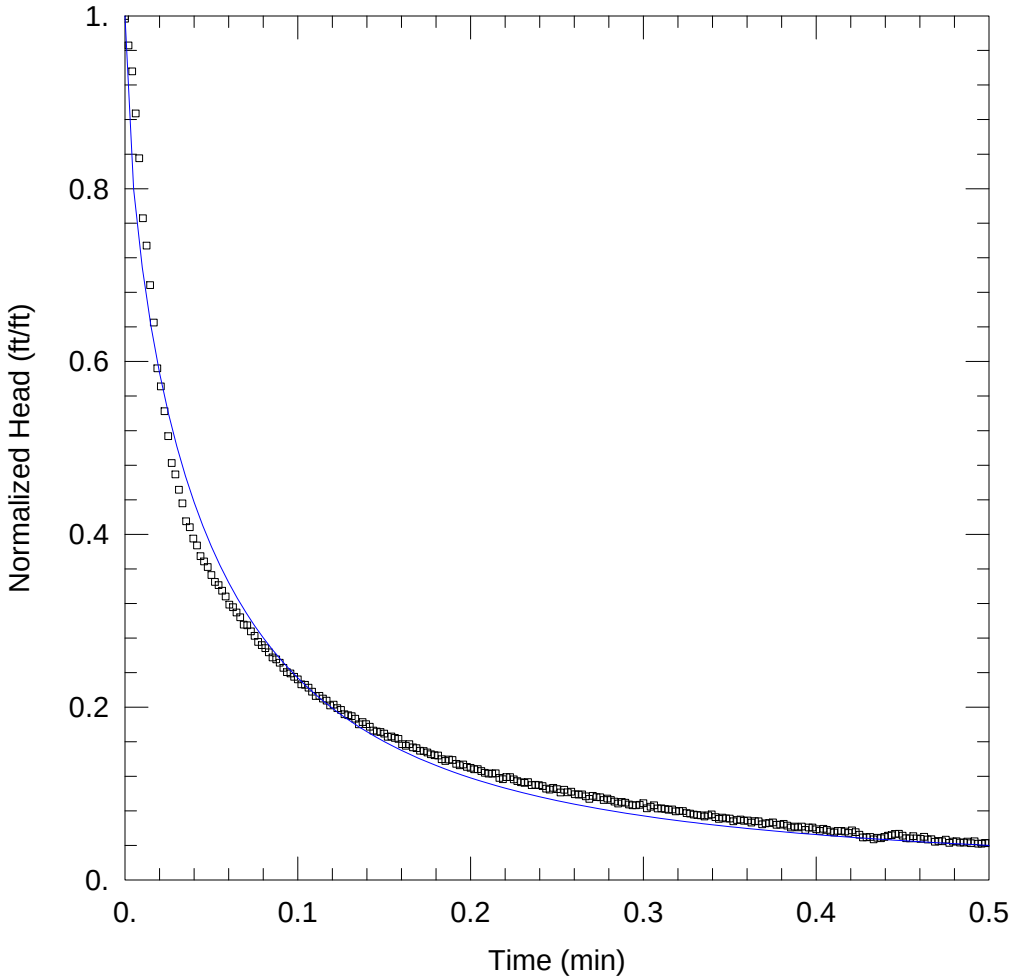
Saturated Thickness: 87. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 0.95 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 6.579E-5 ft/sec
y0 = 0.4676 ft



SHAFT 3 TEST 4

Data Set: \\Us1229-f01\shared_projects\173409058\Rev 1\Shaft_3_Test_4.aqt
Date: 05/11/18 Time: 10:41:10

PROJECT INFORMATION

Company: Stantec
Project: 173409058
Test Well: Shaft 3 Test 4

AQUIFER DATA

Saturated Thickness: 87. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Shaft 3)

Initial Displacement: 0.95 ft
Total Well Penetration Depth: 26.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.5 ft
Screen Length: 25. ft
Well Radius: 0.1096 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.001914 ft^2/sec
S = 0.03669

Appendix H HYDROGEOLOGIC TESTING SUMMARY REPORT

PROJECT MEMORANDUM
DETAILED DESIGN: HYDROGEOLOGY – R2

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TO:	Elie Sabbagh, Stantec	**LAST REVISED DATE:**	January 15, 2019-R2-Final
FROM:	James Carroll, MarshWagner		
COPIES:	For distribution by Stantec Stantec Project #: 173409058	**PROJECT:** **ITI PROJECT #:**	Big Walnut Phase 2 15001
		RE:	Detailed Design: Hydrogeology

Introduction

This Technical Memorandum (TM) provides the results of hydrogeologic analyses performed for the Big Walnut Phase 2 project. The scope of these analyses comprised the following:

Pumping test analyses: Type curve methods were used to analyze pumping test data collected by Resource International Inc. (RII) in order to estimate hydraulic conductivities and storativities of the soil and bedrock materials surrounding the shaft sites.

Dewatering analyses: Analytical well-hydraulics methods were used to estimate pumping rates that would be required to lower the water table at each shaft, should dewatering be allowed for shaft construction. (Or alternatively, the rates at which groundwater would seep into the excavations if no groundwater control were implemented.) These analyses incorporate the hydraulic conductivities and storativities estimated via the pumping test analyses.

Drawdown analyses: The analytical well hydraulics analyses were extended to estimate how far the water table would be drawn down in the regions surrounding the shaft sites. These would serve as a basis for estimating potentially adverse impacts of construction dewatering on nearby water wells and/or on the foundations of nearby building structures.

The reader is referred to the Geotechnical Data Report (GDR) for boring logs and other geotechnical data referenced to in this memorandum. The pumping test analyses were based on field measurements obtained by RII. The field measurement data can be found in the Appendix H of the GDR and is not provided herein. Plan view diagrams of the individual pump well and observation well locations can also be found in Appendix H of the GDR. One source of geotechnical information used within this TM can be found in Appendix A, where the geologic profile of each shaft site is provided. Information regarding slug test results at shaft sites can be found within Appendix G of the GDR.

No pump test analysis for Shaft 2A and Shaft 2 were completed as part of this TM. Pump test results of these general areas are discussed within the Phase 1 Hydrogeologic Investigation for the Phase I Big Walnut Sanitary Trunk Sewer, Eagon and Associates Inc. report (Eagon Report March 10, 2003), Appendix D of this memorandum. Additionally, modeling inputs for the dewatering and drawdown analyses of Shafts 2A and 2 were taken from the Eagon Report.

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The remainder of the report is broken into specific shaft sites where test results and evaluation are grouped by shaft site, followed by the anticipated impacts to residential wells.

Shaft 1 – Soil Aquifer

Two pump tests were performed to interpolate the groundwater aquifer at Shaft 1. The results of these test were used to determine the aquifer characteristics hydraulic conductivity and storativity. The results of the first pump test completed during the RII field work, CRT 1 – Pumping, was not used for analysis due to fluctuations in the water surface caused by a non-recirculating pump in a nearby pond. The second pump test completed by RII, CRT-2 Pumping, was completed with the pond well turned off and was used for all modeling solutions discussed herein.

The CRT-2 pump test was conducted at Shaft 1 with wells screened as shown in Appendix A. Observations Wells (OW) were screened within the soil at Elevations between 917.8 ft – 953.8 ft. For a plan view of well placement in relationship to Shaft 1 see Appendix B of this report. The pump well (PW-1) was an open hole from 46-55 feet deep (Elevation 917 ft – 926 ft) within the decomposed bedrock rock zone. The pump well was laid out to be within the soil but due to the bedrock topography in the area, the planned depth encountered decomposed rock for the full well screen length in the field rather than soil. Even though this was the case, the pump test did in fact provide important information regarding the decomposed rock (shale), as it shows that it was conductive enough to allow pumping and generate drawdown noted in the surrounding observation wells. The following physical and spatial well details shown in Table 1 were used within the pump test and dewatering analysis.

Table 1 Shaft 1 Pump Well and Observation Well Details

	Screen Length (ft)	Screen Type	Radial Distance from PW (ft)	Geologic Material
PW1	46	8 inch Dia. Casing, open hole in bedrock	-	Decomposed Bedford Shale
OW1	20	2 inch slotted PVC	24.8	Non-Cohesive Soil: SP,SW,GP,GM
OW2	20		19.6	
OW3	15		105.36	
OW4	20		83.72	
OW5	15		42.0	

During the pump test at Shaft 1 the groundwater table was drawn down an average of 6 feet over all pump and observation wells to an elevation 962 ft at PW-1 while pumping at a rate of 23 gpm for 24-hours. The time and draw down data for each of the monitoring wells, OW-1 through OW-5, was used to establish the wells transmissivity and storage coefficient. Using a curve matching process, time and draw down data was graphed against several different aquifer models to determine type of aquifer (confined, unconfined, partial penetrating etc.). Once the aquifer type was determined, a best fit was optimized

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through the AquiferWin32 software package giving an estimated transmissivity and storage coefficient. An example of this is shown in Figure 1 below where OW-3 is modeled against the Theis, 1935 aquifer model. This procedure was used to determine the transmissivity and storage coefficient for all OWs at Shaft 1, as can be seen in Table 2 below.

Figure 1: Shaft 1 – OW3 Curve Matching example

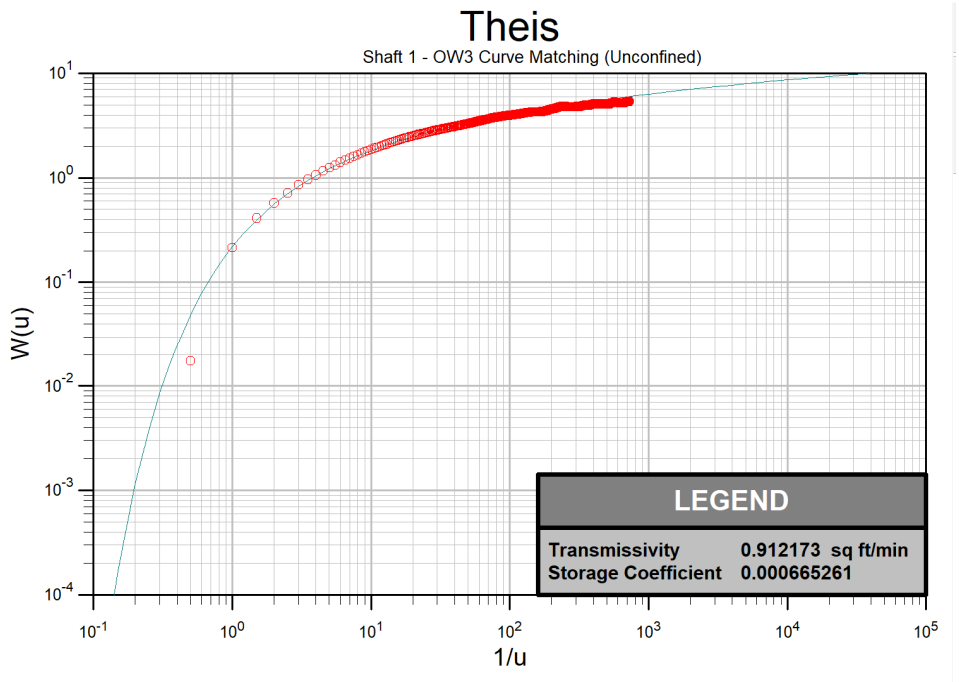

Table 2 Shaft 1 Pump Test Testing Results				
	Transmissivity (gpd/ft)	Hydraulic Conductivity* (cm/sec)	Storage Coefficient	Specific Storage (1/ft)
Shaft 1 Geometric Mean* / Average	1.01E+04*	1.19E-02*	1.14e-03	2.84e-05
OW1	1.12E+04	1.32E-02	8.00E-04	2.00E-05
OW2	1.60E+04	1.89E-02	3.12E-03	7.79E-05
OW3	9.80E+03	1.16E-02	6.65E-04	1.66E-05
OW4	8.08E+03	9.52E-03	6.56E-04	1.64E-05
OW5	7.32E+03	8.63E-03	4.49E-04	1.12E-05
PW1**	5.78E+02	6.81E-04	1.12E-05	2.80E-07

*Geometric mean reported in place of average

** Data point not included in reported Geometric Mean or Average.

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Using the results shown in Table 2, a theoretical aquifer model was built to determine the required number of pumping wells, and the required pump rate to lower the ground water level 40 feet below the existing ground water table at Shaft 1 to an elevation of 935 ft. Lowering 40 feet will provide dry conditions for the construction Shaft 1.

The theoretical aquifer model was built around the Neuman, 1972 solution in AquiferWin 32 Flow Model. The model solution for lowering the groundwater within the aquafer included four pump wells placed 20 feet apart in a square configuration around Shaft 1. Each of the four pump wells was set to a constant pump rate of 120 GPM. Each pump well has a diameter of 6 inches, the top of the screened interval was set at a depth of 6.5 feet from the ground surface, and with 40 feet of screen (Bottom of screen set at a depth of 46.5 ft). In addition, optimizing the transmissivity and storage coefficient in the model, the parameters also took into account the aquifers specific yield (assumed to be 0.2) and the Beta/(r*r) ratio (assumed to be 1). A sensitivity analysis of the Beta/(r*r) ratio was done by adjusting the ratio a few magnitudes above and below one, and no real change in the model results were noted. The optimized transmissivity was found to be 0.975 sqft/min (1.05E+04 gpd/ft). No optimization was found for the storage coefficient of 1.14E-03.

To get an idea of the local effects on the ground water table a draw down cone of depression was calculated. Appendix B, Shaft 1 Cone of Depression, indicates the cone of depression around the shaft excavation, as well as Figure *2* below. The modeled cone of depression for Shaft 1 shows a large area of potentially impacted local wells, a detailed plan view of the Shaft 1 Cone of Depression over the BWSTE Phase 2 alignment can be found in Appendix B.

Note that wells immediately west of Shaft 1 where bedrock rises, and limited permeable ground exists may not recover if dewatered. Wells within this project area are known to be sensitive to changes in groundwater levels due to the age of the wells and recovery properties of the local aquifers, as discussed in the Phase 1 Big Walnut Sanitary Trunk Sewer, Eagon and Associates March 10, 2003 (Eagon Report) sections 2.6 and 8.3

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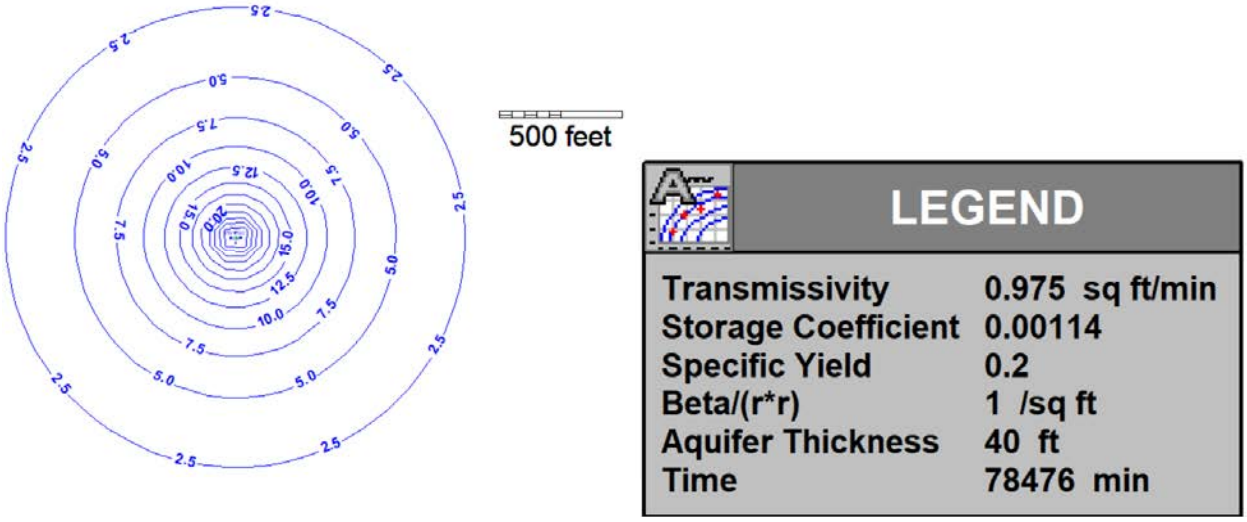
Figure 2: Shaft 1 Cone of Depression



A cone of depression will form if the ground water surface is lowered at Shaft 1 in any attempt to dewater the area for shaft construction. During the hydrogeologic investigation three (3) residential wells were located during pump tests at Shaft 1. Of these three, only the pond well was monitored, which was found to have a water surface drop of 1.33 ft. Further desktop investigation showed that up to approximately 21 wells are within the 2.5 feet drawdown zone, see Appendix B Shaft 1 Cone of Depression Overlay. As discussed above, is anticipated that any change in ground water levels to existing wells may affect those wells and they may not recover. The flow model discussed here, indicates that one of the wells may be affected by as much as 23.5 feet of drawdown. Details on these 21 wells can be found within Appendix C of this TM and are designated by yellow highlighting.

It should be noted that during the construction of the BWSTE Phase 1 project, residents near Manhole #0646S494 were impacted by construction dewatering and alternative means of potable water were provided. Due to the sensitivity of wells in the project area, changes to the groundwater table may negatively affect residential wells.

Due to the sensitive nature of existing residential wells, large cone of depression effecting these wells, known previous construction impacts to residential wells and low chance of well recovery under dewatering conditions, dewatering of Shaft 1 for the construction of the shaft must be avoided.

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Shaft 1 – Bedrock Aquifer

Hydraulic conductivity of the bedrock around Shaft 1 was tested utilizing the in-situ packer test method for the full length of all coring runs for all geologic borings. Details on the packer testing procedures and results can be found within the project GDR Appendix D – Packer Test Results. For the Shaft 1 zone, tests that return a value greater than zero flow during packer testing are shown in the Table 3 below. Note that not all tests returned a value, as many were found to be zero flow(0.0 cm/sec).

Table 3: Shaft 1 Associated Packer Test Values

Boring	Test Interval by Depth Range (ft)	Associate Rock Unit	Average Hydraulic Conductive, K (cm/sec)
B-38 / Shaft 1	47 – 56.8	Decomposed Bedford Shale Zone	7.07E-07
B-16	152 – 162	Ohio Shale	4.33E-08
B-17	126.5 – 136.5	Bedford Shale	1.08E-07
B-17	136.5 – 146.5	Bedford Shale	3.67E-07
B-17	146.5 – 156.6	Bedford / Ohio Shale Contact	5.57E-07
B-17	156.5 – 166.5	Ohio Shale	1.15E-06
B-17	166.5 – 176.5	Ohio Shale	5.58E-07
Overall Average			4.94E-07

From the packer tests we see that the hydraulic conductivity is quite low and well within the anticipated rage of 1 x 10 -11 to 1 x 10-7 cm/s.

Shaft 2A - Soil Aquifer

Data for pump testing at Shaft 2A was compiled from the Eagon Report and B-47 drilled as part of the BWSTE Phase 2 geotechnical investigation. As part of the Eagon Report, pump testing was not completed within the soil aquifer zone, and no soil details are available at this site. Two borings were completed at this site as part of the Eagon Report investigation; boring FTB-20 was a geotechnical boring, boring FTB-29 was drilled approximately 10 feet from FTB-20 specifically for the hydrogeologic investigation using a rotary wash tricone bit. As FTB-29 was completed with a tricone bit no usable geotechnical samples for soil characterization were recovered. The geotechnical data gathered in FTB-20 is assumed to be the same for FTB-29, and boring B-47 also shows similar geologic conditions to FTB-20. The soil descriptions from FTB-20 consist of; very stiff clay from 0 to 3 ft, very stiff to hard silty clay from 3 to 6 ft, followed by Berea sandstone to 50 ft in depth. From a review of the boring logs mentioned the soils can be expected to be impermeable at the Shaft 2A site.

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Shaft 2A - Bedrock Aquifer

Bedrock information within Shaft 2A is taken from the Eagon Report and Phase 2 boing B-47. The site geologic information from boring FTB-20 indicated Berea Sandstone from 6 to 50 ft, Berea Sandstone/Bedford Shale from 50 to 123 ft, Bedford Shale from 123 to 165 ft and Ohio shale from 165 ft to the bottom of the boring at 189 ft. Note that the Big Walnut Phase 2 Tunnel is located at a depth of approximately 170 ft to 180 ft. Due to the lack of aquifers present in the Bedford and Ohio shale the Eagon report only investigated the aquifer potential for the Berea Sandstone.

Discussions are presented on the Berea Sandstone formation, within section 4 of the Eagon Report. The Eagon Report found that the hydraulic conductivity for FTB-29 was 9.04 x 10^{-2} cm/sec, higher than values found during the Phase 2 investigation for the Berea Sandstone formation at the Phase 2 Shaft 3. Within Section 8 of the Eagon Report, the report states the following in regard to the Berea formation in the Shaft 2A area

> … FTB-29 on the interval from 22.5 to 45.0 feet was 1.5 x 10-5 cm/sec (318 gpm/ft). This is the highest value obtained for the Berea within the project area [Phase 1]. This shaft location [Phase I – Shaft 5] is also in the area along Lee Road where residential well survey results reveal that Berea wells are most productive.

For the purpose of modeling groundwater flow, the Eagon Report identified the hydraulic conductivity ranging from 1.5 x 10-2 cm/sec at the Phase 1 Shaft 5 site, or Shaft 2A on the BWSTE Phase 2 project. The Eagon report identified the saturated thickness of the Berea Sandstone aquifer at 44 feet thick, with a transmisivity of 5000 gpd/ft. Note these reported values are much higher than other areas due to the high transmissivity found at FTB-29. These values were used by Eagon to model the ground water drawdown where the Eagon Report model indicated at 10 to 7 feet of drawdown at 500 to 1,000 ft from Phase 1 Shaft 5 location.

In an effort to reproduce the draw down effects from the Eagon Report under construction dewatering conditions at Shaft 2A, Marsh Wagner (MW) modeled the Eagon information within AquifirWin32 Flow Model. The MW model was setup as a Neuman, 1972 model used to determine the required number of wells and the pumping rate to lower the groundwater table below the existing aquifer at a depth below surface of 50 ft. An aquifer thickness of 40 ft was used to match that of the Eagon Report.

The MW flow model estimate to draw the groundwater below the 50 ft depth, required 4 wells 20 feet apart in a square configuration around Shaft 2A. Each of the pump wells was set to a constant pump rate of 68 GPM. The wells were modeled with a diameter of 6 inches, screen top depth of 6 feet below ground surface, and 44 feet of screen length, for a total of 50 feet in depth below ground surface. In addition to optimizing the transmissivity and storage coefficient in the model, the parameters also considered the aquifers specific yield assumed to be 0.06 (from Eagon) and the Beta/(r*r) ration assumed to be 1.

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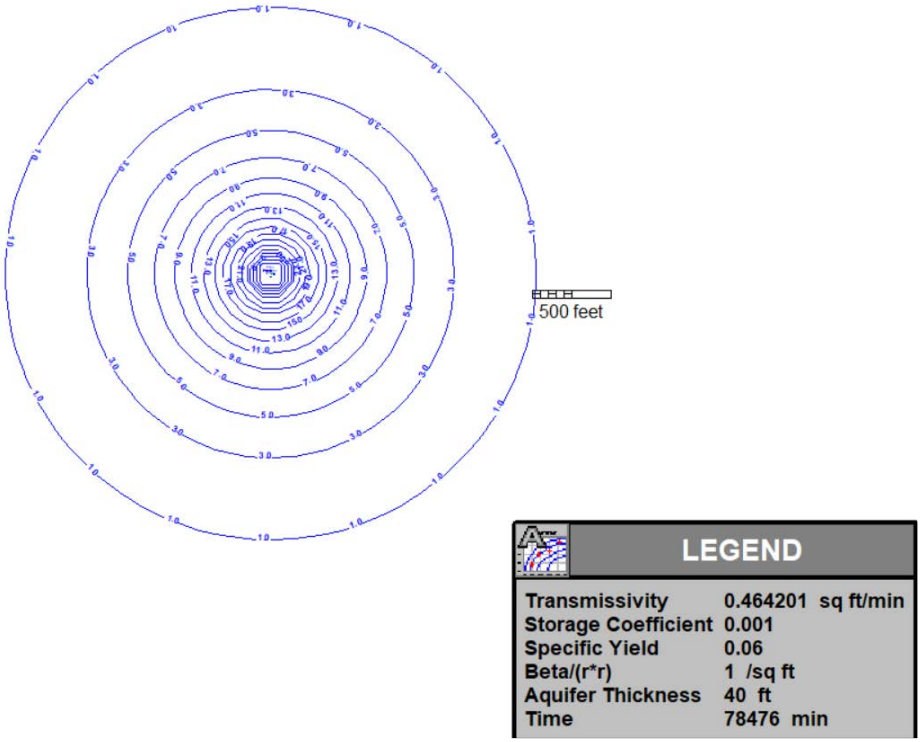
To get an idea of the local effects on the ground water table, a draw down cone of depression was produced as part of the modeling effort. Appendix B, Shaft 2A Cone of Depression, indicates a large cone of depression around the Shaft 2A excavation with local wells in the area impacted. This cone of depression from the AquiferWin32 flow model is Figure *3* shown below. This cone of depression for Shaft 2A indicates a drawdown of 50.6 ft at the shaft, and 11 to 4 ft at 500 to 1000 feet from the shaft site.

Figure 3: Shaft 2A Cone of Depression



The bedrock within Shaft 2A was not tested for hydraulic conductivity by packer test beyond the Berea sandstone layer as part of the Eagon report. The hydraulic conductivity of the rock unit found during the packer testing of Phase 2 boing B-47 ranges from; 1.8x10-3 to 1.8x10-4 cm/sec within the Berea, 3.87x10-6 to 1.13x10-3 cm/sec within the Bedford and 6.3x10-4 to 9.9x10-4 cm/sec within the Ohio Shale.

It should be noted that the local perched zones are common in the Berea Sandstone and joints/fractures may not have been encountered during the geotechnical investigation. If found during construction activities, these features can be expected to drain quickly and recharge with rain. Should one of the local wells be connected the perched aquifer though a joint, the well may be affected more than the model indicates during construction activities.

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Shaft 2 - Soil Aquifer

Data for pump testing at Shaft 2 was compiled from the Hydrogeologic Investigation Report for the Phase 1 Big Walnut Sanitary Trunk Sewer, Eagon and Associates March 10, 2003 (Eagon Report). As part of the Eagon Report pump test were not completed within the soil aquifer zone as such no details are available of the soils at the site. Two borings were completed at this site as part of the Eagon Report investigation; boring FTB-23 was a geotechnical boring, and boring FTB-30 was drilled approximately 10 feet from FTB-23 specifically for the hydrogeologic investigation using a rotary wash tricone bit. As FTB-30 was completed with a tricone bit no usable geotechnical information was recovered. The geotechnical data gathered in FTB-23 is assumed to be the same for FTB-30. The soil from FTB-23 consists of; hard to very stiff clay in the top 6 ft, medium dense silt from 6 to 9 ft, medium stiff clayey silt from 9 to 11.5 ft, a seam of gravel from 11.5 to 12.2 ft, and medium stiff clayey silt from 12.2 to 15.5 ft. From these it is assumed that the only water producing zone may be within the pervious gravel layer from 11.5 to 12.2 ft, all other soil units are impermeable.

Shaft 2 - Bedrock Aquifer

Bedrock information within Shaft 2 is taken from the Eagon Report. At this site, geologic information from boring FTB-23 indicated Berea Sandstone from 15.5 to 40 ft, Bedford Shale/Berea Sandstone from 40 to 75 ft, Bedford Shale from 75 to 153 ft and Ohio shale from 75 ft to the bottom of the boring at 170 ft. Note that the Big Walnut Phase 2 Tunnel is located at a depth of approximately 154 ft to 164 ft at Shaft 2. Due to the lack of aquifers present in the Bedford and Ohio shale the Eagon report only investigated the aquifer potential for the Berea Sandstone.

Discussions are presented on the Berea Sandstone formation within Section 4 of the Eagon Report. The hydraulic conductivity for FTB-30 was 5.8 x 10^{-4} cm/sec, slightly higher than values found for the Berea Sandstone formation at the Phase 2 Shaft 3 under the BWSTE Phase 2 investigation. Within Section 8 of the Eagon Report the impacts to local residential wells due to proposed construction of Part 1 Big Walnut Sanitary Sewer 6F1 Shaft 6 was discussed. For the purpose of modeling ground water flow, the Eagon Report identified the hydraulic conductivity ranging from 3.0 x 10-4 cm/sec to 5.4 x 10-4 cm/sec at the Phase 1 Shaft 6 site or Shaft 2 on the BWSTE Phase 2 project. Further the Eagon report identified the saturated thickness of the Berea Sandstone aquifer at 24.5 feet thick, with a transmisitive of 940 gpd/ft. These values were used to model the ground water drawdown in the Eagon Report modeling at 3 to 6.5 feet for at a distance of 500 to 1,000 ft from BWSTE 1 Shaft 6.

In an effort to reproduce the draw down effects from the Eagon Report under construction dewatering conditions at Shaft 2, MW modeled the Eagon information within AquifirWin32 Flow Model. The MW model was setup as a Neuman, 1972 model used to determine the required number of wells and the pumping rate to lower the groundwater table below the existing aquifer at a depth below surface of 40 ft. This depth arises from the 15.5 feet of soil overlaying the Berea Formation which is reported to end at 40 ft in depth.

The MW model solution to draw the groundwater below the 40 ft depth, required 4 wells 20 feet apart in

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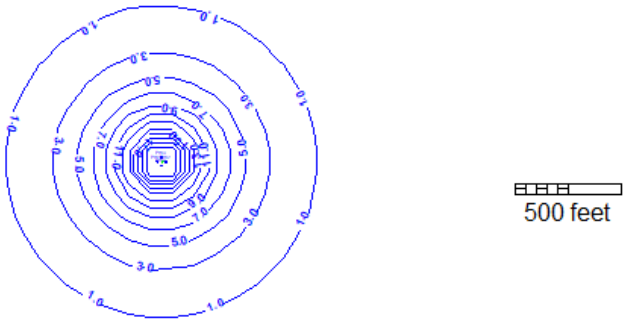
a square configuration around Shaft 2 at the cemetery. Each of the pump wells was set to a constant pump rate of 13 GPM. The wells were modeled with a diameter of 6 inches, screen top depth of 20 feet below ground surface, and 20 feet of screen length, for a total of 40 feet in depth from ground surface. In addition to optimizing the transmissivity and storage coefficient in the model, the parameters also considered the aquifers specific yield assumed to be 0.06 (from Eagon) and the Beta/(r*r) ratio assumed to be 1.

To get an idea of the local effects on the ground water table a draw down cone of depression was produced as part of the MW modeling effort. Appendix B, Shaft 2 - Cone of Depression, indicates a small cone of depression around the shaft excavation with local wells in the area impacted. This cone of depression is also shown in Figure *4* below. This cone of depression for Shaft 2 indicates a drawdown of 40.8 ft at the shaft, and 3.1 to 0.25 ft at 500 to 1000 feet from the shaft site.

Figure 4: Shaft 2 Cone of Depression



The bedrock within Shaft 2 was not tested for hydraulic conductivity by packer test beyond the Berea sandstone layer.

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It should be noted that the local perched zones are common in the Berea Sandstone and joints/fractures may not have been encountered during the geotechnical investigation. If found during construction activities, these features can be expected to drain quickly and recharge with rain. Should one of the local wells be connected to a perched aquifer through a joint, the well may be affected during construction activities more than indicated in the modeling discussed above.

Shaft 3 – Soil Aquifer

One pump test at Shaft 3 was conducted in the top of decomposed Berea Sandstone. The pump well was screened 10 – 59 feet below ground surface at elevations 987.6 – 938.6 ft as shown in Appendix A. Three observation wells were installed with screens a depth of 15.5 to 57.4 feet below the ground surface (elevations 979.86 ft - 944.2ft). The following physical and spatial well details shown in Table 4 below, were used within the pump test and dewatering analysis.

Table 4: Shaft 3 Pump Well and Observation Well Details

	Screen Length (ft)	Screen Type	Radial Distance from PW (ft)	Geologic Material
PW3	40.2	6-inch Dia. open hole in bedrock	-	Decomposed Berea Sandstone
OW10	40.2	3 Dia. casing, open hole in bedrock	25.2	
OW11	38.4		75.1	
OW12	36.9		125.2	

The results from this test were curve-matched in the same manner as described in the Shaft 1 – Soil Aquifer above. The results of the curve matching process for a Theis 1935 aquifer model, established in AquiferWin32, can be seen in Table 5 below. These results are slightly higher than typical transmissivities which range between 3.0E-10 to 6.0E-06 for sandstone formations. However, this can be explained by the decomposed zone screen section included above competent rock.

Table 5: Shaft 3 Pump Test Testing Results

	Transmissivity (gpd/ft)	Hydraulic Conductivity (cm/sec)	Storativity	Specific Storage (1/ft)
Shaft 3 Geometric Mean* or Average	1.35E+03*	1.82E-03*	7.03E-04	2.01E-05
OW10	9.76E+02	1.31E-03	5.41E-04	1.55E-05
OW11	1.18E+03	1.59E-03	1.16E-03	3.30E-05
OW12	2.14E+03	2.88E-03	4.13E-04	1.18E-05
PW3**	1.09E+03	1.47E-03	4.62E-03	1.32E-04

** Data point not included in reported Geometric Mean or Average.

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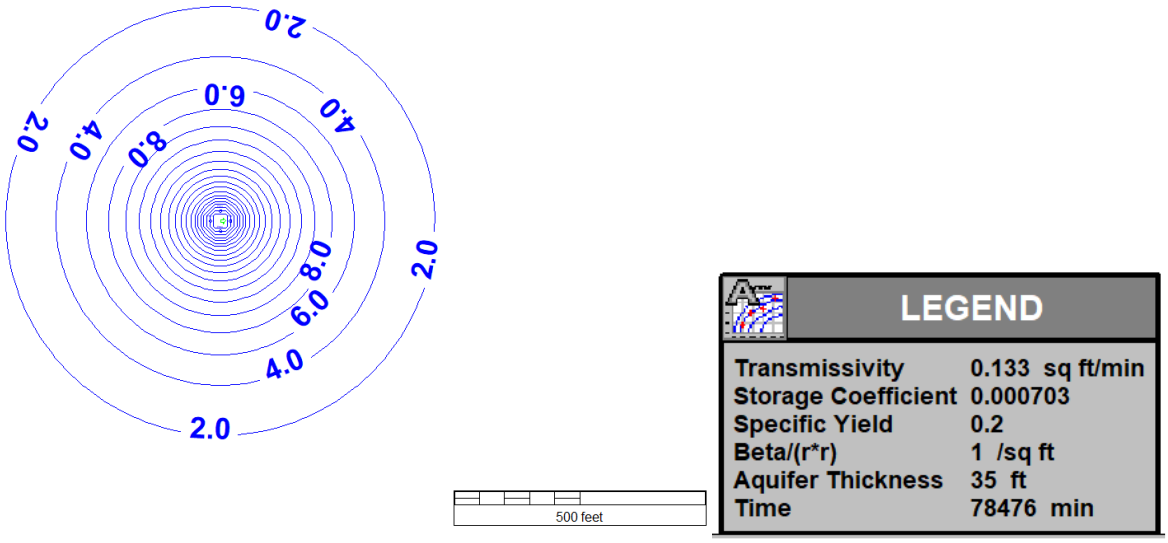
During the Shaft 3 pump test, the pumping was able to draw the groundwater table down over 14 feet to elevation 981 ft at a 12 GPM pumping rate for 24-hours in PW-2. Using this coupled with the data in the tables above a Flow model with a Neuman, 1972 simulation was set up in AquiferWin32 to determine the required number of wells and pumping rate to lower the groundwater table below the existing aquifer at a depth below ground surface of 35 ft.

The model solution to draw the groundwater below the 35 ft depth, required 4 wells 20 feet apart in a square configuration around Shaft 3. Each of the pump wells was set to a constant pump rate of 2 GPM. The wells were modeled with a diameter of 6 inches, screen top depth of 5 feet, and 35 feet of screen length, for a total of 40 feet in depth. In addition to optimizing the transmissivity and storage coefficient in the model, the parameters also considered the aquifers specific yield (assumed to be 0.2) and the Beta/(r*r) ratio (assumed to be 1). The optimized transmissivity was found to be 0.133 sqft/min (1.43x10^3 gpd/ft). No optimization was found for the storage coefficient of 7.03x10^-4.

To get an idea of the local effects on the ground water table a draw down cone of depression was calculated, see Figure *5* below. Appendix B, Shaft 3 Cone of Depression, indicates a small cone of depression around the shaft excavation with local wells in the area impacted.

Figure 5: Shaft 3 Cone of Depression



During the hydrogeologic investigation no residential wells were monitored for the pump tests at Shaft 3. However, desktop investigation shows that four wells may be affected under the assumed dewatering conditions above. Details on these wells can be found within Appendix C of this TM and are designated by yellow highlighting.

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Due to the sensitivity of residential wells in the project area under dewatering conditions and the variability of the sandstone fractures encountered, more wells may be impacted than noted if dewatering is utilized during construction. For these reasons it is recommended to avoid dewatering during the construction of Shaft 3.

Shaft 3 - Bedrock Aquifer

Hydraulic conductivity of the bedrock around Shaft 3 was by in-situ packer test for the full length of all core runs. Details on the packer testing procedures and results can be found within the project GDR Appendix D – Packer Test Results. Packer tests that returned a value greater than zero flow are shown in Table 6 below. Note that not all test returned a value, as many were found to be zero flow.

Table 6: Shaft 3 Associated Packer Test Values

Boring	Test Interval by Depth Range (ft)	Associate Rock Unit	Average Hydraulic Conductive, K (cm/sec)
B-40 / Shaft 3	33 – 43	Decomposed Berea	4.01E-06
B-40 / Shaft 3	43 – 53	Berea / Bedford	5.87E-07
B-40 / Shaft 3	73 – 83	Berea / Bedford	4.28E-07
Overall Average			1.67E-06

From the packer test we see that the hydraulic conductivity is quite low when in competent rock and only slightly higher in the weathered/decomposed rock zones. The values in the Berea/Bedford zone are within the anticipate rage of 1 x 10 -11 to 1 x 10-7 cm/s.

It should be noted that the local perched zones are common in the Berea Sandstone and joints/fractures may not have been encountered during the geotechnical investigation. If found during construction activities, these features can be expected to drain quickly and recharge with rain. Should one of the local wells be connected to a perched aquifer by a joint, the well may be affected more than the models indicate during construction activities.

Conclusion - Number of Impacted Wells

Due to the fragile nature of residential wells in the project area when placed under dewatering conditions it is recommended to avoid dewatering during construction of the Phase 2 project for all shaft sites. Should dewatering be required or requested by the contractor further analysis of the contractors dewatering plan should be completed at that time. Monitoring of residential wells against the contractor's plan and implementation of a contractor's proposed mitigation program is also suggested if dewatering is allowed.

Appendix C is a database of wells within the project area that may be impacted during construction. The most susceptible wells at each shaft are highlighted in yellow within Appendix C. Wells within one mile

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that may be affected are also listed. The total number of susceptible wells for each shaft discussed within this TM are shown in Table 7.

Table 7: Potential Range of Impacted Wells

	Number of Wells Most Susceptible to be Impacted	Number of Wells Within 1 mile of Shaft
Shaft 1	21	159
Shaft 2A	34	55
Shaft 2 @ Cemetery	9	50
Shaft 3	4	10

References

AquiferWin32 Version 5.03 64-bit, Doug Rumbaugh and Jim Rumbaugh copy right 1997-2017 Environmental Simulations, Inc.

Neuman, S.P., 1972, Theory of flow in unconfined aquifers considering delayed response of the watertable, Water Resources Research, vol. 8, pp 1031-1045.

Theis, C.V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Trans. Amer. Geophys. Union, Vol. 16, pp. 519-524.

Hydrogeologic Investigation for the Big Walnut Sanitary Trunk Sewer Extension, Eagon and Associates Inc. Worthington, Ohio, March 10, 2003

RII technical memorandum Big Walnut Sewer Tunnel Extension – Phase 2 Hydrogeologic Data Report, 10/24/2018.

Project Memorandum
Detailed Design: Hydrogeology

Appendix A: Geologic Shaft Profiles

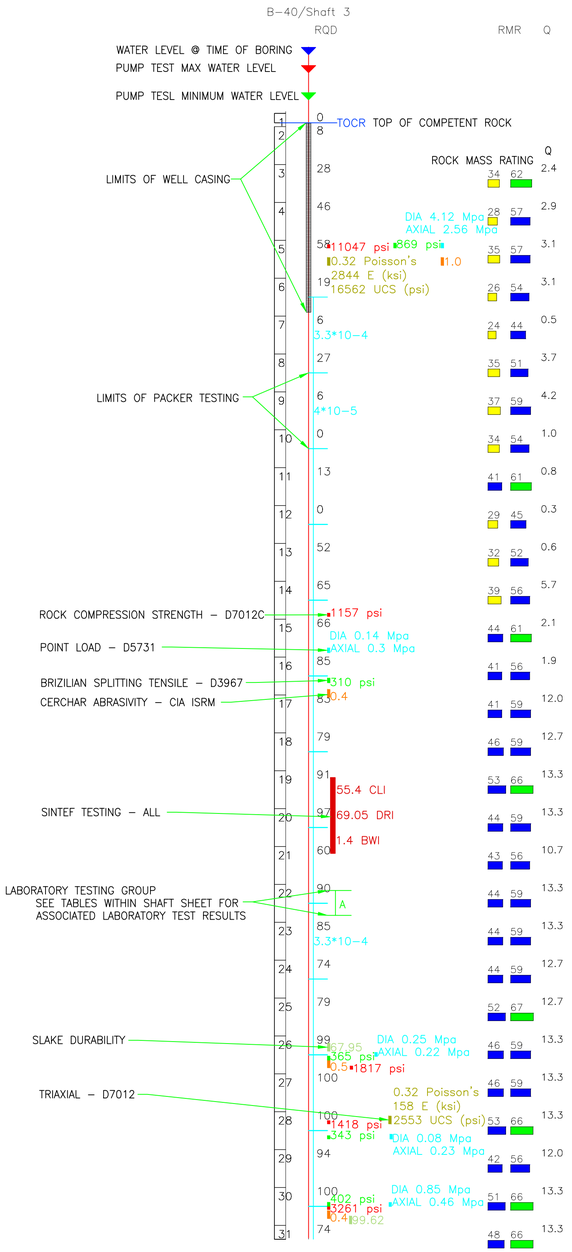
GEOLOGIC BORING LOG SYMBOLS LEGEND:

- WATER LEVEL @ TIME OF BORING
- PUMP TEST MAX WATER LEVEL
- PUMP TESL MINIMUM WATER LEVEL
- LIMITS OF WELL CASING
- 0.0 — LIMITS OF PACKER TESTING
- A — LABORATORY TESTING GROUP
  SEE TABLES WITHIN SHAFT SHEET FOR
  ASSOCIATED LABORATORY TEST RESULTS
- 1064.0 psi — BRIZILIAN SPLITTING TENSILE – D3967
- 0.4 — CERCHAR ABRASIVITY – CIA ISRM
- DIA 1.1 Mpa / AXIAL 3.88 Mpa — POINT LOAD – D5731
- 5232.0 psi — ROCK COMPRESSION STRENGTH – D7012C
- 55.4 CLI / 69.05 DRI / 1.4 BWI — SINTEF TESTING – ALL
- 0.21 Poisson's / 1016 E (ksi) / 12220 UCS (psi) — TRIAXIAL – D7012
- 98.0 — SLAKE DURABILITY
- TOR — TOP OF ROCK
- TOCR — TOP OF COMPETENT ROCK
- 30 48 0.1 — ROCK MASS RATING Q
  RMR IS PROVIDED IN A RANGE FROM:
  0–20 VERY POOR – RED FILL
  20–40 POOR – YELLOW FILL
  40–60 FAIR – BLUE FILL
  60–80 GOOD – GREEN FILL
  80–100 VERRY GOOD – BLACK FILL

GEOLOGIC PROFILE LEGEND:

- LEAN CLAY – CL
- SILTY SAND – SM
- SILT – ML
- POORLY GRADED SAND – SP
  WELL GRADED SAND – SW
  POORLY GRADDED GRAVEL – GP
  SILTY GRAVEL –GM
- TUNNEL EXCAVATION
- WEATHERED ROCK ZONE
- BEREA SANDSTONE
- BEREA / BEDFORD
- BEDFORD SHALE
- OHIO SHALE

SAMPLE BORING STICK:



GEOLOGIC PROFILE NOTES:

THE GEOLOGIC PROFILE PRESENTED WITHIN THESE DRAWINGS CONTAINS INFORMATION FROM GEOLOGIC BORINGS COMPLETED DURING THE PHASE 1 AND PHASE 2 Big Walnut Sanitary Trunk Sewer Extension (BWSTSE), OHIO DEPARTMENT OF NATURAL RESOURCES WELL LOG INFORMATION AND GEOPHYSICS COMPLETED DURING THE BWSTSE PHASE 2 GEOTECHNICAL INVESTIGATION. FURTHER INFORMATION ON ALL DATA SOURCES CAN BE FOUND WITHIN THE BWSTSE PHASE 2 GEOTECNICAL DATA REPORT (GDR).

GEOLOGIC INTERPRETATIONS PROVIDED WITHIN GEOLOGIC PROFILE ARE JUST THAT, INTERPRETATIONS. BORING LOGS AND LAB RESULTS CAN FOUND WITHIN THE GDR.

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GEOLOGIC PROFILE
GEOLOGIC LEGEND

PROJECT TITLE:

BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033-100002

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	INSPECTOR
	AGREEMENT / COMPLETED
	RPD / CKD / CLD / CON. DR.

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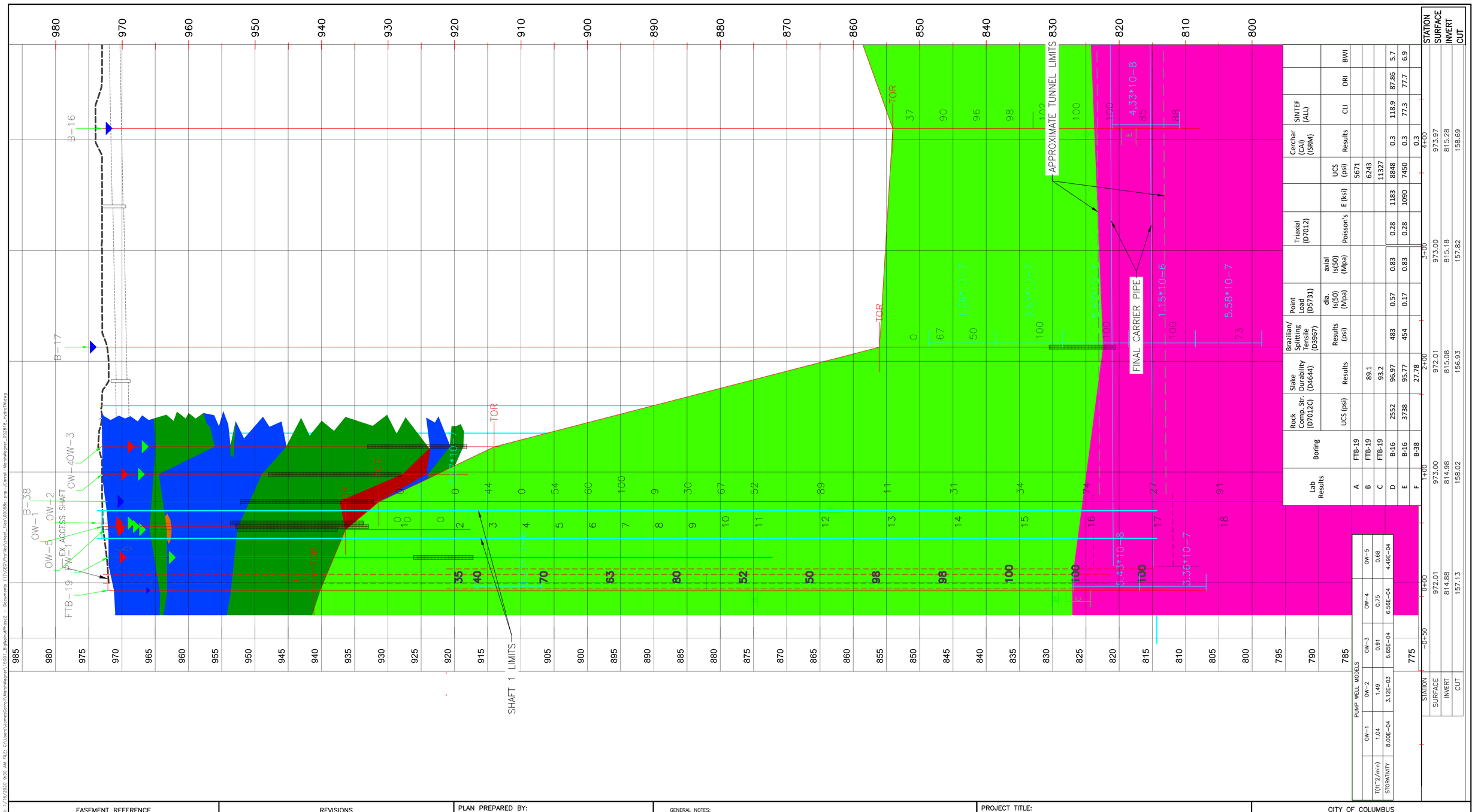

Lab Results	Boring	Rock Comp. Str. (D7012C) UCS (psi)	Slake Durability (D4644) Results	Brazilian/ Splitting Tensile (D3967) Results (psi)	Point Load (D5731) dia. Is(50) (Mpa)	Point Load (D5731) axial Is(50) (Mpa)	Triaxial (D7012) Poisson's	Triaxial (D7012) E (ksi)	UCS (psi)	Cerchar (CAI) (ISRM) Results	SINTEF (ALL) CLI	SINTEF (ALL) DRI	SINTEF (ALL) BWI
A	FTB-19		89.1						5671				
B	FTB-19		93.2						6243				
C	FTB-19								11327				
D	B-16	2552	96.97	483	0.57	0.83	0.28	1183	8848	0.3	118.9	87.86	5.7
E	B-16	3738	95.77	454	0.17	0.83	0.28	1090	7450	0.3	77.3	77.7	6.9
F	B-38		27.78							0.3			

STATION	SURFACE	INVERT	CUT
2+00	972.01	815.08	156.93
3+00	973.00	815.18	157.82
4+00	973.97	815.28	158.69

PUMP WELL MODELS	OW-1	OW-2	OW-3	OW-4	OW-5
T(ft^2/min)	1.04	1.49	0.91	0.75	0.68
STORATIVITY	8.00E-04	3.12E-03	6.65E-04	6.56E-04	4.49E-04

STATION	SURFACE	INVERT	CUT
0+00	972.01	814.88	157.13
1+00	973.00	814.98	158.02
0+50			
0+00			
-0+50			

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GENERAL NOTES:
1. PACKER TESTING WAS COMPLETED IN THE FOLLOWING BORINGS; B-16, B-17, B-38, FTB-19
2. NATURAL GAS NOTED WITH IN BORINGS; B-16

GEOLOGIC PROFILE
SHAFT 1

PROJECT TITLE:

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CAPITAL IMPROVEMENTS PROJECT
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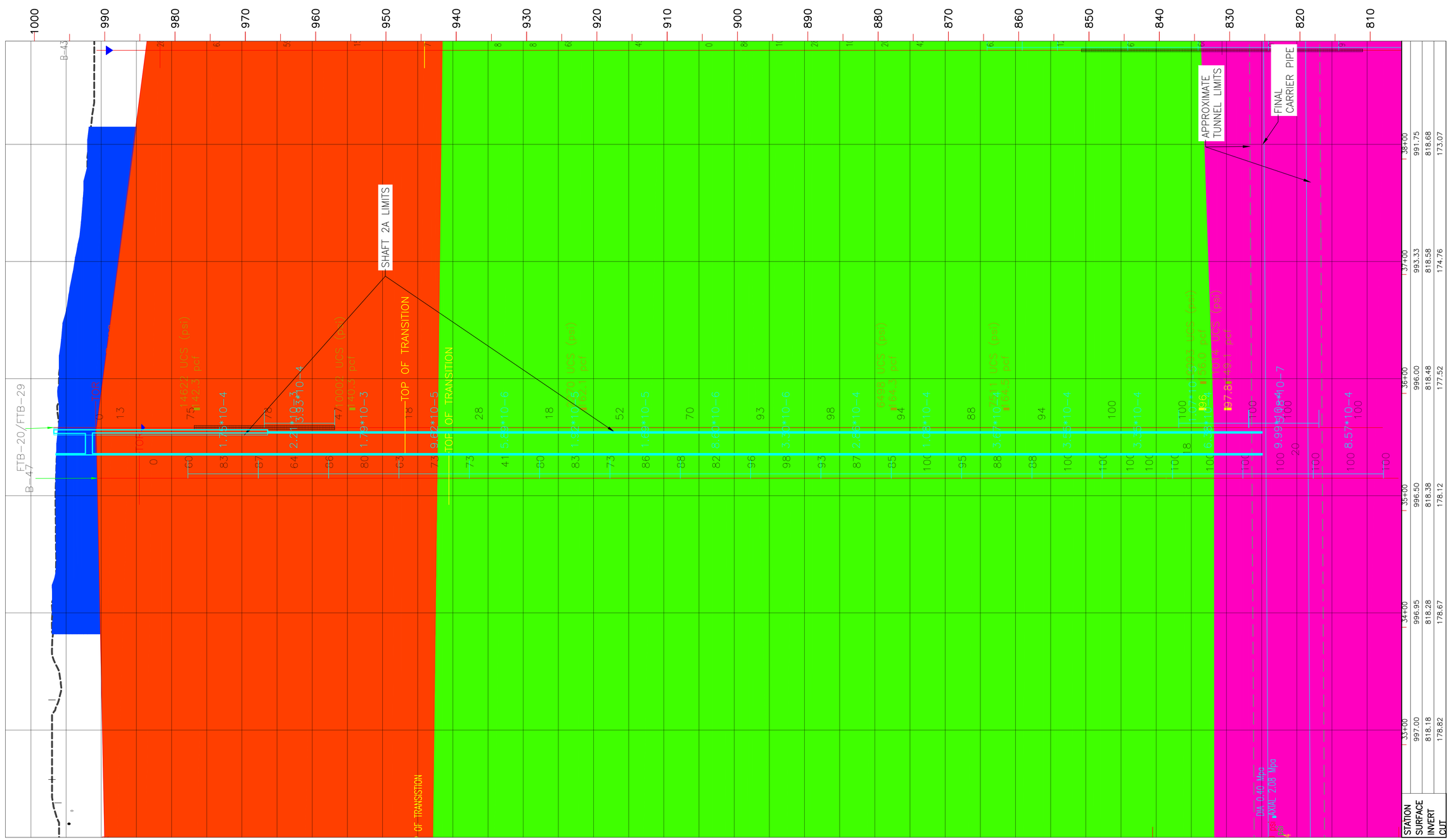

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GENERAL NOTES:
1. PACKER TESTING WAS COMPLETED IN THE FOLLOWING BORINGS; B-47 AND FTB-20
2. NATURAL GAS NOTED WITH IN BORING; B-24

GEOLOGIC PROFILE
SHAFT 2A

PROJECT TITLE:

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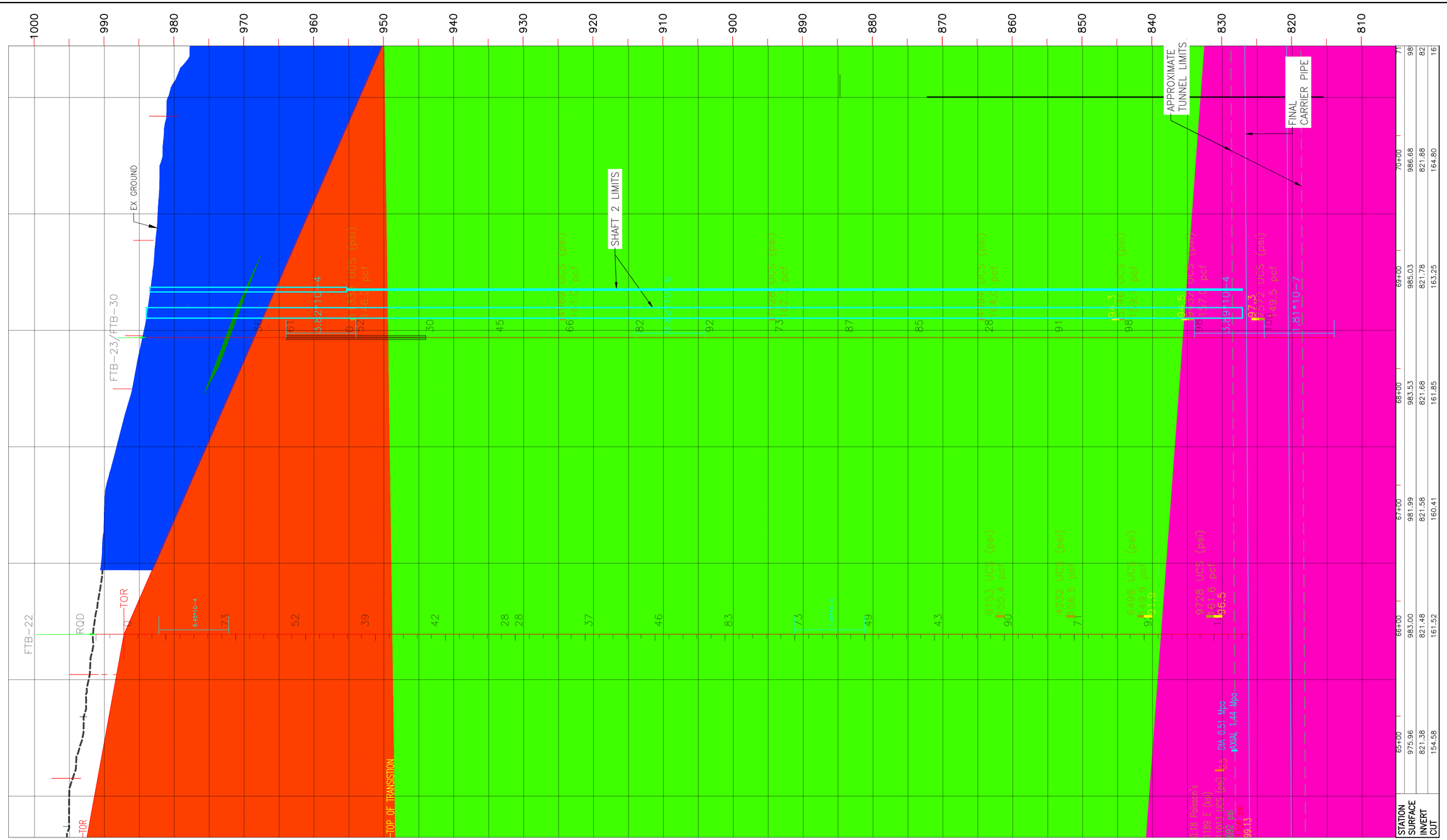

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GENERAL NOTES:
1. PACKER TESTING WAS COMPLETED IN THE FOLLOWING BORINGS; FTB-23, FTB-22

GEOLOGIC PROFILE
SHAFT 2 CEMETERY

PROJECT TITLE:

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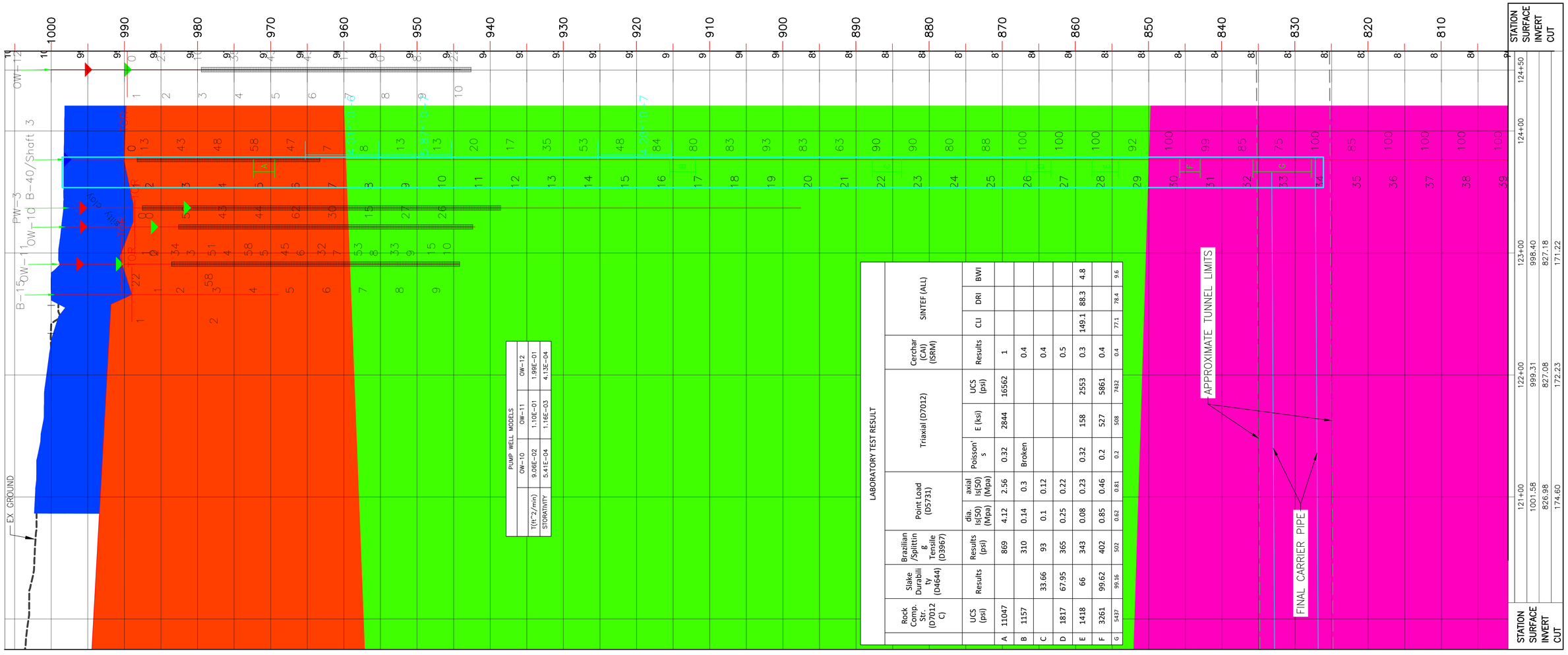

PUMP WELL MODELS

	OW-10	OW-11	OW-12
T(ft^2/min)	9.06E-02	1.10E-01	1.99E-01
STORATIVITY	5.41E-04	1.16E-03	4.13E-04

LABORATORY TEST RESULT

	Rock Comp. Str. (D7012 C)	Slake Durability (D4644)	Brazilian/Splitting Tensile (D3967)	Point Load (D5731)		Triaxial (D7012)			Cerchar (CAI) (ISRM)	SINTEF (ALL)		
	UCS (psi)	Results	Results (psi)	dia. Is(50) (Mpa)	axial Is(50) (Mpa)	Poisson's	E (ksi)	UCS (psi)	Results	CLI	DRI	BWI
A	11047		869	4.12	2.56	0.32	2844	16562	1			
B	1157		310	0.14	0.3	Broken			0.4			
C		33.66	93	0.1	0.12				0.4			
D	1817	67.95	365	0.25	0.22				0.5			
E	1418	66	343	0.08	0.23	0.32	158	2553	0.3	149.1	88.3	4.8
F	3261	99.62	402	0.85	0.46	0.2	527	5861	0.4			
G	5437	99.16	502	0.62	0.81	0.2	508	7432	0.4	77.1	78.4	9.6

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Tel. 614.484.7078
www.marshwagner.com

GENERAL NOTES:
1. PACKER TESTING WAS COMPLETED IN THE FOLLOWING BORINGS; B-40

GEOLOGIC PROFILE
SHAFT 3

PROJECT TITLE:

BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033-100002

DIVISION USE ONLY	OWNER
	CONTRACTOR
	INSPECTOR
	AGREEMENT: RPD / CKD — COMPLETED: CLD / CON. DR.

CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE
DIVISION USE ONLY

SCALE: HORIZ. 1" = 60'
VERT. 1" = 10'

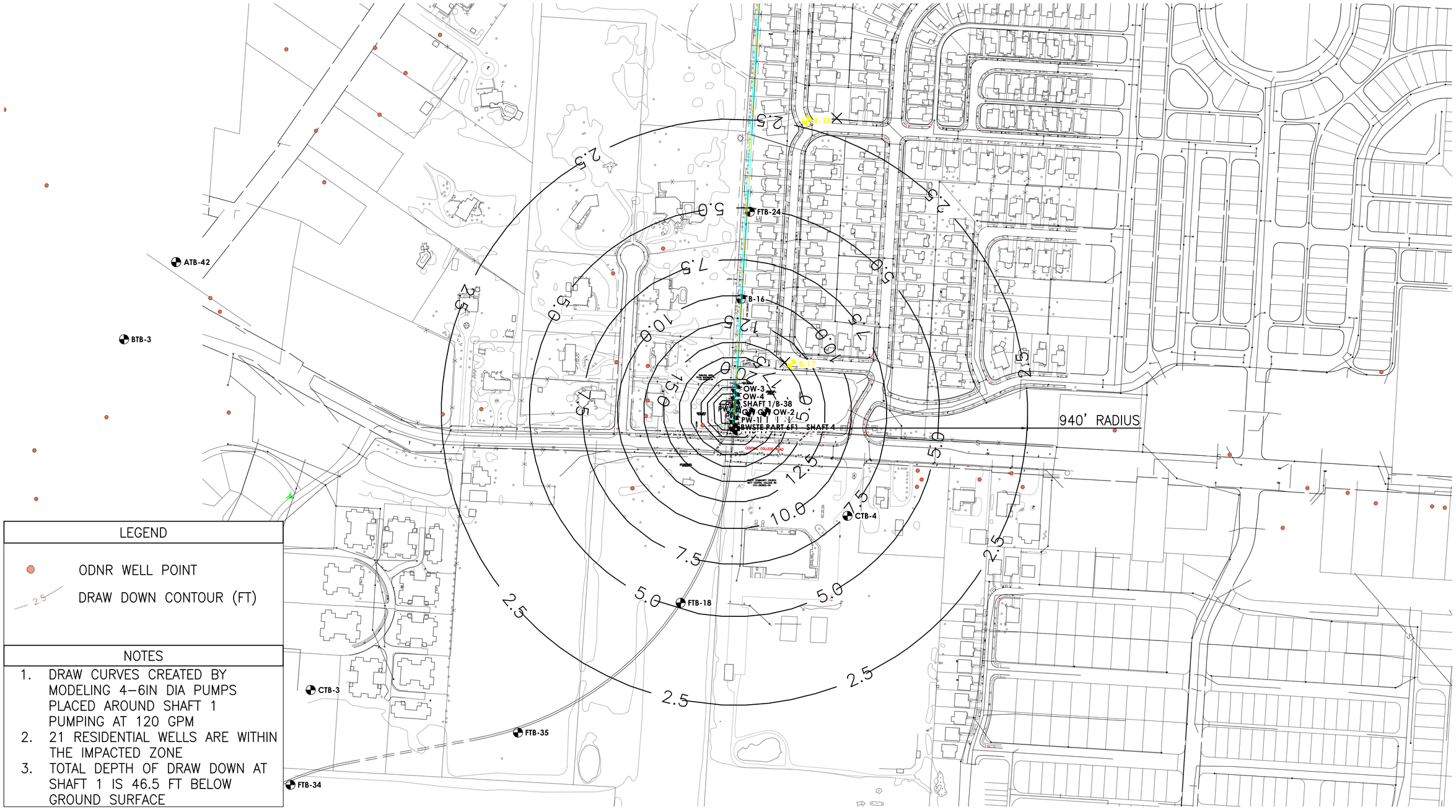
SHEET: GS-3 (XX of XX)

CONTRACT DRAWING NO.
CC-XXXXX

RECORD PLAN NO.

Project Memorandum
Detailed Design: Hydrogeology

Appendix B: Cone of Depressions



LEGEND

ODNR WELL POINT

25 DRAW DOWN CONTOUR (FT)

NOTES

1. DRAW CURVES CREATED BY MODELING 4–6IN DIA PUMPS PLACED AROUND SHAFT 1 PUMPING AT 120 GPM
2. 21 RESIDENTIAL WELLS ARE WITHIN THE IMPACTED ZONE
3. TOTAL DEPTH OF DRAW DOWN AT SHAFT 1 IS 46.5 FT BELOW GROUND SURFACE

EASEMENT REFERENCE			
CITY NO.	COUNTY RECORDER VOL.	COUNTY RECORDER PAGE	GRANTOR

REVISIONS		
NO.	DESCRIPTION	APPROVAL/DATE

PLAN PREPARED BY:

MarshWagner
1201 Dublin Road
Columbus, Ohio 43215
Tel. 614.484.7078
www.marshwagner.com

HYDROGEOLOGY TECHNICAL MEMORANDUM APPENDIX B SHAFT 1 CONE OF DEPRESSION OVERLAY

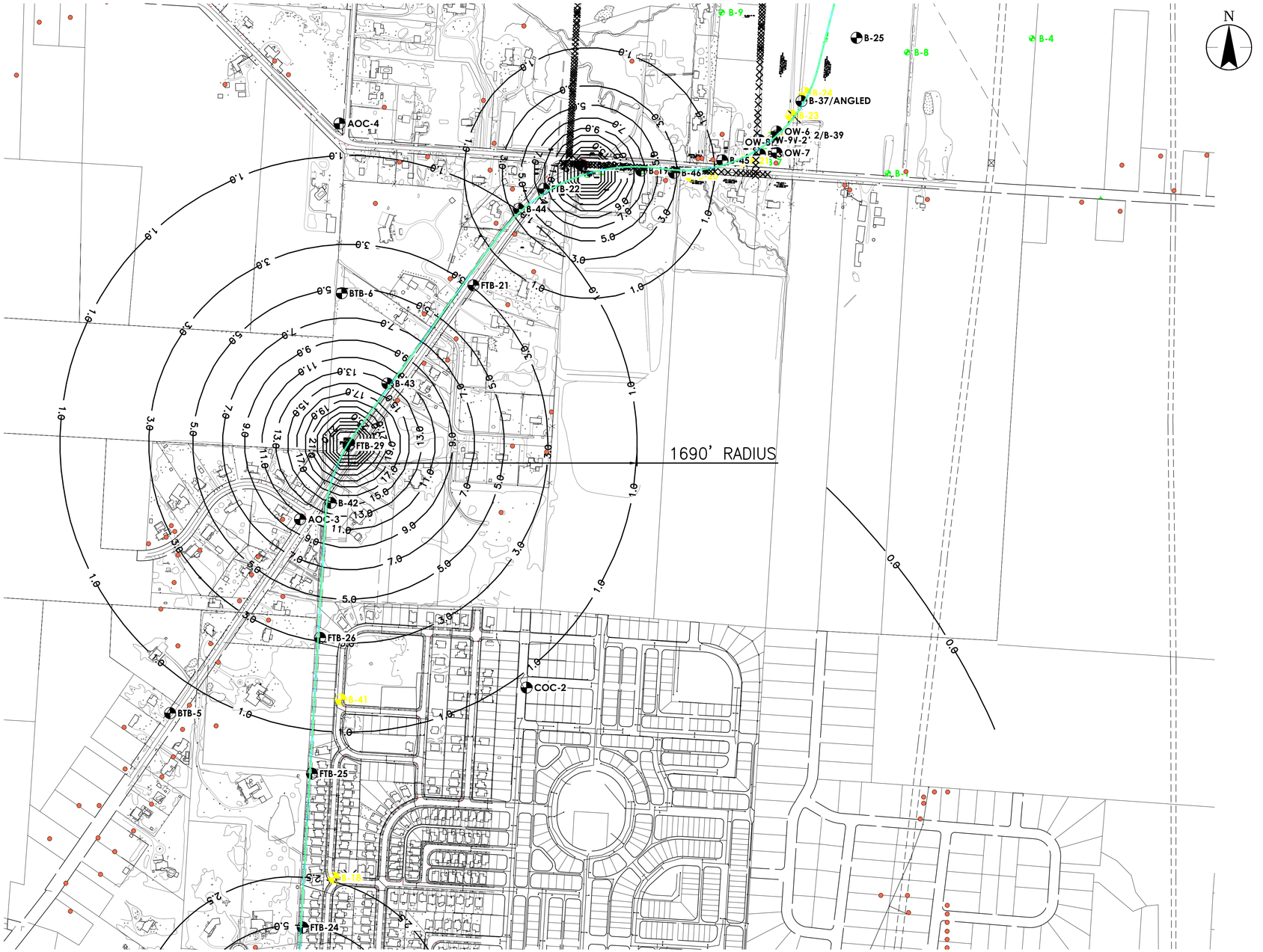
PROJECT TITLE:

BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033–100002

DIVISION USE ONLY	OWNER			
	CONTRACTOR			
	INSPECTOR			
	AGREEMENT		COMPLETED	
	RPD	CKD	CLD	CON. DR.

CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE
DIVISION USE ONLY

SCALE:	SHEET:
NTS	1 of 3
CONTRACT DRAWING NO.	RECORD PLAN NO.
CC–XXXXX	



LEGEND

- ODNR WELL POINT
- 2.5 DRAW DOWN CONTOUR (FT)
- DRAW DOWN CONTOUR (FT)

NOTES

1. DRAW DOWN CURVES CREATED BY MODELING 4–6IN DIA PUMPS PLACED AROUND SHAFT 2A PUMPING AT 68 GPM
2. 34 RESIDENTIAL WELLS ARE WITHIN THE IMPACTED ZONE
3. TOTAL DEPTH OF DRAW DOWN AT SHAFT 2A IS 50 FT BELOW GROUND SURFACE

EASEMENT REFERENCE				REVISIONS		
CITY NO.	COUNTY RECORDER VOL.	COUNTY RECORDER PAGE	GRANTOR	NO.	DESCRIPTION	APPROVAL/DATE

PLAN PREPARED BY:

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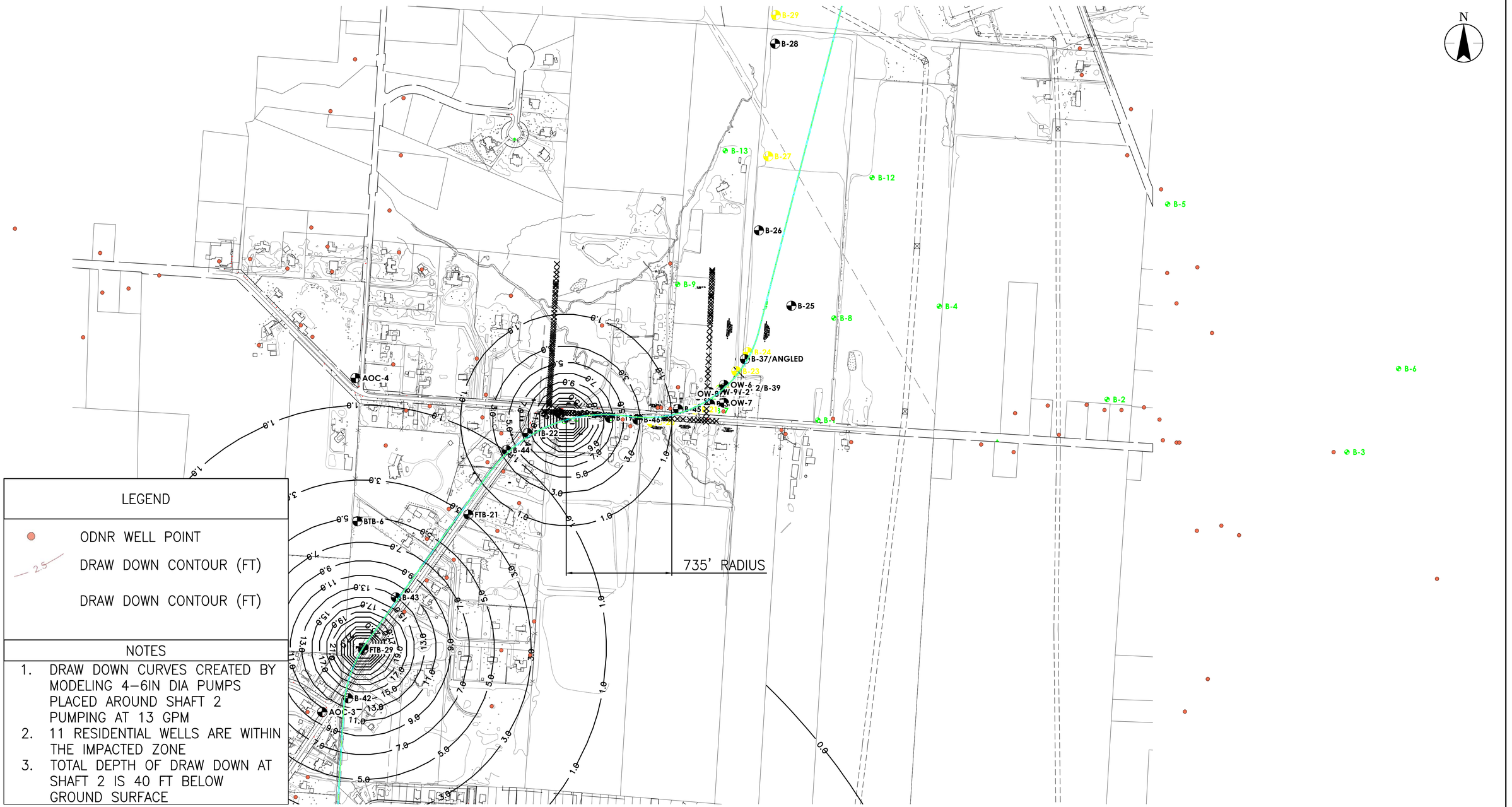
HYDROGEOLOGY TECHNICAL MEMORANDUM
APPENDIX B
SHAFT 2A CONE OF DEPRESSION OVERLAY

PROJECT TITLE:
BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033–100002

DIVISION USE ONLY	OWNER			
	CONTRACTOR			
	INSPECTOR			
	AGREEMENT		COMPLETED	
	RPD	CKD	CLD	CON. DR.

CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE
DIVISION USE ONLY

SCALE: NTS
SHEET: 2 of 3
CONTRACT DRAWING NO.: CC–XXXXX
RECORD PLAN NO.:



LEGEND

- ODNR WELL POINT
- 2.5 DRAW DOWN CONTOUR (FT)
- DRAW DOWN CONTOUR (FT)

NOTES

1. DRAW DOWN CURVES CREATED BY MODELING 4–6IN DIA PUMPS PLACED AROUND SHAFT 2 PUMPING AT 13 GPM
2. 11 RESIDENTIAL WELLS ARE WITHIN THE IMPACTED ZONE
3. TOTAL DEPTH OF DRAW DOWN AT SHAFT 2 IS 40 FT BELOW GROUND SURFACE

EASEMENT REFERENCE			
CITY NO.	COUNTY RECORDER VOL.	COUNTY RECORDER PAGE	GRANTOR

REVISIONS		
NO.	DESCRIPTION	APPROVAL/DATE

PLAN PREPARED BY:
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Columbus, Ohio 43215
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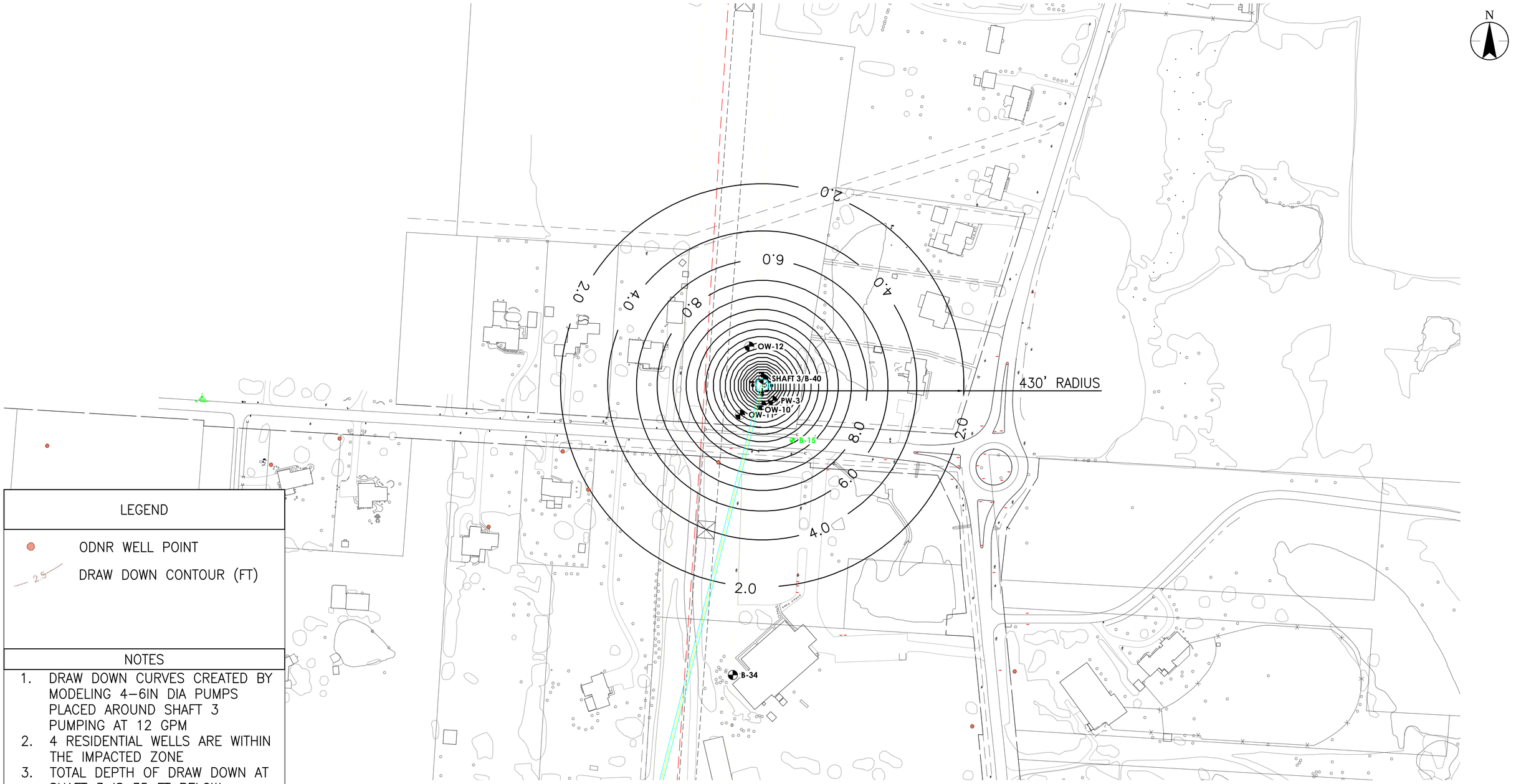
HYDROGEOLOGY TECHNICAL MEMORANDUM
APPENDIX B
SHAFT 2 CONE OF DEPRESSION OVERLAY

PROJECT TITLE:
BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033–100002

DIVISION USE ONLY	OWNER			
	CONTRACTOR			
	INSPECTOR			
	AGREEMENT	COMPLETED		
	RPD	CKD	CLD	CON. DR.

CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE
DIVISION USE ONLY

SCALE: NTS
SHEET: 2 of 3
CONTRACT DRAWING NO. CC–XXXXX
RECORD PLAN NO.



LEGEND

ODNR WELL POINT

DRAW DOWN CONTOUR (FT)

NOTES

1. DRAW DOWN CURVES CREATED BY MODELING 4–6IN DIA PUMPS PLACED AROUND SHAFT 3 PUMPING AT 12 GPM
2. 4 RESIDENTIAL WELLS ARE WITHIN THE IMPACTED ZONE
3. TOTAL DEPTH OF DRAW DOWN AT SHAFT 3 IS 35 FT BELOW GROUND SURFACE

EASEMENT REFERENCE

CITY NO.	COUNTY RECORDER VOL.	COUNTY RECORDER PAGE	GRANTOR

REVISIONS

NO.	DESCRIPTION	APPROVAL/DATE

PLAN PREPARED BY:

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HYDROGEOLOGY TECHNICAL MEMORANDUM
APPENDIX B
SHAFT 3 CONE OF DEPRESSION OVERLAY

PROJECT TITLE:

BIG WALNUT TRUNK EXTENSION PHASE 2
CAPITAL IMPROVEMENTS PROJECT
650033–100002

DIVISION USE ONLY	OWNER
	CONTRACTOR
	INSPECTOR
	AGREEMENT: RPD, CKD — COMPLETED: CLD, CON. DR.

CITY OF COLUMBUS
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE
DIVISION USE ONLY

SCALE: 1"=20'

SHEET: 3 of 3

CONTRACT DRAWING NO.: CC–XXXXX

RECORD PLAN NO.:

Project Memorandum
Detailed Design: Hydrogeology

Appendix C: Potential Range of Impacted Wells

Shaft 1- Potential Impacted Wells

OBJECTID	ODNR Well_LogNo	NAME	ADDRESS	EASTING	NORTHING
485	371494	GEORGE PANCAKE	JOHNSTOWN-UTICA RD	1867426.4	765504.364
778	484520	JOHN BOHLANDER CONT.	6185 ALICE DR	1867426.52	765394.344
798	493825	STEVE ZEHABA	10145 ADAMS RD	1867420.44	765344.459
834	511988	GATCHELL BROTHERS BU	4399 WALNUT ST	1867601.88	765314.59
835	511992	GATCHELL BROTHERS	CENTRAL COLLEGE RD	1867601.88	765314.59
836	516151	ROBERT TAYLOR	6198 ALICE DR	1867601.88	765314.59
438	353671	L RISTINE	9335 HARLEM RD	1867377.55	765113.3
439	353678	FRANK JOST	5740 WARNER RD	1867377.55	765113.3
483	371460	D LANNING	BEVELHEIMER RD	1867326.57	765516.421
484	371485	GARY/J JOHNSON/HOCKWORTH	CENTER VILLAGE TR	1867326.57	765516.421
486	372368	SKILL CONSTRUCTION	6881 CEDAR BROOK	1867315.68	765800.255
489	375916	BOB JORDAN	6869 CENTRAL COLLEGE RD	1867475.46	765879.762
643	430112	MARJORIE GARRABRANT	FANCHER RD	1868301.43	765141.312
847	516198	JOE GALL	4910 WALNUT ST	1868288.96	765169.777
849	519419	CLYDE MASON	5876 HARLEM RD	1868288.96	765169.777
628	426886	MELVIN HATCH	10699 62 SR	1868588.82	765161.303
644	430147	BOB BARR	BEECH/JUG STREET RD	1868918.64	765298.435
733	459600	ROGERS RICKETTS/ESTY CONT	62 SR	1868624.46	765117.446
779	484522	ROBERT TAYLOR	JENNETTE DR	1866771.14	765349.616
815	503012	ROBERT TAYLOR	6115 ALICE DR	1866894.59	765366.606
823	505627	MIKE KEMP	6101 MILLER-PAUL RD	1868486.63	765141.307
474	369021	J STEELESMITH	9111 MILLER-PAUL RD	1866707.42	767168.466
475	369025	LOWELL HATCH BUILDRS	6886 CEDAR BROOK	1866443.45	766710.511
476	369027	MELVIN HATCH	6910 WALNUT ST	1866271.46	766516.305
477	369030	B&L BUILDERS	6000 WALNUT ST	1866994.57	766995.36
478	369031	JOE SCHYBAL	6006 WALNUT ST	1866994.57	766995.36
479	369033	JOHN CREAGER	7226 HOLLANDIA DR	1866652.45	766440.449
480	369034	JOHN CREAGER	7210 HOLLANDIA DR	1866569.39	766307.449
481	369045	LOWELL & HATCH CONST	6857 CEDAR BROOK	1866392.55	766091.404
482	369056	ROGER HATCH	6893 CEDAR BROOK	1866028.5	765721.291
488	372381	SKILL CONSTRUCTION	6865 CENTRAL COLLEGE RD	1866059.09	765677.815
507	380701	CHARLES HAHN	ADAMS RD	1866713.15	766924.725
509	380705	WM FLING	MONTGOMERY TR	1866366.36	766255.81
510	380710	RALPH COOK	6499 CEDAR GLEN CT	1866554.86	766520.989
511	383002	SKILL CONSTRUCTION	6890 CEDAR BROOK	1866554.86	766520.989
513	383029	JOHN GREGEL	6840 CEDAR BROOK	1866561.22	766710.4
514	383030	SKILL CONSTRUCTION	6865 CEDAR BROOK	1867089.5	767298.442
526	385330	ROBERT BAUR	MANITOU DR	1865696.84	765340.486
626	422880	GEORGE HATHAWAY	7388 BEVELHEIMER RD	1869285.66	765220.488
627	426885	MELVIN HATCH	10715 62 SR	1869662.86	765098.79
645	431424	MELVIN HATCH	WILBUR RD	1869752.53	765065.288
701	444127	ROGER/HAROLD ESTY/CORBIN	7564 605 SR	1867245.66	767176.868
738	465071	FRED WILCOXEN	1900 WOODLAND CIR	1869770.67	765484.528
744	465960	M.D. HATCH BUILDERS	7031 DORAN	1866762.6	766562.41
745	465961	ROBERT HILL	7199 CENTRAL COLLEGE RD	1865466.44	765234.32
773	480525	DON STAFFORD	13793 FANCHER RD	1866928.36	766878.321
794	489948	GATCHELL BROTHERRS	W 605/ROBINS RD	1866867.57	766718.637
813	503001	ROBERT TAYLOR	6099 ALICE DR	1867049.49	767156.525
814	503011	ROBERT TAYLOR	6127 ALICE DR	1866652.45	766440.449
816	503025	GARRY BLAIR	15525 MONTGOMERY RD	1866087.44	765355.293
817	503038	RON SHANKS	6528 CENTRAL COLLEGE RD	1865466.44	765234.32
852	520986	MELVIN HATCH	5257 SMOTHERS RD	1869455.39	764986.669
441	353851	ROBERT BENNETT	7088 LEE RD	1864048.37	763887.494
442	353868	JAMES KRAUS	8155 MANITOU DR	1864090.48	764396.613
443	354164	ROGER HATCH	8371 SCHLEPPI RD	1864250.32	764417.446
444	354179	E WOODS	7677 CENTRAL COLLEGE RD	1864801.37	764736.492
445	354208	MYRON LONGSTRETH	10153 62 SR	1864888.58	764853.439
446	354212	W WOODS	7645 CENTRAL COLLEGE RD	1865140.4	764998.492
447	354227	MELVIN HATCH	6490 CEDAR BROOK	1865454.39	764885.369
448	354230	JAMES STEELESMITH	10659 RIDGE VIEW DR	1865454.39	764885.369

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Shaft 1 Potential Impacted Wells

OBJECTID	ODNR Well_LogNo	NAME	ADDRESS	EASTING	NORTHING
449	354231	LOWELL HATCH	7110 BEVELHEIMER RD	1865437.47	764716.402
450	354244	JOHN CREAGER	7244 HOLLANDIA DR	1865363.33	764441.293
451	354245	JOHN CREAGER	7280 HOLLANDIA DR	1865836.42	762858.301
452	354246	JOHN CREAGER	7277 HOLLANDIA DR	1865376.46	766766.576
453	354247	MELVIN HATCH	6899 CEDAR BROOK	1865376.46	766766.576
454	354249	JOE SCHYDAL	6500 CEDAR BROOK	1865370.46	766323.609
455	354723	CHARLES DICKSON	4884 SMOTHERS RD	1864046.43	766192.801
456	354890	RUSS STRINGER	6613 HARLEM RD	1864046.43	766192.437
457	354892	RUSS STRINGER	6613 HARLEM RD	1864046.43	766192.437
458	354990	SKILL CONST.	6961 NEW ALBANY-CONDIT RD	1864427.56	766286.31
459	354998	SKILL CONSTR.	8381 SCHLEPPI RD	1864813.37	766092.372
460	358232	ANDOVER CONSTRUCTION	4420 CENTRAL COLLEGE RD	1865139.51	765943.494
461	358233	ANDOVER CONSTRUCTION	7200 CUBBAGE RD	1865233.47	766070.615
462	358237	ANDOVER CONSTRUCTION	8011 WALNUT ST	1865355.58	766037.329
463	358238	ANDOVER CONSTRUCTION	8001 WALNUT ST	1865505.43	766081.526
464	358813	CHARLES JORDEN	8080 CENTRAL COLLEGE RD	1865505.43	766081.526
465	358817	PAUL DUNCH	5285 RED BANK RD	1866983.51	768349.516
466	358821	ROBERT THACHER	FANCHER CR	1866850.49	768243.675
467	358822	ROY KEAN	KEAN RD	1867149.36	768204.586
468	358850	JAMES STRAUER	6200 HARLEM RD	1867022.54	768177.408
469	366436	SKILL CONSTRUCTION	6878 CEDAR BROOK	1866922.52	767861.596
470	366438	SKILL CONSTRUCTION	6881 CEDAR BROOK	1867491.6	768167.513
471	367769	WOLF OWNER	HARLEM RD	1867453.41	768061.654
472	368335	ANDOVER CONSTRUCTION	8021 WALNUT ST	1867636.41	767934.51
473	368336	ANDOVER CONSTRUCTION	8031 WALNUT ST	1867022.36	767645.528
487	372369	SKILL CONSTRUCTION	6869 CEDAR BROOK	1867004.07	768315.189
504	380669	WEDO BEVILACQUA	5810 WARNER RD	1866953.59	768282.605
505	380680	JOHN TEELE	6500 CEDAR GLEN CT	1866953.59	768282.605
506	380696	ANDOVER CONSTRUCTION CO	13540 FANCHER CR	1866953.59	768282.605
508	380702	ROBBIN NYE	62 USRT	1867214.03	767658.602
512	383028	SKILL CONST. CO.	8080 CLOUSE RD	1867382.87	767909.294
525	385326	JOHN CREAGER	7955 BEVELHEIMER RD	1865463.68	764419.754
550	398326	MELVIN HATCH	6883 CEDAR BROOK PL	1864830.4	767855.524
551	398329	NEW ALBANY CHURCH OF	62 SR	1864548.51	767738.649
552	398336	JOHN SNOWLY	13585 BEVELHEIMER RD	1864487.35	767016.489
553	398337	JOHN CREAGER	HOLLANDIA DR	1864526.46	766867.329
554	398338	JOHN CREAGER	HOLLANDIA DR	1864472.47	766528.386
555	398353	MELVIN HATCH	6877 CEDAR BROOK DR	1864273.48	766573.651
556	398355	JOE SCHYBAL	8025 BEVELHEIMER RD	1865138.56	767214.547
557	398356	JOE SCHYBAL	8039 BEVELHEIMER RD	1865061.53	767053.476
558	398381	ROGER HATCH	6901 CEDAR BROOK DR	1865061.53	767053.476
559	399453	MILLARD BARROW	11175 FANCHER RD	1865061.55	766717.59
560	400651	KRASINSKI REALTORS	5596 CENTRAL COLLEGE RD	1865061.55	766717.59
561	400694	WILLARD CECIL	1049 HARMON AVE	1865061.55	766717.59
562	400919	S ENDSLOW	HARLEM RD	1865409.56	767131.471
563	400922	DALA HOLTREY	13435 BEVELHEIMER RD	1865387.37	766903.509
565	400946	AUGUST WENGER	ADAMS RD	1869258.64	762187.428
566	400947	CHARLES ROTH	ADAMS RD	1869477.62	762092.58
567	405255	GARY SMITH	11530 JOHNSTOWN RD	1870007.65	762549.526
568	405263	DENNIS BROWN	8195 WALNUT ST	1870329.49	762426.597
605	414178	STANLEY WEGRICK	167 LAWRENCE LN	1869208.54	769015.359
606	414179	JORDAN CONTR BOB	6603 HAVENS CORNERS RD	1869180.48	768781.587
646	431432	JOHN CREAGER	7558 LEE RD	1870051.52	765046.634
647	431450	MELVIN HATCH	7619 WILBUR RD	1870174.57	765036.319
648	431871	CLARK	10930 62 USRT	1870331.45	765017.494
649	432955	ROBERT BARR	13581 CENTER VILLAGE RD	1870652.49	765203.499
650	432967	HARLEM GRANAGE HALL	CENTER VILLAGE RD	1870871.51	765193.544
651	432976	SCHEPLLER	5939 WALNUT RD	1871368.42	765283.432
652	432980	JAMES ZAISER	10574 ADAMS RD	1871482.5	765121.608
653	432982	JOE DANNA	9816 ADAMS RD	1871624.64	765126.527

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Shaft 1 Potential Impacted Wells

	FeatID	BEDROCK_DE	TOTAL_DEPT	LONGITUDE	LATITUDE
654	432983	BRUCE LEHNER	10201 ADAMS RD	1871758.59	765112.535
675	438009	R HULL	7882 PETER HOOVER RD	1868746.6	762254.29
676	438012	GENE ADAMS	6495 CENTRAL COLLEGE RD	1869020.67	762435.36
690	443961	GATCHELL & GATCHELL	11053 JOHNSTOWN RD	1867258.35	767549.134
691	443962	GATCHELL & GATCHELL	13074 BEVELHEIMER RD	1868462.54	769300.273
692	443976	GATCHELL & GATCHELL	11053 JOHNSTOWN RD	1868307.83	769082.305
693	443979	GATCHELL & GATCHELL	13725 BEVELHEIMER RD	1868307.83	769082.305
699	444122	VIRGINIA MEYERS	10716 JOHNSTOWN RD	1863884.07	764073.603
703	448933	CHAS SIGLER	5181 WARNER RD	1865760.13	761987.205
720	456029	STANLEY KITSMILLER	8390 CENTRAL COLLEGE RD	1865982.82	762738.216
724	458271	PAUL FILING BUILDER	7360 CUBBAGE RD	1870251.29	762462.602
731	459571	M.D. HATCH BUILDERS	6995 DORAN DR	1870149.49	762473.563
736	463819	HAROLD BAKER	10905 JOHNSTOWN RD	1870592.19	763790.974
739	465080	ROGER HATCH-CONTRACT	8077 CENTRAL COLLEGE RD	1868730.85	762586.958
743	465959	M.D.HATCH BUILDERS	6834 WALNUT ST	1865332.32	766644.35
750	467029	J VOWE	7763 SCHLEPPI RD	1867635.41	768386.613
759	472972	ROGER & ESTY CONT.	13380 BEVELHEIMER RD	1868913.91	768427.078
760	473406	ROBERT RANNEY	6526 KITZMILLER RD	1869932.66	765055.477
762	473413	& GARCHELL GATCHELL	39 E MAIN ST NEW ALBANY	1869522.56	762492.405
774	480541	JAME FRY	WALNUT ST	1865020.5	764890.421
777	484511	ROGER HILL	12549 FANCHER RD	1864494.54	766656.529
782	484545	RONALD SHANKS BUILDE	6833 CENTRAL COLLEGE RD	1870766.6	765194.314
783	484546	W BOARDMAN	5979 HARLEM RD	1868980.62	768815.525
786	488012	HAROLD PHILLIPS	7447 BEVELHEIMER RD	1870472.56	762378.318
787	488014	LANG LEFFEL ROGERS	7869 PETER HOOVER RD	1871768.45	765056.759
793	489941	GATCHELL BROTHERS	BEECH RD	1865139.51	765943.494
795	492738	JOHN REDMOND	7849 WALNUT ST	1865901.56	762569.511
796	493817	RONALD SHANKS	6801 CENTRAL COLLEGE RD	1871460.79	765076.154
797	493820	STEVE CARR	5801 RED BANK RD	1865061.55	766717.59
799	493826	CECIL ROUTTE CONT	10940 ADAMS RD	1864760.51	763302.407
802	493834	HAROLD MOE BLDRS. IC	5492 RED BANK RD	1870999.62	765188.313
810	495514	R B FRUMAN	TIPPET RD	1864273.48	766573.651
811	495545	BOB FREEMAN	TIPPET RD	1864890.52	766417.377
812	497573	J & B CONST. CO.	62 SR	1867552.49	767796.41
824	505663	JERRY SMITH	7891 WALNUT ST	1871406.53	764935.378
827	506461	DON/JIM JOTOROW/BLAIR	13310 BEVELHEIMER RD	1869078.49	762197.244
831	506726	ROBERT TAYLOR	6071 ALICE DR	1865471.96	765079.105
832	507689	DEAN CONWIN	8411 CENTRAL COLLEGE RD	1865506.61	764656.375

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Shaft 2A - Potential Impacted Wells

OBJECTID	ODNR Well_LogNo	NAME	ADDRESS	EASTING	NORTHING
466	358821	ROBERT THACHER	FANCHER CR	1866850.492	768243.6745
467	358822	ROY KEAN	KEAN RD	1867149.362	768204.586
468	358850	JAMES STRAUER	6200 HARLEM RD	1867022.537	768177.4083
469	366436	SKILL CONSTRUCTION	6878 CEDAR BROOK	1866922.524	767861.5959
470	366438	SKILL CONSTRUCTION	6881 CEDAR BROOK	1867491.599	768167.5134
471	367769	WOLF OWNER	HARLEM RD	1867453.412	768061.6542
473	368336	ANDOVER CONSTRUCTION	8031 WALNUT ST	1867022.358	767645.5277
487	372369	SKILL CONSTRUCTION	6869 CEDAR BROOK	1867004.069	768315.1888
487	372369	SKILL CONSTRUCTION	5810 WARNER RD	1866953.588	768282.6045
504	380669	WEDO BEVILACQUA	6500 CEDAR GLEN CT	1866953.588	768282.6045
505	380680	JOHN TEELE	13540 FANCHER CR	1866953.588	768282.6045
506	380696	ANDOVER CONSTRUCTION	62 USRT	1867214.027	767658.6018
508	380702	ROBBIN NYE	8080 CLOUSE RD	1867382.87	767909.2938
512	383028	SKILL CONST. CO.	6070 LAKEWOOD DR	1869104.636	769836.5416
600	413050	RON GERWIG	7374 BEVELHEIMER RD	1868615.544	769795.4835
601	413101	BILL CLARK	SHER LIN COURT RT 2	1868464.521	769588.4286
603	414159	FRANK CROSSWELL	CENTER VILLAGE RD	1868650.514	769443.4287
604	414175	GAIL JACOBUS	167 LAWRENCE LN	1869208.535	769015.3589
605	414178	STANLEY WEGRICK	6603 HAVENS CORNERS	1869180.484	768781.587
606	414179	JORDAN CONTR BOB	6880 BEVELHEIMER RD	1868994.176	770055.9227
681	438411	ROGER HATCH	11053 JOHNSTOWN RD	1867258.346	767549.1335
690	443961	GATCHELL & GATCHELL	11053 JOHNSTOWN RD	1868307.833	769082.3046
692	443976	GATCHELL & GATCHELL	13725 BEVELHEIMER RD	1868307.833	769082.3046
693	443979	GATCHELL & GATCHELL	BEECH RD	1868178.153	770236.2023
710	449871	BOB BARR CONSTRUCTIO	7763 SCHLEPPI RD	1867635.414	768386.613
750	467029	J VOWE	13380 BEVELHEIMER RD	1868913.912	768427.0775
780	484530	DON PIERCE	5912 MILLER-PAUL RD	1868884.507	770120.4723
783	484546	W BOARDMAN	5979 HARLEM RD	1868980.618	768815.5252
812	497573	J & B CONST. CO.	62 SR	1867552.494	767796.4102
820	504832	ROGER HATCH-BUILDER	10696 JOHNSTOWN RD	1868601.631	769318.6661
474	369021	J STEELESMITH	9111 MILLER-PAUL RD	1866707.415	767168.4664
477	369030	B&L BUILDERS	6000 WALNUT ST	1866994.569	766995.3602
478	369031	JOE SCHYBAL	6006 WALNUT ST	1866994.569	766995.3602
507	380701	CHARLES HAHN	ADAMS RD	1866713.147	766924.7253
514	383030	SKILL CONSTRUCTION	6865 CEDAR BROOK	1867089.499	767298.4424
527	385334	JOHN FLYNN	8117 MANITOU DR	1867588.515	771070.6202
528	390006	LEO RICHARDS	605 SR	1867669.305	770990.1507
596	412771	MODULOR ELECTORS	11061 JOHNSTOWN RD	1868319.528	770479.3599
599	413033	KEN HOLTRY	6944 605 SR	1868849.372	770431.3615
607	414194	CLIFF JOHNSTON	4665 GLENMAW AVE	1869876.477	770370.4984
688	441588	ANDOVER CONSTRUCTION	6828 BEVELHEIMER RD	1868484.112	770509.6733
689	443960	GATCHELL & GATCHELL	11057 JOHNSTOWN RD	1868873.206	770588.2821
700	444124	RICHARD SHUPE	62/CLOUSE ROAD USRT	1867297.64	770932.6202
701	444127	ROGER/HAROLD	7564 605 SR	1867245.664	767176.8677
729	459559	WAYNE HARSEY	5026 CENTRAL COLLEGE	1869823.515	770416.9717
755	468294	CARL SOUDER	5241 E WALNUT ST	1868230.456	770799.5716
773	480525	DON STAFFORD	13793 FANCHER RD	1866928.36	766878.3212
794	489948	GATCHELL BROTHERRS	W 605/ROBINS RD	1866867.573	766718.6372
800	493828	ROBERT TAYLOR	6158 ALICE DR	1868810.426	770839.5348
813	503001	ROBERT TAYLOR	6099 ALICE DR	1867049.486	767156.5254

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Shaft 2 - Potential Impacted Wells

OBJECTID	ODNR Well_LogNo	NAME	ADDRESS	EASTING	NORTHING
600	413050	RON GERWIG	6070 LAKEWOOD DR	1869104.636	769836.5416
607	414194	CLIFF JOHNSTON	4665 GLENMAW AVE	1869876.477	770370.4984
681	438411	ROGER HATCH	6880 BEVELHEIMER RD	1868994.176	770055.9227
683	438451	LOWELL MC COLLAM	8019 CLOUSE RD	1870067.178	770499.8106
689	443960	GATCHELL & GATCHELL	11057 JOHNSTOWN RD	1868873.206	770588.2821
718	455925	MACK STEWART	7989 CLOUSE RD	1870067.178	770499.8106
729	459559	WAYNE HARSEY	5026 CENTRAL COLLEGE	1869823.515	770416.9717
780	484530	DON PIERCE	5912 MILLER-PAUL RD	1868884.507	770120.4723
819	504830	HAROLD MCCLAIN	8959 PETER HOOVER RD	1868980.394	770320.461
527	385334	JOHN FLYNN	8117 MANITOU DR	1867588.515	771070.6202
528	390006	LEO RICHARDS	605 SR	1867669.305	770990.1507
536	390820	RAY WEBB	6896 LEE RD	1867236.547	771530.6872
537	390835	FLOYD CAMPBELL	HATCH RD	1867236.547	771530.6872
538	390843	DENSE BORRES	13381 BEVELHEIMER RD	1867495.833	771464.4385
539	390844	CHARLES DAVIS	6576 MILLER/PARK CR	1867805.362	771442.4371
541	394335	W BROWN	7810 605 SR	1867661.429	771749.3908
593	412497	ELLIS BRICKEY	6941 605 SR	1868283.483	772250.3825
594	412498	W MCKINNEY	6499 CEDAR BROOK DR	1868270.46	771576.4722
595	412760	MODULAR ERECTORS	6439 EVANS RD	1868428.572	771457.4465
596	412771	MODULOR ELECTORS	11061 JOHNSTOWN RD	1868319.528	770479.3599
597	413026	CARL GREENHART	7436 NEW ALBANY-	1869047.368	771275.4004
601	413101	BILL CLARK	7374 BEVELHEIMER RD	1868615.544	769795.4835
602	413184	JOHN CREAGER	HUGHES RD	1868953.393	769643.6925
603	414159	FRANK CROSSWELL	SHER LIN COURT RT 2	1868464.521	769588.4286
604	414175	GAIL JACOBUS	CENTER VILLAGE RD	1868650.514	769443.4287
605	414178	STANLEY WEGRICK	167 LAWRENCE LN	1869208.535	769015.3589
606	414179	JORDAN CONTR BOB	6603 HAVENS CORNERS	1869180.484	768781.587
608	416603	KENNARD FOREST	RED BANK CR	1870153.583	771499.4866
609	416607	JOE SCHYBAL	7901 BEVELHEIMER RD	1870207.857	770640.9766
610	416657	MELVIN HATCH	6846 CEDAR BROOK PL	1870207.576	770640.6134
611	416659	ROGER HATCH	6734 BEVELHEIMER RD	1870954.515	770315.6734
682	438433	JACK HALL	10913 JOHNSTOWN RD	1870925.254	770343.4735
684	438452	MELVIN HATCH	7685 WILBUR RD	1870153.855	770492.1868
688	441588	ANDOVER CONSTRUCTION	6828 BEVELHEIMER RD	1868484.112	770509.6733
691	443962	GATCHELL & GATCHELL	13074 BEVELHEIMER RD	1868462.54	769300.2729
692	443976	GATCHELL & GATCHELL	11053 JOHNSTOWN RD	1868307.833	769082.3046
693	443979	GATCHELL & GATCHELL	13725 BEVELHEIMER RD	1868307.833	769082.3046
700	444124	RICHARD SHUPE	62/CLOUSE ROAD USRT	1867297.64	770932.6202
710	449871	BOB BARR CONSTRUCTIO	BEECH RD	1868178.153	770236.2023
717	454733	GARY DORAN CONTRACTO	62 SR	1871283.576	770422.2383
751	467035	BERNARD DEMATTIES	ALICE DR	1868204.49	771867.4485
752	468259	DORANCE GRPOVE	5576 RED BANK RD	1871409.655	770259.6384
755	468294	CARL SOUDER	5241 E WALNUT ST	1868230.456	770799.5716
759	472972	ROGER & ESTY CONT.	13380 BEVELHEIMER RD	1868913.912	768427.0775
783	484546	W BOARDMAN	5979 HARLEM RD	1868980.618	768815.5252
800	493828	ROBERT TAYLOR	6158 ALICE DR	1868810.426	770839.5348
807	494035	JOHN MOORE	<Null>	1867495.554	771464.4396
820	504832	ROGER HATCH-BUILDER	10696 JOHNSTOWN RD	1868601.631	769318.6661
821	504843	ROGER HATCH	6516 CEDAR BROOK	1870207.576	770640.6134
839	516156	JOE YOAKUM	7777 SCHOTT RD	1870522.984	770472.537

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Shaft 3 - Potential Impacted Wells						
FeatID	OBJECTID	ODNR Well_LogNo	NAME	ADDRESS	EASTING	NORTHING
694	694	443994	GATCHELL & GATCHELL	6834 CEDAR BROOK	1871919.25	775738.638
695	695	443998	GATCHELL/GATCHELL	3721 GREEN-COOK RD	1871919.25	775738.638
696	696	443999	GATCHELL & GATCHELL	6835 CEDAR BROOK	1871919.25	775738.638
756	756	468295	JOHN MORRIS	4485 CENTRAL COLLEGE	1871643.58	775680.677
781	781	484531	RANDY THOMPSON	13030 BEVELHEIMER RD	1871432.43	775601.705
631	631	428474	ANDREW STARINCHAK	6381 ULRY RD	1872456.84	775179.201
634	634	429616	DAVE DIXON ROGER & E	7790 WALNUT ST	1872546.76	775295.437
697	697	444104	DAVE MC KINNER	7558 SCHLEPPI RD	1871116.88	775789.08

Yellow Highlighted cells indicate those wells that are within the modeled drawdown zone, Un-highlighted cell indicated those wells within 2500 feet of the shaft.

Project Memorandum
Detailed Design: Hydrogeology

Appendix D: Phase 1 Hydrogeologic Investigation for the Phase I Big Walnut Sanitary Trunk Sewer, Eagon and Associates Inc. Report

HYDROGEOLOGIC INVESTIGATION REPORT

FOR THE

BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Prepared for

DODSON-STILSON, INC.
and
CITY OF COLUMBUS, OHIO
DEPARTMENT OF PUBLIC UTILITIES
DIVISION OF SEWERAGE AND DRAINAGE

Prepared by

EAGON & ASSOCIATES, INC.
Worthington, Ohio

March 10, 2003

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100 Old Wilson Bridge Road, Suite 320
Worthington, Ohio 43085
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1.0 INTRODUCTION

1.1 Purpose and Scope

In 1999, Eagon & Associates, Inc. was retained as a subcontractor to Dodson-Stilson, Inc. to perform the hydrogeologic investigation and assessment to support the engineering study to select the alignment and final design for the Big Walnut Sanitary Trunk Sewer Extension. The investigation included compilation and review of available information relevant to the hydrogeologic conditions in the project area and participation in the geotechnical field investigation to collect site specific data relative to ground-water quality and quantity. The assessment involved the evaluation of various design alternatives for potential impacts on ground water and local domestic wells during construction in order to assist the consultation team in preparing final design recommendations and in developing options for controlling ground water during tunnel and shaft construction.

The primary study objectives were as follows:

1. To establish background conditions and describe the hydrogeologic setting.
2. To collect data necessary to determine ambient conditions on ground-water levels and ground-water quality.
3. To estimate aquifer characteristics to be used to evaluate various design alternatives and to be used in design of dewatering plans and/or specific control measures to minimize ground-water impacts during construction.
4. To evaluate potential impacts on ground-water levels in the project area and the effect of construction on existing residential wells.
5. To provide recommendations for ground-water monitoring and mitigation measures during construction.

Information was collected from numerous sources including both published and unpublished reports from the Ohio Department of Natural Resources (ODNR) Division of Water and Division of Geological Survey. The driller's logs for existing water wells in the project area were obtained from ODNR and compiled in a residential well database. A door-to-door well survey was performed

to document preconstruction conditions relative to ground-water quality and well performance. Data from the well logs and well survey was used in conjunction with geotechnical test hole results to develop and refine bedrock topography and potentiometric maps for the project area.

Water levels were measured periodically in piezometers installed in various geotechnical borings and pressure transducers and data loggers were used to provide continuous record of ground-water level fluctuations at selected locations. Pumping tests were performed at four locations to define aquifer characteristics and slug tests were performed in numerous piezometers in order to determine site specific values of hydrogeologic conductivity of both unconsolidated and bedrock deposits.

1.2 Background

A substantial part of the hydrogeologic evaluation was focused on the assessment of alignment and design alternatives which were eliminated from consideration during the engineering study. A ground-water flow model was developed to evaluate the potential impacts of open cut and microtunneling alternatives along various alignments. Additionally, some of the pumping test and slug test sites are not adjacent to the final alignment selected. All of the basic data generated during the hydrogeologic investigation is included in this report. However, model analysis and impact assessment that are not relevant to the final alignment and design selected are not included.

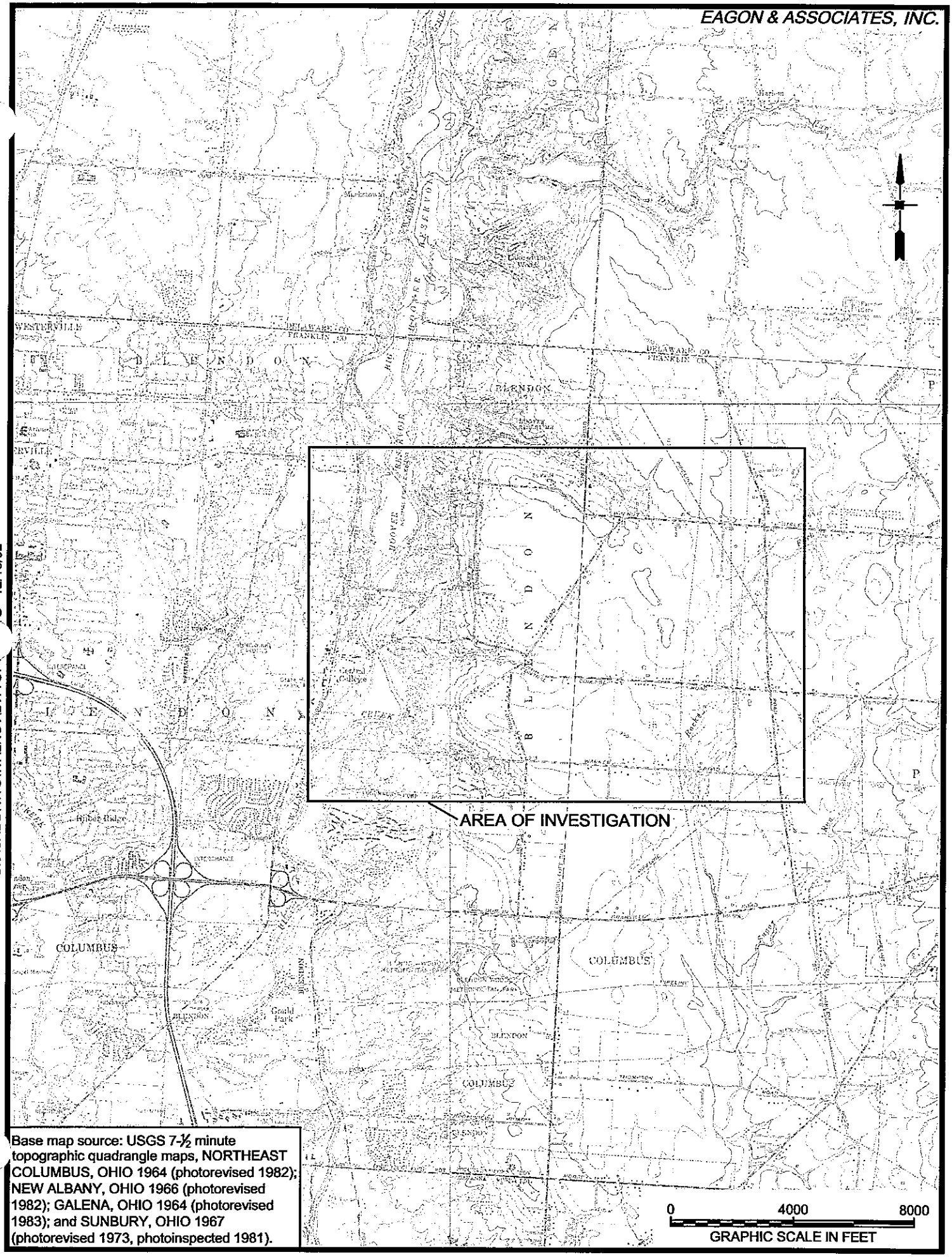

FIGURE 1-1. GENERAL LOCATION MAP

2.0 HYDROGEOLOGY

2.1 Geomorphology and Surface Water

2.1.1 Physiography

The project area lies along the eastern margin of the Central Lowlands on the first of two inconspicuous westward-facing escarpments. These irregular escarpments and terraces trend north-south forming steps by which ascent is made to the Appalachian Plateau which begins in Franklin County near the Licking County Line. Big Walnut Creek is located at or near the base of the lowest scarp which rises from an elevation of about 800 feet to 1010 feet. The first terrace is one to two miles wide before the topography rises again to the east toward Blacklick Creek (Schmidt and Goldthwait, 1958).

2.1.2 Soils and Topography

Soils within the project area fall within three general categories. On the relatively flat upland areas, soils are of the Bennington-Pewamo association. These soils are deep, nearly level and gently sloping, somewhat poorly drained and very poorly drained soils formed in medium textured and moderately fine textured glacial till. The slopes on which these soils are developed range from 0 to 2 percent and from 2 to 6 percent.

The soils on the slopes and in the ravines between the upland areas and Hoover Reservoir or Big Walnut Creek are of the Cardington-Alexandria-Bennington association. These soils are deep, gently sloping to steep, well drained, moderately well drained, and somewhat poorly drained soils formed in medium textured and moderately fine textured glacial till. Topography in the area on which these soils are developed is quite variable locally, with slopes as low as 2 to 6 percent to as much as 18 to 25 percent. Where slopes exceed 12 to 18 percent, this soil association includes outcroppings of shale bedrock.

The soils associated with the floodplain of Big Walnut Creek are of the Medway-Genesee-Sloan association. These are deep, nearly level, well drained, moderately well drained, and very poorly drained soils formed in moderately coarse to moderately fine-textured recent alluvium. These soils are developed on flat lying areas with slopes of 0 to 2 percent and have a seasonal high water table near the surface in winter, spring, and other extended wet periods.

2.1.3 Streamflow

The Big Walnut Creek drainage basin upstream of the gaging station located 0.4 mile downstream from Hoover Dam is 190 square miles. The flow in Big Walnut Creek has been completely regulated by Hoover Reservoir since 1954. Based on the period of record from 1955 to 1998, the annual mean flow is 200 cubic feet per second (cfs). The highest daily mean flow, which occurred in January 1959, was 10,600 cfs. The instantaneous peak flow which occurred at that time was 23,800 cfs and resulted in a stream stage elevation of 834.91 feet MSL. The 100 year flood stage elevation for Big Walnut Creek in the project area ranges from 831 feet to 833 feet MSL.

2.2 Geologic Setting

2.2.1 Surficial Materials and Glacial Geology

The project area lies a few miles south of the Powell Moraine and the upland area is characterized as flat to gently rolling ground moraine comprised of silty loam till of Late Wisconsinan age (Goldthwait and Pavy, 1993). The mantle of till overlying bedrock is relatively thin throughout most of the project area. To the west, along the east side of Hoover Reservoir, bedrock crops out along the bluffs and ravines. Glacial outwash deposited by meltwater from the last retreat of Pleistocene glaciers occupies the valley of Big Walnut Creek. These materials are confined to the narrow channel which underlies the floodplain.

To the east of the project area in western Plain Township, a fairly deep buried valley trends generally north-south and represents a significant preglacial drainage feature. This buried valley

generally coincides with the present valley of Rocky Fork and is filled with a complex sequence of glacial drift consisting mostly of thick layers of clayey till with scattered lenses of sand and gravel. This buried valley has two east-west trending tributary buried valleys that extend eastward to the headwater areas of two minor tributaries to Big Walnut Creek. The western extent of the southern tributary valley coincides with the head of a ravine located near the intersection of Central College Road and Lee Road. The ravine trends west to Big Walnut Creek whereas the tributary valley trends east and joins the main buried valley about 4700 feet to the east. The western end of a second tributary valley to the north is just north of the intersection of Walnut Street and Schott Road and trends southwest about a mile to join the main buried valley. The associated ravine trends west-northwest into Hoover Reservoir. The small lateral buried valleys also are filled primarily with clayey till that is sparsely interbedded with thin sand and gravel lenses.

2.2.2 Bedrock

The bedrock units of interest in the project area are the Ohio Shale of Devonian age, and the Bedford Shale and Berea Sandstone of Mississippian age. Regional dip on the bedrock is to the east-southeast and ranges from about 25 to 32 feet per mile. An unconformity separates the Bedford Shale and the Berea Sandstone (Stauffer, 1911).

The Ohio Shale is dominantly black or brown, carbonaceous, and, in part, somewhat arenaceous, grading from a massive structure to thinly laminated or fissile. The total thickness in eastern Franklin County is as much as 450 feet (Schmidt and Goldthwait, 1958). When exposed, the shale soon weathers to thin laminae which break up into small fissile fragments that weather to clay. This formation is characterized by the occurrence of large "iron-stone" concretions. Near the upper limit of the formation is a layer of numerous small flat concretions of iron pyrites; this layer is fairly persistent in the vicinity of the project area.

The Bedford Shale rests conformably on the Ohio Shale and is a soft, gritless, laminated, shale that is gray, red or brown color, weathering to yellow or red clay. The red color is usually confined to the middle portion. The thickness of the Bedford in the area varies from 60 to 90 feet

(Lamborn, 1938). Exposures of Bedford Shale occur along Big Walnut Creek north of Central College. The upper part of the Bedford grades to predominantly sandstone. Gradually, thin layers of sandstone begin to appear and these keep increasing in number until the shale is in the minority and finally disappears (Stauffer, 1911).

The overlying Berea Sandstone typically is rather fine grained, gray to buff colored, and deposited in layers of varying thickness which become more massive towards the top of the formation. The thickness of the Berea varies over a wide range from north to south in Franklin County, and is estimated to be as much as 55 feet in the north where it is thickest (Schmidt and Goldthwait, 1958).

2.2.3 Bedrock Topography

Plate 1 is a map showing the bedrock surface topography that has been developed using the information that is currently available. The open file bedrock map from ODNR, Division of Geologic Survey has been updated using data from more recently drilled water wells and bedrock elevation data from geotechnical borings drilled for this project. As shown, there is a broad deep buried bedrock valley that trends north-south, generally coincident with Rocky Fork Creek. There are two fairly narrow bedrock tributary valleys that trend generally east-west and which generally coincide with the topographic ravines near Central College Road and Walnut Street within the project area.

2.3 Aquifers

There are four primary aquifer systems in the project area, the Berea Sandstone, the upper part of the Bedford Shale, the alluvial deposits associated with Big Walnut Creek, and the glacial deposits within the buried valley associated with Rocky Fork Creek. Where encountered, sand and gravel lenses within the buried valley segments may be considered to be local aquifers. Figure 2-1 is a conceptual hydrogeologic model which illustrates the configuration of aquifers in the project

area. Figure 2-2 is a portion of the Franklin County Groundwater Resources Map which includes the project area.

2.3.1 Glacial Deposits

Unconsolidated deposits associated with Big Walnut Creek are predominantly alluvium comprised of clay, silt, and fine sand that is underlain by till and/or outwash. Well yields typically are about 5 to 25 gpm, although higher yields may be encountered where the stream is hydraulically connected to permeable alluvium or underlying outwash materials. Depth to water in wells ranges from 5 to 15 feet.

Sand and gravel deposits that may be encountered in the buried valley system in western Plain Township potentially yield significant quantities of ground water. Yields from sand and gravel wells developed in the east-west tributary valleys generally are 5 to 25 gpm, whereas properly constructed screened wells developed in sand and gravel zones in the main north-south trending buried valley may yield as much as 25 to 100 gpm. Typical well depths range from 80 to 135 feet. Depth to water in such confined aquifer wells usually ranges from 15 to 30 feet.

2.3.2 Bedrock Formations

The most productive aquifer in the project area is the Berea Sandstone. Individual wells screened in the upper part of the formation generally yield from 5 to 25 gallons per minute (gpm), although yields of as much as 70 gpm have been reported. As the lower part of the formation becomes more shaley, well yields may be only 3 to 10 gpm. This aquifer is of limited areal extent because the Berea is the highest stratigraphic unit and limited to the upland areas. The Berea Sandstone is truncated to the west as the topography descends toward the valley of Big Walnut Creek. To the east, the Berea is truncated by the Rocky Fork Creek buried valley. Therefore, the Berea Sandstone aquifer in the project area is present only in a zone that generally is about one mile wide trending north-south along the Blendon-Plain Township lines. The extent of the Berea Sandstone aquifer is further restricted by the surface ravines and buried bedrock valleys that trend

east-west in the project area as shown by Figure 2-2. Potential well yields are minimal in areas where the sandstone is thin along the aquifer margins. The Berea is overlain by a relatively thin cover of glacial till that is about 10 to 20 feet thick. However, till thicknesses of less than 10 feet are not uncommon. Typically depth to water is shallow, ranging from 10 to 20 feet.

The Bedford Shale is a poor source of ground water, but may support small supplies of as much as 2 gpm from the upper part of the formation, or where the bedrock is weathered and broken along the valley margins. The permeability of the Bedford Shale rapidly diminishes away from the weathered upper surface and the lower part of the Bedford is considered to be an aquitard, i.e. a confining bed that retards the flow of water to or from an adjacent aquifer. Where the Bedford is not overlain by the Berea, the overlying glacial drift is typically less than 40 feet thick and may be less than 10 feet thick along the steeper slopes east of Big Walnut Creek. Generally, the depth to water in Bedford Shale wells ranges from 15 to 30 feet.

The Ohio Shale, which underlies the Bedford, is generally considered to be an aquitard, although it may yield as much or more water than the Bedford where fractures are persistent. Yields of as much as 3 gpm have been developed from wells in the uppermost weathered part of the formation. Few wells yield appreciable supplies from the deeper fractured zones within the Ohio Shale. The Ohio Shale contains significant amounts of iron pyrite (FeS_2) which is the source of hydrogen sulfide commonly present in the ground water. Ground water that is encountered at greater depths in the Ohio Shale will be of extremely poor quality, with total dissolved solids concentrations exceeding 1600 milligrams per liter (mg/ℓ). Methane gas also is likely to be present in significant quantities within fracture zones encountered in the Ohio Shale.

2.4 Ground-Water Flow

2.4.1 Flow Direction

The direction of ground-water flow generally conforms to the topography of the area and regionally is from east to west. From the upland areas underlain by the Berea Sandstone, the

dominant flow direction is expected to be west toward the Big Walnut Creek Valley where the Berea is truncated. Flow also is generally to the east-west ravines which are natural discharge areas. The same general flow pattern is true for the underlying Bedford Shale in eastern Blendon Township. However, in western Plain Township, flow patterns may vary locally depending on the relationships between the bedrock units and the unconsolidated deposits in the buried valley. Hydraulic gradients in the upland areas are relatively flat and there is at least a shallow component of flow toward Rocky Fork. From the area of Central College Road in western Plain Township, there is a component of flow to the southeast associated with the buried valley system (Raab, et.al., 1992). The general flow direction in the unconsolidated deposits associated with Big Walnut Creek is toward the stream and down valley to the south.

2.4.2 Recharge-Discharge Relationships

Recharge to the Berea Sandstone aquifer occurs as direct infiltration of precipitation with discharge to the Big Walnut Creek Valley to the west, and probably to the east to the Rocky Fork Creek buried valley system in areas where the Berea sandstone may be in contact with more permeable sand and gravel interbeds in the unconsolidated valley fill. Depending on local conditions, the potential exists for the Berea to discharge to, or receive recharge from, the buried valley system. Even though well yields in the Berea are quite good in places, the resource potential of this aquifer is limited, and somewhat vulnerable, because of its limited extent and limited recharge area. The recharge potential of the Berea Sandstone Aquifer is moderate due to the relatively low permeability of the soils and till that overlie it.

The recharge potential to support water use from the Bedford Shale is even more restricted. The vertical flow gradient from the Berea where it overlies the Bedford is downward. However, as noted previously, the lower part of the Berea is thought to be less permeable. Where the Bedford is overlain by glacial till, the recharge is very local and moderate at best due to the relatively low permeability of the overlying soils and the shale itself.

Big Walnut Creek is a regional discharge area. However, ground-water discharge from the bedrock system is extremely low owing to the low permeability of the shale bedrock which potentially discharges either to the creek or to the unconsolidated deposits associated with it. Most of the ground-water discharge from the bedrock system probably occurs as minor springs, seeps, or seasonal wet spots within the ravines, well above the valley floor. It is likely that most of the smaller tributary streams in the project area are dry at certain times of the year.

Water levels in bedrock wells can be expected to fluctuate several feet seasonally and from year to year depending on recharge conditions and drought cycles. Another variable in the magnitude and responsiveness of water-level fluctuations to seasonal changes is the proximity to local discharge areas. Based on the long term record from ODNR, Division of Water, Observation Well F-1, located southeast of the project area in Fairfield County, seasonal fluctuations of 7 to 8 feet might be expected. Well F-1 is 84 feet deep and is completed in Mississippian sandstone formations similar to those found in the project area (Raab, et.al., 1992).

As illustrated by the conceptual hydrogeologic model (Figure 2-1), there is a deep, north-south buried bedrock valley that is generally coincident with Rocky Fork Creek in the eastern part of the project area. The Ohio Department of Natural Resources Ground Water Resources Map (Figure 2-2) indicates that unconsolidated deposits within this buried valley may yield from 25 to 100 gallons per minute (gpm) to properly constructed wells. East-west tributary valleys associated with the main buried valley are generally coincident with the heads of the topographic valleys near Central College Road and Walnut Street. Unconsolidated deposits within these buried valley segments may yield 5 to 25 gpm.

Hydrogeologic conditions within the buried valley deposits are likely to be varied and complex, based on a review of water well logs in the area. Water levels are relatively shallow (generally ranging from 5 to 15 feet in depth). Shallow ground-water flow is probably from the upland area toward Rocky Fork Creek which acts as a ground-water discharge area. There are many existing residential wells in the area which are only 30 to 35 feet deep. Many of these wells

terminate in sand and gravel when sufficient supply is encountered. However, deeper wells (70 feet or more) are not uncommon.

2.5 Ground-Water Quality

Table 2-1, taken from Schmidt (1958), is a summary of selected water-quality data from wells considered to be representative of the Berea Sandstone, and the Bedford and Ohio Shales. Water produced from the Berea generally has the best quality, although objectional concentrations of iron appear to be universal due to the fact that the secondary maximum contaminant level (SMCL) of 0.3 milligrams per liter (mg/ℓ) is always exceeded. Of the four samples reported for the Berea, the total dissolved solids (TDS) of one sample exceeds the secondary MCL of 500 mg/ℓ. Hydrogen sulfide occasionally is encountered in the Berea. In one of the Berea water samples listed in Table 2-1 , low pH (5.8) and high nitrate (81.0 mg/ℓ) was reported, which may have been the result of septic tank leach-bed contamination.

Ground water produced from the Bedford and Ohio Shale is of poor quality and can be expected to become more objectionable with depth. Iron, sulfate, and TDS concentrations typically exceed secondary MCLs. Only shale wells that produce water from the upper weathered portion of the bedrock can be expected to produce water of useable quality. With depth, TDS and most other water quality indicator constituents are elevated to the extent of rendering the water unusable.

Water from sand and gravel zones encountered within the buried valley systems can be expected to provide water of usable quality. Water quality usually is a function of depth and proximity to the recharge source. Generally, total hardness can be expected to range from about 300 to 500 mg/ℓ. Iron content can be quite variable, ranging from less than the secondary MCL of 0.30 to as much as 3.0 mg/ℓ.

2.6 Ground-Water Use

The Berea Sandstone is the most reliable aquifer in the project area. Where the Berea is sufficiently thick, residential wells produce sufficient quantities to support normal household use in addition to relatively unlimited auxiliary uses such as lawn and garden watering. However, iron concentrations often result in maintenance problems for wells and water-treatment equipment. Where the Berea is 30 to 40 feet or more in thickness, wells typically penetrate the full aquifer thickness and are drilled 5 to 20 feet into the underlying Bedford Shale.

In areas where the Berea thins toward the valley margins, wells that encounter only a few feet of sandstone may be drilled as much as 50 feet into the underlying Bedford Shale, presumably for well storage. Adequate yields for domestic use may be developed in this manner, but most of the water actually produced is from the Berea in the upper portion of the uncased borehole. This completion technique results in a marginally reliable well because, once the water in the well is lowered below the water producing zones in the sandstone, the well is no longer productive. Such wells may appear to be adequate initially, but often are prone to subsequent failure as water producing zones in the borehole become clogged due to mineralization over time.

Wells developed in the Bedford Shale for domestic use are poor to marginal at best. Only the upper, more weathered part of the formation has the potential to produce much water and the quantity and quality diminish with depth. Dry holes and marginal wells that run dry are common occurrences in parts of Blendon and Plain Townships (Weatherington, 1978). Many residents in certain areas have historically relied on cisterns and water haulers, and have established service connections with Del-Co Water, a private water utility, as soon as this source of supply became available to the area.

Residential wells that currently are being relied upon for domestic supplies in the project area should be considered to be extremely vulnerable. Even where strong Berea wells exist, supplies are vulnerable because of limited available drawdown and the fact that the aquifer is of limited extent. There simply are no other options for development of adequate domestic ground-water supplies other

than those presently being used. Deeper aquifers with ground water of useable quality do not exist in the area.

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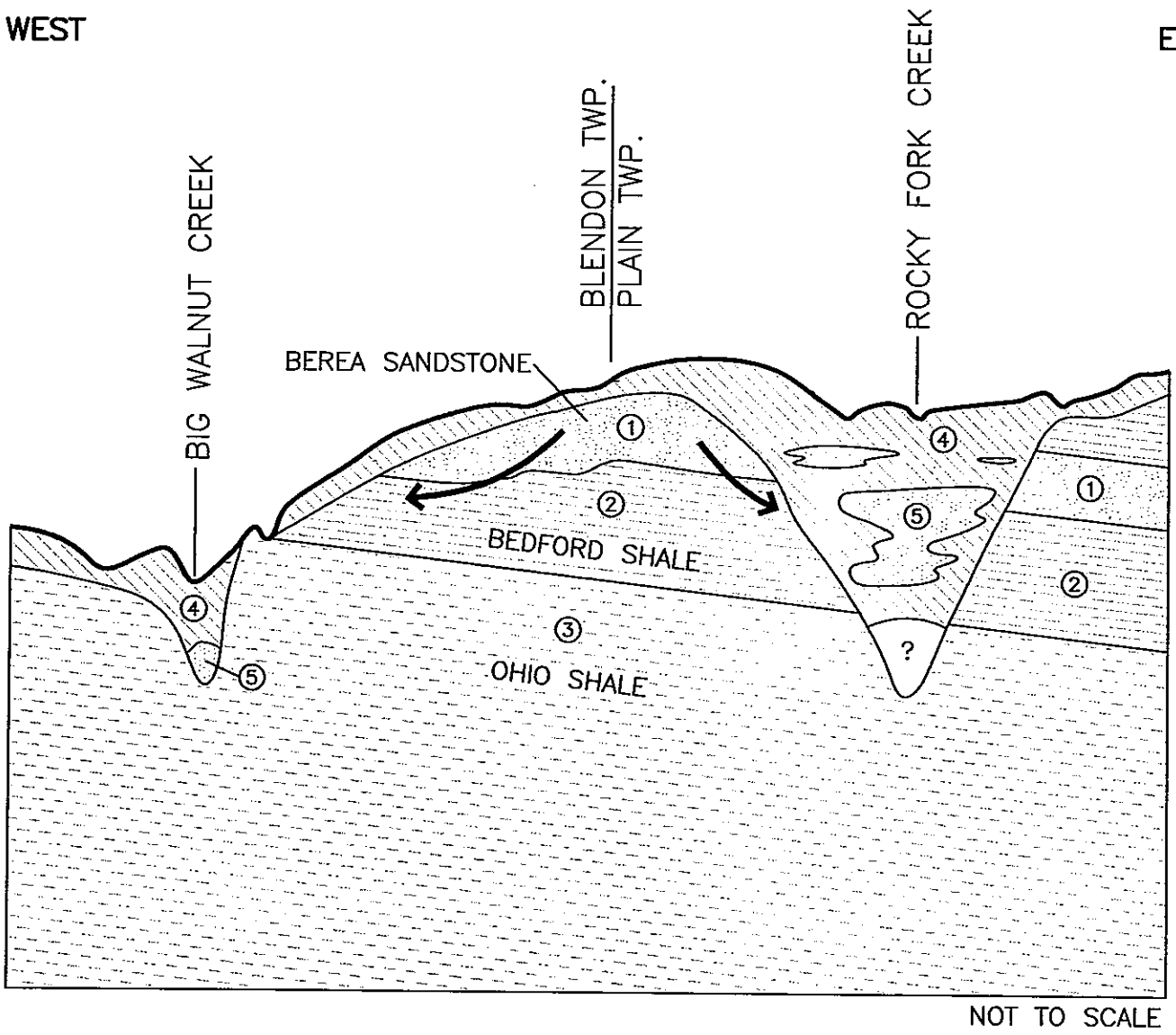


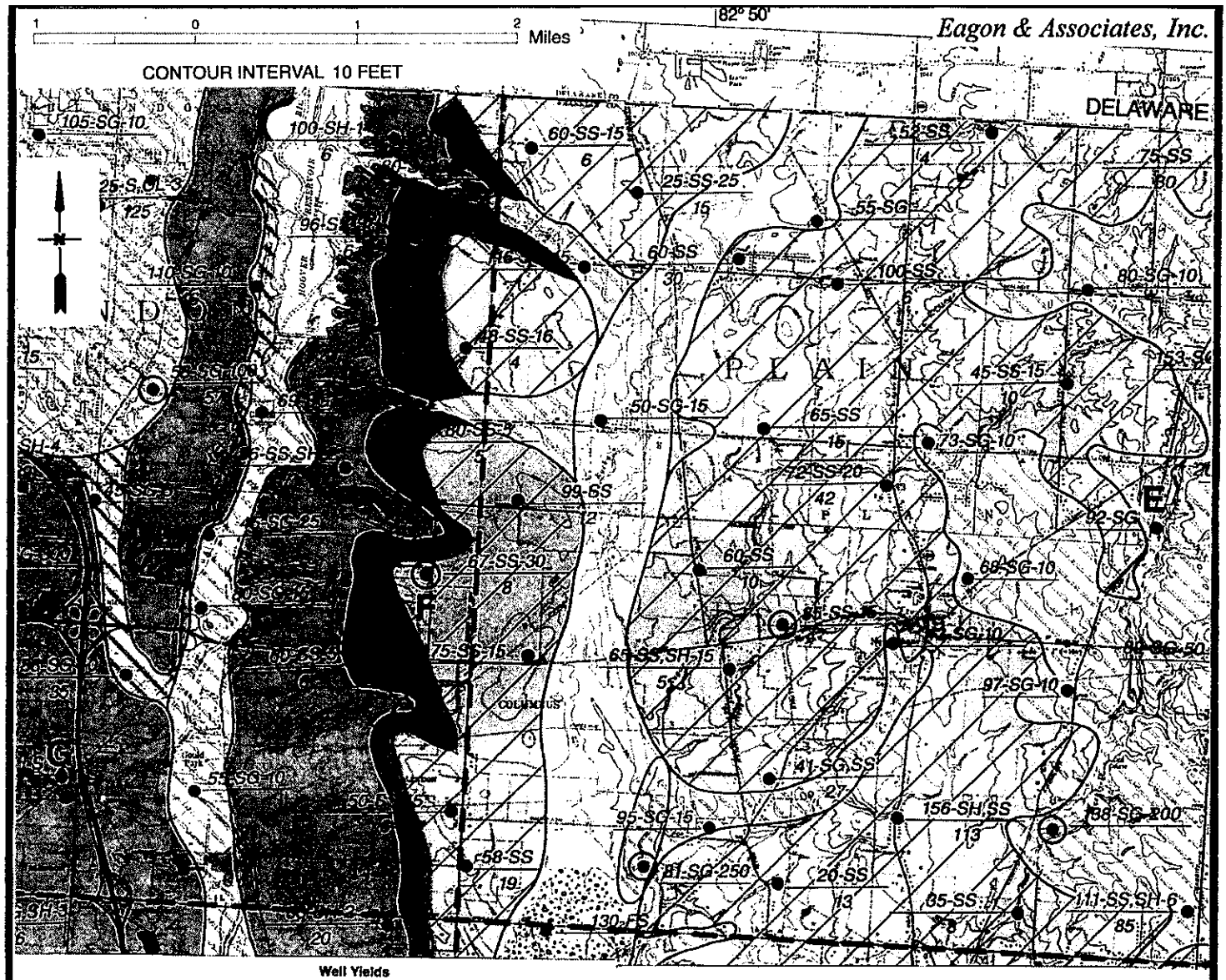
NOT TO SCALE

	STRATIGRAPHIC UNIT	HYDROGEOLOGIC SIGNIFICANCE
①	BEREA SANDSTONE	AQUIFER
②	BEDFORD SHALE	UPPER WEATHERED PART – MARGINAL AQUIFER DEEP UNWEATHERED PART – AQUITARD
③	OHIO SHALE	AQUITARD
④	GLACIAL TILL / ALLUVIUM	AQUITARD (ALLUVIUM MAY INCLUDE PERMEABLE BEDS)
⑤	SAND & GRAVEL	LOCAL AQUIFER WHERE ENCOUNTERED

← GENERAL DIRECTION OF GROUND WATER FLOW

C:\ACADDRWG\WALNUT\FIGXSECT.DWG 01/02/03

FIGURE 2–1
CONCEPTUAL HYDROGEOLOGIC MODEL



Well Yields

AREAS IN WHICH YIELDS OF 500 TO 1000 OR MORE GALLONS PER MINUTE MAY BE DEVELOPED.

Areas having greatest potential for development of municipal and industrial ground water supplies. Extensive test drilling necessary to locate relatively thick, permeable deposits at depths ranging from 60 to 115 feet. Yields in excess of 1000 gallons per minute developed from large diameter wells.

AREAS IN WHICH YIELDS OF 100 TO 500 GALLONS PER MINUTE MAY BE DEVELOPED.

Regionally extensive, thick, permeable deposits of sand and gravel may yield as much as 500 gallons per minute to large diameter screened wells. Extensive test drilling is recommended to locate coarse deposits at depths of 30 to 200 feet. Bedrock is non-water-bearing shale.

AREAS IN WHICH YIELDS OF 25 TO 100 GALLONS PER MINUTE MAY BE DEVELOPED.

Lenses of sand and gravel thinly scattered in the thin to thick layers of clayey till which overlies non-water-bearing Mississippian or Devonian shale. Properly constructed screened wells may yield 25 to 100 gallons per minute at average depths of 80 to 135 feet, but ranging in depth to 225.

AREAS IN WHICH YIELDS OF 5 TO 25 GALLONS PER MINUTE MAY BE DEVELOPED.

Ground water supplies developed at depths of 60 to 75 feet in the Mississippian sandstone or sandstone and shale bedrock. Yields seldom exceed 20 gallons per minute, although exceptional yields to large diameter wells have exceeded 100 gallons per minute at depths of about 170 feet.

Thin lenses of sand and gravel sparsely interbedded in thick deposits of clayey till. Yields of 5 to 25 gallons per minute may be developed at depths of 25 to more than 150 feet. Exceptional yields are logged at depths of 130 feet. Thick deposits of fine sand and silty clay often prevent the development of domestic supplies at depths of 200 to 300 feet. Wells in Perry Township not encountering a usable aquifer in the glacial deposits may obtain a ground water supply from the limestone bedrock which occurs at depths of 110 to 260 feet below the surface.

AREAS IN WHICH YIELDS OF 3 TO 10 GALLONS PER MINUTE MAY BE DEVELOPED.

Basal portion of shaley sandstone fringe zone of the Berea sandstone yields 4 to 6 gallons per minute from a very limited area at depths of less than 65 feet.

Very limited and often quite shallow glacial deposits of sand and gravel overlying shale bedrock of eroded ancestral drainage channel. Potential yields may not exceed 5 gallons per minute at depths of 15 to 35 feet.

AREAS IN WHICH YIELDS OF LESS THAN 2 GALLONS PER MINUTE MAY BE DEVELOPED.

Devonian and Mississippian shale bedrock yields less than 2 gallons per minute at depths of less than 100 feet. Occasionally, thin lenses of sand and gravel may be encountered near the surface of the weathered shale at depths of 18 to 45 feet and yield as much as 5 gallons per minute. If sand and gravel is not present, home owners rely upon cisterns and additional storage to develop a supply for peak demand. Devonian limestone beneath the shale in Perry and Sharon Townships yield larger supplies. Proper well construction may deter presence of hydrogen sulfide.

Areas which may contain hydrogen sulfide in the limestone bedrock and Berea sandstone. Ground water in the limestone bedrock may also be highly mineralized; however, this water is potable and free of excessive chlorides.

Relatively thick lenses of fine silty sand in buried valley deposits.

Well Site Symbols

WELL INFORMATION
(SEE NOTE)

DEPTH (ft.) Total depth of well in feet.
AQUIFER TYPE Water-bearing formation
YIELD (gpm) Amount of water a well produces in gallons per minute.
WELL SITE Approximate well location
75-SS-20
26
DEPTH TO BEDROCK (ft.) Depth to bedrock in feet.

WELL TYPES

- Well Site
- Municipal-Industrial Well
- Observation Well Site
- Test Well**
- A Chemical Analyses

AQUIFER TYPES

- S – Sand
- G – Gravel
- SG – Sand & Gravel
- SS – Sandstone
- SH – Shale
- LS – Limestone
- CL – Clay
- FS – Fine Sand

Figure 2-2 ODNR Ground Water Resources Map (Schmidt 1993)

TABLE 2-1
SUMMARY OF GROUND-WATER QUALITY DATA
BIG WALNUT TRUNK SEWER EXTENSION

Formation	Well Depth (feet)	pH	Specific Conductance µmhos/mc	Iron mg/ℓ	Sulfate mg/ℓ	TDS mg/ℓ	Total Hardness mg/ℓ	Nitrate mg/ℓ
Berea Sandstone	55	5.8	621	0.86	102	371	260	81.0
Berea Sandstone	67	6.8	571	2.80	98	364	279	0.0
Berea Sandstone	70	7.4	762	0.80	37	460	330	0.2
Berea Sandstone	63	7.0	1070	0.39	250	718	528	0.1
Bedford Shale	65	7.2	920	0.50	122	560	408	8.2
Bedford/Ohio Shale	90	7.6	2080	0.47	390	1360	178	12.0
Ohio Shale	67	7.2	1960	0.31	904	1612	1184	0.0
Maximum Contaimination Level (MCL)								10.0
Secondary Maximum Contaminant Level (SMCL)				0.30	250	500		

3.0 RESIDENTIAL WELL SURVEY

3.1 Coverage and Procedures

A residential well survey was conducted beginning on July 6, 1999 and was completed on July 30, 1999. The survey was performed to document the preconstruction condition of residential wells along the tunnel alignment to respond to questions, concerns, and complaints that may occur during the project. Additional surveys were conducted during August - September 2002 at selected locations. The survey was conducted in the vicinity of Lee Road from south of Central College Road north along Lee Road and ending on Schott Road north of Walnut Street. Plate 1 displays the locations of the wells that were surveyed.

Approximately 110 surveys were completed. Residents who could not be contacted in the field were left a letter explaining the purpose of the survey and were given a contact number to arrange an appointment. Within the survey area, approximately 10 residents declined to participate in the survey and letters were left at about 30 locations where contact could not be made.

Individual survey forms were completed for each residence. Residents were questioned about their well, pumping system, and water-quality treatment equipment. Available information from ODNR well logs was included on the survey forms and included the year the well was drilled, depth of the well, diameter, formation, and the depth of the pump setting. Questions were asked during the survey relative to the usage of the well and previous problems associated with the well including quantity or quality problems. A site diagram was drawn for each survey location indicating the location of the well on the property.

Water levels were measured in each well where access was possible and were measured to one one-hundredth of a foot from the top of casing using an electric water-level tape. An attempt was made to measure the depth of the pump setting at each location by lowering the electric tape down the well until the pump was encountered. A short pumping test also was conducted to measure the well yield and assess the efficiency of the well. The yield of the well was measured using a

flow-thru water meter while measurements were collected approximately every 1 - 2 minutes to determine the amount of drawdown. In general, the pumping tests consisted of 20 minutes of pumping while measuring water levels, shutting the well off, and measuring the recovery of water levels for about 10 minutes.

Water-quality sampling also was performed for each well during the survey. In most cases, wells were sampled following the pumping test using an unsoftened outside spigot as the sampling point. The following water-quality parameters were measured in the field: pH, specific conductance, temperature, turbidity, hydrogen sulfide, iron, and hardness. Samples for total coliform bacteria were collected in the field and delivered to a local laboratory for analysis. Table 3-1 includes the water-level and water-quality data collected during the survey. The map number shown on Table 3-1 correlates to the locations displayed on Plate 1.

3.2 Residential Well Database

A residential well database has been compiled to organize the available factual information for existing wells. Table 3-2 displays data from ODNR well logs as well as data collected during the well survey. The database contains the well owner's name, address, phone number, and also specific information about the well. A master file has been created that contains the field survey forms, ODNR well logs, and other relative information pertaining to each well.

The map number in Table 3-2 correlates to the location numbers displayed on Plate 1. It is noted that some locations shown on Plate 1 do not have information included on Tables 3-1 and 3-2 as some homeowners could not be contacted or declined to participate.

3.3 Well Yield Analysis

Information obtained from the pumping tests conducted during the well survey has been used to quantify well yields within the project area. Well yields are generally low throughout the project area and vary somewhat depending on the age, condition, and location of the well. In general, older

wells produce less water due to mineralization in the well. The yield of bedrock wells is dependent on the number of openings in the bedrock encountered in the well borehole.

In order to evaluate well-yield data, the specific capacity has been calculated for each well surveyed and is shown on Table 3-1. Specific capacity of a well is defined as the yield per unit of drawdown expressed as gallons per minute per foot of drawdown (gpm/ft). It is noted that the specific capacity varies with the duration of discharge and the specific capacity data have been calculated using the maximum drawdown measured at the end of the 20 minute pumping tests conducted during the well survey.

Most of the residential wells in the project area are completed in the Berea Sandstone aquifer. The saturated thickness of the Berea Sandstone at a given well generally dictates the yield of the well in that wells completed in areas where the Berea Sandstone is thin usually yield less water. Wells south of Central College Road along Lee Road have the lowest observed well yields with specific capacities ranging between 0.17 gpm/ft and 0.64 gpm/ft. The Berea Sandstone is of limited areal extent south of Central College Road and is thinner than in other areas within the project limits.

The specific capacity of wells surveyed along Central College Road including Hollandia Drive and Sandimark Place generally ranges between 0.5 gpm/ft and 1.6 gpm/ft. Higher yields were measured in wells north of Central College Road along Lee Road south of Cautella. Specific capacities calculated for these wells generally range from 0.5 gpm/ft to 3.0 gpm/ft. Three high yielding wells were measured in this area with specific capacities ranging from 12.3 gpm/ft to 15.6 gpm (Map No. 76, 79, and 80). Specific Capacities range from 0.3 gpm/ft to 3.1 gpm/ft for wells along Cautella Drive.

Wells located in the northern end of the project area are low yielding. Most wells surveyed along Walnut Street and Schott Road had very low yields and specific capacities are generally less than 1.0 gpm/ft.

In summary, well yields are low south of Central College Road along Lee Road and to the north along Walnut and Schott Roads. The highest yielding wells on average are located along Lee Road between Central College Road and Walnut Street.

3.4 Water-Quality Analysis

The water-quality data collected during the well survey are shown in Table 3-1. The average hardness of water samples collected from wells in the survey area is approximately 382 mg/ℓ and the average iron concentration is approximately 2.2 mg/ℓ. Iron concentrations were measured over a large range from 0 mg/ℓ to greater than 5 mg/ℓ. The ground-water quality in the project area is such that many residences utilize water conditioning equipment to remove iron and hardness from the raw water.

Samples for total coliform were collected at 58 locations during the well survey. Some wells are used for irrigation purposes only and therefore coliform samples were not collected from these wells. The coliform test is the standard bacteriological method for judging the suitability of water for domestic use. Of the 58 coliform samples collected and analyzed from the residential wells within the project area, 37 samples were reported as positive for total coliform (64 percent). Bacterial contamination of wells in this area is attributed to septic system discharge that enters the shallow aquifer through fractures and openings in the bedrock.

Hydrogen sulfide (H_2S) samples were analyzed in the field and only 1 well (Map No. 44.1) had H_2S that was measured above the detection limit of 0.5 mg/ℓ. Turbidity (water clarity) also was measured in the field. Many wells had turbidity values measured above the water-quality standard for turbidity of 0.5 NTU. Older wells with low specific capacity generally have higher turbidity values.

3.5 Water Use Patterns

Many residences within the project area are connected to Del-Co water service. Del-Co is a private water company that has water lines in most of the project area. Some properties are connected to Del-Co water service and use the original well on the property for outdoor purposes only. Very few wells however have sufficient yield for extensive irrigation.

TABLE 3-1. WELL SURVEY DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Static Water Level (feet)	Pumping Water Level (feet)	Average Pumping Rate (gpm)	Pumping Duration (min.)	Specific Capacity (gpm/ft)	pH (S.U.)	Specific Conductance (umhos/cm)	Turbidity (N.T.U.)	Hardness (mg/l)	Iron (mg/l)	Hydrogen Sulfide (mg/l)	Coliform Bacteria (pos./neg.)
8.0	Casto, Terry	6868 Lee Rd	--	--	6.0	26		7.06	676	2.39	410	1.1	<0.5	Positive
9.0	Webb, Roderick & Dorward, Roberta	6896 Lee Rd	17.07	>31.00	5.5	5	0.42	--	--	--	--	--	--	--
14.0	Gempel, Jack & Nan	6982 Lee Rd.	16.28	40.20	6.5	20	0.27	7.07	572	200	393	0.0	<0.5	Positive
15.0	Dennis, Nancy	6585 Ulry Rd.	17.48	29.21	4.3	15	0.37	6.94	692	2.06	410	0.0	<0.5	Negative
16.0	Lott, Vera	7000 Lee Rd.	16.95	36.75	3.5	19	0.17	7.21	711	0.98	0.0	0.0	<0.5	Positive
17.0	Thomas, Donald & Margo	6611 Ulry Rd.	13.54	>36	5.3	12	0.24	7.19	619	0.49	376	0.0	<0.5	Negative
18.0	Bailey, Bobby & Carol	7022 Lee Rd.	16.64	>27	7.0	8	0.64	7.03	750	2.56	342	0.9	<0.5	Positive
20.0	Douglas, Floyd & Elizabeth	7044 Lee Rd.	13.57	>41	4.5	8	0.17	7.19	817	0.48	530	0.0	<0.5	Positive
22.0	Farinet, Fred & Margaret	7070 Lee Rd.	13.03	>33	6.0	10	0.29	7.38	700	0.66	462	0.0	<0.5	Positive
23.1	Watson, James & Rebecca	6731 Ulry Rd.	9.73	>35	7.5	5	0.30	7.37	643	1.44	376	0.0	<0.5	Positive
23.2	Watson, James & Rebecca	6731 Ulry Rd.	10.76	>47	8.5	7	0.23	7.43	822	2.07	274	<0.5	<0.5	--
24.0	Marzullo, Philip & Kathleen	7088 Lee Rd.	11.42	--	6.0	9	0.18	7.23	1248	0.73	564	0.0	<0.5	--
27.0	Mojzisik, Allan & Cathy	7188 Hollandia Dr.	3.95	26.80	3.8	20	0.17	7.35	601	1.7	1.88	0.6	<1.0	Negative
34.0	Foley, Charles & Myrna	4500 Central College Rd.	11.37	14.28	5.4	20	1.32	7.39	456	1.89	239	1.6	<0.5	--
35.0	Rice, Raymond & Norma	4520 Central College Rd.	12.25	16.71	4.0	20	0.90	7.37	512	3.8	325	1.3	<0.5	--
39.0	Howard, Tony	7210 Hollandia Dr.	6.56	14.39	6.0	20	0.77	6.54	228	4.9	120	0.8	<0.5	--
40.0	Vandermeulen, Besselina	7226 Hollandia Dr.	10.65	15.72	5.2	20	1.02	7.02	502	7.05	257	1.5	<0.5	Positive
44.1	Estep, Wade & Sandra	4694 Central College Rd.	13.68	21.52	6.5	20	0.82	7.89	779	9.88	410.4	3.5	1.0	Positive

TABLE 3-1. WELL SURVEY DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Static Water Level (feet)	Pumping Water Level (feet)	Average Pumping Rate (gpm)	Pumping Duration (min.)	Specific Capacity (gpm/ft)	pH (S.U.)	Specific Conductance (umhos/cm)	Turbidity (N.T.U.)	Hardness (mg/l)	Iron (mg/l)	Hydrogen Sulfide (mg/l)	Coliform Bacteria (pos./neg.)
50.0	Sainey, Timothy & Sandra	7160 Lee Rd.	10.42	22.47	7.9	20	0.66	7.67	678	0.60	291	0.3	<0.5	--
51.0	Kerkman, Gayle	7157 Lee Rd.	13.83	26.88	7.6	20	0.58	6.83	1082	1.4	462	0.4	<0.5	Positive
52.0	Geer, Tess	7181 Lee Rd.	17.36	19.04	4.1	20	0.62	6.96	664	2.12	359	0.6	<0.5	Positive
53.0	Moslein, Gerald & Carolyn	7188 Lee Rd.	12.93	15.05	6.5	20	3.07	6.97	700	7.9	410	2.7	<0.5	--
54.2	Gambaiani, John & Linda	7176 Lee Rd.	14.40	16.07	3.4	25	2.03	7.06	715	2.13	222	0.2	<0.5	Positive
56.0	Porter, Pamela	7276 Lee Rd.	9.00	10.55	5.6	20	2.77	6.40	610	5.13	359	3.2	<0.5	--
58.2	Coolidge, Robin & Valerie	7196 Lee Rd.	24.75	>29.00	7.0	9	1.63	6.95	993	4.55	308	0.4	<0.5	Positive
59.0	Kyle, Donald & Amy	7199 Lee Rd.	17.23	24.03	5.0	22	0.73	6.94	1186	4.64	376	0.0	<0.5	Positive
60.0	Mentzer, Jake & Pam	7217 Lee Rd.	15.90	2340	8.0	20	0.99	6.86	1367	370	428	0.6	<0.5	Positive
61.0	Callaghan, Howard & Calvene	7214 Lee Rd.	17.27	22.15	8.4	20	1.72	6.92	925	7.78	462	0.8	<0.5	--
62.0	Shreve, Dennis & Susan	7235 Lee Rd.	17.96	27.57	4.1	20	0.42	6.91	614	5.9	376	0.6	<0.5	Positive
63.0	Gornall, Glenn & Suzanne	7232 Lee Rd.	16.07	25.45	5.7	15	0.61	7.04	776	5.99	342	0.4	<0.5	--
66.0	Stimmel, Gary & Toni	7289 Lee Rd.	14.57	22.42	4.8	20	0.56	6.59	924	12.9	393	0.9	<0.5	Positive
67.0	Rishel, James & Linda	7288 Lee Rd.	11.60	14.10	7.0	20	1.60	6.87	952	3.4	564	4.4	<0.5	--
68.0	Mullins, Robert & Marjorie	7315 Lee Rd.	12.97	14.80	3.5	20	1.91	6.28	695	38.5	445	>5.0	<0.5	--
69.0	Gornall, Glenn & Suzanne	7245 Lee Rd.	14.65	18.77	5.4	20	1.31	7.12	883	42.6	496	3.8	<0.5	Positive
70.0	Gornall, Glenn & Suzanne	7350 Cubbage Rd.	8.10	11.39	7.2	20	2.19	7.31	777	1.96	342	0.4	<0.5	Negative
76.0	Cox, Samuel & Christina	7310 Lee Rd.	15.40	15.65	6.4	20	14.2	6.61	736	3.60	479	>5.0	<0.5	Positive

TABLE 3-1. WELL SURVEY DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Static Water Level (feet)	Pumping Water Level (feet)	Average Pumping Rate (gpm)	Pumping Duration (min.)	Specific Capacity (gpm/ft)	pH (S.U.)	Specific Conductance (umhos/cm)	Turbidity (N.T.U.)	Hardness (mg/l)	Iron (mg/l)	Hydrogen Sulfide (mg/l)	Coliform Bacteria (pos./neg.)
79.0	Carrol, Charles & Janice	7318 Lee Rd.	15.18	15.55	6.1	20	15.64	6.56	899	2.71	632	>5.0	<0.5	--
80.0	Murphy, John & Laura	7399 Lee Rd.	17.48	17.95	5.8	20	12.3	6.59	929	1.83	547	>5.0	<0.5	--
81.0	Koelbl, Michael & Loraine	7332 Lee Rd.	17.02	31.10	7.4	20	0.53	6.96	793	5.67	445	3.5	<0.5	--
83.0	Karingada, Sebastian & Veronica	4650 Cautella Dr.	16.50	35.90	6.3	5	0.32	6.98	833	>1000	428	>5.0	<0.5	Negative
84.0	Nelson, Michael	4610 Cautella Dr.	16.8	21.71	4.0	21	0.61	6.91	888	1.77	0	0.2	<0.5	--
85.0	McKee, Larry & Eunice	4582 Cautella Dr.	14.8	34.32	7.1	14	0.36	6.53	958	38.9	393	>5.0	<0.5	Negative
88.0	Fisher, Steven & Mary	4555 Cautella Dr.	12.55	13.53	3.0	26	3.06	6.97	710	2.17	428	3.1	<0.5	Positive
89.0	Myers, Frank & Mae	4571 Cautella Dr.	15.5	18.83	9.0	17	2.70	6.43	744	2.90	393	3.3	<0.5	--
91.0	Moninger, Donald & Marie	4605 Cautella Dr.	17.83	>29.00	6.0	11	0.53	6.72	749	247	428	>5.0	<0.5	Negative
92.0	Manly, Donald & Marie	4625 Cautella Dr.	17.85	25.47	6.0	26.5	0.79	6.98	743	24.0	393	1.1	<0.5	Positive
94.0	Czekanski, Joseph & Elizabeth	4667 Cautella Dr.	16.78	21.47	5.2	23	1.09	6.84	842	15.2	428	>5.0	<0.5	Negative
100.0	Schlagheck, Patrick & Melissa	7562 Lee Rd.	19.40	>28.00	3.3	9	0.36	6.95	529	139	393	>5.0	<0.5	Positive
101.0	Lisle, Douglas & Nesley	9554 Lee Rd.	11.97	24.62	5.8	20	0.43	6.68	751	50.2	462	4.5	<0.5	Negative
104.1	Whitley, Gary & Barbara	7524 Lee Rd.	11.30	12.17	5.3	20	6.46	6.17	511	18.4	239	>5.0	<0.5	Positive
105.0	Yusko, Joseph & Bonnie	7572 Lee Rd.	10.34	11.89	4.9	25	2.93	6.89	600	4.24	325	3.5	<0.5	Negative
106.0	Slack, Francis & Nancy	7536 Lee Rd.	11.82	12.35	6.9	20	13.01	6.67	551	13.1	291	<5.0	<0.5	--
109.0	Bruck, Patrick & Linda	7576 Lee Rd.	11.90	20.31	4.1	16	0.49	7.27	626	16.8	359	4.3	<0.5	Positive
110.1	Siders, Paul	7580 Lee Rd.	--	--	4.0	20		7.12	480	3.28	<17.1	0.2	<0.5	Negative

TABLE 3-1. WELL SURVEY DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Static Water Level (feet)	Pumping Water Level (feet)	Average Pumping Rate (gpm)	Pumping Duration (min.)	Specific Capacity (gpm/ft)	pH (S.U.)	Specific Conductance (umhos/cm)	Turbidity (N.T.U.)	Hardness (mg/l)	Iron (mg/l)	Hydrogen Sulfide (mg/l)	Coliform Bacteria (pos./neg.)
111.0	Greenlee, George & Francyl	7551 Lee Rd.	11.36	14.51	6.7	20	2.12	6.61	559	10.8	291	>5.0	<0.5	Negative
114.0	Tayim, Fauzi	7601 Lee Rd.	16.18	17.95	4.2	20	2.23	7.09	524	6.45	291	>5.0	<0.5	Positive
115.0	Murphy, Marvin & Nancy	7600 Lee Rd.	12.45	43.85	6.2	20	0.20	6.86	707	54.3	359	5.0	<0.5	Negative
117.0	Merrell, Clyde & Gail	7645 Lee Rd.	17.15	30.47	9.4	15	0.71	7.10	608	23.1	274	<5.0	<0.5	Negative
120.0	Wagner, James & Virginia	4897 E. Walnut St.	15.89	36.84	2.5	17.5	0.12	7.12	1109	192	496	<5.0	<0.5	Positive
126.0	Simpson, Leonard	7778 Schott Rd.	10.27	>30.00	6.75	5	0.34	6.75	973	1.62	324.9	0.0	<0.5	Positive
132.1	Horn, Tim	4930 E. Walnut St.	16.47	40.25	3.2	15	0.13	7.34	560	3.34	342	0.7	<0.5	Positive
133.0	Thompson, Michael & Lou Ann	7790 Schott Rd.	8.80	34.26	6.8	20	0.27	6.96	696	5.96	291	1.4	<0.5	--
135.0	Hudson, Michael & Sandra	7822 Schott Rd.	18.06	23.10	4.4	20	0.87	6.98	498	1.99	325	0.5	<0.5	Negative
136.0	Timm, Frederic & Ann	7828 Schott Rd.	16.29	>47	2.1	20	0.07	7.25	822	0.69	342	0.3	<0.5	Positive
137.0	Loeffert, Larry & Elaine	7830 Schott Rd.	12.14	>60.00	5.6	20	0.12	6.95	617	60.6	325	4.4	<0.5	Negative
138.1	Doran, David & Lisa	4736 E. Walnut St.	14.92	>48	7.25	15	0.20	6.98	1033	0.94	513	0.0	<0.5	Positive
138.2	Doran, David & Lisa	4736 E. Walnut St.	11.22	>48	7.7	7.5	0.20	6.65	1330	2.08	445	1.2	<0.5	Positive
140.0	Matthews, Paul & Cathy	7777 Schott Rd.	16.15	>36.15	5.0	19	0.25	7.51	569	173	376	4.7	<0.5	Negative
141.0	Alvarez, Eleanor	4720 Walnut St.	12.33	23.88	4.9	20.5	0.32	7.40	1091	4.56	291	0.0	<0.5	Positive
144.1	Phillips, John & Elaine	7925 Schott Rd.	38.48	42.08	6.6	15	3.97	7.45	800	39.2	291	>5.0	<0.5	Negative
144.2	Phillips, John & Elaine	7925 Schott Rd.	5.46	6.58	9.0	300	0.81	7.63	880	4.10	496	0.5	<0.5	--
145.0	Phillips, John & Elaine	7813 Schott Rd.	11.62	>29.00	4.4	10	0.25	7.11	846	1.71	325	0.1	<0.5	Positive

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Map No.	Owner	Address	Static Water Level (feet)	Pumping Water Level (feet)	Average Pumping Rate (gpm)	Pumping Duration (min.)	Specific Capacity (gpm/ft)	pH (S.U.)	Specific Conductance (umhos/cm)	Turbidity (N.T.U.)	Hardness (mg/l)	Iron (mg/l)	Hydrogen Sulfide (mg/l)	Coliform Bacteria (pos./neg.)
150.0	Bachman, Harold	7951 Schott Rd.	--	--	4.0	--		7.29	852	14.4	308	1.5	<0.5	Negative
152.1	Pickering, Susan	7066 Sandimark Pl.	7.06	12.05	8.0	20	1.60	7.28	557	27.8	342	2.0	<0.5	Positive
153.0	Halliwell, Jason	6345 Ulry Rd.	10.00	21.23	5.0	20	0.45	6.20	962	64.9	530.1	>5.0	<0.5	Positive
154.0	Huff, Jerri	7057 Sandimark Pl.	12.52	20.17	6.5	20	0.75	6.94	754	8.47	461.7	2.5	<0.5	Negative
155.0	Roullard, Melanie	7088 Sandimark Pl.	13.54	15.68	2.5	20	1.17	6.97	706	18.2	410.4	3.5	<0.5	Positive
156.0	Gummer, George	7076 Sandimark Pl.	11.35	20.34	10.5	20	1.17	7.70	669	1.07	324.9	2.0	<0.5	Positive
157.0	Donnenwirth, Keith	6375 Ulry Rd.	17.12	27.72	7.0	20	0.66	6.66	629	63.4	307.8	>5.0	<0.5	Negative

TABLE 3-2. RESIDENTIAL WELL DATABASE
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Phone Number	ODNR Located Log #	ODNR Log #	Well Depth (feet)	Pump Setting (feet)	Original Static Water Level (feet)	Year Drilled	Surface Elevation (feet, MSL)	Bedrock Elevation (feet, MSL)	Pump Type jet/sub	Notes
2.0	Smith, Kenneth & Annabell	6800 Lee Rd.			689	65		40	1948				
3.0	Shafer, Fannie	6834 Lee Rd				16				949.5			no pump
4.0	Fowler, Benjamin & Jean	6846 Lee Rd.											no survey
6.0	Degnan, John & Steigerwald Julia	6862 Lee Rd.	898-7646		239453	130	105		1959	948	938	sub	
8.0	Casto, Terry	6868 Lee Rd	890-7747			80		8	1958			sub	
9.0	Webb, Roderick & Dorward, Roberta	6896 Lee Rd		254	390820	85		16	1969	984	980		
10.0	Jones, Paul	6900 Lee Rd.								985	980		Del-Co, well abnd
11.0	Lewis, William & Gail	6926 Lee Rd.											Del-Co, well not in use, buried
13.0	Morris, Theodore & Walker, Phylis	6966 Lee Rd.	890-8364		261560	70	70	12	1961	982	978	jet	buried
14.0	Gempel, Jack & Nan	6982 Lee Rd.	882-1144		257377	77	75	16	1961	981	977	sub	
15.0	Dennis, Nancy	6585 Ulry Rd.	882-8022		679357	47	35	17	1988	984	978	sub	
16.0	Lott, Vera	7000 Lee Rd.	882-3266	256		75	70	17	1999	980		sub	
17.0	Thomas, Donald & Margo	6611 Ulry Rd.		263	314297	80		14	1965	980	975	jet	
18.0	Bailey, Bobby & Carol	7022 Lee Rd.	899-0150	257	257168	75	40	17	1962	977	969	sub	
20.0	Douglas, Floyd & Elizabeth	7044 Lee Rd.	882-4041			69	65	14	1967	977		sub	
21.0	Salts, Roger	6687 Ulry Rd.		262	304792	70		4	1964				
22.0	Farinet, Fred & Margaret	7070 Lee Rd.		259	304758	66		13	1963	975	969	jet	
23.1	Watson, James & Rebecca	6731 Ulry Rd.	899-1937	261	175734	56		10	1958	972	966	jet	

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23.2	Watson, James & Rebecca	6731 Ulry Rd.	899-1937	261	643782	60		11	1985	973	967	sub	
24.0	Marzullo, Philip & Kathleen	7088 Lee Rd.						11	1964	970		sub	Del-Co water
26.0	Ziesenheim, Erik & Sherry	7100 Lee Rd.	901-0160					9				sub	Del-Co water
27.0	Mojzisik, Allan & Cathy	7188 Hollandia Dr.	890-6301			30		4	1972	972		jet	
28.1	Ellermets, Kent & Valerie	4511 Central College Rd.		218	461568	75			1974	952	947		Del-Co water
28.2	Ellermets, Kent & Valerie	4511 Central College Rd.		218	618774	101			1982	952	931		Del-Co water
29.0	Beckett, Duane & Cathy	4495 Central College Rd.	891-2228	217	480333	83	23	22	1975	964	949	sub	Del-Co water, well disconnected
30.1	Eyen, Matthew	4485 Central College Rd.	898-1985					24	1956	963		jet	Del-Co water, well disconnected
30.2	Eyen, Matthew	4485 Central College Rd.	898-1985	216	468295	90	86	22	1975	964	954.5	sub	Del-Co water, well disconnected
31.0	Paul, Eugene & Polly	4479 Central College Rd.		215	667475	80		30	1987				
33.0	Barr, William & Judyth	4445 Central College Rd.	882-1267	214	304756	100		29	1963	952	946	sub	Del-Co water, well disconnected
34.0	Foley, Charles & Myrna	4500 Central College Rd.	882-7606			52	42	11	1969	966		sub	Del-Co water inside, well outside
35.0	Rice, Raymond & Norma	4520 Central College Rd.	882-6923	211	280316	66		12	1962	967	936	jet	Del-Co water inside, well outside
36.0	Herb, David & Lori	4540 Central College Rd.			280323	34		24	1962	971	938		
39.0	Howard, Tony	7210 Hollandia Dr.	890-9965	210	369034	40		7	1968	977	973	jet	Del-Co water inside, well outside
40.0	Vandermeulen, Besselina	7226 Hollandia Dr.	891-1063	209	458285	45		11	1974	979	974	jet	
41.0	Lakeman, Margaret	7242 Hollandia Dr.			455943	39		0	1973	980	960		
42.0	Wolverton, Betty	7080 Lee Rd.		243	418635	34	25	8	1971	967		sub	Del-Co water, well disconnected

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43.0	Snedegar, Phyllis	4608 Central College Rd.			711619	100	90	26	1990	968	957		
44.1	Estep, Wade & Sandra	4694 Central College Rd.	855-0835					14		970		sub	Side of house
44.2	Estep, Wade & Sandra	4694 Central College Rd.	855-0835					14					Behind house
44.3	Estep, Wade & Sandra	4694 Central College Rd.	855-0835	244	663759	47	30		1987	970			Geothermal well
45.2	Anderson, Sylvia	7077 Sandimark Pl.		245	655732	68		8	1986	977			
49.0	Hemmert, Thomas & Jacqueline	4590 Central College Rd.											well used on outside, not accessible for wls
50.0	Sainey, Timothy & Sandra	7160 Lee Rd.	890-1226	241	577651	90	70	10	1980	979	970	sub	Del-Co indoor use, well outdoor use
51.0	Kerkman, Gayle	7157 Lee Rd.	890-3705	234	548738	60		14	1979	984	979	sub	
52.0	Geer, Tess	7181 Lee Rd.	895-6783		520988	36	33	17	1978	988	981	sub	
53.0	Moslein, Gerald & Carolyn	7188 Lee Rd.	891-5236		599885	50	35	13	1982	983	977	sub	Del-co inside, well outside
54.1	Gambaiani, John & Linda	7176 Lee Rd.	891-6677	240	663790	105			1988	978	891		WLs not possible
54.2	Gambaiani, John & Linda	7176 Lee Rd.	891-6677	240	663795	50	35	14	1988	978		sub	
56.0	Porter, Pamela	7276 Lee Rd.	890-2891			67	57	9	1984	979		sub	Del-co inside & pool, well outside
57.0	Andrews, Johnny & Marsha	7204 Lee Rd.		238	593162	36	30	6	1982	986	975		
58.1	Coolidge, Robin & Valerie	7196 Lee Rd.	895-7810	239	564085	45	35		1980	987	977		unused
58.2	Coolidge, Robin & Valerie	7196 Lee Rd.	895-7810	239				25	1980	986		sub	geothermal system
59.0	Kyle, Donald & Amy	7199 Lee Rd.	882-8182	233	548727	60	40	17	1979	989	982	sub	
60.0	Mentzer, Jake & Pam	7217 Lee Rd.			551609	50	50	16	1979	988	981	sub	

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61.0	Callaghan, Howard & Calvene	7214 Lee Rd.	882-1865	237	555225	69	36	17	1979	987	978	sub	Del-Co inside, well outside
62.0	Shreve, Dennis & Susan	7235 Lee Rd.	891-9129		520985	34	30	18	1978	990	978	sub	
63.0	Gornall, Glenn & Suzanne	7232 Lee Rd.	882-2378				35	16					Del-Co inside, well outside
64.0	Fleet, Ronald & Vicki	7267 Lee Rd.		232	516181	60		12	1978	988	978		
65.1	Hall, Douglas & Linda	7266 Lee Rd.		236	564084	35			1980				Del-Co, well abnd
65.2	Hall, Douglas & Linda	7266 Lee Rd.		236	599876	50			1981				Del-Co, well abnd
66.0	Stimmel, Gary & Toni	7289 Lee Rd.	891-7675					15		988		sub	
67.0	Rishel, James & Linda	7288 Lee Rd.	891-4258	235	599867	45	30	12	1981	984	976	sub	Del-co inside, well outside
68.0	Mullins, Robert & Marjorie	7315 Lee Rd.	891-7017				34	13		987		sub	Del-co inside, well outside
69.0	Gornall, Glenn & Suzanne	7245 Lee Rd.	882-2378		593186	55	23	15	1984			sub	Has Del-co tap - not used
70.0	Gornall, Glenn & Suzanne	7350 Cubbage Rd.	882-2378				14	8				sub	Owned by Gornall (7245 Lee)
71.0	Smith, Patricia	7339 Lee Rd.		227	520992	34	25	11	1978	987	983		
72.0	Kyees, John & Judy	7300 Lee Rd.			764382	50	30	21	1993	991	987		
74.0	Storm, Linda	7349 Lee Rd.	794-1461	231	664734	48	25	11	1988	990	986	sub	Del-co, well not used
76.0	Cox, Samuel & Christina	7310 Lee Rd.	890-4395	229	599998	50	30	15	1982	995	982	sub	All taps softened
78.0	Torlone, William & Susan	7385 Lee Rd.	890-5162	228	175729	50	45	17	1958	996	989	jet	Del-Co, well disconnected
79.0	Carrol, Charles & Janice	7318 Lee Rd.	891-4210	230	643808	50	35	15	1984	994	988	sub	Del-co inside, well outside
80.0	Murphy, John & Laura	7399 Lee Rd.	890-8941	227	664710	50	45	17	1987	996	992	sub	Del-co inside, well outside

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81.0	Koelbl, Michael & Loraine	7332 Lee Rd.	895-7016		727117	75	70	17	1992	995	990	sub	Del-co inside, well outside
82.0	Townsend, Sidney & Redwine, Donna	7413 Lee Rd.			203521	40	25	13	1957	996	991		
83.0	Karingada, Sebastian & Veronica	4650 Cautella Dr.	898-7839				42	17	1989			sub	
84.0	Nelson, Michael	4610 Cautella Dr.		222	643797	57	46	17	1986	999	991	sub	Del-co inside, well outside
85.0	McKee, Larry & Eunice	4582 Cautella Dr.		224	679353	47	35	15	1988	998	995	sub	
86.0	Wolfe, Michael & Pamela	4566 Cautella Dr.		225	664721	50	46	21	1987	998	993		
87.0	Nolan, Patrick & Sharlene	4550 Cautella Dr.	890-7455	226	667062	110			1987				Del-co water, well not working
88.0	Fisher, Steven & Mary	4555 Cautella Dr.			679385	38	35	13	1989	994	989	sub	
89.0	Myers, Frank & Mae	4571 Cautella Dr.						16	1993	996		sub	Del-co inside, well outside
90.0	Allen, Timothy & Sheila	4587 Cautella Dr.		221	655691	100	80	70	1986	998	988		
91.0	Moninger, Donald & Marie	4605 Cautella Dr.	890-6503	220	664715	50	44	18	1987	1000	995	sub	
92.0	Manly, Donald & Marie	4625 Cautella Dr.	891-7636			59	40	18	1986	1000	989	sub	
93.0	Mallet, Stephen & Jacqueline	4645 Cautella Dr.											Del-Co water, no well
94.0	Czekanski, Joseph & Elizabeth	4667 Cautella Dr.		219	643779	50	45	17	1985	998	993	sub	
96.0	Gardner, Harold & Hazel	7566 Lee Rd.		158	599967	54		6	1981	998	985		
99.0	Davidheiser, Timothy	7568 Lee Rd.		157	493831	72		1977	990	985			
100.0	Schlagheck, Patrick & Melissa	7562 Lee Rd.	523-1324					19	1985	990		sub	
101.0	Lisle, Douglas & Nesley	9554 Lee Rd.	523-3942		711613	76	60	12	1990	992	986	sub	

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104.1	Whitley, Gary & Barbara	7524 Lee Rd.	895-2803		434443	45	35	11	1972	993	989	sub	
104.2	Whitley, Gary & Barbara	7524 Lee Rd.	895-2803		563826								not in use, log illegible
105.0	Yusko, Joseph & Bonnie	7572 Lee Rd.	895-1236		575116	59		10	1980	993	985	sub	
106.0	Slack, Francis & Nancy	7536 Lee Rd.	891-2993		438431	31	29	12	1973	993	989	jet	Del-co inside, well outside
107.0	Maynard, Paul & Baumann, Tina	7550 Lee Rd.			599859	75	65		1981	993	988		Return for Geothermal
108.0	Feazel, Todd	7558 Lee Rd.		160.5	431432	31		6	1972	995	991		
109.0	Bruck, Patrick & Linda	7576 Lee Rd.	882-5048		628957	52	46	12	1986	994	987	sub	
110.1	Siders, Paul	7580 Lee Rd.	882-3916		376236	90			1968	996	991	sub	well buried
111.0	Greenlee, George & Francyl	7551 Lee Rd.	882-6786		378446	64	60	11	1968	993	989	sub	
112.0	Miller, Scott	7561 Lee Rd.				25		8					Miller new owner since 2002, Del-Co water
113.0	Tayim, Fauzi & Clarissa	7577 Lee Rd.		155	300774	60		12	1963	998	994		
114.0	Tayim, Fauzi	7601 Lee Rd.	890-6033		599989	50		16	1982	1000	993	sub	
115.0	Murphy, Marvin & Nancy	7600 Lee Rd.	890-5010		493844	64	45	12	1977	997	991	sub	
116.0	Day, Mary	7640 Lee Rd.				55			1960				Del-Co water
117.0	Merrell, Clyde & Gail	7645 Lee Rd.	895-8299		627460	40	30	18	1985	1000	965	sub	
118.0	Courts, Gordon & Delong, Karen	4953 E. Walnut St.											Not interested in participating
119.0	Richardson, Terrance & Spring	4935 E. Walnut St.			635410	65			1986	998	988	sub	Not interested in participating
120.0	Wagner, James & Virginia	4897 E. Walnut St.	882-2563		334618	55	47	16	1995	1000	997	sub	

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121.0	Lewis, Richard & Shelley	4865 E. Walnut St.											Well buried, Del-Co water
122.0	Wenrich, Barry & Patricia	4855 E. Walnut St.			274177	52			1962	1001	997		Well disconnected, Del-Co water
124.0	Vesmer, Daryl & Teresa	4739 Walnut St.										jet	Del-Co
126.0	Simpson, Leonard	7778 Schott Rd.				32		10		997		sub	
128.0	McCarron, Aidan & Patricia	4870 E. Walnut St.			599977	50			1981				Declined to be surveyed
129.0	McCarron, Aidan & Patricia	E. Walnut St.			376215	90		6	1968	996	992		
130.0	Indiciani, James	4910 E. Walnut St.			516198	60			1978				Declined to be surveyed
131.0	Lightbody, Mary	4948 E. Walnut St.			599985	51		17	1982	975	959		
132.1	Horn, Tim	4930 E. Walnut St.	891-8822 -W		563833	54	47	16	1980	976	951	sub	
132.2	Horn, Tim	4930 E. Walnut St.	891-8822 -W		599976	51	45	10	1981			sub	Not currently in use
133.0	Thompson, Michael & Lou Ann	7790 Schott Rd.	895-3476		299070	61	40	9	1964	990		sub	Del-Co inside & pool, well outside
135.0	Hudson, Michael & Sandra	7822 Schott Rd.	890-1387			82	77	18	1960	983			
136.0	Timm, Frederic & Ann	7828 Schott Rd.	890-5107		516184	74	70	16	1978	977	967	sub	
137.0	Loeffert, Larry & Elaine	7830 Schott Rd.	891-6423		203784	75	65	12	1960	975	965	sub	Well outside, cistern inside
138.1	Doran, David & Lisa	4736 E. Walnut St.	882-8281			52	52	11		1004		sub	Barn well
138.2	Doran, David & Lisa	4736 E. Walnut St.	882-8281		695683	100	95	15	1992	1000	996	sub	House well
139.0	Linzell, Doreen	7731 Schott Rd.	882-1740	181	434444	95		17	1972	988	986		Well Disconnected, Del-Co water
140.0	Matthews, Paul & Cathy	7777 Schott Rd.	898-9466	182	516156	77		16	1977	978	975	sub	

TABLE 3-2. RESIDENTIAL WELL DATABASE
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Phone Number	ODNR Located Log #	ODNR Log #	Well Depth (feet)	Pump Setting (feet)	Original Static Water Level (feet)	Year Drilled	Surface Elevation (feet, MSL)	Bedrock Elevation (feet, MSL)	Pump Type jet/sub	Notes
141.0	Alvarez, Eleanor	4720 Walnut St.	891-9149	180	743031	50	46	12	1991	992	989	sub	
142.0	Cuervo, Armando & Catherine	4710 Walnut St.											2 wells abandoned, Del-Co water
143.0	St. Pauls Evangelical Lutheran Church	4686 Walnut St.											Well abandoned
144.1	Phillips, John & Elaine	7925 Schott Rd.				100	100	38	1948			sub	
145.0	Phillips, John & Elaine	7813 Schott Rd.	891-1027	183	412482	95	90	12	1971	975	972	sub	
146.0	Daugherty, Richard & Myrna	7860 Schott Rd.			203798	78	66	16	1961				
147.0	Cheadle, Daniel & Mary	7900 Schott Rd.	895-2309	147	599987	39	35	22	1982			sub	Also have cistern
150.0	Bachman, Harold	7951 Schott Rd.	882-4687						1939			sub	Well inside workshop, no access
151.1	Georges, Ilene	7067 Sandimark Pl.	855-0768						1985				Declined to be surveyed
151.2	Georges, Ilene	7067 Sandimark Pl.	855-0768		782293	54			1995				Declined to be surveyed
152.1	Pickering, Susan	7066 Sandimark Pl.	939-1960	247	634663	75		8	1986	975	910	sub	Geothermal system
152.2	Pickering, Susan	7066 Sandimark Pl.	939-1960					6				sub	Geothermal system
153.0	Halliwell, Jason	6345 Ulry Rd.	895-9801			50	37	10		986		jet	
154.0	Huff, Jerri	7057 Sandimark Pl.	855-0417		622031	51		13	1986	973		sub	
155.0	Roullard, Melanie	7088 Sandimark Pl.			617041	52	35	14	1989	981	931	sub	
156.0	Gummer, George	7076 Sandimark Pl.	855-4790	246	632836	68	62	11	1986	977		sub	
157.0	Donnenwirth, Keith	6375 Ulry Rd.	895-8349				60	17	1957	988		sub	
158.0		6390 Ulry Rd.			731466	54		30	1991				

TABLE 3-2. RESIDENTIAL WELL DATABASE
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Owner	Address	Phone Number	ODNR Located Log #	ODNR Log #	Well Depth (feet)	Pump Setting (feet)	Original Static Water Level (feet)	Year Drilled	Surface Elevation (feet, MSL)	Bedrock Elevation (feet, MSL)	Pump Type jet/sub	Notes
159.0		5091 Walnut			254771	23		6	1961				Declined to be surveyed
160.0	O'Daniel	7646 Lee Rd.			242507	58			1960				Declined to be surveyed
161.0		7056 Sandimark Pl.			634019	57	30	6	1986				

4

4.0 AQUIFER TESTING

4.1 Test Locations

Pumping tests were performed during the hydrogeologic field investigation in order to provide information on hydraulic characteristics of significant water producing zones so that construction considerations and potential impacts on existing residential wells could be evaluated. Tests were performed on wells drilled into the Berea Sandstone in the upland area and on wells completed in unconsolidated materials that exist along the beginning of the tunnel alignment. The locations of these test sites are shown on Plate 1.

Pumping tests on bedrock aquifer wells were performed early in the project in order to evaluate potential impact on residential wells due to open trench construction, before the final alignment and construction methods were determined. Therefore, most of these test sites are west of the final alignment and may not be representative of conditions in the Berea Sandstone along the final alignment. Because open trench construction was not selected as a construction method, the hydraulic characteristics of the shallow bedrock aquifer is only relevant to shaft construction for deep tunneling. Nevertheless all of the bedrock pumping tests results are included in this report. This information is supplemented by slug tests performed on piezometers set in the sandstone aquifer at Shafts 5 and 6.

Two pumping tests were performed on wells (PW-3 and PW-4) developed in the sand and gravel deposits encountered within the vertical interval of the tunnel between Station 0+00 and Shaft 1. Because the hydraulic characteristics of these materials are critically important to soft ground tunneling and dewatering considerations, two pumping tests were conducted in this area to verify results and determine consistency of conditions.

4.2 Test Procedures

The well characteristics, duration, and pumping rate for the tests performed are summarized on Table 4-1. Pumping tests of 24 hour duration were performed at the PW-1 and AOC-1 test sites and utilized observation wells (4 and 2, respectively) for water-level data collection. A submersible pump powered by a portable electric generator was installed in the pumping well and the discharge line was equipped with an in-line flow meter and valve to measure and control the pumping rate. Due to the low flow rates involved it was possible to verify pumping rates volumetrically with a 5 gallon bucket and stop watch. Water levels were measured to the nearest 0.01 foot using Solinst electric water level meters in both the pumping and observation wells.

It was intended to install observation wells at the PW-2 test site, but the low yield of the well made it impractical to perform an extensive test at this location. A test pump was installed and a short test was performed, but the pump broke suction after only 24 minutes at 2 gallons per minute (gpm). An alternative site was selected for installation of a 5-inch pumping well and observation wells near boring BTB-6. However, the low yield of the test well again made it impractical to perform an elaborate test at this location. The well was able to sustain a rate of only one gpm for one hour. A 20 minute test at a rate of 3 gpm was performed on the 2-inch piezometer (BTB-6) at this location.

Single well pumping tests also were performed at AOC-3 and BTB-5 which are 2-inch piezometers installed in NX-Core holes drilled for the geotechnical investigation. A 1.75-inch Grundfos Rediflow pump was installed for these tests with flow and water-level measurements being made in the same manner.

Short pumping tests were performed on numerous residential wells during the door-to-door survey. Where possible, wells were pumped for about 20 minutes and flow was measured volumetrically from an outside spigot. Water levels (drawdown) was measured in the well with a Soiltest electric water-level meter. Although short in duration, the results of these tests indicate that aquifer characteristics of the Berea Sandstone along Lee Road between Central College and Walnut

Street are better and many existing wells are capable of higher production rates than indicated by the test wells that were installed for the investigation. The results of several of these residential wells are considered representative of conditions along Lee Road north of Central College (see Table 4-1 and 4-2).

Test wells PW-3 and PW-4 were 6-inch wells installed by conventional rotary drilling methods. An 8¾-inch hole was advanced to bedrock and 10 feet of 0.040 inch slot wire wound well screen was installed. Formation stabilizer consisting of No. 4 quartz sand was poured into the annular space around the well screen and the top 25 feet of the annulus was sealed with bentonite. The logs are included in Appendix A. A submersible pump was installed and powered by a towed diesel generator. The wellhead was equipped with a valve, discharge line, and 3x4-inch orifice pipe to measure and control the pumping rate.

Two 2-inch observation wells (FTB-27 and FTB-28) were installed with hollow stem augers for the test on PW-3. Due to the prolific nature of the aquifer observed and owing to the uncertainty as to whether or not such conditions extended all the way to Shaft 1, it was decided to conduct a second test on PW-4. Two additional observations wells (FTB-29 and FTB-30) were drilled, providing 4 observation wells for the second test. Troll transducers and data loggers were installed in all of the observation wells for both tests. Water levels were measured in the pumping well during tests with a Solinst electric water-level meter and check measurements were made in the observation wells. The location of the pumping wells and observation wells are shown on Figure 4-24.

4.3 Analysis of Bedrock Aquifer Tests

4.3.1 PW-1 Test Site

Test well PW-1 was installed near geotechnical boring AOC-4 at Walnut Street and Schott Road. AOC-4 was used as an observation well and three additional 2-inch observation wells were installed at various distances from the pumping well (PW-1) as shown on Figure 4-1. As shown by the log of PW-1 (Appendix A) the Berea Sandstone at this location contains interbedded shale layers,

thus the well yield was less than expected based on existing residential well logs in the area. The pumping well was completed open hole from 11 to 58 feet. Observation wells were 50 feet deep with open borehole completion.

Figure 4-2 is a plot of the water-level data from the PW-1 pumping test for the pumping well and observation wells resulting from a rate of 3 gpm for 24 hours. Drawdowns for each well were calculated by subtracting the static water levels prior to the test from water levels measured during the test. Figure 4-3 is a distance-drawdown graph and calculations, based on a best-fit line, yield a transmissivity of 634 gpd/ft and a storativity of 1.3×10^{-4} for the Berea Sandstone aquifer. Time-drawdown graphs were prepared with the data for each well and calculations yield values ranging from 311 to 471 gpd/ft for transmissivity and 1.4×10^{-4} to 1.6×10^{-3} for storativity (Figures 4-4 to 4-8). Figure 4-9 is a log-log time drawdown plot and the calculations, based on a best-fit to the nonleaky artesian type curve, yield aquifer characteristics of 506 gpd/ft for transmissivity and 1.1×10^{-4} for storativity. The results are in close agreement. The average values are listed on Table 4-2. Based on a saturated thickness of 40 feet, the hydraulic conductivity is estimated to be 11.1 gpd/ft^2 or 5.2×10^{-4} cm/sec.

4.3.2 PW-2 and PW-2A Test Site

A second site was selected for an aquifer test using observation wells to evaluate characteristics of the Berea Sandstone. Well PW-2 was drilled at the end of Cautela Drive west of Lee Road, but the well yield encountered was not sufficient to warrant constructing observation wells at that location. The test well was pumped for only 20 minutes before breaking suction at a pumping rate of 2 gpm. An alternative site was selected farther to the north and well PW-2A was drilled (see Plate 1). The yield encountered at this well was also insufficient for a meaningful aquifer test, producing only 1.0 gpm for 60 minutes before breaking suction. Semi-log time-drawdown graphs for these short tests are included as Figures 4-10 and 4-11 and calculations reveal that the transmissivity at these locations is about 13 and 41 gpd/ft, relatively. Based on the aquifer thickness at these locations the hydraulic conductivity of the Berea Sandstone is about 2.4×10^{-5} and 5.2×10^{-5}

cm/sec, more than an order of magnitude lower than that which was observed at PW-1 (see Table 4-2).

4.3.3 AOC-1 Test Site

Well AOC-1 is a 2-inch well completed in an NX-corehole. The boring log reports sandstone from 8 to 32 feet and shale with interbedded sandstone from 32 to 50 feet. The static level was about 17 feet below ground so the saturated thickness was about 33 feet. This site was considered to be representative of conditions in the bedrock aquifer along Lee Road southwest of Central College Road, so two observation wells were installed for a pumping test on AOC-1 at locations shown on Figure 4-12. A 24-hour pumping test was performed on AOC-1 at a rate of 1.95 gpm. The resulting water-level data is plotted on Figure 4-13.

Drawdowns for each well were calculated and Figure 4-14 is a distance-drawdown graph for the end of the 24-hour test. Calculations based on this graph give a transmissivity of 490 gpd/ft and a storativity of 3.1×10^{-4}. Note that these values should be considered as approximations as drawdown was much greater to the west than to the east. However, the values are in the same order of magnitude as determined from the time-drawdown data as shown by Figures 4-15 to 4-18. The response to pumping appears to have been affected by boundary conditions. Calculations based on the interpretation of the time-drawdown graphs gives transmissivity values ranging from 195 to 592 gpd/ft and storativity values ranging from 2.0×10^{-2} to 1.3×10^{-3}. Values listed in Table 4-2 are considered most reasonable for this site are T = 460 gpd/ft and $S = 2.6 \times 10^{-3}$. The hydraulic conductivity computed based on an aquifer thickness of 33 feet is 13.9 gpd/ft^2 or 6.6×10^{-4} cm/sec.

4.3.4 Single Well Pumping Tests

Additional pumping tests were performed on available piezometers installed in geotechnical brings to supplement the evaluation of the Berea Sandstone Aquifer. Calculations based on the test on BTB-5 (Figure 4-19) gave a transmissivity value of 43.5 gpd/ft which is considered to be representative of the lower end of the range of values for the Berea Sandstone aquifer. Note that cascading water was noted in the borehole when drawdown exceeded 13 feet (water level of about

25 feet below ground level) which is typical of many residential wells which produce much of the water in the upper part of the borehole.

Another single well pumping test was performed on the piezometer installed in AOC-3 located at Lee Road and Cautela Drive. The results of this test (Figure 4-20) are considered to be more typical of conditions along Lee Road between Central College Road and Walnut Street. The transmissivity based on a four hour test on this well at a rate of 6 gpm was determined to be 1932 gpd/ft. Assuming a saturated thickness of the Berea Sandstone of 36 feet, the hydraulic conductivity is 53.7 gpd/ft^2 or 2.5 x 10^{-3} cm/sec (see Table 4-2).

The residential well survey results revealed that many existing wells in the area produce more water than could be pumped from the test wells and geotechnical borings. Therefore, it was concluded that the pumping test results are not representative of the high end of the range of hydraulic conditions that might be encountered in the Berea Sandstone within the project area. Short tests (20 minutes) were performed on residential wells where possible during the well survey. Although not considered precise, estimates of transmissivity and hydraulic conductivity based on these tests are included on Table 4-2 for several wells considered typical of conditions observed at wells along Lee Road between Central College Road and Walnut Street. These values range from 249 to 4668 gpd/ft for transmissivity and 2.5 x 10^{-4} to 9 x 10^{-3} cm/sec for hydraulic conductivity.

4.3.5 Slug Test Analyses

Slug tests were performed on piezometers completed in the Berea Sandstone at the locations of Shaft 4 and 5. At Shaft 4, piezometer FTB-29 was installed adjacent to geotechnical boring FTB-20. Twenty feet of 2-inch PVC well screen was installed in a 4-inch diameter borehole, quartz sand filter pack was installed in the annular space to a level 2.5 feet above the screen, and a bentonite seal and grout was placed above the sand pack. Thus the tested interval was 22.5 feet. Logs and construction diagrams are included in Appendix A. Figure 4-21 shows the slug test results and calculations. Only the "bar-in" test was considered reliable, due to difficulty removing the slug bar without disturbing the transducer. The hydraulic conductivity derived from the test was about

1.2×10^{-3} cm/sec, which is similar to the results derived from the pumping test on AOC-3 which is located about 500 feet to the south.

A slug test also was performed on piezometer FTB-30 installed adjacent to geotechnical boring FTB-23 at Shaft 5. The construction methods and procedures were the same as used for FTB-29. Twenty feet of screen were installed and the sand pack was extended two feet above the top of the screen before the seal was placed in the annular space (see Appendix A for log and construction diagram). Figure 4-22 shows the slug test results and calculations. The hydraulic conductivity derived from the test was about 5.8×10^{-4} cm/sec, which is similar to the results derived from the pumping test on PW-1 which is located to the west at Schott Road and Walnut Street.

Another slug test was performed on FTB-16 which is a 2-inch piezometer installed in the NX-corehole of the geotechnical boring which was reamed with a 3⅞-inch tricone bit to 52.5 feet. Twenty-five feet of screen was placed from 27 to 52 feet and the annular space above the screen was sealed (see Appendix A for the log and construction diagram). The Ohio Shale within the vertical interval of the tunnel was tested and the results are shown on Figure 4-23. The hydraulic conductivity value derived from the test was about 2.0×10^{-3} cm/sec which compare favorably with packer tests of the interval from 13 to 53 feet. The relative high hydraulic conductivity of the Ohio Shale at this location is due to weathering and fracturing in the rock which would be expected beneath this ravine.

4.4 Analysis of Unconsolidated Aquifer Tests

Geotechnical borings drilled along the final alignment in the beginning of the project area between the Outfall and Shaft 1 (Station 0+00 to Station 6+00) indicated the presence of a substantial saturated thickness of permeable sand and gravel. Heaving sands were encountered at Borings ETB-1, FTB-1, and FTB-2 (see Figure 4-24). Slug tests performed on piezometers installed at FTB-27 and FTB-28 were analyzed to make preliminary estimates of hydraulic conductivity which ranged from 1.3×10^{-2} to 5.7×10^{-2} cm/sec. The cross section shown in Figure 4-25 shows that these saturated sand and gravel deposits occur within the vertical interval for the tunnel excavation.

Pumping tests were performed to characterize the hydraulic properties of the unconsolidated aquifer in this area.

4.4.1 PW-3 Pumping Test

Well PW-3 was a 6-inch well drilled by mud rotary method and 10 feet of 0.040 inch slot wire wound screen was installed. The well log in Appendix A shows that granular material was encountered from 20 to 46.5 feet and was reported to have no notable clay fraction. Observation of samples taken from mud circulation returns indicates that the material would flow freely into an excavation. This is consistent with heaving sands reported on the logs for ETB-1, FTB-1, FTB-1A, and FTB-2. The driller encountered a boulder at 16 feet in PW-3 which caused significant difficulty in setting the casing and well screen in the borehole. The location of PW-3 is shown on Figure 4-24 and the screened interval is represented on the cross section (Figure 4-25).

Figure 4-26 is a plot of the water-level data from the step-drawdown test on PW-3. Note that the highest rate pumped was 112.5 gallons per minute (gpm) which was about the maximum capacity of the test pump. The specific capacity (Q/s) at that rate was 45 gallons per minute per foot of drawdown (gpm/ft). Figure 4-27 is a plot of water-level data for PW-3 for the 24 hour test at a constant rate of 95.5 gpm.

Transducers and data loggers were set in the observation wells to continuously measure and record water-level changes during the pumping test. Figures 4-28 and 4-29 are semi-log plots of the drawdown data from FTB-27 and FTB-28. Figure 4-30 is a semi-log plot of the drawdown data from the pumping well. The early data gives fairly consistent values for aquifer characteristics with transmissivity of about 49,000 gpd/ft and storativity in the 10^{-3} range which suggests confined conditions. The distance-drawdown graph (Figure 4-31) calculations yield a slightly higher value for transmissivity (~55,000 gpd/ft) and higher storativity (10^{-2}) indicating semi-confined conditions. Note that there are only two points fairly closely spaced for distance-drawdown (the pumped well drawdown is not reliable for use in this analysis due to hydraulic factors affecting the effective well radius).

The deviation of the drawdowns in the pumping well after about 700 minutes from the straight-line time-drawdown plot (Figure 4-30) is due to river stage change in Big Walnut Creek caused by a major rain storm during the night of June 5. Figure 4-32 shows the complete transducer record for the observation wells and a plot of river stage at the Big Walnut Creek gage below Hoover Dam. Figure 4-33 is an expanded plot of the same data for the 24 hour test period. Although the water-level change in the observation wells is small in comparison with river stage change, there is an apparent relationship. Without the recharge event that occurred the water levels at the end of the test would likely have remained on the straight-line projection of the data shown on Figures 4-28, 4-29, and 4-30. PW-3 is about 470 feet from Big Walnut Creek. The relationship between the stage of Big Walnut Creek and the sand and gravel aquifer is discussed in Sections 5.2 and 5.3. The ground-water level elevation at FTB-27 and FTB-28 was 818.60 and 818.62, respectively. These levels are similar with a slight gradient toward Big Walnut Creek as would be expected.

4.4.2 PW-4 Pumping Test

Visual classifications of soil samples from geotechnical borings suggest that materials within the tunnel interval become more cohesive toward Shaft 1 (see Figure 4-25). in order to determine whether or not the results of the PW-3 test were representative of conditions closer to Shaft 1, well PW-4 was installed and a second pumping test was performed. Well PW-4 was drilled and constructed in the same manner as PW-3 and the well log is included in Appendix B. Conditions encountered were indeed similar, in fact, the specific capacity was event higher than observed during the step test on Well PW-3 (see Figure 4-34). The constant rate test on PW-4 was conducted at a rate of 100 gpm, and produced only 2.3 feet of drawdown in the pumping well by the end of the 24 hour test period.

Two additional observation wells were installed for the PW-4 pumping test. Well FTB-31 was installed near the location of geotechnical boring FTB-1 about 50 feet from PW-4, and FTB-32 was installed west of the Outfall at the end of the proposed tunnel. Transducers were installed in all of the observation wells for water-level data collection and water levels were measured manually in

PW-3 and PW-4 during the test. Figure 4-35 is a graph of the water-level data before, during, and after the test on PW-4.

Figures 4-36 to 4-41 are semi-logarithmic graphs of the time-drawdown data for wells measured during the pumping test on Well PW-4. The calculated values for transmissivity and storativity are summarized on Table 4-3 and range from 48,000 to 52,888 gpd/ft and 6.3×10^{-4} to 1.1×10^{-3}, respectively. Based on the thickness of the saturated zone encountered, the hydraulic conductivity values computed range from 2087 gpd/ft^{-2} (9.8×10^{-2} cm/sec) to 2456 gpd/ft^{2} (1.2×10^{-1} cm/sec). Well FTB-32 was much slower to respond than the other wells. It is the most distant from the pumping well, but it may not have been fully developed.

Calculations based on the distance-drawdown graph (Figure 4-42) give a transmissivity value that is considered to be unreasonably high when compared to the time-drawdown data and the results of the PW-3 pumping test. Note also that the drawdown at FTB-32 does not fall on the best fit line of the other data points. This could be due to a change in hydraulic conductivity in that direction or, as mentioned earlier, the well may not have been fully developed. Regardless, the aquifer geometry and boundary conditions likely distort the distance-drawdown relationships. Conditions along the proposed tunnel alignment and in the vicinity are expected to be anisotropic. The time-drawdown data best characterizes average conditions which are considered to be about 50,000 gpd/ft for transmissivity and about 10^{-3} for storativity. Hydraulic conductivity of granular materials encountered will be in the range of 1.0×10^{-1} cm/sec.

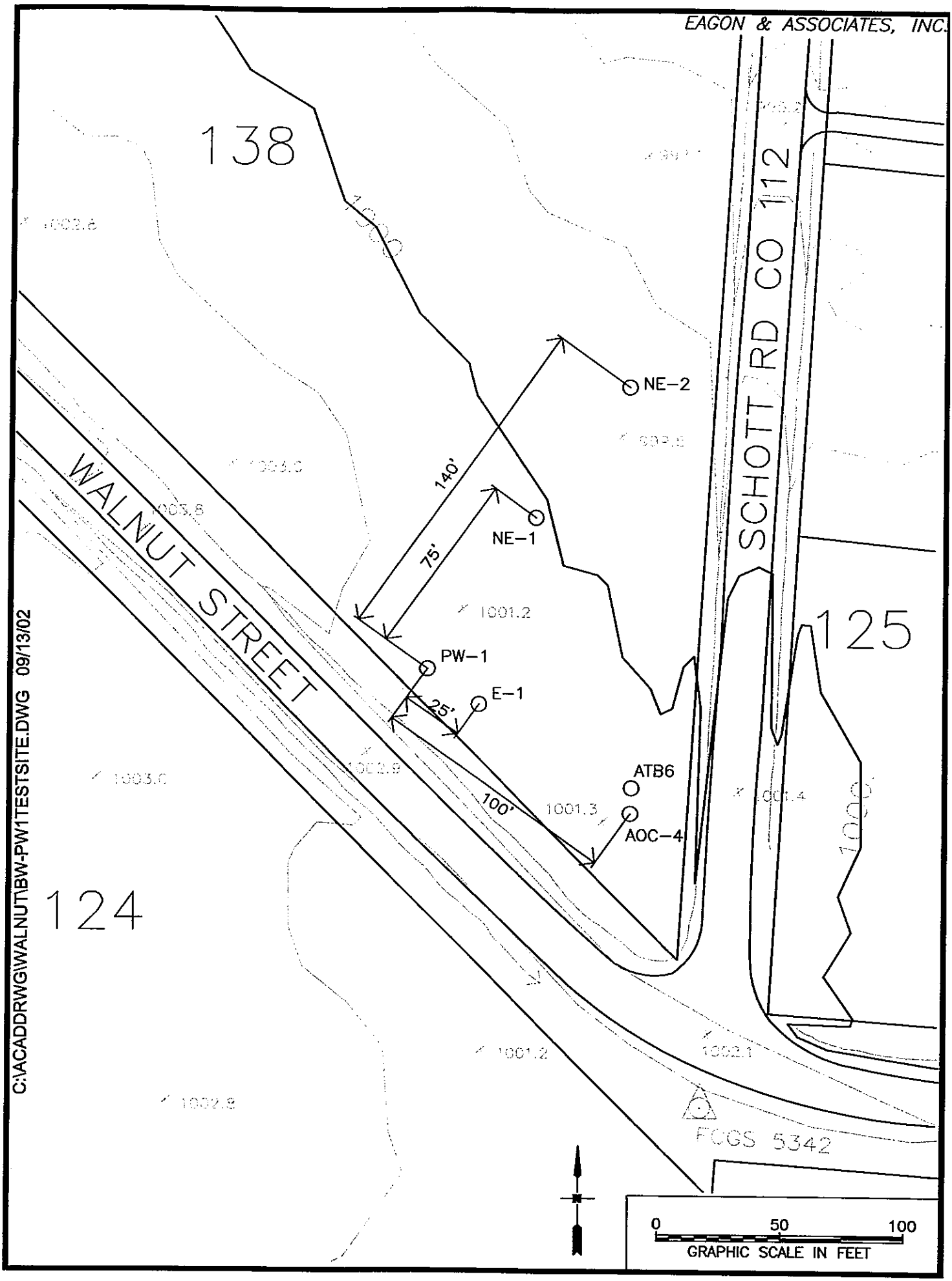
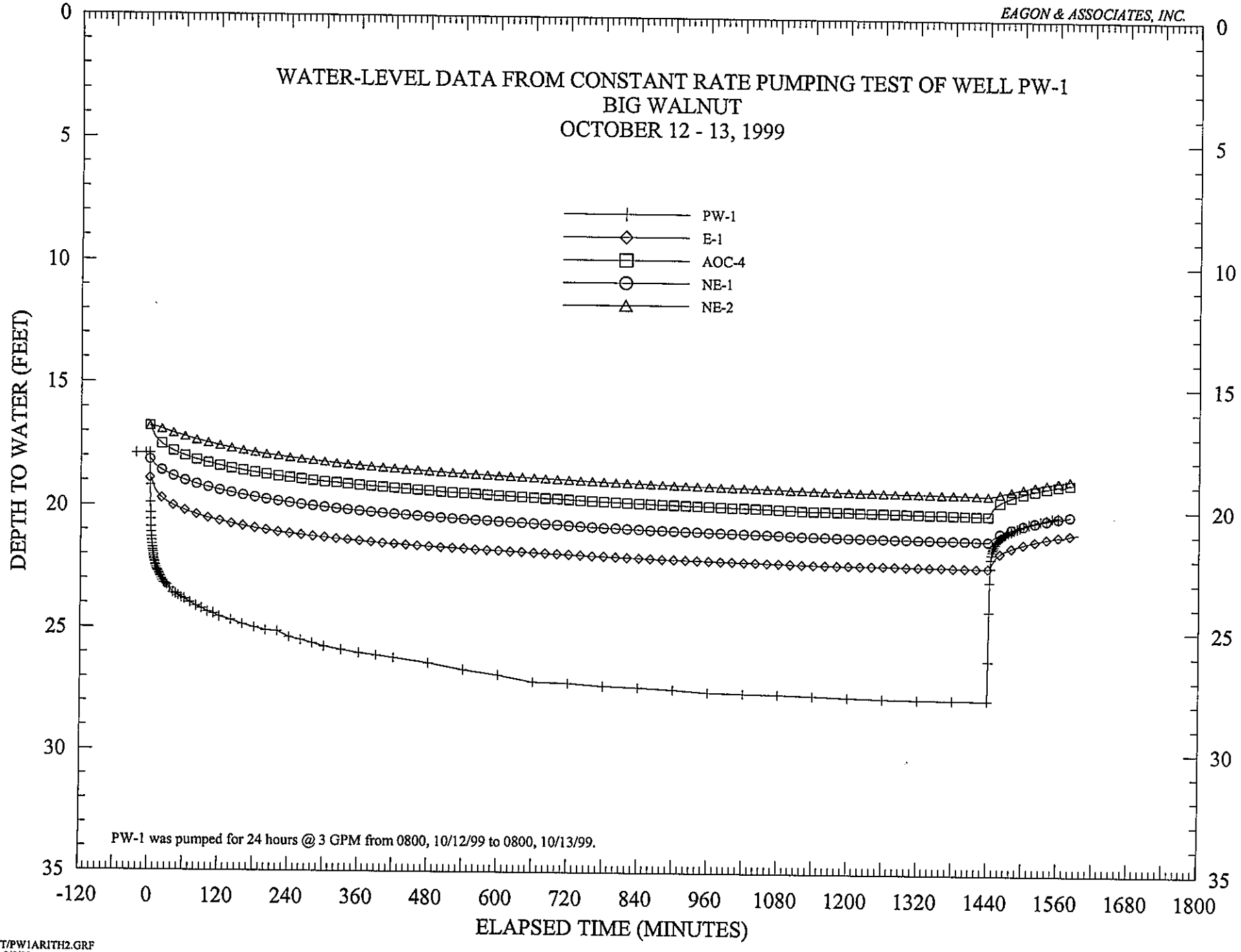
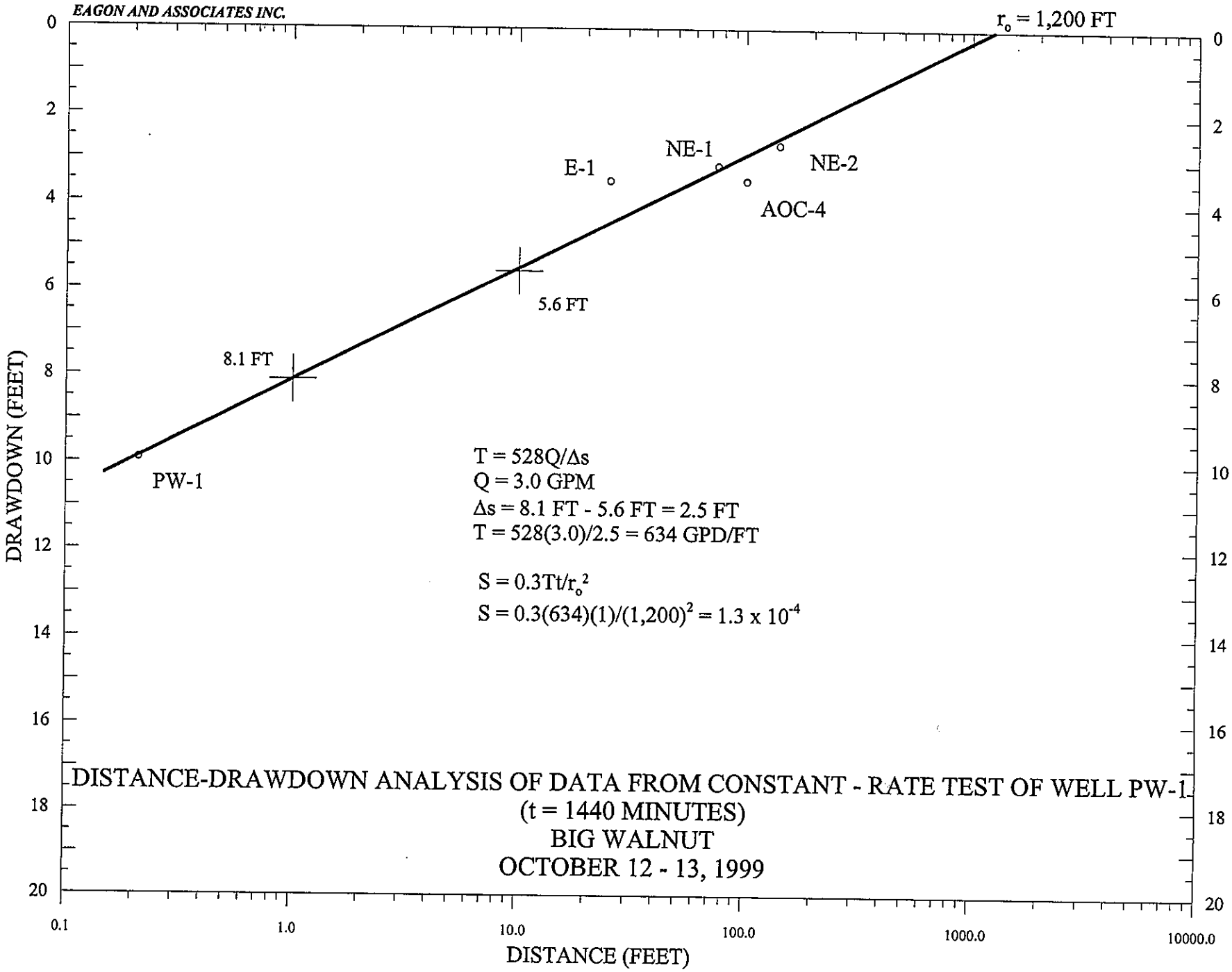


FIGURE 4-1. PW-1 PUMPING TEST SITE



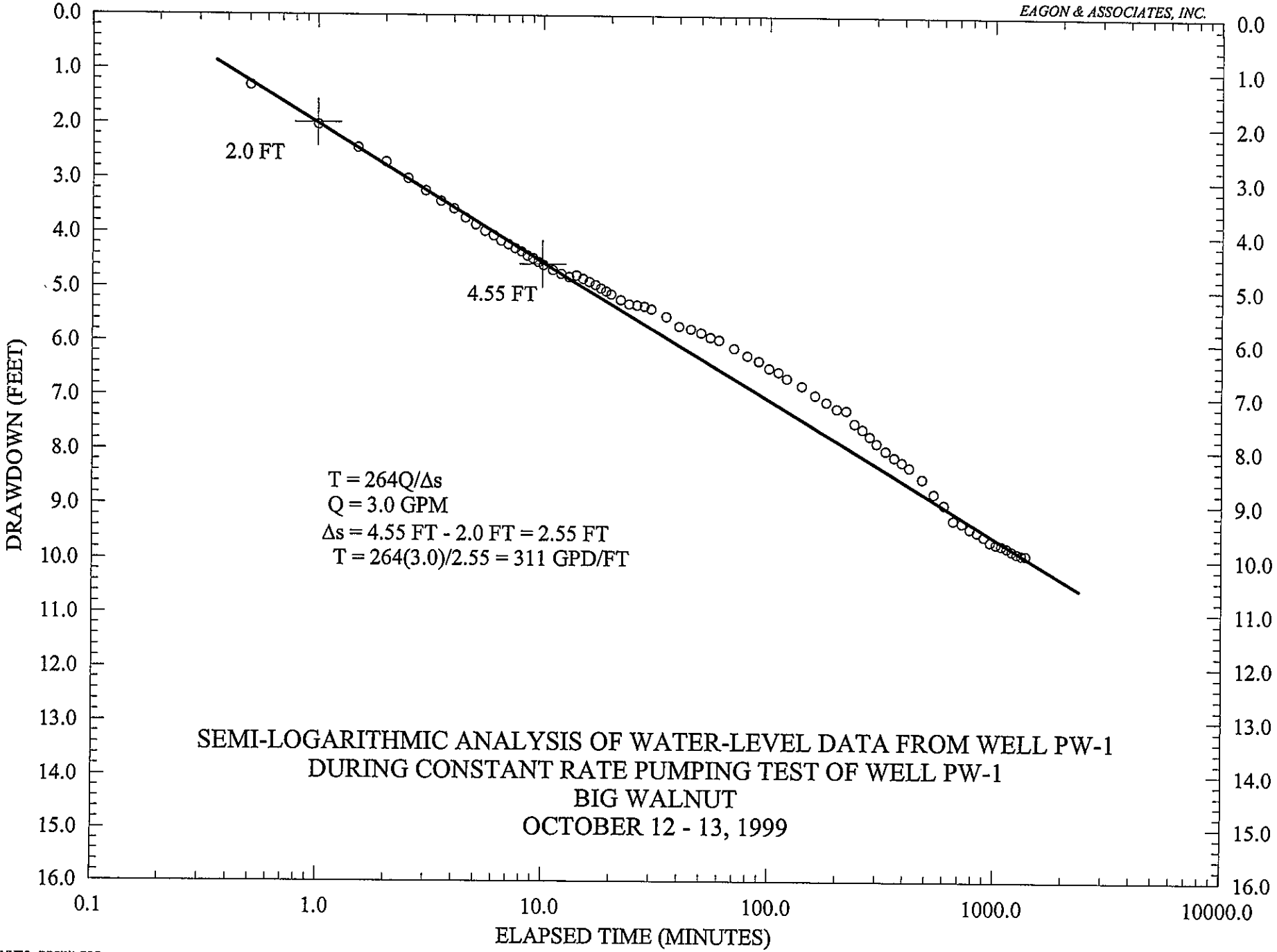
BIGWALNUT/PW1ARITH2.GRF
9/9/02

FIGURE 4-2. WATER LEVEL DATA FOR PW-1 PUMPING TEST



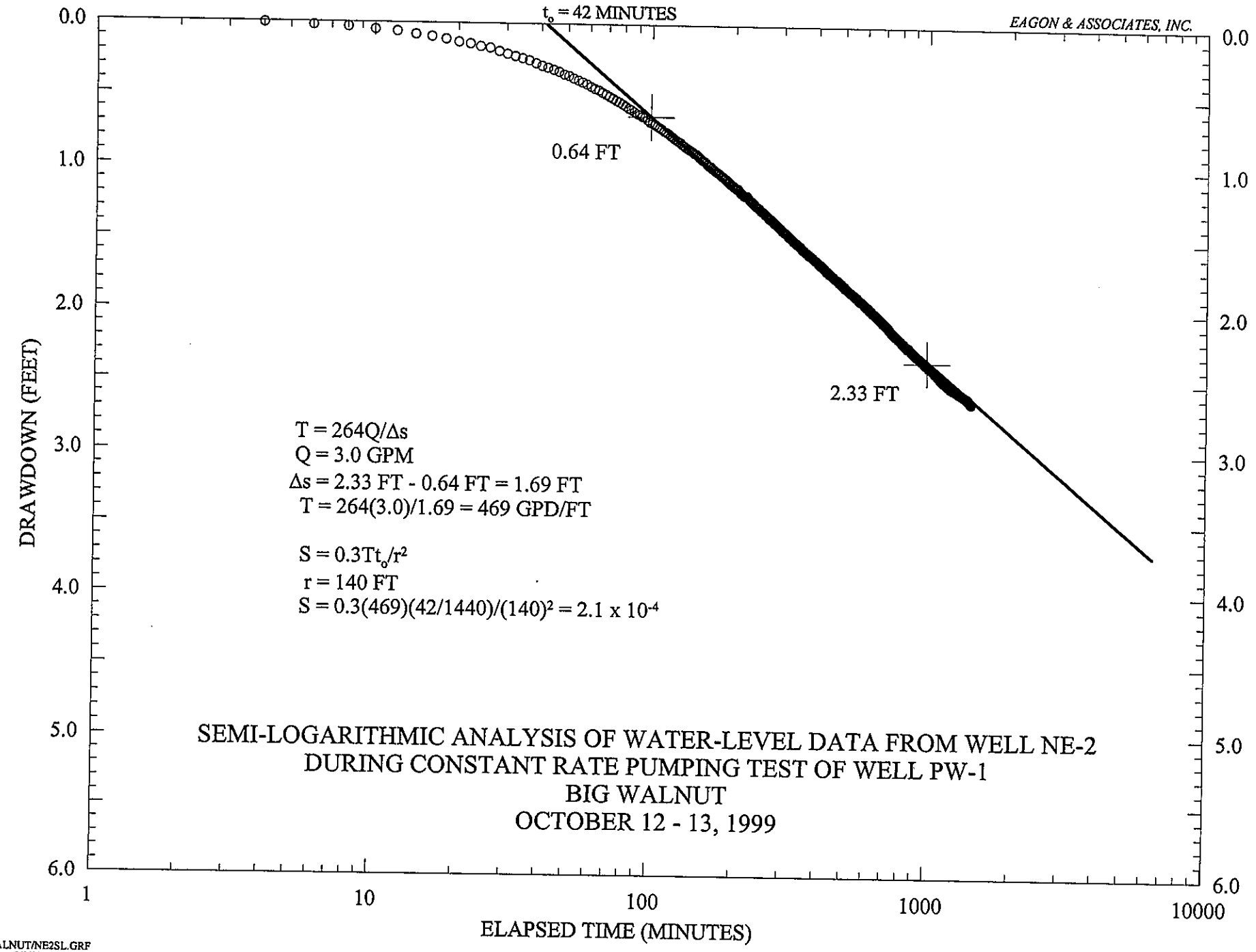
BIGWALNUT/DISTDD24.GRF
9/9/02

FIGURE 4-3. DISTANCE-DRAWDOWN GRAPH FOR PW-1 PUMPING TEST



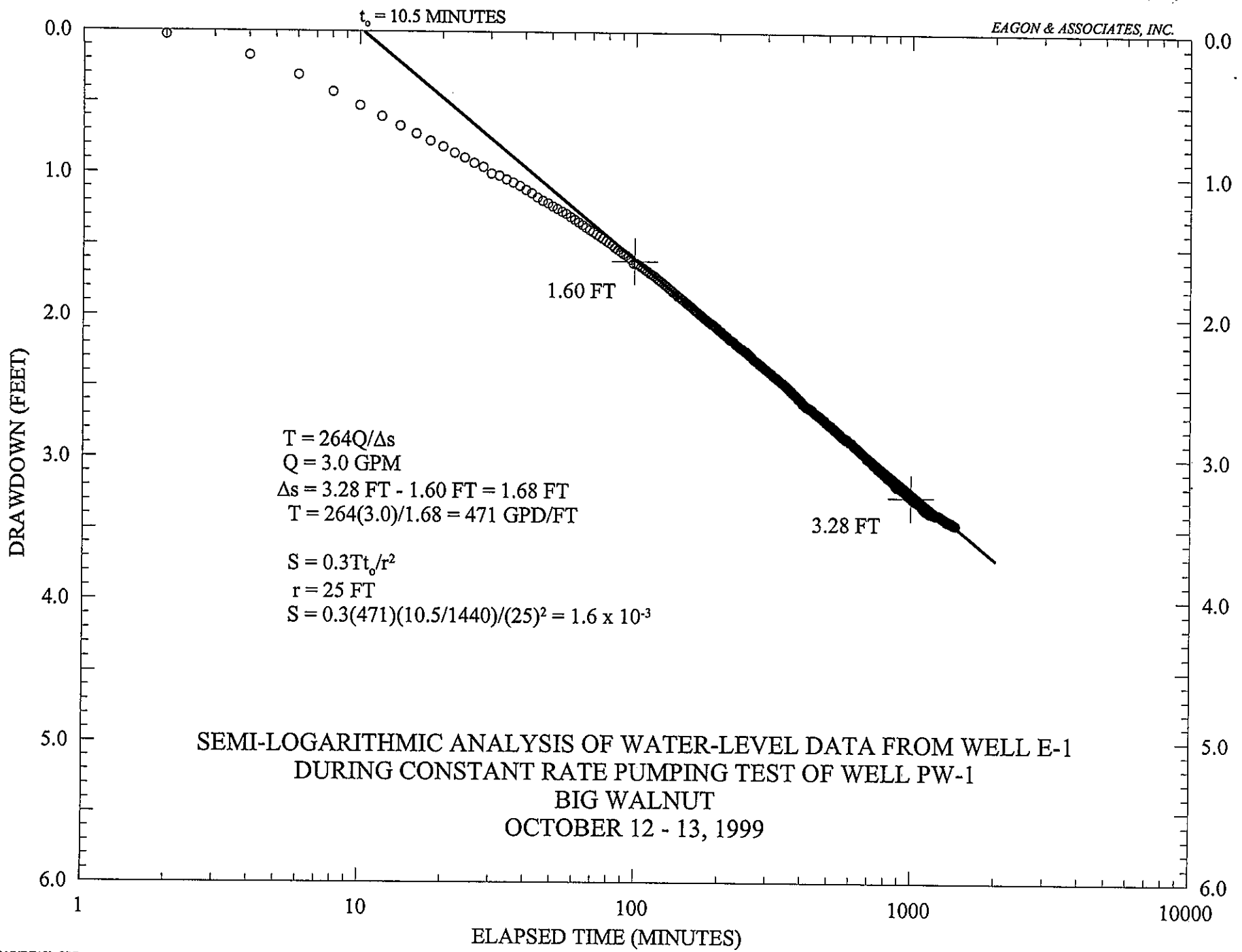
BIGWALNUT/LnDDPW1.GRF
9/9/02

FIGURE 4-4. TIME-DRAWDOWN GRAPH FOR PW-1



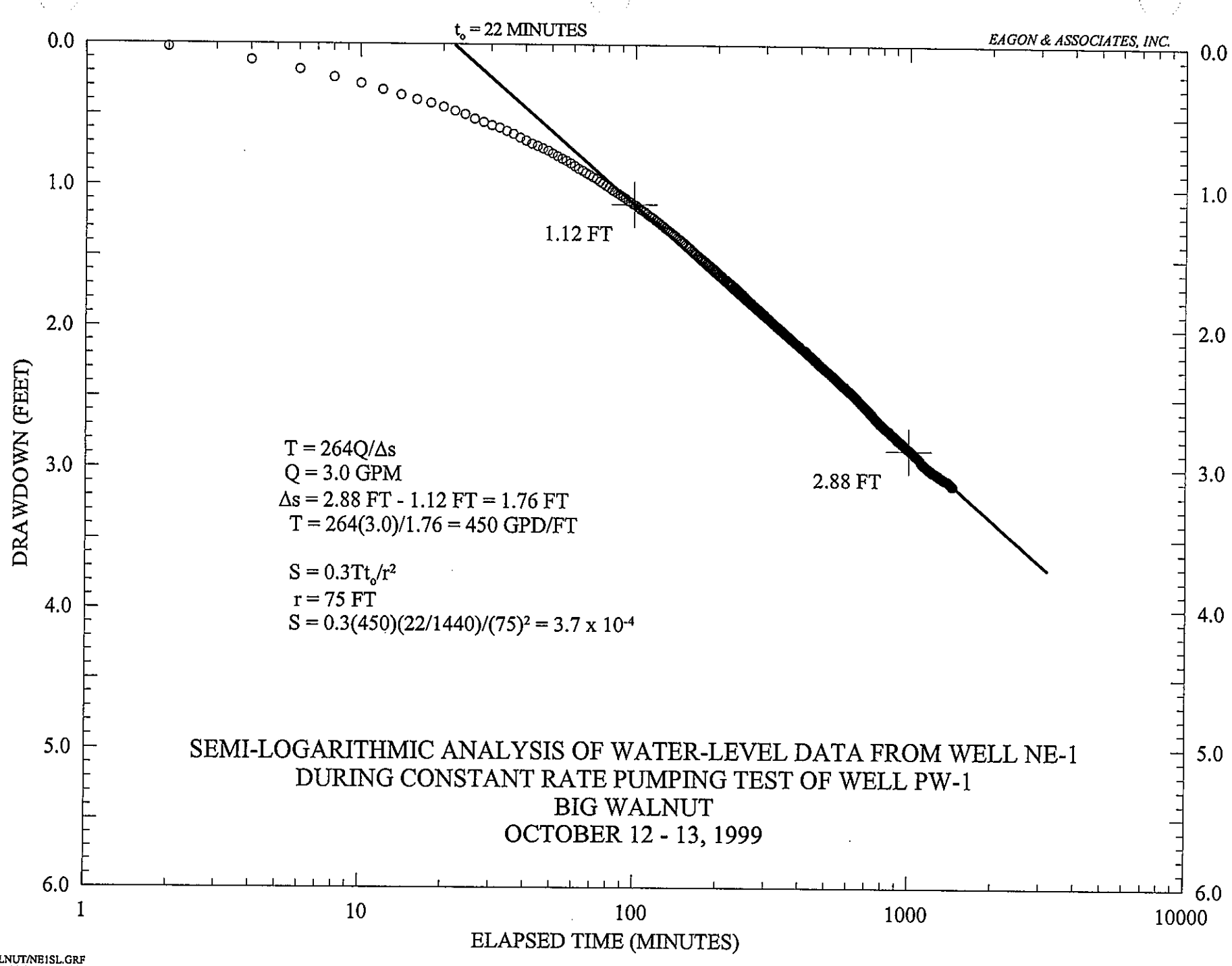
BIGWALNUT/NE2SL.GRF
9/9/02

FIGURE 4-5. TIME-DRAWDOWN GRAPH FOR WELL NE-2 (PW-1 TEST)



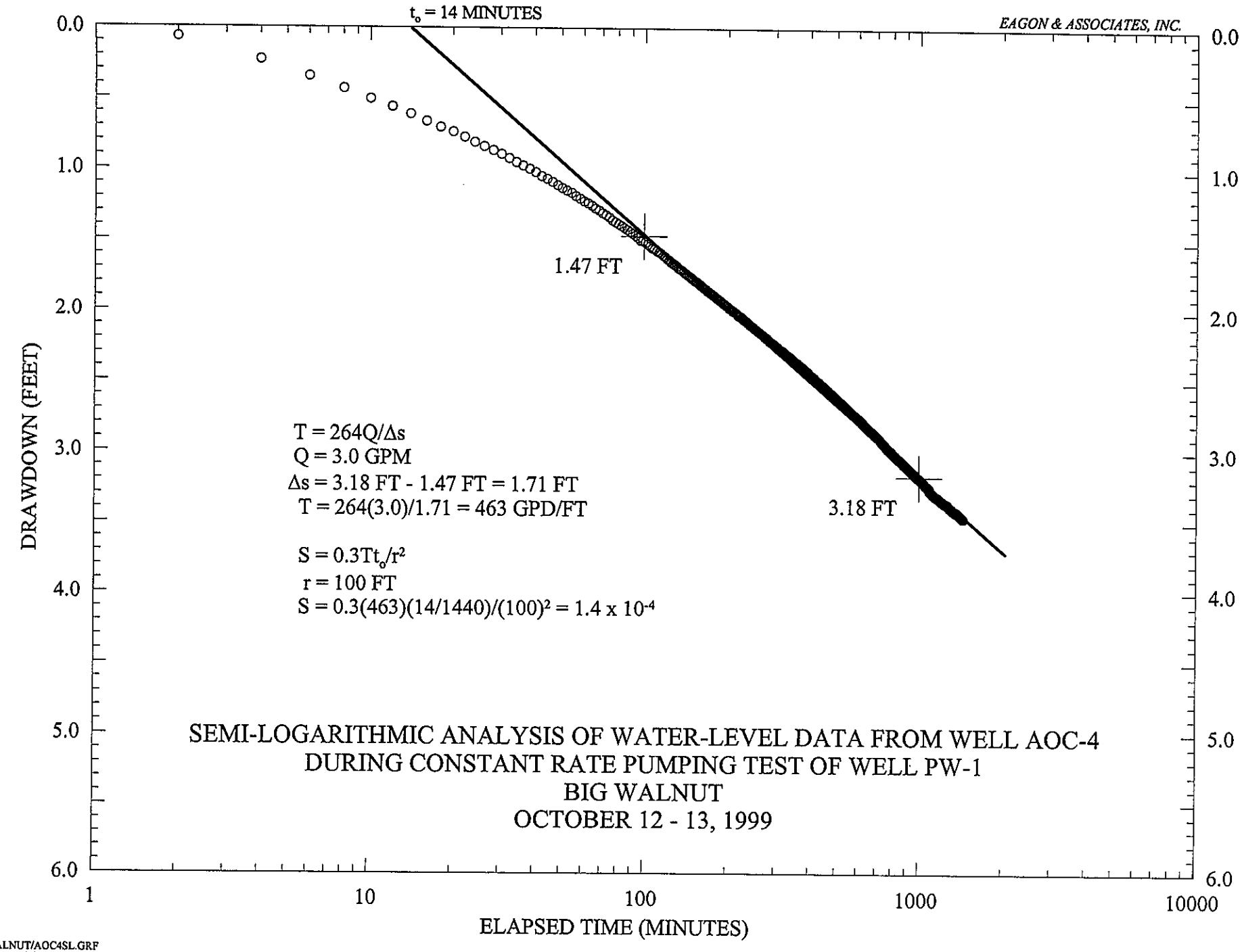
BIGWALNUT/E1SL.GRF
9/9/02

FIGURE 4-6. TIME-DRAWDOWN GRAPH FOR WELL E-1 (PW-1 TEST)



BIGWALNUT/NE1SL.GRF
9/9/02

FIGURE 4-7. TIME-DRAWDOWN GRAPH FOR WELL NE-1 (PW-1 TEST)



BIGWALNUT/AOC4SL.GRF
9/9/02

FIGURE 4-8. TIME-DRAWDOWN GRAPH FOR WELL AOC-4 (PW-1 TEST)

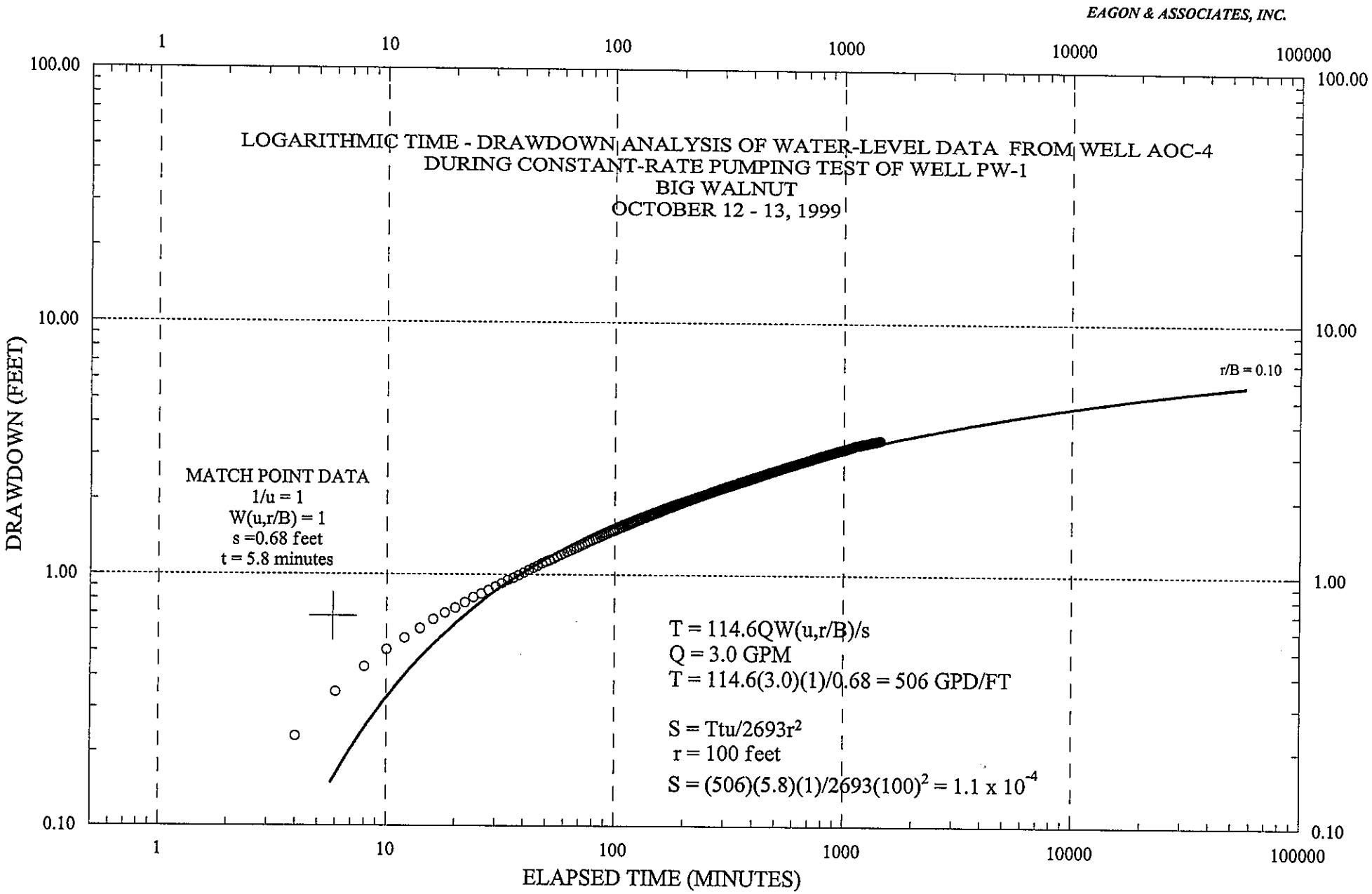
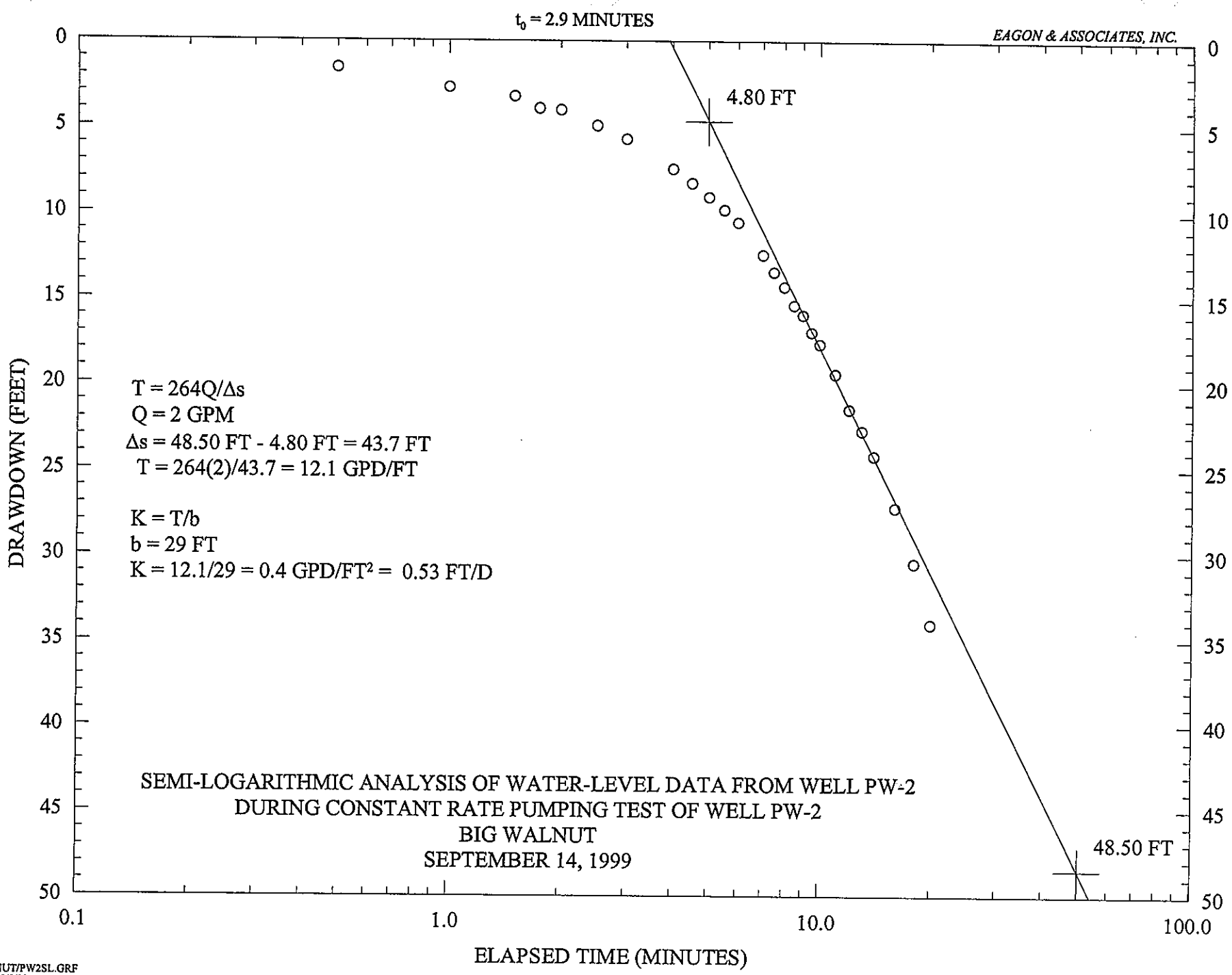
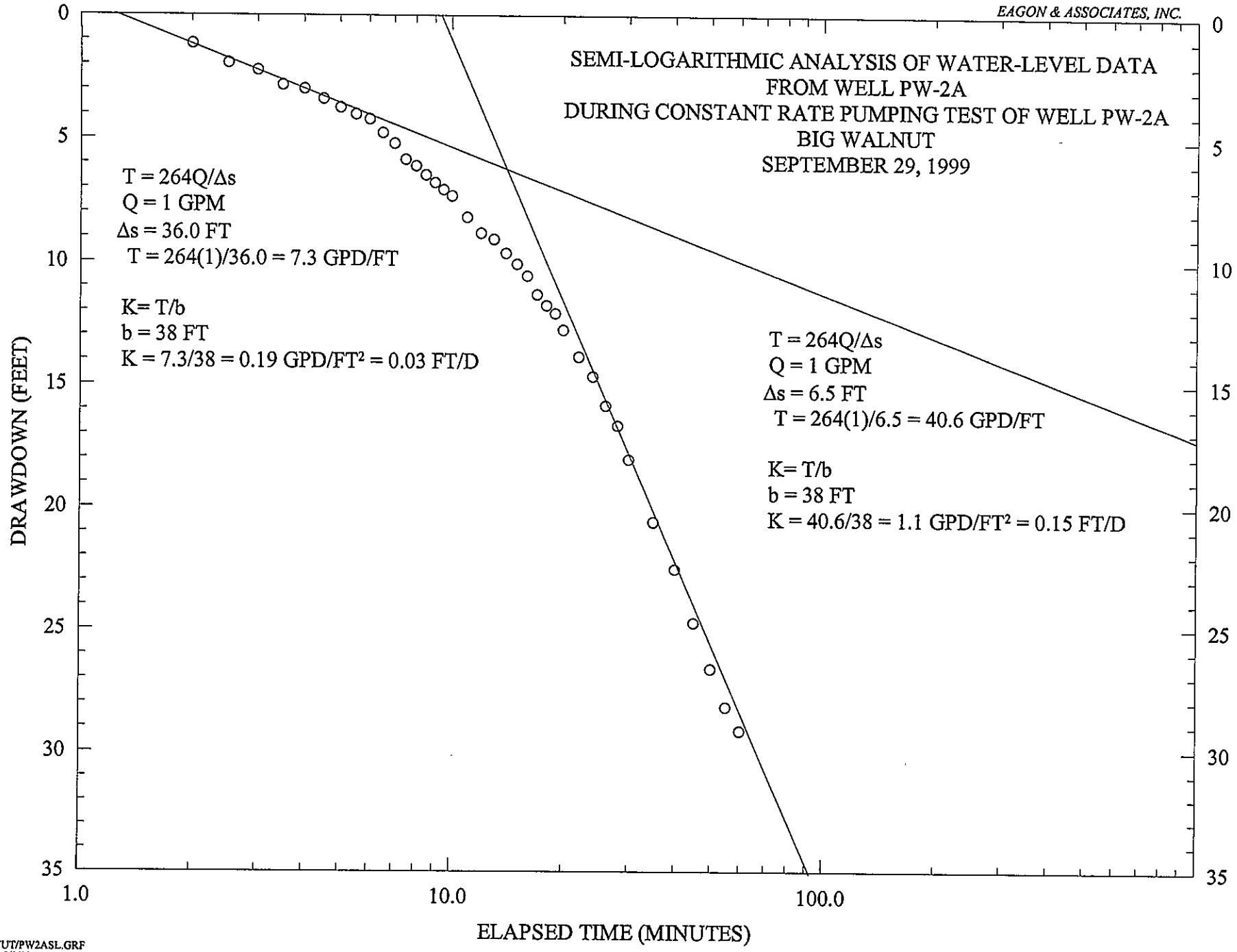


FIGURE 4-9. LOG-LOG TIME-DRAWDOWN GRAPH FOR WELL AOC-4 (PW-1 TEST)



BIGWALNUT/PW2SL.GRF
9/9/02

FIGURE 4-10. TIME-DRAWDOWN DATA FOR PW-2



BIGWALNUT/PW2ASL.GRF
9/9/02

FIGURE 4-11. TIME-DRAWDOWN DATA FOR PW-2A

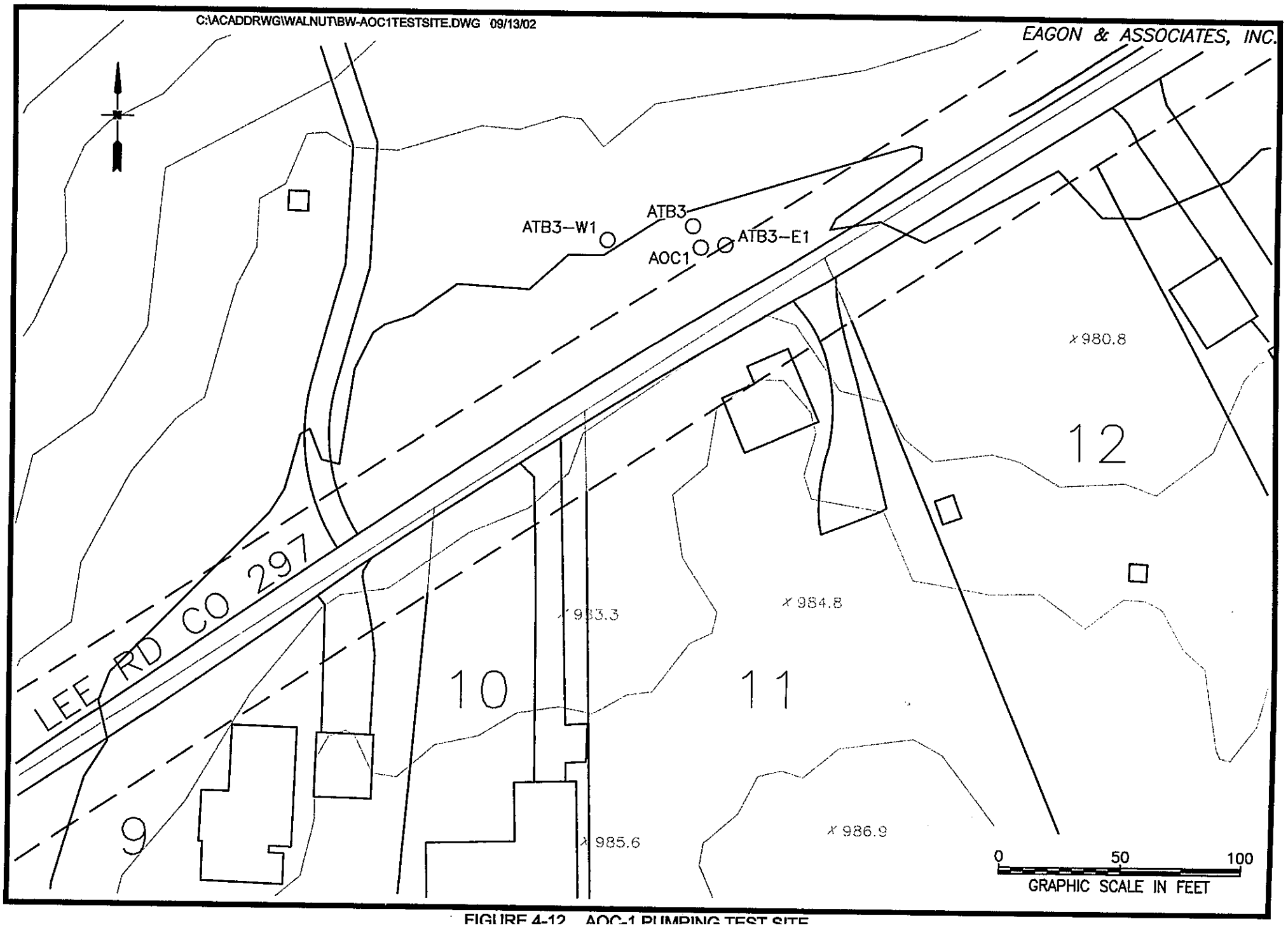
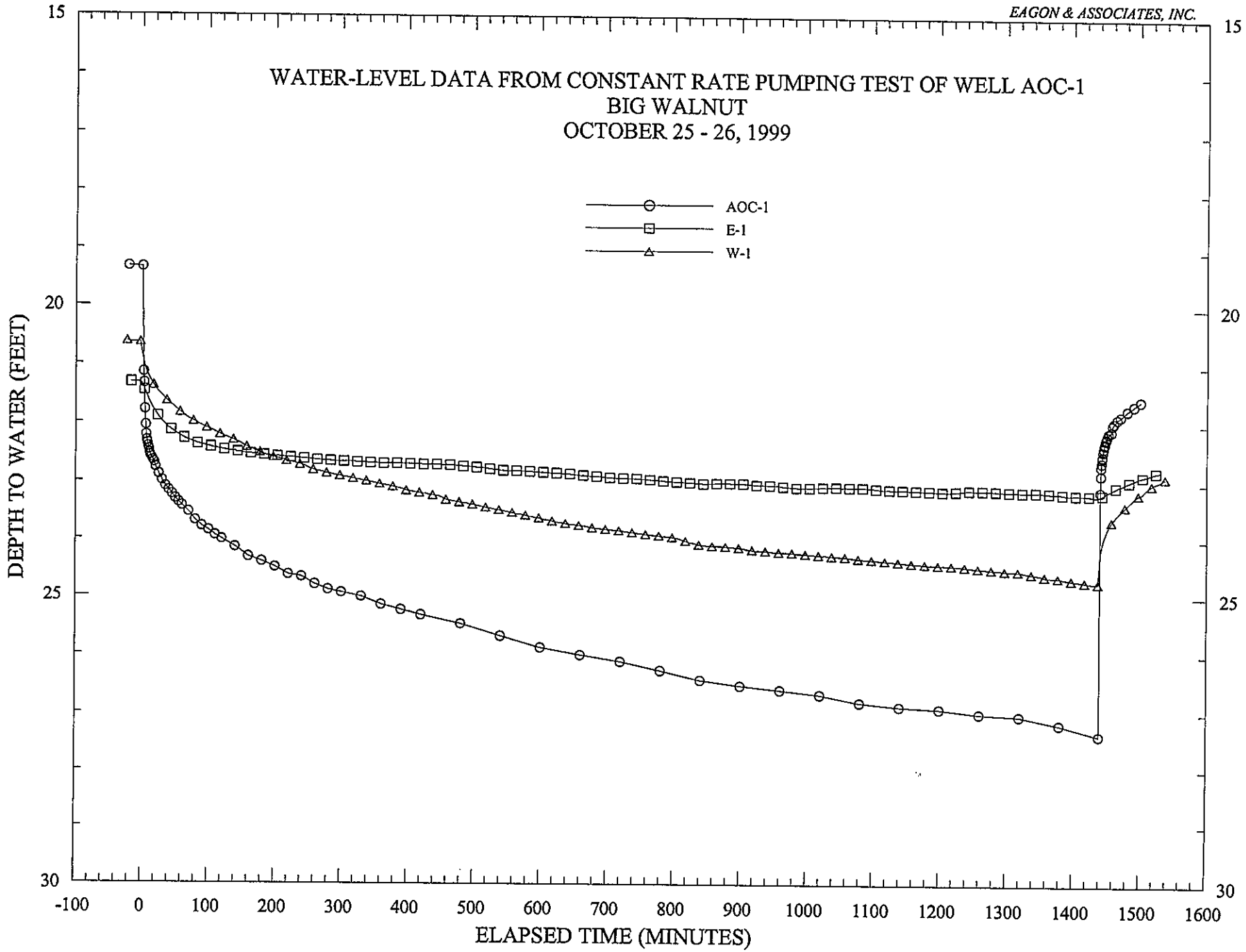
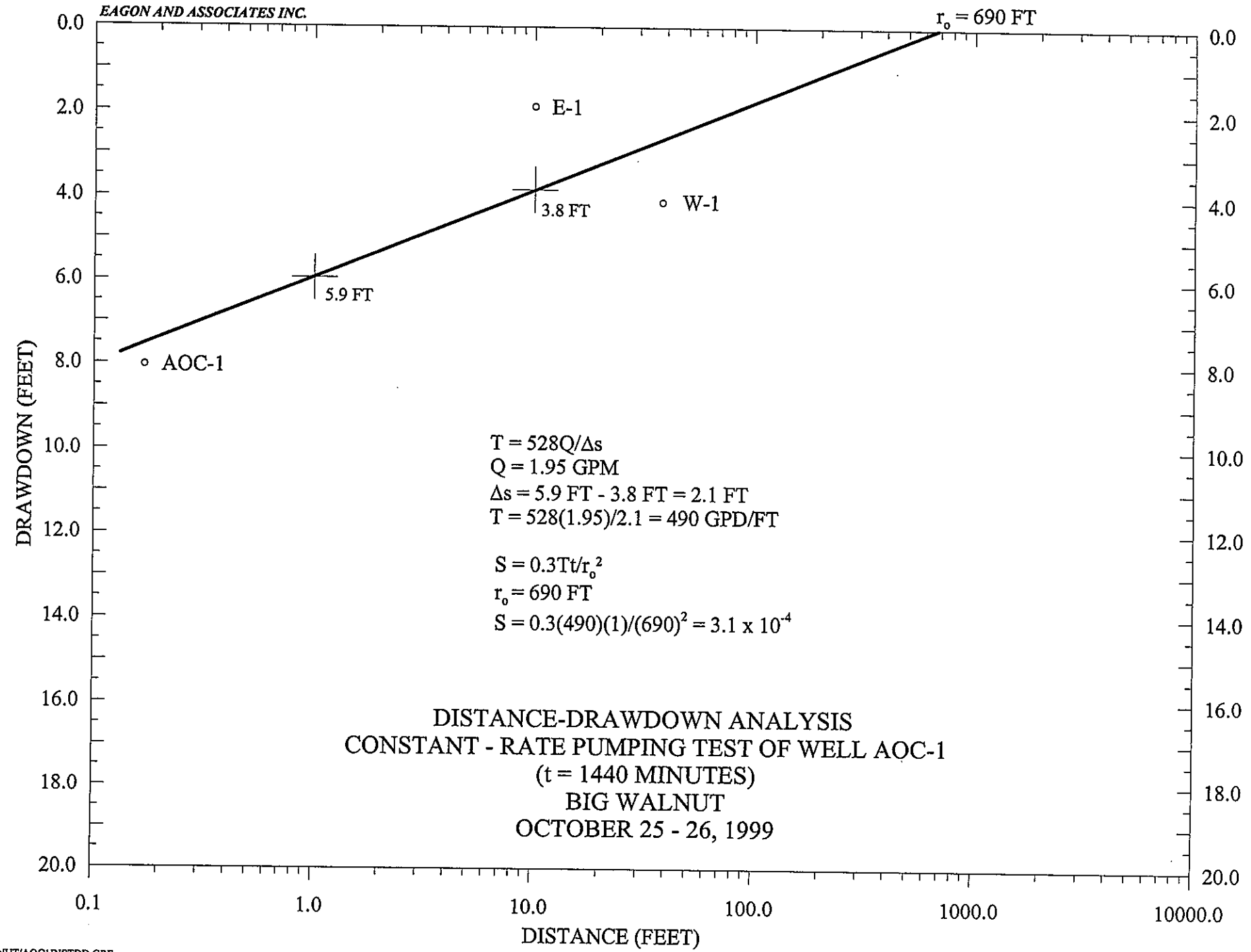


FIGURE 4-12 AOC-1 PUMPING TEST SITE



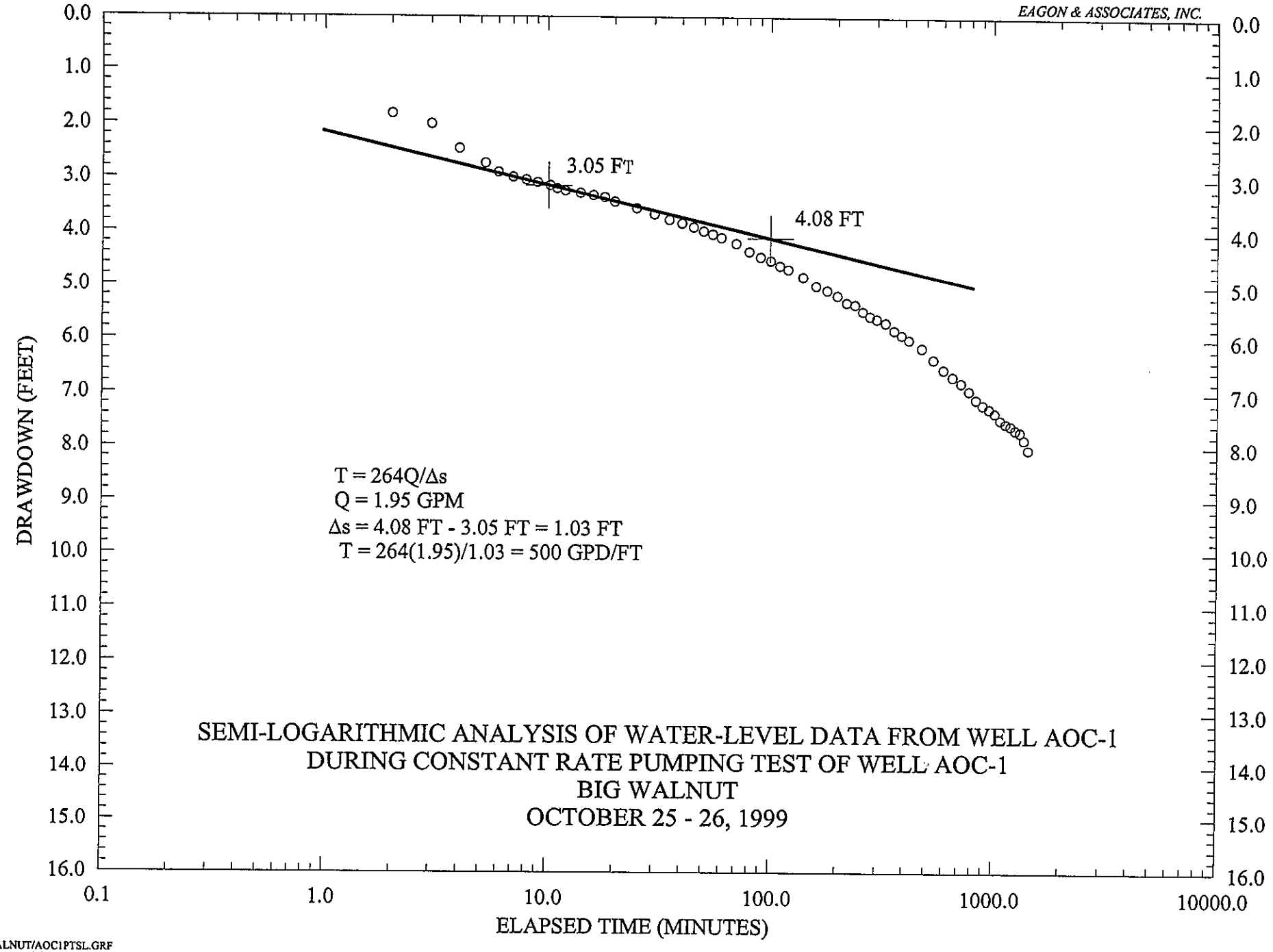
BIGWALNUT/AOC-1PTARITH.GRF
9/9/02

FIGURE 4-13. WATER LEVEL DATA FOR AOC-1 PUMPING TEST



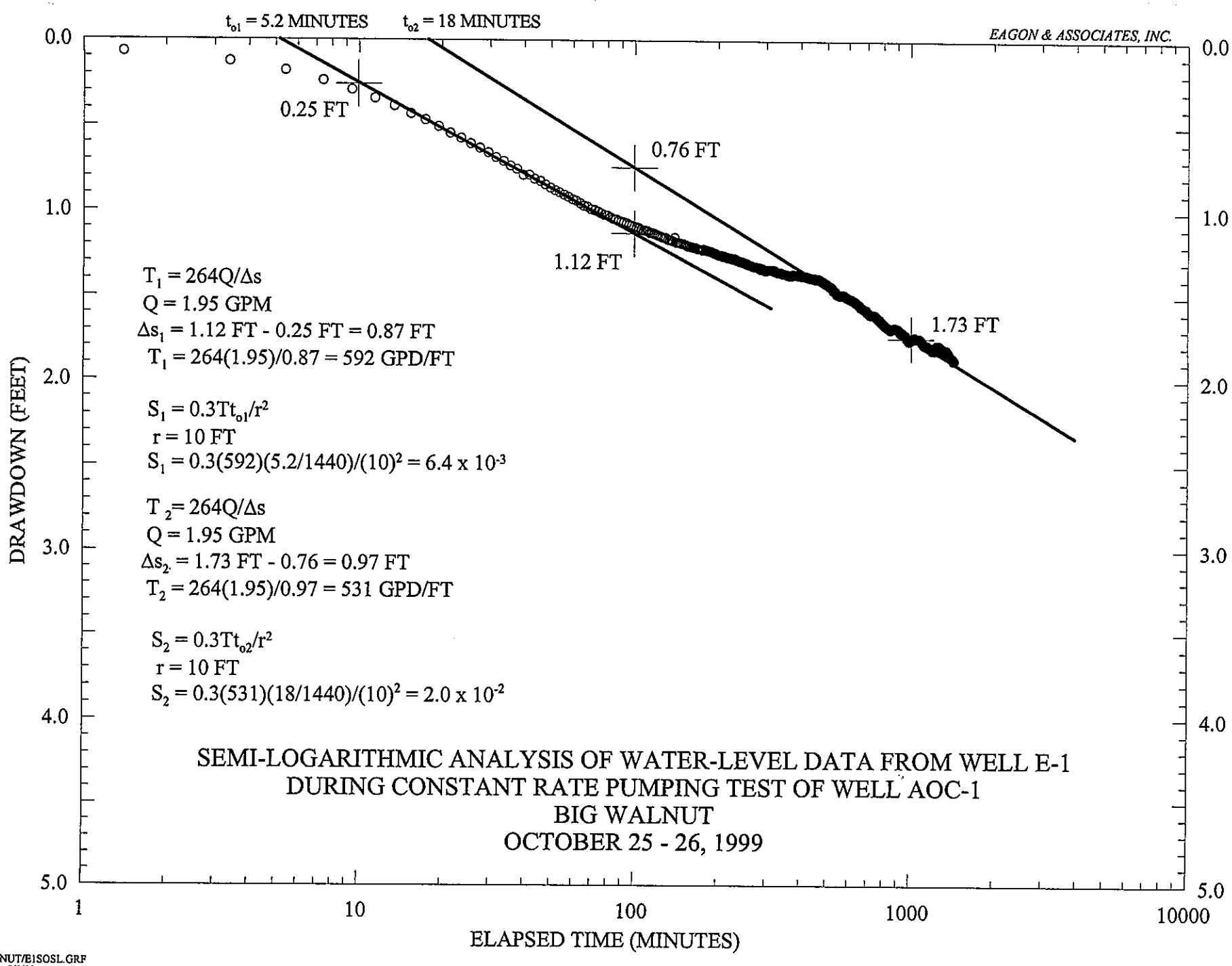
BIGWALNUT/AOC1DISTDD.GRF
9/9/02

FIGURE 4-14. DISTANCE-DRAWDOWN GRAPH FOR AOC-1 PUMPING TEST



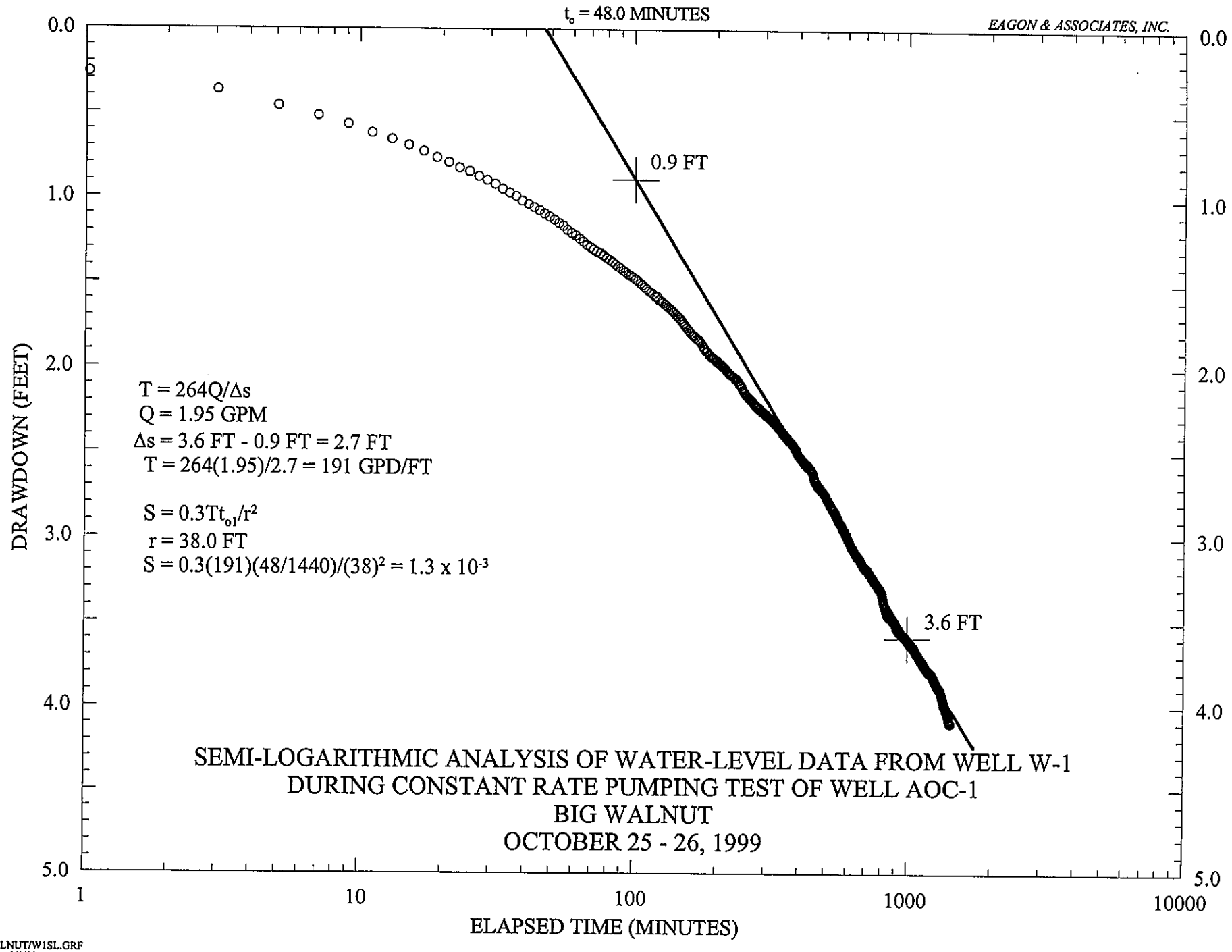
BIGWALNUT/AOC1PTSL.GRF
9/9/02

FIGURE 4-15. TIME-DRAWDOWN GRAPH FOR WELL AOC-1



BIGWALNUT/E1SOSL.GRF
9/9/02

FIGURE 4-16. TIME-DRAWDOWN GRAPH FOR WELL E-1 (AOC-1 TEST)



BIGWALNUT/W1SL.GRF
9/9/02

FIGURE 4-17. TIME-DRAWDOWN GRAPH FOR WELL W-1 (AOC-1 TEST)

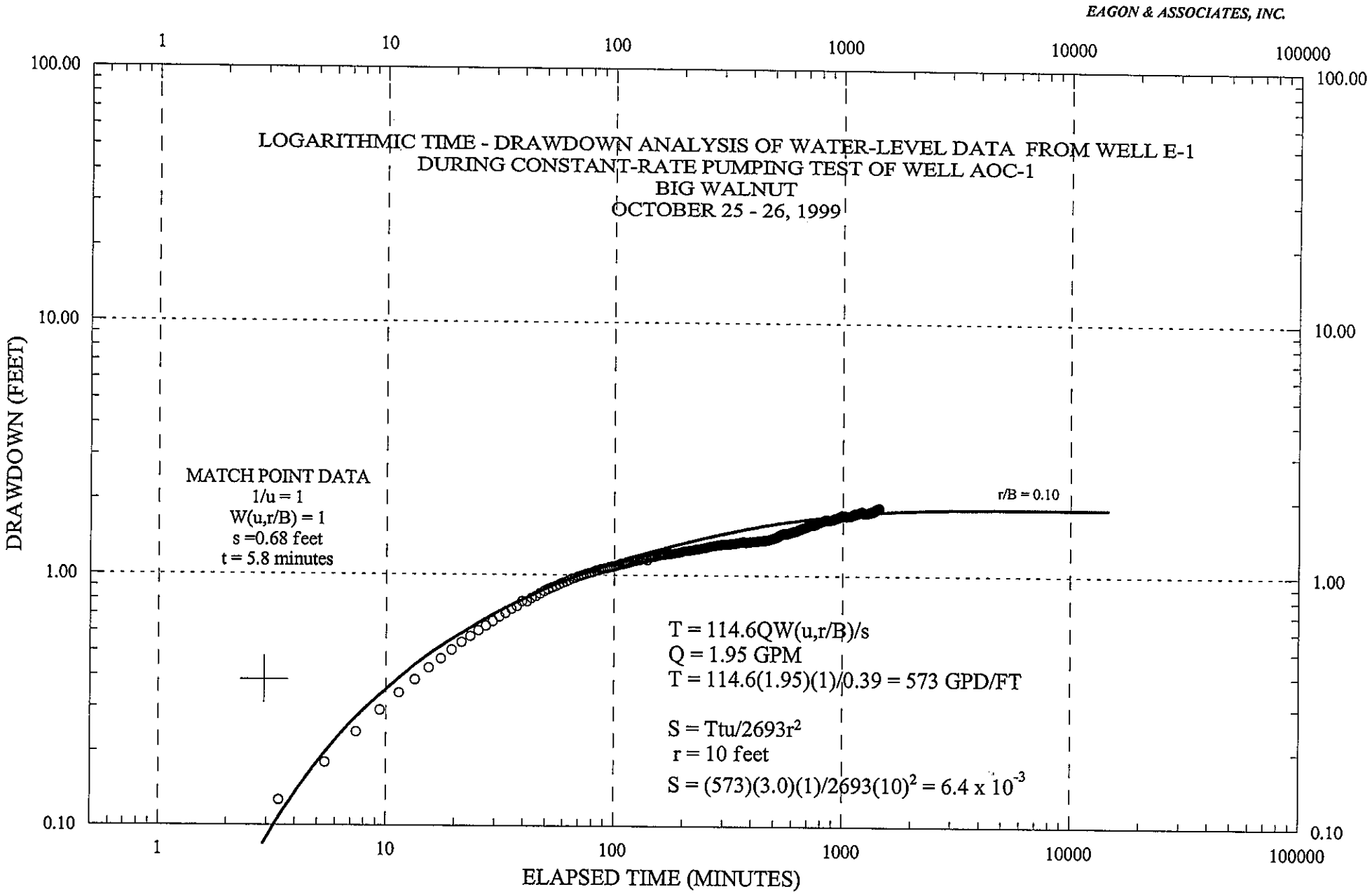
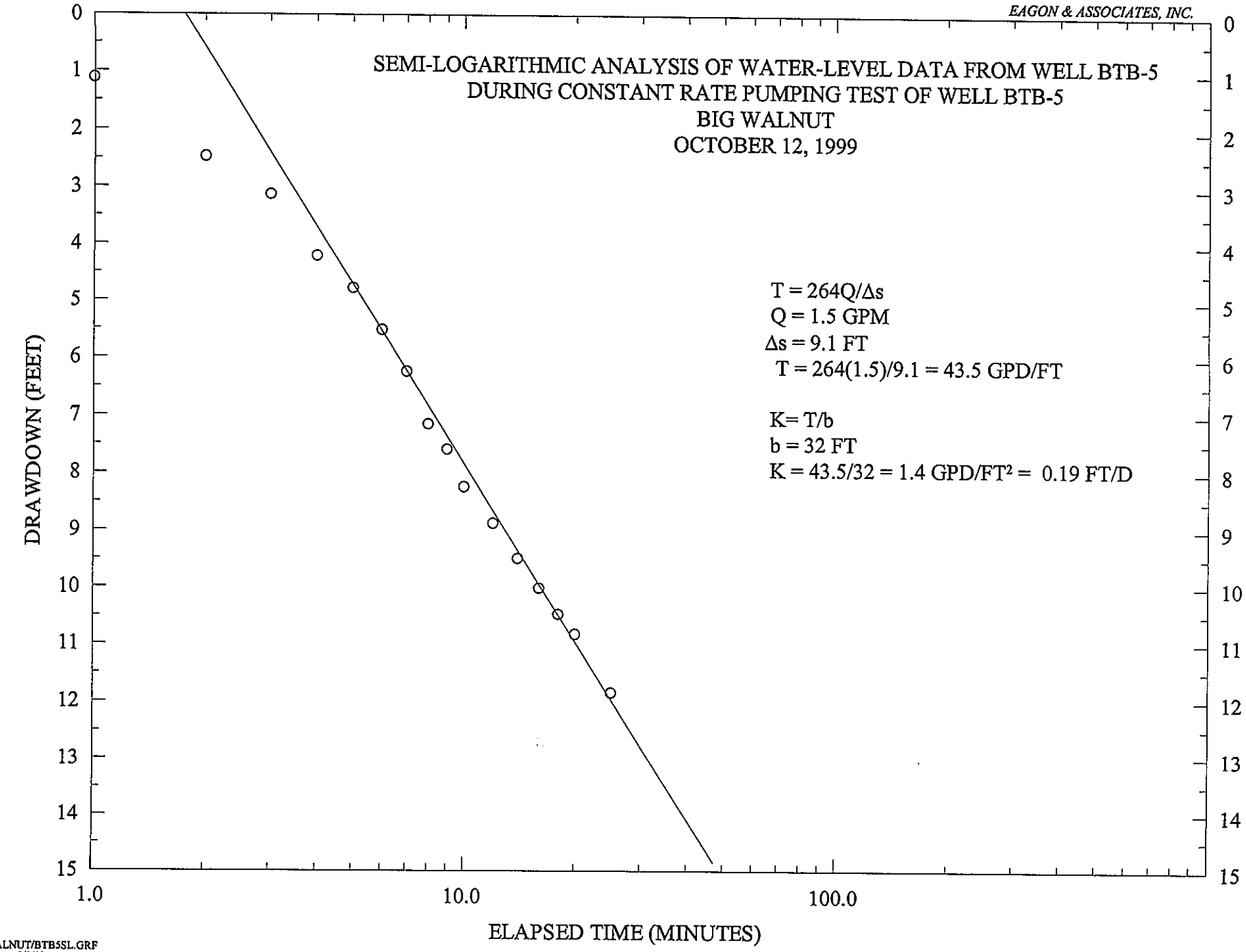
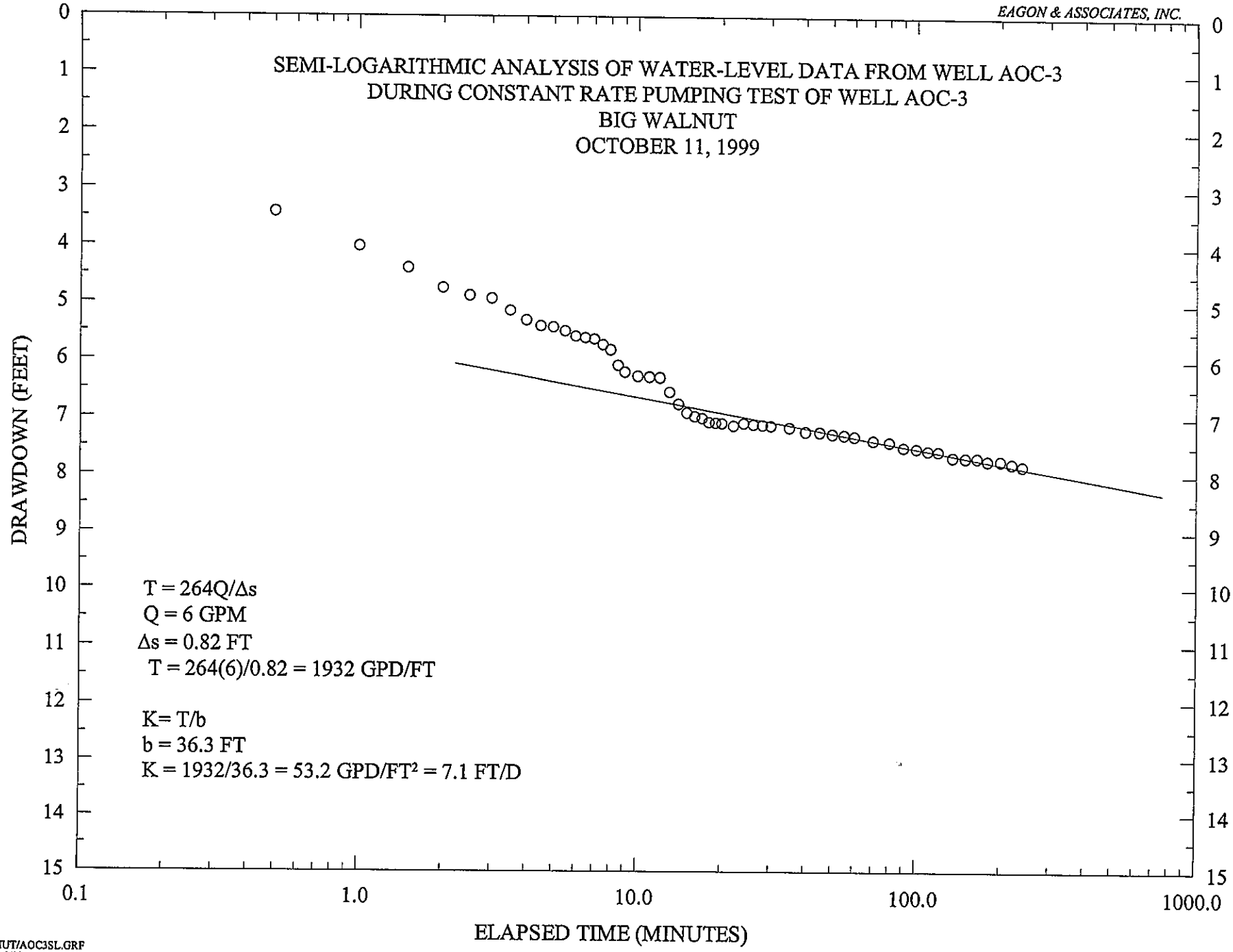


FIGURE 4-18. LOG-LOG TIME-DRAWDOWN GRAPH FOR WELL W-1 (AOC-1 TEST)



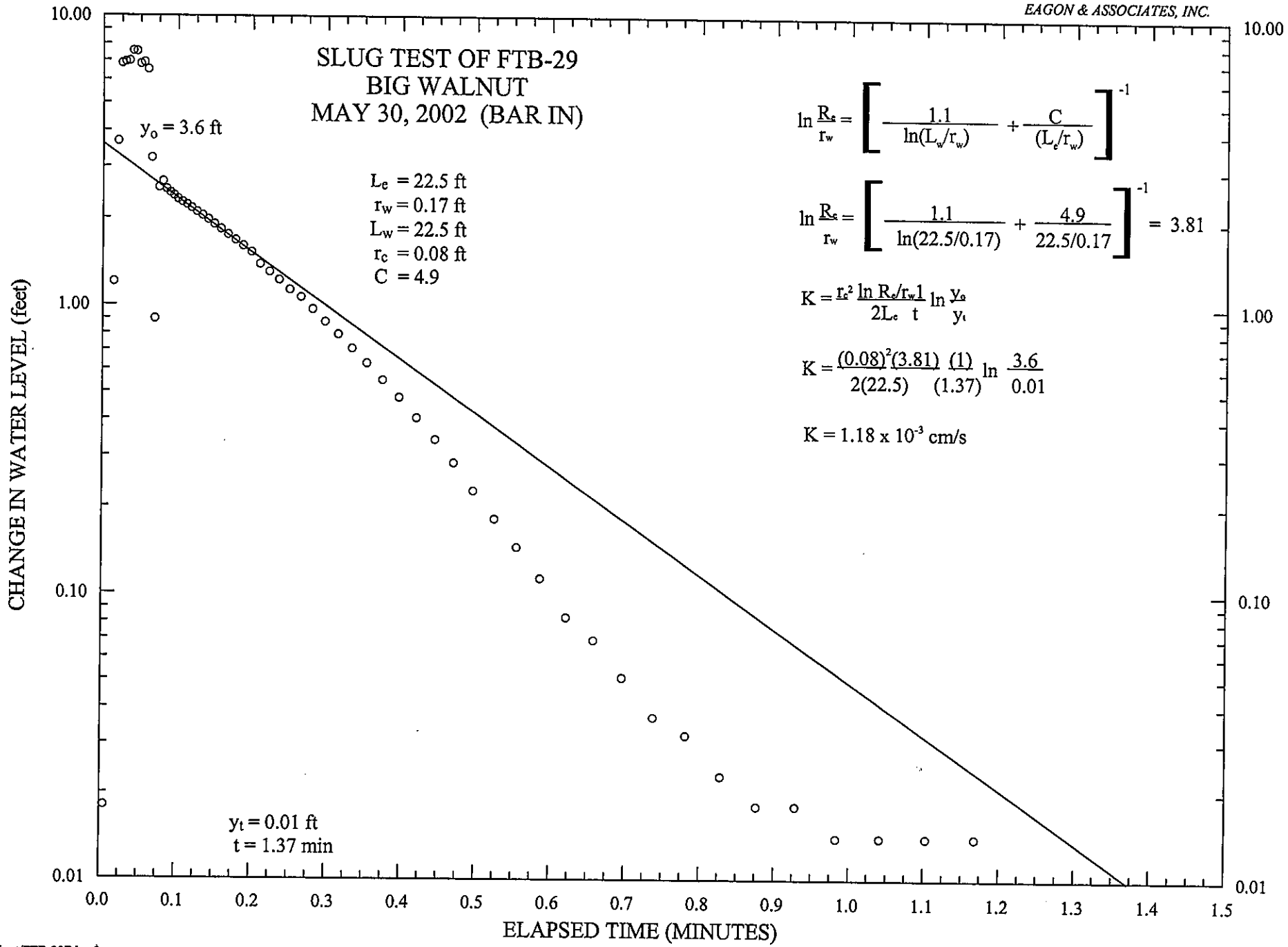
BIGWALNUT/BTB5SL.GRF
9/9/02

FIGURE 4-19. TIME-DRAWDOWN GRAPH FOR WELL BTB-5



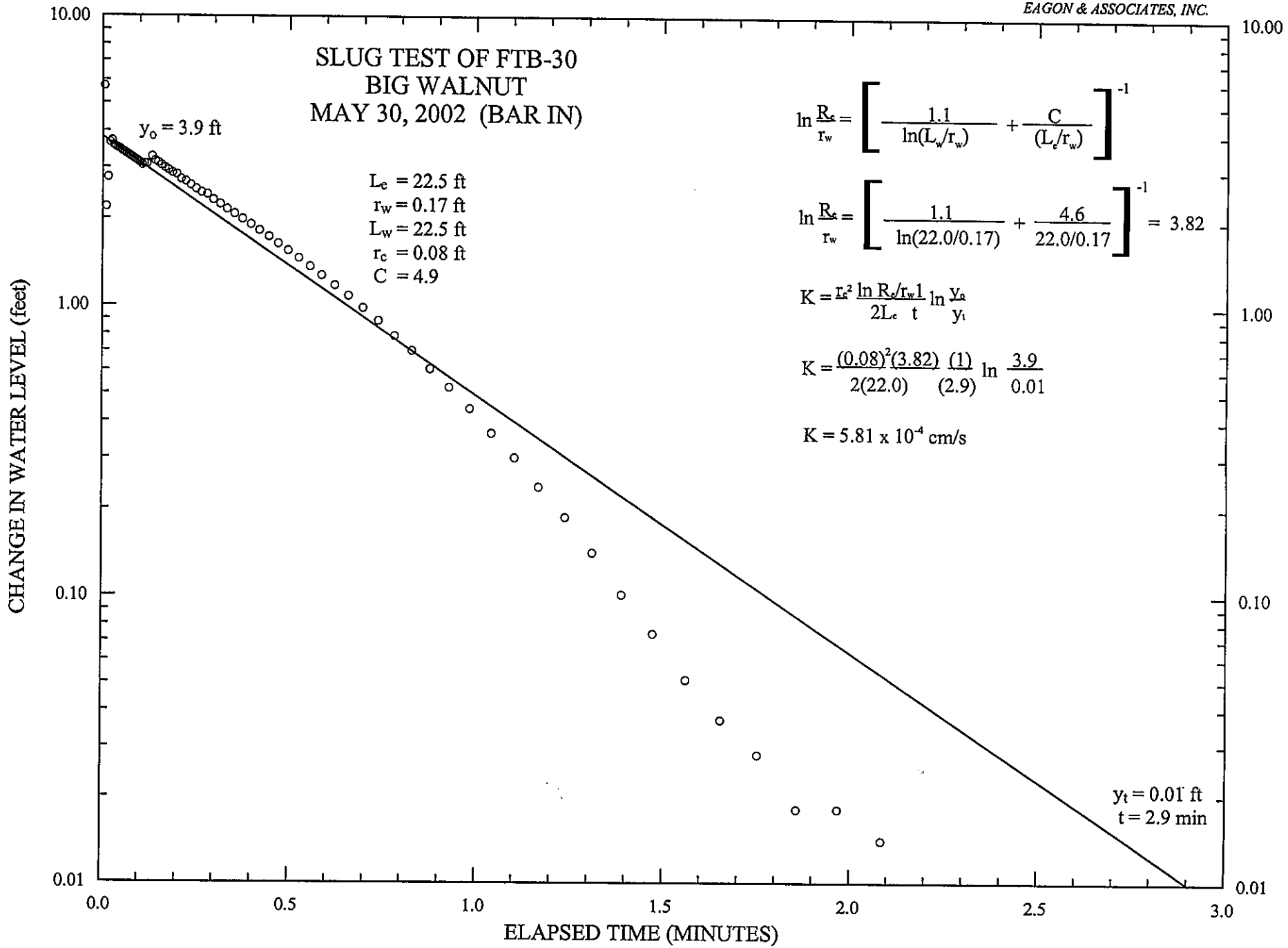
BIGWALNUT/AOC3SL.GRF
9/9/02

FIGURE 4-20. TIME-DRAWDOWN GRAPH FOR WELL AOC-3



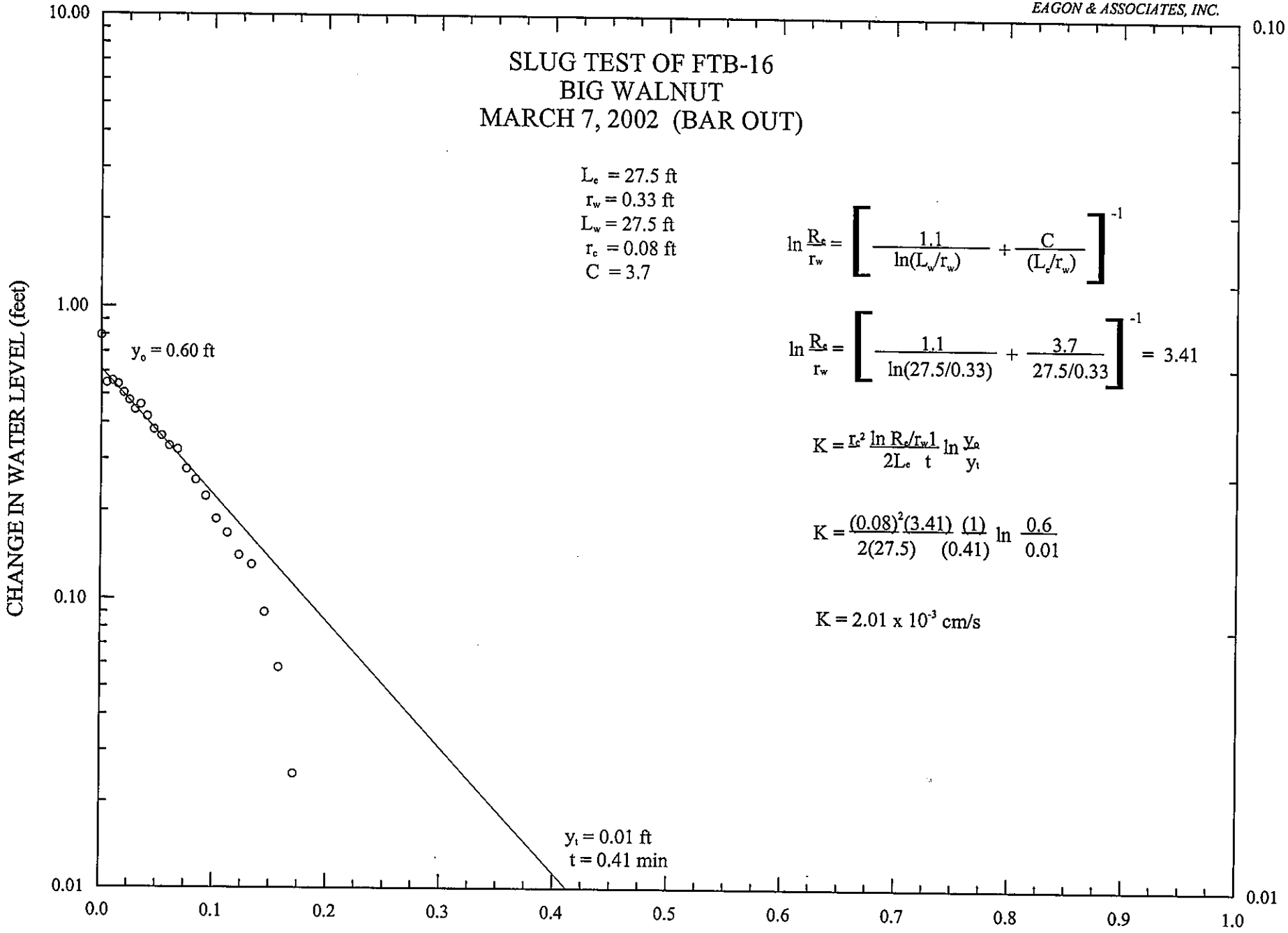
BigWalnut/FTB-29IN.grf
9/9/02

FIGURE 4-21. SLUG TEST RESULTS, WELL FTB-29



BigWalnut/FTB-30IN.grf
9/9/02

FIGURE 4-22. SLUG TEST RESULTS, WELL FTB-30



BigWalnut/FTB-16OUT.grf
3/11/02

FIGURE 4-23. SLUG TEST RESULTS, WELL FTB-16

EAGON & ASSOCIATES, INC.

C:\ACADDRWG\WALNUT\3-12-2002\PUMP-1.DWG 09/13/02

BIG WALNUT CREEK

CLEAR STREAM WAY

BEARS PAW CT

WINDY BLUFF CT

EURNT WOOD WAY

BLUE SKY CT

CAMBRIA WAY

TELLURIDE BLUFF

LITTLE TURTLE COUNTRY CLUB

UNCONSOLIDATED AQUIFER TEST AREA

FTB-28

FTB-31

FTB-1A

PW-4

SHAFT 1

ETB-2

FTB-11

FTB-10

FTB-9

PW-3

FTB-12

Outfall

FTB-32

FTB-27

ETB-1

FTB-1

FTB-2

FTB-4

1+00

2+00

3+00

4+00

5+00

6+00

7+00

8+00

9+00

10+00

12+00

0 100 200

GRAPHIC SCALE IN FEET

FIGURE 4-24. UNCONSOLIDATED AQUIFER TEST AREA

EAGON & ASSOCIATES, INC.

WEST

EAST

850
840
830
820
810
800
790
780

FTB-32
EL=832'
OUTFALL
FTB-27
EL=835.1'
PW-3
EL=837'
ETB-1
EL=837.4'
FTB-28
EL=839.2'
FTB-12
EL=841.0'
PW-4
EL=844'
FTB-31
FTB-1
FTB-1A
EL=845.0'
FTB-2
EL=845.6'
SHAFT 1
ETB-2
EL=843.9'

INV=798.76'

6/5/02
12/20/02
8/14/02

TD=44.8'
TD=60.5'
TD=50'
TD=45'
TD=54'
TD=54.5'
TD=51'
TD=60'
TD=55.4'
TD=55'

BEDROCK SUFACE

INV=799.81'
INV=799.91'

BIG WALNUT CREEK:
06/05/02 812.52'–815.93'
08/14/02 812.47'

NOTE:
Lithology shown on Geotechnical Borings is according to Unifies Soil Classification (USCS) based on visual inspection of samples. Lithology shown on Test Wells is based on driller's description explained in legend.

TEST WELL

PW-3
EL=837'
WELL SCREEN
TD=50'

GEOTECHNICAL BORING/PIEZOMETER

FTB-31
EL=845.0'
MEASURED W.L.
%SILT/%CLAY— 6/6
WELL SCREEN
6'—HEAVING SAND
TD=60.0'

LEGEND

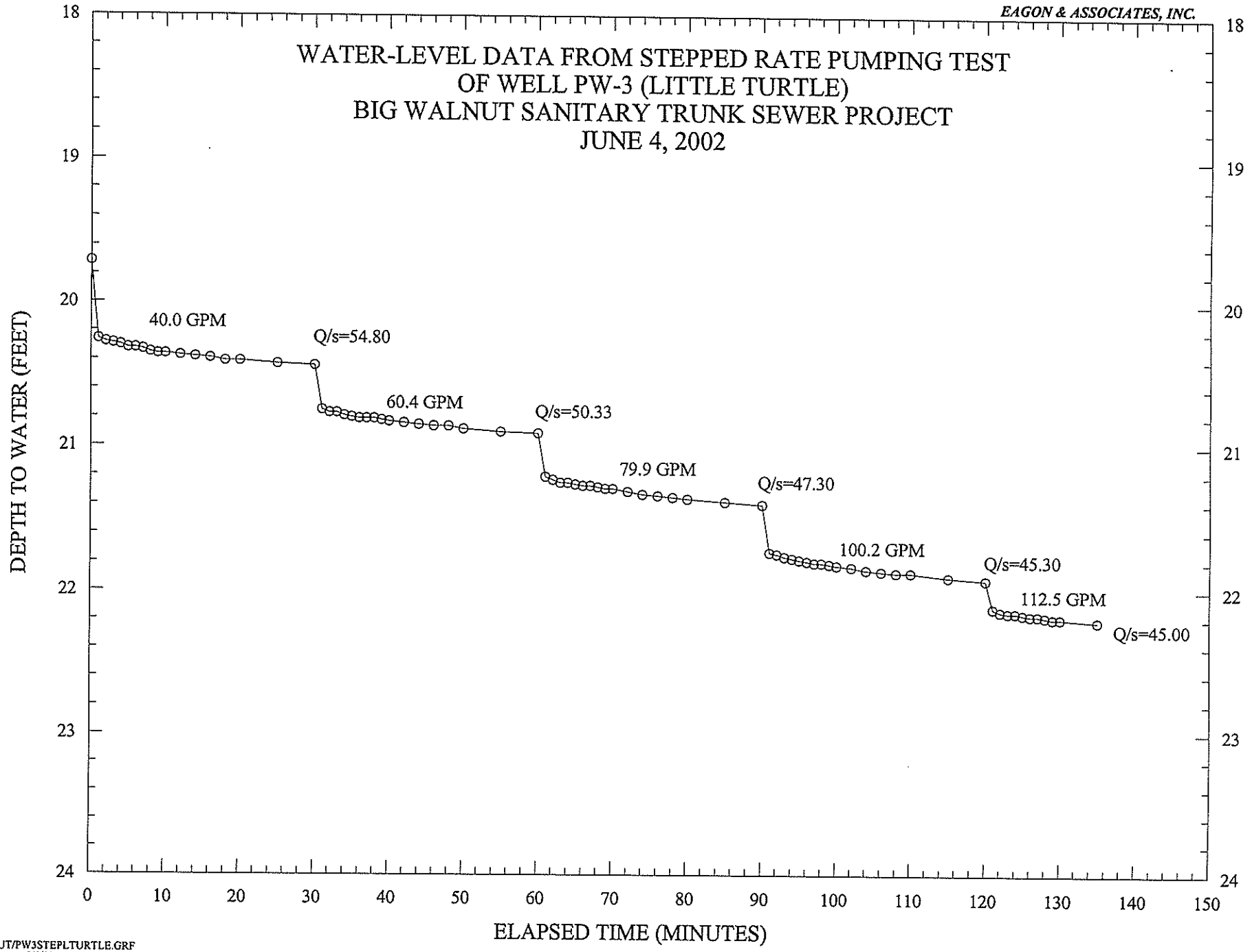
*—CBLS & Boulders
S&G—Sand and Gravel
CL—Clay
GR—Gravel
S—Sand
Med—Medium
LL—Liquid Limit
PL—Plastic Limit

0 10 20
VERTICAL SCALE IN FEET

0 50 100
HORIZONTAL SCALE IN FEET

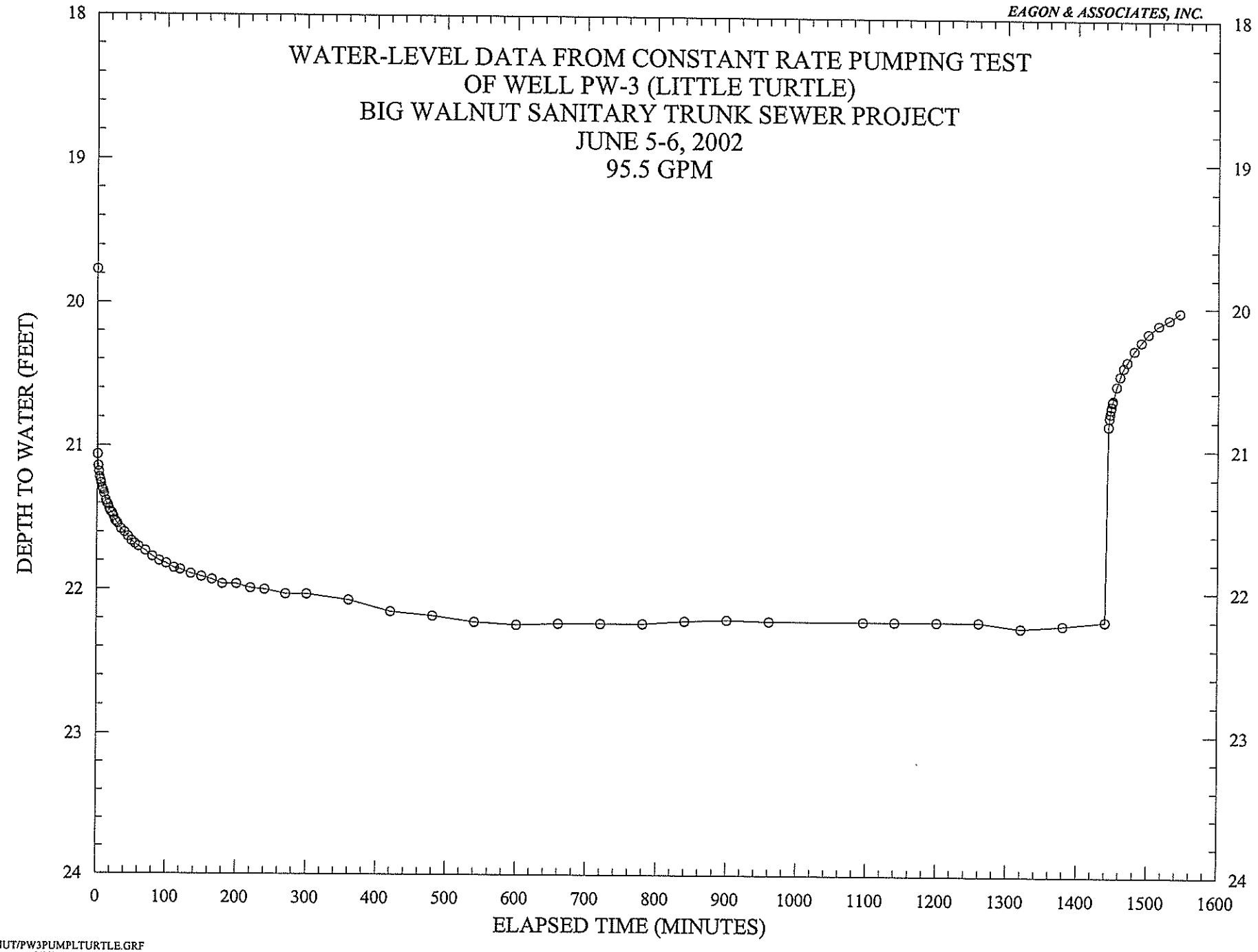
FIGURE 4-25
CROSS SECTION
SHOWING UNCONSOLIDATED AQUIFER

C:\ACADDRWG\WALNUT\BW-GRAPHLOG.DWG 03/07/03



BIGWALNUT/PW3STEPLTURTLE.GRF
9/9/02

FIGURE 4-26. WELL PW-3 STEP TEST DATA



BIGWALNUT/PW3PUMPLTURTLE.GRF
9/9/02

FIGURE 4-27. WELL PW-3 CONSTANT RATE TEST WATER LEVELS

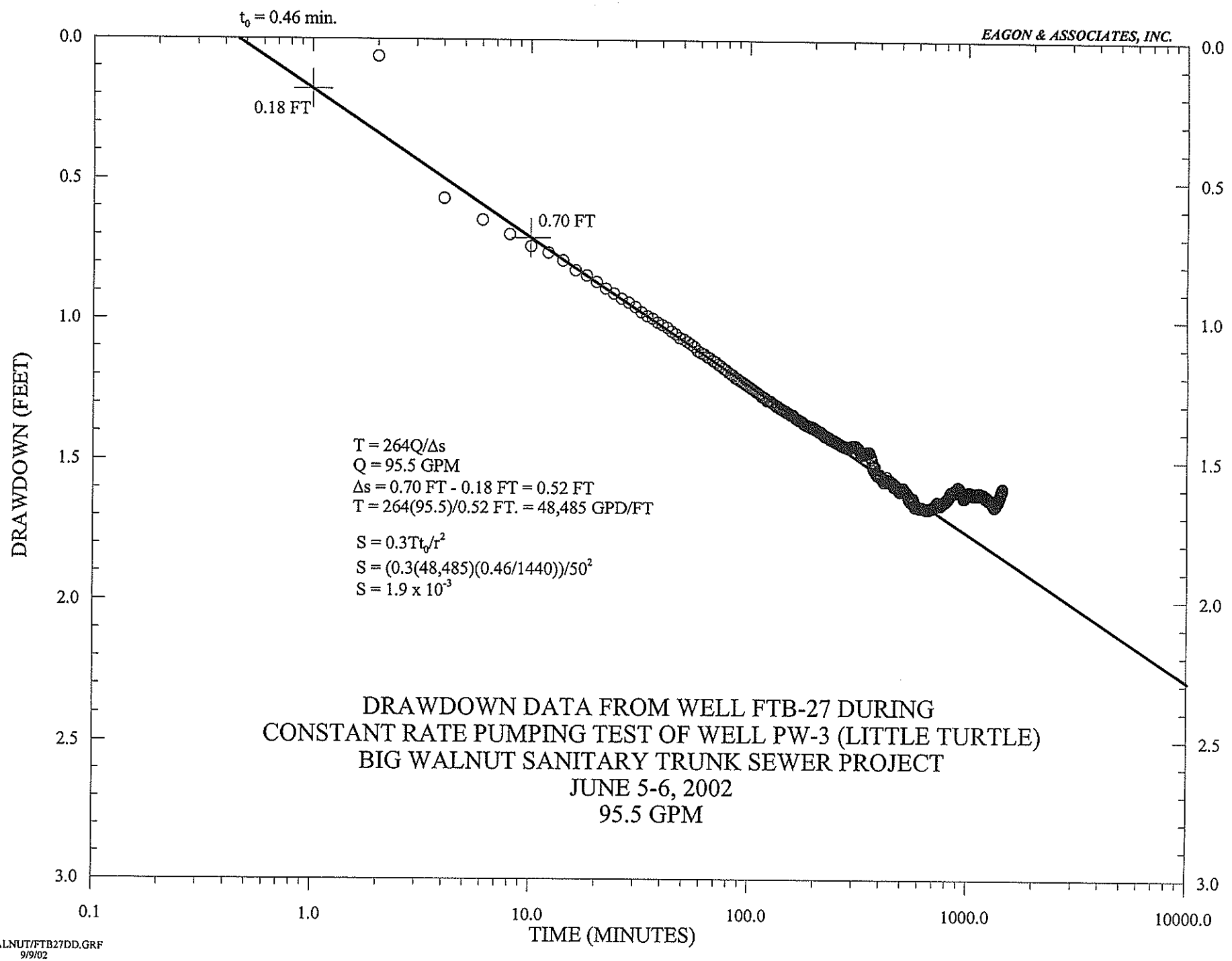


FIGURE 4-28. TIME-DRAWDOWN GRAPH FOR FTB-27 (PW-3 TEST)

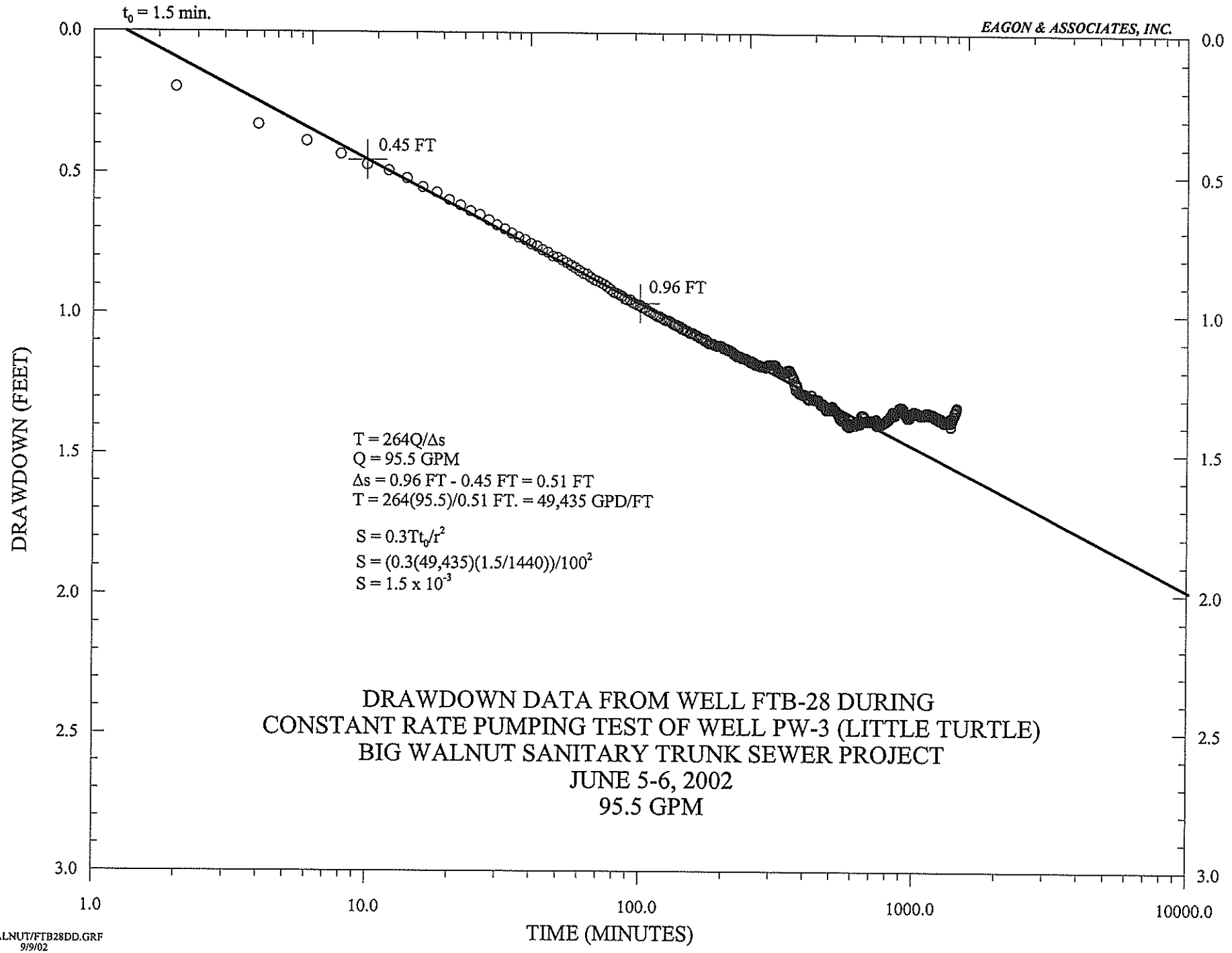


FIGURE 4-29. TIME-DRAWDOWN GRAPH FOR WELL FTB-28 (PW-3 TEST)

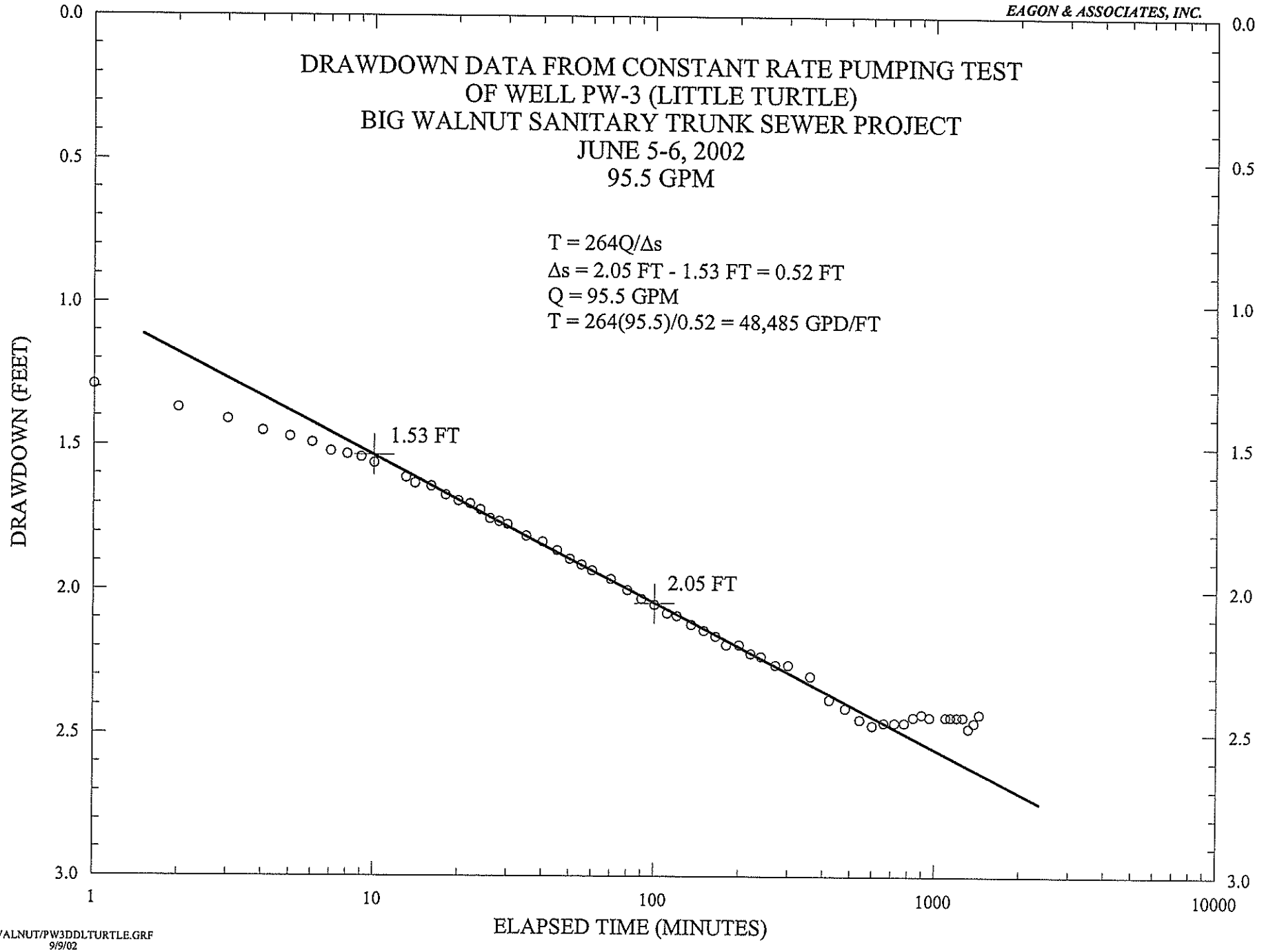
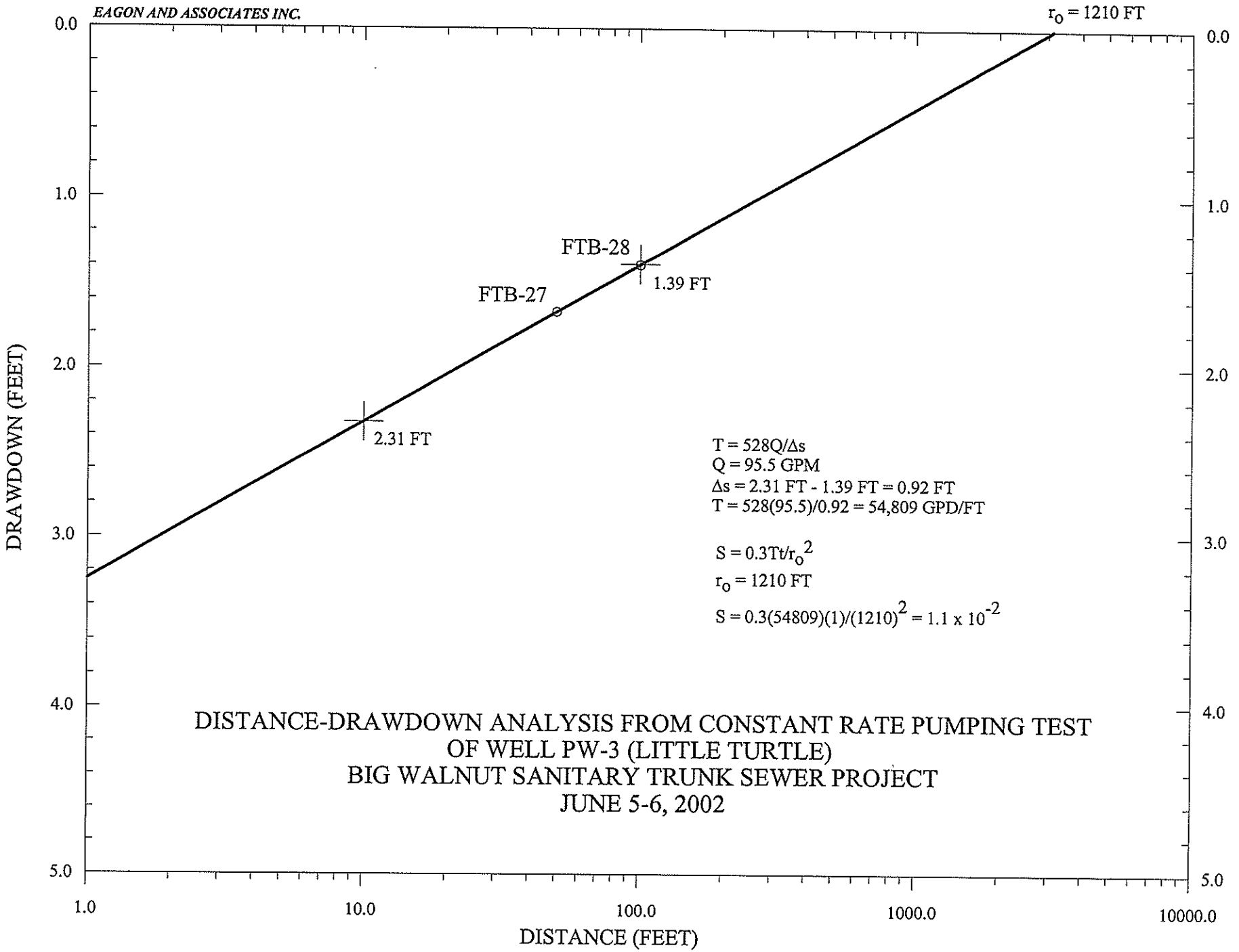


FIGURE 4-30. TIME-DRAWDOWN GRAPH FOR WELL PW-3



DISTANCE-DRAWDOWN ANALYSIS FROM CONSTANT RATE PUMPING TEST
OF WELL PW-3 (LITTLE TURTLE)
BIG WALNUT SANITARY TRUNK SEWER PROJECT
JUNE 5-6, 2002

BIGWALNUT/PW3DISTDDLTURTLE.GRF
9/9/02

FIGURE 4-31. DISTANCE-DRAWDOWN GRAPH FOR PW-3 PUMPING TEST

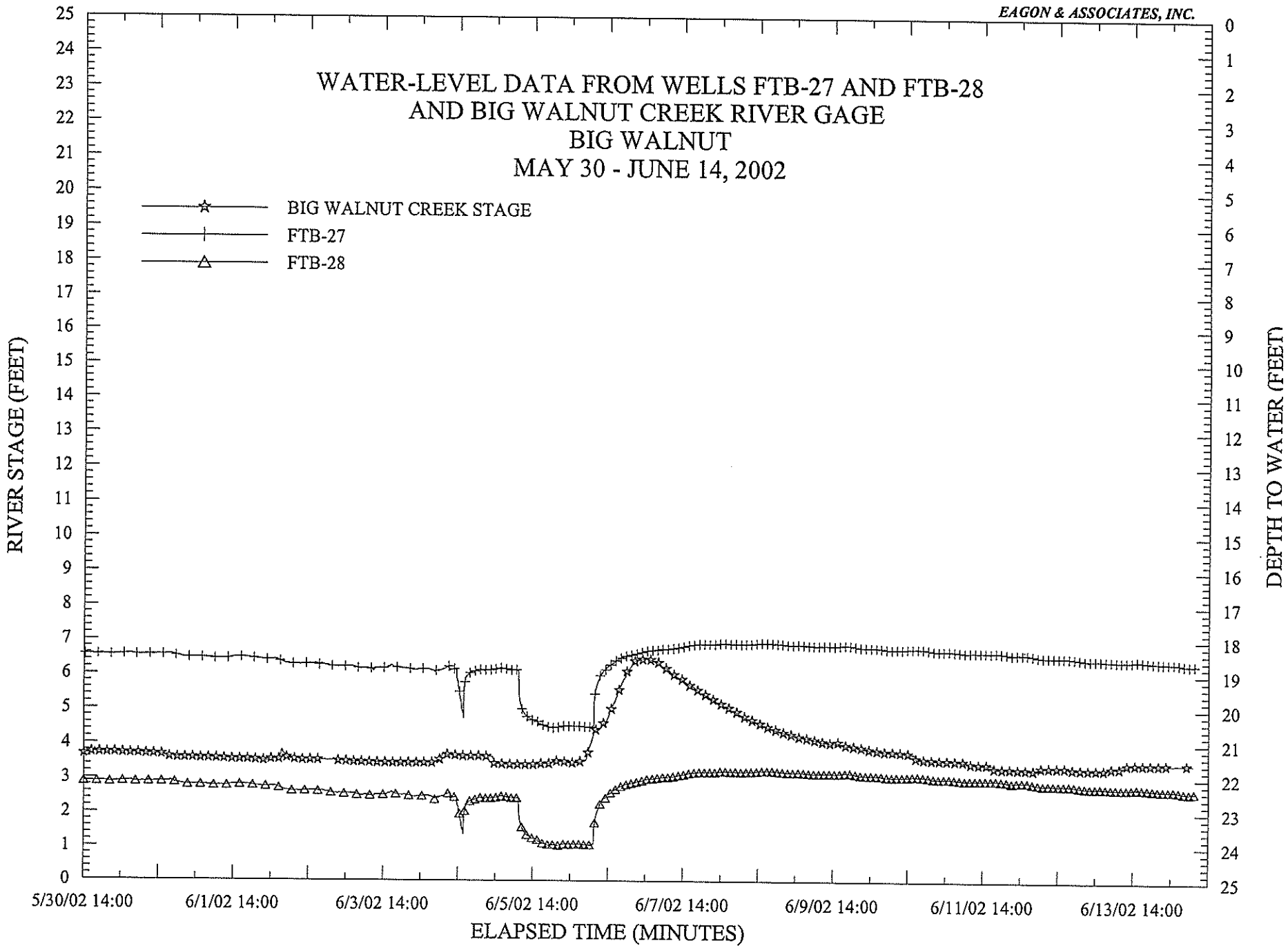
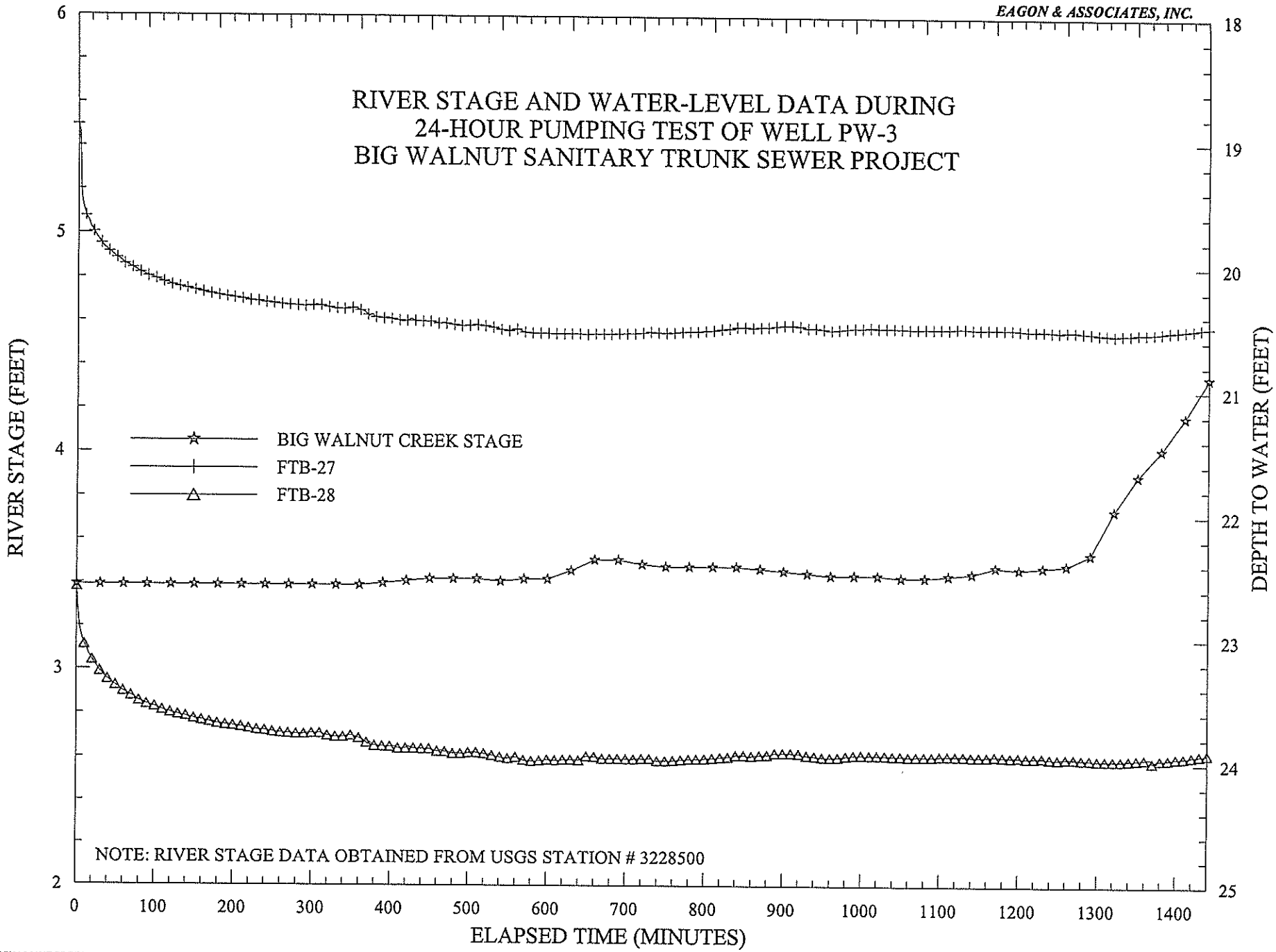


FIGURE 4-32. COMPARISON OF GROUND WATER LEVELS AND BIG WALNUT CREEK STAGE DATA

BIGWALNUT/WALNUTCREEKb.GRF



BIGWALNUT/WALNUTCREEKc.GRF
9/9/02

FIGURE 4-33. EXPANDED GRAPH OF GROUND WATER LEVELS AND RIVER STAGE

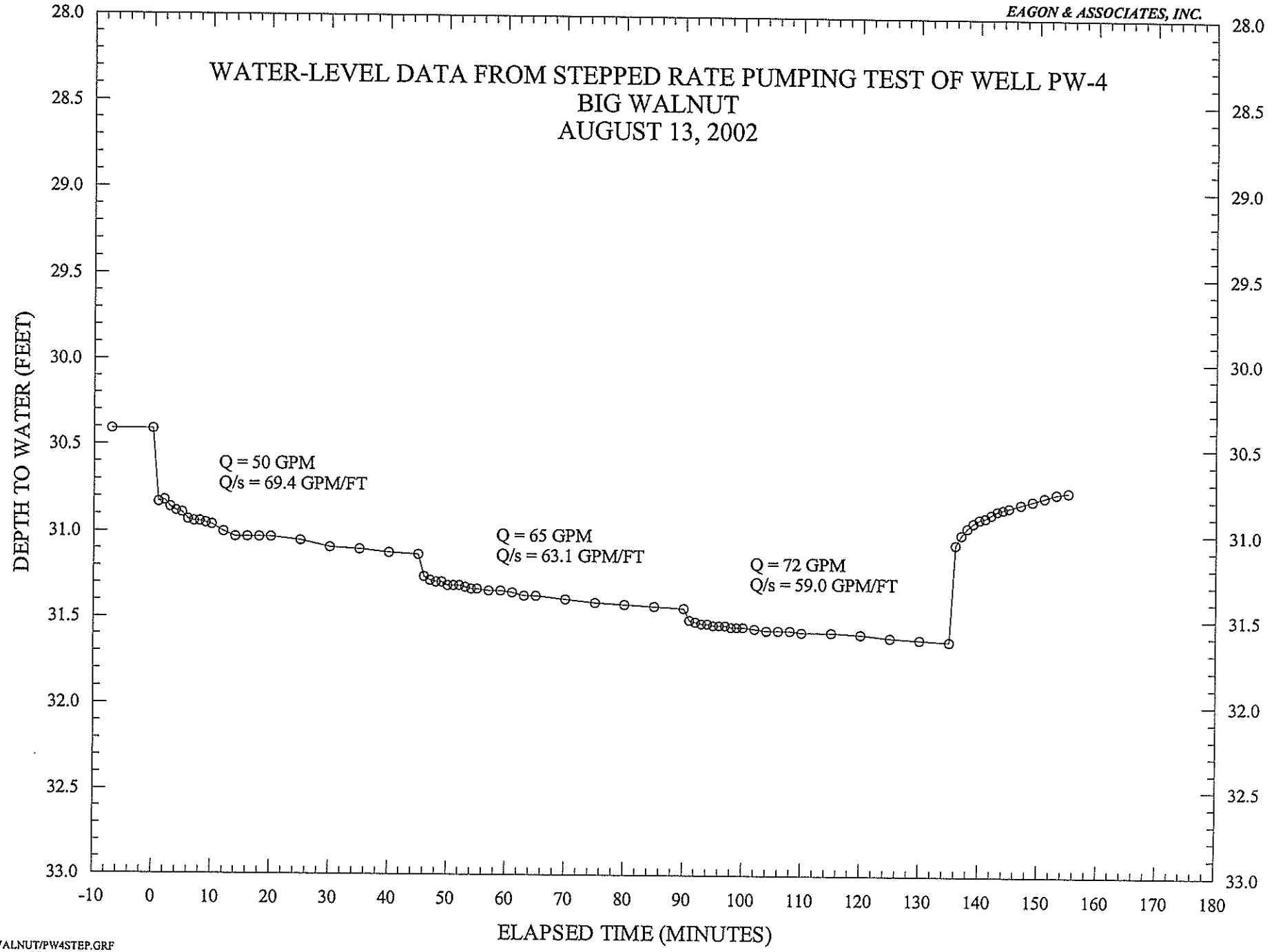
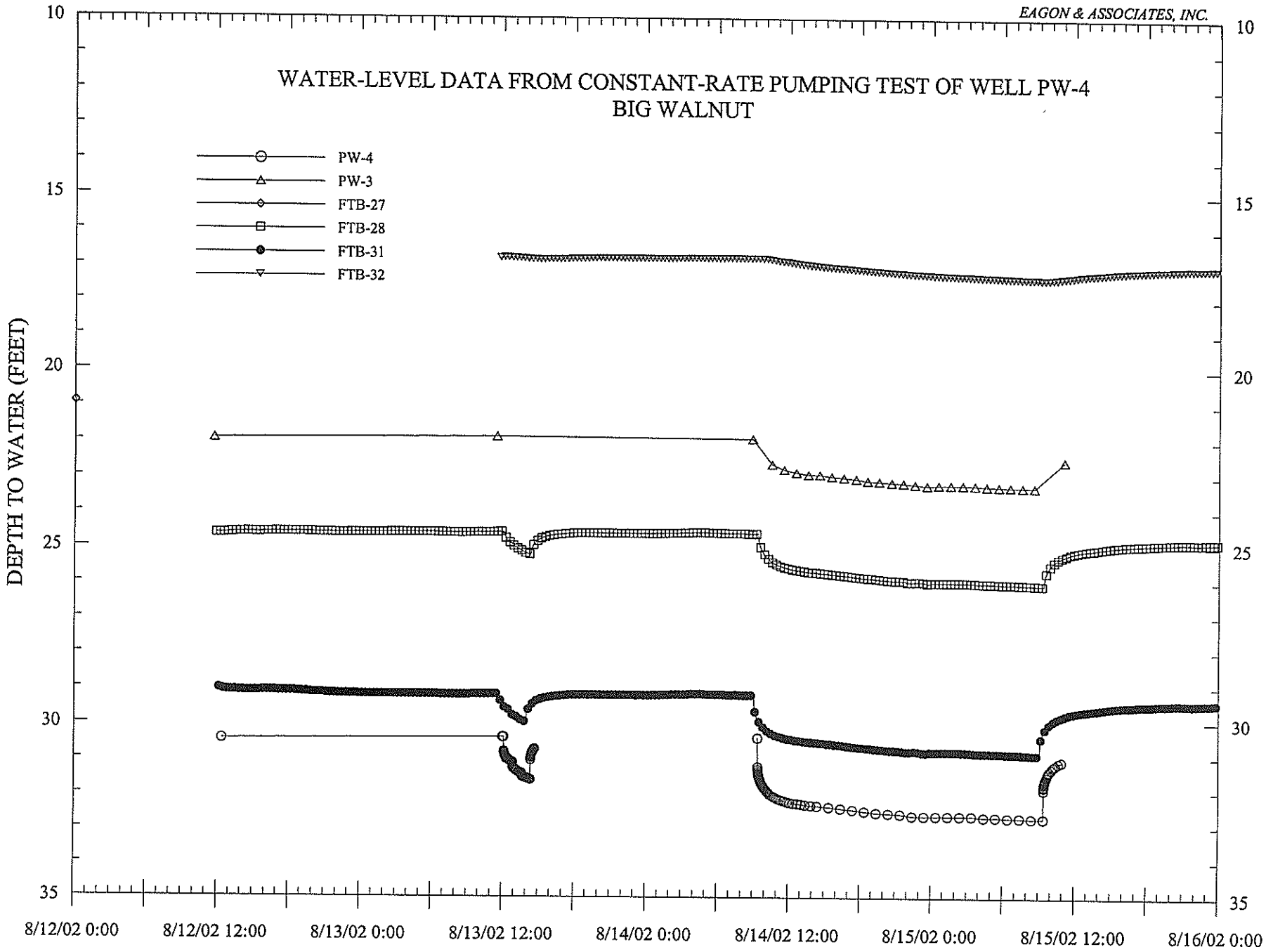
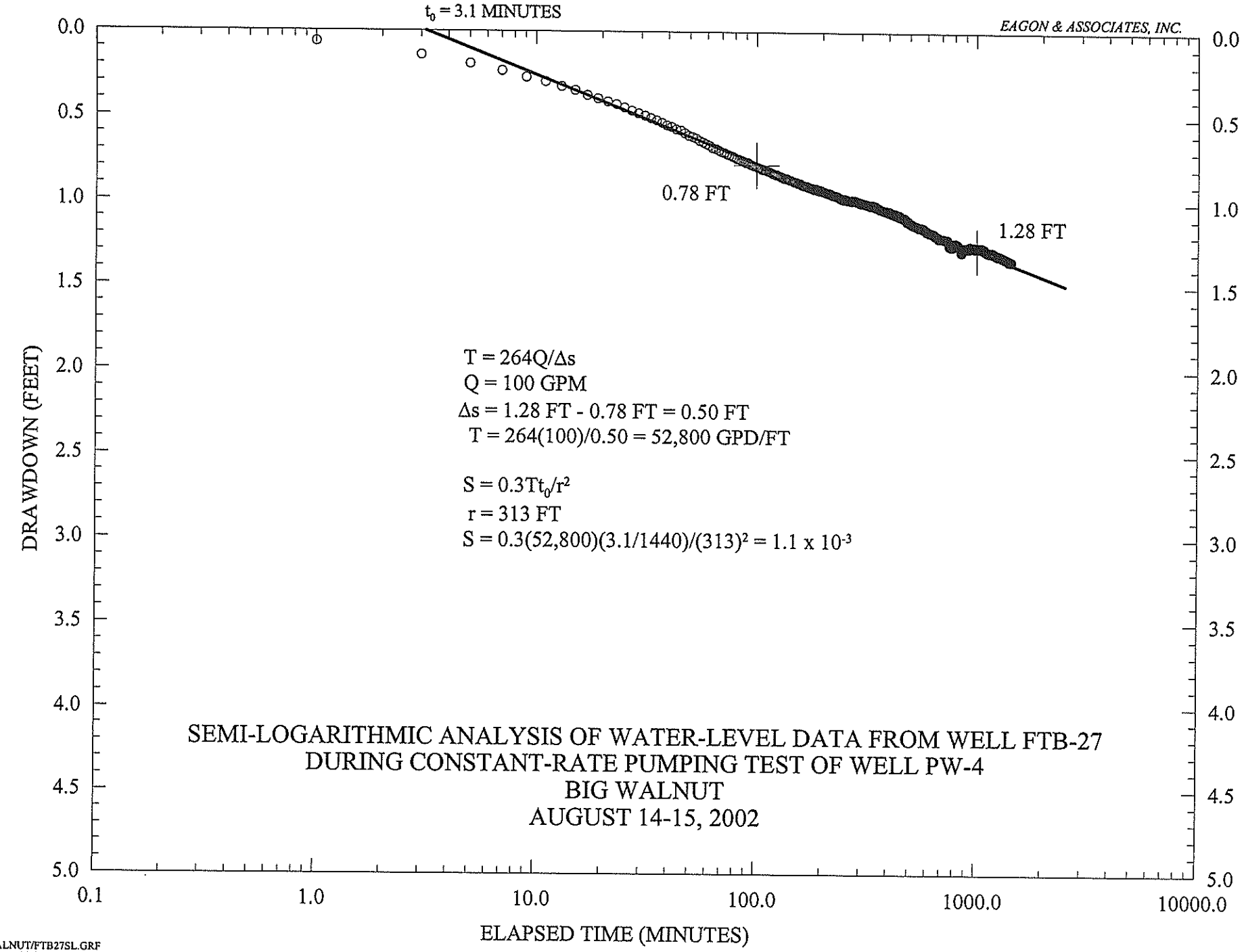


FIGURE 4-34. WELL PW-4 STEP TEST DATA



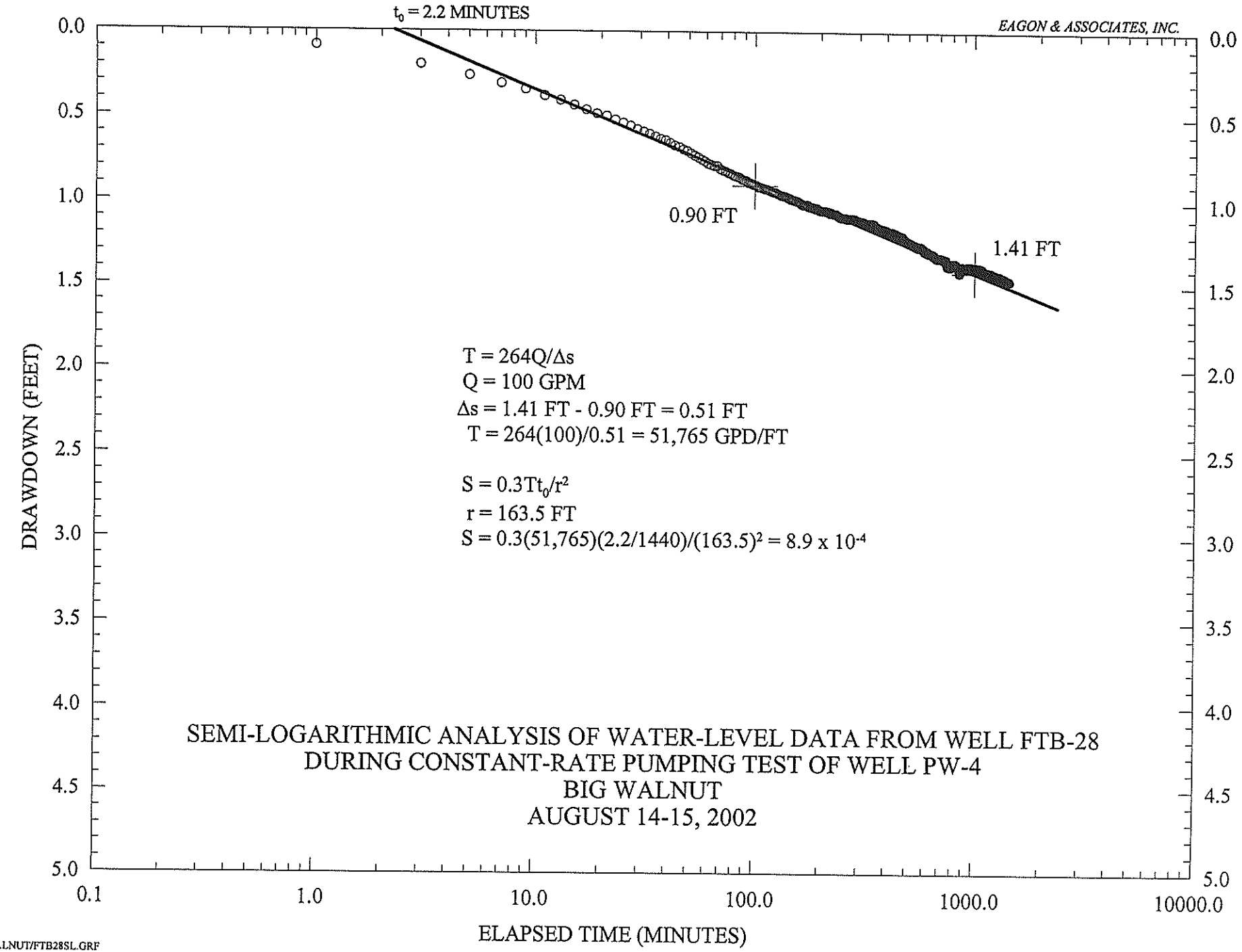
BIGWALNUT/PW4ARITH.GRF
9/9/02

FIGURE 4-35. WATER LEVEL DATA FOR PW-4 PUMPING TEST



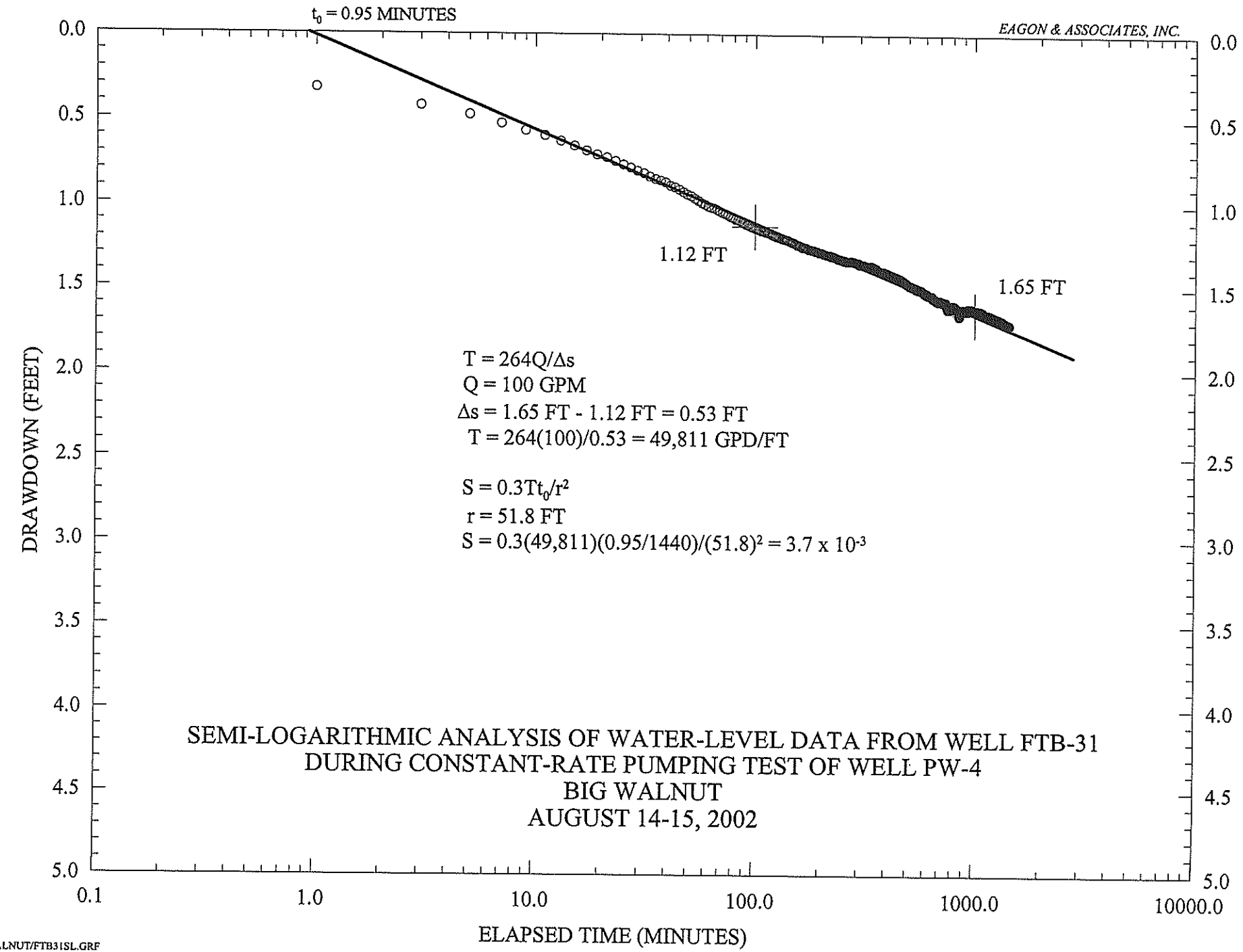
BIGWALNUT/FTB27SL.GRF
9/9/02

FIGURE 4-36. TIME-DRAWDOWN GRAPH FOR WELL FTB-27 (PW-4 TEST)



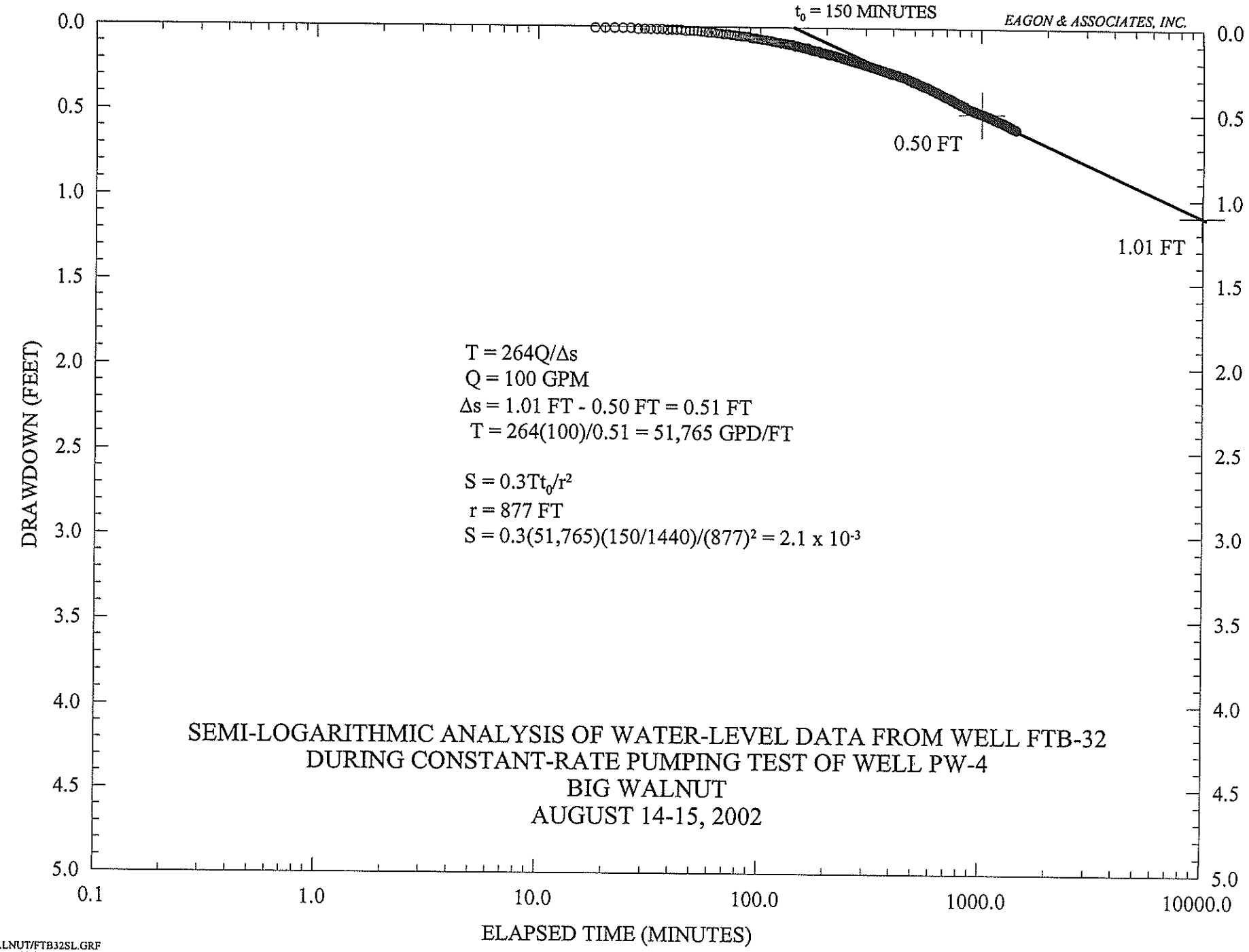
BIGWALNUT/FTB28SL.GRF
9/9/02

FIGURE 4-37. TIME-DRAWDOWN GRAPH FOR WELL FTB-28 (PW-4 TEST)



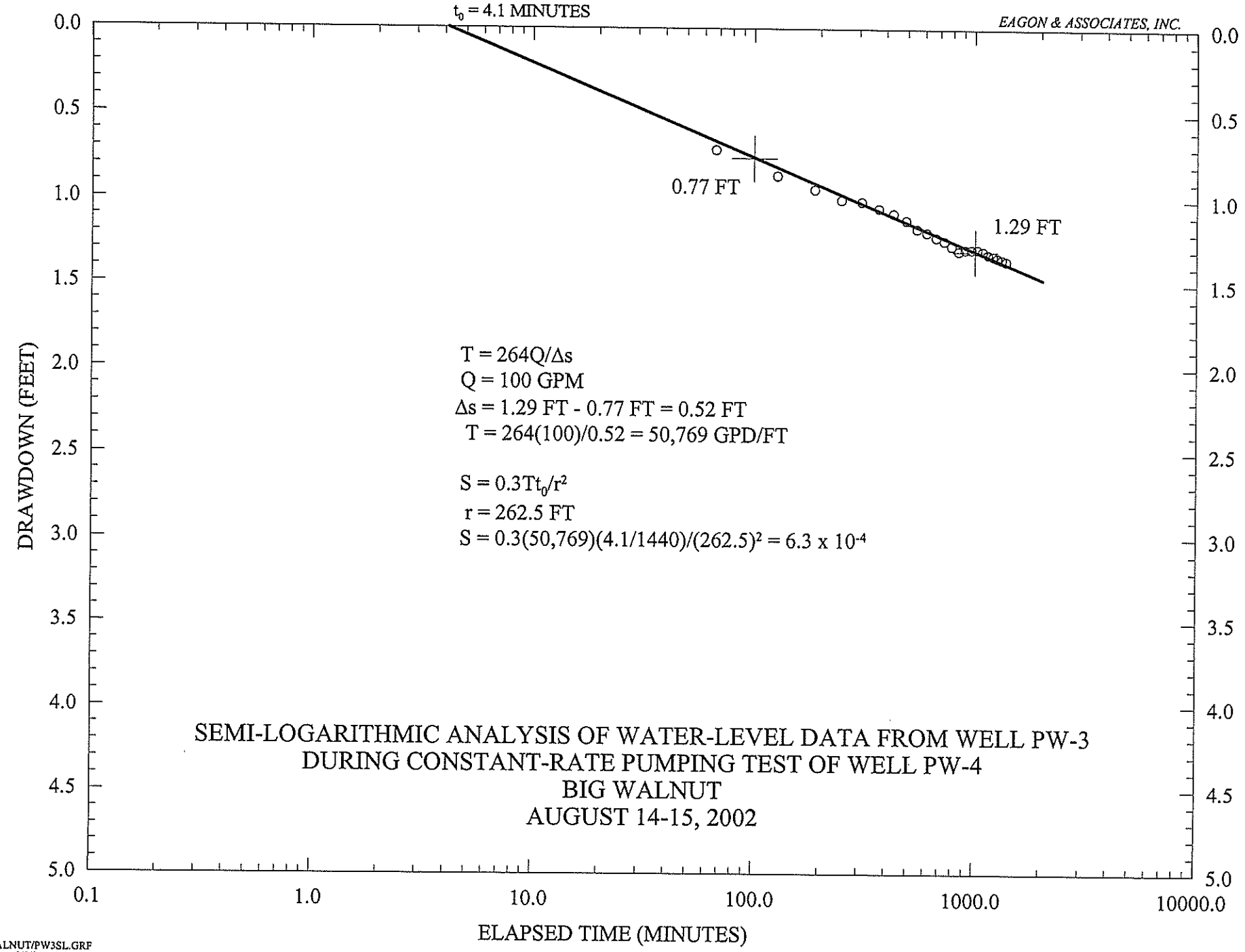
BIGWALNUT/FTB31SL.GRF
9/9/02

FIGURE 4-38. TIME-DRAWDOWN GRAPH FOR WELL FTB-31 (PW-4 TEST)



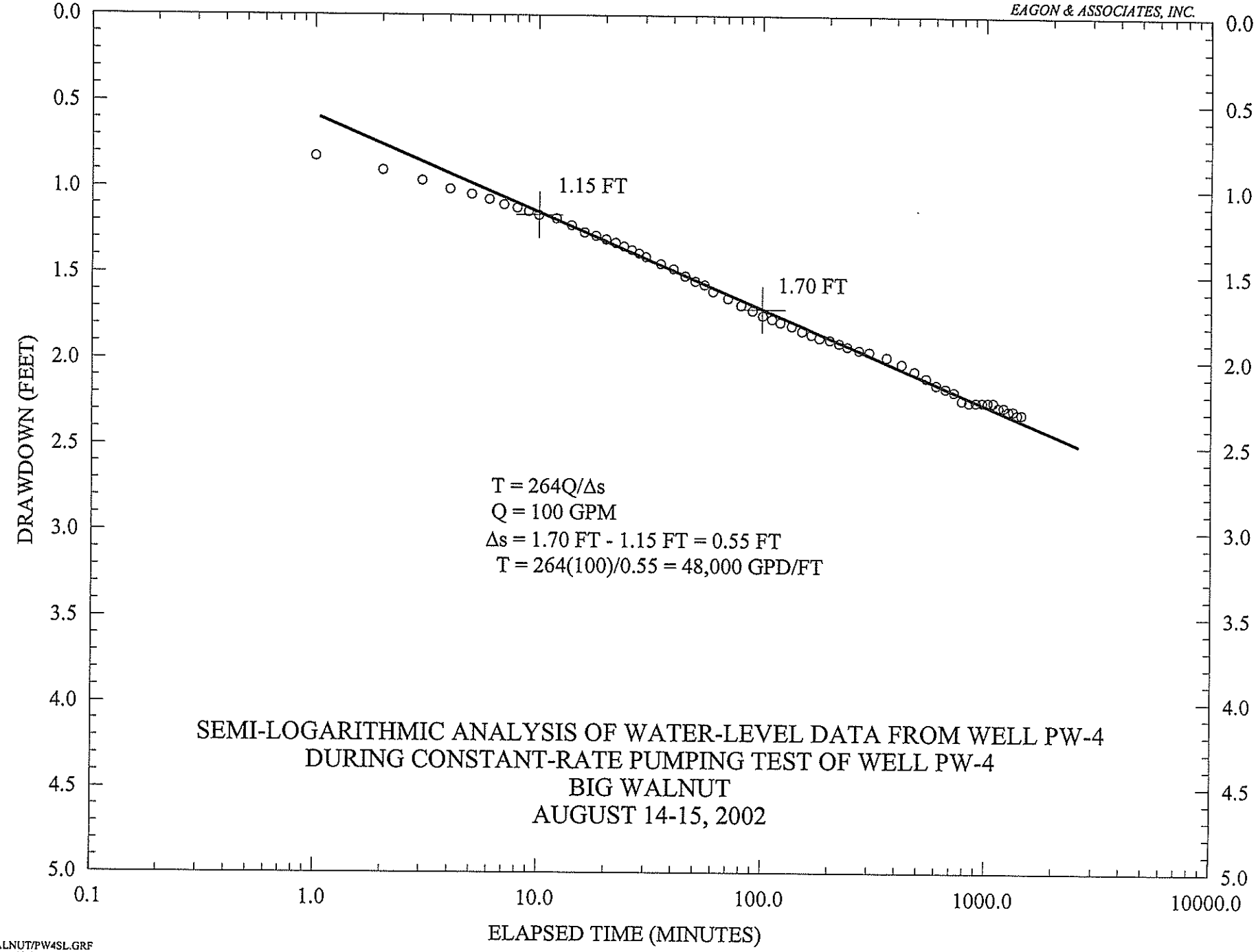
BIGWALNUT/FTB32SL.GRF
9/9/02

FIGURE 4-39. TIME-DRAWDOWN GRAPH FOR WELL FTB-32 (PW-4 TEST)



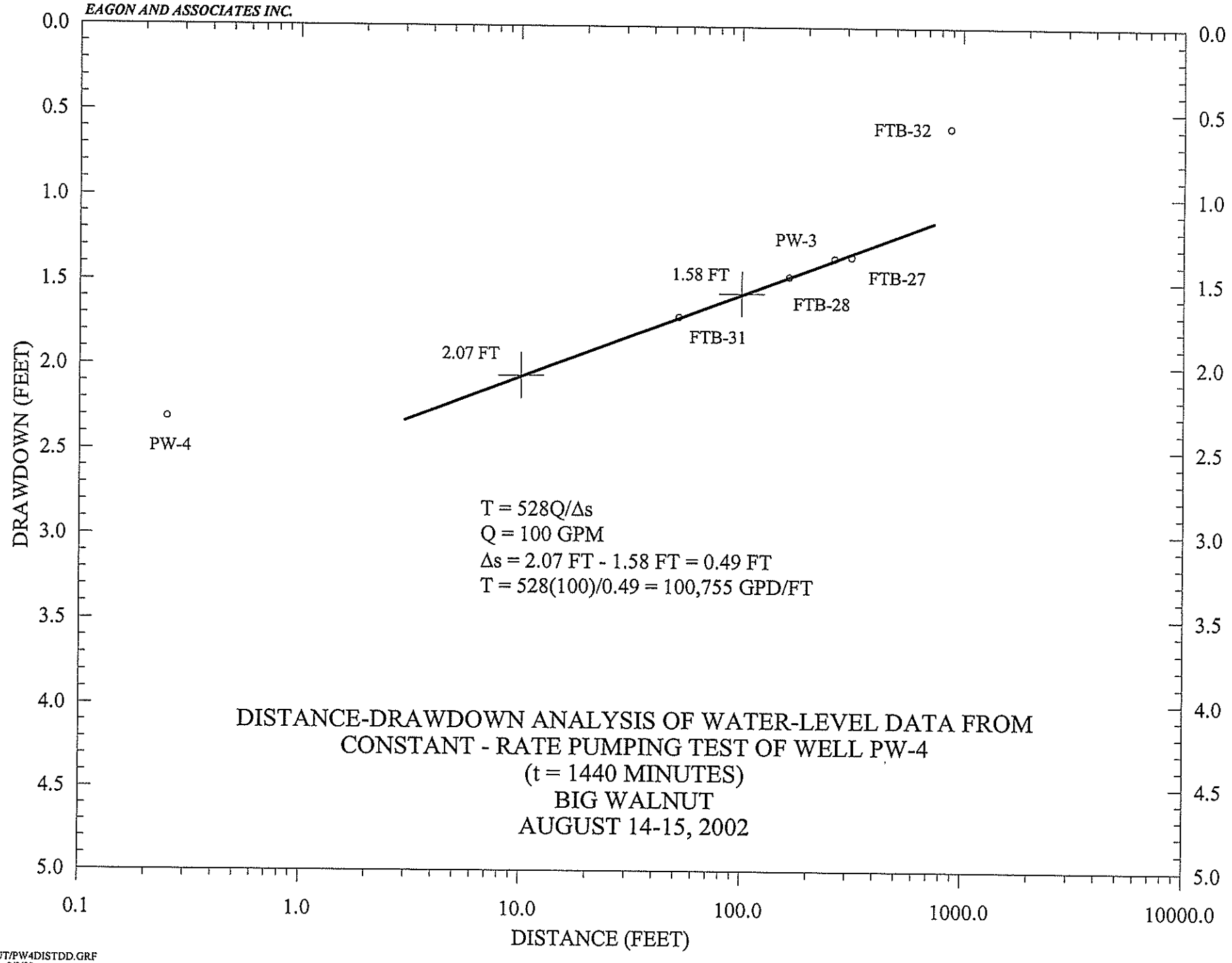
BIGWALNUT/PW3SL.GRF
9/9/02

FIGURE 4-40. TIME-DRAWDOWN GRAPH FOR WELL PW-3 (PW-4 TEST)



BIGWALNUT/PW4SL.GRF
9/9/02

FIGURE 4-41. TIME-DRAWDOWN GRAPH FOR WELL PW-4



BIGWALNUT/PW4DISTDD.GRF
9/9/02

FIGURE 4-42. DISTANCE-DRAWDOWN GRAPH FOR PW-4 PUMPING TEST

TABLE 4-1
PUMPING TEST SUMMARY
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Pumping Well	Diameter (in)	Total Depth (ft)	Open Hole	Static Level (ft)	Test Duration	Pumping Rate (gpm)	OBS Wells
PW-1	5	58	11 - 58'	20	24 hrs	3	4
PW-2	5			13	24 min	2	--
PW-2A	5	58	11 - 58'	8	60 min	1	--
AOC-1	NX Core	50	30 - 50'	18	24 hrs	1.95	2
AOC-3	NX	50	20 - 50'	17	240 min	6	--
BTB-5				13	240 min	1.5	--

TABLE 4-2.
HYDRAULIC CHARACTERISTICS OF BEREA SANDSTONE
BASED ON PUMPING TEST RESULTS
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well	Transmissivity (T)	Thickness (m)	Hydraulic Conductivity (K)			Storativity
PW-1	445 gpd/ft	40'	11.1 gpd/ft^2	1.5 ft/d	5.2 x 10^{-4} cm/sec	5 x 10^{-4}
PW-2	13.2 gpd/ft	29'	0.5 gpd/ft^2	0.06 ft/d	2.4 x 10^{-5} cm/sec	--
PW-2A	40.6 gpd/ft	38'	1.1 gpd/ft^2	0.14 ft/d	5.2 x 10^{-5} cm/sec	--
AOC-1	460 gpd/ft	33'	13.9 gpd/ft^2	1.9 ft/d	6.6 x 10^{-4} cm/sec	2.6 x 10^{-3}
AOC-3	1932 gpd/ft	36'	53.7 gpd/ft^2	7.2 ft/d	2.5 x 10^{-3} cm/sec	--
BTB-5	43.5 gpd/ft	32'	43.5 gpd/ft^2	1.5 ft/d	2.1 x 10^{-3}cm/sec	--
BTB-6	37.2 gpd/ft	32'	37.2 gpd/ft^2	1.2 ft/d	1.8 x 10^{-3} cm/sec	--
RESIDENTIAL WELL TESTS						
50	1227 gpd/ft	49'	25 gpd/ft^2	3.3 ft/d	1.2 x 10^{-3} cm/sec	--
51	249 gpd/ft	45'	5.5 gpd/ft^2	0.7 ft/d	2.5 x 10^{-4} cm/sec	--
79	4668 gpd/ft	24'	195 gpd/ft^2	26 ft/d	9 x 10^{-3} cm/sec	--
SLUG TESTS						
FTB-16	1993 gpd/ft	47'	42.4 gpd/ft^2	5.7 ft/d	2.0 x 10^{-3} cm/sec	--
FTB-29	1016 gpd/ft	40'	25.4 gpd/ft^2	3.4 ft/d	1.2 x 10^{-3} cm/sec	--
FTB-30	301 gpd/ft	24.5	12.3 gpd/ft^2	1.6 ft/d	5.8 x 10^{-4} cm/sec	--

TABLE 4-3
PUMPING TEST RESULTS FOR WELLS PW-3 AND PW-4
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

	Transmissivity (Time-Drawdown)	Saturated Thickness	Hydraulic Conductivity	Storativity
Pumping Test on PW-3				
PW-3	48,485 gpd/ft	21.5'	2255 gpd/ft^2 (1.1×10^{-1} cm/sec)	--
FTB-27	48,485 gpd/ft	21.5'	2255 gpd/ft^2 (1.1×10^{-1} cm/sec)	1.9×10^{-3}
FTB-28	49,435 gpd/ft	21.5'	2299 gpd/ft^2 (1.1×10^{-1} cm/sec)	1.5×10^{-3}
Distance Drawdown	54,809 gpd/ft	21.5'	2549 gpd/ft^2 (1.2×10^{-1} cm/sec)	1.1×10^{-3}
Pumping Test on PW-4				
PW-4	48,000 gpd/ft	23'	2087 gpd/ft^2 (9.8×10^{-2} cm/sec)	--
FTB-27	52,800 gpd/ft	21.5'	2456 gpd/ft^2 (1.2×10^{-1} cm/sec)	1.1×10^{-3}
FTB-28	51,765 gpd/ft	21.5'	2408 gpd/ft^2 (1.1×10^{-1} cm/sec)	8.9×10^{-4}
FTB-31	49,811 gpd/ft	23'	2166 gpd/ft^2 (1.0×10^{-1} cm/sec)	3.7×10^{-3}
FTB-32	51,765 gpd/ft			2.1×10^{-3}
PW-3	50,769 gpd/ft	21.5'	2361 gpd/ft^2 (1.1×10^{-1} cm/sec)	6.3×10^{-4}
Distance Drawdown	100,755 gpd/ft*	22'	*	--*

5

5.0 GROUND-WATER LEVEL MONITORING

5.1 Water-Level Monitoring Network

Ground-water levels have been measured in a network of observation wells that were installed during each phase of the geotechnical boring program. Ground-water level monitoring began in June 1999 with the ATB series borings. Table 5-1 is a list of wells included in the monitoring network as well as a summary of all ground-water level data collected to date. The depth-to-water measurements have been transformed to ground-water elevation for the purpose of constructing hydrographs which show trends in ground-water levels over time. Appendix C contains hydrographs for wells in the monitoring network. Transducers and data loggers have been utilized in selected wells to obtain continuous record of water level fluctuations. Periodic hand measurements have been made in others.

Wells included in the monitoring network are used to monitor water levels in several stratigraphic units which include the Berea Sandstone, Bedford Shale, Ohio Shale, unconsolidated materials and sand and gravel deposits. Table 5-1 displays the well depth and the monitored unit at each observation well location. The locations of wells for which water level data is available are shown on Plate 2.

5.2 Water-Level Fluctuations

Ground-water levels fluctuate within the project area in response to seasonal conditions and local ground-water usage patterns. Ground-water levels monitored in wells completed in the Berea Sandstone display a range of fluctuation of approximately 10-15 feet over the period of record. As shown on the hydrographs in Appendix C, ground-water levels in the Berea Sandstone in late 1999 and early 2000 were generally the lowest observed over the period of record and represent severe to extreme drought conditions as determined by the Palmer Drought Severity Index. Ground-water levels in the upper section of the Bedford Shale in the transition zone between the Berea Sandstone and the Bedford Shale generally fluctuate on parallel trends with water levels in the Berea Sandstone.

Trends in ground-water levels in the lower Bedford Shale and Ohio Shale units are generally flat after water levels have fully equilibrated. Ground-water level fluctuations in these units are usually less than 5 feet. The hydrographs for some of the ATB observation wells show the slow recovery of water levels due to water being removed during well development. Complete water-level recovery for some deep shale wells occurred over a 2 to 3 year period and is due to the low hydraulic conductivity of the shale.

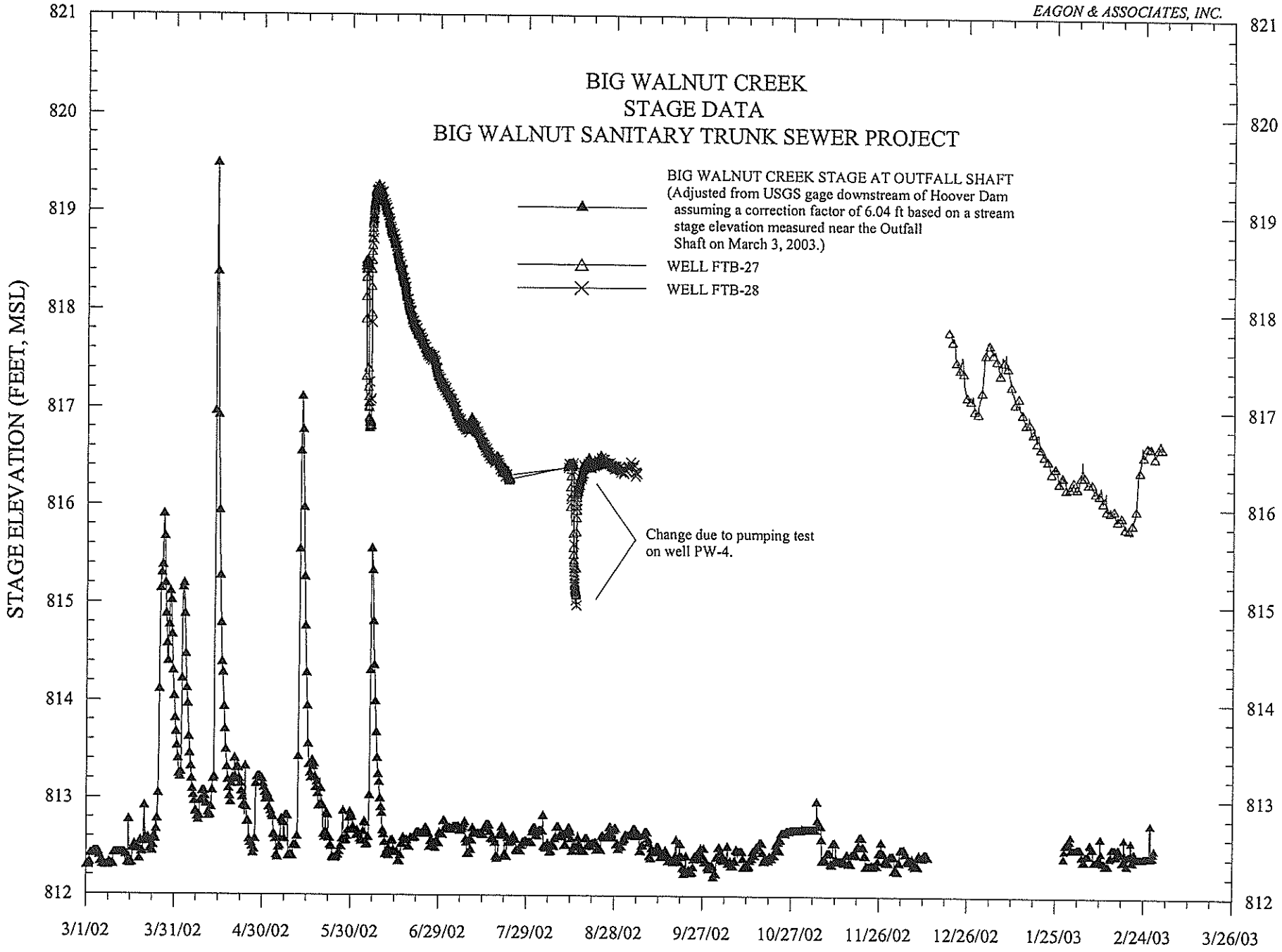
Water-level fluctuations in the sand and gravel wells located between the Outfall Shaft and Shaft 1 are on the order of 1 to 3 feet, based on ground-water level data collected to date. Figure 5-1 shows the relationship between water levels in sand and gravel wells FTB-27 and FTB-28 and changes in stream stage elevation of the Big Walnut Creek. The flow of Big Walnut Creek is controlled by the dam on Hoover Reservoir upstream of the project area. There is a USGS stream gage located below the dam approximately 1.27 miles upstream of the Outfall Shaft. Based on the 7 ½ minute quadrangle topographic map, the fall of Big Walnut Creek through this reach is about 4.29 feet per mile. Assuming the fall is uniform, the stage near the Outfall Shaft would be about 5.45 feet lower than recorded at the stream gage. However, comparison of the surveyed elevation of the stream stage near the Outfall Shaft on March 3, 2003, revealed that the stage was 6.04 feet lower than measured at the USGS gage on that date. The stream stage hydrograph included in Figure 5-1 has been adjusted using the correction of 6.04 feet and shows the stage elevation near the Outfall Shaft during base-flow conditions is in the range of elevation 812 and 813 MSL. Ground water levels in FTB-27 and FTB-28 during the period recorded ranged from about elevation 816 to 819 MSL.

5.3 Ground-Water Flow

Plate 2 is a map showing the potentiometric surface in the Berea Sandstone. This map is based on water-level elevations determined from wells measured during the well survey, piezometers installed and monitored during the project, and is supplemented by water levels recorded on well logs. The direction of ground-water flow is perpendicular to the potentiometric (water level)

contours. From the upland area generally along Lee Road, ground water flows toward the ravines to the north, south, and west, as well as to the east and south toward the buried valley areas.

The direction of ground-water flow in the sand and gravel aquifer in the vicinity of the Outfall Shaft and Shaft 1 is generally east to west, toward Big Walnut Creek. The gradient toward Big Walnut Creek is very small, being only a few hundredths of a foot over a few hundred feet. The fact that there is a head difference of more than 3 feet between ground-water levels and the stage of Big Walnut Creek (see Figure 5-1) suggests a poor hydraulic connection between the sand and gravel aquifer and the creek. It appears that ground-water levels respond more to major precipitation recharge events than stage changes in Big Walnut Creek. A major stream stage change would be required to reverse the gradient between the sand and gravel aquifer and the creek. The stage of Big Walnut Creek normally is controlled by the operation of Hoover Dam. The 100 year flood stage in the vicinity of the Outfall Shaft is elevation 828 MSL.



BIGWALNUT/PUMPTEST/Hydro+River.GRF
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Figure 5-1. Big Walnut Creek Stage and adjacent Ground-Water Levels

TABLE 5-1
GROUND-WATER LEVEL DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well	Measuring Point Elevation (ft., MSL)	Well Depth (ft.TOC)	Monitored[1] Unit	6/9/99		6/11/99		6/15/99		6/22/99		7/8/99		8/6/99		8/13/99		8/20/99		8/27/99		9/2/99	
				Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)
AOC-1	979.05	49.68	BSS	13.92	965.13	14.16	964.89	14.25	964.80	14.70	964.35	15.30	963.75	16.00	963.05	16.60	962.45	16.90	962.15	17.20	961.85	17.40	961.65
AOC-2	963.96	68.08	UC / BSH	3.66	960.30	4.31	959.65	4.25	959.71	4.70	959.26	5.20	958.76	6.40	957.56	6.70	957.26	6.60	957.36	6.80	957.16	6.80	957.16
AOC-3	996.20	49.79	BSS	10.40	985.80	10.92	985.28	10.50	985.70	11.10	985.10	11.40	984.80	10.60	985.60	10.40	985.80	11.30	984.90	11.70	984.50	12.30	983.90
AOC-4	1000.03	49.85	BSS	10.98	989.05	11.21	988.82	11.25	988.78	11.60	988.43	12.30	987.73	13.40	986.63	13.60	986.43	14.20	985.83	14.30	985.73	14.70	985 33
ATB-1OW	824.38	41.00	OSH							8.60	815.78	9.00	815.38	9.50	814.88	9.50	814.88	29.60	794.78	36.10	788.28	33.30	791.08
ATB-1R	824.18	42.00	OSH									8.00	816.18	8.65	815.53	8.90	815.28	10.20	813.98	9.80	814 38	9.90	814 28
ATB-2	823.38	53.15	OSH																				
ATB-3	979.00	189.83	OSH			152.58	826.42			150.80	828.20	150.30	828.70	143.30	835.70	149.80	829.20	150.20	828.80			149.50	829.50
ATB3-E1	981.65	51.95	BSS																				
ATB3-W1	980.28	52.26	BSS / BSH																				
ATB-4	963.81	184.23	BSH / OSH	3.38	960.43	4.12	959.69	4.25	959.56	4.70	959.11	5.10	958.71	6.80	957.01	6.30	957.51	6.50	957.31	6.10	957.71	6.30	957.51
ATB-4R	964.24	184.29	BSH / OSH																				
ATB-5	996.08	199.62	BSH / OSH			172.91	823.17			172.20	823.88	171.80	824.28	170.10	825.98	171.70	824.38	171.60	824.48	171.50	824.58	171.30	824.78
ATB-6	999.83	199.43	OSH			174.51	825.32			173.50	826.33	172.20	827.63	170.10	829.73	169.80	830.03	169.50	830.33	169.40	830.43	169.30	830.53
ATB6-E1	1002.20	51.95	BSS																				
ATB6-NE1	1001.32	52.12	BSS / BSH																				
ATB6-NE2	999.98		BSS / BSH																				
ATB-7	977.38	174.76	OSH	142.52	834.86	141.95	835.43	141.00	836.38	147.30	830.08	144.40	832.98	147.80	829.58	150.20	827.18	149.50	827.88	148.70	828.68	148.90	828.48
ATB-8	929.55	140.00	BSH / OSH											4.30	925.25	4.10	925.45	6.40	923.15	6.20	923.35	4.30	925.25
BTB-3	962.29	174.70	OSH															24.20	938.09	4.10	958.19		
BTB-5	982.79	59.74	BSS																				
BTB-6	990.53	61.03	BSS																				
CTB-1	991.42	188.34	BSH / OSH																				
CTB-1H	991.75	48.25	BSS																				
CTB-3	977.26	48.56	BSS																				
CTB-4	974.42	94.89	S & G																				
DTB-3	980.53	42.16	S & G																				
FTB-2	845.23	55.40	S & G / OSH																				
FTB-4	861.56	70.00	S & G / OSH																				
FTB-15	916.16	121.16	BSH / OSH																				
FTB-16	841.81	54.51	OSH																				
FTB-17	989.05	187.62	BSS / BSH / OSH																				
FTB-19	974.75	167.84	BSH / OSH																				
FTB-20	996.76	189.00	BSH / OSH																				
FTB-23	987.21	173.21	BSH / OSH																				
FTB-25	988.53	168.23	BSS / BSH / OSH																				
FTB-27	837.35	57.62	S & G																				
FTB-28	841.03	57.20	S & G																				
FTB-29	998.59	47.35	BSS																				
FTB-30	985.78	40.41	BSS																				
FTB-31	845.42	53.93	S & G																				
FTB-32	833.56	40.62	S & G																				

[1] *UC = Unconsolidated; S&G = Sand and Gravel; BSS = Berea Sandstone; BSH = Bedford Shale; OSH = Ohio Shale*

TABLE 5-1
GROUND-WATER LEVEL DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well	Measuring Point Elevation (ft., MSL)	Well Depth (ft.TOC)	Monitored Unit [1]	9/10/99 Depth To Water (ft., TOC)	9/10/99 Ground Water Elevation (ft., MSL)	9/17/99 Depth To Water (ft., TOC)	9/17/99 Ground Water Elevation (ft., MSL)	9/24/99 Depth To Water (ft., TOC)	9/24/99 Ground Water Elevation (ft., MSL)	10/2/99 Depth To Water (ft., TOC)	10/2/99 Ground Water Elevation (ft., MSL)	10/8/99 Depth To Water (ft., TOC)	10/8/99 Ground Water Elevation (ft., MSL)	10/15/99 Depth To Water (ft., TOC)	10/15/99 Ground Water Elevation (ft., MSL)	10/22/99 Depth To Water (ft., TOC)	10/22/99 Ground Water Elevation (ft., MSL)	10/29/99 Depth To Water (ft., TOC)	10/29/99 Ground Water Elevation (ft., MSL)	11/05/99 Depth To Water (ft., TOC)	11/05/99 Ground Water Elevation (ft., MSL)	11/18/99 Depth To Water (ft., TOC)	11/18/99 Ground Water Elevation (ft., MSL)
AOC-1	979.05	49.68	BSS	17.80	961.25	18.10	960.95	16.40	962.65	18.90	960.15	18.90	960.15	19.10	959.95			19.60	959.45	20.10	958.95	20.00	959.05
AOC-2	963.96	68.08	UC / BSH	7.20	956.76	7.30	956.66	7.30	956.66	7.40	956.56	7.50	956.46	7.40	956.56	7.50	956.46	7.60	956.36	7.60	956.36	7.50	956.46
AOC-3	996.20	49.79	BSS	12.90	983.30	16.70	979.50	16.50	979.70	17.40	978.80	17.10	979.10	17.60	978.60	17.40	978.80	17.40	978.80	17.90	978.30	17.30	978.90
AOC-4	1000.03	49.85	BSS	14.80	985.23	16.30	983.73	16.70	983.33	16.10	983.93	16.40	983.63	17.10	982.93	17.00	983.03	17.40	982.63	17.40	982.63	17.70	982.33
ATB-1OW	824.38	41.00	OSH	28.00	796.38	23.60	800.78	20.30	804.08	17.40	806.98	16.10	808.28	14.50	809.88	13.40	810.98	12.70	811.68	11.90	812.48	11.00	813.38
ATB-1R	824.18	42.00	OSH	10.00	814.18	10.10	814.08	10.10	814.08	10.00	814.18	10.10	814.08	10.00	814.18	10.00	814.18	10.20	813.98	10.00	814.18	10.10	814.08
ATB-2	823.38	53.15	OSH													6.60	816.78	6.30	817.08			5.70	817.68
ATB-3	979.00	189.83	OSH	149.50	829.50	149.50	829.50	149.50	829.50	151.30	827.70	188.10	790.90	187.70	791.30	184.08	794.92	187.00	792.00	186.50	792.50	185.10	793.90
ATB3-E1	981.65	51.95	BSS													21.70	959.95	21.70	959.95	21.80	959.85	21.60	960.05
ATB3-W1	980.28	52.26	BSS / BSH													20.80	959.48	20.40	959.88	21.50	958.78	21.70	958.58
ATB-4	963.81	184.23	BSH / OSH	6.50	957.31	6.70	957.11	7.00	956.81	6.70	957.11	7.10	956.71	7.40	956.41	5.50	958.31	7.60	956.21	7.20	956.61	7.60	956.21
ATB-4R	964.24	184.29	BSH / OSH													14.00	950.24						
ATB-5	996.08	199.62	BSH / OSH	171.40	824.68	171.40	824.68	171.50	824.58	171.50	824.58	171.30	824.78	171.20	824.88	171.20	824.88	171.30	824.78	171.60	824.48	171.20	824.88
ATB-6	999.83	199.43	OSH	169.10	830.73	167.30	832.53	168.70	831.13	168.70	831.13	168.80	831.03	167.10	832.73	165.60	834.23	164.80	835.03	162.90	836.93	166.00	833.83
ATB6-E1	1002.20	51.95	BSS													18.20	984.00	19.50	982.70	19.50	982.70	19.80	982.40
ATB6-NE1	1001.32	52.12	BSS / BSH													18.30	983.02	18.70	982.62	18.60	982.72	19.00	982.32
ATB6-NE2	999.98		BSS / BSH													16.90	983.08	17.30	982.68	16.80	983.18	17.50	982.48
ATB-7	977.38	174.76	OSH	148.40	828.98	150.80	826.58	149.80	827.58	150.80	826.58	150.10	827.28	151.30	826.08	151.10	826.28	151.30	826.08	150.90	826.48	156.40	820.98
ATB-8	929.55	140.00	BSH / OSH	4.10	925.45	4.40	925.15	4.00	925.55	4.10	925.45	4.40	925.15	4.20	925.35	4.00	925.55	5.00	924.55	5.00	924.55	4.90	924.65
BTB-3	962.29	174.70	OSH									12.80	949.49			7.60	954.69	5.40	956.89	12.70	949.59	0.80	961.49
BTB-5	982.79	59.74	BSS																			14.20	968.59
BTB-6	990.53	61.03	BSS																			9.20	981.33
CTB-1	991.42	188.34	BSH / OSH																				
CTB-1H	991.75	48.25	BSS																				
CTB-3	977.26	48.56	BSS																				
CTB-4	974.42	94.89	S & G																				
DTB-3	980.53	42.16	S & G																				
FTB-2	845.23	55.40	S & G / OSH																				
FTB-4	861.56	70.00	S & G / OSH																				
FTB-15	916.16	121.16	BSH / OSH																				
FTB-16	841.81	54.51	OSH																				
FTB-17	989.05	187.62	BSS / BSH / OSH																				
FTB-19	974.75	167.84	BSH / OSH																				
FTB-20	996.76	189.00	BSH / OSH																				
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FTB-25	988.53	168.23	BSS / BSH / OSH																				
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FTB-29	998.59	47.35	BSS																				
FTB-30	985.78	40.41	BSS																				
FTB-31	845.42	53.93	S & G																				
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[1] *UC = Unconsolidated; S&G = Sand and Gravel; BSS = Berea Sandstone; BSH = Bedford Shale; OSH = Ohio Shale*

TABLE 5-1
GROUND-WATER LEVEL DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well	Measuring Point Elevation (ft., MSL)	Well Depth (ft.TOC)	Monitored [1] Unit	12/2/99		12/17/99		1/19/00		3/6/00		6/9/00		6/26/00		9/28/00		11/29/00		2/02/01		3/20/01	
				Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)
AOC-1	979.05	49.68	BSS	20.6	958.45	20.3	958.75	19.5	959.55	14.7	964.35	11.3	967.75	13.3	965.75	15.2	963.85	12.0	967.05	8.9	970.15		
AOC-2	963.96	68.08	UC / BSH	8.1	955.86	7.9	956.06	6.4	957.56	4.5	959.46	1.7	962.26	3.7	960.26					4.7	959.26		
AOC-3	996.20	49.79	BSS	17.9	978.30	14.3	981.90	9.2	987.00	5	991.20	3.6	992.60	5.2	991.00	8.6	987.60	6.9	989.30	2.9	993.30		
AOC-4	1000.03	49.85	BSS	18.1	981.93	17.4	982.63	14.6	985.43	8	992.03	6.7	993.33	7.9	992.13	12	988.03	7.9	992.13	5.9	994.13		
ATB-1OW	824.38	41.00	OSH	10.5	813.88	10	814.38	8.9	815.48	9	815.38	7.4	816.98	7.9	816.48	9	815.38	8.6	815.78	8.6	815.78		
ATB-1R	824.18	42.00	OSH	10.1	814.08	10	814.18	9.9	814.28	9.5	814.68	8.3	815.88	8.8	815.38	9.5	814.68	9.4	814.78	9.1	815.08		
ATB-2	823.38	53.15	OSH	5.8	817.58	29	794.38	18.8	804.58	13.9	809.48	9.5	813.88	9.1	814.28	8.6	814.78			7.1	816.28		
ATB-3	979.00	189.83	OSH	185	794.00	183.5	795.50	182	797.00	178.5	800.50	174.9	804.10	174.6	804.40	170.7	808.30	166.3	812.70	162.1	816.90		
ATB3-E1	981.65	51.95	BSS	22	959.65	21.8	959.85	20.5	961.15	15.3	966.35	12.4	969.25	14.1	967.55			15.9	965.75			10.76	970.89
ATB3-W1	980.28	52.26	BSS / BSH	21.9	958.38	21.8	958.48	21.5	958.78	17.1	963.18	14.6	965.68	16.7	963.58	18.7	961.58			12.8	967.48		
ATB-4	963.81	184.23	BSH / OSH	8	955.81	7.7	956.11	6.5	957.31	5	958.81	1.7	962.11	3.7	960.11	5.4	958.41	5.5	958.31	3.0	960.81		
ATB-4R	964.24	184.29	BSH / OSH	1	963.24	11.2	953.04	4.2	960.04	1.6	962.64	1.2	963.04			5.5	958.74	1.8	962.44	3.5	960.74		
ATB-5	996.08	199.62	BSH / OSH	171.2	824.88	172.2	823.88	171.5	824.58	161	835.08	157.8	838.28	157.1	838.98	156.3	839.78	152.9	843.18	140.2	855.88		
ATB-6	999.83	199.43	OSH	157.7	842.13	155.3	844.53	149.5	850.33	137.8	862.03	89.4	910.43	84.4	915.43	66.6	933.23	53.4	946.43	38	961.83		
ATB6-E1	1002.20	51.95	BSS	20.2	982.00	19.9	982.30	16.7	985.50	9.9	992.30	8.7	993.50	9.9	992.30	13.6	988.60	8.5	993.70	6.7	995.50		
ATB6-NE1	1001.32	52.12	BSS / BSH	19.5	981.82	19.1	982.22	15.6	985.72	9.4	991.92	8.3	993.02	9.4	991.92	12.7	988.62	9.9	991.42				
ATB6-NE2	999.98		BSS / BSH	17.8	982.18	16	983.98	11.4	988.58	6.9	993.08	6.3	993.68	8.1	991.88	8.9	991.08	6.2	993.78	4.6	995.38		
ATB-7	977.38	174.76	OSH	149	828.38	150	827.38	153.6	823.78	154	823.38	154.3	823.08	153.3	824.08	174	803.38	153	824.38	151.5	825.88		
ATB-8	929.55	140.00	BSH / OSH	4.5	925.05	4.8	924.75	4.7	924.85	4.7	924.85	4.3	925.25	4.2	925.35	4.8	924.75	4.4	925.15	4.6	924.95		
BTB-3	962.29	174.70	OSH	0.8	961.49	0	962.29	0	962.29	3.8	958.49	6.6	955.69	30.8	931.49	4.2	958.09	7.8	954.49	2.5	959.79		
BTB-5	982.79	59.74	BSS	14.5	968.29	14.3	968.49	9.9	972.89	6.5	976.29	5.2	977.59	7	975.79	9.1	973.69	6.9	975.89	3.9	978.89		
BTB-6	990.53	61.03	BSS	9.4	981.13	9.4	981.13			2.6	987.93	1.5	989.03	1.8	988.73	4.5	986.03	1.5	989.03				
CTB-1	991.42	188.34	BSH / OSH													9.9	981.52	9.4	982.02	5.6	985.82		
CTB-1H	991.75	48.25	BSS																			15.9	975.85
CTB-3	977.26	48.56	BSS																			6.82	970.44
CTB-4	974.42	94.89	S & G													5.2	969.22	4.4	970.02				
DTB-3	980.53	42.16	S & G																			11.82	968.71
FTB-2	845.23	55.40	S & G / OSH																				
FTB-4	861.56	70.00	S & G / OSH																				
FTB-15	916.16	121.16	BSH / OSH																				
FTB-16	841.81	54.51	OSH																				
FTB-17	989.05	187.62	BSS / BSH / OSH																				
FTB-19	974.75	167.84	BSH / OSH																				
FTB-20	996.76	189.00	BSH / OSH																				
FTB-23	987.21	173.21	BSH / OSH																				
FTB-25	988.53	168.23	BSS / BSH / OSH																				
FTB-27	837.35	57.62	S & G																				
FTB-28	841.03	57.20	S & G																				
FTB-29	998.59	47.35	BSS																				
FTB-30	985.78	40.41	BSS																				
FTB-31	845.42	53.93	S & G																				
FTB-32	833.56	40.62	S & G																				

[1] *UC = Unconsolidated; S&G = Sand and Gravel; BSS = Berea Sandstone; BSH = Bedford Shale; OSH = Ohio Shale*

TABLE 5-1
GROUND-WATER LEVEL DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well	Measuring Point Elevation (ft., MSL)	Well Depth (ft.TOC)	Monitored [1] Unit	6/07/01		4/6/02		5/14/02		6/3/02		7/2/02		8/6/02		9/11/02		12/16/02	
				Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)	Depth To Water (ft., TOC)	Ground Water Elevation (ft., MSL)
AOC-1	979.05	49.68	BSS	7.0	972.05			6.9	972.15	8.5	970.55	12.1	966.95	14.5	964.55	16.5	962.55	13.4	965.65
AOC-2	963.96	68.08	UC / BSH	2.1	961.86	3.4	960.56			3.1	960.86	7.0	956.96	8.6	955.36	10.0	953.96	8.8	955.16
AOC-3	996.20	49.79	BSS	1.9	994.30	4.0	992.20			3.8	992.40	7.0	989.20	8.3	987.90	10.5	985.70	8.1	988.10
AOC-4	1000.03	49.85	BSS	4.6	995.43	5.4	994.63			5.1	994.93	7.3	992.73	9.4	990.63	12.0	988.03	9.7	990.33
ATB-1OW	824.38	41.00	OSH	6.8	817.58	7.5	816.88			7.2	817.18	7.8	816.58	8.5	815.88	8.8	815.58		
ATB-1R	824.18	42.00	OSH	6.6	817.58	8.7	815.48			8.3	815.88	9.1	815.08	9.8	814.38	10.1	814.08		
ATB-2	823.38	53.15	OSH	6.4	816.98			5.9	817.48	6.0	817.38	6.4	816.98	6.5	816.88	6.6	816.78	6.1	817.28
ATB-3	979.00	189.83	OSH	161.8	817.20			104.8	874.20	101.8	877.20	98.1	880.90	90.2	888.80	88.9	890.10	73.6	905.40
ATB3-E1	981.65	51.95	BSS							9.3	972.35	13.4	968.25	16.0	965.65	18.5	963.15	15.3	966.35
ATB3-W1	980.28	52.26	BSS / BSH	10.5	969.78	12.5	967.78			12.5	967.78	15.8	964.48	17.9	962.38	19.7	960.58	16.4	960.58
ATB-4	963.81	184.23	BSH / OSH	0.0	963.81	1.8	962.01			2.2	961.61	4.8	959.01	5.8	958.01	7.3	956.51	5.3	958.51
ATB-4R	964.24	184.29	BSH / OSH	0.0	964.24	1.6	962.64			1.6	962.64	1.9	962.34	1.9	962.34	1.6	962.64	7.9	956.34
ATB-5	996.08	199.62	BSH / OSH	105.4	890.68	75.2	920.88			62.3	933.78	60.9	935.18	61.0	935.08	61.0	935.08	60.9	935.18
ATB-6	999.83	199.43	OSH	0.0	999.83	0.0	999.83			0.0	999.83	0.9	998.93	1.6	998.23	2.2	997.63	4.7	995.13
ATB6-E1	1002.20	51.95	BSS	5.6	996.60	7.3	994.90			7.2	995.00	8.7	993.50	11.4	990.80	15.1	987.10	8.3	993.90
ATB6-NE1	1001.32	52.12	BSS / BSH	5.7	995.62	7.9	993.42			6.7	994.62	8.6	992.72	11.3	990.02	13.8	987.52	11.8	989.52
ATB6-NE2	999.98		BSS / BSH	3.6	996.38	5.6	994.38			5.2	994.78	8.1	991.88	10.2	989.78	12.7	987.28	5.8	994.18
ATB-7	977.38	174.76	OSH	144.0	833.38	106.0	871.38			144.0	833.38	141.7	835.68	142.7	834.68	141.9	835.48	144.3	833.08
ATB-8	929.55	140.00	BSH / OSH	4.0	925.55	4.1	925.45			4.3	925.25	4.3	925.25	4.6	924.95	4.7	924.85	4.6	924.95
BTB-3	962.29	174.70	OSH	22.5	939.79	0.0	962.29			0.8	961.49	0.4	961.89	0.5	961.79	0.0	962.29	1.3	960.99
BTB-5	982.79	59.74	BSS	3.8	978.99	4.7	978.09			4.3	978.49	8.0	974.79	10.0	972.79	13.0	969.79	7.8	974.99
BTB-6	990.53	61.03	BSS	0.0	990.53	0.0	990.53			0.0	990.53	2.4	988.13	4.0	986.53	6.3	984.23	3.0	987.53
CTB-1	991.42	188.34	BSH / OSH	3.9	987.52	4.1	987.32			3.9	987.52	4.1	987.32	4.5	986.92	4.7	986.72	5.2	986.22
CTB-1H	991.75	48.25	BSS							--		--		--		--	--	--	--
CTB-3	977.26	48.56	BSS							--		--		--		--	--	--	--
CTB-4	974.42	94.89	S & G	2.1	972.32	3.3	971.12			2.9	971.52	4.6	969.82	5.3	969.12	6.8	967.62	3.9	970.52
DTB-3	980.53	42.16	S & G							10.9	969.63	12.1	968.43	13.0	967.53	13.9	966.63	13.2	967.33
FTB-2	845.23	55.40	S & G / OSH					22.9	822.33	23.2	822.03	25.7	819.53	25.2	820.03	27.9	817.33	25.9	819.33
FTB-4	861.56	70.00	S & G / OSH					7.8	853.76	8.1	853.46	9.3	852.26	10.6	850.96	11.4	850.16	9.9	851.66
FTB-15	916.16	121.16	BSH / OSH					20.0	896.16	19.7	896.46	20.5	895.66	22.0	894.16	22.7	893.46	21.0	895.16
FTB-16	841.81	54.51	OSH					7.5	834.31	7.6	834.21	7.8	834.01	7.7	834.11	7.8	834.01	8.6	833.21
FTB-17	989.05	187.62	BSS / BSH / OSH					7.9	981.15	7.9	981.15	10.3	978.75	13.2	975.85	15.1	973.95		
FTB-19	974.75	167.84	BSH / OSH					8.4	966.35	9.3	965.45	11.1	963.65	11.8	962.95	13.0	961.75	10.0	964.75
FTB-20	996.76	189.00	BSH / OSH					16.9	979.86	15.2	981.56	15.5	981.26	17.1	979.66	20.2	976.56	16.6	980.16
FTB-23	987.21	173.21	BSH / OSH					16.7	970.51	16.6	970.61	16.4	970.81	16.5	970.71	16.8	970.41	17.3	969.91
FTB-25	988.53	168.23	BSS / BSH / OSH					5.4	983.13	4.7	983.83	6.8	981.73	9.4	979.13	11.2	977.33	7.2	981.33
FTB-27	837.35	57.62	S & G					18.3	819.05	18.9	818.45	20.1	817.25	--		--	--	--	--
FTB-28	841.03	57.20	S & G					22.2	818.83	22.6	818.43	--		24.9	816.13	--	--	--	--
FTB-29	998.59	47.35	BSS					9.0	989.59	9.7	988.89	12.9	985.69	15.1	983.49	17.2	981.39	13.3	985.29
FTB-30	985.78	40.41	BSS					3.6	982.18	4.5	981.28	6.7	979.08	8.3	977.48	10.1	975.68	6.8	978.98
FTB-31	845.42	53.93	S & G													29.5	815.92	28.0	817.42
FTB-32	833.56	40.62	S & G													16.9	816.66	15.6	817.96

-- = transducer in well

[1] UC = Unconsolidated; S&G = Sand and Gravel; BSS = Berea Sandstone; BSH = Bedford Shale; OSH = Ohio Shale

6.0 GROUND-WATER QUALITY DATA

Ground-water sampling was conducted for characterization parameters for wells AOC-1, ATB-3, and ATB-4R in 1999. The wells were purged a total of three well volumes or until dry prior to collecting a sample. The parameters pH, specific conductance, and turbidity were measured in the field while the parameters calcium, iron, magnesium, manganese, potassium, sodium, alkalinity, chloride, and total dissolved solids (TDS) were submitted to the DLZ Laboratories, Inc. for analysis. Appendix B contains the results of the field and laboratory analyses. Table 6-1 is a summary of water-quality results for wells AOC-1, ATB-3, and ATB-4R.

Well AOC-1 is completed in the Berea Sandstone. Based on the analyses conducted for this well, the water is classified as a calcium-bicarbonate type water as shown on the Piper trilinear diagram included in Appendix B. Many of the residential wells within the project area are completed in the Berea Sandstone and the water quality in those wells is expected to be similar to that of well AOC-1.

Well ATB-3 is completed in the Ohio Shale and well ATB-4R is completed in the Bedford Shale/Ohio Shale. As shown on the Piper diagram, the water quality for these wells is classified as a sodium-chloride type water and is characterized by a high TDS content. Results for TDS for well ATB-3 were reported at 7,440 mg/ℓ and at 28,000 mg/ℓ for well ATB-4R. The U.S. Geological Survey has a classification system based on the dissolved solids content of a sample. Based on this system, the water quality from well ATB-3 is classified as moderately saline and the water from well ATB-4R is classified as very saline.

In addition to the inorganic parameters analyzed, samples for BTEX (benzene, toluene, ethylbenzene, xylenes) organic compounds were analyzed. The result of analyses for these parameters were all reported below the applicable Maximum Contaminant Levels (MCLs) as established by the U.S. Environmental Protection Agency except for benzene at well ATB-3. The MCL for benzene is 5.0 µg/ℓ and the result for benzene at well ATB-3 was reported at 16.2 µg/ℓ.

Any water collected for discharge as a result of tunneling /excavating in the Ohio Shale should be analyzed for characterization parameters to determine the discharge or disposal requirements. Although the volume of water coming from the Ohio Shale may be low, the water may contain volatile organic compounds (VOCs) above the applicable MCL. Considering the potential VOC content and high TDS content, appropriate measures should be taken for disposal of this water.

TABLE 6-1. WATER-QUALITY DATA
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Parameters	Units	Well AOC-1	Well ATB-3	Well ATB-4R
Inorganic Compounds				
Alkalinity	mg/ℓ	300	130	270
Calcium	mg/ℓ	85.5	155	1600
Chloride	mg/ℓ	18	4,620	17,000
Iron	µg/ℓ	<60.0	13,700	19,600
Magnesium	mg/ℓ	27.6	43.6	452
Manganese	µg/ℓ	182	317	211
Potassium	mg/ℓ	2.24	22.9	52.3
Sodium	mg/ℓ	17.2	1,990	5,500
Sulfate	mg/ℓ	69	74	<1
TDS	mg/ℓ	431	7,440	28,000
Organic Compounds				
Benzene	µg/ℓ	<0.5	16.2	1.2
Toluene	µg/ℓ	<0.5	3.8	1.0
Ethylbenzene	µg/ℓ	<0.5	1.3	<0.5
Xylenes	µg/ℓ	<1.0	2.8	<1.0
Field Data				
pH	SU	6.70	6.17	6.61
Specific Conductance	µmhos/cm	748	8,840	19,000
Turbidity	NTU	3.28	>1,000	>1,000
Temperature	°C	13.3	13.6	--

7.0 GROUND-WATER FLOW MODEL RESULTS

A finite difference, three-dimensional numerical ground-water flow model was used to evaluate potential impacts and inflows as a result of open trench construction through the Berea Sandstone along various alignments considered during the preliminary design analysis. These results were presented in Appendix 1.3.4-1 and 1.3.4-3 of the Final Design Report, but are not included here as these methods and alignments were eliminated from consideration.

This section presents the results of an analysis of the hydrogeologic effects caused by the construction of a sewer tunnel through the Ohio Shale. A two-dimensional cross-section model was used to assess ground-water inflow rates into the tunnel and the potential for residential well impacts during tunnel construction. Ground-water inflow rates were quantified in the model and expected ranges are presented. No impacts are expected in residential wells developed in the Berea Sandstone as a result of tunneling in the Ohio Shale. The only wells that might be affected, are sand and gravel wells in the vicinity of Central College Road, which potentially could be hydraulically connected to fractured zones in the underlying shale. Such impacts were not quantified due to the lack of pumping test and other hydraulic data for wells completed in the glacial deposits of the buried valley aquifer. However, general conclusions about the extent of residential well impacts are inferred from the model results.

7.1 Model Design

For this analysis, the tunnel profile is assumed to cut through shale about 110 feet below the Bedford Shale/Berea Sandstone contact. The proposed tunnel alignment will require boring through the Ohio Shale where the Ohio/Bedford Shale sequence is overlain by the Berea Sandstone, as well as boring through areas where the shale is overlain by glacial deposits present in the buried bedrock valleys. The shale underlying the Berea Sandstone consists of tight, unfractured shale which has a very low hydraulic conductivity. Values of hydraulic conductivity reported from packer tests performed in the Ohio Shale ranged from 2.8×10^{-3} to 2.8×10^{-5} ft/d (10^{-6} to 10^{-8} cm/s). Some of the packer test results recorded no water intake into the formation which means permeabilities in some

parts of the Ohio Shale could be lower than the reported 2.8 x 10^{-8} ft/d (10^{-8} cm/sec). The shale sequence present beneath the buried bedrock valleys located near Central College Road and Walnut Street is thought to contain fracture zones which increase permeability of the shale in these areas. Two slug tests were performed on well ATB-4, which is screened in the Ohio Shale beneath the buried valley near Central College Road. This area coincides with the head of a small tributary valley to Big Walnut Creek. This east-west trending linear valley segment is believed to be fracture controlled topography. These slug tests yielded a hydraulic conductivity of 0.1 ft/d (3.5 x 10^{-5} cm/s). This indicates that the shale beneath the buried valleys is more permeable than the shale beneath the upland areas of the alignment.

Two cross-section models designated as Scenario 1 and Scenario 2 were designed to simulate ground-water flow during tunnel construction through the two different geologic settings. The conceptual diagrams of the two model designs are shown in Figures 7-1 and 7-2. The highest values of hydraulic conductivities resulting from the packer and slug tests were input into the cross-section models to enable the model to produce conservative estimates of inflow rates and drawdown resulting from tunnel construction. The remaining model input values are also shown in Figures 7-1 and 7-2 and are similar to the values used in the three-dimensional model simulation of open cut trench excavation and dewatering.

The basic assumptions for both models include two-dimensional flow, flow in from precipitation recharge, and flow out to Hoover Reservoir, Big Walnut Creek, Rocky Fork Creek, and the proposed tunnel. The model for Scenario 1 was designed to simulate tunneling through the unweathered and unfractured shale beneath the upland area between the topographic and buried valleys. The model for Scenario 2 was designed to simulate tunneling in the fractured shale that may be encountered beneath the valley areas near Central College Road. Since almost no hydrogeologic data exists for area in the buried valleys, the model was designed to be conservative and therefore yield maximum values for tunnel inflow rates and drawdowns. The conservative design for the Scenario 2 model included providing a direct connection between the glacial deposits and fractured shale (no clay layers separating the two zones), giving the shale the permeability of the fracture zone

(as measured from the slug tests on ATB-4), and giving the glacial deposits an average hydraulic conductivity reflecting sand, gravel, and clay instead of separating them into discreet zones.

The two models were set up to simulate steady-state conditions in order to produce a static potentiometric surface against which the affects of tunnel construction could be measured. When the models produced static potentiometric surfaces similar to those observed in the field, the models were considered to be calibrated. A constant head node was placed at the proposed elevation of the tunnel which allowed the model to simulate water flowing into the tunnel. Transient simulations were then used to assess the effects of tunneling on the ground-water flow system. Time steps of 1, 7, 30, 60, 180, and 365 days were used in the transient simulations to assess the effects of the open tunnel over time. Resulting ground-water elevations and tunnel inflow rates were recorded for each time step.

7.2 Model Results

Table 7-1 shows the resulting tunnel inflow rates from both models for different time periods. The results from Scenario 1 represent the maximum effects to be expected for tunneling through the shale beneath the Berea Sandstone in the upland areas. Results from simulations using lower values of hydraulic conductivity of 2.8×10^{-4} ft/d to 2.8×10^{-6} ft/d (10^{-7} to 10^{-9} cm/s) revealed no significant inflow or drawdown from tunnel construction. The upper limit of hydraulic conductivity values (10^{-6} cm/s) for the shale in this area were used in Scenario 1 and therefore show the maximum inflows to be expected. The results reveal that maximum flow into the tunnel occurs within the first day that rock with this corresponding permeability is encountered. Tunnel inflow rates decrease over time because hydraulic head over the tunnel decreases with time as the flow system approaches steady-state. Resulting inflows from the unfractured shale range from 75 gpd / 100 ft (gallons per day per 100 feet of tunnel) to 230 gpd / 100 ft. The maximum of 230 gpd / 100 ft would be equal to 8.5 gpm / mile (gallons per minute per one mile of tunnel). The results of Scenario 1 also indicate that water levels in the Berea Sandstone would be unaffected by tunnel construction in the Ohio Shale. However, water levels in the Berea Sandstone could be affected if shaft construction fails to cut off water inflow.

Results from Scenario 2a and 2b are based on the model simulating tunnel construction in the shale beneath the buried bedrock valley south of Central College Road between Station 87+00 and 93+00 and north of Central College Road between Station 100+00 and 108+00 (see Plate 1). In Scenario 2a the Ohio Shale was simulated with a horizontal hydraulic conductivity of 0.1 ft/d (3.5 x 10^{-5} cm/sec) and a vertical hydraulic conductivity of 0.01 ft/d (3.5 x 10^{-6} cm/sec). Scenario 2b uses the same horizontal hydraulic conductivity as Scenario 2a, but uses an increased vertical hydraulic conductivity of 0.1 ft/d to estimate what would be considered as the maximum inflows which would be expected in this geologic setting. The Scenario 2a simulation predicted inflow rates from the fractured shale to be in the range of 12 gpm / 100 ft (gallons per minute per 100 feet of tunnel) to 3 gpm / 100 ft. Again, the maximum inflow occurs during the first day and decreases with time as the flow system approaches steady-state conditions. The Scenario 2b simulation predicted inflow rates for the fractured shale to be in the range of 34 gpm / 100 ft to 4 gpm / 100 ft. It should be noted that in this simulation a large decrease in tunnel inflow occurs from day 1 to day 7. This essentially means that tunnel inflows have the potential to be relatively large when the boring machine encounters the fracture zone, but inflows will decrease significantly with time. It should be noted that the conditions represented by this simulation would not be expected to be more than a few hundred feet wide, i.e., fractured zone beneath the valley. Therefore, inflows for Scenarios 2a and 2b shown on Table 1 represent only a small part of the total tunnel length.

Results from Scenario 2a show that ground-water levels in the glacial deposits of the buried valley would decrease by no more than 12 feet in a period of 1 year. Results from Scenario 2b show a greater change in water levels within the buried valley. Scenario 2b predicts a maximum drawdown of 30 feet in 2 months and a maximum drawdown of 50 feet in 6 months. The maximum drawdown for these scenarios is substantial, but is limited to an area within 200 feet of the tunnel. Predicted drawdowns are greatest in the area directly over the tunnel and reduce rapidly at distance with drawdowns of no greater than 10 feet predicted for areas more than 1,000 feet away from the tunnel. This is assuming that water is able to drain into the tunnel for this entire period of time. Again, it should be noted that the model represents a fractured zone 100 feet wide that crosses the tunnel alignment is an east-west direction. Potential impact on ground-water levels in residential wells is essentially limited to areas directly above the fractured zones to the east and west of the

tunnel. As a practical matter, wells west of the tunnel are bedrock wells adjacent to the topographic valley and are not connected to the fractured zones represented by the model. Only a few sand and gravel wells in the vicinity of Central College Road would potentially be impacted by the conditions simulated by the model.

The model simulations predict that small amounts of water will be encountered while tunneling through the unfractured Ohio Shale that underlies the Berea Sandstone. The model also predicted no significant drawdown for wells completed in the Berea Sandstone and therefore no well impacts would be expected as a result of tunneling beneath the Berea Sandstone. Tunneling through the fractured shale beneath the buried valley could potentially produce larger tunnel inflows, but these inflows should reduce significantly over time. Tunneling in this area could possibly lower water levels in wells completed in the sand and gravel deposits within the buried valley, but would only affect wells within 1,000 feet of the tunnel operation that are in direct hydraulic connection with the fractured shale. Model results for tunneling beneath the buried valley are conservative and are believed to represent worst-case scenarios. It is believed that the glacial geology within the buried valley is much more complicated than shown in the simple cross section model and likely to contain a large percentage of glacial till deposits which would isolate sand and gravel lenses from the fractured shale below. If this is the case, the tunnel inflow rates and water-level drawdown would be significantly less than the estimates provided herein.

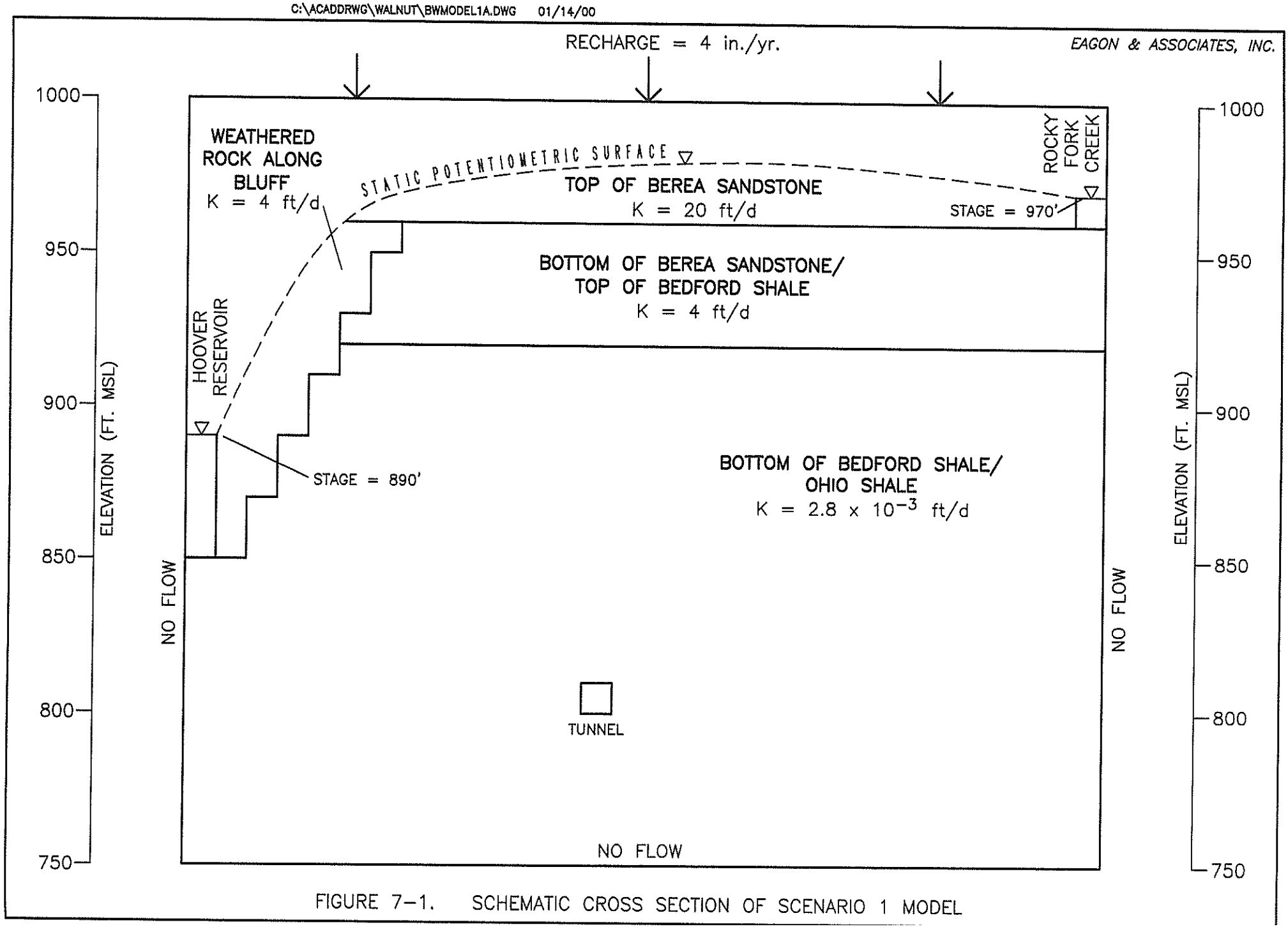


FIGURE 7–1. SCHEMATIC CROSS SECTION OF SCENARIO 1 MODEL

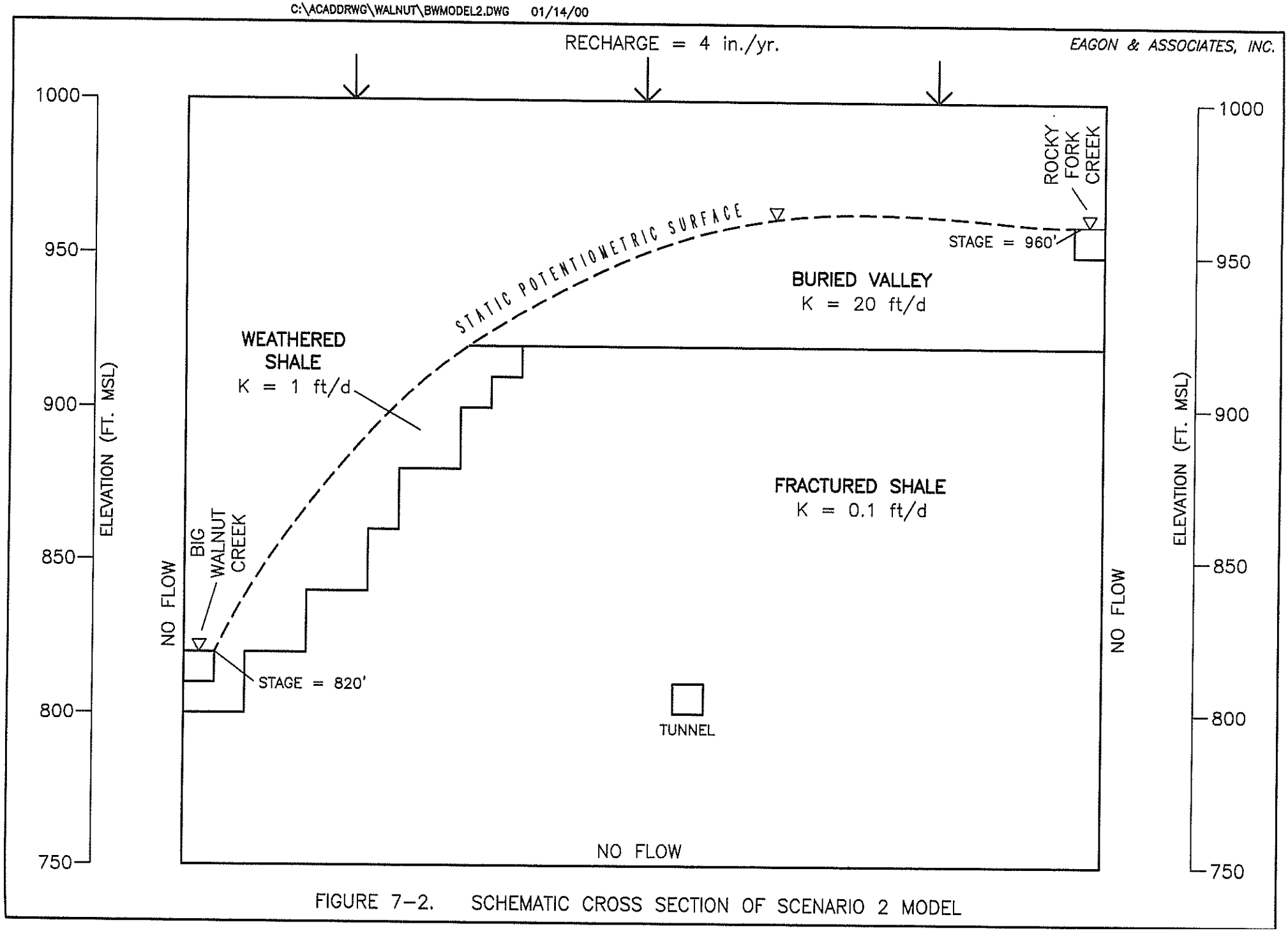


FIGURE 7–2. SCHEMATIC CROSS SECTION OF SCENARIO 2 MODEL

TABLE 7-1. TUNNEL INFLOW RATES
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Model Simulations	Time	Inflow Rate (per 100 ft. of tunnel)
Scenario 1	1 day	230 gpd
(Unfractured Shale)	1 week	217 gpd
($k = 10^{-6}$ cm/sec)	1 month	180 gpd
	2 months	150 gpd
	6 months	93 gpd
	1 year	75 gpd
Scenario 2a	1 day	12 gpm
(Fractured Shale)	1 week	7 gpm
($k_h = 3.5 \times 10^{-5}$ cm/sec)	1 month	5 gpm
($k_v = 3.5 \times 10^{-6}$ cm/sec)	2 months	4 gpm
	6 months	3.5 gpm
	1 year	3 gpm
Scenario 2b	1 day	34 gpm
(Fractured Shale)	1 week	16 gpm
($k_h = 3.5 \times 10^{-5}$ cm/sec)	1 month	13 gpm
($k_v = 3.5 \times 10^{-5}$ cm/sec)	2 months	12 gpm
	6 months	5 gpm
	1 year	4 gpm

8

8.0 GROUND-WATER CONSIDERATIONS FOR CONSTRUCTION

8.1 Soft Ground Tunneling (Station 0+00 to Shaft 1)

Hydrogeologic conditions encountered between Station 0+00 (Outfall Shaft) and Shaft 1 are likely to make construction dewatering for the tunnel in this area extremely difficult. Moreover, failure to adequately dewater the sand would result in loose sand flowing into the excavation. Consequently, the ability or inability to effectively dewater this area should be carefully considered in the selection of construction methods and alternatives. The following discussion describes the factors that must be considered in order to evaluate the feasibility of dewatering this area.

Ten test holes were drilled in this area to define the lithology of the unconsolidated deposits and two pumping tests were conducted to determine the hydraulic characteristics of the water bearing materials. The results of these pumping tests are described in Section 4.4. Figure 4-24 is a map showing the locations of test borings and pumping test wells, and Figure 4-25 is a profile view of the area showing graphic logs. Analysis of the information reveals the following:

- Materials within the tunnel interval consist of sands, gravel, cobbles, boulders, silty clays, and clayey gravel.

- Pumping tests reveal that the transmissivity of the water bearing formation is about 50,000 gpd/ft and the storativity is 0.01.

- Although the overall transmissivity is relatively high, there are some cohesive layers and silty/clayey gravel zones (silt/clay percentages of more than 25 percent) that have much lower hydraulic conductivity within the screened interval for dewatering wells.

- The saturated interval between the sewer invert and the relatively impermeable shale bedrock varies from about 9 feet to as little as 5 feet in thickness.

- The pumping tests indicate that the tunnel construction interval is hydraulically connected to the alluvial sands associated with Big Walnut Creek.

- Ambient ground-water levels in the construction area are in the range of elevation 816 to 820 feet MSL, or about 17 to 21 feet above sewer invert elevation.

- During periods of potential flooding, it is anticipated that ground-water levels might increase by another 5 feet in elevation.

One of the most important factors to consider in evaluating dewatering feasibility is the limited available drawdown (freeboard) between the sewer invert and the shale bedrock. For example, lowering water levels two feet below the sewer invert would leave only three feet of screen saturated for operating dewatering wells at FTB-32 near the Outfall Shaft (see Figure 4-25). In addition, where the saturated thickness between the invert and the shale bedrock is greater, there are places where part of that interval is less productive which will reduce the effectiveness of the screened interval of dewatering wells. The probable result will be that vertical dewatering wells will not be as productive as needed to achieve the desired drawdown. Even if wells are constructed with sumps drilled into the shale to accommodate pump intakes at or below the base of unconsolidated deposits, and even if stringent QA/QC measures are taken to ensure well screens and gravel pack placed at the base of the water bearing formation are of optimum size and condition, required well yields may be difficult or impossible to achieve.

Conditions at the surface also affect the practicality of installing and operating an effective dewatering system. Buried utilities and space limitations along Cambria Way limit the ability to place vertical dewatering wells in optimum locations. Moreover, some flexibility in placement of wells will be required to compensate for locations where the desired well yield cannot be achieved due to conditions already described. Replacing wells or adding more wells than planned would further compound the space limitations. Use of horizontal wells, at least in part, might be considered as a viable alternative. However, space limitations are also a significant consideration as entry and

exit drilling locations are significantly uphill from Shaft 1 and/or on the golf course property west of the Outfall Shaft due to the angles required to directional drill from the required elevation.

8.1.1 Preliminary Dewatering Estimates

In order to assess the feasibility and practicality of dewatering for tunnel excavation and construction from the Outfall Shaft to Shaft 1, preliminary estimates were made of pumping rates and number of wells that might be required. These estimates should not be considered precise, rather they are intended only to demonstrate an order of magnitude of the requirement. If dewatering is implemented as part of the construction in this area, additional analysis would be required for design of a system. Such a system would have to allow for flexibility in well placement and nonstandard design of dewatering wells to accommodate varying field conditions encountered. Additionally, the existing wells and piezometers would have to be monitored closely in order to determine the performance of a dewatering system during construction and flow meters would be required on discharge lines in order to evaluate and verify dewatering system performance.

Ground-water withdrawal rates (a.k.a. pumping rates, dewatering rates) that would be required to lower the water table in order to permit construction of the Big Walnut sanitary sewer extension were estimated using a ground-water flow model. The estimated withdrawal rates include dewatering for construction of the Outfall Shaft and tunneling from the Outfall Shaft eastward, to STA 6+50 feet. Three construction dewatering scenarios were considered. Two of these were further subdivided to consider varying depths to which the water table would be lowered.

Scenario 1 (A & B)

The first scenario considers the use of vertical wells to lower the water table along the entire length of the tunnel. For Scenario 1A, the water table would be lowered to elevation 796 feet at the tunnel, or 2 feet below the sewer invert elevation at the outfall shaft. For Scenario 1B, the water table would be lowered to elevation 800 feet.

Scenario 2 (A & B)

The second scenario considers the use of vertical wells to lower the water table only in the vicinity of the outfall shaft. For Scenario 2A, the water table would be lowered to elevation 796 feet at the outfall shaft whereas for Scenario 2B, the water table would be lowered to elevation 800 feet at the outfall shaft.

Scenario 3

The third scenario considers the use of horizontal wells to lower the water table along the entire length of the tunnel to elevation 796 feet.

8.1.1.1 Calculation Method

The estimated dewatering rates required to lower the water table necessary for construction were calculated using the computer program MODFLOW (version 2000). The program was developed by the U. S. Geological Survey and is in the public domain. MODFLOW uses a finite-difference method to compute ground-water potentials and ground-water flow rates based upon a user specified set of hydrogeologic parameters, boundary conditions, and ground-water sources and removal mechanisms.

MODFLOW performs calculations using an orthogonal grid system defined by a system of rows, columns, and layers. The grid system was comprised of 111 rows to extend the calculation area 1000 feet northward and southward from the limits of excavation and 237 columns to extend the calculation area 982 feet westward and 702 feet eastward. The finite-difference grid was divided vertically into two layers. The lower grid layer extended from elevation 792 feet to elevation 814 feet. This layer represents the higher permeability sand and gravel material overlying the shale bedrock. The upper grid layer extended upward from elevation 814 feet to the water table. The layer extends upward to elevation 840 feet. However only that part lying below the water table is used

to compute the transmissivity. By default, MODFLOW assigns zero-flux boundary conditions to all of the exterior grid boundaries.

Hydrogeologic parameter values incorporated into the calculations are summarized in the following table. The horizontal hydraulic conductivity component for the lower layer was determined based on the pumping tests (Section 4.4) pumping tests. All other parameters were estimated based on the materials present.

Layer	Hydraulic Conductivity (ft/day)		Storage Coefficients	
	Horizontal Component	Vertical Component	Specific Storage (ft^{-1})	Specific Yield
Layer 1 (upper)	3	0.3	10^{-5}	0.2
Layer 2 (lower)	300	30	10^{-5}	0.2

Ambient ground-water flow conditions were approximately reproduced by adding ground water at grid nodes adjacent to the eastern and western grid boundaries and by removing ground water at grid nodes located at Big Walnut Creek. Ground-water inflow rates at the boundaries are specified via MODFLOW's well package. Discharge and or recharge to Big Walnut Creek is implemented using MODFLOW's River Package. An inflow rate of 100 gallons per day per linear (horizontal) foot was added to each cell along the eastern and western boundaries. Big Walnut Creek was assigned a water elevation of 816 feet. The hydraulic conductivity and thickness of the river sediments were set to 0.25 ft/day and 1 foot, respectively.

Ground-water discharge to dewatering wells and/or horizontal drains was implemented using the MODFLOW DRAIN package. Drain elevations were set between one and two feet below the target dewatering elevation, as needed to meet the dewatering requirements.

8.1.1.2 Calculation Results

Steady-state withdrawal rates and the number of wells required to meet dewatering requirements for each scenario are summarized in Table 8-1. Preliminary estimates (absent flood conditions) of pumping rates required to maintain desired ground-water levels range from about 600 to 840 gpm. However, pumping requirements to initially dewater the construction zone in a reasonable time period are estimated to be in the range of 1600 to 1800 gpm.

Considering the practical space limitations at the surface, it would seem that Scenarios 1A and 2A are simply not feasible given the number of wells required. Moreover, the limited available drawdown and saturated thickness remaining at target water levels are such that these two scenarios make it highly questionable that the required well yields could be achieved and maintained. Scenarios 1B and 2B appear to be feasible from the standpoint of space and well yields, but failure to lower ground water to levels below the sewer invert would not preclude serious construction problems due to running sands which would surely occur. Use of horizontal wells (Scenario 3) might fail to produce the required yield due to encountering lower permeability materials through areas of the screened interval which would be placed near the bedrock.

Based on these preliminary calculations and consideration of the factors discussed herein, a combination of Scenario 2B and Scenario 3 might be the most viable alternative if dewatering were to be attempted. Clearly, there are difficult site conditions that should be more thoroughly evaluated if a dewatering system is to be used for construction. The analysis presented here is intended only to serve as an evaluation of the relative feasibility and cost of the various dewatering alternatives. Nothing in this discussion should be construed as recommendations for the design of a dewatering system.

8.2 Deep Rock Tunneling

As described in Section 7, model simulations revealed no significant ground-water inflow would occur where rock hydraulic conductivities are in the range of 10^{-7} to 10^{-9} cm/sec. The upper

limit of hydraulic conductivity in the Ohio Shale throughout most of the area was assumed to be 10^{-6} cm/sec. Resulting inflow estimates based on this assumption range from 75 gpd/100 ft (gallons per day per 100 feet of tunnel) to 230 gpd/ft or 2.8 to 8.4 gpm per mile of tunnel.

There are a few areas along the tunnel where an exception to this rule might be anticipated. The packer test of the Ohio Shale at ATB-4 from 138 to 185 feet in depth gave hydraulic conductivity values in the 10^{-5} cm/sec range. This boring is located at Lee Road and Central College Road near the head of a deep ravine trending generally east-west and generally coincident with the buried valley with a similar orientation shown on Plate 1. The likelihood of fractured zones and weathering features in the deep bedrock is greatly increased in these areas, particularly where overlain by more permeable unconsolidated deposits in the buried valley.

Model simulations indicate that initial encounters of inflows could be on the order of 12 gpm per 100 feet to as much as 34 gpm per 100 feet. The maximum inflow to the tunnel would be within the first day that fractured rock of this hydraulic conductivity was encountered, and decrease over time as the flow system approaches steady state conditions. Sustained flows after a week to one month would be expected to diminish to about 5 to 13 gpm per 100 feet, or perhaps less depending upon the degree of connection to overlying zones of higher hydraulic conductivity. Areas along the tunnel alignment where such conditions might be encountered are south of Central College Road between Station 87+00 and 93+00 and north of Central College Road between Station 100+00 and 108+00 (see Plate 1).

Uncharacteristically high hydraulic conductivities in the Ohio Shale also may be encountered due to bedrock fractures beneath the ravine near Station 38+00. Packer tests and slug tests in FTB-16 reveal that hydraulic conductivity are as much as 2×10^{-3} cm/sec. However, sustained inflow in this area is not anticipated as there is no source of water in the adjacent low permeability bedrock, although runoff in the ravine due to a major storm event could potentially seep into the tunnel excavation.

8.3 Shaft Construction

Dewatering of the Berea Sandstone for shaft construction has the potential for significant impacts on existing residential wells in the project area. Many of the sandstone wells are marginal producers and many have relatively shallow water producing zones. If water levels fall below these producing zones, there is no water potentially available at deeper levels in the Berea, much less the Bedford and Ohio Shale. Deeper drilling for well replacement is not an option in this area. Many wells have chronic iron problems that could be exacerbated as a result of lowered water levels due to dewatering. Due to the fragile nature of many of the well systems in the area, lowering of water levels of only a few feet could cause well failures.

Calculations were made using hydraulic conductivity values for the Berea Sandstone derived from slug tests and packer tests to estimate potential inflow and impact on ground water levels during shaft construction. It is estimated that upon excavating 10 to 20 feet into the Berea Sandstone with a shaft having a diameter of 16 feet that initial inflows at Shaft 3, 5, and 6 would be on the order of 4 gpm, 75 gpm, and 20 gpm, respectively. If allowed to drain for 30 days, sustained inflows at Shaft 3, 5, and 6 might be on the order of 2 to 3 gpm, 33 gpm, and 9 gpm, respectively. The actual inflows will depend upon the nature of fractures encountered at the walls of the shaft. Therefore, these estimates should be considered as an approximation for planning purposes only. However, the impacts on water levels on existing residential wells as a result of the estimated inflows at Shafts 5 and 6 could be substantial. Therefore, it is recommended that consideration be given to constructing Shafts 5 and 6 without dewatering the Berea Sandstone.

8.3.1 Shaft 2

Berea Sandstone is not present at this location and there are no existing private wells in the immediate area. Little or no ground water is expected to be encountered. No restrictions on shaft construction are required at this site.

8.3.2 Shaft 3

Berea Sandstone is present at this location from 7.5 to 49.5 feet in depth. Packer tests on the Berea indicate that the hydraulic conductivity is on the order of 1.7 x 10^{-4} cm/sec (3.6 gpd/ft^2). Assuming that the saturated thickness is about 40 feet, the transmissivity is estimated to be about 144 gpd/ft (40 ft x 3.6 gpd/ft^2), which is toward the lower range observed for the Berea in the project area (see Table 4.2). Initial inflow during shaft construction is expected to be on the order of 4 gpm. There are 3 private wells within 500 feet of the shaft location, the closest being about 350 feet away. On the short term, this magnitude of inflow would not be expected to cause significant impact on residential wells. However, if the shaft excavation was allowed to drain indefinitely at rates of 2 to 3 gpm, drawdowns of 2.5 to 5 feet could occur at a distance of 500 feet which could adversely impact some wells.

8.3.3 Shaft 4

There was no Berea Sandstone encountered in the geotechnical boring at this location. Bedford Shale was encountered at a depth of 31 feet. Sand was reported from 18 to 31 feet in depth and visually classified as SM and SC. Measures may be required to stabilize this sand during excavation through this interval as sand heave was reported at a depth of 24 feet. There are 7 private wells located within 500 feet of this shaft location. Well logs are available for only 4 of these locations. Three of the wells are bedrock wells and should not be affected because minimal water seepage is expected from the bedrock. One well is developed in sand and gravel which correlates in depth to the sand encountered in boring FTB-19. If this zone is dewatered during excavation this well could be affected.

8.3.4 Shaft 5

Berea Sandstone is present at this location from 6 to 50 feet in depth and the saturated thickness is about 35 feet. Packer tests on the interval from 35 to 45 feet indicate hydraulic conductivity values of 1.4 x 10^{-4} cm/sec (3.0 gpd/ft^2) to 5.3 x 10^{-4} cm/sec (11.2 gpd/ft^2). The

hydraulic conductivity value derived from the slug test on FTB-29 on the interval from 22.5 to 45.0 feet was 1.5 x 10^{-2} cm/sec (318 gpd/ft^2). This is the highest value obtained for the Berea within the project area. This shaft location is also in the area along Lee Road where residential well survey results reveal that Berea wells are most productive. Inflow estimates were calculated based on the assumption of a formation transmissivity of 5000 gpd/ft (hydraulic conductivity 125 gpd/ft^2 x thickness 40 ft). Initial inflows of 75 gpm might be expected with sustained inflow after 30 days of about 33 gpm.

There are 6 homes located within 500 feet of the shaft location, 4 of which are believed to be supplied with wells. There are 20 homes located between 500 and 1000 feet from Shaft 5. All have wells, although it appears that 6 of these houses are on Delco water and the wells are maintained only for outside uses. Available information indicates that yields of these wells range to as much as 16 to 30 gpm. Based on the inflows estimated, drawdowns calculated assuming unrestricted flow for 30 days would be about 7 to 10 feet at distances of 200 to 500 feet away, and 5 to 7 feet between 500 and 1000 feet away. Clearly, dewatering of the Berea at this location would produce substantial impact on existing residential wells.

8.3.5 Shaft 6

Berea Sandstone is present at this location from 15.5 to 40 feet in depth. Packer tests on the interval from 20 to 60 feet indicate hydraulic conductivities in the range of 3.0 x 10^{-4} cm/sec (6.4 gpd/ft^2) to 5 x 10^{-4} cm/sec (10.6 gpd/ft^2). The hydraulic conductivity derived from the slug test on FTB-30 was 1.2 x 10^{-3} cm/sec (25.4 gpd/ft^2). The saturated thickness of the Berea Sandstone near the shaft is only 24.5 feet. However, the sandstone thickness is greater in the immediate vicinity. For purposes of estimating inflows and impact, a transmissivity of 940 gpd/ft (37 feet x 25.4 gpd/ft^2) was used in the calculations. Initial inflow was estimated to be about 20 gpm and about 9 gpm after 30 days if allowed to flow into the excavation continually. The sustained flow would be expected to create drawdowns of about 3 to 6.5 feet between distances of 500 to 1000 feet form the shaft. There are 5 homes within 500 feet of the shaft location, 4 of which are believed to be supplied with

wells. There are believed to be 17 wells located between 500 to 1000 feet from Shaft 6. Dewatering of the Berea at this location would be expected to adversely impact residential wells in this area.

TABLE 8-1

ESTIMATED DEWATERING REQUIREMENTS

Scenario	Construction to Dewater	Dewatering Method	Target Water Table Elevation (ft)	Steady-State Withdrawal Rate (gpm)	Minimum No. of Wells.
1A	Outfall & tunnel trace	vertical wells	796	820	44
1B	Outfall & tunnel trace	vertical wells	800	760	22
2A	Outfall only	vertical wells	796	670	18
2B	Outfall only	vertical wells	800	600	10
3	Outfall & tunnel trace	horizontal wells	796	840	2

Note: These estimates are based on preliminary calculations and are intended only to be used to evalute the relative feasibility and cost of dewatering alternatives. These estimates should not be used as a basis for design.

9.0 GROUND-WATER IMPACT ANALYSIS

9.1 Deep Tunneling

It is anticipated that very little water will be encountered in tunneling through the Ohio Shale. Therefore, no impact (water-level lowering) is expected for wells completed in the Berea Sandstone as a result of tunneling beneath the Berea. The hydraulic conductivity of the deep shale is generally considered to be on the order of 1×10^{-7} cm/sec or less. The only exception would be where the shale is weathered and fractured. For example, the slug test on FTB-16 revealed a hydraulic conductivity of 1.6×10^{-4} cm/sec for the Ohio Shale. This well is located at the bottom of the ravine near Station 38+00 and the zone tested is only about 20 to 50 feet below land surface. Similar conditions, or at least more highly weathered and fractured conditions, could potentially exist beneath the buried valley areas in the vicinity of Station 59 and north of Shaft 4 in the vicinity of FTB-24 (see Plate 1). The buried valley tributary north of Shaft 4 shown on Plate 1 is based on the results of a seismic survey conducted along the tunnel alignment and the depth to bedrock shown on water well logs and geotechnical borings in the immediate area. This tributary valley appears to be the most significant buried bedrock feature along the tunnel alignment where increased permeability of the bedrock due to fracturing and weathering might be expected. If such fracture zones are hydraulically connected to sand and gravel deposits within the buried valley these could be a source of water inflow into the tunnel excavation. Water in such deposits might slowly drain into the tunnel, although conditions which would have any significant impact on ground-water levels in the unconsolidated deposits are considered to be unlikely. Most wells in the vicinity of this part of the alignment are developed in the Berea Sandstone which may be hydraulically connected to sand and gravel zones within the buried valley deposits in some places. Although the possibility of any significant impact on water levels in Berea Sandstone wells as a result of deep tunneling through the Ohio Shale seems remote, that possibility should be considered in the preparation of contingency plans with respect to residential well impact. If significant water inflow is encountered in this section of the tunnel, monitoring of water levels in the closest residential wells should be considered.

9.2 Shaft Construction

There are no residential water wells in the vicinity of Shafts 1 and 2 which could potentially be affected by construction. Shafts 3, 5, and 6 will be excavated through the Berea Sandstone. The potential exists for significant ground-water inflows into the shaft during excavation, particularly at Shaft 5. Such inflows would adversely impact residential water wells developed in the Berea Sandstone, therefore, it is recommended that measures be taken to construct Shafts 5 and 6 without dewatering and to ensure that seepage into the shaft from the Berea Sandstone is precluded. As pointed out earlier in the report, many Berea Sandstone wells in the area are extremely vulnerable to water-level change of only a few feet. Even an inflow of as little as 5 to 10 gpm into a shaft excavation, if left unabated, could have a significant impact on Berea Sandstone wells. Figures 9.1 and 9.2 show distance-drawdown relationships based on estimates of initial inflow and sustained inflow after 30 days assuming aquifer characteristics within the range considered most likely to be encountered at Shafts 5 and 6. At a distance of 500 feet from Shaft 5, it is estimated that ground-water levels would be lowered about 7 feet if inflow to the shaft excavation continued unrestricted for 30 days (see Figure 9.1). At a distance of 500 feet from Shaft 6, it is estimated that ground-water levels would be lowered about 6 feet after 30 days of unrestricted in flow (see Figure 9.2). Greater inflows are certainly possible and the magnitude of drawdown created is likely to be somewhat directional owing to the anisotropic nature of the sandstone aquifer, making it difficult to predict which wells may be adversely impacted. Table 9.1 shows the number and type of wells within 500 feet and 1000 feet of each shaft.

Based on boring FTB-19, there is no Berea Sandstone at Shaft 4. The only material encountered at Shaft 4 which has the potential for any significant water production would be the 13 feet of sand encountered from 18 to 31 feet. This material is logged as SC and SM and is not considered to be particularly permeable however, 2 feet of sand heave was observed and some measures may be required to stabilize the sand during excavation. If some type of dewatering is employed during construction at Shaft 4 it could locally have some effect on ground-water levels. There is one well developed in sand and gravel which is only 26.5 feet deep in close proximity to Shaft 4. A piezometer should be installed in the sand zone to the northwest of Shaft 4 so that water

levels can be monitored during shaft construction. If a significant change in water level is noted in the piezometer during shaft construction the nearby sand and gravel well and shallow Berea Sandstone wells which might be hydraulically connected should be checked. No impact on residential wells is expected as a result of construction of Shaft 4, however, that possibility should be considered in the development of a contingency plan for construction.

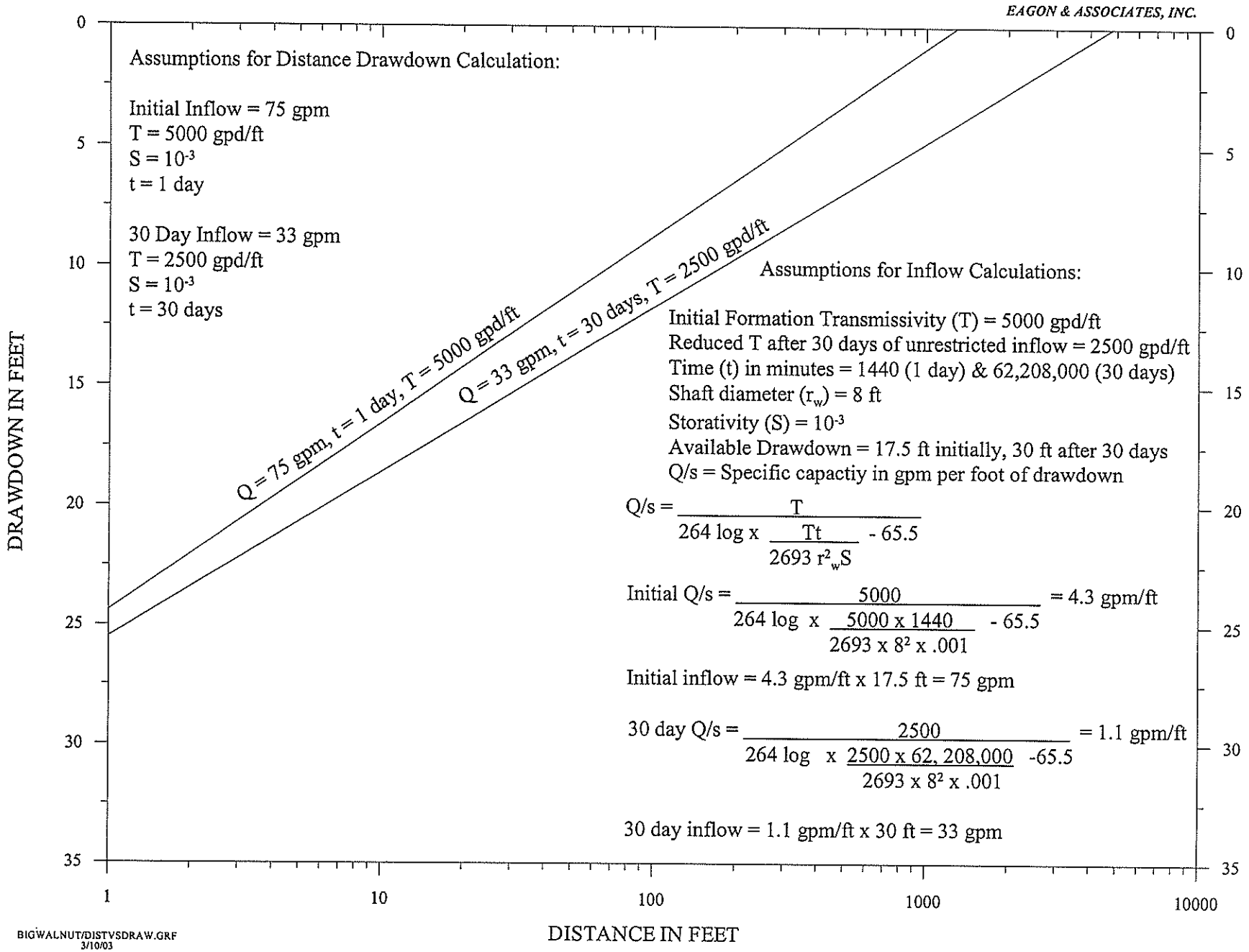


FIGURE 9.1 ESTIMATE OF IMPACT DUE TO DEWATERING AT SHAFT 5

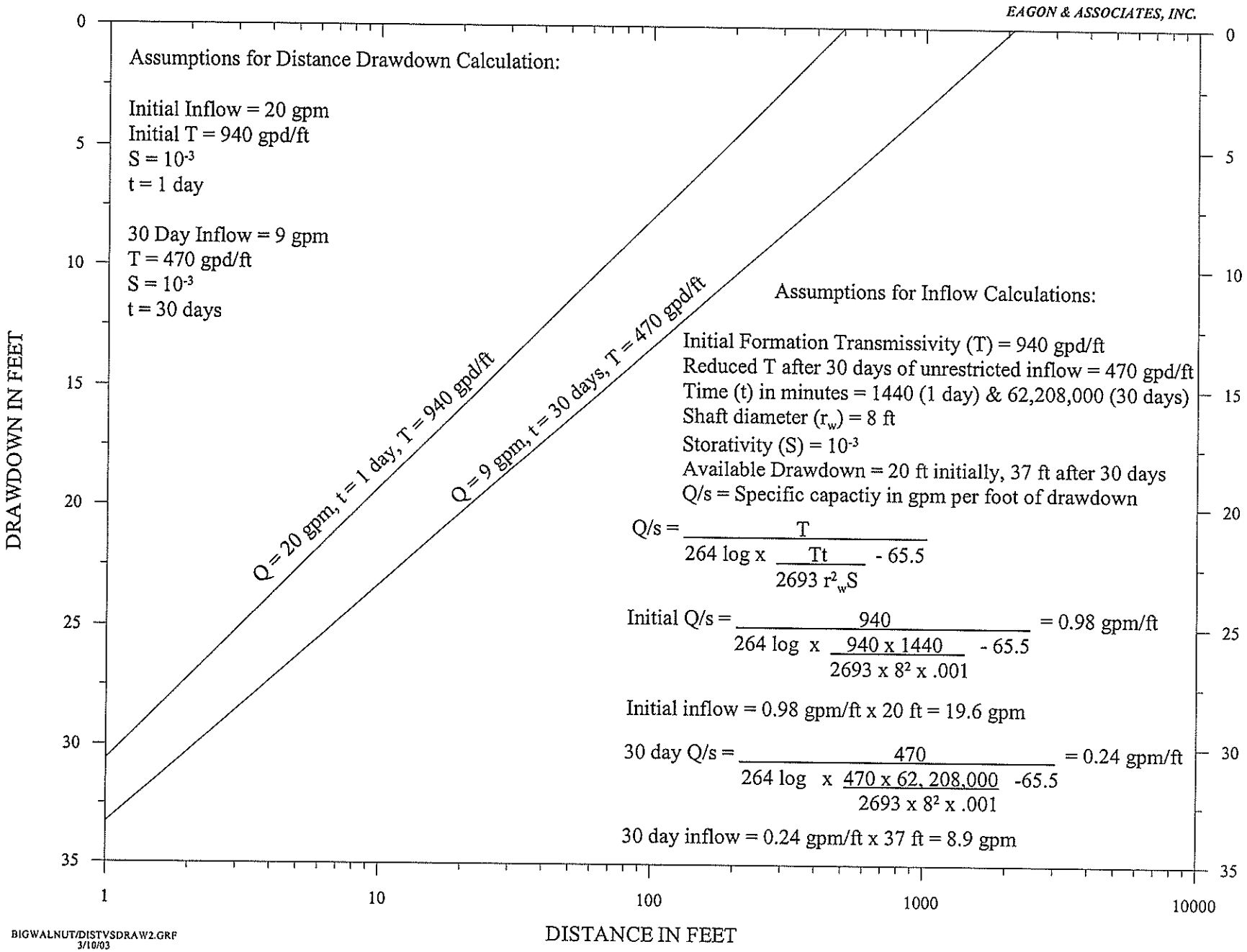


FIGURE 9.2 ESTIMATE OF IMPACT DUE TO DEWATERING AT SHAFT 6

TABLE 9.1
RESIDENTIAL WELLS NEAR SHAFT LOCATIONS
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Wells Located Within 500'	Wells Located Within 1000'	Formation	Depth (ft)	Water Level (ft)	Pump Setting (ft)	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	Remarks
Shaft 3									
153	X		Berea SS	50	10.0 m	37	5.0	0.5	
157	X		Berea SS	?	17.0 m	60	7.0	0.7	
158	X		Berea SS	54L	30	?			
162		X	Berea SS	?	?	?			
265		X	Berea SS	52L	12	?			
--		X	Berea SS	?	?	?			
15		X	Berea SS	47L	17.5 m	35	4.3	0.4	
17		X	Berea SS	80L	13.5 m	?	5.3	0.2	
--		X	Berea SS	?	?	?			
Shaft 4									
152	X		S&G	75L	7.0 m	?	8.0	1.6	Used for geothermal system
154	X		S&G	51L	12.5 m	?	6.5	0.8	
156	X		S&G	68L	11.5 m	62	10.5	1.2	
161	X		Berea SS	57L	6	30			
248	X		S&G	40L	?	37			
216	X		?	?	?	?			
44		X	S&G	47L	21.5 m	30	6.5	0.8	Used for geothermal system
45		X	S&G	68L	8	?			
151		X	S&G	54L	?	?			Declined to be surveyed
155		X	Berea SS	52L	13.5 m	35	2.5	1.2	
217		X	?	?	?	?			
218		X	?	?	?	?			
--		X	?	?	?	?			
Shaft 5									
93	X		--	--	--	--			Served by Delco
94	X		Berea SS	50L	17.0 m	45	5.2	1.1	
96	X		Berea SS	54L	69	?			Well not in use
104	X		Berea SS	?	?	?			Well not in use
--	X		?	?	?	?			
78		X	Berea SS	50L	17	45			Served by Delco

TABLE 9.1
RESIDENTIAL WELLS NEAR SHAFT LOCATIONS
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Wells Located Within 500'	Wells Located Within 1000'	Formation	Depth (ft)	Water Level (ft)	Pump Setting (ft)	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	Remarks
Shaft 5 (cont'd)									
79		X	Berea SS	50L	15.0 m	35	6.1	15.6	Delco water inside; Well used outside
80		X	Berea SS	50L	17.5 m	45	5.8	12.3	Delco water inside; Well used outside
81		X	Berea SS	75L	17.0 m	70	7.4	0.5	Delco water inside; Well used outside
82		X	Berea SS	40L	13	25			
83		X	?	?	16.5 m	42	6.3	0.3	
84		X	Berea SS	57L	16.8 m	46	4.0	0.6	Delco water inside; Well used outside
85		X	Berea SS	47L	14.8 m	35	7.1	0.4	
90		X	Berea SS	100L	?	80			
91		X	Berea SS	50L	17.8 m	44	6.0	0.5	
92		X	Berea SS	59	17.9 m	40	6.0	0.8	
100		X	Berea SS	?	19.4 m	?	3.3	0.4	
101		X	Berea SS	76L	12.0 m	60	5.8	0.4	
105		X	Berea SS	59L	10.3 m	?	4.9	2.9	
106		X	Berea SS	31L	11.8 m	29	6.9	13.0	Delco water inside; Well used outside
107		X	Berea SS	75L	?	65			Geothermial system
108		X	Berea SS	31L	6	?			
109		X	Berea SS	52L	11.9 m	46	4.1	0.5	
111		X	Berea SS	64L	11.4 m	60	6.7	2.1	
--		X	Berea SS	?	?	?			
Shaft 6									
159	X		Berea SS	23	6	?			Declined to be surveyed
160	X		Berea SS	58	?	?			
118	X		Berea SS	?	?	?			Declined to be surveyed
131	X		Berea SS	?	?	?			
116		X	Berea SS	55	?	?			Served by Delco
115		X	Berea SS	64L	12.5 m	45	6.2	0.2	
114		X	Berea SS	50L	16.2 m	?	4.2	2.2	
113		X	Berea SS	60L	12	?			
112		X	Berea SS	25	8	?			Served by Delco
117		X	Berea SS	40L	17.2 m	30	9.4	0.7	
119		X	Berea SS	65L	?	?			Declined to be surveyed

TABLE 9.1
RESIDENTIAL WELLS NEAR SHAFT LOCATIONS
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Map No.	Wells Located Within 500'	Wells Located Within 1000'	Formation	Depth (ft)	Water Level (ft)	Pump Setting (ft)	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	Remarks
Shaft 6 (cont'd)									
120		X	Berea SS	55L	15.9 m	47	2.5	0.1	
128		X	Berea SS	50L	?	?			Declined to be surveyed
129		X	Berea SS	90L	6	?			
130		X	Berea SS	60L	?	?			Declined to be surveyed
717		X	Berea SS						
715		X	Berea SS						
--		X	?	?	?	?			
--		X	?	?	?	?			
--		X	?	?	?	?			
--		X	?	?	?	?			

10.0 GROUND-WATER MITIGATION PLAN

10.1 Monitoring Plan

Piezometers at Shafts 3, 4, 5, and 6 should be equipped with transducers and data loggers to monitor ground-water level fluctuations before and during construction. Prior to construction at each shaft location water levels should be measured in selected residential wells within 500 feet of each shaft, in order to update the residential well database and document preconstruction conditions. No additional monitoring is considered necessary, unless significant water-level changes are observed in the piezometer at any shaft location. Because construction methods that will be employed are designed to preclude any adverse impacts on residential wells, none are expected. However, some water-level monitoring is considered desirable in order to provide factual information to demonstrate that water-level impacts are not occurring or, if water-level changes do occur, to determine the cause, effect, and magnitude of such changes. Because this area has a history of chronic well problems it will be important to have reliable baseline data on water-level fluctuations. The activities associated with shaft construction will be highly visible to area residents. Well problems that occur during construction will likely be associated with such activities, whether or not there is a causal relationship. Without reliable baseline data there will be no way to validate or invalidate such claims.

10.2 Mitigation Plan

Construction methods have been selected to preclude adverse impacts on residential wells in the project area. In the unlikely event that impacts do occur such impacts would be temporary in nature. The most appropriate mitigation measure would be temporary or permanent connection to an existing waterline or temporary tanks and water hauling if an existing waterline is not available. Should shaft construction cause the demise of an old and fragile Berea Sandstone well that cannot be rehabilitated, well replacement would be the next step in the mitigation process. Nothing in the planned construction methods would cause any long term impact on the Berea Sandstone aquifer that would preclude replacement of Berea Sandstone wells.

10.3 Contingency Plan

The only contingency plan considered necessary would be to expand the residential well monitoring program should unexpected conditions be encountered or if the contractor fails to effectively seal off shaft inflows from the Berea Sandstone. Water-level data should be reviewed in a timely manner to identify any unexpected changes. If conditions are observed that could potentially have an adverse impact on residential wells, water levels should be measured periodically during construction in those wells considered most vulnerable.

APPENDIX A.

LOGS FOR TEST WELLS
AND
OBSERVATION WELLS

TABLE A-1
GEOTECHNICAL BORINGS / PIEZOMETERS
USED FOR HYDROGEOLOGIC CHARACTERIZATION
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Boring/Well No.	Depth	Formation	Pumping Test Well	Pumping Test Observation Well	Slug Test Well	Lithologic Information
ATB-3/AOC-1	50'	Berea	X			
ATB-3 E-1	50'	Berea		AOC-1		
ATB-3 W-1	50'	Berea		AOC-1		
ATB-5 / AOC-3	50'	Berea / Bedford	X			
ATB-6 / AOC-4	50'	Berea		PW-1		
ATB-6 E-1	50'	Berea		PW-1		
ATB-6 NE-1	50'	Berea		PW-1		
ATB-6 NE-2	50'	Berea		PW-1		
BTB-5 / AOC-3	60'	Berea	X			
BTB-6	60'	Berea	X			
ETB-1	45'	Unconsolidated				PW-3&4
ETB-2	55'	Unconsolidated				PW-3&4
FTB-1 & 1A	60'	Unconsolidated				PW-3&4
FTB-2	55.4'	Unconsolidated				PW-3&4
FTB-12	54.5'	Unconsolidated				PW-3&4
FTB-16	52.5'	Ohio Shale			X	
FTB-27	60.5'	Unconsolidated		PW-3&4		
FTB-28	54'	Unconsolidated		PW-3&4		
FTB-29	45'	Berea			X	
FTB-30	39'	Berea			X	
FTB-31	52'	Unconsolidated		PW-4		
FTB-32	44.8'	Unconsolidated		PW-4		

Note: Boring logs and installation details for piezometers are contained in Volume III of the Geotechnical Degsign Summary Report.

DNR 7802.96

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

895863

WELL LOCATION

County Franklin Township N/A

Owner/Builder (Circle One or Both) *Eagon & Associates (First / Last)

Address of Well Location Walnut Street (Number / Street Name)

City _____ Zip Code +4 _____

Permit No. _____ Section/Lot No. (Circle One or Both) _____

Location of Well in State Plane coordinates, if available: Use of Well Monitoring Well

N ☐ X _____ . _____ +/- _____ ft. or m

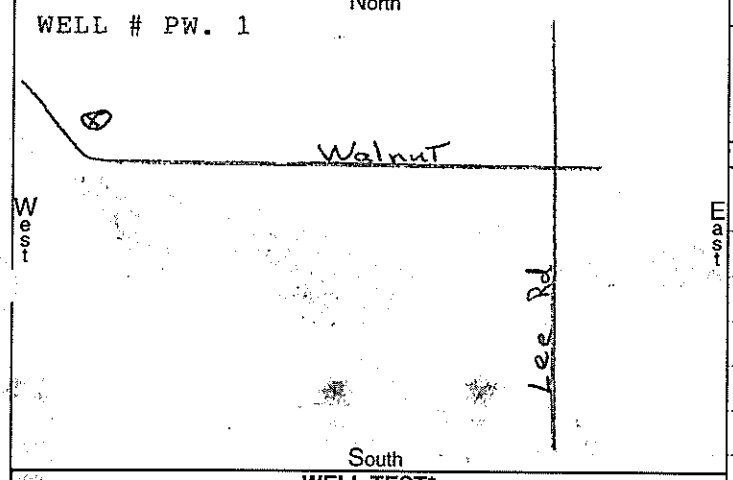
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____



WELL TEST*

Pre-Pumping Static Level 20 ft. Date 9/28/99

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other _____

☐ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate _____ gpm Duration of Test 1/2 hrs.

Feet of Drawdown 5-6 ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☒ No Flowing Well? ☐ Yes ☒ No

Quality _____

PUMP/PITLESS

Type of pump N/A Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump installed by _____

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Jackson & Sons Drilling & Pump, Inc.

Address 3401 St. Rt. 13 S.

City, State, Zip Mansfield, Ohio 44904

Signed Sheila Mowry Date 9/28/99

ODH Registration Number 606

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 7 7/8 inches Depth 10 ft.
Casing Diameter 5 in. Length 11 ft. Thickness SDR21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.
Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground _____ ft.

Type 1 ☐ 2 ☐ Steel 1 ☐ 2 ☐ Galv. 1 ☒ 2 ☒ PVC 1 ☐ 2 ☐ Other _____

Joints 1 ☐ 2 ☐ Threaded 1 ☐ 2 ☐ Welded 1 ☒ 2 ☐ Solvent 1 ☐ 2 ☐ Other _____

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Benseal/Hole P Volume/Weight Used 125LBS

Method of Installation Dry

Depth: Placed FROM 10 ft. TO 0 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay	0	4
Brown Shale	4	5
Brown SS	5	14
Gray SS	14	14½
Brown SS	14½	16
Gray Shale	16	17
Gray SS w/ Layers Gray Shale	17	28
Trace Brown SS/Gray SS	28	47
Gray Shale/Traces of Gray SS	47	58

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 9/28/99 Total Depth of Well 58 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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PW-1

DNR 7802.96

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WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

895844

WELL LOCATION

County Franklin Township Plain

Owner/Builder (Circle One or Both) ~~Eagan~~ (First) & Associates (Last)

Address of Well Location 6 (Number) Cautela Drive (Street Name)

City Westerville Zip Code +4 43081

Permit No. _____ Section/Lot No. (Circle One or Both) _____

Location of Well in State Plane coordinates, if available: Use of Well Monitoring Well

N ☐ X _____ . _____ +/- _____ ft. or m

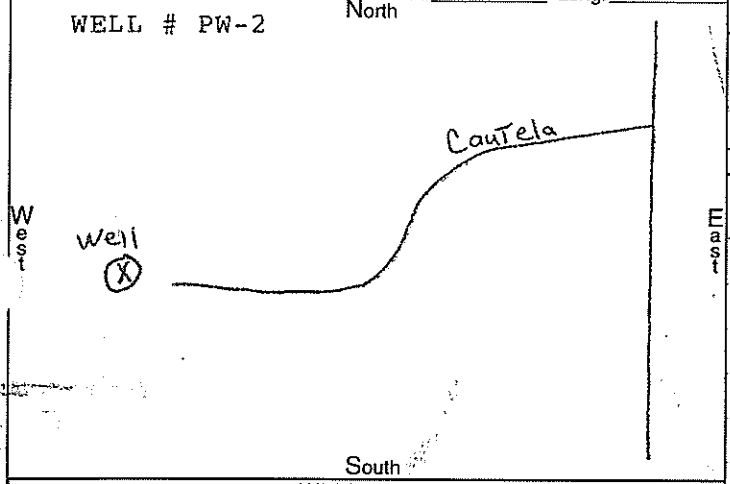
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____



WELL TEST*

Pre-Pumping Static Level _____ ft. Date 9/08/99

Measured from: ☐ Top of Casing ☐ Ground Level ☐ Other _____

☒ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate 0-1 gpm Duration of Test _____ hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☐ No

Quality N/A

PUMP/PITLESS

Type of pump N/A Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump installed by N/A

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Jackson & Sons Drilling & Pump

Address 3401 St. Rt. 13 S.

City, State, Zip Mansfield, Ohio 44904

Signed James D Jackson Date 9/08/99

DH Registration Number 606

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 7 7/8 inches Depth _____ ft.

Casing Diameter 5 in. Length 15 ft. Thickness _____ in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground _____ ft.

Type 1 ☐ 2 ☐ Steel 1 ☐ 2 ☐ Galv. 1 ☒ 2 ☐ PVC 1 ☐ 2 ☐ Other _____

Joints 1 ☐ 2 ☐ Threaded 1 ☐ 2 ☐ Welded 1 ☒ 2 ☐ Solvent 1 ☐ 2 ☐ Other _____

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 150

Method of Installation Pressure Pump

Depth: Placed FROM 0 ft. TO 15 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay	0	7
Brown Shale	7	14
Gray Sandstone-Trace of Water	14	28
Blue Shale	28	29
Gray Sandstone	29	32
Blue Shale	32	38
Gray Sandstone	38	41
Blue Shale	41	50
Gray Sandstone	50	53
Blue Shale	53	54
Gray Sandstone	54	55
Blue Shale	55	60

(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 9/08/99 Total Depth of Well 60 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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PW-2

DNR 7802.96

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WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

895864

WELL LOCATION

County Franklin Township N/A

Owner/Builder (Circle One or Both) Eagon & Associates (First / Last)

Address of Well Location Lee Rd (Number / Street Name)

City _____ Zip Code +4 _____

Permit No. _____ Section/Lot No. (Circle One or Both) _____

Location of Well in State Plane coordinates, if available: Use of Well Monitoring Well

N ☐ X _____ . _____ +/- _____ ft. or m

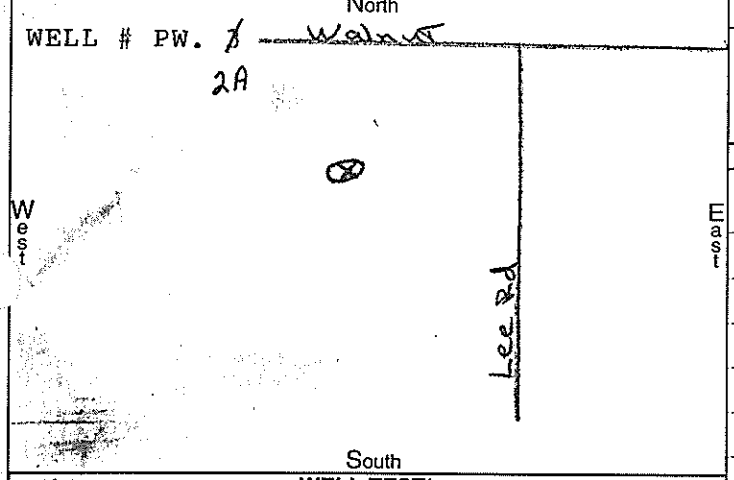
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____



WELL TEST*

Pre-Pumping Static Level 57 ft. Date 9/28/99

Measured from: ☐ Top of Casing ☐ Ground Level ☐ Other _____

☒ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate 1 or less gpm Duration of Test _____ hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☐ No

Quality _____

PUMP/PITLESS

Type of pump N/A Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump Installed by _____

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Jackson & Sons Drilling & Pump, Inc.

Address 3401 St. Rt. 13 S.

City, State, Zip Mansfield, Ohio 44904

Signed Sheila Mowry Date 9/28/99

OH Registration Number 606

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 7 7/8 inches Depth 10 ft.

Casing Diameter 5 in. Length 11 ft. Thickness SDR21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground _____ ft.

Type 1 ☐ Steel 1 ☐ Galv. 1 ☒ PVC 1 ☐
2 ☐ 2 ☐ 2 ☒ 2 ☐ Other _____

Joints 1 ☐ Threaded 1 ☐ Welded 1 ☒ Solvent 1 ☐
2 ☐ 2 ☐ 2 ☒ 2 ☐ Other _____

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Benseal/Hole Plug Volume/Weight Used 125LBS

Method of Installation Dry

Depth: Placed FROM 10 ft. TO 0 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay	0	4
Clay & Brown SS	4	6
Brown SS	6	12
Gray SS	12	14
Brown SS (Trace)	14	14
Gray SS w/ Layers of Gray Shale	14	44
Gray Shale	44	47
Gray SS	47	48
Gray Shale	48	49
Gray SS w/ Layers Gray Shale	49	56
Gray Shale	56	58

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 9/28/99 Total Depth of Well 58 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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PW-2A

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WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

946413

WELL LOCATION

County Franklin Township

Owner/Builder (Circle One or Both) City of Columbus First Big Walnut Sewer Extention Last

Address of Well Location Little Turtle Way
Number Street Name

City Columbus Zip Code +4

Permit No. N/A Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Test well

N ☐ X _____ . _____ +/- _____ ft. or m

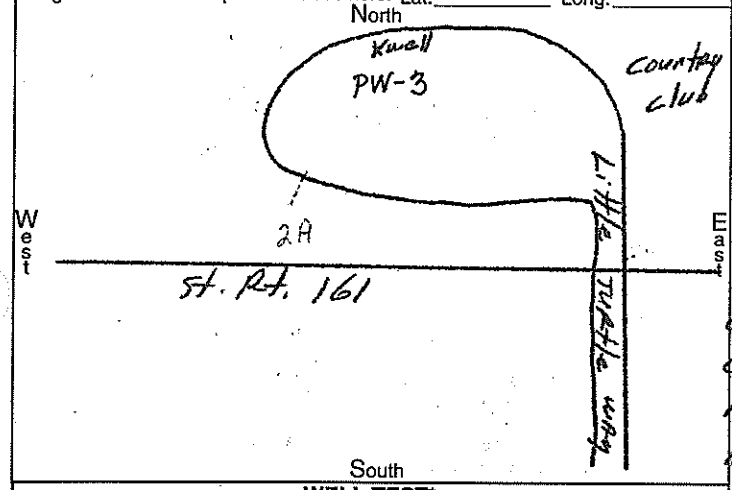
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: Long:



WELL TEST*

Pre-Pumping Static Level 22 ft. Date 5-23-02

Measured from: ☐ Top of Casing ☒ Ground Level ☐ Other

☒ Air ☐ Bailing ☐ Pumping* ☐ Other

Test Rate 150 gpm Duration of Test 2 hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☒ No Flowing Well? ☐ Yes ☒ No

Quality clear

PUMP/PITLESS

Type of pump N/A Capacity _____ gpm

Pump set at _____ ft. Pitless Type

Pump installed by

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Jackson & Sons Drilling Co.

Address 3401 St. Rt. 13 South

City, State, Zip Mansfield, OH. 44904

Signed James D. Jackson Date 5-29-02

ODH Registration Number 606

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other

BOREHOLE/CASING (measured from ground surface)

1 ☒ Borehole Diameter 8 3/4 inches Depth 50 ft.

Casing Diameter 6 in. Length 36 1/2 ft. Thickness .250 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 2 ft.

Type 1 ☒ Steel 1 ☐ Galv. 1 ☐ PVC 1 ☐
2 ☐ 2 ☐ 2 ☐ 2 ☐ Other

Joints 1 ☒ Threaded 1 ☐ Welded 1 ☐ Solvent 1 ☐
2 ☐ 2 ☐ 2 ☐ 2 ☐ Other

SCREEN

Diameter 6" Slot Size .040 Screen Length 10 ft.

Type Wire Material S.S.

Set Between 44 1/2 ft. and 34 1/2 ft.

GRAVEL PACK (Filter Pack)

Material/Size #4 Quartz Volume/Weight Used 1600 LBS.

Method of Installation Poured

Depth: Placed FROM 50 ft. TO 25 ft.

GROUT

Material Hole Plug Volume/Weight Used 500 LBS.

Method of Installation Poured

Depth: Placed FROM 0 ft. TO 25 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay & Top Soil	0	1
Cobbles, Clay & Gravel	1	5
Cobbles, Clay w/ Little Gravel	5	10
Mostly Brown Clay - Some fine Sand	10	15
Brown Clay - Sand - Medium Gravel	15	20
Med. Size Gravel & Sand No Clay	20	25
Uniform Gravel - Shale chips	25	30
Uniform Gravel - Flat Shale chips	30	46 1/2
Black Shale - Blue Soft Streaks	46 1/2	50

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 5-23-02 Total Depth of Well 44 1/2 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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PW-3

DNR 7802.96

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WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

946493

WELL LOCATION

County Franklin Township

Owner/Builder (Circle One or Both) City of Columbus (First / Last)

Address of Well Location Little Turtle Way (Number / Street Name)

City Columbus Zip Code +4

Permit No. N/A Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Monitor

N ☐ X _____ . _____ +/- _____ ft. or m

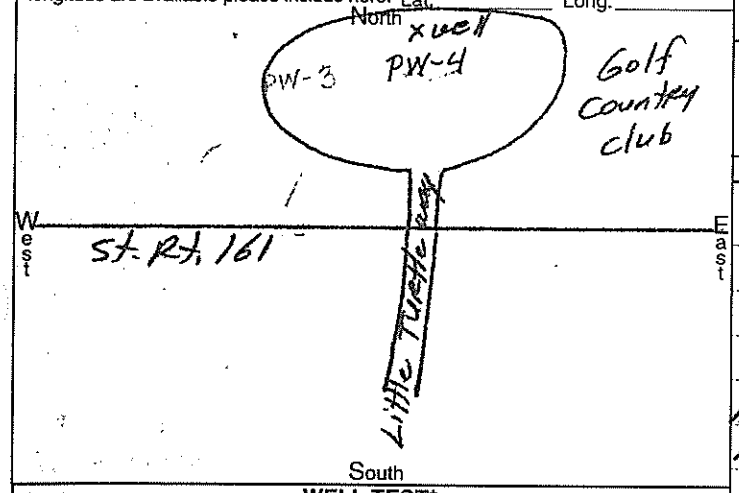
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: Long:



WELL TEST*

Pre-Pumping Static Level _____ ft. Date 8-15-02

Measured from: ☐ Top of Casing ☒ Ground Level ☐ Other

☐ Air ☐ Bailing ☒ Pumping* ☐ Other

Test Rate 100 gpm Duration of Test 24 hrs.

Feet of Drawdown 2 ft. Sustainable Yield 100+ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☒ No Flowing Well? ☐ Yes ☒ No

Quality Clear

PUMP/PITLESS

Type of pump N/A Capacity _____ gpm

Pump set at _____ ft. Pitless Type N/A

Pump installed by N/A

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Jackson & Sons Drilling Co.

Address 3401 St. Rt. 13 South

City, State, Zip Mansfield, Oh. 44904

Signed James D. Jackson Date 8-19-02

ODH Registration Number 606

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other

BOREHOLE/CASING (measured from ground surface)

1 ☒ Borehole Diameter 8 3/4 inches Depth 52 ft.

Casing Diameter 6" in. Length 40 ft. Thickness .250 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter 2" in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 2 ft.

Type 1 ☒ Steel ☐ Galv. ☐ PVC ☐ 2 ☐ Other

Joints 1 ☒ Threaded ☐ Welded ☐ Solvent ☐ 2 ☐ Other

SCREEN

Diameter 6" Slot Size .040 Screen Length 10 ft.

Type S.S. wire wrap Material Stainless

Set Between 38 ft. and 48 ft.

GRAVEL PACK (Filter Pack)

Material/Size Quartz #4 Volume/Weight Used 1100 LBS.

Method of Installation Poured

Depth: Placed FROM 52 ft. TO 28 ft.

GROUT

Material Benseal Volume/Weight Used 300 LBS.

Method of Installation Pressure Pump

Depth: Placed FROM 0 ft. TO 28 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay & SAND - Gravel	0	1
SAND - Cobbles	1	4
Clay - SAND & Gravel	4	15
Brown SAND & Gravel - Medium	15	20
Med. Size Gravel - No clay	20	30
Some clay - Gravel & SAND	30	51
Bedrock - Shale	51	

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 8-13-02 Total Depth of Well 48 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

PW-4

County Permit No. _____

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

577651

328

COUNTY Franklin TOWNSHIP Blendon SECTION OF TOWNSHIP _____

OWNER S+W Investment, Inc. ADDRESS 7339 Lee Rd Westerville

LOCATION OF PROPERTY 7160 Lee Rd

CONSTRUCTION DETAILS

Casing diameter 4½" Length of casing 41'

Type of screen — Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting Set pump at 70'

Date of completion Oct 8/80

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 10 gpm Duration of test _____

Drawdown 30 ft Date Oct 8/80

Static level (depth to water) 8 973 MSL

Quality (clear, cloudy, taste, odor) _____

Needs pumped out

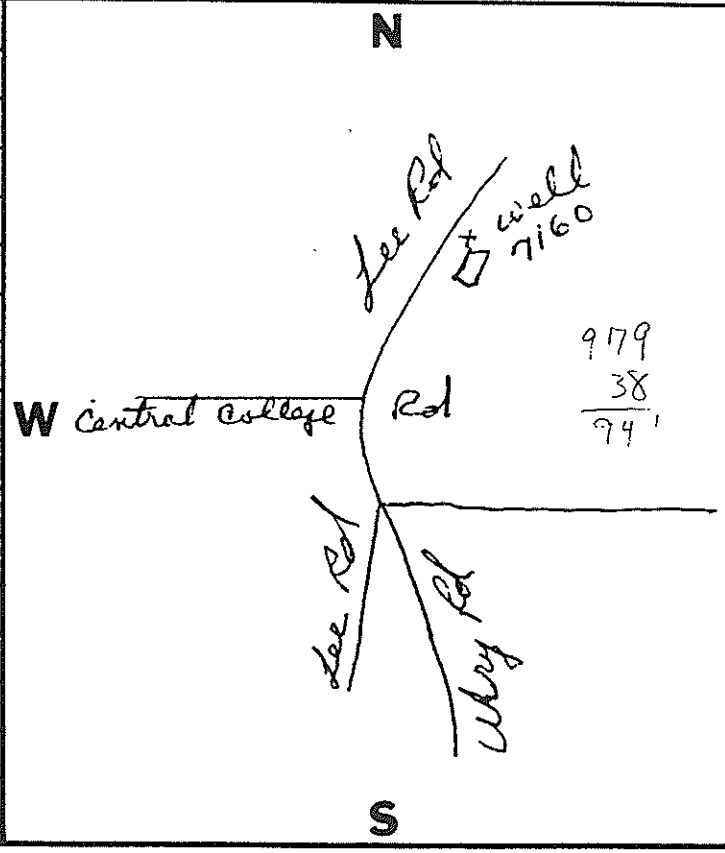
Pump installed by Tested by Bailing

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay	0 ft	9 ft
Sandstone	9	15
Clay	15	38
Sandstone	38	90

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Arthur E. Plummer Son DATE Oct 8/80

ADDRESS 5871 Brand Rd Dublin, O. SIGNED Robert L. Plummer

*If additional space is needed to complete well log, use next consecutive numbered form.

#50

1 241

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

22D 548738

377

COUNTY Franklin TOWNSHIP Blendon SECTION OF TOWNSHIP 1

OWNER Al Coates Bldr ADDRESS 5947 Pine Ridge Ct

LOCATION OF PROPERTY 7157 Lee Rd

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 15'

Type of screen — Length of screen —

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion 3-23-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 20 gpm Duration of test 4 hr

Drawdown 0 ft Date 3-23-79

Static level (depth to water) 10 f

Quality (clear, cloudy, taste, odor) Clear

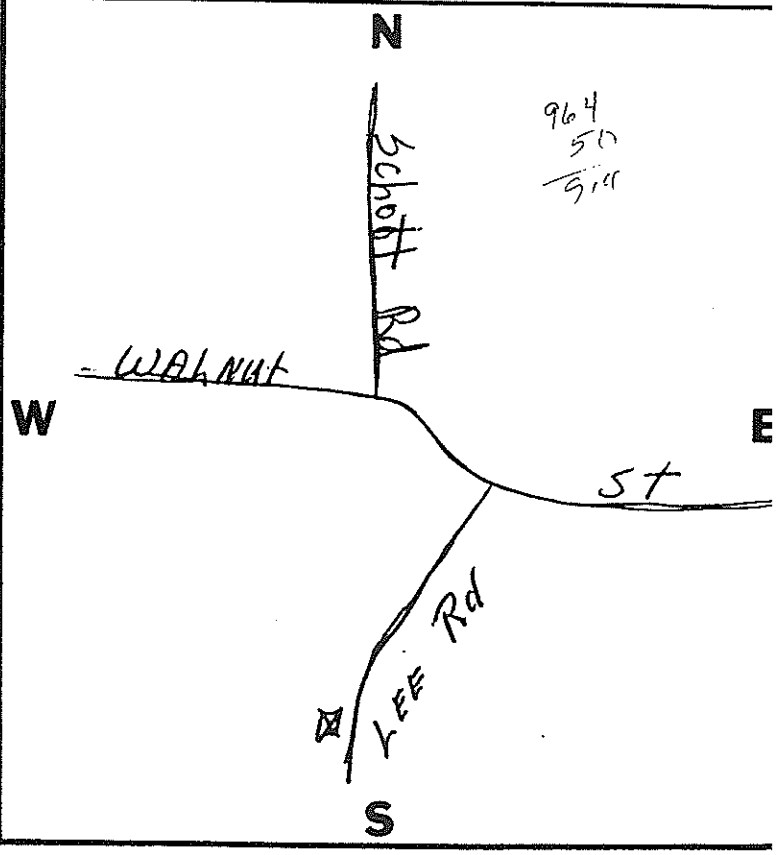
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay	0 ft	5 ft
Sandstone	5	10
Clay	10	11
Sandstone	11	50
Soapstone	50	54
Sandstone	54	60

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Symmes McDonald DATE 3-23-79

ADDRESS Galena Ohio SIGNED C. Mcdonald

*If additional space is needed to complete well log, use next consecutive numbered form.

234 (#51)
231

WE LOG AND DRILLING RE ORT

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

643808

391

COUNTY Franklin TOWNSHIP Blendon SECTION OF TOWNSHIP

OWNER Charles R. Carroll ADDRESS 7318 Lee Rd

LOCATION OF PROPERTY Westerville, O.

CONSTRUCTION DETAILS

Casing diameter 5" Length of casing 26'

Type of screen — Length of screen

Type of pump

Capacity of pump

Depth of pump setting Set pump at 35'

Date of completion Oct 10/84

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 18 gpm Duration of test

Drawdown — ft Date Oct 10/84

Static level (depth to water) 20

Quality (clear, cloudy, taste, odor)

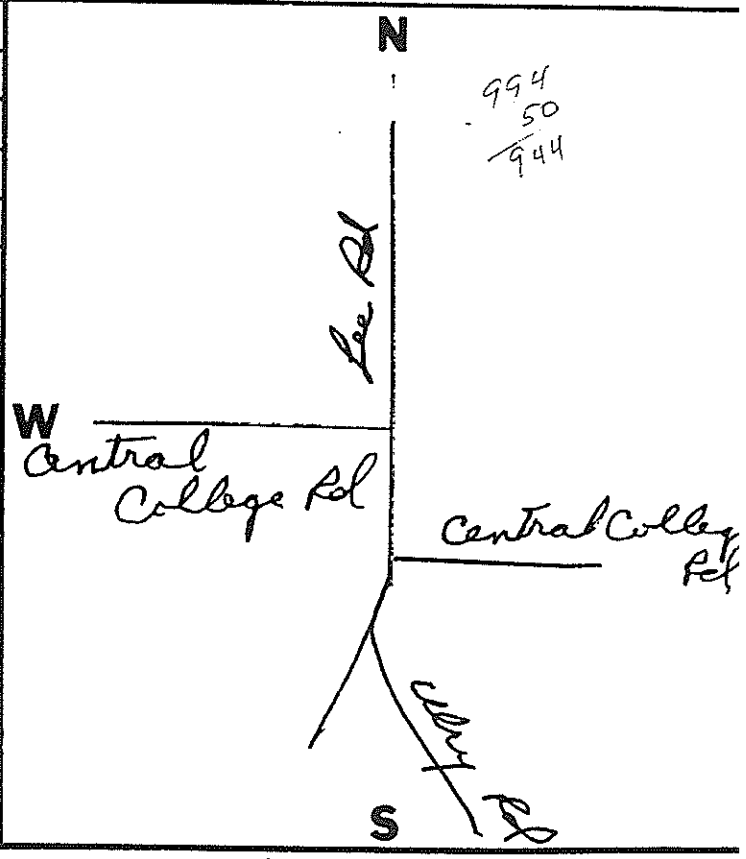
Pump installed by Tested by Bailing

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay	0 ft	6 ft
Sandstone	6	50

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM Arthur E. Plummer & Son DATE Oct 10/84

ADDRESS 176 W. Mohawk Dr. Powell, O SIGNED Robert L. Plummer

*If additional space is needed to complete well log, use next consecutive numbered form.

#79

ORIGINAL COPY - ODNR DIVISION OF WATER FOUNTAIN SQ COLS OHIO 43224 230

APPENDIX B.

WATER-QUALITY DATA

LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Lab Number: SL23148-2
Report Date: 11/05/99
DLZ Project Number: 8503-01

Job Name: BIG WALNUT

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
AOC-1	Aqueous	CLIENT	25 OCT 99/14:00	25 OCT 99

CONSTITUENT	RESULT	*RDL	UNITS	METHOD	ANALYZED	BY
Calcium, Total-SDWA	85.5	0.50	mg/L	200.7	10-29-99	EAJ
Iron, Total-SDWA	<60.0	60.0	ug/L	200.7	10-28-99	EAJ
Magnesium, Total-SDWA	27.6	0.50	mg/L	200.7	10-29-99	EAJ
Manganese, Total-SDWA	182	20.0	ug/L	200.7	10-28-99	EAJ
Potassium, Total-SDWA	2.24	0.50	mg/L	200.7	10-28-99	EAJ
Sodium, Total-SDWA	17.2	1.00	mg/L	200.7	10-29-99	EAJ
Alkalinity - SDWA	300	5	mg/L	2320B	10-26-99	BDY
Chloride - SDWA	18	1	mg/L	4500-CL-B	10-26-99	BDY
Residue Total Filterable @ 180 C	431	20	mg/L	160.1	10-28-99	BDY
Sulfate - SDWA	69	1	mg/L	4500SO4-D	10-26-99	BDY

* Reporting Detection Limit

A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Job Name: BIG WALNUT

Lab Number: SL23148-2
Report Date: 11/05/99
Analyzed :10-29-99
Analyzed by:KBJ
Method :524.2

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
AOC-1	Aqueous	CLIENT	25 OCT 99/14:00	25 OCT 99

ANALYTE	RESULT ug/L	*RDL ug/L
Purgeable Aromatic Hydrocarbons		
Benzene	<0.5	0.5
Toluene	<0.5	0.5
Ethylbenzene	<0.5	0.5
Xylenes, Total	<1.0	1.0

* Reporting Detection Limit

DLZ LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Lab Number: SL23148-1
Report Date: 11/05/99
DLZ Project Number: 8503-01

Job Name: BIG WALNUT

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
ATB-3	Aqueous	CLIENT	25 OCT 99/12:43	25 OCT 99

CONSTITUENT	RESULT	*RDL	UNITS	METHOD	ANALYZED	BY
Calcium, Total-SDWA	155	0.50	mg/L	200.7	10-29-99	EAJ
Iron, Total-SDWA	13700	60.0	ug/L	200.7	10-28-99	EAJ
Magnesium, Total-SDWA	43.6	0.50	mg/L	200.7	10-29-99	EAJ
Manganese, Total-SDWA	317	20.0	ug/L	200.7	10-28-99	EAJ
Potassium, Total-SDWA	22.9	0.50	mg/L	200.7	10-28-99	EAJ
Sodium, Total-SDWA	1990	1.00	mg/L	200.7	10-29-99	EAJ
Alkalinity - SDWA	130	5	mg/L	2320B	10-26-99	BDY
Chloride - SDWA	4620	1	mg/L	4500-CL-B	10-26-99	BDY
Residue Total Filterable @ 180 C	7440	20	mg/L	160.1	10-28-99	BDY
Sulfate - SDWA	74	1	mg/L	4500SO4-D	10-26-99	BDY

* Reporting Detection Limit

DLZ LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Job Name: BIG WALNUT

Lab Number: SL23148-1
Report Date: 11/05/99
Analyzed :10-28-99
Analyzed by:KBJ
Method :524.2

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
ATB-3	Aqueous	CLIENT	25 OCT 99/12:43	25 OCT 99

ANALYTE	RESULT ug/L	*RDL ug/L
Purgeable Aromatic Hydrocarbons		
Benzene	16.2	0.5
Toluene	3.8	0.5
Ethylbenzene	1.3	0.5
Xylenes, Total	2.8	1.0

* Reporting Detection Limit

DLZ LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Lab Number: C9912090-1
Report Date: 04/18/00
DLZ Project Number: 9507-07

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
ATB-4R EARLY	Aqueous	CLIENT	16 DEC 99/11:25	16 DEC 99

CONSTITUENT	RESULT	*RDL	UNITS	METHOD	ANALYZED	BY
Calcium, Total-SDWA	1600	0.1	mg/L	200.7	04-07-00	SUB
Iron, Total-SDWA	19600	50.0	ug/L	200.7	02-23-00	EAJ
Magnesium, Total-SDWA	452	0.50	mg/L	200.7	02-23-00	EAJ
Manganese, Total-SDWA	211	20.0	ug/L	200.7	02-23-00	EAJ
Potassium, Total-SDWA	52.3	0.50	mg/L	200.7	02-23-00	EAJ
Sodium, Total-SDWA	5500	0.1	mg/L	200.7	04-07-00	SUB
Alkalinity - SDWA	270	2	mg/L	310.1	12-26-99	BDY
Chloride - SDWA	17000	1.0	mg/L	325.3	12-28-99	BDY
Residue Total Filterable @ 180 C	28000	1	mg/L	160.1	12-23-99	JRM
Sulfate - SDWA	<1	1	mg/L	375.4	12-28-99	BDY

* Reporting Detection Limit

6121 Huntley Road • Columbus, Ohio 43229-1003 • Telephone (614) 848-4333 • FAX (614) 841-0818
E-Mail: dlzlabs@dlzcorp.com

DLZ LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Lab Number: C9912090-1
Report Date: 04/18/00
Analyzed :12-21-99
Analyzed by:KBJ
Method :524.2

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
ATB-4R EARLY	Aqueous	CLIENT	16 DEC 99/11:25	16 DEC 99

ANALYTE	RESULT ug/L	*RDL ug/L
Purgeable Aromatic Hydrocarbons		
Benzene	1.2	0.5
Toluene	1.0	0.5
Ethylbenzene	<0.5	0.5
Xylenes, Total	<1.0	1.0

* Reporting Detection Limit

LABORATORIES, INC.
A DLZ Company
ENVIRONMENTAL TESTING • COMPLIANCE ANALYSES
INDUSTRIAL HYGIENE

MR. CHRIS COBEL
EAGON & ASSOCIATES, INC.
100 OLD WILSON BRIDGE ROAD, SUITE 320
WORTHINGTON OH 43085

Lab Number: C9912090-1
Report Date: 04/18/00
Analyzed :01-03-00
Analyzed by:DEB
Method :120.1

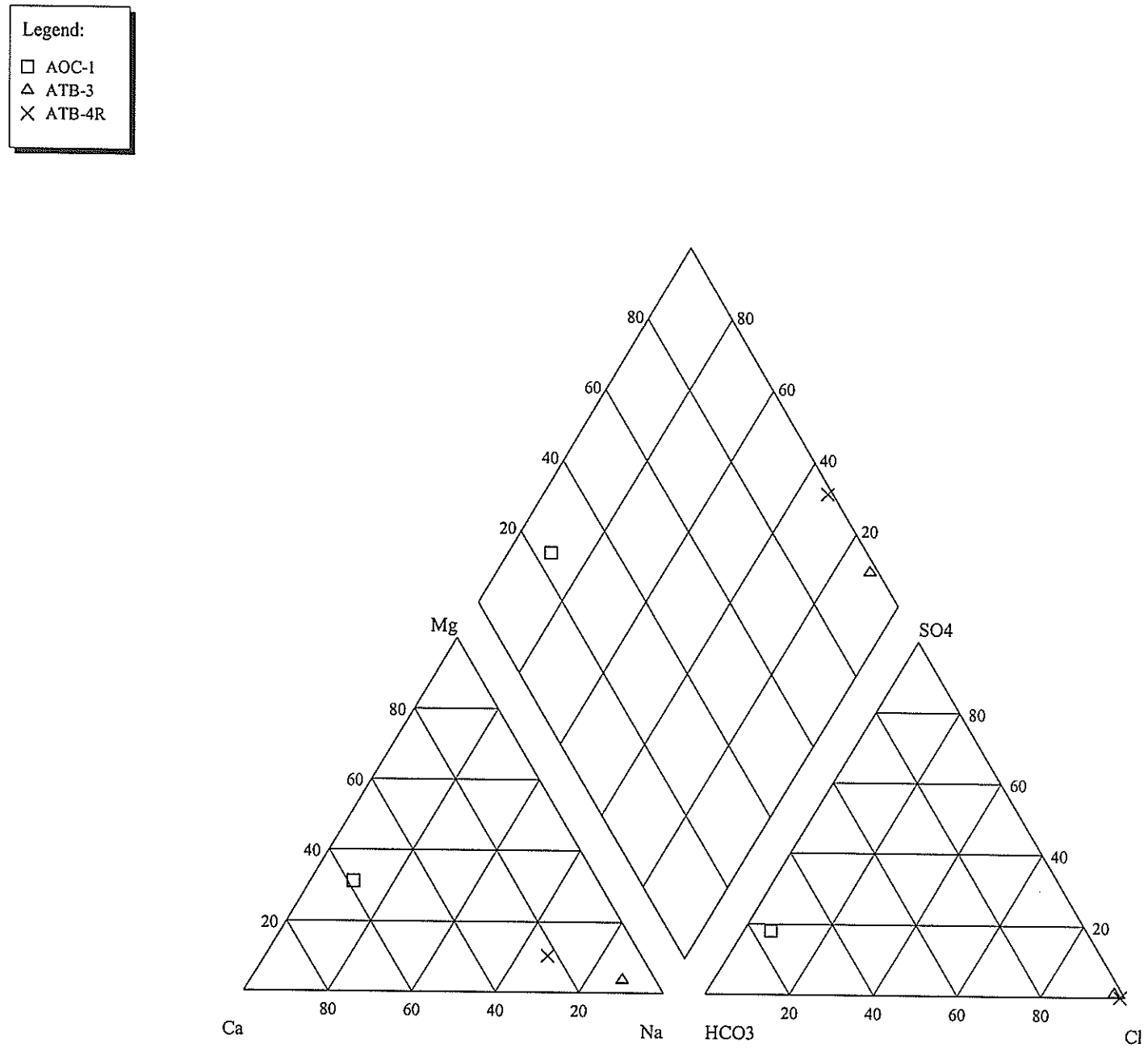
SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE/TIME	RECEIVED
ATB-4R EARLY	Aqueous	CLIENT	16 DEC 99/11:25	16 DEC 99

ANALYTE	RESULT UMHOS/CM	*RDL UMHOS/CM
Conductivity	56000	

* Reporting Detection Limit

FIELD WATER-QUALITY RESULTS
AOC-1, ATB-3, ATB-4R
BIG WALNUT SANITARY TRUNK SEWER EXTENSION

Well No.	Date	pH (SU)	Specific Conductance (umhos/cm)	Turbidity (NTU)	Temp (°C)	Notes
AOC-1	10/25/1999	6.70	748	3.28	13.3	
ATB-3	10/25/1999	6.17	8840	>1,000	13.6	Slight H_2S odor
ATB-4R	12/16/1999	6.61	19,000	>1,000	--	



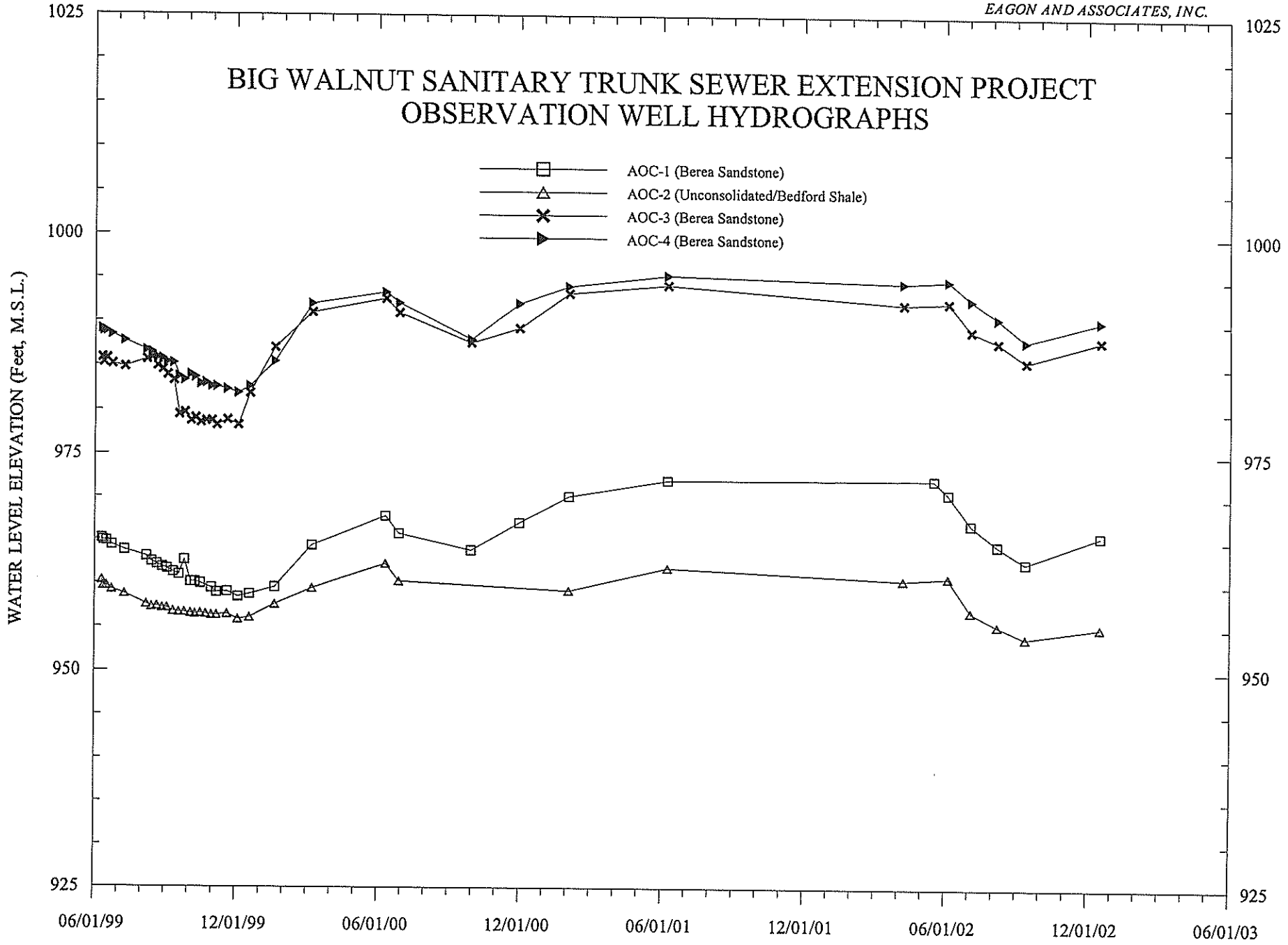
PIPER TRILINEAR DIAGRAM, BIG WALNUT

APPENDIX C.

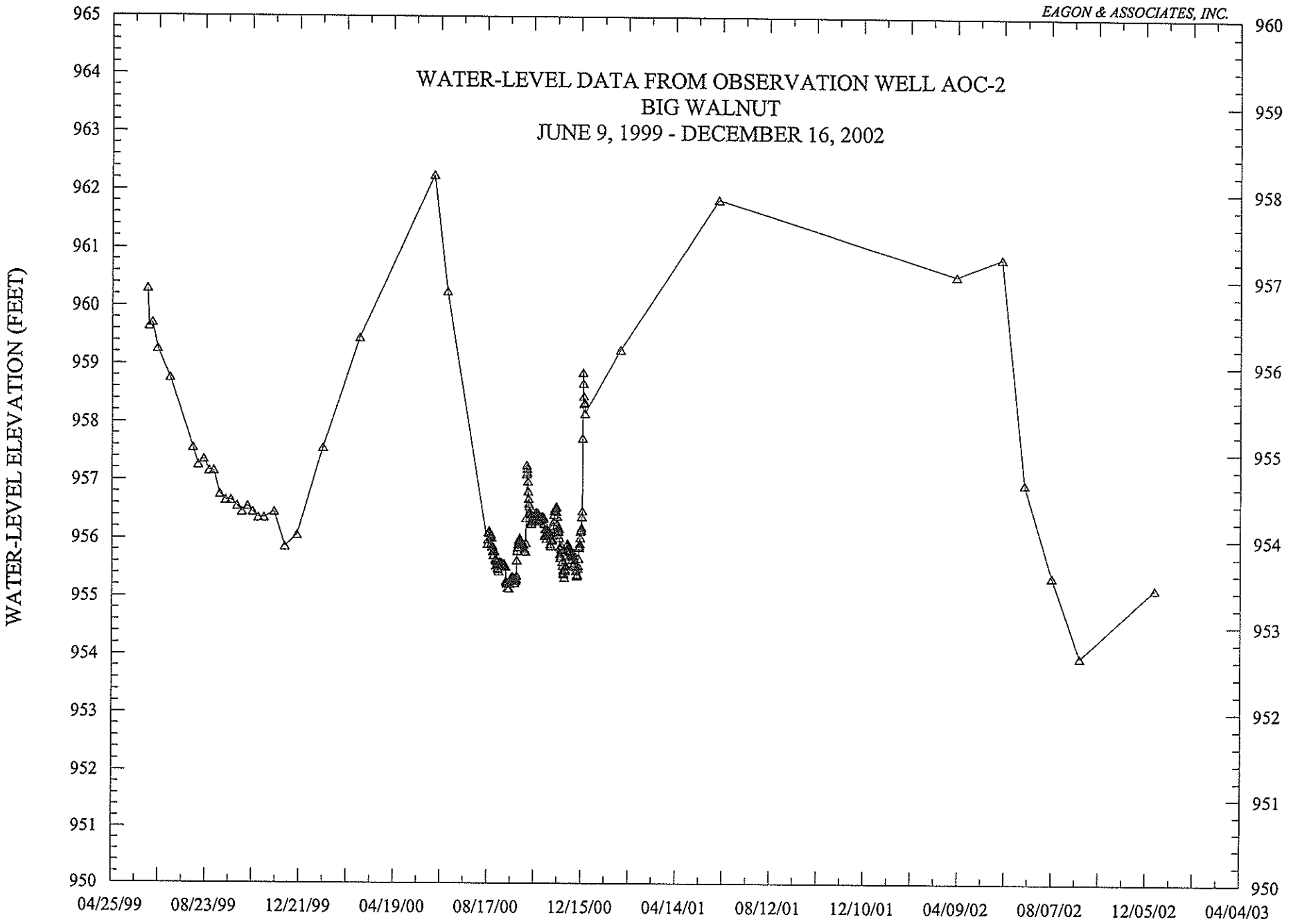
HYDROGRAPHS

EAGON AND ASSOCIATES, INC.

BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



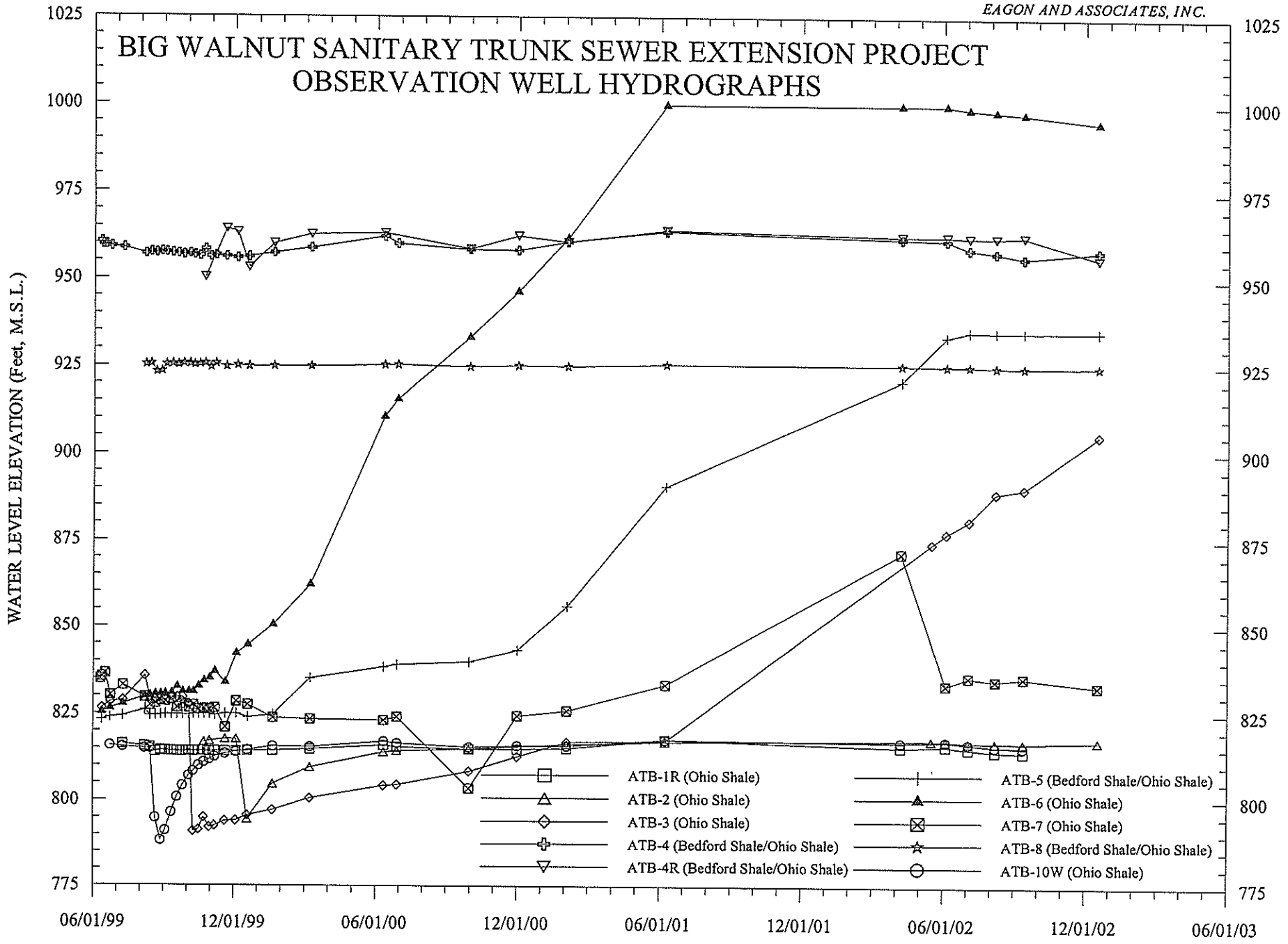
BIGWALNUT/AOCHYD.GRF
1/6/03



BIGWALNUT/AOC-2.GRF
1/7/03

EAGON AND ASSOCIATES, INC.

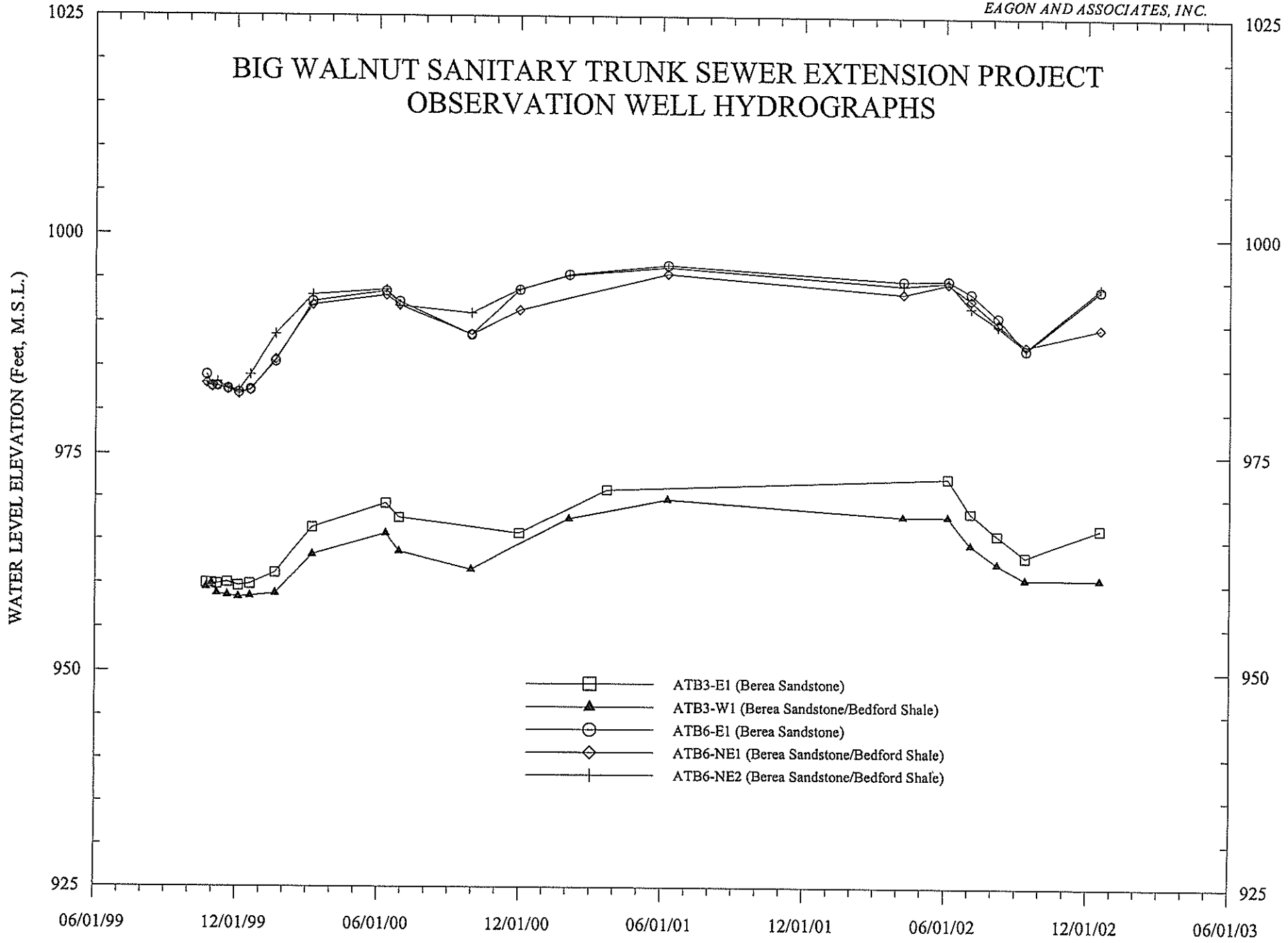
BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



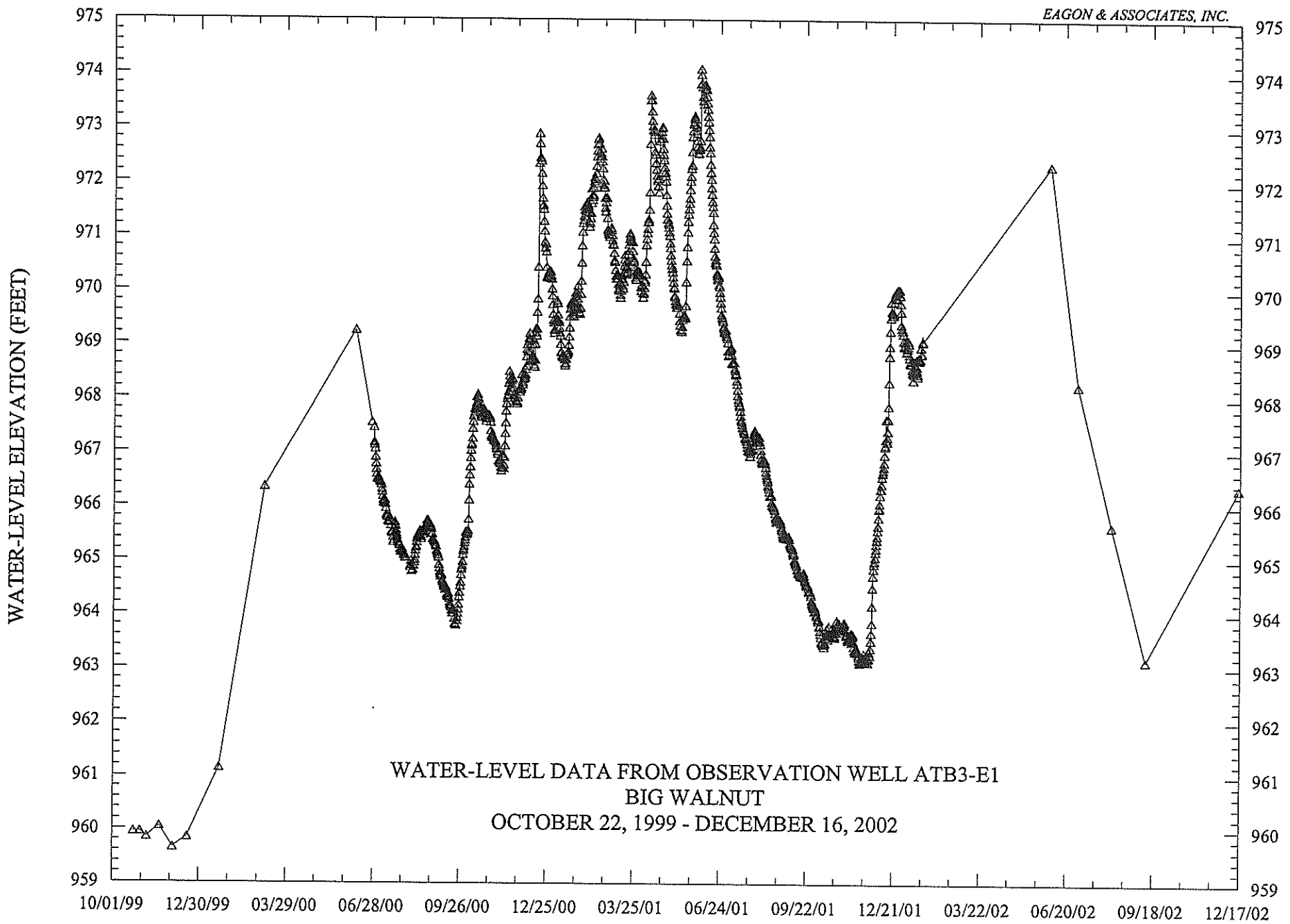
BIGWALNUT/ATBHYD.GRF
1/6/03

EAGON AND ASSOCIATES, INC.

BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



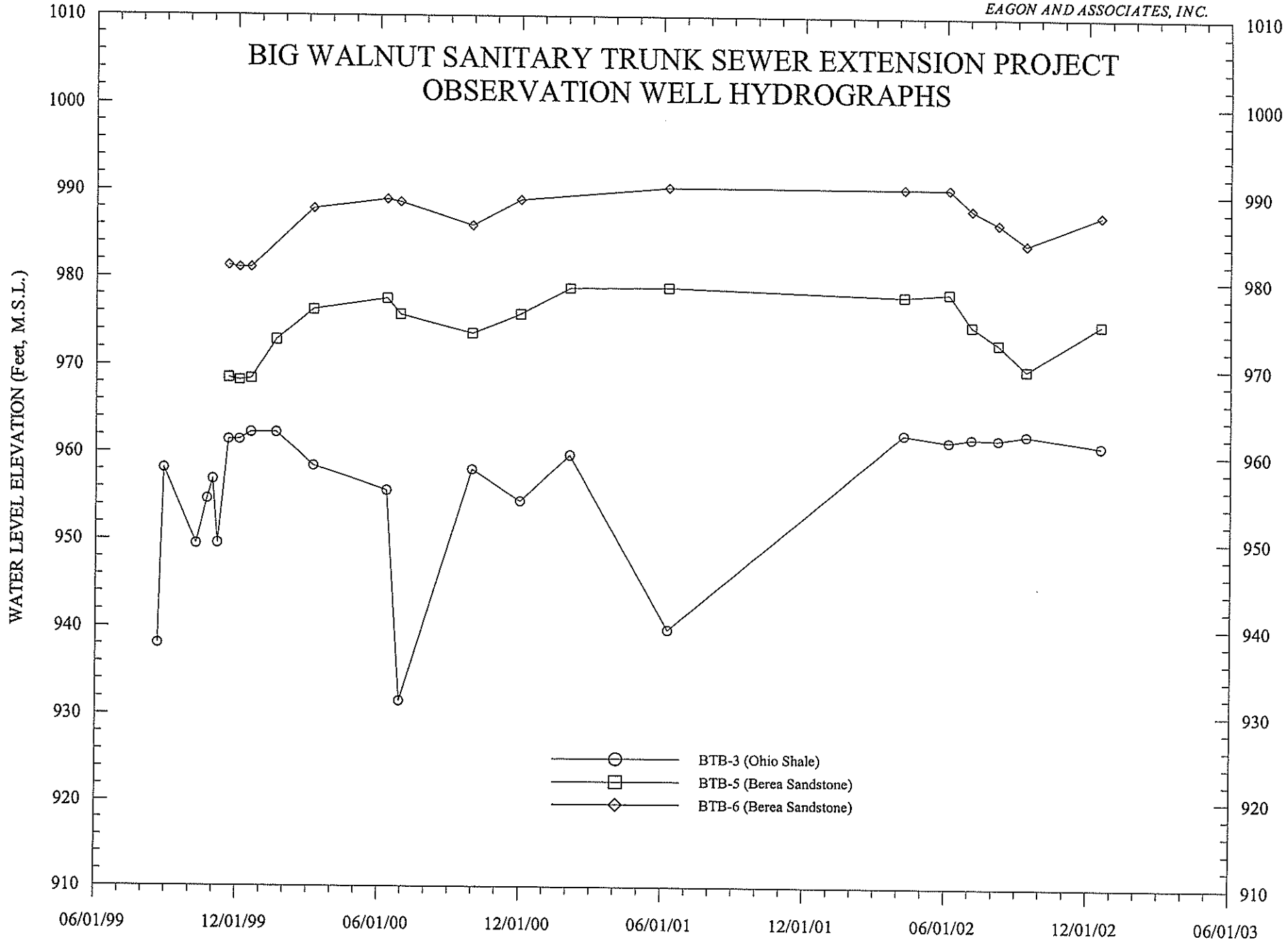
BIGWALNUT/E-1HYD.GRF
1/6/03



BIGWALNUT/E1.GRF
1/6/03

EAGON AND ASSOCIATES, INC.

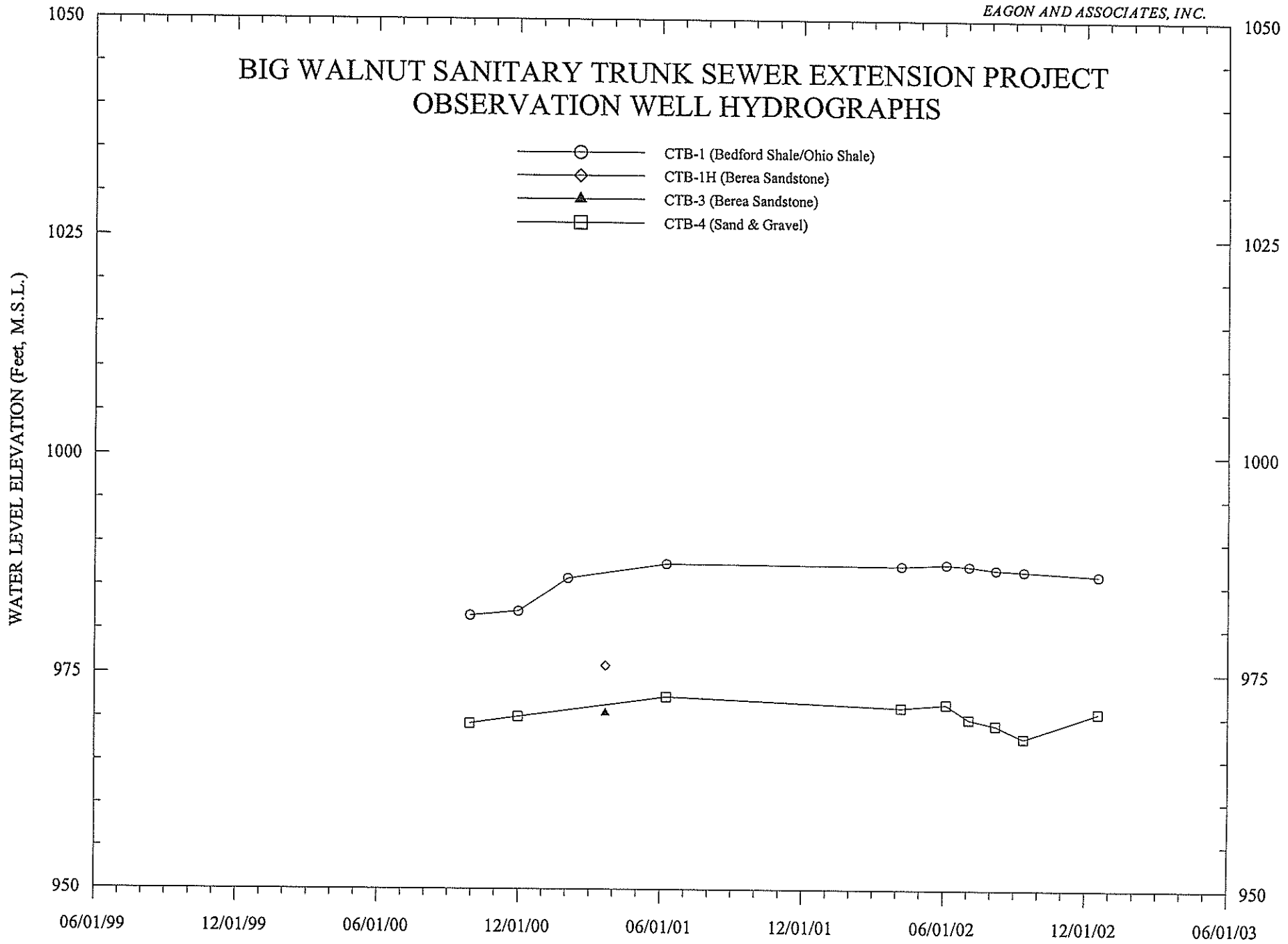
BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



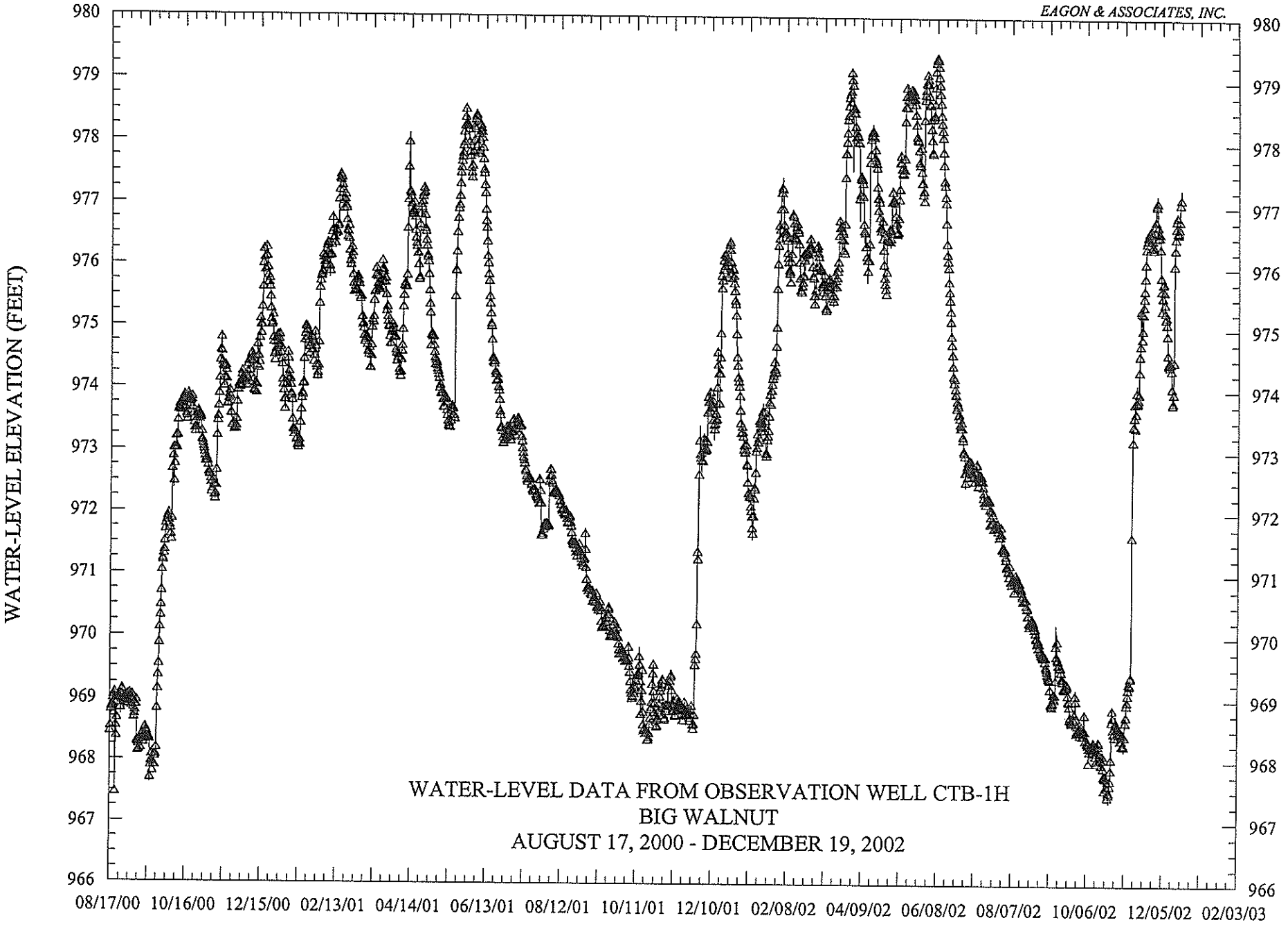
BIGWALNUT/BTBHYD.GRF
1/6/03

EAGON AND ASSOCIATES, INC.

BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



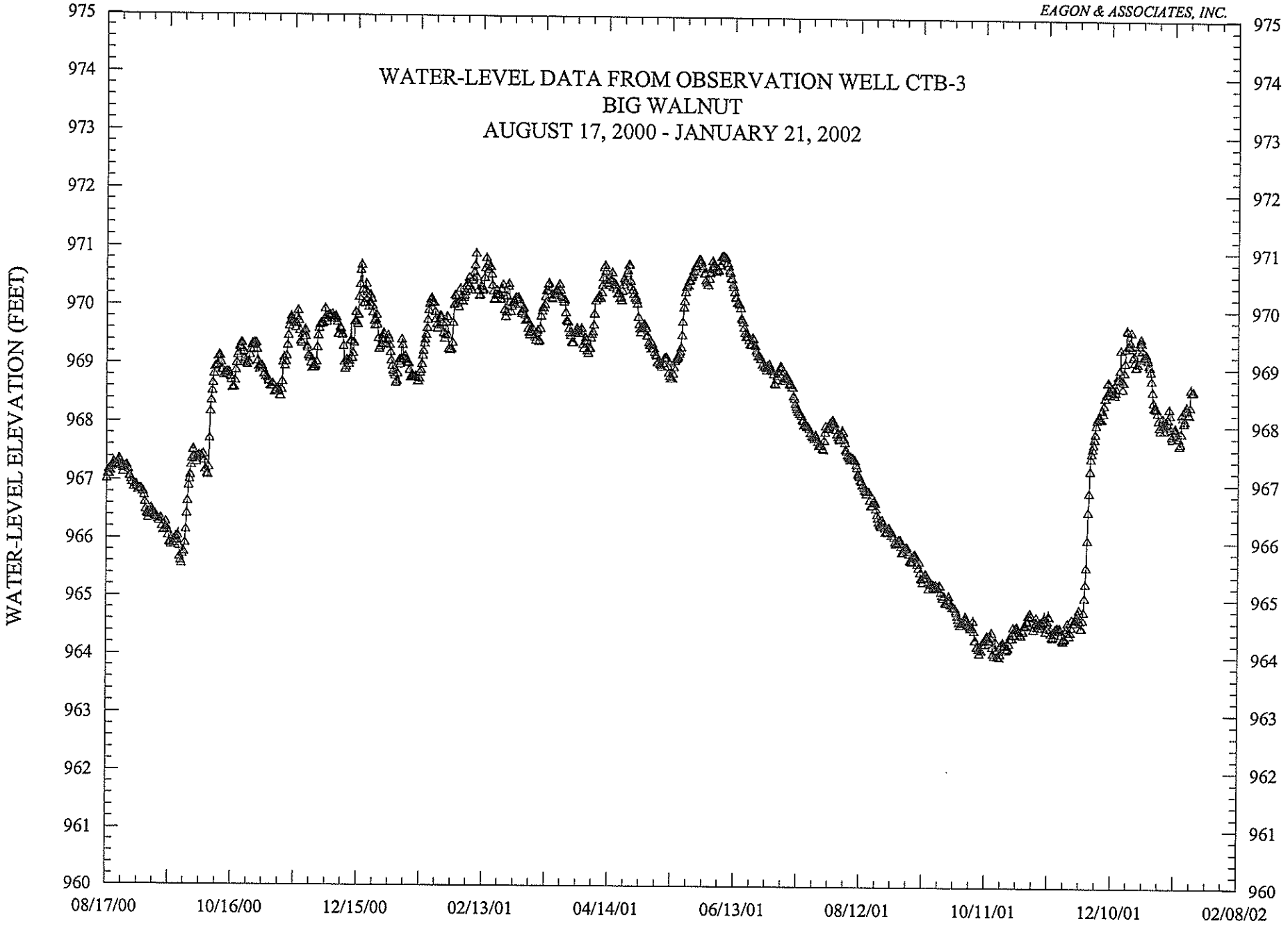
BIGWALNUT/CTBHYD.GRF
1/6/03



BIGWALNUT/CTB-1H.GRF
1/7/03

EAGON & ASSOCIATES, INC.

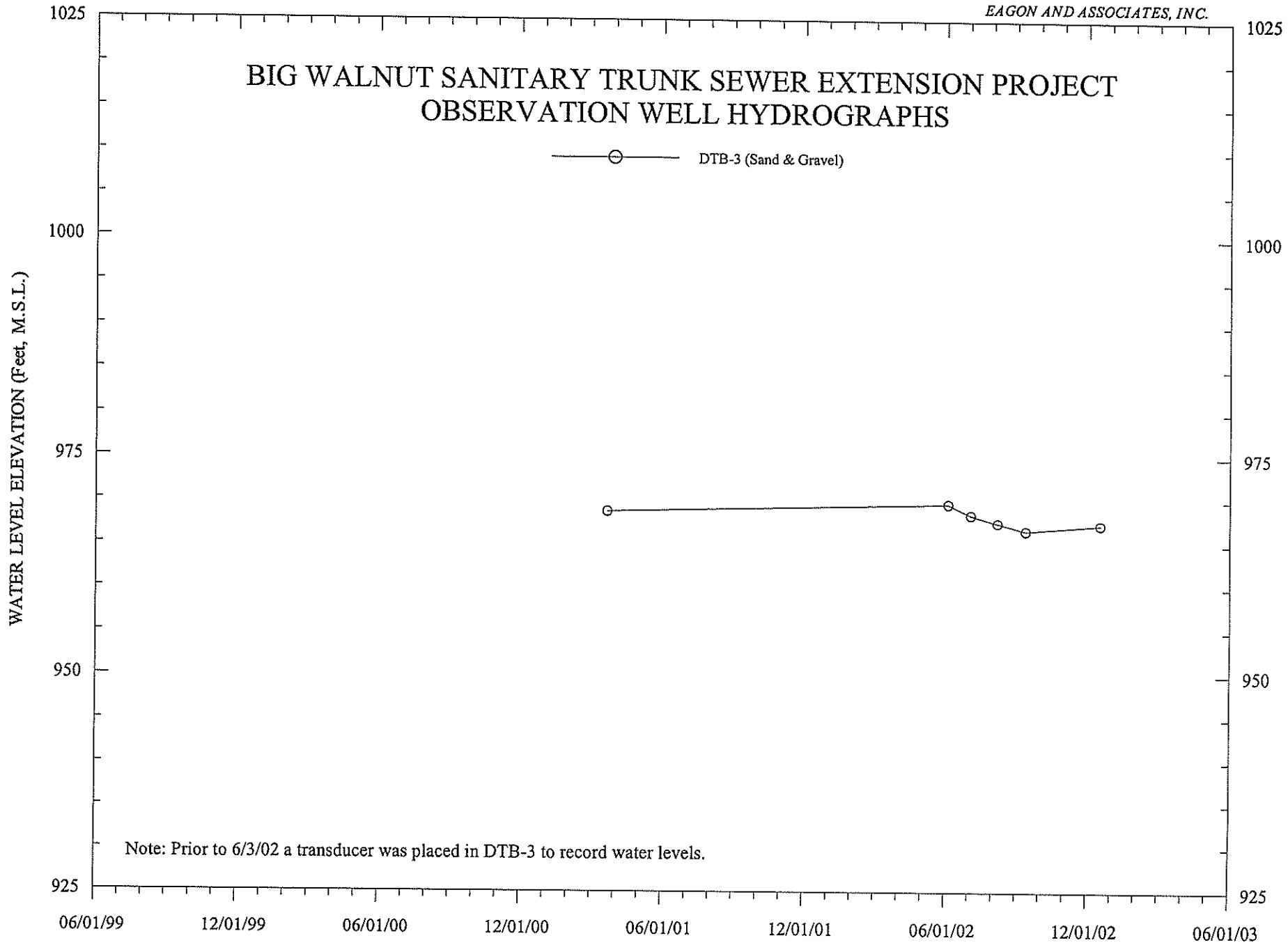
WATER-LEVEL DATA FROM OBSERVATION WELL CTB-3
BIG WALNUT
AUGUST 17, 2000 - JANUARY 21, 2002



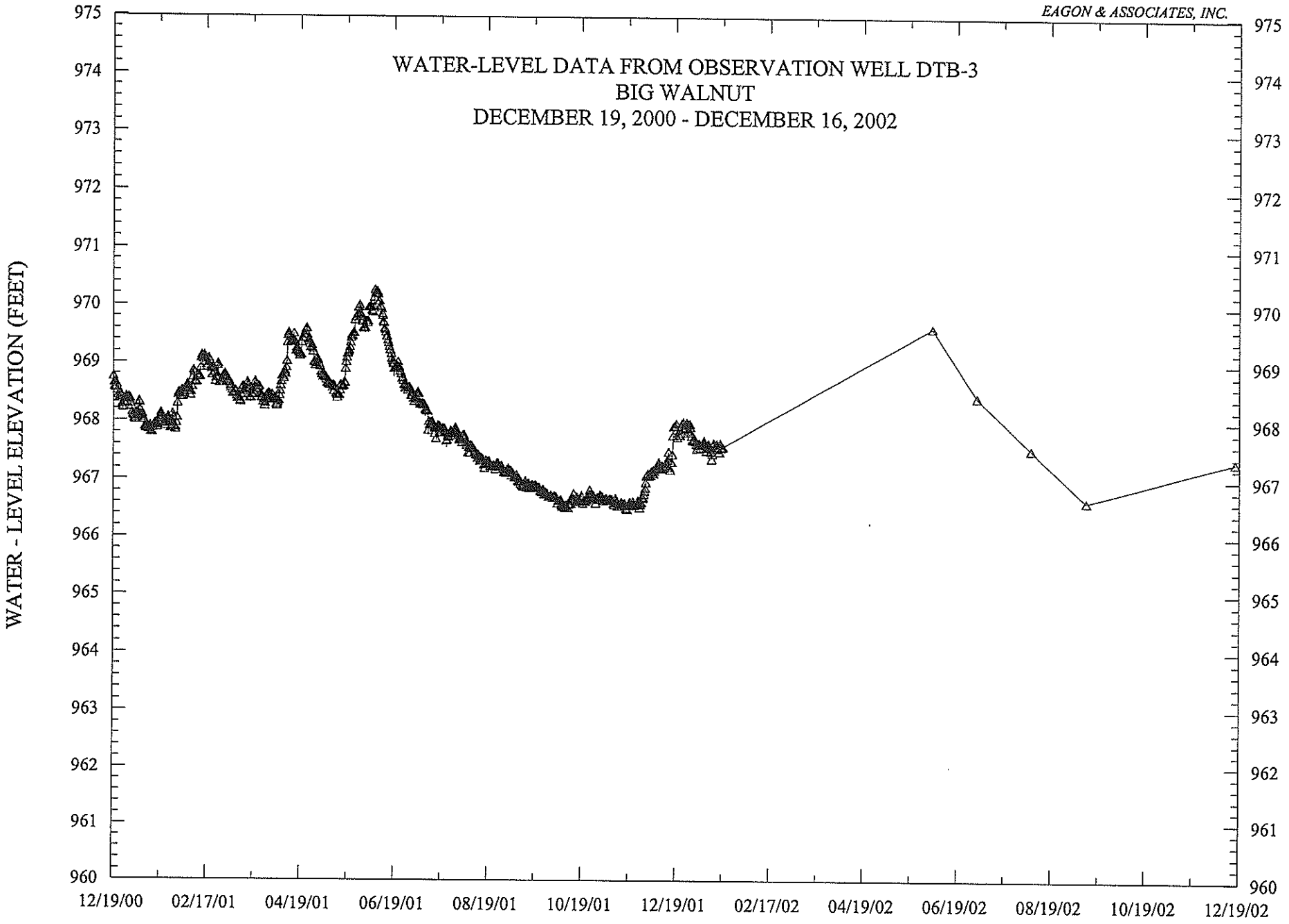
BIGWALNUT/CTB-3.GRF
9/16/02

EAGON AND ASSOCIATES, INC.

BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



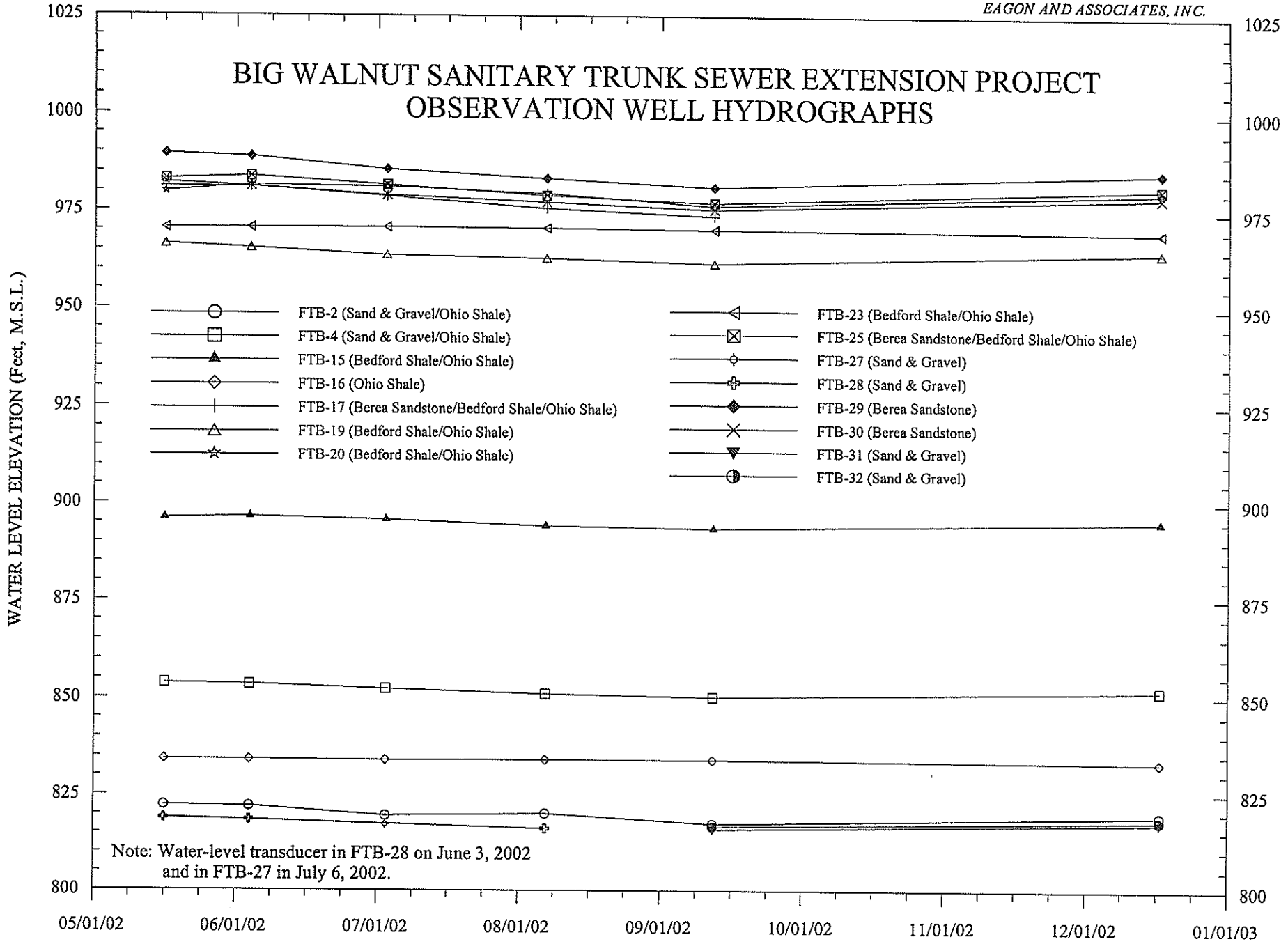
BIGWALNUT/DTB-3HYD.GRF
1/6/03



BIGWALNUT/DTB-3.GRF
1/7/03

EAGON AND ASSOCIATES, INC.

BIG WALNUT SANITARY TRUNK SEWER EXTENSION PROJECT
OBSERVATION WELL HYDROGRAPHS



Note: Water-level transducer in FTB-28 on June 3, 2002
and in FTB-27 in July 6, 2002.

BIGWALNUT/FTBHYD.GRF
1/6/03

PROJECT NO. 2016053A **DATE** 4/7/2018 **LOG OF TEST BORING** **BOCI-01**

ELEVATION ft	Depth	DEPTH (ft)	SAMPLE NO.	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	PID (ppm)
	Ground Surface Elevation	0											
	TOPSOIL 1.0												
	FILL - Medium dense poorly graded fine sand, trace clay, trace wood fragments, brown, moist (SP) (foreign odor noted) 3.5		SS1	7-12-10	22	2.5							
	FILL - Very soft lean clay, few sand, trace wood fragments, trace organics, gray and brown (CL) 6.0	5	SS2	3-2-2	4	5.0	<>	18.1					
	FILL - Very loose poorly graded fine sand, trace gravel, trace clay, trace wood fragments, gray, wet (SP) 8.5		SS3	2-1-3	4	7.5							
		10	SS4	3-5-8	13	10.0		18.9					
	Medium dense to dense SILT, few fine sand, trace clay, gray, wet (ML) (clay layer at 13.5 feet)		SS5	10-14-17	31	12.5		18.2		NP	NP	89	
	16.0	15	SS6	3-6-6	12	15.0							
			SS7	2-4-6	10	17.5	5000*	19.1					
	Stiff to very stiff LEAN CLAY, frequent silt partings, occasionally silty clay layers, gray (CL)	20	SS8	6-7-8	15	20.0	5000*	19.8		26	9	100	
			SS9	3-4-7	11	22.5	4500*	19.1					
		25	SS10	4-6-6	12	25.0	2000*	24.8		28	7	100	

▼ SPT N VALUE ▼ 10 20 30 40

● MOISTURE CONTENT (%) ● 10 20 30 40

■ UCS STRENGTH (psf) ■ 2000 4000 6000 8000

BORING COORDINATES

GROUNDWATER READINGS
First Encountered: 6 feet
Upon Completion: None
Remarks:

Drilling Company: DLZ
Drill Rig: CME-55 Track
Engineer on Rig:
Drilling Method: 3 1/4 inch HSA
Hammer Type: Auto
Backfilled With: Cuttings/bentonite grout
Date Started: 04-07-18
Date Completed: 04-04-18
Checked By: SAP

Torvane
* Pocket Penetrometer
<> Disturbed Sample

DRAFT

Somat Engineering

Burke Open Channel Improvements
Northeast Ohio Regional Sewer District
Cleveland, Ohio

PROJECT NO. 2016053A **DATE** 11/2/2017 **LOG OF TEST BORING** **BOCI-04**

ELEVATION ft	Depth	DEPTH (ft)	SAMPLE NO.	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	PID (ppm)
	Ground Surface Elevation	0											
	13" TOPSOIL 1.1												
	FILL: Loose silty sand, trace clay, brown, moist (SM) 3.5		SS1	1-2-2	4	2.6							
	FILL: Medium dense poorly graded fine sand, trace silt, reddish brown, moist (SP) 4.2	5	SS2	2-8-5	13	5.0							
	FILL: Loose silty fine sand, trace gravel, trace clay, dark brown, moist (SM) 8.5		SS3	2-2-3	5	7.5		12.0				26	
	Loose SILT, trace clay, trace fine sand, brown with gray, contains roots, wet (ML) 11.0	10	SS4	1-2-4	6	10.0		22.5					
	Medium dense SILT, few clay, trace fine sand, gray, wet (ML) 13.5		SS5	5-8-9	17	12.5		17.2		NP	NP	95	
	Stiff LEAN CLAY, gray (CL)	15	SS6	1-2-3	5	15.0	4000*	20.7					
			SS7	2-3-3	6	17.5	4000*	19.0		24	8	99	
		20	SS8	1-2-3	5	20.0	3000*	22.8					
			SS9	1-3-3	6	22.5	4000*	20.8					
		25	SS10	1-2-3	5	25.0	3000*	22.0		28	8	100	

▼ SPT N VALUE ▼ (10 20 30 40)

● MOISTURE CONTENT (%) ● (10 20 30 40)

■ UCS STRENGTH (psf) ■ (2000 4000 6000 8000)

BORING COORDINATES

GROUNDWATER READINGS
First Encountered: 8.5 feet
Upon Completion: None
Remarks:

Drilling Company: DLZ
Drill Rig: CME-75 Track
Engineer on Rig:
Drilling Method: 3 1/4 inch HSA
Hammer Type: Auto
Backfilled With: Auger cuttings and grout
Date Started: 11-02-17
Date Completed: 11-02-17
Checked By: RAK

Torvane
* Pocket Penetrometer
<> Disturbed Sample

DRAFT

Somat Engineering

Morgana Run Relief Sewer
Northeast Ohio Regional
Cleveland, Ohio

LEGEND

- PLANNED SEWER ALIGNMENT
- 970 — ELEVATION OF BEDROCK SURFACE (FT. MSL). CONTOUR INTERVAL 25 FEET
- ×974 — BEDROCK ELEVATION (FT. MSL)
- ◇880 — SEISMIC SURVEY DATA
- PW-2A ○ — PUMPING TEST WELL
- ATB6-NE2 — GEOTECHNICAL BORING/PIEZOMETER USED FOR HYDROGEOLOGIC CHARACTERIZATION AND/OR WATER LEVEL DATA COLLECTION
- OTHER GEOTECHNICAL BORING/PIEZOMETER
- 186 — MAP LOCATION NUMBERS FOR RESIDENTIAL WELL SURVEY/DATABASE (TABLES 3-1 & 3-2)
- 124 — ODNR MAP LOCATION NUMBERS FOR ADDITIONAL WELL LOGS USED FOR HYDROGEOLOGIC CHARACTERIZATION (700 SERIES FIELD LOCATED BY EAGON & ASSOCIATES)

HOOVER RESERVOIR
HOOVER DAM
CENTRAL COLLEGE RD CO 18
BIG WALNUT CREEK
CUBBAGE ROAD
WALNUT ST CO 19
SCHOTT RD CO 112
LEE RD CO 169
ULRY RD CO 169
SHAFT 1
SHAFT 2
SHAFT 3
SHAFT 4
SHAFT 5
SHAFT 6
HARLEM RD CO 111
BARDWARK PL
CAUSEA DR

GRAPHIC SCALE IN FEET 0 400 800

DESIGNED BY: HBE	PLATE TITLE: BEDROCK SURFACE
DRAFTED BY: RMH/CAK	PROJECT TITLE: BIG WALNUT SANITARY TRUNK SEWER EXTENSION
CHECKED BY: HBE	PREPARED BY: EAGON & ASSOCIATES, INC. 100 OLD WILSON BRIDGE ROAD, SUITE 320 WORTHINGTON, OHIO 43085
APPROVED BY: HBE	PLATE NUMBER: 1
DATE: FEBRUARY 28, 2003	

C:\ACADDRWG\WALNUT\3-12-2002\BW-EAGON1.DWG 2/28/03

LEGEND

- PLANNED SEWER ALIGNMENT
- 970 — POTENTIOMETRIC (WATER LEVEL) ELEVATION CONTOUR (FT. MSL)
- 974 — WATER LEVELS MEASURED DURING WELL SURVEY SUPPLEMENTED BY WELL LOG DATA
- GROUND-WATER FLOW DIRECTION
- PW-2A — PUMPING TEST WELL
- ATB6-NE2 — GEOTECHNICAL BORING/PIEZOMETER USED FOR HYDROGEOLOGIC CHARACTERIZATION AND/OR WATER LEVEL DATA COLLECTION
- OTHER GEOTECHNICAL BORING/PIEZOMETER
- 186 — MAP LOCATION NUMBERS FOR RESIDENTIAL WELL SURVEY/DATABASE (TABLES 3-1 & 3-2)
- 124 — ODNR MAP LOCATION NUMBERS FOR ADDITIONAL WELL LOGS USED FOR HYDROGEOLOGIC CHARACTERIZATION (700 SERIES FIELD LOCATED BY EAGON & ASSOCIATES)

HOOVER RESERVOIR
HOOVER DAM
CENTRAL COLLEGE RD CO 18
WALNUT ST CO 19
SCHOTT RD CO 112
LEE RD CO 189
CUBBAGE ROAD
BIG WALNUT CREEK
BANDMARK PL
ULRY RD CO 188
HARLEM RD CO 111
CAUTELA DR
SHAFT 1
SHAFT 2
SHAFT 3
SHAFT 4
SHAFT 5
SHAFT 6

GRAPHIC SCALE IN FEET 0 400 800

COMPILED BY: HBE	PLATE TITLE: POTENTIOMETERIC SURFACE BEREA SANDSTONE AQUIFER - JULY 1999
DRAFTED BY: RMH/CAK	PROJECT TITLE: BIG WALNUT SANITARY TRUNK SEWER EXTENSION
CHECKED BY: HBE	PREPARED BY: EAGON & ASSOCIATES, INC. 100 OLD WILSON BRIDGE ROAD, SUITE 320 WORTHINGTON, OHIO 43085
APPROVED BY: HBE	PLATE NUMBER: 2
DATE: FEBRUARY 28, 2003	

C:\ACADDWG\WALNUT\3-12-2002\BW-EAGON1.DWG 2/28/03

Appendix I SOIL LABORATORY TESTING RESULTS

I.1 Specific Gravity Laboratory Results

I.2 Soil Classification Laboratory Results

I.3 Triaxial Compression Laboratory Results

I.1 SPECIFIC GRAVITY LABORATORY RESULTS

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-4
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #8

Mass of Pycnometer: 46.99 g (Mf)
Mass of Pycnometer + Sample: 56.99 g
Mass of Sample: 10 g (Mo)

Mass of Pycnometer + Sample + Water: 153.025 g (Mb)
Water Temperature: 23.4 C (Tb)
Mass of Pycnometer with Water @ Tb: 146.626 g (Ma)* for Pyc.# 8

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02358 (Tb) + 147.178
for Pycnometer #8 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.777** K @ Tb = 0.99922 (see chart)
G @ 20.0 C = **2.775**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-6
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____

Pycnometer No. PYC #7

Mass of Pycnometer: 46.89 g (Mf)
Mass of Pycnometer + Sample: 56.891 g
Mass of Sample: 10.001 g (Mo)

Mass of Pycnometer + Sample + Water: 153.147 g (Mb)
Water Temperature: 23.4 C (Tb)
Mass of Pycnometer with Water @ Tb: 146.734 g (Ma)* for Pyc.# 7

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02363 (Tb) + 147.287
for Pycnometer #7 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.787 K @ Tb = 0.99922 (see chart)
G @ 20.0 C = 2.785

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-10
Technician: Hoyt
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #8

Mass of Pycnometer: 46.994 g (Mf)
Mass of Pycnometer + Sample: 56.998 g
Mass of Sample: 10.004 g (Mo)

Mass of Pycnometer + Sample + Water: 153.022 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 146.624 g (Ma)* for Pyc.# 8

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02358 (Tb) + 147.178
for Pycnometer #8 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.774 K @ Tb = 0.9992 (see chart)
G @ 20.0 C = 2.772

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-13
Technician: Hoyt
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____

Pycnometer No. PYC #9

Mass of Pycnometer: 46.839 g (Mf)
Mass of Pycnometer + Sample: 56.842 g
Mass of Sample: 10.003 g (Mo)

Mass of Pycnometer + Sample + Water: 151.949 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.554 g (Ma)* for Pyc.# 9

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02336 (Tb) + 146.098
for Pycnometer #9 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.772** K @ Tb = 0.99924 (see chart)
G @ 20.0 C = **2.770**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-15
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #10

Mass of Pycnometer: 46.471 g (Mf)
Mass of Pycnometer + Sample: 56.474 g
Mass of Sample: 10.003 g (Mo)

Mass of Pycnometer + Sample + Water: 152.272 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.865 g (Ma)* for Pyc.# 10

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02352 (Tb) + 146.414
for Pycnometer #10 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.781 K @ Tb = 0.99924 (see chart)
G @ 20.0 C = 2.779

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-38
Sample No.: S-16
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____

Pycnometer No. PYC #9

Mass of Pycnometer: 46.84 g (Mf)
Mass of Pycnometer + Sample: 56.84 g
Mass of Sample: 10 g (Mo)

Mass of Pycnometer + Sample + Water: 151.953 g (Mb)
Water Temperature: 23.4 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.552 g (Ma)* for Pyc.# 9

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02336 (Tb) + 146.098
for Pycnometer #9 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.779 K @ Tb = 0.99922 (see chart)
G @ 20.0 C = 2.777

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-5
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #10

Mass of Pycnometer: 46.467 g (Mf)
Mass of Pycnometer + Sample: 56.474 g
Mass of Sample: 10.007 g (Mo)

Mass of Pycnometer + Sample + Water: 152.263 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.865 g (Ma)* for Pyc.# 10

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02352 (Tb) + 146.414
for Pycnometer #10 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.772** K @ Tb = 0.9992 (see chart)
G @ 20.0 C = **2.770**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-7
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #11

Mass of Pycnometer: 47.15 g (Mf)
Mass of Pycnometer + Sample: 57.148 g
Mass of Sample: 9.998 g (Mo)

Mass of Pycnometer + Sample + Water: 152.267 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.865 g (Ma)* for Pyc.# 11

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02336 (Tb) + 146.409
for Pycnometer #11 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.780 K @ Tb = 0.99924 (see chart)
G @ 20.0 C = 2.778

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-9
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____ Vacuumed

Pycnometer No. PYC #12

Mass of Pycnometer: 47.108 g (Mf)
Mass of Pycnometer + Sample: 57.107 g
Mass of Sample: 9.999 g (Mo)

Mass of Pycnometer + Sample + Water: 151.869 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.503 g (Ma)* for Pyc.# 12

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02328 (Tb) + 146.046
for Pycnometer #12 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.752** K @ Tb = 0.99924 (see chart)
G @ 20.0 C = **2.750**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-11
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #1

Mass of Pycnometer: 32.471 g (Mf)
Mass of Pycnometer + Sample: 42.475 g
Mass of Sample: 10.004 g (Mo)

Mass of Pycnometer + Sample + Water: 88.339 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 81.947 g (Ma)* for Pyc.# 1

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01171 (Tb) + 82.222
for Pycnometer #1 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.770 K @ Tb = 0.9992 (see chart)
G @ 20.0 C = 2.767

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0		1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
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6350 Presidential Gateway
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Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-13
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____

Pycnometer No. PYC #2

Mass of Pycnometer: 32.392 g (Mf)
Mass of Pycnometer + Sample: 42.392 g
Mass of Sample: 10 g (Mo)

Mass of Pycnometer + Sample + Water: 88.301 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 81.928 g (Ma)* for Pyc.# 2

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01172 (Tb) + 82.203
for Pycnometer #1 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.757** K @ Tb = 0.9992 (see chart)
G @ 20.0 C = **2.755**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

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6350 Presidential Gateway
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Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-18
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #3

Mass of Pycnometer: 32.059 g (Mf)
Mass of Pycnometer + Sample: 42.059 g
Mass of Sample: 10 g (Mo)

Mass of Pycnometer + Sample + Water: 88.014 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 81.645 g (Ma)* for Pyc.# 3

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01174 (Tb) + 81.921
for Pycnometer #3 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.754** K @ Tb = 0.9992 (see chart)
G @ 20.0 C = **2.752**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
Columbus, Ohio 43231
Phone (614) 823-4949
Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-23
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #4

Mass of Pycnometer: 32.041 g (Mf)
Mass of Pycnometer + Sample: 42.046 g
Mass of Sample: 10.005 g (Mo)

Mass of Pycnometer + Sample + Water: 88.497 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 82.110 g (Ma)* for Pyc.# 4

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01185 (Tb) + 82.388
for Pycnometer #4 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.765 K @ Tb = 0.9992 (see chart)
G @ 20.0 C = 2.763

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
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Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-28
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #5

Mass of Pycnometer: 32.021 g (Mf)
Mass of Pycnometer + Sample: 42.021 g
Mass of Sample: 10 g (Mo)

Mass of Pycnometer + Sample + Water: 87.971 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 81.571 g (Ma)* for Pyc.# 5

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01173 (Tb) + 81.847
for Pycnometer #5 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.778** K @ Tb = 0.9992 (see chart)
G @ 20.0 C = **2.775**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
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Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-41
Technician: HOYT
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____ Vacuumed

Pycnometer No. PYC #6

Mass of Pycnometer: 32.773 g (Mf)
Mass of Pycnometer + Sample: 42.771 g
Mass of Sample: 9.998 g (Mo)

Mass of Pycnometer + Sample + Water: 88.435 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 82.060 g (Ma)* for Pyc.# 6

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.01167 (Tb) + 82.335
for Pycnometer #6 only.
Exp. 1/15/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.759 K @ Tb = 0.9992 (see chart)
G @ 20.0 C = 2.757

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
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Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-44
Technician: Hoyt
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____

Pycnometer No. PYC #7

Mass of Pycnometer: 46.891 g (Mf)
Mass of Pycnometer + Sample: 56.889 g
Mass of Sample: 9.998 g (Mo)

Mass of Pycnometer + Sample + Water: 153.153 g (Mb)
Water Temperature: 23.2 C (Tb)
Mass of Pycnometer with Water @ Tb: 146.739 g (Ma)* for Pyc.# 7

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02363 (Tb) + 147.287
for Pycnometer #7 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.790 K @ Tb = 0.99924 (see chart)
G @ 20.0 C = 2.788

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
Engineering Consultants
6350 Presidential Gateway
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Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-39
Sample No.: S-47
Technician: Hoyt
Date: 6/22/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X** Vacuumed
P-4 _____

Pycnometer No. PYC #11

Mass of Pycnometer: 47.143 g (Mf)
Mass of Pycnometer + Sample: 57.138 g
Mass of Sample: 9.995 g (Mo)

Mass of Pycnometer + Sample + Water: 152.267 g (Mb)
Water Temperature: 23.5 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.860 g (Ma)* for Pyc.# 11

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02336 (Tb) + 146.409
for Pycnometer #11 only.
Calibration expires 3/19/19

G @ 20.0C = K x (G @ Tb)

G @ Tb = 2.785 K @ Tb = 0.99924 (see chart)
G @ 20.0 C = 2.783

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

Specific Gravity of Soils

(ASTM D 854, AASHTO T 100)

RESOURCE INTERNATIONAL, INC.
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6350 Presidential Gateway
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Fax (614) 823-4990

Project: BWSTE
Project No.: W-15-012
Boring No.: B-40
Sample No.: S-2
Technician: Hoyt
Date: 6/20/2018

Test procedure: **X** A - oven-dry specimens
_____ B - moist specimens

Portion of sample used: P-10 **X**
P-4 _____ Vacuumed

Pycnometer No. PYC #12

Mass of Pycnometer: 47.107 g (Mf)
Mass of Pycnometer + Sample: 57.106 g
Mass of Sample: 9.999 g (Mo)

Mass of Pycnometer + Sample + Water: 151.869 g (Mb)
Water Temperature: 23.3 C (Tb)
Mass of Pycnometer with Water @ Tb: 145.503 g (Ma)* for Pyc.# 12

Specific Gravity:
G @ Tb = Mo / (Mo + (Ma - Mb))

* Ma @ Tb = -0.02328 (Tb) + 146.046
for Pycnometer #12 only.
Calibration expires 3/19/19

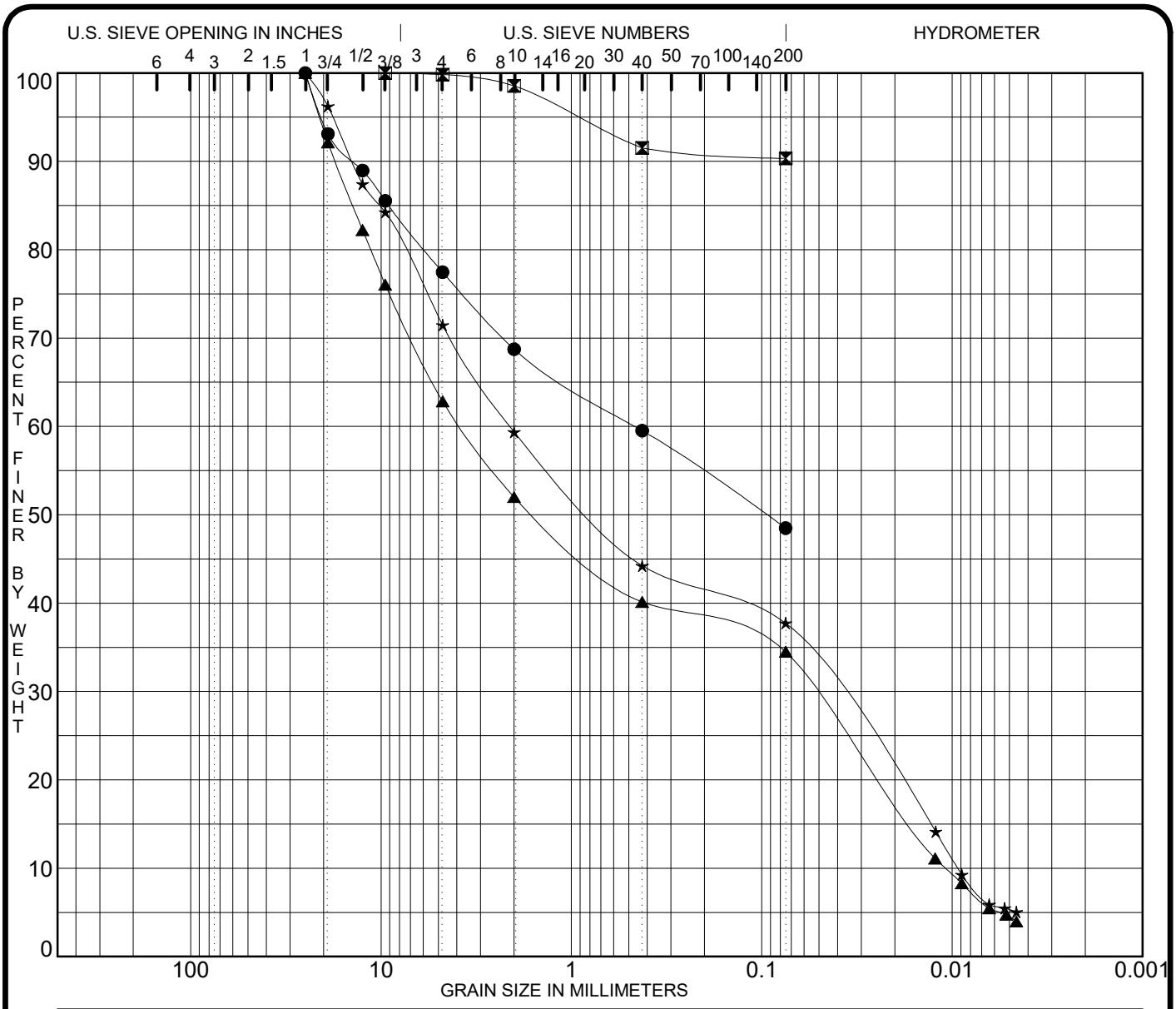
G @ 20.0C = K x (G @ Tb)

G @ Tb = **2.752** K @ Tb = 0.99924 (see chart)
G @ 20.0 C = **2.750**

Temp.(C)	Water Density (g/ml)	Correction Factor K
18.0	0.9986	1.0004
18.5	0.9985	1.0003
19.0	0.9984	1.0002
19.5	0.0998	1.0001
20.0	0.9982	1.0000
20.5	0.9981	0.9999
21.0	0.9980	0.9998
21.5	0.9979	0.9997
22.0	0.9978	0.9996
22.5	0.9977	0.9995
23.0	0.9976	0.9993
23.5	0.99745	0.9992
24.0	0.99732	0.9991
24.5	0.9972	0.999
25.0	0.99707	0.9988
25.5	0.99694	0.9987
26.0	0.99681	0.9986

I.2 SOIL CLASSIFICATION LABORATORY RESULTS

Stantec



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen ID	Depth	Classification	MC%	LL	PL	PI	Cc	Cu
● B-21B ANGLED	103.2	SILTY SAND SM (VISUAL)	18					
⧓ B-21B ANGLED	112.0	FAT CLAY CH (VISUAL)	18					
▲ B-21B ANGLED	146.9	CLAYEY GRAVEL with SAND GC	3	40	24	16	0.07	349.3
★ B-21B ANGLED	149.1	CLAYEY SAND with GRAVEL SC	3	41	23	18	0.09	224.2

Specimen ID	Depth	D100	D60	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand medium	%Sand fine	%Silt	%Clay
● B-21B ANGLED	103.2	25.00	0.46			6.9	15.6	8.7	9.2	11.0	48.5	
⧓ B-21B ANGLED	112.0	9.50				0.0	0.2	1.3	7.0	1.2	90.3	
▲ B-21B ANGLED	146.9	25.00	3.78	0.053	0.0108	7.9	29.3	10.8	11.9	5.6	30.0	4.5
★ B-21B ANGLED	149.1	25.00	2.09	0.041	0.0093	3.8	24.8	12.1	15.1	6.5	32.4	5.3

PROJECT **Big Walnut Sewer Trunk Extension Phase 2** PROJECT NO. **W-15-012**

GRADATION CURVES

RESOURCE INTERNATIONAL, INC.

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-64

BORING NO. B-38 SAMPLE NO. 4 DEPTH:

- ⊗ GRADATION[1]
- ○ HYDROMETER (soak)
- ⊗ ATTERBERG
- ⊗ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	213.48
WEIGHT OF CUP	213.29
	30.31
Total Wt. Of Dryed Soil	

INITIALS CAI

	RUSH
Moisture Tin #	X-5
Dry Soil Wt.	147.97

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	5.86
# 10	7.32
PAN (P10)	170.03
Calculated Percent Finer	

***Any material retained on the 2" sieve must be placed thru the next largest sieve.*

INITIALS CA /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	23	2ND TRIAL	25
WEIGHT OF CUP AND WET SOIL			24.94
WEIGHT OF CUP AND DRY SOIL			22.48
WEIGHT OF CUP (CUP NO. 1-B)			11.00

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	24.80
WEIGHT OF CUP AND DRY SOIL	23.23
WEIGHT OF CUP (CUP NO. 1-A)	12.08

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	28.06
WEIGHT OF CUP & OVEN DRIED SOIL	28.00
WEIGHT OF CUP (CUP NO. S-16)	11.62

Require at least ~~10 g~~ 15g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	70.15
CUP NUMBER	X-5
WEIGHT RETAINED BY #40	7.57
WEIGHT RETAINED BY #200	15.48

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***		
:	30***		
:	60***		
:	90***		
:	120***		
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-172

BORING NO. B-38 SAMPLE NO. 6 DEPTH:

- [x] GRADATION[1]
- [ ] HYDROMETER (soak)
- [x] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	151.87
WEIGHT OF CUP	30.47
Total Wt. Of Dryed Soil	

INITIALS IA /

	RUSH
Moisture Tin #	JOb
Dry Soil Wt.	121.59

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	34.50
3/4"	.
1/2"	11.56
3/8"	2.45
# 4	8.88
# 10	9.68
PAN (P10)	176.39
Calculated Percent Finer	

***Any material retained on the 2" sieve must be placed thru the next largest sieve.*

INITIALS /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	25	2ND TRIAL	26
WEIGHT OF CUP AND WET SOIL			24.40
WEIGHT OF CUP AND DRY SOIL			21.89
WEIGHT OF CUP (CUP NO. 2-B)			11.11

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	26.65
WEIGHT OF CUP AND DRY SOIL	24.74
WEIGHT OF CUP (CUP NO. 2-A)	12.07

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	27.66
WEIGHT OF CUP & OVEN DRIED SOIL	27.58
WEIGHT OF CUP (CUP NO. S-1)	11.60

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	105.15
CUP NUMBER	CL-119
WEIGHT RETAINED BY #40	11.40
WEIGHT RETAINED BY #200	22.73

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS IA /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **		
:	**30*** **		
:	**60*** **		
:	**90*** **		
:	**120*** **		
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-154

BORING NO. B-38 SAMPLE NO. 10 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	226.32
WEIGHT OF CUP	226.08
Total Wt. Of Dryed Soil	30.60

INITIALS CA

	RUSH
Moisture Tin #	
Dry Soil Wt.	

W-15-012 B-38 10 6/8/18 CL-154 85.58

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	22.92
1/2"	19.67
3/8"	11.06
# 4	16.88
# 10	23.72
PAN (P10)	101.19
Calculated Percent Finer	

INITIALS CA /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL	.		
WEIGHT OF CUP AND DRY SOIL	.		
WEIGHT OF CUP (CUP NO._____)	.		

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	26.54
WEIGHT OF CUP & OVEN DRIED SOIL	26.48
WEIGHT OF CUP (CUP NO. S-48)	10.88

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	85.58
CUP NUMBER	WL-105
WEIGHT RETAINED BY #40	29.73
WEIGHT RETAINED BY #200	24.59

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA!

HYDROMETER AASHTO T88

START: 10:11	MINUTES	READING	TEMP (C°)
:	2		
:	5		
10:26	**15*** **	18	26.0
10:41	**30*** **	15.5	26.0
11:11	**60*** **	14	25.9
11:41	**90*** **	13	25.8
12:11	**120*** **	12	25.7
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-114

BORING NO. B-38 SAMPLE NO. 13 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
	234.63
WEIGHT OF CUP + AIR DRIED SOIL	234.52
WEIGHT OF CUP	30.52
Total Wt. Of Dryed Soil	

INITIALS CA

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	24.05
3/4"	11.50
1/2"	26.01
3/8"	5.02
# 4	18.26
# 10	24.49
PAN (P10)	94.75
Calculated Percent Finer	

W-15-012 CL-114 70.698 B-38 13 6/8/18

INITIALS CA

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	26.82
WEIGHT OF CUP & OVEN DRIED SOIL	26.78
WEIGHT OF CUP (CUP NO. S-36)	10.85

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	78.69
CUP NUMBER	G-226
WEIGHT RETAINED BY #40	35.31
WEIGHT RETAINED BY #200	22.N

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA /

HYDROMETER AASHTO T88

START: 10:11	MINUTES	READING	TEMP (C°)
:	2		
:	5		
10:26	15***	15	26.1
10:41	30***	13.5	26.1
11:11	60***	12.5	25.9
11:41	90***	11.5	25.8
12:11	120***	10.5	25.8
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 **ASSIGNMENT DATE** 06/05/18

PROJECT NAME Big Walnut **TIN NO.** CL-134

BORING NO. B-38 **SAMPLE NO.** 15 **DEPTH:**

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
	204.29
WEIGHT OF CUP + AIR DRIED SOIL	204.12
WEIGHT OF CUP	30.48
Total Wt. Of Dryed Soil	

INITIALS AT

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	.
# 10	0.06
PAN (P10)	173.78
Calculated Percent Finer	

***Any material retained on the 2" sieve must be placed thru the next largest sieve.*

CL-134 76.20g X-117 B-38 S-53 10/18/18

INITIALS AT

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	26.12
WEIGHT OF CUP & OVEN DRIED SOIL	26.11
WEIGHT OF CUP (CUP NO. S-53)	10.95

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	76.20
CUP NUMBER	X-117
WEIGHT RETAINED BY #40	1.22
WEIGHT RETAINED BY #200	42.28

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS AT

HYDROMETER AASHTO T88

START: 10:11	MINUTES	READING	TEMP (C°)
:	2		
:	5		
10:26	15***	16	25.8
10:41	30***	14.5	25.8
11:11	60***	13.5	25.8
11:41	90***	12.5	25.7
12:11	120***	12	25.7
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-199

BORING NO. B-38 SAMPLE NO. 16 DEPTH:

- ⊗ GRADATION[1]
- ⊗ HYDROMETER (soak)
- ○ ATTERBERG
- ⊗ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	235.83
WEIGHT OF CUP	235.37
Total Wt. Of Dryed Soil	30.71

INITIALS CA

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	28.85
1/2"	12.05
3/8"	7.60
# 4	10.93
# 10	3.56
PAN (P10)	141.72
Calculated Percent Finer	

** or plastic fines

INITIALS CA

8/11/18 CL-15-012 B-38 16 CL-199 113.07g

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL	.		
WEIGHT OF CUP AND DRY SOIL	.		
WEIGHT OF CUP (CUP NO.)	.		

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO.)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	27.50
WEIGHT OF CUP & OVEN DRIED SOIL	27.47
WEIGHT OF CUP (CUP NO. S-30)	10.94

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	113.07
CUP NUMBER	S-112
WEIGHT RETAINED BY #40	4.70
WEIGHT RETAINED BY #200	9.57

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA

HYDROMETER AASHTO T88

START: 10 : 10	MINUTES	READING	TEMP (C°)
:	2		
:	5		
10 : 25	15***	33.0	24.1
10 : 40	30***	28.5	24.2
11 : 10	60***	24.5	24.4
11 : 40	90***	21.5	24.6
12 : 10	120***	20.5	24.8
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

SOIL TEST DATA

1/22/18 rev.

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-158

BORING NO. B-39 SAMPLE NO. 5 DEPTH:

○ GRADATION[1]
⊗ HYDROMETER (soak)
⊗ ATTERBERG
⊗ SPEC.GRAV.
○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	227.61
WEIGHT OF CUP	227.15
	30.71
Total Wt. Of Dryed Soil	

INITIALS AI

	RUSH
Moisture Tin #	WC-44
Dry Soil Wt.	101.77

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	11.91
# 10	10.21
PAN (P10)	174.72
Calculated Percent Finer	

INITIALS AI

9/11/19 B-39 5 W-15-012 CL-158 60.74 8.47

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	25	2ND TRIAL	27
WEIGHT OF CUP AND WET SOIL			22.64
WEIGHT OF CUP AND DRY SOIL			20.37
WEIGHT OF CUP (CUP NO. 3-B)			11.02

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	22.17
WEIGHT OF CUP AND DRY SOIL	20.70
WEIGHT OF CUP (CUP NO. 3-A)	11.60

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	28.02
WEIGHT OF CUP & OVEN DRIED SOIL	27.98
WEIGHT OF CUP (CUP NO. 34-A)	12.24

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	60.74
CUP NUMBER	WC-32
WEIGHT RETAINED BY #40	7.68
WEIGHT RETAINED BY #200	8.85

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS AI

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	34.0	24.2
:	**30*** **	30.0	24.2
:	**60*** **	27.0	24.4
:	**90*** **	25.0	24.7
:	**120*** **	23.5	24.9
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-66

BORING NO. B-39 SAMPLE NO. 7 DEPTH:

⊗ GRADATION[1]
⊗ HYDROMETER (soak)
○ ATTERBERG
⊗ SPEC.GRAV.
○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	221.60
WEIGHT OF CUP	221.29
Total Wt. Of Dryed Soil	30.44

INITIALS /

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	1.80
# 4	12.82
# 10	20.11
PAN (P10)	156.46
Calculated Percent Finer	

**Any material retained on the 2" sieve must be placed thru the next largest sieve.

W-15-012 CL-66 114.00 B-39 7 6/11/18

INITIALS /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	29.60
WEIGHT OF CUP & OVEN DRIED SOIL	29.58
WEIGHT OF CUP (CUP NO. S-62)	10.94

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	114.00
CUP NUMBER	WC-156
WEIGHT RETAINED BY #40	27.62
WEIGHT RETAINED BY #200	60.80

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	17.0	24.7
:	30***	15.5	24.3
:	60***	14.0	24.5
:	90***	13.0	24.7
:	120***	12.5	24.8
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-140

BORING NO. B-39 SAMPLE NO. 9 DEPTH:

- ⊗ GRADATION[1]
- ⊗ HYDROMETER (soak)
- ○ ATTERBERG
- ⊗ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	207.05
WEIGHT OF CUP	206.77
Total Wt. Of Dryed Soil	80.67

INITIALS /

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	4.75
3/8"	1.60
# 4	3.29
# 10	8.22
PAN (P10)	158.19
Calculated Percent Finer	

INITIALS CA/

W-15-012 B-39 9 64.45 CL-140

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO.)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO.)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	28.64
WEIGHT OF CUP & OVEN DRIED SOIL	28.62
WEIGHT OF CUP (CUP NO. S-57)	10.04

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	64.45
CUP NUMBER	WC-66
WEIGHT RETAINED BY #40	9.69
WEIGHT RETAINED BY #200	24.81

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	14.5	24.3
:	30***	13.0	24.4
:	60***	12.0	24.5
:	90***	11.0	24.7
:	120***	10.5	24.9
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

4

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-187

BORING NO. B-39 SAMPLE NO. 11 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	224.74
WEIGHT OF CUP	224.36
Total Wt. Of Dryed Soil	80.32

INITIALS CA/

	RUSH
Moisture Tin #	G-39
Dry Soil Wt.	139.87

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	46.42
3/4"	36.52
1/2"	22.92
3/8"	20.60
# 4	36.31
# 10	28.10
PAN (P10)	142.98
Calculated Percent Finer	

INITIALS CA/

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

	1ST TRIAL		2ND TRIAL
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	28.93
WEIGHT OF CUP & OVEN DRIED SOIL	28.89
WEIGHT OF CUP (CUP NO. S-51)	10.98

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	115.14
CUP NUMBER	X-48
WEIGHT RETAINED BY #40	33.46
WEIGHT RETAINED BY #200	22.14

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA/

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	33.0	24.3
:	**30*** **	28.5	24.3
:	**60*** **	26.0	24.5
:	**90*** **	24.0	24.7
:	**120*** **	23.0	24.9
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-36

BORING NO. B-39 SAMPLE NO. 13 DEPTH:

- ○ GRADATION[1]
- ⊗ HYDROMETER (soak)
- ⊗ ATTERBERG
- ⊗ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	216.39
WEIGHT OF CUP	215.89
	30.10
Total Wt. Of Dryed Soil	

INITIALS AT

	RUSH
Moisture Tin #	G-25
Dry Soil Wt.	149.16

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	28.67
3/4"	12.31
1/2"	30.75
3/8"	13.35
# 4	15.81
# 10	26.65
PAN (P10)	207.37
Calculated Percent Finer	

**Any material retained on the 2" sieve must be placed thru the next largest sieve.

INITIALS AT

W-15-012 CL-36 10.91g
B-39 13
6/11/18

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL	N/P		.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO. 4-B)			11.16

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	N/P	.
WEIGHT OF CUP AND DRY SOIL		.
WEIGHT OF CUP (CUP NO. 4-A)		10.93

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	29.78
WEIGHT OF CUP & OVEN DRIED SOIL	29.75
WEIGHT OF CUP (CUP NO. S-56)	10.91

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	101.12
CUP NUMBER	X-21
WEIGHT RETAINED BY #40	31.30
WEIGHT RETAINED BY #200	20.73

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	25.0	24.3
:	30***	22.5	24.3
:	60***	20.5	24.5
:	90***	19.5	24.7
:	120***	18.0	24.9
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-17

BORING NO. B-39 SAMPLE NO. 18 DEPTH:

- [X] GRADATION[1]
- [X] HYDROMETER (soak)
- [ ] ATTERBERG
- [X] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
	229.13
WEIGHT OF CUP + AIR DRIED SOIL	228.66
WEIGHT OF CUP	30.22
Total Wt. Of Dryed Soil	

INITIALS AI

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	8.53
3/8"	17.92
# 4	28.96
# 10	21.95
PAN (P10)	121.26
Calculated Percent Finer	

INITIALS AI

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	27.82
WEIGHT OF CUP & OVEN DRIED SOIL	27.80
WEIGHT OF CUP (CUP NO. S-18)	11.26

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	104.68
CUP NUMBER	OSU
WEIGHT RETAINED BY #40	3779
WEIGHT RETAINED BY #200	39.08

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS AI

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	20.0	24.3
:	30***	18.0	24.4
:	60***	16.5	24.6
:	90***	15.5	24.8
:	120***	15.0	24.9
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-43

BORING NO. B-39 SAMPLE NO. 23 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
	205.06
WEIGHT OF CUP + AIR DRIED SOIL	204.57
WEIGHT OF CUP	30.25
Total Wt. Of Dryed Soil	

INITIALS CA/

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	.
# 10	0.13
PAN (P10)	174.46
Calculated Percent Finer	

W-15-012 CL-43 64.88g B-39 23 61111 B

INITIALS CA/

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	31.22
WEIGHT OF CUP & OVEN DRIED SOIL	31.18
WEIGHT OF CUP (CUP NO. 37-A)	11.61

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	64.88
CUP NUMBER	BEER 30
WEIGHT RETAINED BY #40	0.09
WEIGHT RETAINED BY #200	8.39

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA/

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	17.5	24.4
:	30***	15	24.4
:	60***	13.0	24.6
:	90***	12.0	24.8
:	120***	11.5	25.0
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

SOIL TEST DATA

1/22/18 rev.

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-83

BORING NO. B-39 SAMPLE NO. 28 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	213.28
WEIGHT OF CUP	212.95
Total Wt. Of Dryed Soil	30.33

INITIALS CA

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	13.36
3/8"	10.99
# 4	31.45
# 10	25.95
PAN (P10)	101.04
Calculated Percent Finer	

**Any material retained on the 2" sieve must be placed thru the next largest sieve.

12-15-012 CL-83 B-39 28 85.61 6/11/18

INITIALS CA

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	26.28
WEIGHT OF CUP & OVEN DRIED SOIL	26.27
WEIGHT OF CUP (CUP NO. S-12)	10.90

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	85.61
CUP NUMBER	4-410
WEIGHT RETAINED BY #40	32.91
WEIGHT RETAINED BY #200	19.64

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	20.0	24.2
:	**30*** **	17.5	24.3
:	**60*** **	16.0	24.6
:	**90*** **	15.5	24.8
:	**120*** **	15.0	25.0
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-76

BORING NO. B-39 SAMPLE NO. 41 DEPTH:

- [x] GRADATION[1]
- [x] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh	208.70
WEIGHT OF CUP + AIR DRIED SOIL		208.33
WEIGHT OF CUP		30.33
Total Wt. Of Dryed Soil		

INITIALS AT

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION

AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	.
# 10	0.11
PAN (P10)	178.09
Calculated Percent Finer	

W-15-012 B-39 41 CL-76 62.988 6/11/18

INITIALS AT

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL		2ND TRIAL	
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	31.55
WEIGHT OF CUP & OVEN DRIED SOIL	31.53
WEIGHT OF CUP (CUP NO. S-7)	10.85

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	62.98
CUP NUMBER	WC-154
WEIGHT RETAINED BY #40	0.30
WEIGHT RETAINED BY #200	15.48

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

HYDROMETER

AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	17.0	24.4
:	**30*** **	15.0	24.5
:	**60*** **	13.5	24.6
:	**90*** **	12.5	24.8
:	**120*** **	12.0	25.0
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

10

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-190

BORING NO. B-39 SAMPLE NO. 44 DEPTH:

- ○ GRADATION[1]
- ⊗ HYDROMETER (soak)
- ⊗ ATTERBERG
- ⊗ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	224.69
WEIGHT OF CUP	30.70
Total Wt. Of Dryed Soil	

INITIALS CA/

	RUSH
Moisture Tin #	X-101
Dry Soil Wt.	108.94

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	14.06
3/8"	.
# 4	3.68
# 10	5.48
PAN (P10)	170.82
Calculated Percent Finer	

W-15-012 B-39 44 6/11/18 60.408 CL-190

INITIALS CA/

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	23	2ND TRIAL	23
WEIGHT OF CUP AND WET SOIL			24.74
WEIGHT OF CUP AND DRY SOIL			22.38
WEIGHT OF CUP (CUP NO. 4-B)			11.15

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	22.42
WEIGHT OF CUP AND DRY SOIL	21.00
WEIGHT OF CUP (CUP NO. 4-A)	10.93

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	27.09
WEIGHT OF CUP & OVEN DRIED SOIL	27.08
WEIGHT OF CUP (CUP NO. 35-A)	11.57

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	60.40
CUP NUMBER	M-4
WEIGHT RETAINED BY #40	4.84
WEIGHT RETAINED BY #200	14.35

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS CA/

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	27.5	24.2
:	30***	25.0	24.2
:	60***	23.0	24.5
:	90***	21.5	24.8
:	120***	20.5	25.0
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

1/22/18 rev.

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-84

BORING NO. B-39 SAMPLE NO. 47 DEPTH:

- [x] GRADATION[1]
- [ ] HYDROMETER (soak)
- [ ] ATTERBERG
- [x] SPEC.GRAV.
- [ ] OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	193.69
WEIGHT OF CUP	30.15
Total Wt. Of Dryed Soil	

INITIALS VA

	RUSH
Moisture Tin #	
Dry Soil Wt.	

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	.
# 10	.
PAN (P10)	165.46
Calculated Percent Finer	

***Any material retained on the 2" sieve must be placed thru the next largest sieve.*

INITIALS VA

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

	1ST TRIAL		2ND TRIAL
WEIGHT OF CUP AND WET SOIL			.
WEIGHT OF CUP AND DRY SOIL			.
WEIGHT OF CUP (CUP NO._____)			.

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	.
WEIGHT OF CUP AND DRY SOIL	.
WEIGHT OF CUP (CUP NO._____)	.

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	28.84
WEIGHT OF CUP & OVEN DRIED SOIL	28.55
WEIGHT OF CUP (CUP NO. S-39)	10.99

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	69.78
CUP NUMBER	CL 84
WEIGHT RETAINED BY #40	0.22
WEIGHT RETAINED BY #200	0.36

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS VA

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***		
:	30***		
:	60***		
:	90***		
:	120***		
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

SOIL TEST DATA

PROJECT NO. W-15-012 ASSIGNMENT DATE 06/05/18

PROJECT NAME Big Walnut TIN NO. CL-102

BORING NO. B-40 SAMPLE NO. 2 DEPTH:

○ GRADATION[1]
⊗ HYDROMETER (soak)
⊗ ATTERBERG
⊗ SPEC.GRAV.
○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	197.14
WEIGHT OF CUP	196.34
	30.48
Total Wt. Of Dryed Soil	

INITIALS VA /

	RUSH
Moisture Tin #	T5-70
Dry Soil Wt.	105.59

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	4.19
# 10	4.74
PAN (P10)	157.61
Calculated Percent Finer	

***Any material retained on the 2" sieve must be placed thru the next largest sieve.*

W-15-012 CL102 60.01g B-40 2 6/12/18

INITIALS VA /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	26	2ND TRIAL	25
WEIGHT OF CUP AND WET SOIL			23.72
WEIGHT OF CUP AND DRY SOIL			20.50
WEIGHT OF CUP (CUP NO. S-B)			11.19

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	23.27
WEIGHT OF CUP AND DRY SOIL	21.28
WEIGHT OF CUP (CUP NO. S-A)	10.90

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	27.29
WEIGHT OF CUP & OVEN DRIED SOIL	27.14
WEIGHT OF CUP (CUP NO. S-15)	11.58

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	60.01
CUP NUMBER	WC-25
WEIGHT RETAINED BY #40	4.86
WEIGHT RETAINED BY #200	7.68

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS VA /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	15***	41.0	24.4
:	30***	37.0	24.4
:	60***	34.5	24.7
:	90***	32.5	24.9
:	120***	30.5	25.1
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

SOIL TEST DATA

PROJECT NO. W-15-017 **ASSIGNMENT DATE** B-3

PROJECT NAME BIG WALNUT **TIN NO.** CL-132

BORING NO. OW-8 **SAMPLE NO.** ST-1 **DEPTH:**

- ○ GRADATION[1]
- ● HYDROMETER (soak)
- ● ATTERBERG
- ○ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	264.31
WEIGHT OF CUP	80.49
Total Wt. Of Dryed Soil	

INITIALS /

	RUSH
Moisture Tin #	WC-68
Dry Soil Wt.	183.14

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	.
# 4	6.41
# 10	13.70
PAN (P10)	212.19
Calculated Percent Finer	

**Any material retained on the 2" sieve must be placed thru the next largest sieve.

INITIALS /

OW-8 ST-1 W-15-017 CL-132 60.45

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	24.57
WEIGHT OF CUP & OVEN DRIED SOIL	24.31
WEIGHT OF CUP (CUP NO. S-24)	11.64

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	60.45
CUP NUMBER	X-180
WEIGHT RETAINED BY #40	7.08
WEIGHT RETAINED BY #200	8.81

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	25	2ND TRIAL	24
WEIGHT OF CUP AND WET SOIL			24.76
WEIGHT OF CUP AND DRY SOIL			21.92
WEIGHT OF CUP (CUP NO. 3-B)			11.01

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	23.36
WEIGHT OF CUP AND DRY SOIL	21.71
WEIGHT OF CUP (CUP NO. 3-A)	11.60

INITIALS /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	31.5	22.6
:	**30*** **	29.0	22.6
:	**60*** **	25.0	22.6
:	**90*** **	23.5	22.6
:	**120*** **	22.0	22.8
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

SOIL TEST DATA

1/22/18 rev.

PROJECT NO. W-15-012 **ASSIGNMENT DATE** 8-2-18

PROJECT NAME BIG WALNUT **TIN NO.** CL-64

BORING NO. OW-9 **SAMPLE NO.** ST-1 **DEPTH:**

- ○ GRADATION[1]
- ◉ HYDROMETER (soak)
- ◉ ATTERBERG
- ○ SPEC.GRAV.
- ○ OTHER

[1] If Gradation only, requires a wash

SAMPLE WEIGHT

	Reweigh
WEIGHT OF CUP + AIR DRIED SOIL	262.91
WEIGHT OF CUP	30.30
Total Wt. Of Dryed Soil	

INITIALS /

	RUSH
Moisture Tin #	WC-168
Dry Soil Wt.	145.59

GRADATION AASHTO T58/T88

SIEVE	WEIGHT OF SAMPLE
2"**	.
1 1/2"	.
1"	.
3/4"	.
1/2"	.
3/8"	3.53
# 4	6.83
# 10	23.63
PAN (P10)	197.12
Calculated Percent Finer	

**Ar on t plac larg

W-15-012 CL-64 OW-9 ST-1 8/1: 60.92

INITIALS /

ATTERBERG LIMITS

ODOT: Perform PL first. Continue with LL if material is plastic. Perform LL twice on organic soils.

LIQUID LIMIT AASHTO T 89, Method B

1ST TRIAL	23	2ND TRIAL	24
WEIGHT OF CUP AND WET SOIL			24.90
WEIGHT OF CUP AND DRY SOIL			22.06
WEIGHT OF CUP (CUP NO. 4-B)			11.16

INITIALS /

PLASTIC LIMIT AASHTO T90, One-point Method

WEIGHT OF CUP AND WET SOIL	22.85
WEIGHT OF CUP AND DRY SOIL	21.22
WEIGHT OF CUP (CUP NO. 4-A)	10.93

INITIALS /

HYGROSCOPIC MOISTURE

WEIGHT OF CUP & AIR DRIED SOIL	23.61
WEIGHT OF CUP & OVEN DRIED SOIL	23.37
WEIGHT OF CUP (CUP NO. S-5)	11.50

Require at least 10 g for hygroscopic moisture.

#40 AND #200 WASH (for hydro/grad)

WEIGHT OF P10 USED*	60.92
CUP NUMBER	X-165
WEIGHT RETAINED BY #40	6.70
WEIGHT RETAINED BY #200	8.77

*For silty or clayey material - need approximately 60 g for P10 used, for sandy soil, need approximately 110 g

INITIALS /

HYDROMETER AASHTO T88

START: :	MINUTES	READING	TEMP (C°)
:	2		
:	5		
:	**15*** **	31.5	22.5
:	**30*** **	29.0	22.5
:	**60*** **	26.0	22.6
:	**90*** **	24.0	22.6
:	**120*** **	23.0	22.7
:	250		
:	1440		

***Take only the bolded readings unless specified.
Constant Temperature Room used during testing.

INITIALS /

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/13/18	Checked By:	jdt
Depth :	---	Test Id:	467199		

Moisture Content of Soil and Rock - ASTM D2216

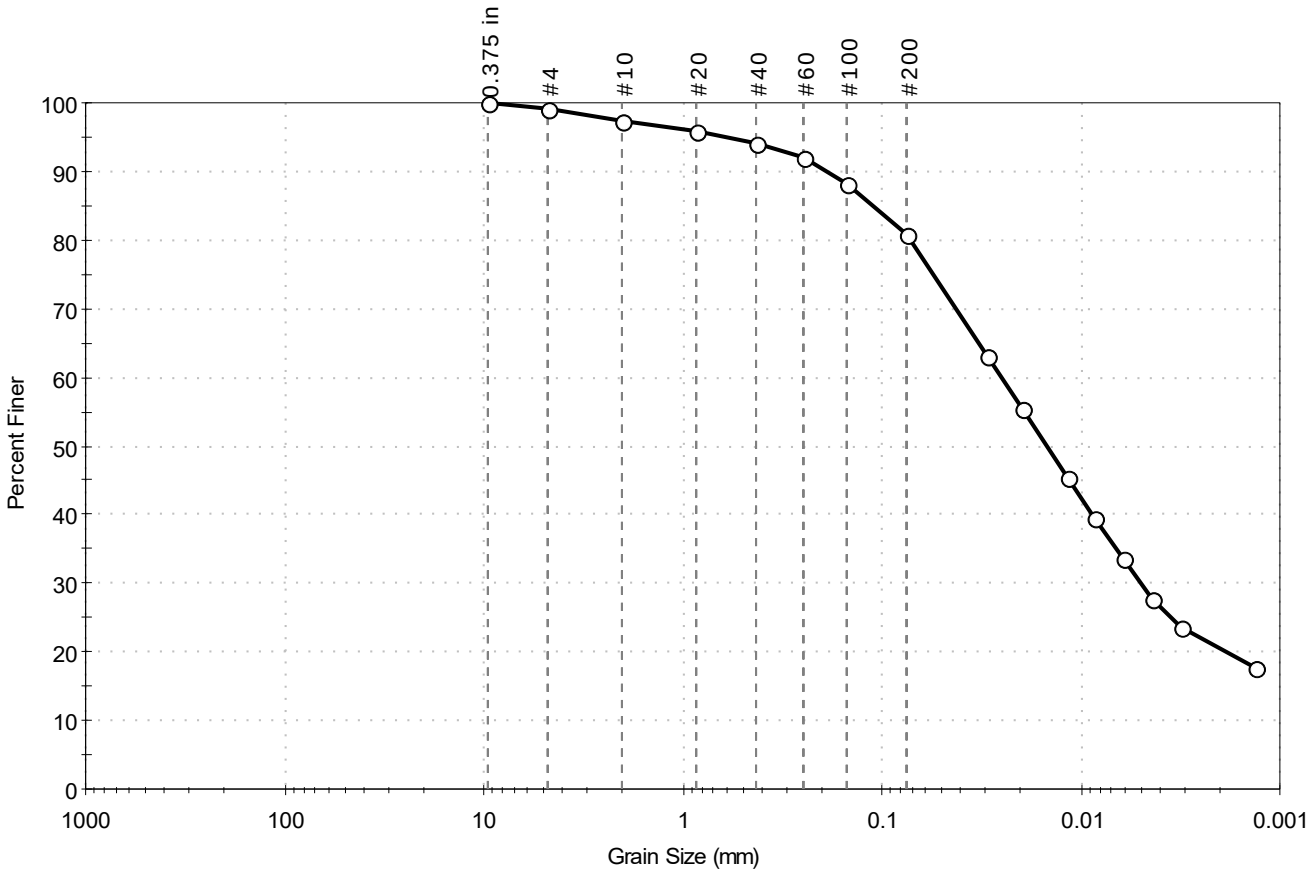
Boring ID	Sample ID	Depth	Description	Moisture Content, %
OW-3	ST- 1	6.75-8 ft	Moist, brownish gray clay with sand	20.8
OW-4	ST- 1A	4-4.5 ft	Moist, grayish brown clay with gravel	28.2
OW-5	ST- 1	3.9-5 ft	Moist, mottled dark grayish brown and yellowish brown clay with sand.	22.8
OW-6	ST- 1	15.4-16.5 ft	Moist, gray sandy clay	14.4

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-3	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-1	Test Date:	08/15/18	Checked By:	jdt
Depth :	6.75-8 ft	Test Id:	467190		
Test Comment:	---				
Visual Description:	Moist, brownish gray clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.9	18.3	80.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	96		
#40	0.42	94		
#60	0.25	92		
#100	0.15	88		
#200	0.075	81		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0294	63		
---	0.0196	55		
---	0.0118	45		
---	0.0085	40		
---	0.0061	34		
---	0.0044	28		
---	0.0032	24		
---	0.0013	18		

Coefficients

D_{85} = 0.1119 mm	D_{30} = 0.0050 mm
D_{60} = 0.0249 mm	D_{15} = N/A
D_{50} = 0.0149 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Lean CLAY with Sand (CL)

AASHTO Clayey Soils (A-6 (7))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

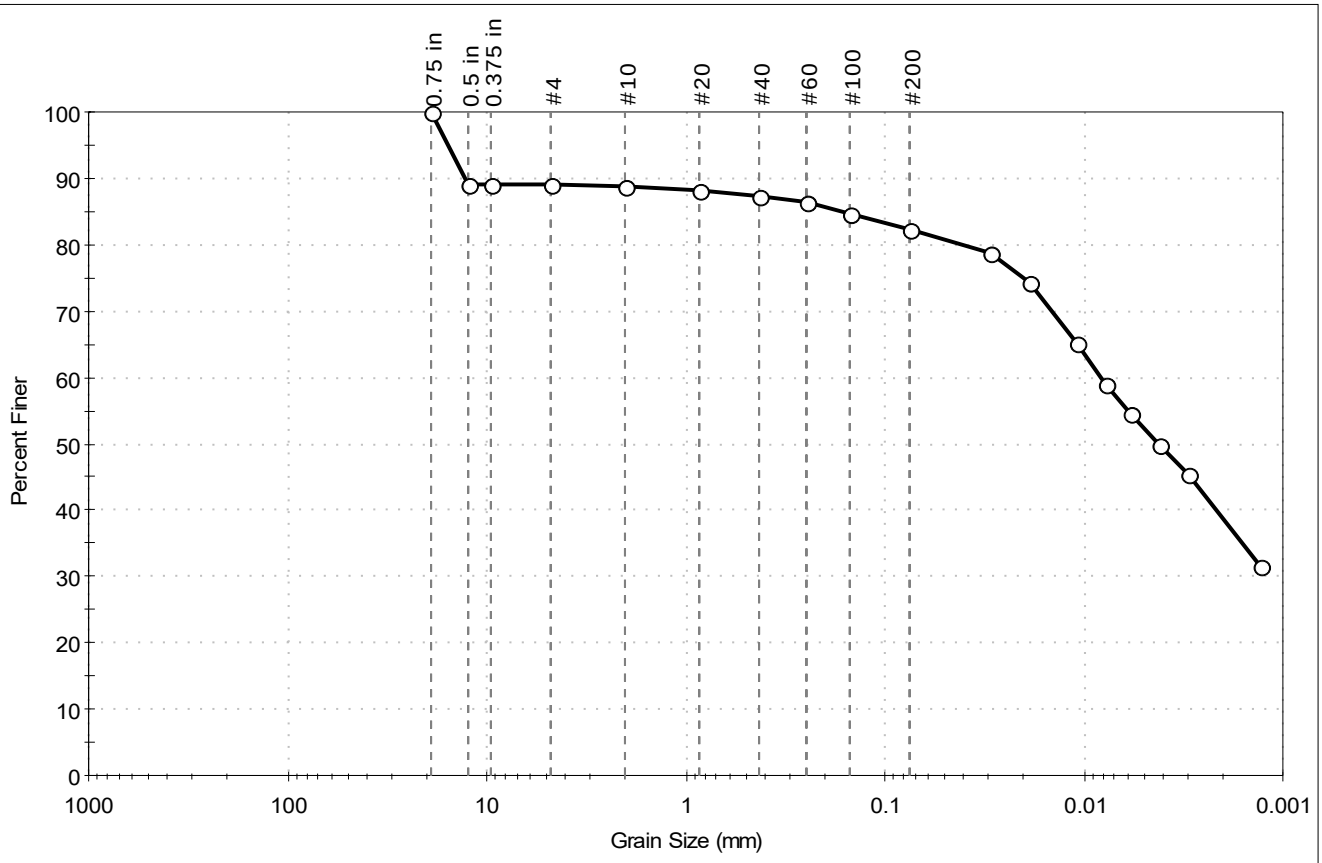
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-4	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-1A	Test Date:	08/16/18	Checked By:	jdt
Depth :	4-4.5 ft	Test Id:	467191		
Test Comment:	---				
Visual Description:	Moist, grayish brown clay with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	11.0	6.8	82.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	89		
#4	4.75	89		
#10	2.00	89		
#20	0.85	88		
#40	0.42	87		
#60	0.25	86		
#100	0.15	85		
#200	0.075	82		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0298	79		
---	0.0190	74		
---	0.0109	65		
---	0.0077	59		
---	0.0058	54		
---	0.0042	50		
---	0.0030	45		
---	0.0013	32		

Coefficients

D_{85} = 0.1620 mm	D_{30} = N/A
D_{60} = 0.0082 mm	D_{15} = N/A
D_{50} = 0.0042 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Fat CLAY with Gravel (CH)

AASHTO Clayey Soils (A-7-6 (27))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

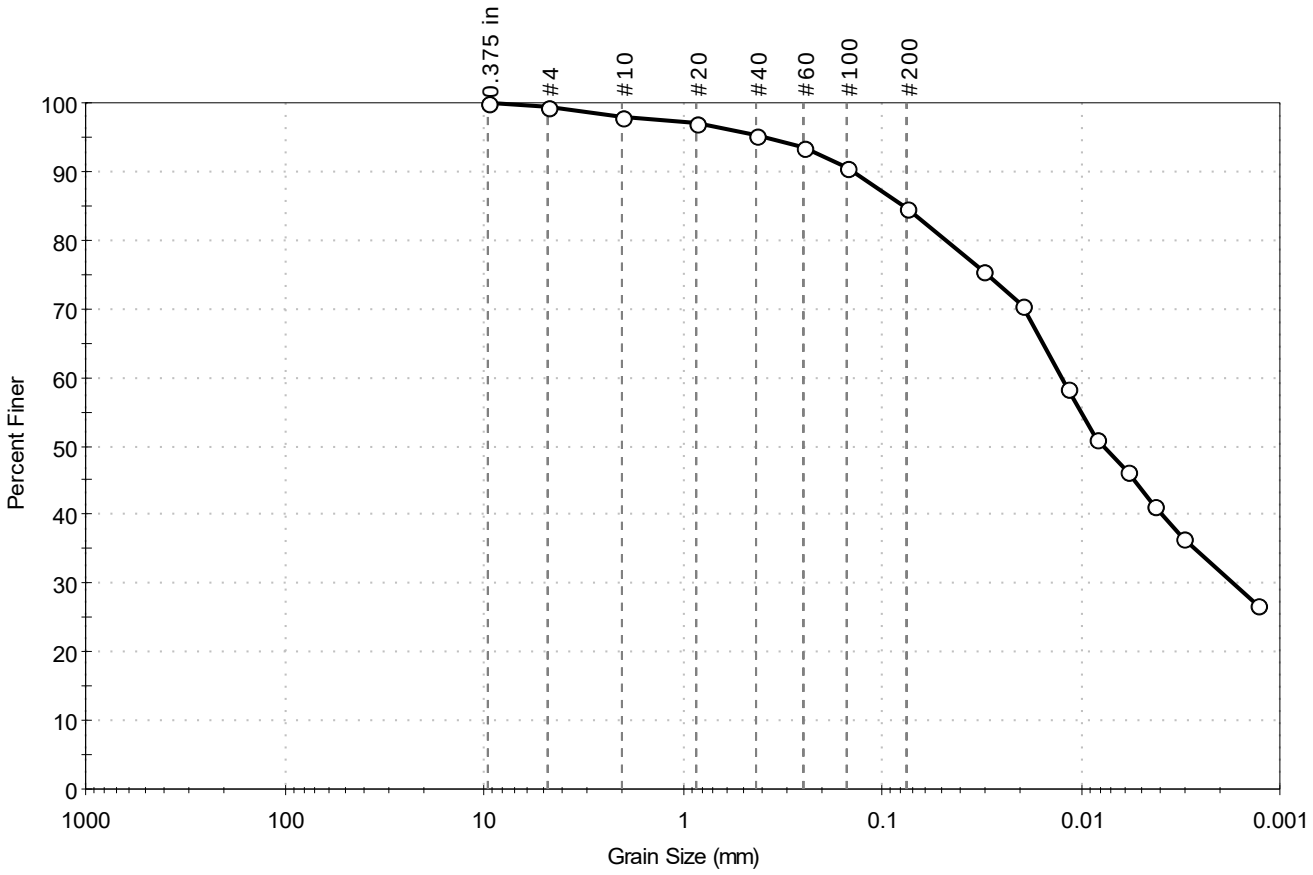
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-5	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-1	Test Date:	08/15/18	Checked By:	jdt
Depth :	3.9-5 ft	Test Id:	467193		
Test Comment:	---				
Visual Description:	Moist, mottled dark grayish brown and yellowish brown clay with sand.				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	14.8	84.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	97		
#40	0.42	95		
#60	0.25	94		
#100	0.15	91		
#200	0.075	85		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0310	75		
---	0.0196	71		
---	0.0118	58		
---	0.0084	51		
---	0.0058	46		
---	0.0043	41		
---	0.0031	36		
---	0.0013	27		

Coefficients

D_{85} = 0.0789 mm	D_{30} = 0.0017 mm
D_{60} = 0.0126 mm	D_{15} = N/A
D_{50} = 0.0077 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Lean CLAY with Sand (CL)

AASHTO Clayey Soils (A-6 (18))

Sample / Test Description

Dispersion Device : Apparatus A - Mech Mixer

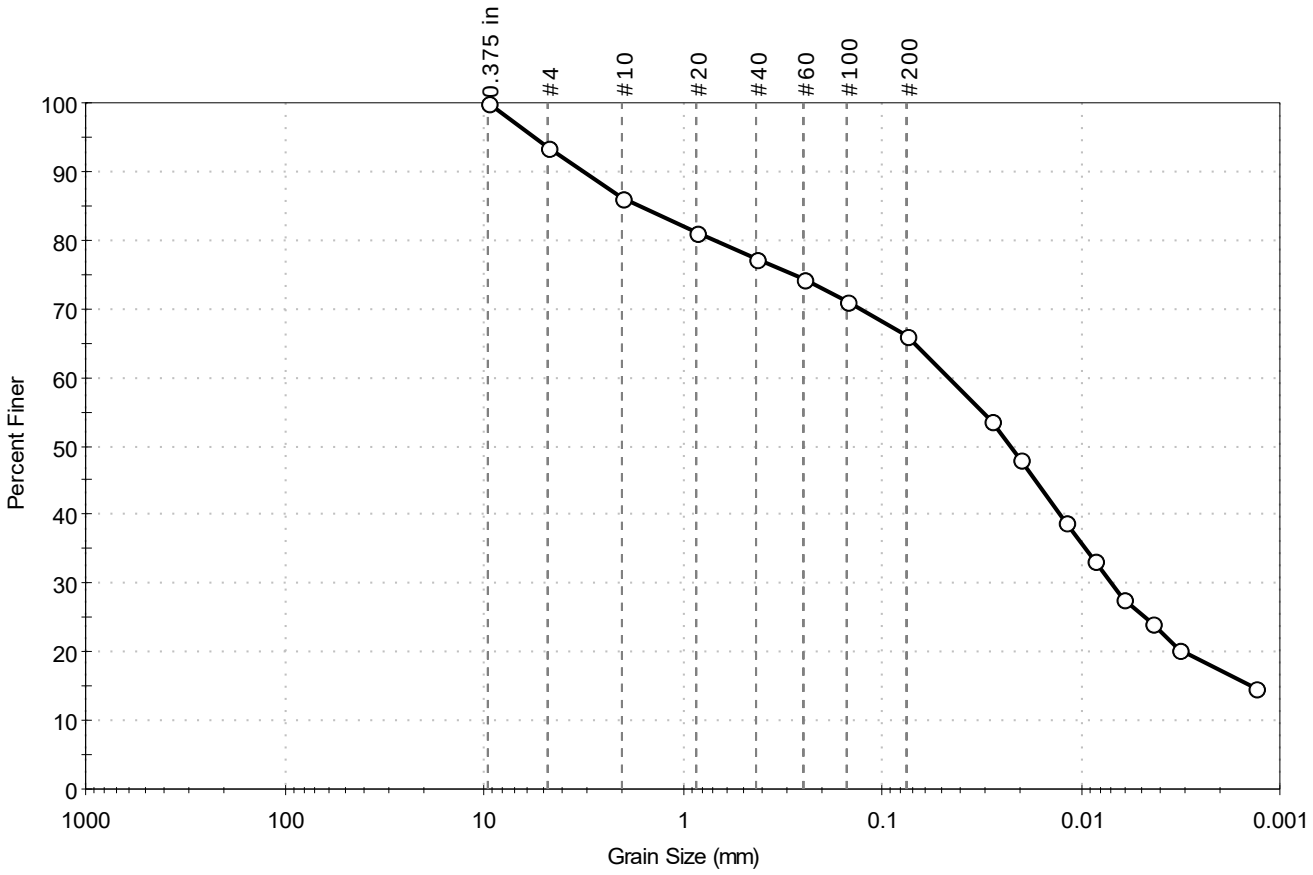
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-6	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-1	Test Date:	08/16/18	Checked By:	jdt
Depth :	15.4-16.5 ft	Test Id:	467194		
Test Comment:	---				
Visual Description:	Moist, gray sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.5	27.5	66.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	93		
#10	2.00	86		
#20	0.85	81		
#40	0.42	77		
#60	0.25	74		
#100	0.15	71		
#200	0.075	66		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0282	54		
---	0.0201	48		
---	0.0120	39		
---	0.0086	33		
---	0.0061	28		
---	0.0044	24		
---	0.0032	20		
---	0.0013	15		

Coefficients

D_{85} = 1.6452 mm	D_{30} = 0.0070 mm
D_{60} = 0.0466 mm	D_{15} = 0.0014 mm
D_{50} = 0.0225 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Lean CLAY (CL)

AASHTO Silty Soils (A-4 (3))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

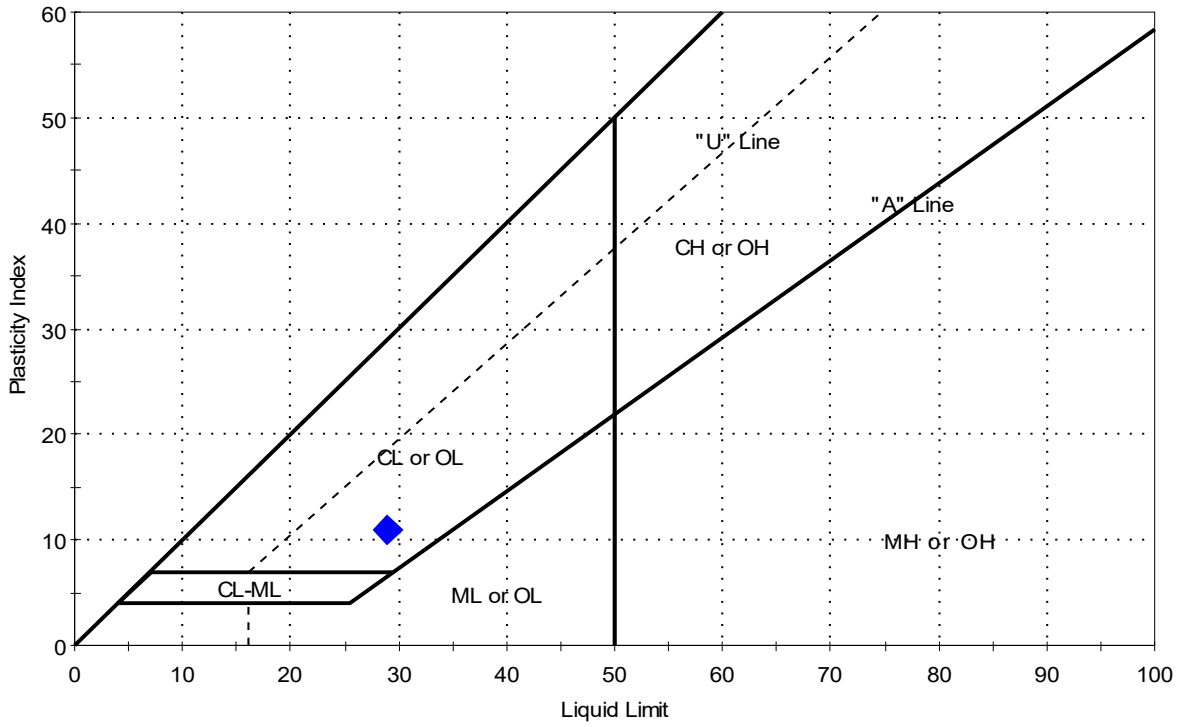
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-3	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-1	Test Date:	08/15/18	Checked By:	jdt
Depth :	6.75-8 ft	Test Id:	467185		
Test Comment:	---				
Visual Description:	Moist, brownish gray clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

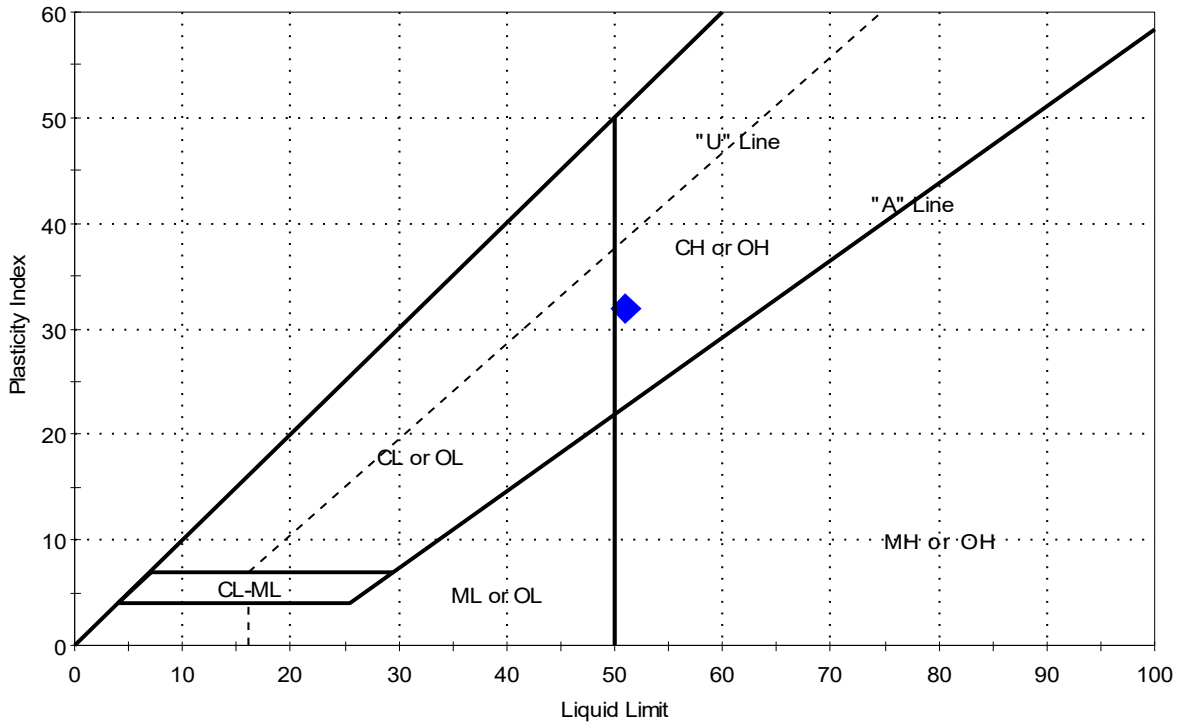


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1	OW-3	6.75-8 ft	21	29	18	11	0.3	Lean CLAY with Sand (CL)

Sample Prepared using the WET method
6% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-4	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-1A	Test Date:	08/16/18	Checked By:	jdt
Depth :	4-4.5 ft	Test Id:	467186		
Test Comment:	---				
Visual Description:	Moist, grayish brown clay with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

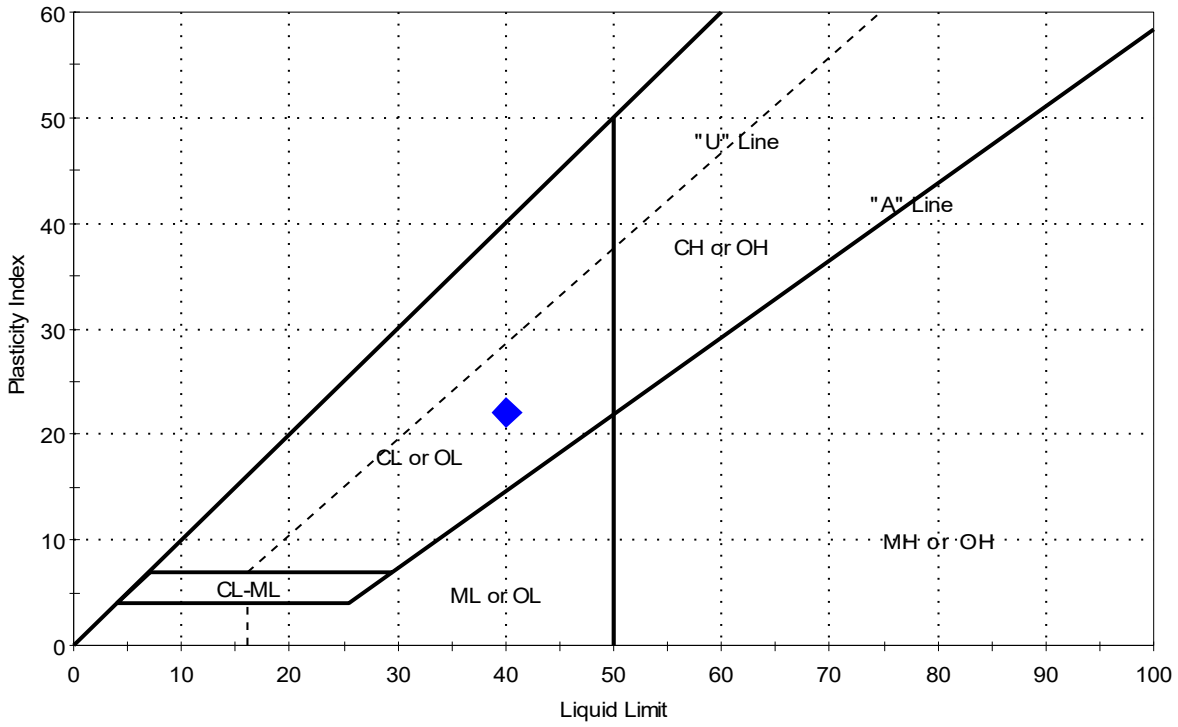


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1A	OW-4	4-4.5 ft	28	51	19	32	0.3	Fat CLAY with Gravel (CH)

Sample Prepared using the WET method
13% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-5	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-1	Test Date:	08/13/18	Checked By:	jdt
Depth :	3.9-5 ft	Test Id:	467188		
Test Comment:	---				
Visual Description:	Moist, mottled dark grayish brown and yellowish brown clay with sand.				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

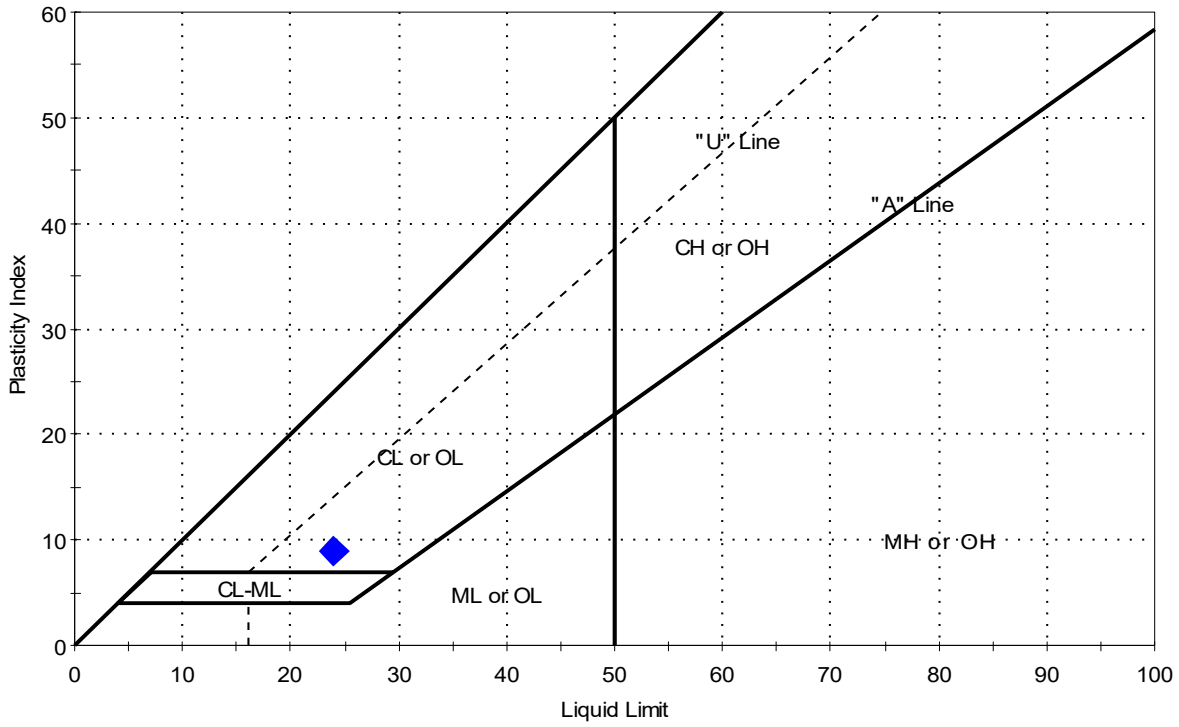


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1	OW-5	3.9-5 ft	23	40	18	22	0.2	Lean CLAY with Sand (CL)

Sample Prepared using the WET method
5% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Resource International, Inc.				
Project:	Big Walnut				
Location:	---			Project No:	GTX-308582
Boring ID:	OW-6	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-1	Test Date:	08/15/18	Checked By:	jdt
Depth :	15.4-16.5 ft	Test Id:	467189		
Test Comment:	---				
Visual Description:	Moist, gray sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



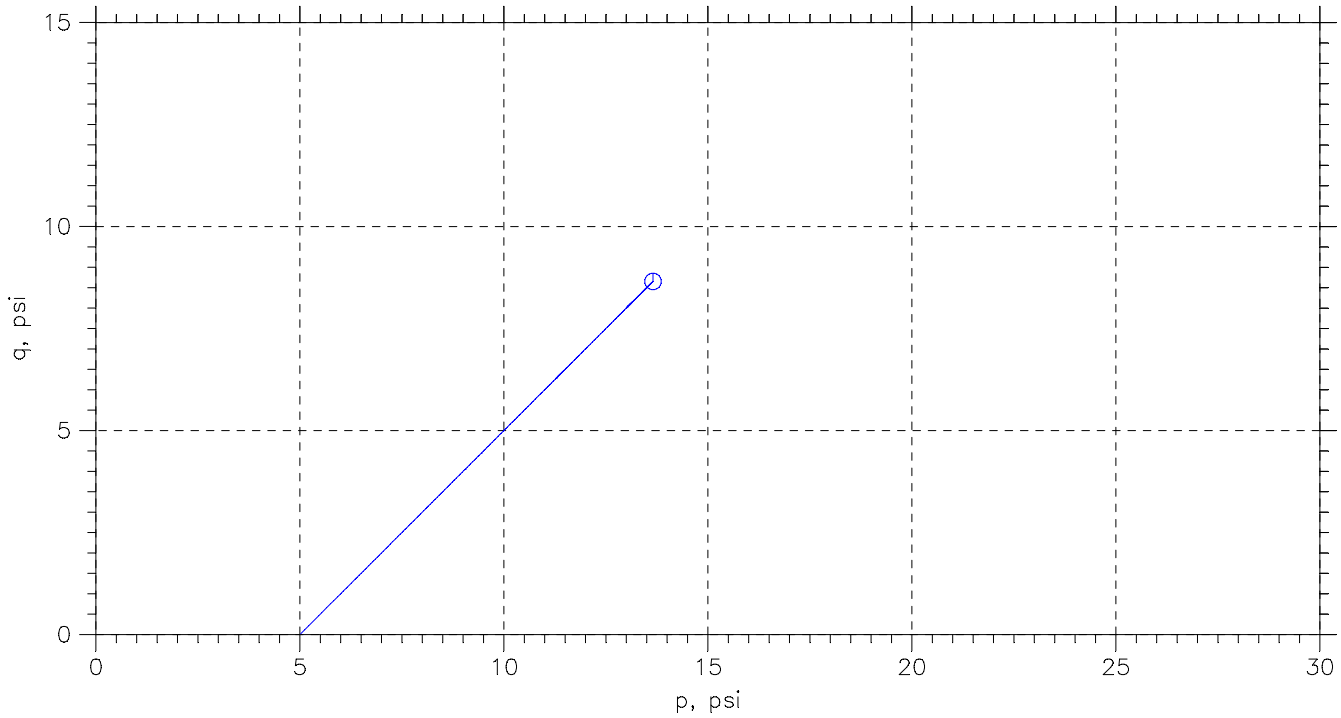
Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1	OW-6	15.4-16.5 ft	14	24	15	9	-0.1	Sandy Lean CLAY (CL)

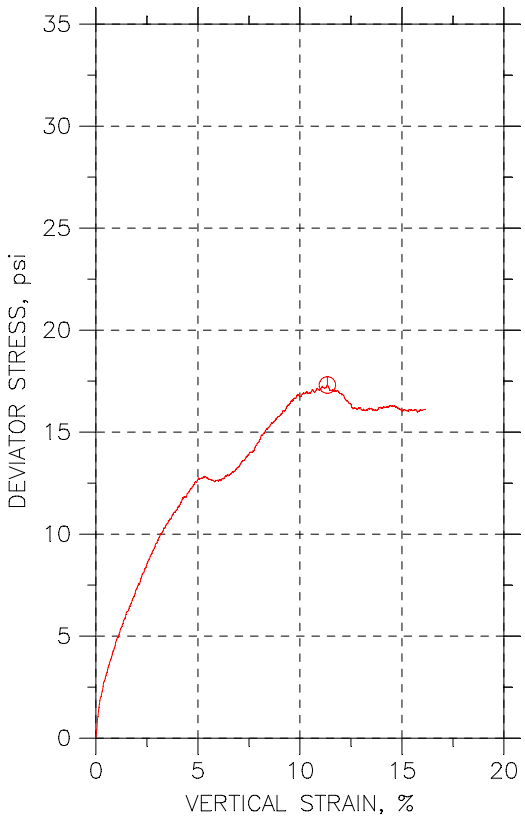
Sample Prepared using the WET method
23% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

I.3 TRIAXIAL COMPRESSION LABORATORY RESULTS

Stantec

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1			
Test No.	UU-3			
Depth	6.75-8ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	1.41			
Height, in	3			
Water Content, %	13.6			
Dry Density, pcf	108.7			
Saturation, %	66.5			
Void Ratio	0.55			
Confining Stress, psi	5			
Undrained Strength, psi	8.654			
Max. Dev. Stress, psi	17.31			
Strain at Failure, %	11.3			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	29			
Plastic Limit	18			
Plasticity Index	11			

GeoTesting EXPRESS

Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-3

Sample Type: intact

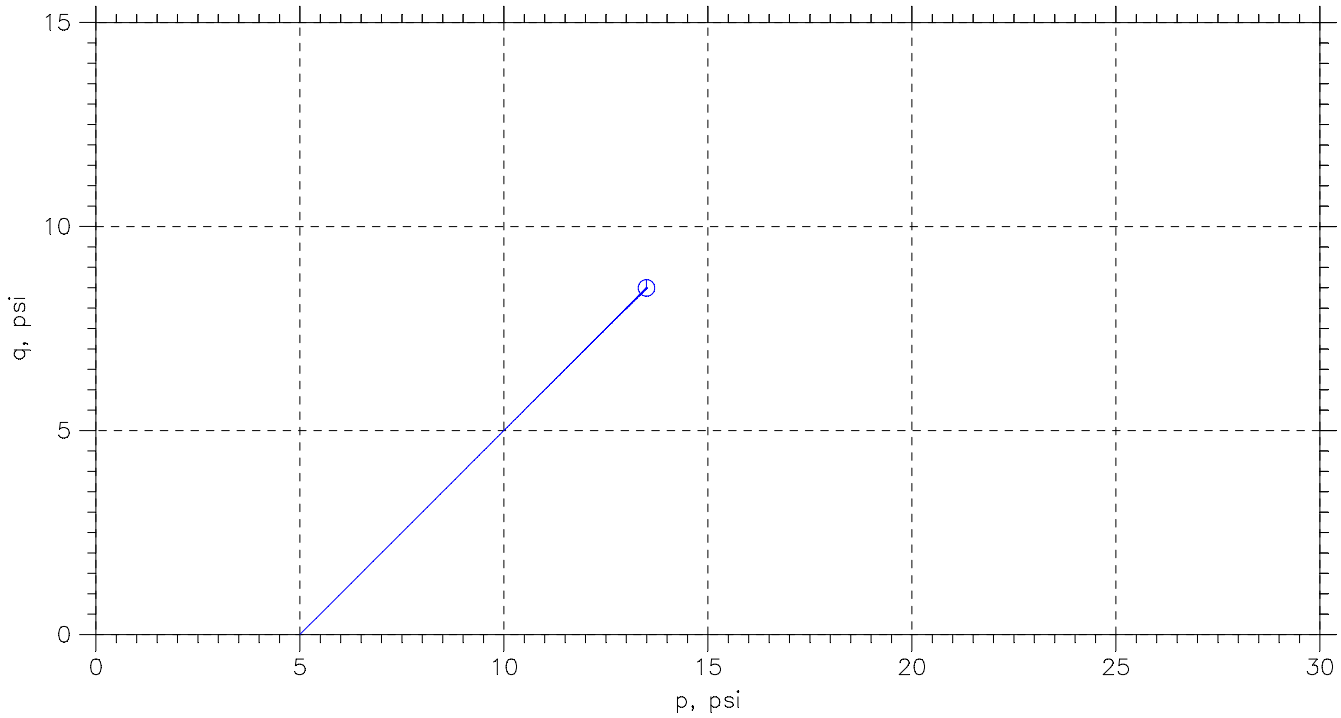
Description: Moist, brownish gray clay with sand

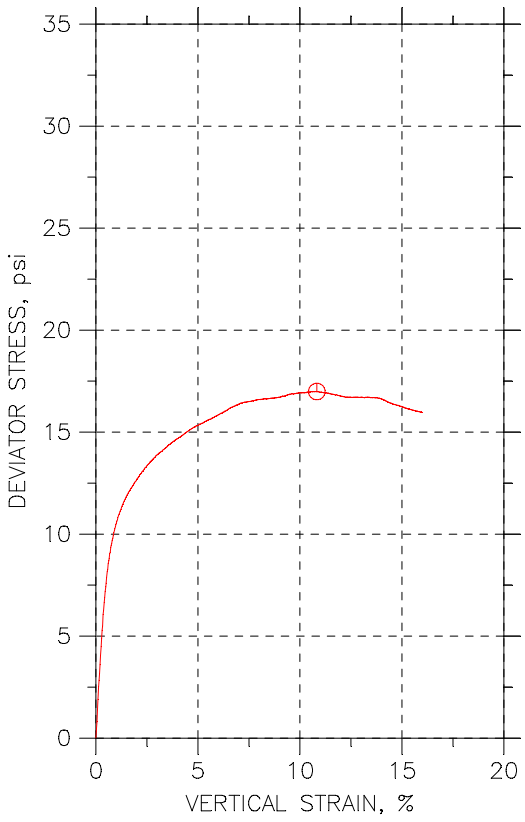
Remarks: System W

Phase calculations based on start and end of test.

Thu, 16-AUG-2018 10:19:30

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1B			
Test No.	UU-5			
Depth	4.5-5 ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	2.85			
Height, in	5.92			
Water Content, %	32.7			
Dry Density, pcf	88.46			
Saturation, %	97.6			
Void Ratio	0.905			
Confining Stress, psi	5			
Undrained Strength, psi	8.495			
Max. Dev. Stress, psi	16.99			
Strain at Failure, %	10.8			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	---			
Plastic Limit	---			
Plasticity Index	---			

GeoTesting EXPRESS

Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-4

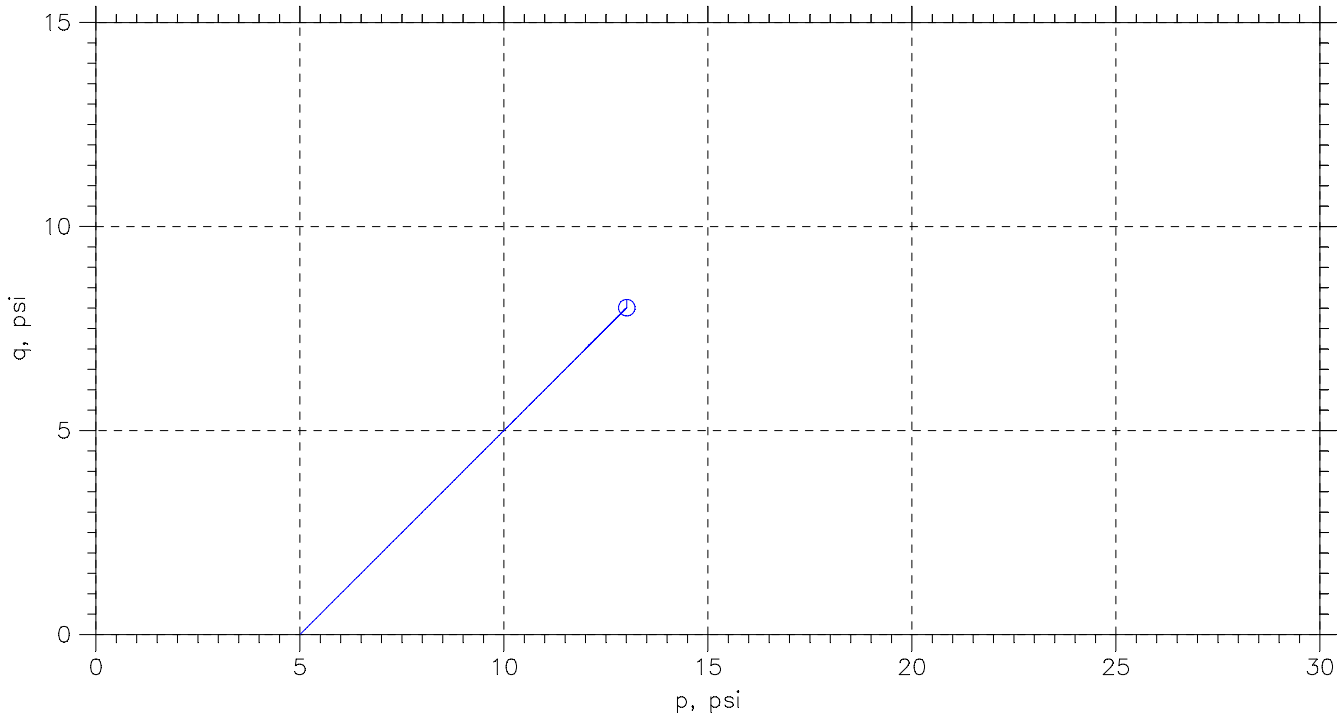
Sample Type: intact

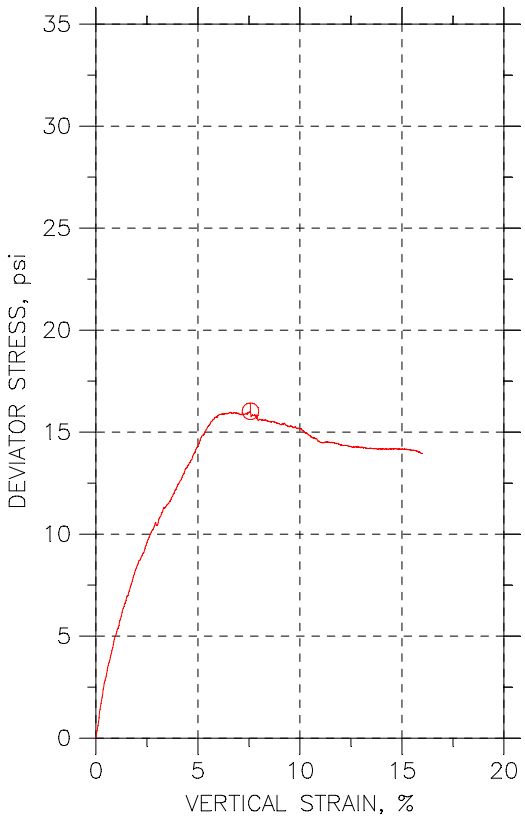
Description: Moist, grayish brown clay with gravel

Remarks: System W

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1			
Test No.	UU-2			
Depth	3.9-5 ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	2			
Height, in	4			
Water Content, %	21.6			
Dry Density, pcf	99.9			
Saturation, %	84.8			
Void Ratio	0.687			
Confining Stress, psi	5			
Undrained Strength, psi	8.011			
Max. Dev. Stress, psi	16.02			
Strain at Failure, %	7.58			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	40			
Plastic Limit	18			
Plasticity Index	22			

GeoTesting EXPRESS

Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-5

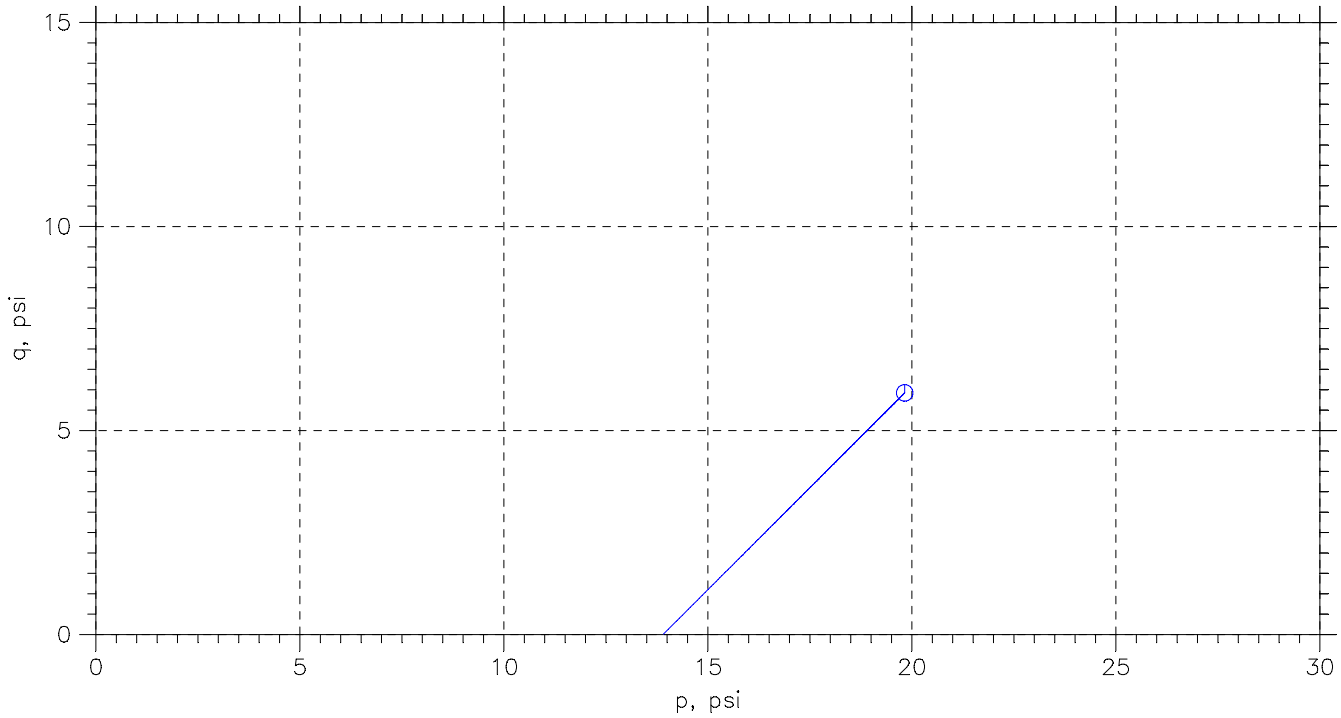
Sample Type: intact

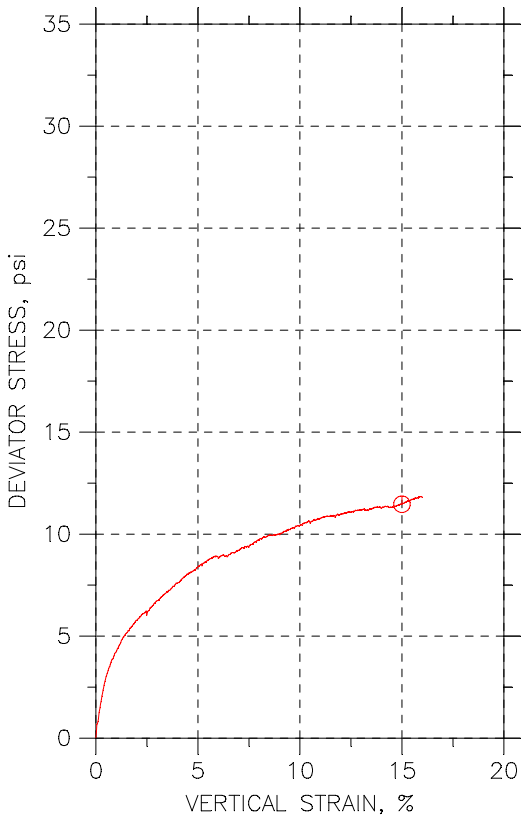
Description: Moist, mottled dark grayish brown and yellowish brown clay with sand

Remarks: System W

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1			
Test No.	UU-1			
Depth	15.4-16.5ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	1.41			
Height, in	3.6			
Water Content, %	12.3			
Dry Density, pcf	117.9			
Saturation, %	77.3			
Void Ratio	0.429			
Confining Stress, psi	13.9			
Undrained Strength, psi	5.733			
Max. Dev. Stress, psi	11.47			
Strain at Failure, %	15			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	24			
Plastic Limit	15			
Plasticity Index	9			

GeoTesting EXPRESS

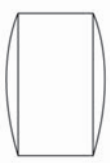
Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-6

Sample Type: intact

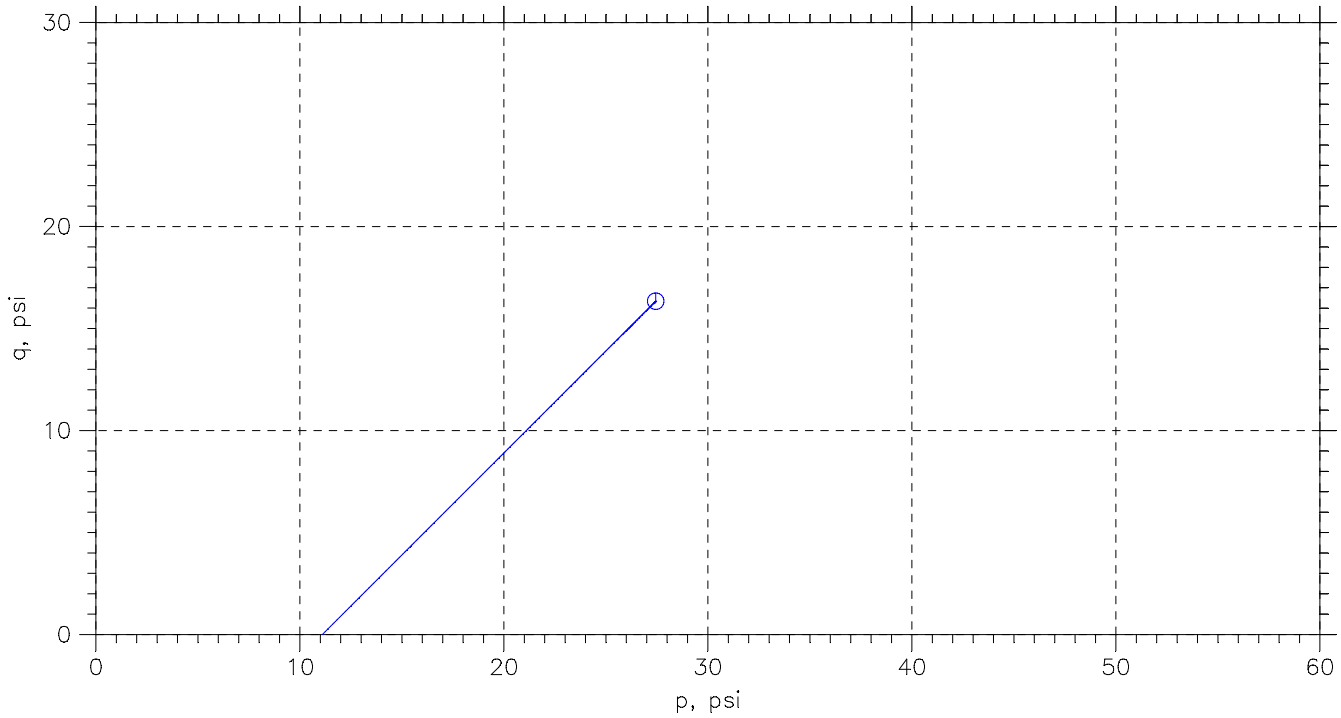


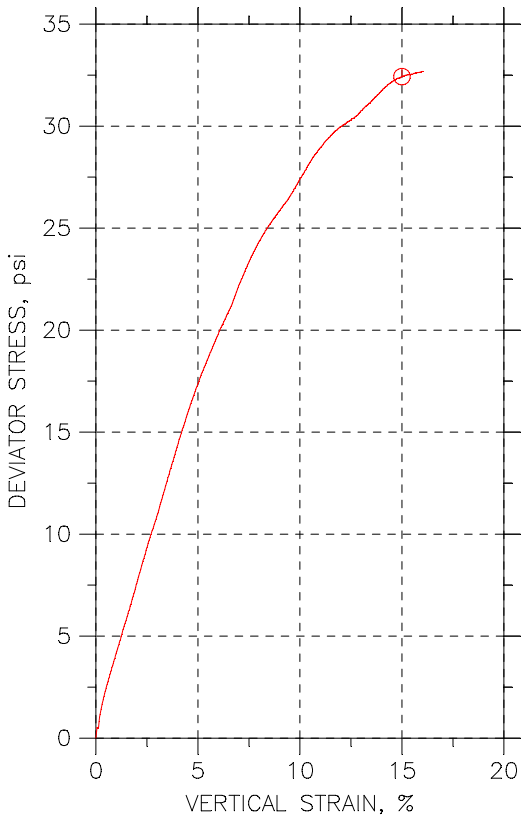
Description: Moist, gray sandy clay

Remarks: System W

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1B			
Test No.	UU-6			
Depth	12.5-13 ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	2.77			
Height, in	5.6			
Water Content, %	12.7			
Dry Density, pcf	124.9			
Saturation, %	98.1			
Void Ratio	0.349			
Confining Stress, psi	11.1			
Undrained Strength, psi	16.21			
Max. Dev. Stress, psi	32.43			
Strain at Failure, %	15			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	---			
Plastic Limit	---			
Plasticity Index	---			

GeoTesting EXPRESS

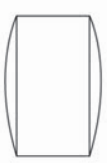
Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-8

Sample Type: intact

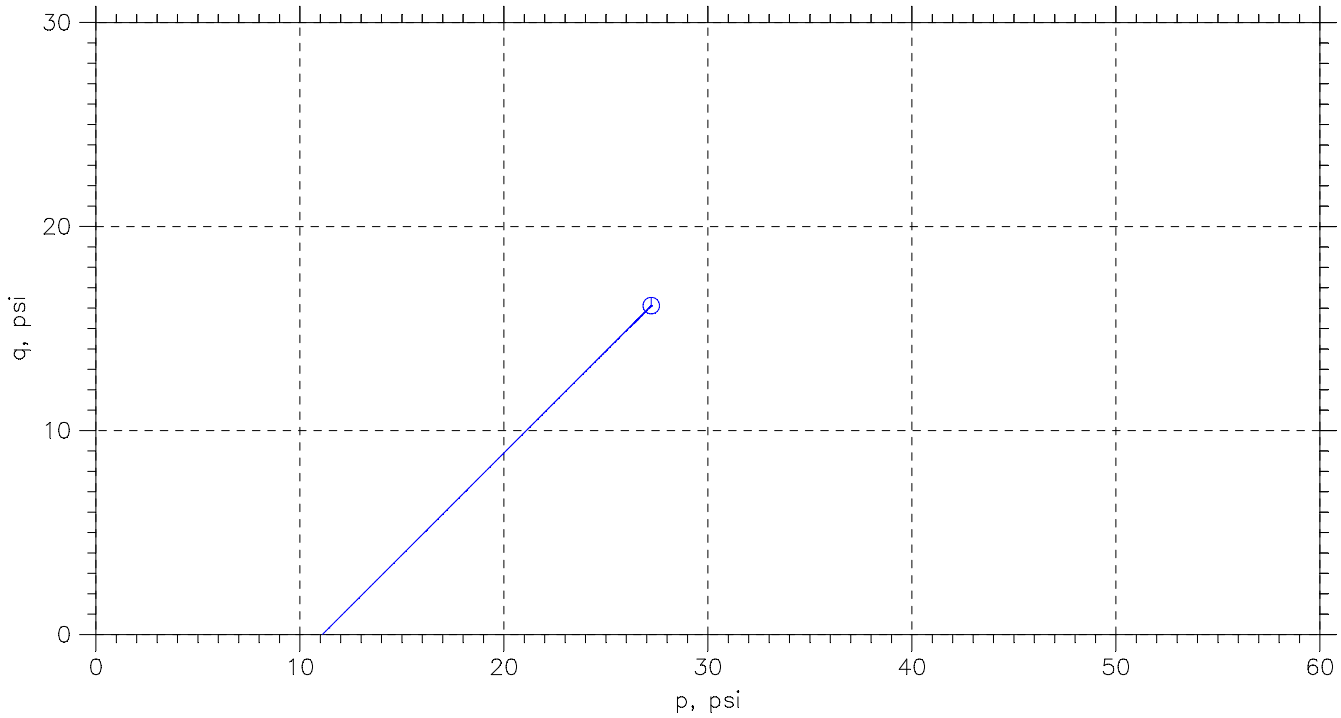


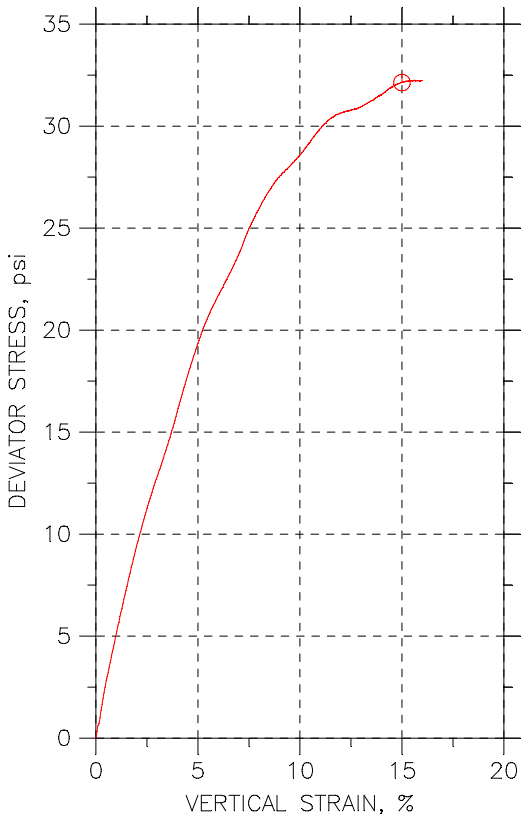
Description: Moist, gray clay with sand

Remarks: System W

Phase calculations based on start and end of test.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏲			
Sample No.	ST-1B			
Test No.	UU-4			
Depth	12.5-13 ft			
Tested by	md			
Test Date	8/14/18			
Checked by	njh			
Check Date	**8/16/18**			
Diameter, in	2.76			
Height, in	5.9			
Water Content, %	14.9			
Dry Density, pcf	122.8			
Saturation, %	107.9			
Void Ratio	0.373			
Confining Stress, psi	11.1			
Undrained Strength, psi	16.07			
Max. Dev. Stress, psi	32.14			
Strain at Failure, %	15			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	---			
Plastic Limit	---			
Plasticity Index	---			

GeoTesting EXPRESS

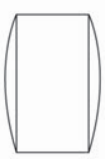
Project: Big Walnut

Location: ---

Project No.: GTX-308582

Boring No.: OW-9

Sample Type: intact



Description: Moist, gray clay with sand

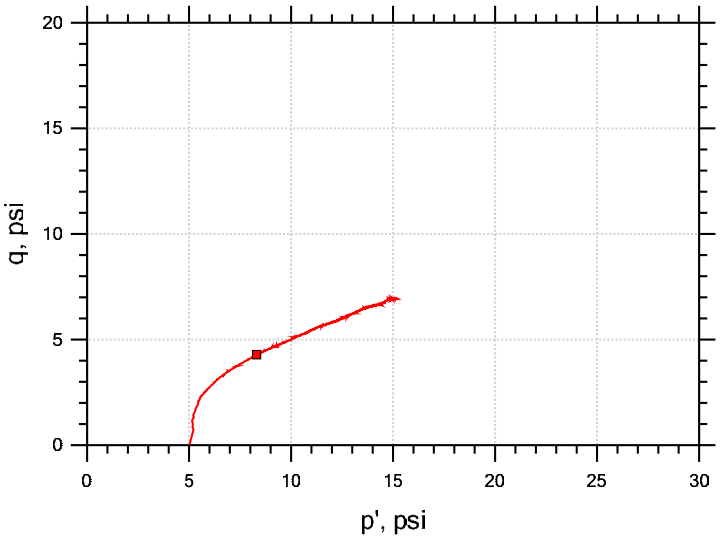
Remarks: System W

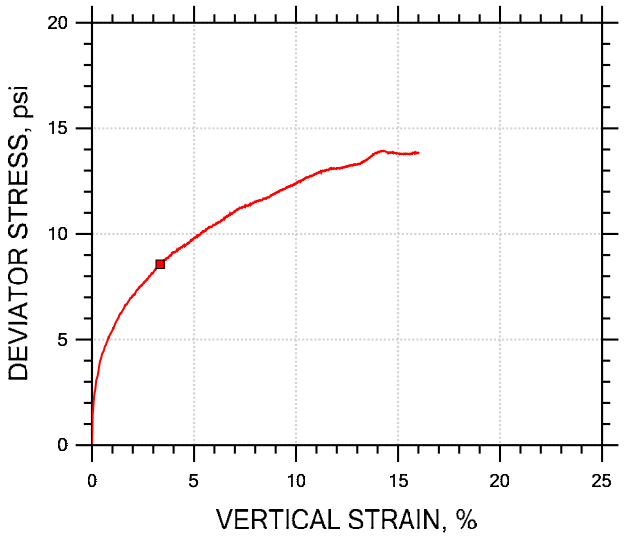
Phase calculations based on start and end of test.

Thu, 16-AUG-2018 10:25:43

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-3	
Preparation: intact	
Description: Moist, brownish gray clay with sand	
Classification: Lean CLAY with Sand	
Group Symbol: CL	
Liquid Limit: 29	Plastic Limit: 18
Plasticity Index: 11	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





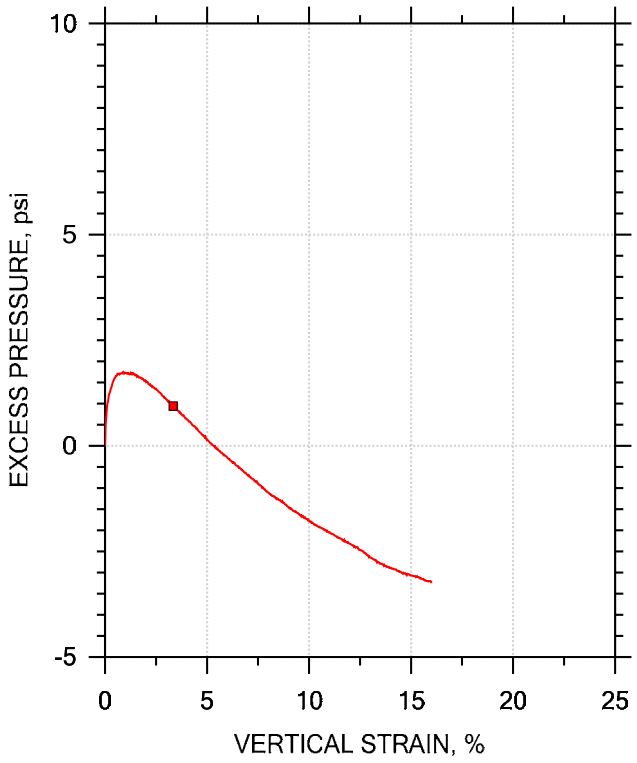
Symbol		■			
Sample ID		ST-1			
Depth, ft		6.75-8.0 ft			
Test Number		CU-3-1			
Initial	Height, in	2.910			
	Diameter, in	1.410			
	Moisture Content (from Cuttings), %	19.0			
	Dry Density, pcf	99.7			
	Saturation (Wet Method), %	74.4			
	Void Ratio	0.691			
Before Shear	Moisture Content, %	25.5			
	Dry Density, pcf	99.8			
	Cross-sectional Area (Method A), in²	1.561			
	Saturation, %	100.0			
	Void Ratio	0.690			
	Back Pressure, psi	150.8			
Vertical Effective Consolidation Stress, psi		5.014			
Horizontal Effective Consolidation Stress, psi		4.996			
Vertical Strain after Consolidation, %		0.2259			
Volumetric Strain after Consolidation, %		0.6836			
Time to 50% Consolidation, min		12.96			
Shear Strength, psi		4.282			
Strain at Failure, %		3.33			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		8.564			
Effective Minor Principal Stress at Failure, psi		4.027			
Effective Major Principal Stress at Failure, psi		12.59			
B-Value		0.95			

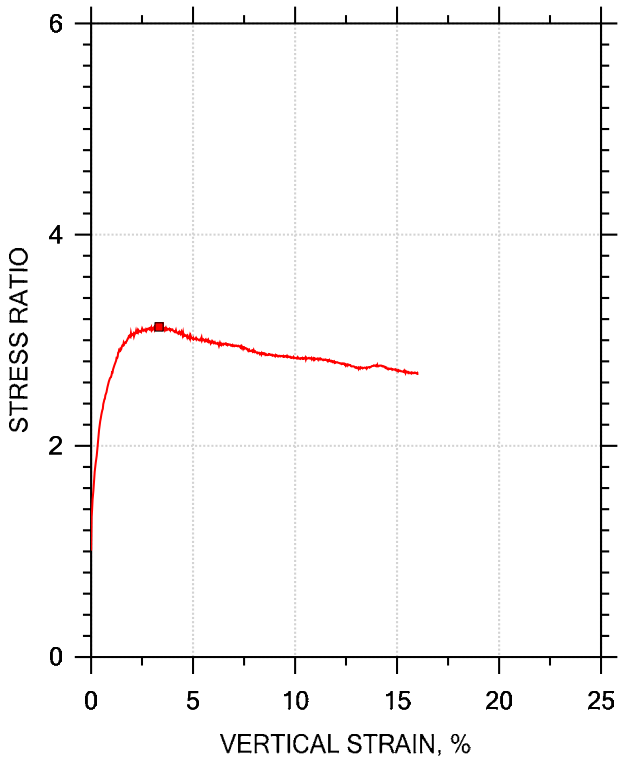
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

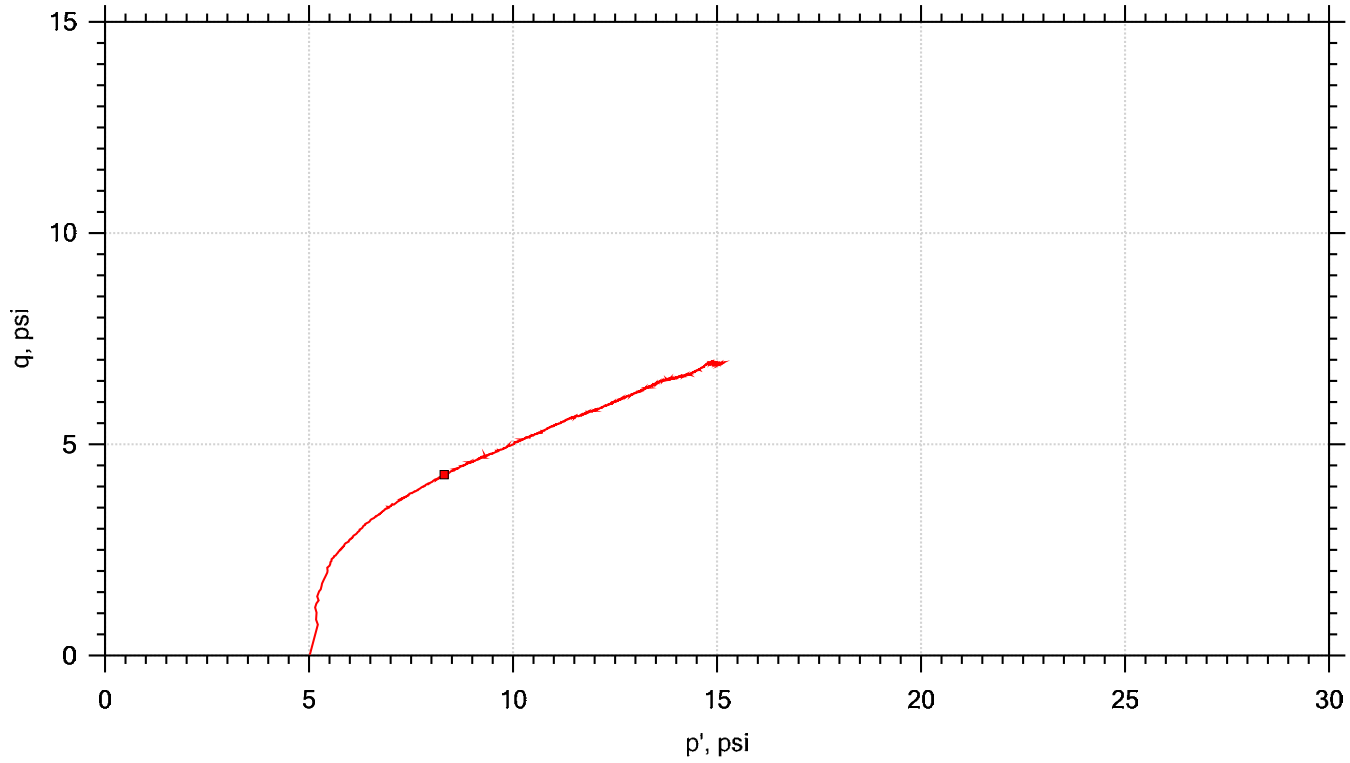
Remarks:

System II

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







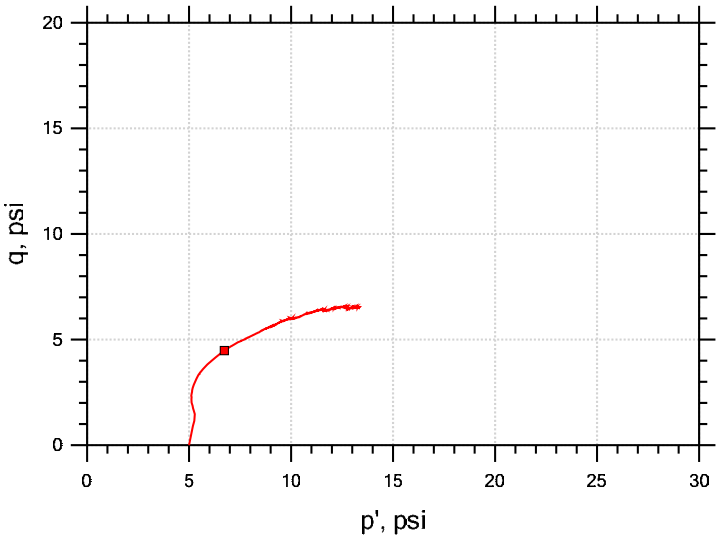
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-3-1	6.75-8.0 ft	md	08/08/18	njh	8/15/18	308582-CU-3-1n.dat

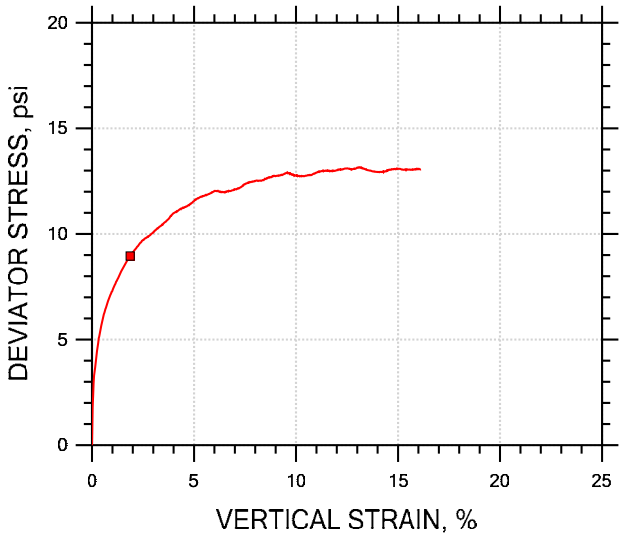
GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-3	Sample Type: intact	
Description: Moist, brownish gray clay with sand		
Remarks: System II		

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-4	
Preparation: intact	
Description: Moist, grayish brown clay with gravel	
Classification: Fat CLAY with Gravel	
Group Symbol: CH	
Liquid Limit: 51	Plastic Limit: 19
Plasticity Index: 32	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

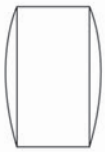




Symbol		■			
Sample ID		ST-1A			
Depth, ft		4-4.5 ft			
Test Number		CU-6-1			
Initial	Height, in	5.600			
	Diameter, in	2.860			
	Moisture Content (from Cuttings), %	27.3			
	Dry Density, pcf	97.0			
	Saturation (Wet Method), %	99.9			
	Void Ratio	0.738			
Before Shear	Moisture Content, %	28.4			
	Dry Density, pcf	95.4			
	Cross-sectional Area (Method A), in²	6.541			
	Saturation, %	100.0			
	Void Ratio	0.767			
	Back Pressure, psi	152.9			
Vertical Effective Consolidation Stress, psi		4.948			
Horizontal Effective Consolidation Stress, psi		4.994			
Vertical Strain after Consolidation, %		0.8279			
Volumetric Strain after Consolidation, %		0.3280			
Time to 50% Consolidation, min		121.0			
Shear Strength, psi		4.477			
Strain at Failure, %		1.86			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		8.953			
Effective Minor Principal Stress at Failure, psi		2.250			
Effective Major Principal Stress at Failure, psi		11.20			
B-Value		0.95			

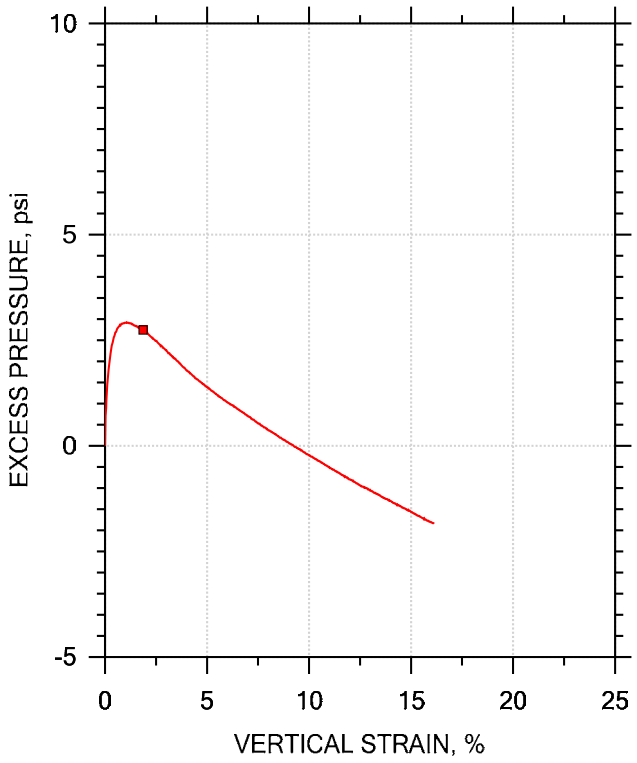
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

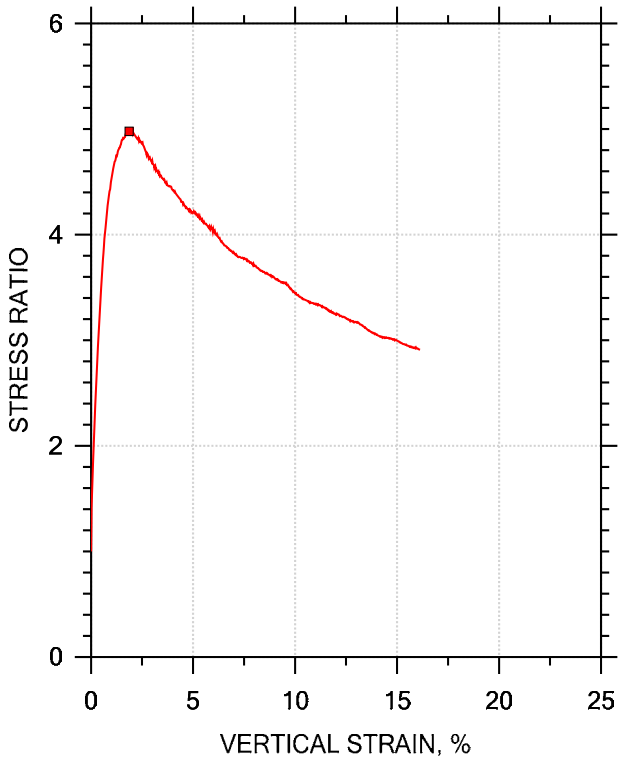
Remarks:

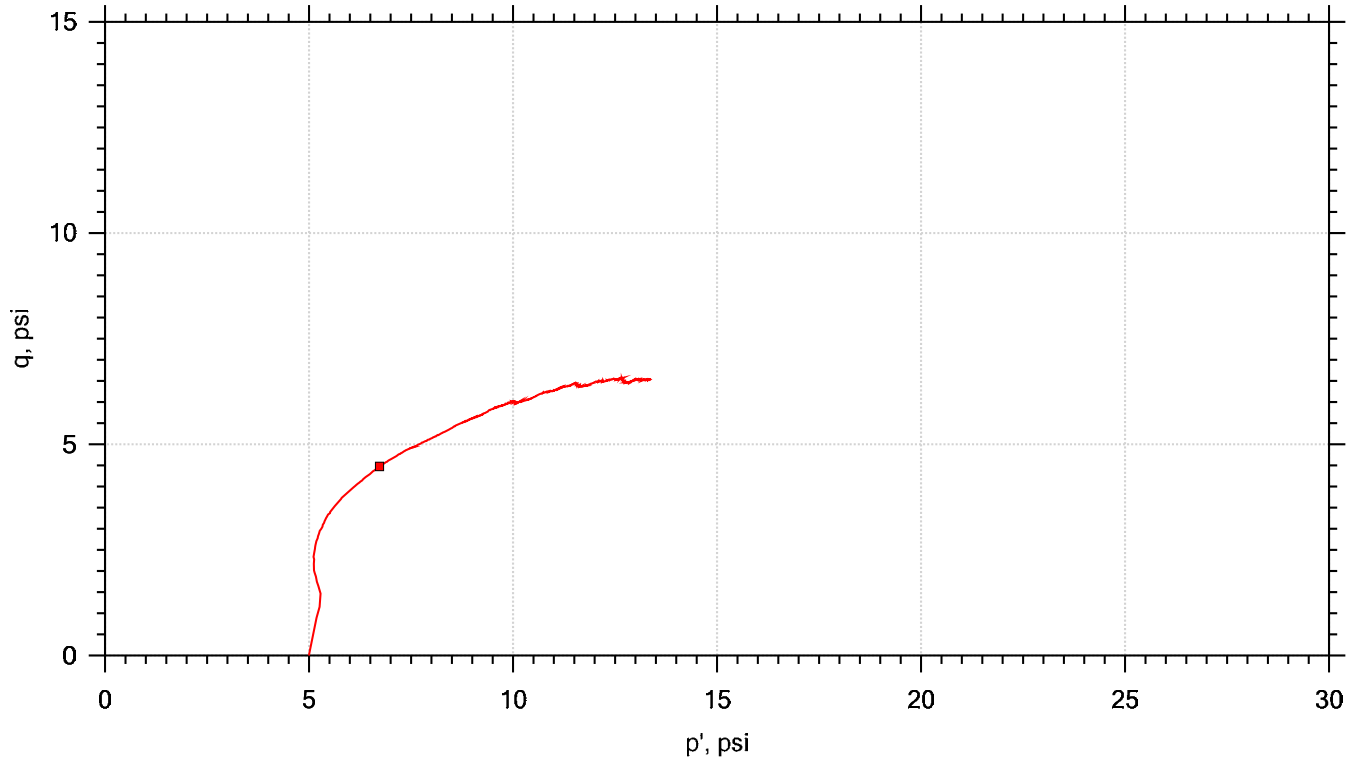


System D

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







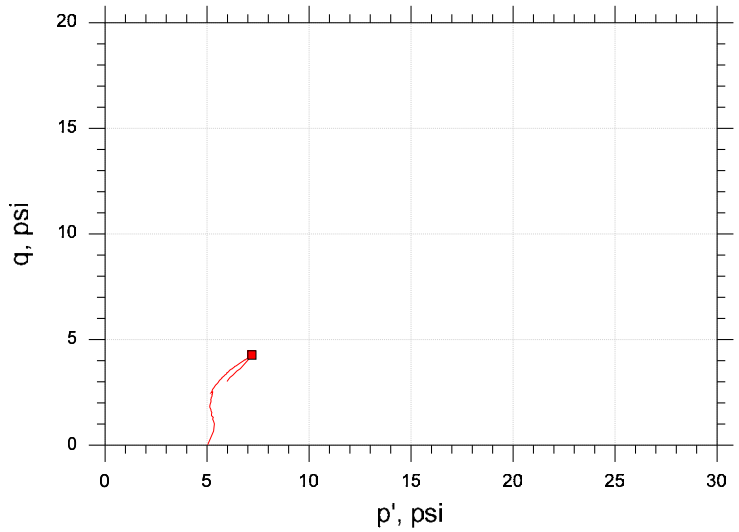
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1A	CU-6-1	4-4.5 ft	md	08/09/18	njh	8/15/18	308582-CU-6-1n.dat

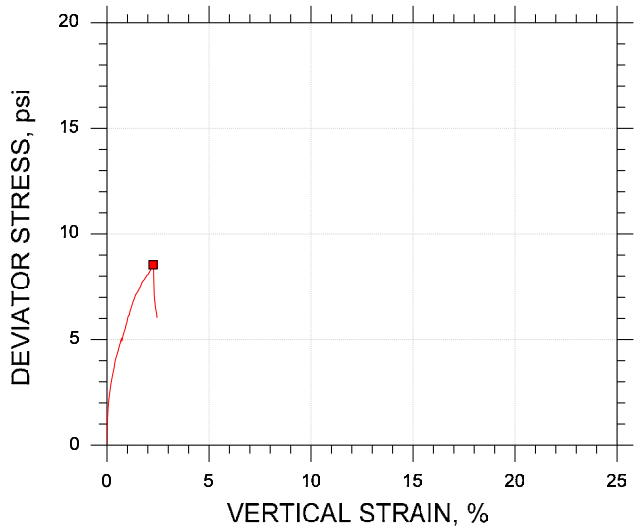
GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-4	Sample Type: intact	
Description: Moist, grayish brown clay with gravel		
Remarks: System D		

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-5	
Preparation: intact	
Description: Moist, mottled dark grayish brown and yellowish brown clay with sand	
Classification: Lean CLAY with Sand	
Group Symbol: CL	
Liquid Limit: 40	Plastic Limit: 18
Plasticity Index: 22	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





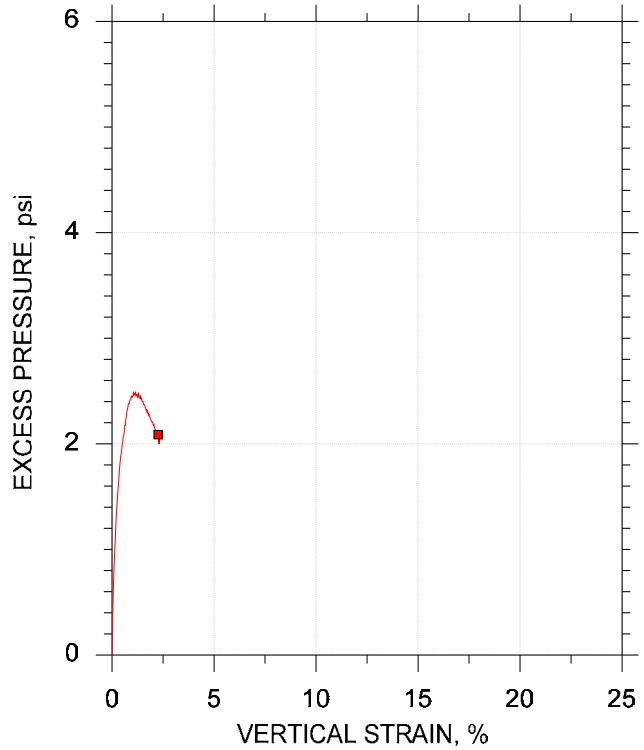
Symbol		■			
Sample ID		ST-1			
Depth, ft		3.9-5.0 ft			
Test Number		CU-1-1			
Initial	Height, in	4.000			
	Diameter, in	2.000			
	Moisture Content (from Cuttings), %	22.4			
	Dry Density, pcf	99.5			
	Saturation (Wet Method), %	87.1			
	Void Ratio	0.695			
Before Shear	Moisture Content, %	25.3			
	Dry Density, pcf	100.			
	Cross-sectional Area (Method A), in²	3.131			
	Saturation, %	100.0			
	Void Ratio	0.682			
	Back Pressure, psi	152.8			
Vertical Effective Consolidation Stress, psi		5.021			
Horizontal Effective Consolidation Stress, psi		5.022			
Vertical Strain after Consolidation, %		0.2703			
Volumetric Strain after Consolidation, %		0.3902			
Time to 50% Consolidation, min		0.1600			
Shear Strength, psi		4.269			
Strain at Failure, %		2.25			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		8.537			
Effective Minor Principal Stress at Failure, psi		2.927			
Effective Major Principal Stress at Failure, psi		11.46			
B-Value		0.95			

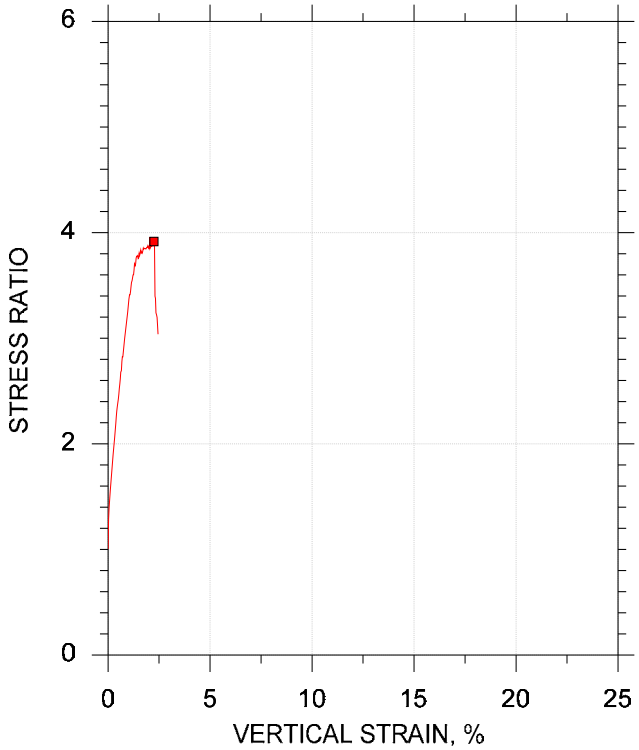
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

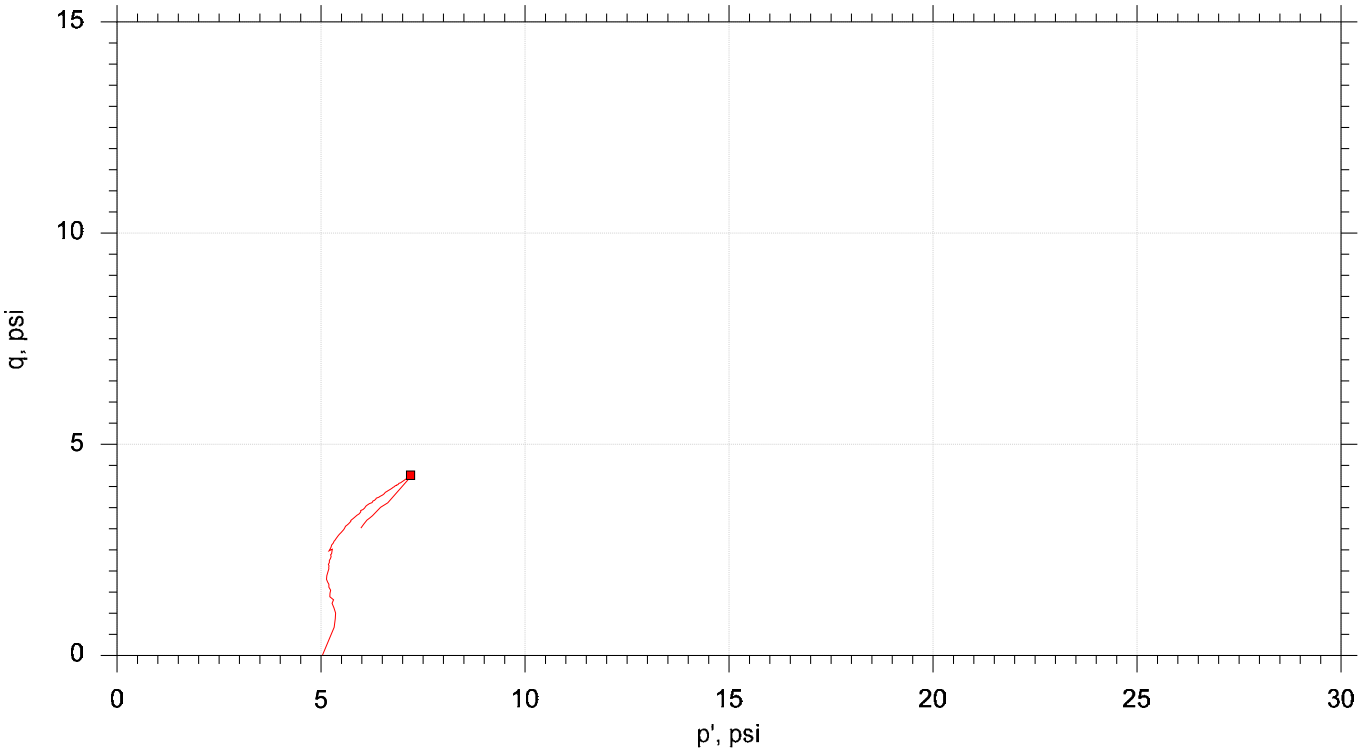
Remarks:

System R

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







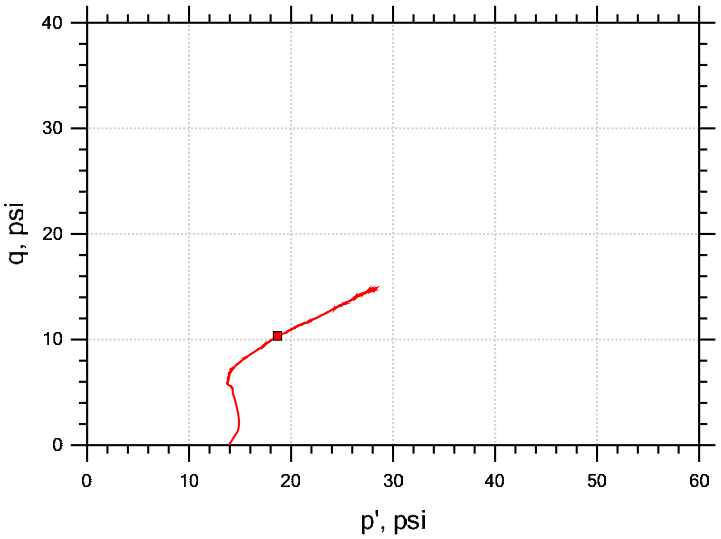
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-1-1	3.9-5.0 ft	md	08/08/18	njh	8/15/18	308582-CU-1-1n.dat

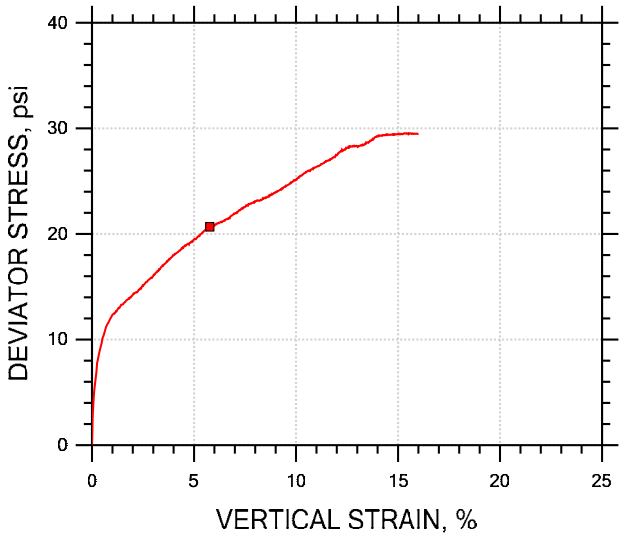
GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-5	Sample Type: intact	
Description: Moist, mottled dark grayish brown and yellowish brown clay with sand		
Remarks: System R		

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-6	
Preparation: intact	
Description: Moist, gray sandy clay	
Classification: Sandy Lean CLAY	
Group Symbol: CL	
Liquid Limit: 24	Plastic Limit: 15
Plasticity Index: 9	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767

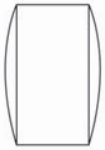




Symbol		■			
Sample ID		ST-1			
Depth, ft		15.4-16.5 ft			
Test Number		CU-2-1			
Initial	Height, in	3.020			
	Diameter, in	1.420			
	Moisture Content (from Cuttings), %	11.9			
	Dry Density, pcf	128.			
	Saturation (Wet Method), %	100.0			
	Void Ratio	0.322			
Before Shear	Moisture Content, %	10.6			
	Dry Density, pcf	131.			
	Cross-sectional Area (Method A), in²	1.551			
	Saturation, %	100.0			
	Void Ratio	0.287			
	Back Pressure, psi	152.6			
Vertical Effective Consolidation Stress, psi		13.91			
Horizontal Effective Consolidation Stress, psi		13.89			
Vertical Strain after Consolidation, %		0.2260			
Volumetric Strain after Consolidation, %		1.662			
Time to 50% Consolidation, min		16.00			
Shear Strength, psi		10.34			
Strain at Failure, %		5.78			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		20.67			
Effective Minor Principal Stress at Failure, psi		8.334			
Effective Major Principal Stress at Failure, psi		29.01			
B-Value		0.95			

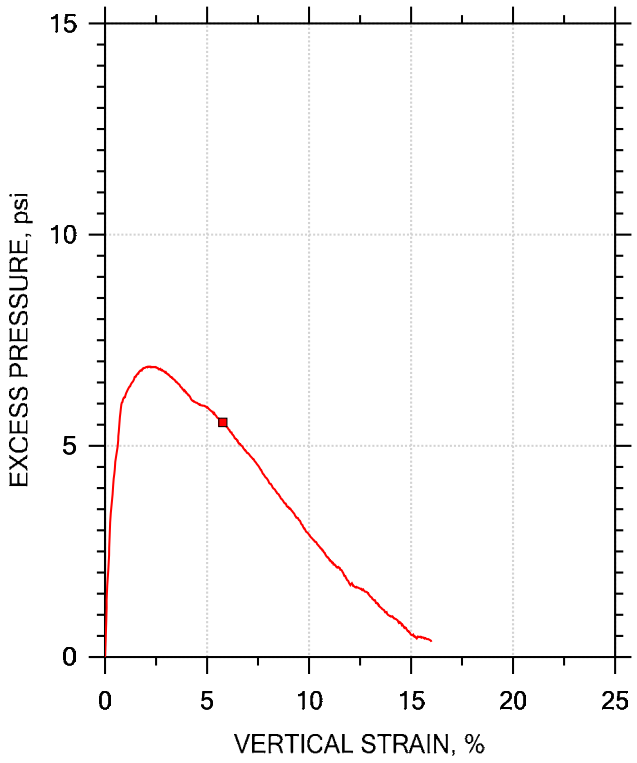
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

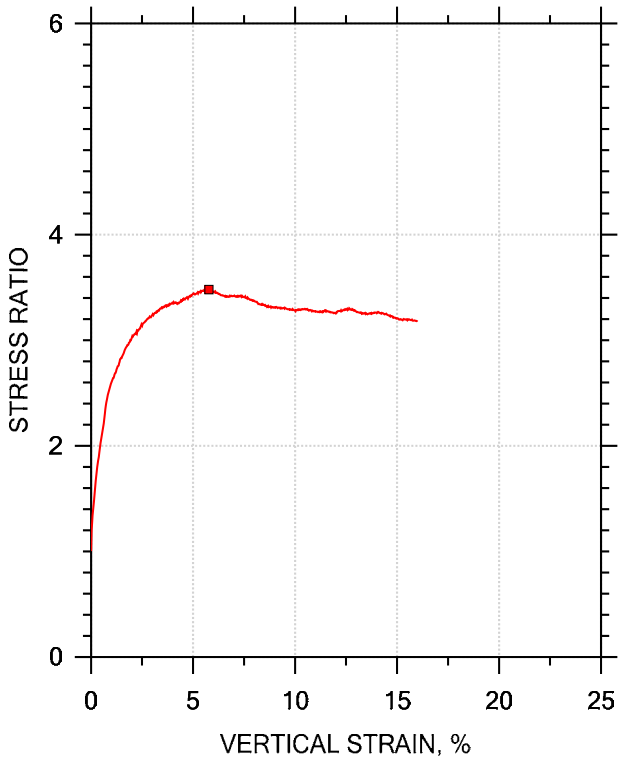
Remarks:

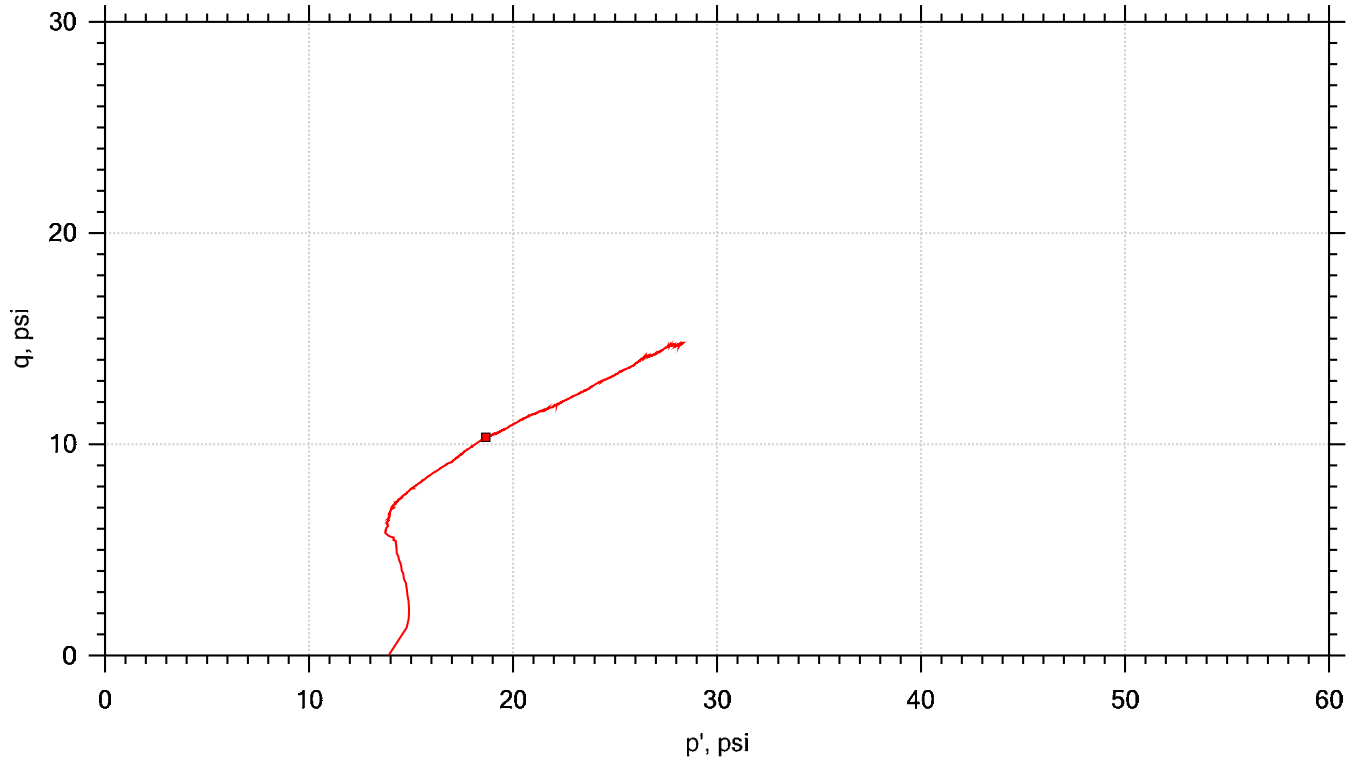


System JJ

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







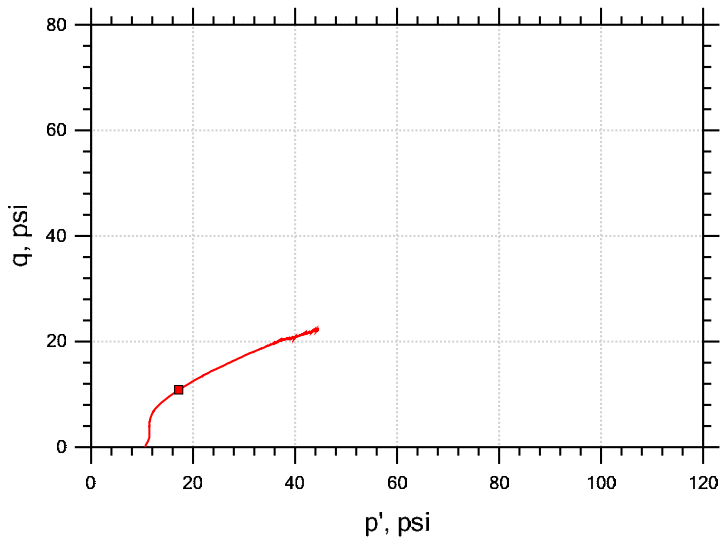
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-2-1	15.4-16.5 ft	md	08/08/18	njh	8/15/18	308582-CU-2-1n.dat

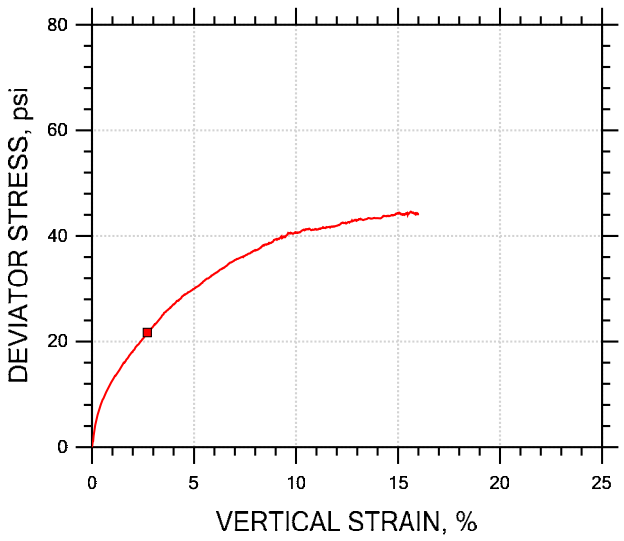
GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-6	Sample Type: intact	
Description: Moist, gray sandy clay		
Remarks: System JJ		

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-8	
Preparation: intact	
Description: Moist, gray clay with sand	
Classification: ---	
Group Symbol: ---	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.7

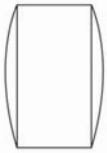
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■			
Sample ID		ST-1A			
Depth, ft		12-12.5 ft			
Test Number		CU-5-1			
Initial	Height, in	5.650			
	Diameter, in	2.750			
	Moisture Content (from Cuttings), %	12.0			
	Dry Density, pcf	126.			
	Saturation (Wet Method), %	95.4			
	Void Ratio	0.338			
Before Shear	Moisture Content, %	11.6			
	Dry Density, pcf	128.			
	Cross-sectional Area (Method A), in²	5.858			
	Saturation, %	100.0			
	Void Ratio	0.314			
	Back Pressure, psi	57.00			
Vertical Effective Consolidation Stress, psi		10.59			
Horizontal Effective Consolidation Stress, psi		10.60			
Vertical Strain after Consolidation, %		0.3738			
Volumetric Strain after Consolidation, %		1.532			
Time to 50% Consolidation, min		56.25			
Shear Strength, psi		10.86			
Strain at Failure, %		2.70			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		21.72			
Effective Minor Principal Stress at Failure, psi		6.339			
Effective Major Principal Stress at Failure, psi		28.05			
B-Value		1.00			

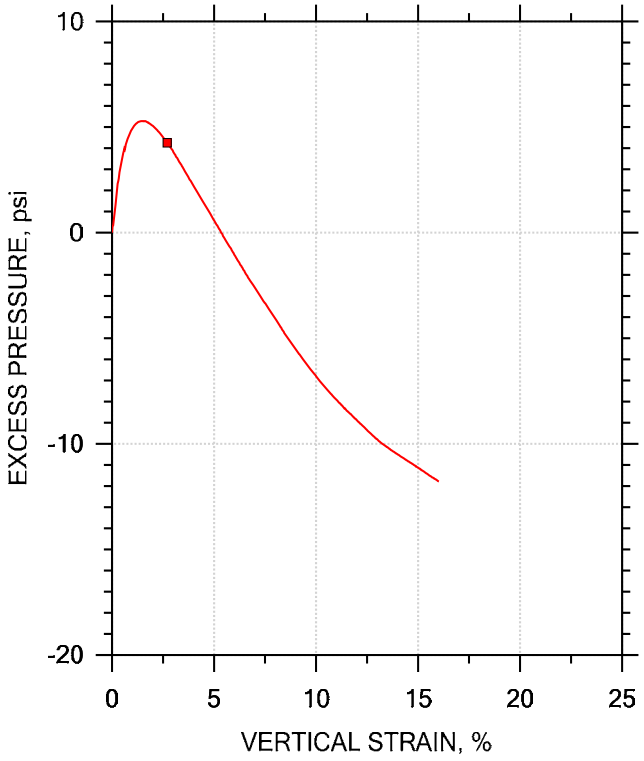
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

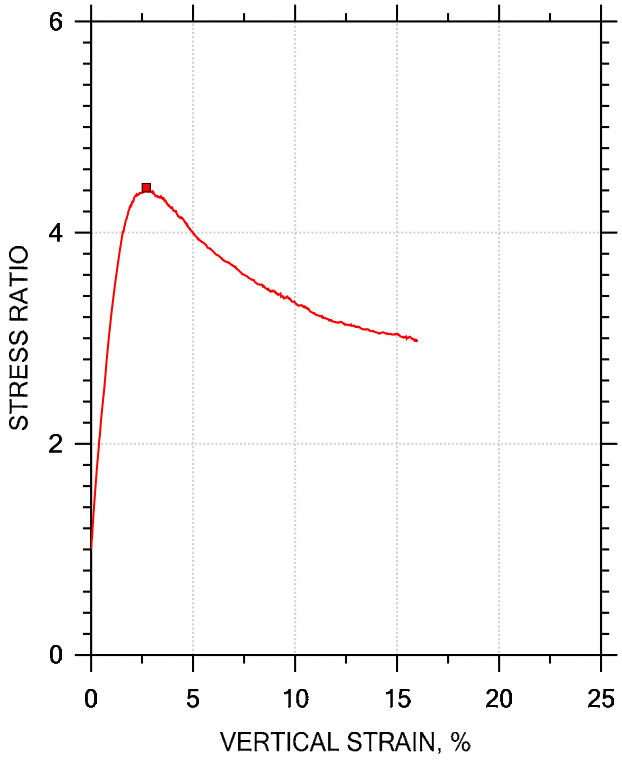


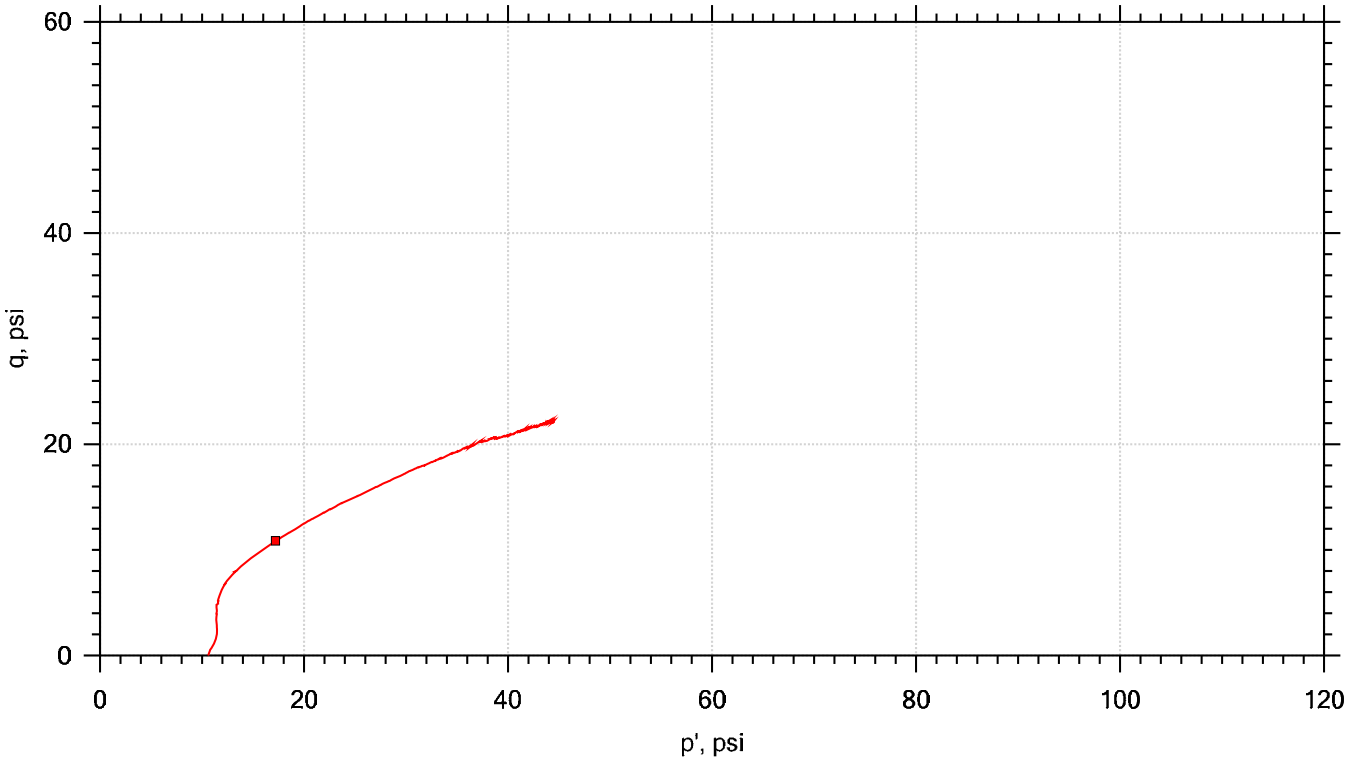
Remarks:

System F

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







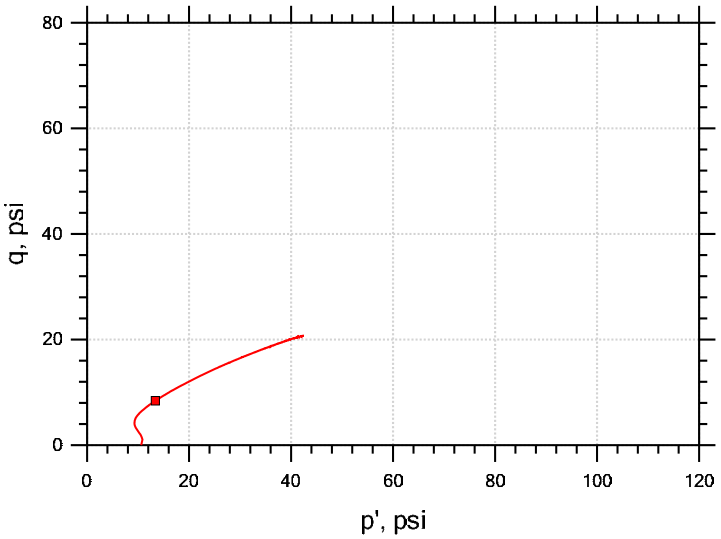
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1A	CU-5-1	12-12.5 ft	md	08/09/18	njh	8/15/18	308582-CU-5-1n.dat

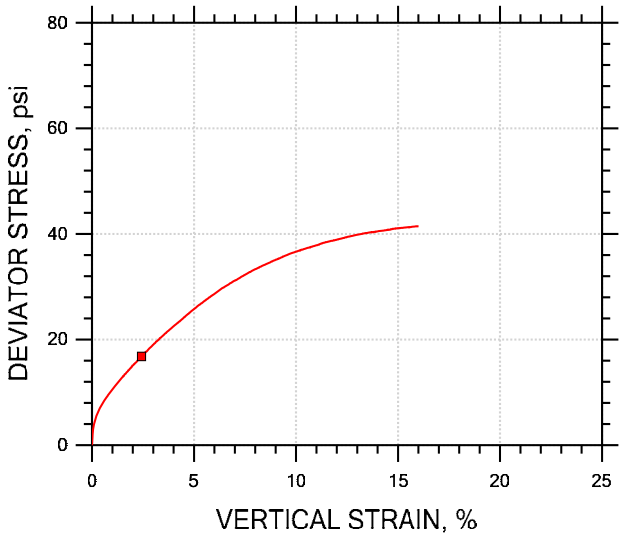
GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-8	Sample Type: intact	
Description: Moist, gray clay with sand		
Remarks: System F		

Client: Resource International, Inc.	
Project Name: Big Walnut	
Project Location: ---	
Project Number: GTX-308582	
Tested By: md	Checked By: njh
Boring ID: OW-9	
Preparation: intact	
Description: Moist, gray clay with sand	
Classification: ---	
Group Symbol: ---	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.7

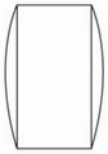
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■			
Sample ID		ST-1A			
Depth, ft		12-12.5 ft			
Test Number		CU-4-1			
Initial	Height, in	5.810			
	Diameter, in	2.750			
	Moisture Content (from Cuttings), %	12.8			
	Dry Density, pcf	125.			
	Saturation (Wet Method), %	98.2			
	Void Ratio	0.352			
Before Shear	Moisture Content, %	12.6			
	Dry Density, pcf	126.			
	Cross-sectional Area (Method A), in²	5.904			
	Saturation, %	100.0			
	Void Ratio	0.340			
	Back Pressure, psi	150.8			
Vertical Effective Consolidation Stress, psi		10.58			
Horizontal Effective Consolidation Stress, psi		10.60			
Vertical Strain after Consolidation, %		0.3091			
Volumetric Strain after Consolidation, %		0.9317			
Time to 50% Consolidation, min		121.0			
Shear Strength, psi		8.399			
Strain at Failure, %		2.43			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psi		16.80			
Effective Minor Principal Stress at Failure, psi		4.982			
Effective Major Principal Stress at Failure, psi		21.78			
B-Value		0.95			

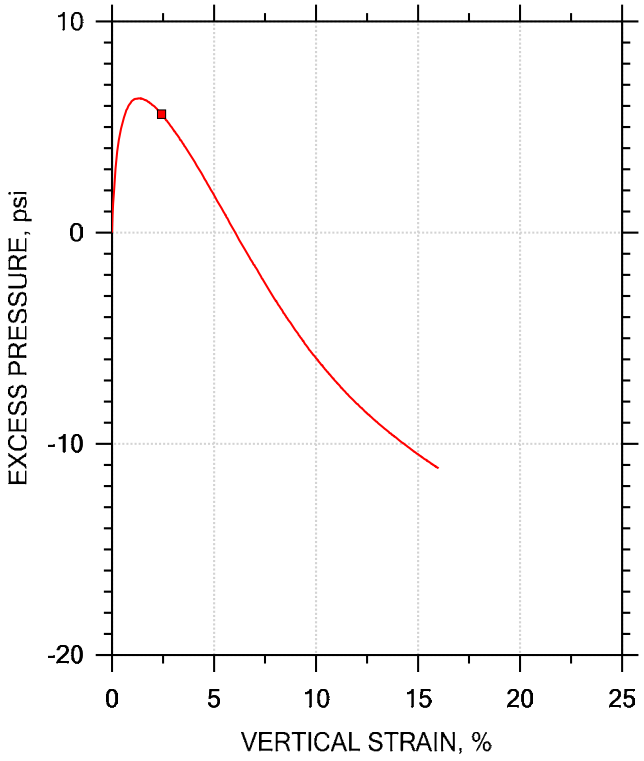
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

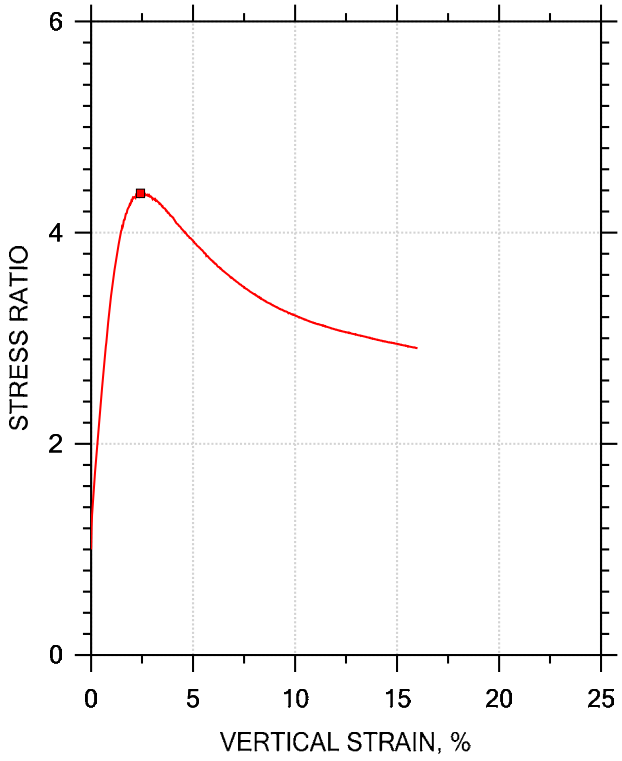


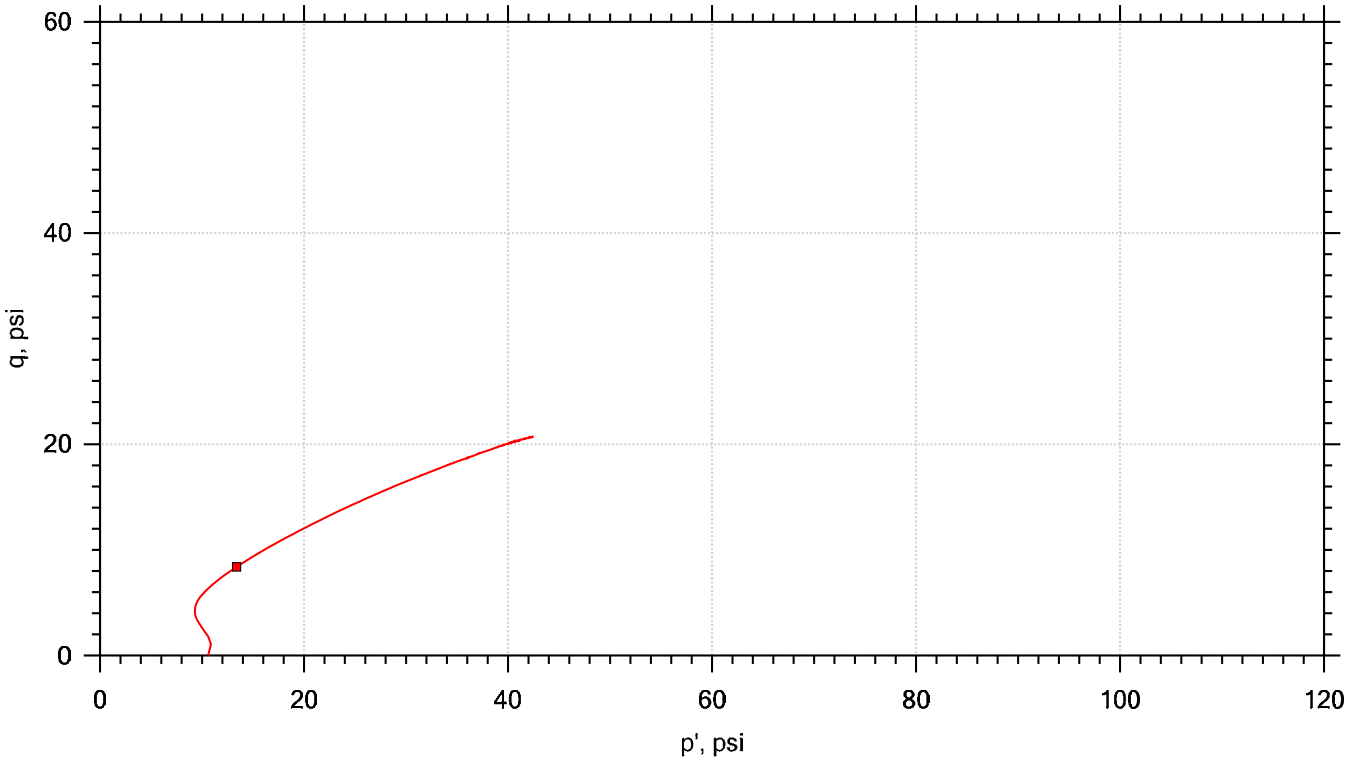
Remarks:

System E

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1A	CU-4-1	12-12.5 ft	md	08/09/18	njh	8/15/18	308582-CU-4-1n.dat

GeoTesting EXPRESS

Project: Big Walnut	Location: ---	Project No.: GTX-308582
Boring No.: OW-9	Sample Type: intact	
Description: Moist, gray clay with sand		
Remarks: System E		

Appendix J BEDROCK LABORATORY TESTING RESULTS

J.1 Unconfined Compressive Strength Laboratory Results
J.2 Uniaxial Compressive Strength Laboratory Results
J.3 Splitting Tensile Laboratory Results
J.4 Slake Durability Laboratory Results
J.5 Point Load Laboratory Results
J.6 Petrography Laboratory Results
J.7 Cerchar Laboratory Results
J.8 SINTEF Laboratory Results
J.9 Direct Shear Laboratory Results
J.10 pH Laboratory Results

J.1 UNCONFINED COMPRESSIVE STRENGTH LABORATORY RESULTS

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

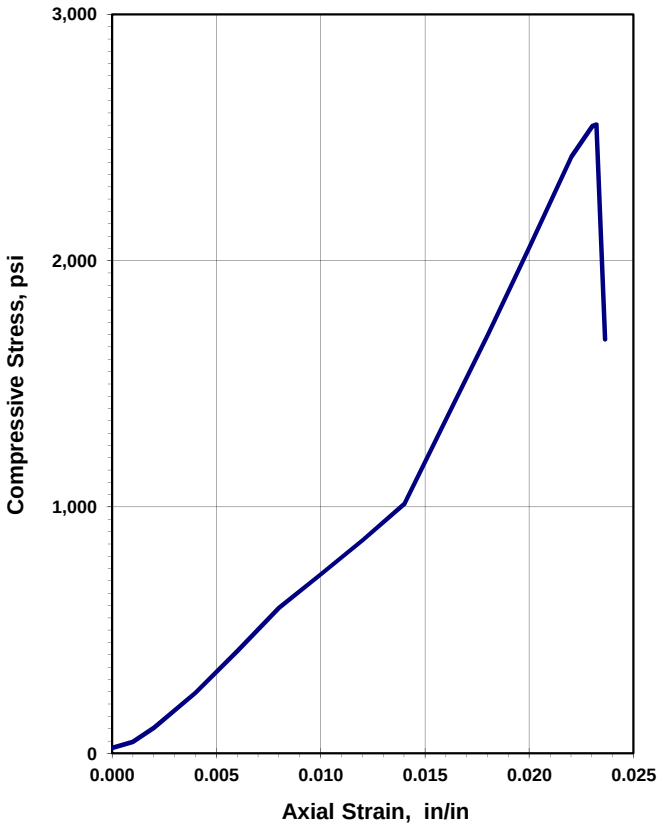
Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/12/2018
Test Performed by: C.Straub

Rock Description: Shale, blue to blueish gray, unweathered, soft, laminated to thin bedded.
Rock Formation: Bedford Shale

Boring No.:	B-16		Average Length:	4.994	in
Sample No:	HQ-6		Average Diameter:	2.3995	in
Depth (ft):	147.7-148.1	feet	Length to diameter ratio:	2.081	
Moisture condition:	as received		Cross Sectional Area:	4.522	in^2
			Volume:	0.0131	ft^3
Testing Temperature:	21	^oC			
Rate of Loading:	35.0	lbs/sec	Failure Load:	11,540	lbs
Testing Time:	330	sec	Axial Strain at Failure:	0.0232	in/in
(Rate 2-15 minutes to failure)			Compressive Strength:	2,552	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/12/2018
Test Performed by: C.Straub

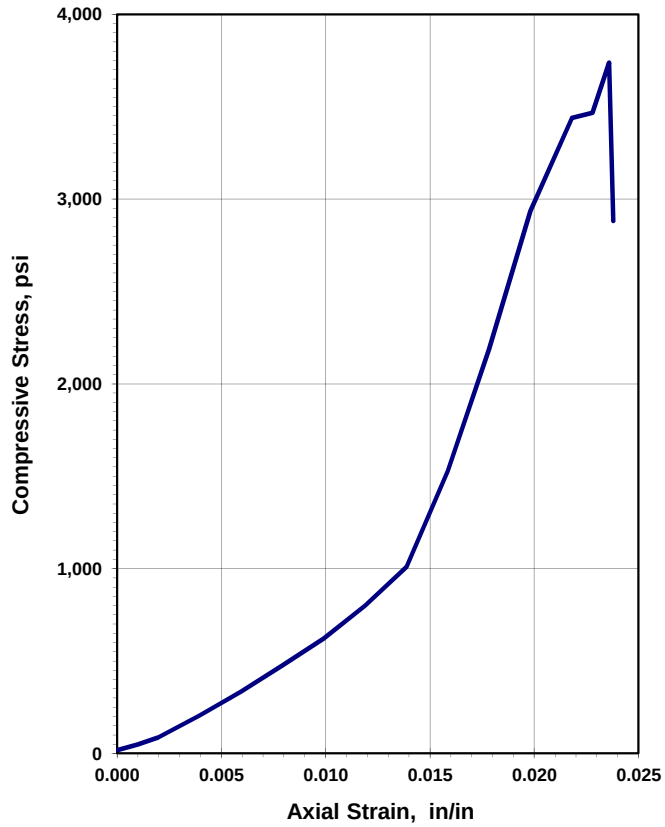
Rock Description: Shale, black, unweathered, moderately hard, laminated to thin bedded, slightly pyritic.
Rock Formation: Ohio Shale

Boring No.:	B-16	
Sample No:	HQ-7	
Depth (ft):	153.3-153.8'	feet
Moisture condition:	as received	
Testing Temperature:	21	°C
Rate of Loading:	56.2	lbs/sec
Testing Time:	300	sec
(Rate 2-15 minutes to failure)		

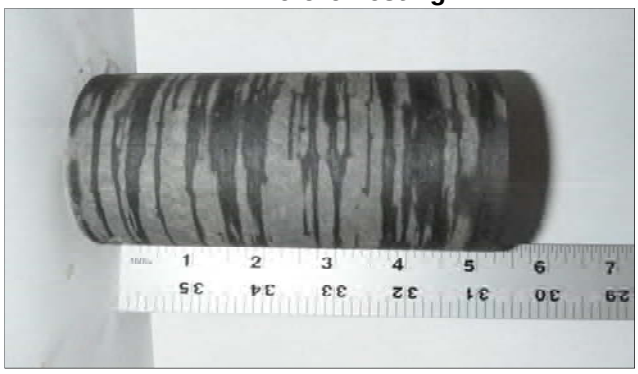
Average Length:	5.045	in
Average Diameter:	2.3965	in
Length to diameter ratio:	2.105	
Cross Sectional Area:	4.511	in^2
Volume:	0.0132	ft^3
Failure Load:	16,860	lbs
Axial Strain at Failure:	0.0236	in/in
Compressive Strength:	3,738	psi

Sample Preparation: Per ASTM D4543

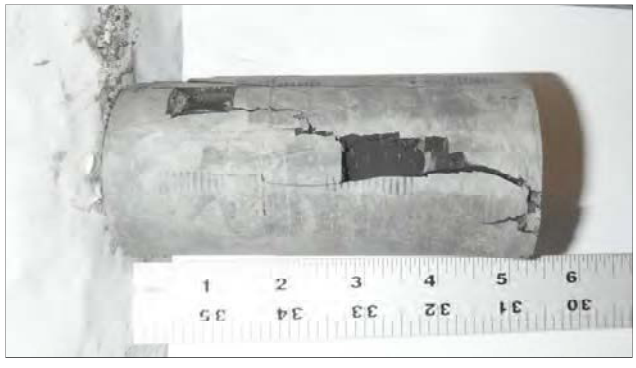
Unconfined Compression Test



Before Testing



After Failure



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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 4/3/2018
Test Performed by: C.Straub

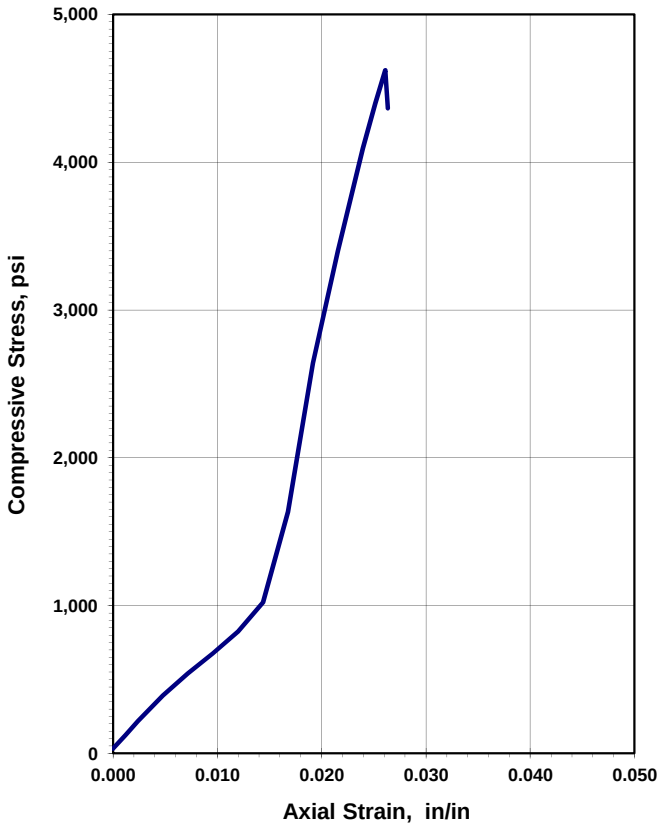
Rock Description: Bluish Gray SHALE, soft, slightly weathered, flat bedded, fresh rock.
Rock Formation: Bedford Shale

Boring No.:	B-18	
Sample No:	NQ-12	
Depth (ft):	152.7-153.0	feet
Moisture condition:	as received	
Testing Temperature:	21	°C
Rate of Loading:	37.8	lbs/sec
Testing Time:	375	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.174	in
Average Diameter:	1.976	in
Length to diameter ratio:	2.112	
Cross Sectional Area:	3.067	in^2
Volume:	0.0074	ft^3
Failure Load:	14,170	lbs
Axial Strain at Failure:	0.0261	in/in
Compressive Strength:	4,621	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

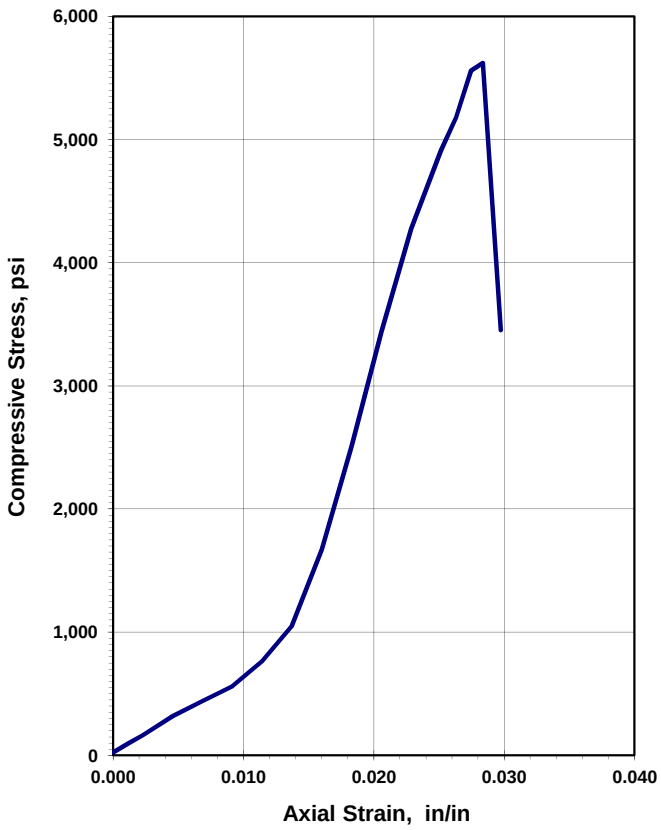
Project: Big Walnut San. Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 4/3/2018
Test Performed by: C.Straub

Rock Description: Black Shale, moderately hard, slightly weathered, laminated, fresh rock.
Rock Formation: Ohio Shale

Boring No.:	B-18		Average Length:	4.372	in
Sample No:	NQ-13		Average Diameter:	1.9745	in
Depth (ft):	161.0-161.4'	feet	Length to diameter ratio:	2.214	
Moisture condition:	as received		Cross Sectional Area:	3.062	in^2
			Volume:	0.0077	ft^3
Testing Temperature:	21	^oC			
Rate of Loading:	46.1	lbs/sec	Failure Load:	17,210	lbs
Testing Time:	373	sec	Axial Strain at Failure:	0.0284	in/in
(Rate 2-15 minutes to failure)			Compressive Strength:	5,621	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/24/2018
Test Performed by: C.Straub

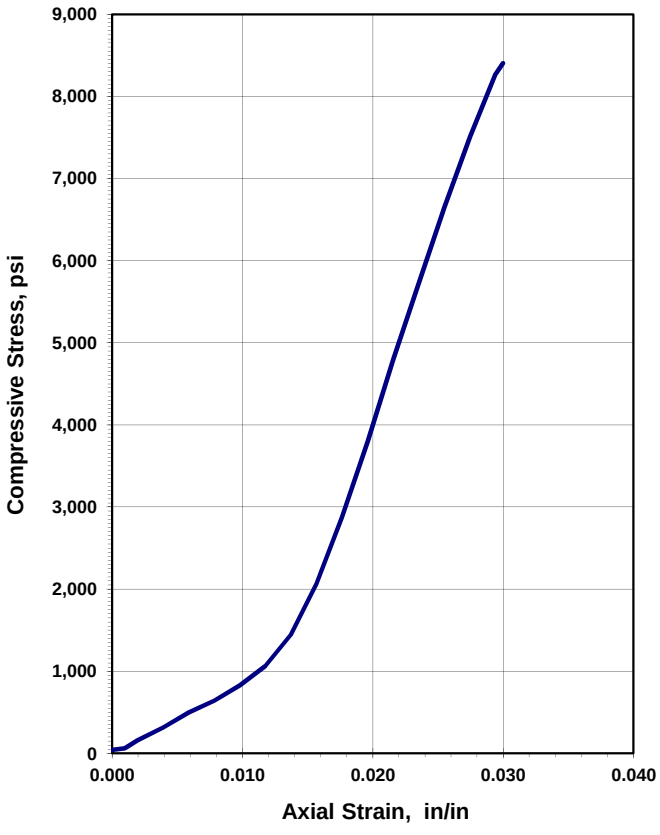
Rock Description: Black Shale, moderately hard, unweathered, thin bedded, flat bedded, moderately fractured.
Rock Formation: Ohio Shale

Boring No.:	B-20	
Sample No:	HQ-16	
Depth (ft):	152.8-153.2	feet
Moisture condition:	as received	
Testing Temperature:	20	^{o}C
Rate of Loading:	69.2	lbs/sec
Testing Time:	550	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.100	in
Average Diameter:	2.4015	in
Length to diameter ratio:	2.124	
Cross Sectional Area:	4.530	in^2
Volume:	0.0134	ft^3
Failure Load:	38,070	lbs
Axial Strain at Failure:	0.0300	in/in
Compressive Strength:	8,405	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San. Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 4/3/2018
Test Performed by: C.Straub

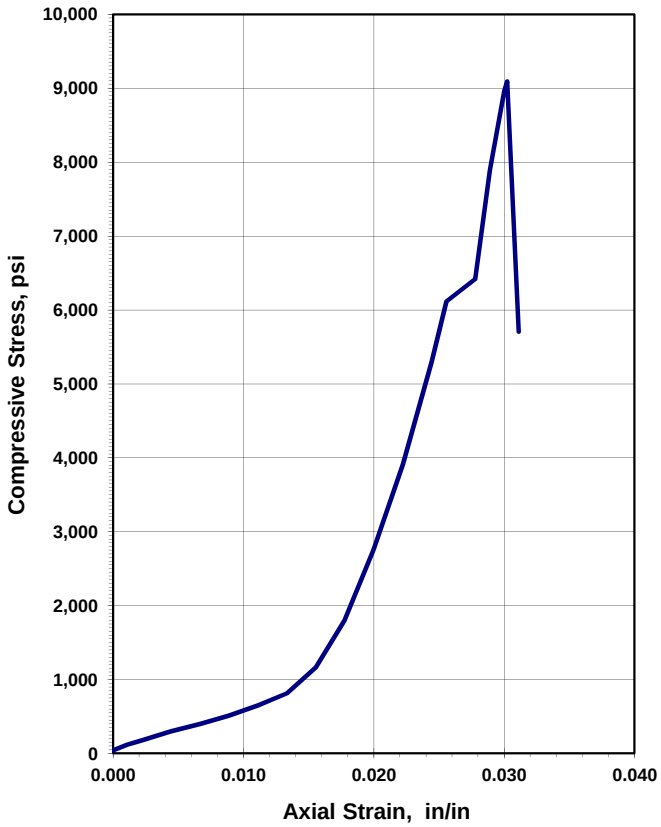
Rock Description: Gray Shale, soft to moderately hard, slightly to moderately weathered, thin bedded.
Rock Formation: Bedford Shale

Boring No.:	B-23	
Sample No:	HQ-11	
Depth (ft):	156.6-157.0	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	79.5	lbs/sec
Testing Time:	501	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.499	in
Average Diameter:	2.362	in
Length to diameter ratio:	1.905	
Cross Sectional Area:	4.382	in^2
Volume:	0.0114	ft^3
Failure Load:	39,830	lbs
Axial Strain at Failure:	0.0302	in/in
Compressive Strength:	9,090	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San. Trunk Sew. PH2

Project No.: W-15-012

Date of Testing: 4/12/2018

Test Performed by: E.Mesko

Rock Description: Black Shale, slightly weathered, thin to medium bedded, moderately strong.

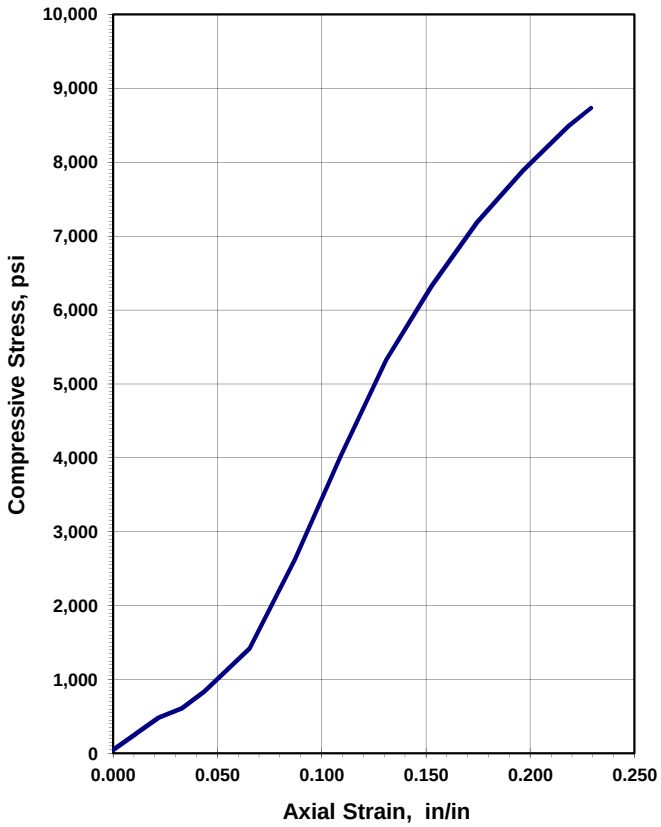
Rock Formation: Ohio Shale

Boring No.:	B-23	
Sample No:	HQ-13	
Depth (ft):	170.6-171.1	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	76.6	lbs/sec
Testing Time:	468	sec
(Rate 2-15 minutes to failure)		

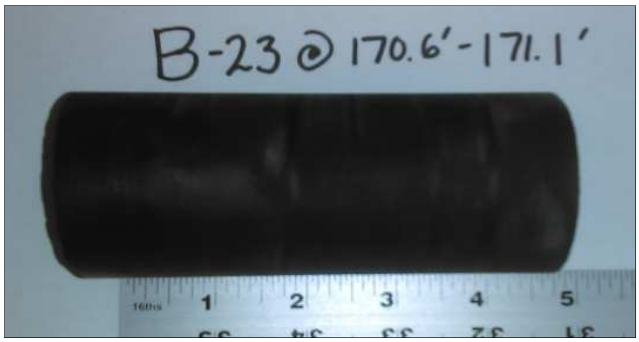
Average Length:	4.582	in
Average Diameter:	2.287	in
Length to diameter ratio:	2.004	
Cross Sectional Area:	4.106	in^2
Volume:	0.0109	ft^3
Failure Load:	35,853	lbs
Axial Strain at Failure:	0.2292	in/in
Compressive Strength:	8,732	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing



After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/24/2018
Test Performed by: C.Straub

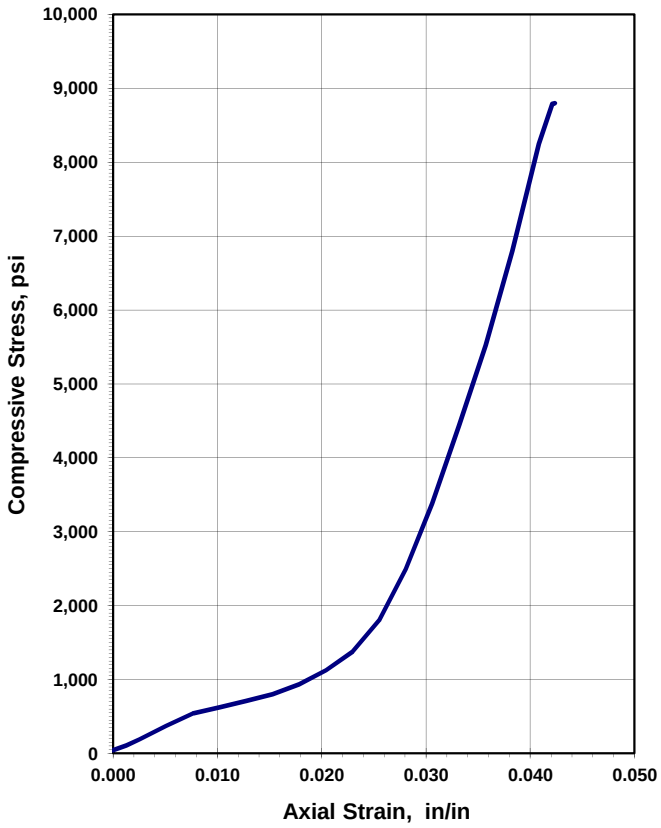
Rock Description: Black Shale, unweathered, moderately hard, thin bedded, unfractured to slightly fractured.
Rock Formation: Ohio Shale

Boring No.:	B-27	
Sample No:	NQ-18	
Depth (ft):	176.7-177.0	feet
Moisture condition:	as received	
Testing Temperature:	20	^{o}C
Rate of Loading:	56.8	lbs/sec
Testing Time:	484	sec
(Rate 2-15 minutes to failure)		

Average Length:	3.919	in
Average Diameter:	1.9955	in
Length to diameter ratio:	1.964	
Cross Sectional Area:	3.127	in^2
Volume:	0.0071	ft^3
Failure Load:	27,510	lbs
Axial Strain at Failure:	0.0424	in/in
Compressive Strength:	8,796	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/23/2018
Test Performed by: C.Straub

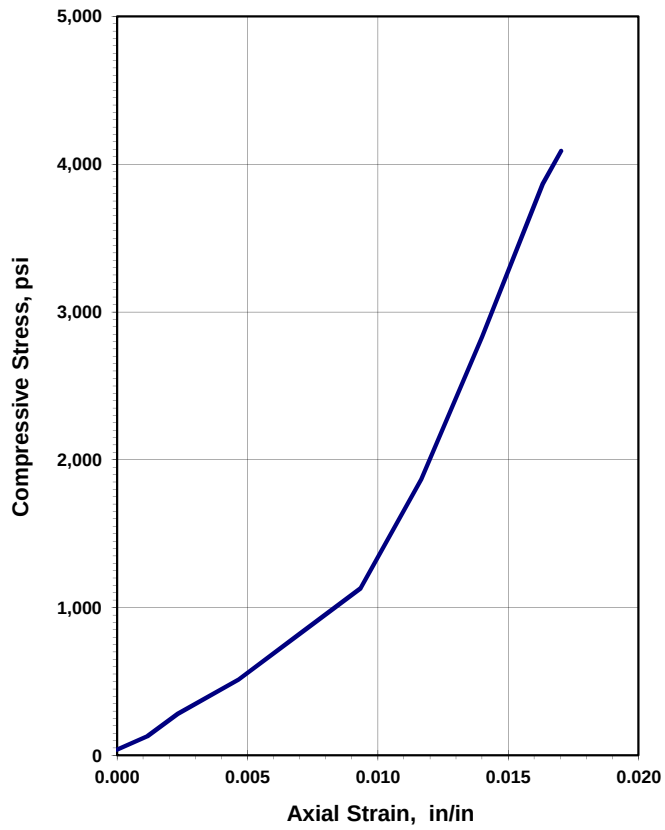
Rock Description: Black Shale, unweathered, moderately hard, thin bedded, flat bedded, unfractured.
Rock Formation: Ohio Shale

Boring No.:	B-29	
Sample No:	NQ-18	
Depth (ft):	170.3-170.7'	feet
Moisture condition:	as received	
Testing Temperature:	20	°C
Rate of Loading:	37.3	lbs/sec
Testing Time:	340	sec
(Rate 2-15 minutes to failure)		

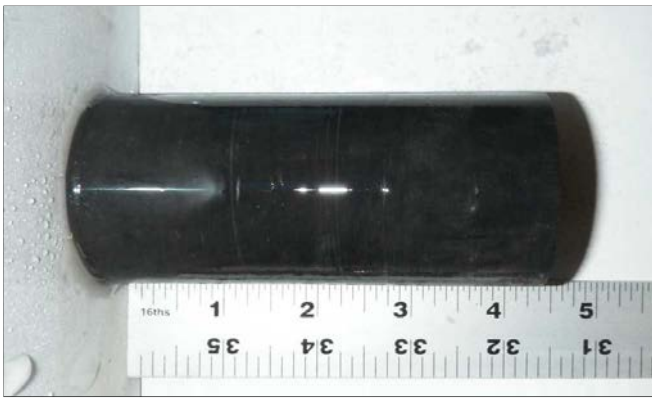
Average Length:	4.285	in
Average Diameter:	1.988	in
Length to diameter ratio:	2.155	
Cross Sectional Area:	3.104	in^2
Volume:	0.0077	ft^3
Failure Load:	12,690	lbs
Axial Strain at Failure:	0.0170	in/in
Compressive Strength:	4,088	psi

Sample Preparation: Per ASTM D4543

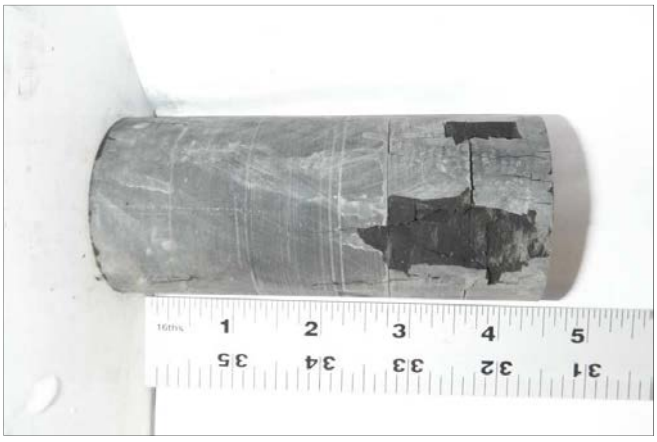
Unconfined Compression Test



Before Testing



After Failure



REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2

Project No.: W-15-012

Date of Testing: 5/23/2018

Test Performed by: C.Straub

Rock Description: Black Shale, moderately hard, unweathered, laminated to thin bedded, flat bedded, unfractured.

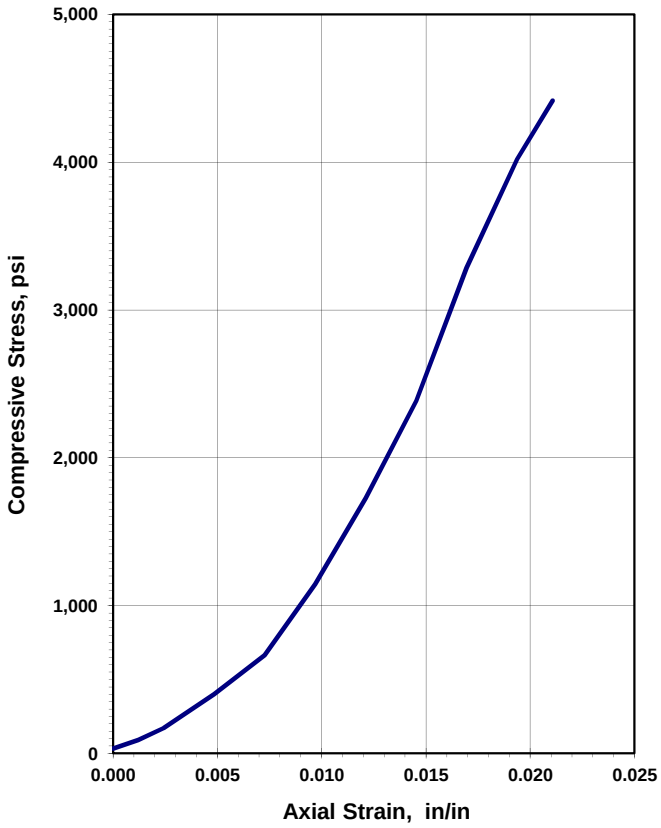
Rock Formation: Ohio Shale

Boring No.:	B-31	
Sample No:	NQ-20	
Depth (ft):	174.8-175.2'	feet
Moisture condition:	as received	
Testing Temperature:	20	^{o}C
Rate of Loading:	32.6	lbs/sec
Testing Time:	420	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.129	in
Average Diameter:	1.9875	in
Length to diameter ratio:	2.077	
Cross Sectional Area:	3.102	in^2
Volume:	0.0074	ft^3
Failure Load:	13,700	lbs
Axial Strain at Failure:	0.0211	in/in
Compressive Strength:	4,416	psi

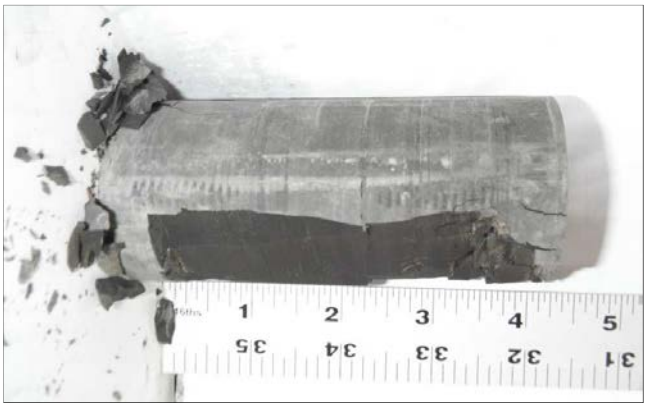
Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure



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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/23/2018
Test Performed by: C.Straub

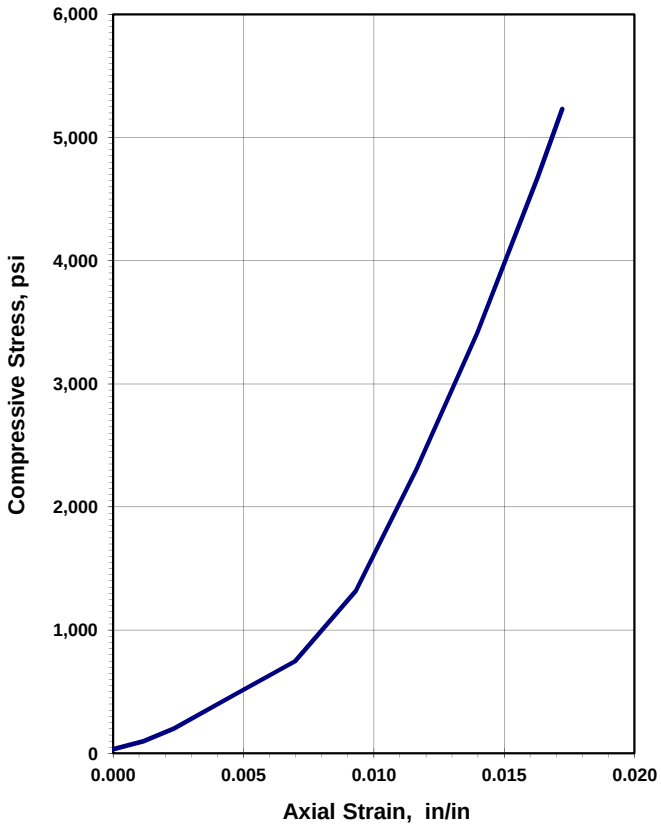
Rock Description: Black Shale, moderately hard, unweathered, thin bedded, unfractured.
Rock Formation: Ohio Shale

Boring No.:	B-33	
Sample No:	NQ-18	
Depth (ft):	178.8-179.2'	feet
Moisture condition:	as received	
Testing Temperature:	20	°C
Rate of Loading:	55.8	lbs/sec
Testing Time:	288	sec
(Rate 2-15 minutes to failure)		

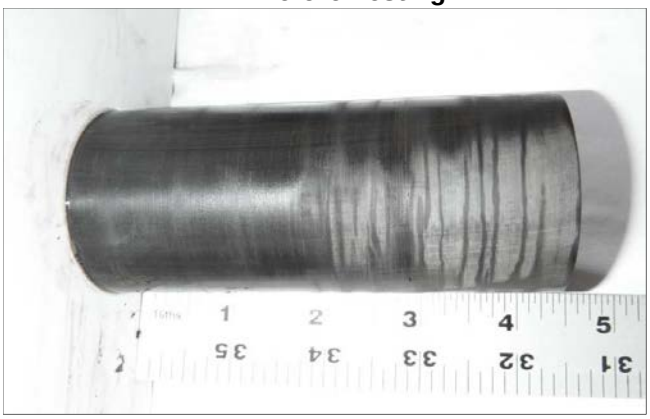
Average Length:	4.297	in
Average Diameter:	1.977	in
Length to diameter ratio:	2.173	
Cross Sectional Area:	3.070	in^2
Volume:	0.0076	ft^3
Failure Load:	16,060	lbs
Axial Strain at Failure:	0.0172	in/in
Compressive Strength:	5,232	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing



After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/12/2018
Test Performed by: C.Straub

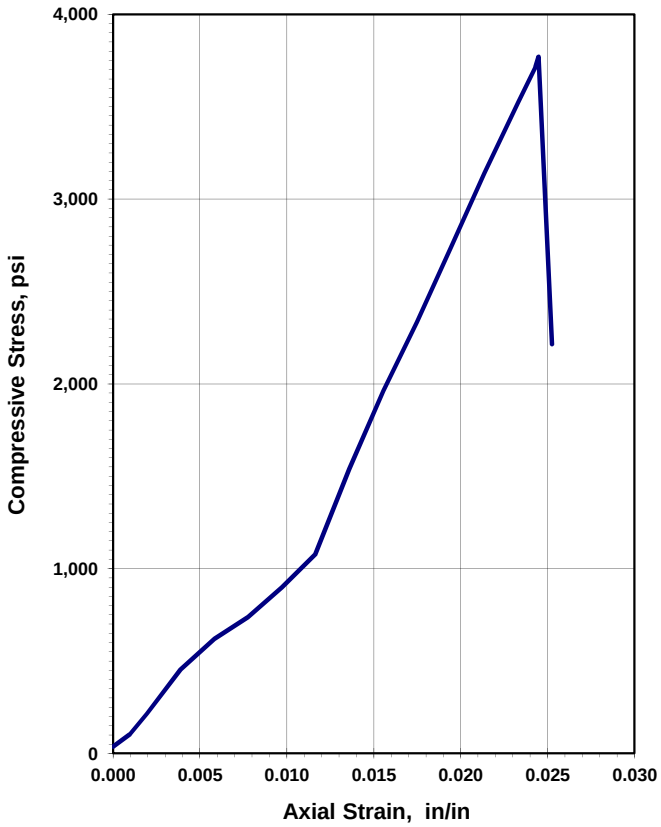
Rock Description: Shale, blueish gray, unweathered to slightly weathered, soft, thin bedded.
Rock Formation: Bedford Shale

Boring No.:	B-39	
Sample No:	HQ-6	
Depth (ft):	154.2-154.6	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	48.9	lbs/sec
Testing Time:	348	sec
(Rate 2-15 minutes to failure)		

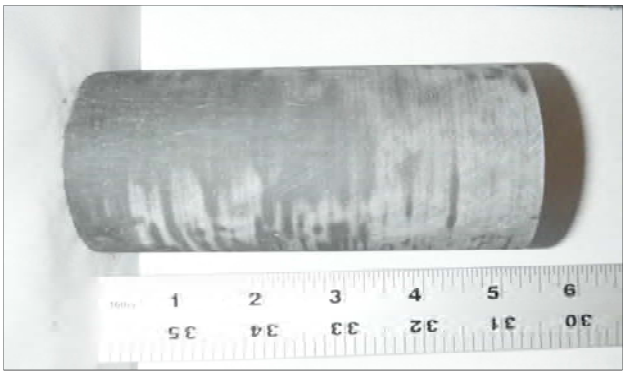
Average Length:	5.147	in
Average Diameter:	2.3975	in
Length to diameter ratio:	2.147	
Cross Sectional Area:	4.514	in^2
Volume:	0.0134	ft^3
Failure Load:	17,020	lbs
Axial Strain at Failure:	0.0245	in/in
Compressive Strength:	3,770	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing



After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/12/2018
Test Performed by: C.Straub

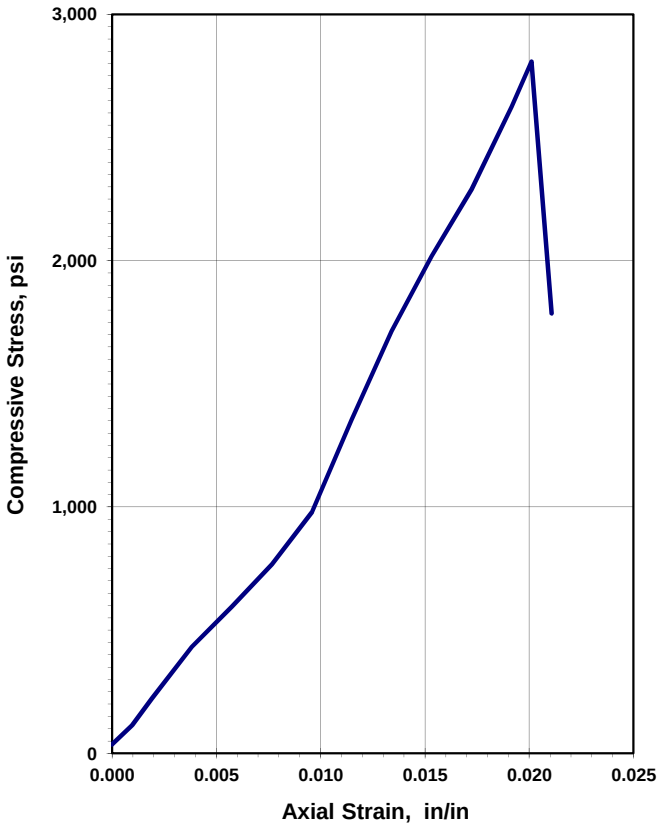
Rock Description: Shale, black, unweathered, moderately hard, thin bedded.
Rock Formation: Ohio Shale

Boring No.:	B-39	
Sample No:	HQ-7	
Depth (ft):	158.3-158.7	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	69.9	lbs/sec
Testing Time:	180	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.220	in
Average Diameter:	2.3885	in
Length to diameter ratio:	2.185	
Cross Sectional Area:	4.481	in^2
Volume:	0.0135	ft^3
Failure Load:	12,580	lbs
Axial Strain at Failure:	0.0201	in/in
Compressive Strength:	2,808	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2

Project No.: W-15-012

Date of Testing: 8/8/2018

Test Performed by: E.Mesko

Rock Description: Sandstone, gray, slightly to unweathered, moderately hard, medium to fine grained, thin bedded.

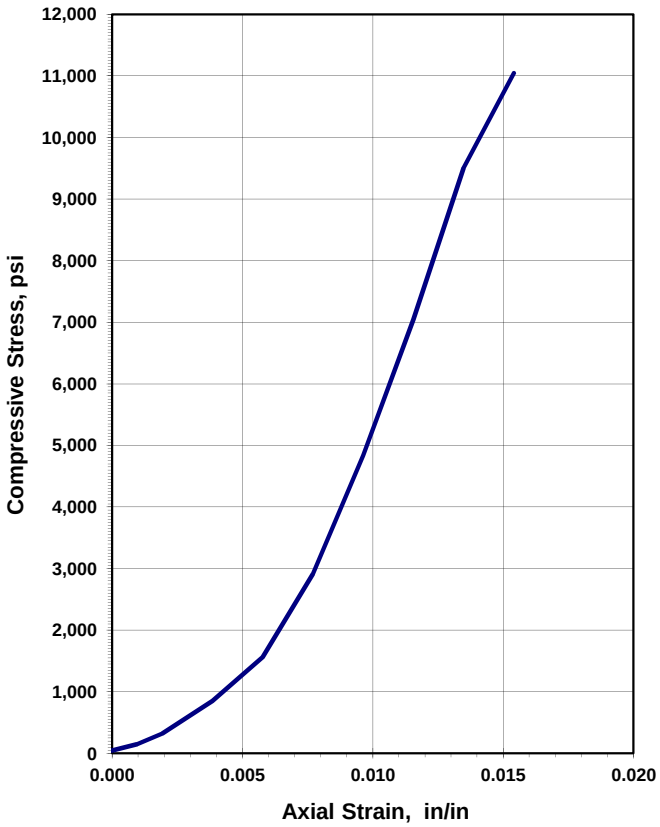
Rock Formation: Berea Sandstone and Bedford Shale, undivided (Berea Sandstone)

Boring No.:	B-40	
Sample No:	HQ-5	
Depth (ft):	26.5'-26.9'	feet
Moisture condition:	as received	
Testing Temperature:	25	^{o}C
Rate of Loading:	102.3	lbs/sec
Testing Time:	488	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.191	in
Average Diameter:	2.399	in
Length to diameter ratio:	2.164	
Cross Sectional Area:	4.520	in^2
Volume:	0.0136	ft^3
Failure Load:	49,932	lbs
Axial Strain at Failure:	0.0154	in/in
Compressive Strength:	11,047	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

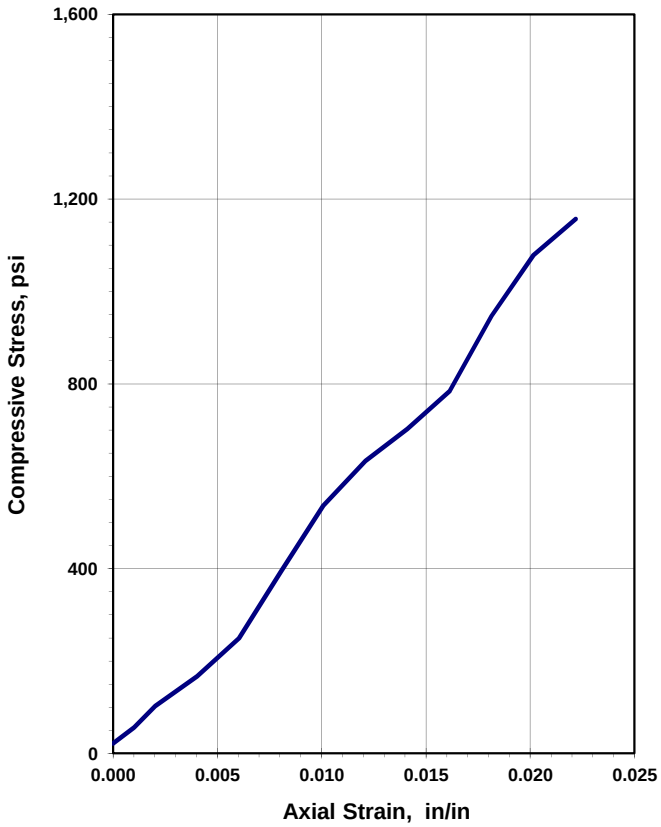
Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 8/8/2018
Test Performed by: E.Mesko

Rock Description: Interbedded Shale and Sandstone (55%:45%), Dark and light gray, unweathered, thin bedded.
Rock Formation: Berea Sandstone and Bedford Shale, undivided (Berea Sandstone)

Boring No.:	B-40		Average Length:	4.960	in
Sample No:	HQ-16		Average Diameter:	2.396	in
Depth (ft):	82.8'	feet	Length to diameter ratio:	2.070	
Moisture condition:	as received		Cross Sectional Area:	4.509	in^2
			Volume:	0.0129	ft^3
Testing Temperature:	25	^oC			
Rate of Loading:	24.3	lbs/sec	Failure Load:	5,216	lbs
Testing Time:	215	sec	Axial Strain at Failure:	0.0222	in/in
(Rate 2-15 minutes to failure)			Compressive Strength:	1,157	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 8/8/2018
Test Performed by: E.Mesko

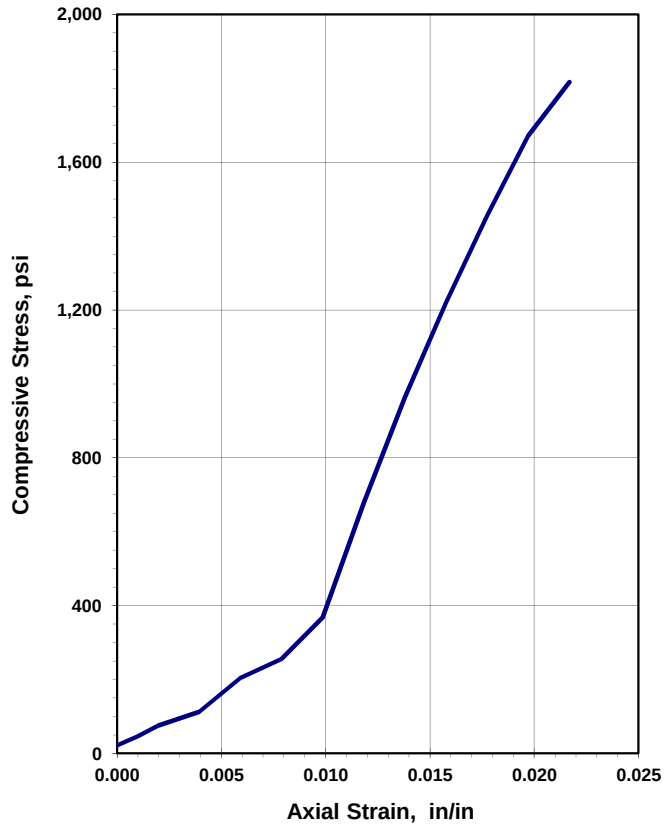
Rock Description: Shale, blue with red bands, unweathered, soft, flat bedded.
Rock Formation: Berea Sandstone and Bedford Shale, undivided (Bedford Shale)

Boring No.:	B-40	
Sample No:	HQ-26	
Depth (ft):	134.5'-134.9'	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	24.6	lbs/sec
Testing Time:	335	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.072	in
Average Diameter:	2.403	in
Length to diameter ratio:	2.111	
Cross Sectional Area:	4.535	in^2
Volume:	0.0133	ft^3
Failure Load:	8,240	lbs
Axial Strain at Failure:	0.0217	in/in
Compressive Strength:	1,817	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 8/8/2018
Test Performed by: E.Mesko

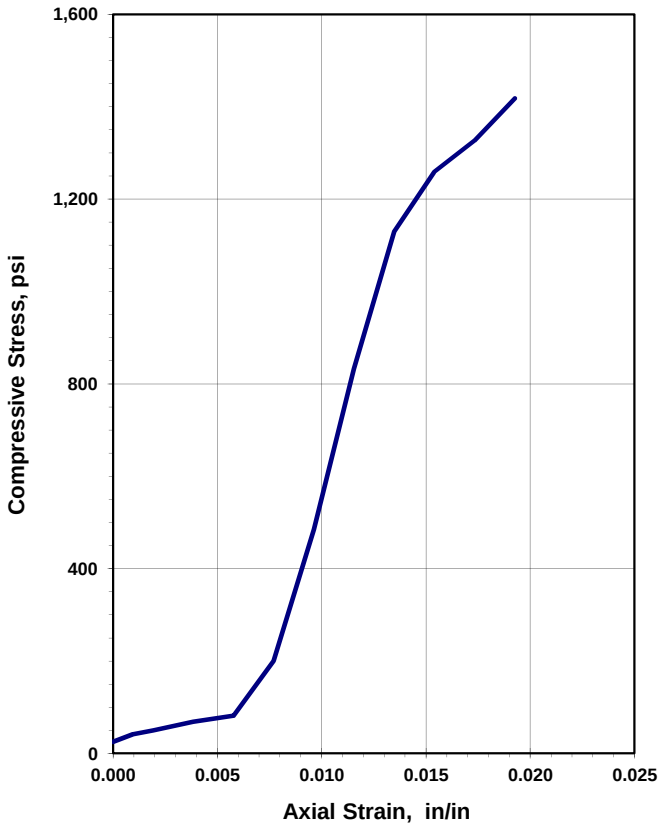
Rock Description: Shale, gray, unweathered, soft, flat bedded.
Rock Formation: Berea Sandstone and Bedford Shale, undivided (Bedford Shale)

Boring No.:	B-40	
Sample No:	HQ-28	
Depth (ft):	141.9'-150.3'	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	25.0	lbs/sec
Testing Time:	256	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.193	in
Average Diameter:	2.398	in
Length to diameter ratio:	2.166	
Cross Sectional Area:	4.516	in^2
Volume:	0.0136	ft^3
Failure Load:	6,404	lbs
Axial Strain at Failure:	0.0193	in/in
Compressive Strength:	1,418	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2

Project No.: W-15-012

Date of Testing: 8/8/2018

Test Performed by: E.Mesko

Rock Description: Shale, black, unweathered, moderately hard, pyritic, thin bedded.

Rock Formation: Ohio Shale

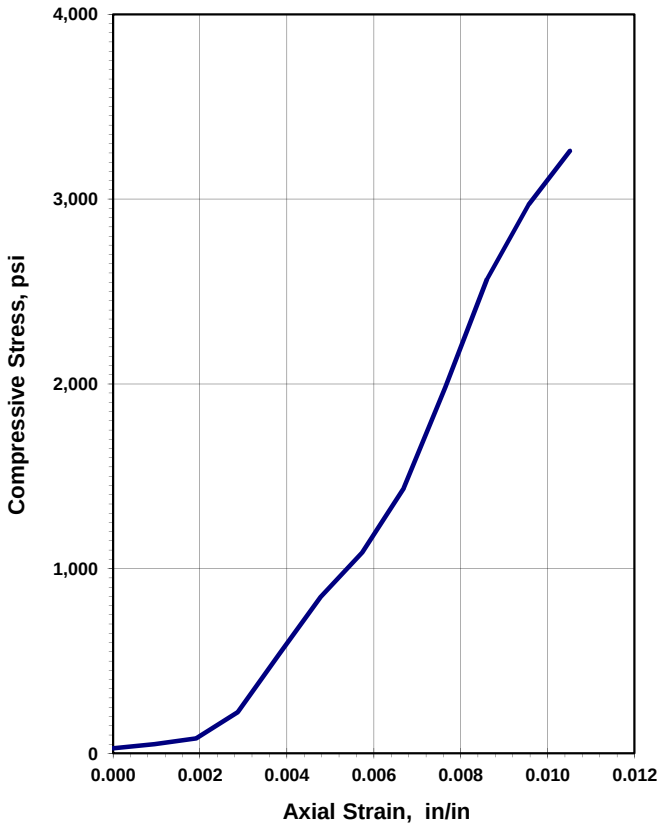
Boring No.:	B-40	
Sample No:	HQ-30	
Depth (ft):	153.0'-153.4'	feet
Moisture condition:	as received	
Testing Temperature:	25	^{o}C
Rate of Loading:	50.0	lbs/sec
Testing Time:	296	sec

(Rate 2-15 minutes to failure)

Average Length:	5.230	in
Average Diameter:	2.404	in
Length to diameter ratio:	2.176	
Cross Sectional Area:	4.539	in^2
Volume:	0.0137	ft^3
Failure Load:	14,801	lbs
Axial Strain at Failure:	0.0105	in/in
Compressive Strength:	3,261	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 8/8/2018
Test Performed by: E.Mesko

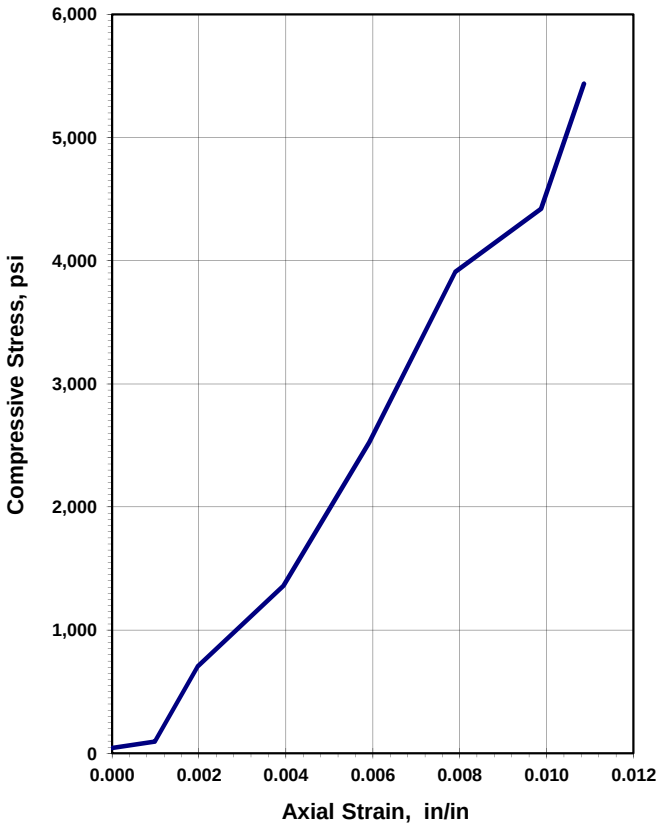
Rock Description: Shale, black, unweathered, pyritic, moderately hard, thin bedded.
Rock Formation: Ohio Shale

Boring No.:	B-40	
Sample No:	HQ-32	
Depth (ft):	162.5'-162.9'	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	90.6	lbs/sec
Testing Time:	271	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.066	in
Average Diameter:	2.398	in
Length to diameter ratio:	2.113	
Cross Sectional Area:	4.516	in^2
Volume:	0.0132	ft^3
Failure Load:	24,556	lbs
Axial Strain at Failure:	0.0100	in/in
Compressive Strength:	5,437	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2

Project No.: W-15-012

Date of Testing: 7/12/2018

Test Performed by: C.Straub

Rock Description: Shale, black, unweathered, moderately hard, pyritic, thin bedded.

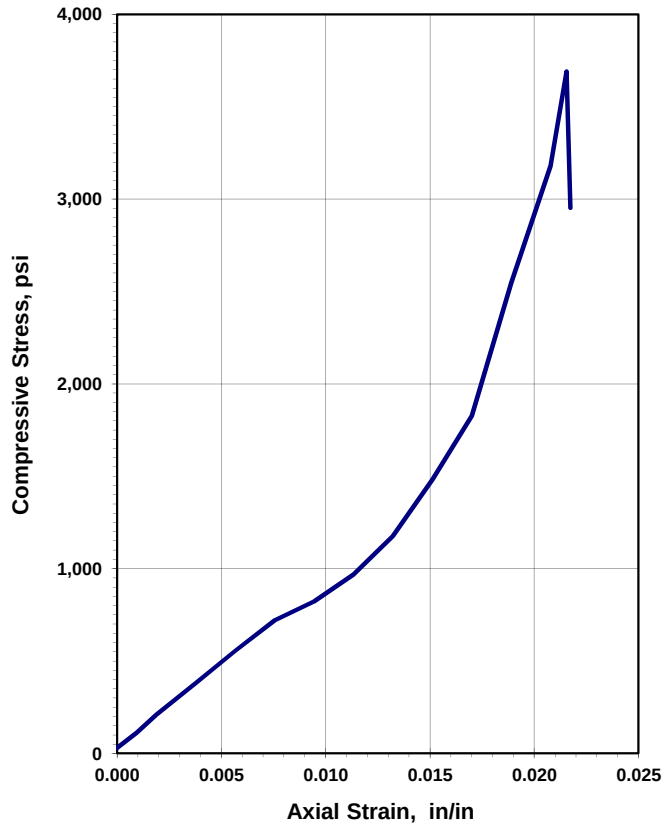
Rock Formation: Ohio Shale

Boring No.:	B-41	
Sample No:	HQ-32	
Depth (ft):	168.5-169.0	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	61.8	lbs/sec
Testing Time:	270	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.292	in
Average Diameter:	2.3995	in
Length to diameter ratio:	2.205	
Cross Sectional Area:	4.522	in^2
Volume:	0.0138	ft^3
Failure Load:	16,690	lbs
Axial Strain at Failure:	0.0215	in/in
Compressive Strength:	3,691	psi

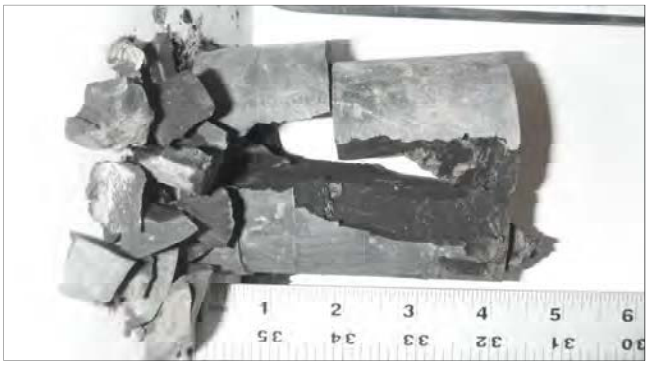
Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure



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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/23/2018
Test Performed by: C.Straub

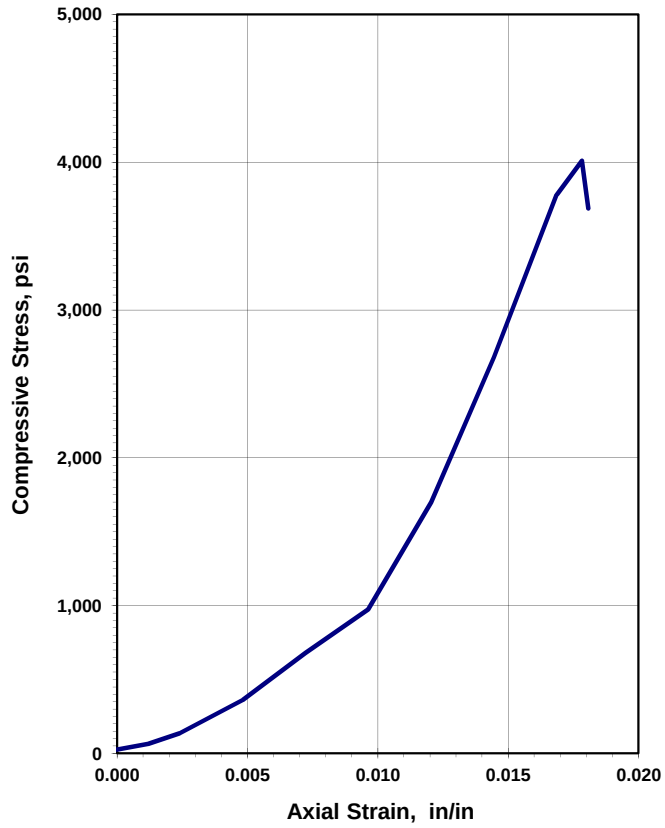
Rock Description: Black Shale, unweathered, moderately hard to soft, thin bedded, moderately to slightly fractured.
Rock Formation: Ohio Shale

Boring No.:	B-42	
Sample No:	NQ-18	
Depth (ft):	171.1-171.5'	feet
Moisture condition:	as received	
Testing Temperature:	20	^{o}C
Rate of Loading:	37.5	lbs/sec
Testing Time:	330	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.151	in
Average Diameter:	1.9835	in
Length to diameter ratio:	2.093	
Cross Sectional Area:	3.090	in^2
Volume:	0.0074	ft^3
Failure Load:	12,390	lbs
Axial Strain at Failure:	0.0178	in/in
Compressive Strength:	4,010	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/24/2018
Test Performed by: C.Straub

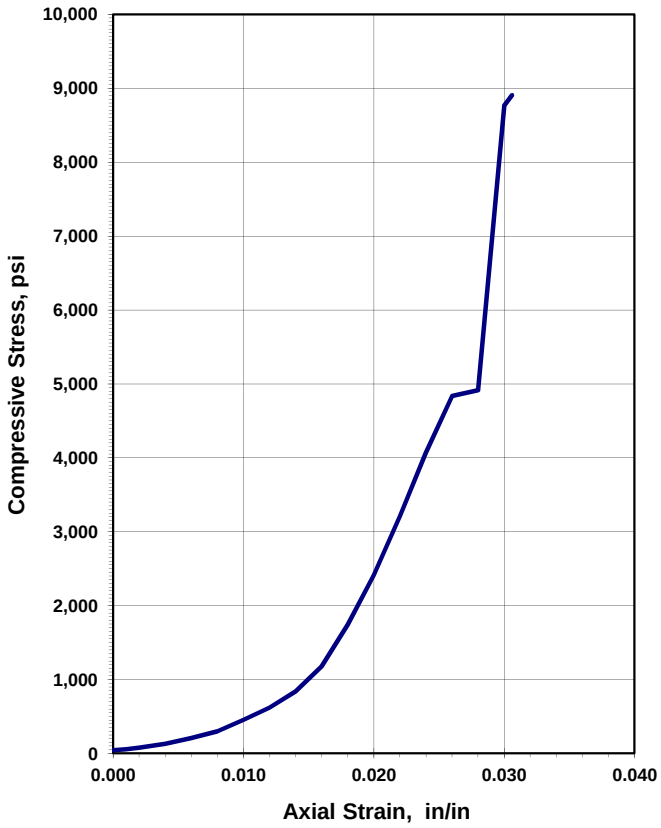
Rock Description: Black Shale, slightly to moderately weathered, moderately hard, thin bedded, mod. to highly fract.
Rock Formation: Ohio Shale

Boring No.:	B-43	
Sample No:	HQ-20	
Depth (ft):	164.3-164.7'	feet
Moisture condition:	as received	
Testing Temperature:	20	°C
Rate of Loading:	84.0	lbs/sec
Testing Time:	453	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.999	in
Average Diameter:	2.333	in
Length to diameter ratio:	2.143	
Cross Sectional Area:	4.275	in^2
Volume:	0.0124	ft^3
Failure Load:	38,070	lbs
Axial Strain at Failure:	0.0306	in/in
Compressive Strength:	8,906	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 5/23/2018
Test Performed by: C.Straub

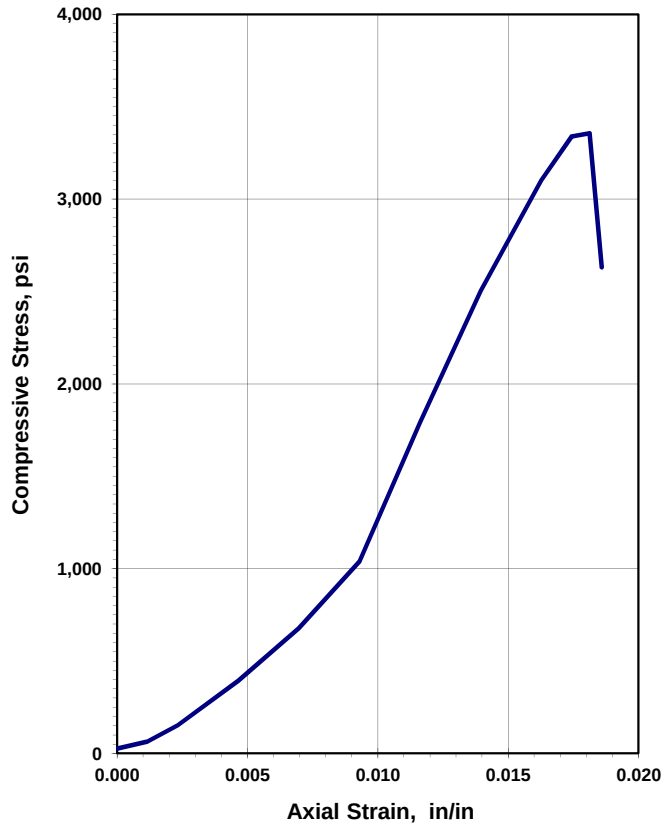
Rock Description: Dark gray and black Shale, unweathered, soft to moderately hard, thin bedded, moderately fractured.
Rock Formation: Ohio Shale

Boring No.:	B-44	
Sample No:	NQ-19	
Depth (ft):	168.2-168.6'	feet
Moisture condition:	as received	
Testing Temperature:	20	^{o}C
Rate of Loading:	54.7	lbs/sec
Testing Time:	190	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.303	in
Average Diameter:	1.9865	in
Length to diameter ratio:	2.166	
Cross Sectional Area:	3.099	in^2
Volume:	0.0077	ft^3
Failure Load:	10,400	lbs
Axial Strain at Failure:	0.0181	in/in
Compressive Strength:	3,356	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Columbus, OH 43231
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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/12/2018
Test Performed by: C.Straub

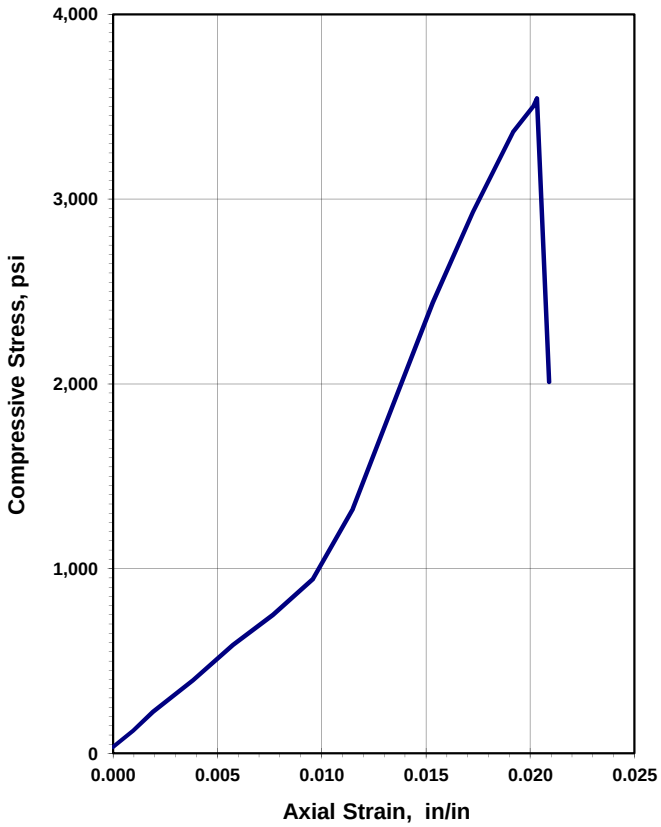
Rock Description: Shale, black, unweathered, soft to moderately hard, thin bedded.
Rock Formation: Ohio Shale

Boring No.:	B-46	
Sample No:	HQ-20	
Depth (ft):	148.8-149.2	feet
Moisture condition:	as received	
Testing Temperature:	21	^{o}C
Rate of Loading:	59.0	lbs/sec
Testing Time:	272	sec
(Rate 2-15 minutes to failure)		

Average Length:	5.216	in
Average Diameter:	2.4005	in
Length to diameter ratio:	2.173	
Cross Sectional Area:	4.526	in^2
Volume:	0.0137	ft^3
Failure Load:	16,040	lbs
Axial Strain at Failure:	0.0203	in/in
Compressive Strength:	3,544	psi

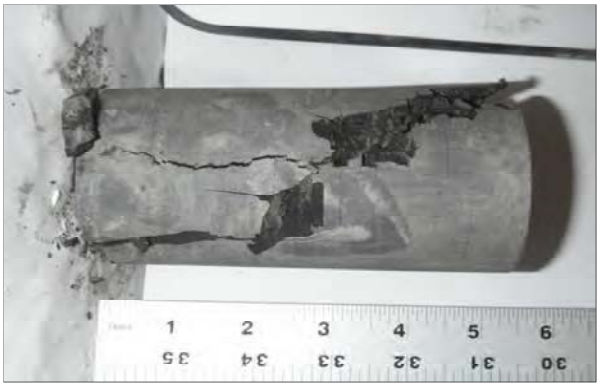
Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure



REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Columbus, OH 43231
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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/2/2019
Test Performed by: EM/KL

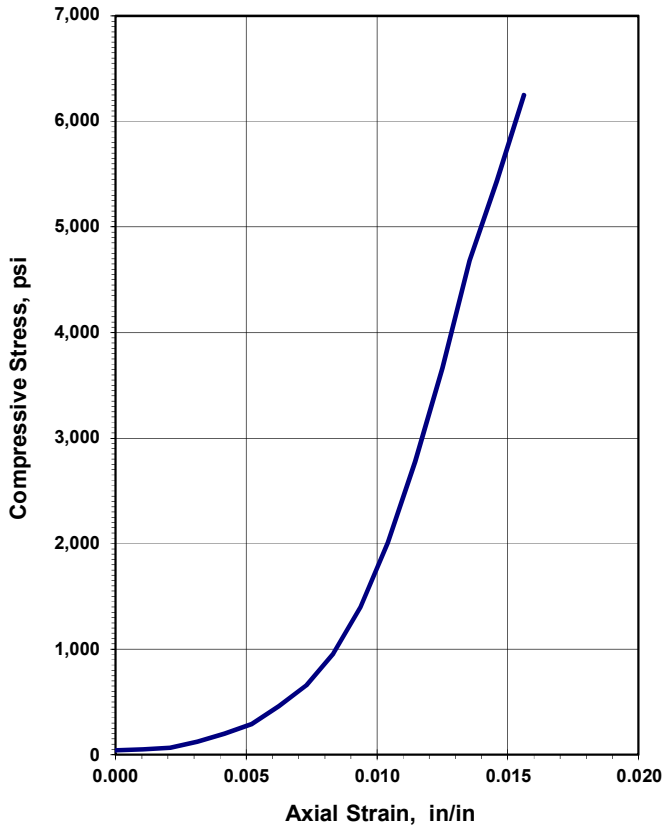
Rock Description: Sandstone, gray, very fine-grained to fine-grained.
Rock Formation: Berea Sandstone

Boring No.:	B-47	
Sample No:	HQ-2	
Depth (ft):	14.9	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	154.8	lbs/sec
Testing Time:	284	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.802	in
Average Diameter:	2.387	in
Length to diameter ratio:	2.012	
Cross Sectional Area:	4.475	in^2
Volume:	0.0124	ft^3
Failure Load:	43,970	lbs
Axial Strain at Failure:	0.0198	in/in
Compressive Strength:	9,826	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/2/2019
Test Performed by: EM/KL

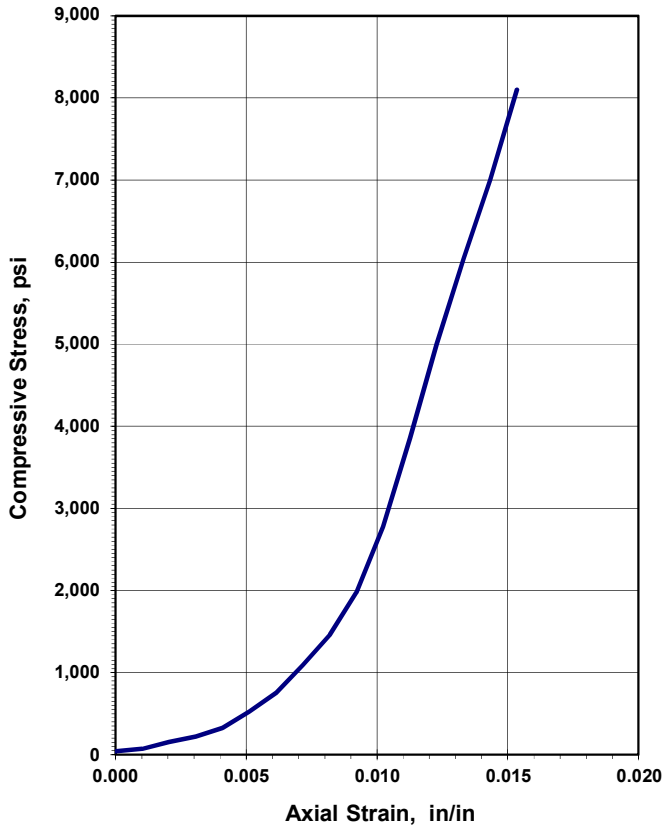
Rock Description: Sandstone, gray, very fine-grained to fine-grained.
Rock Formation: Berea Sandstone

Boring No.:	B-47	
Sample No:	HQ-3	
Depth (ft):	18.1	feet
Moisture condition:	as received	
Testing Temperature:	21	°C
Rate of Loading:	130.2	lbs/sec
Testing Time:	345	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.885	in
Average Diameter:	2.389	in
Length to diameter ratio:	2.045	
Cross Sectional Area:	4.483	in^2
Volume:	0.0127	ft^3
Failure Load:	44,913	lbs
Axial Strain at Failure:	0.0174	in/in
Compressive Strength:	10,020	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.	9885 Rockside Road	4480 Lake Forest Drive
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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/2/2019
Test Performed by: EM/KL

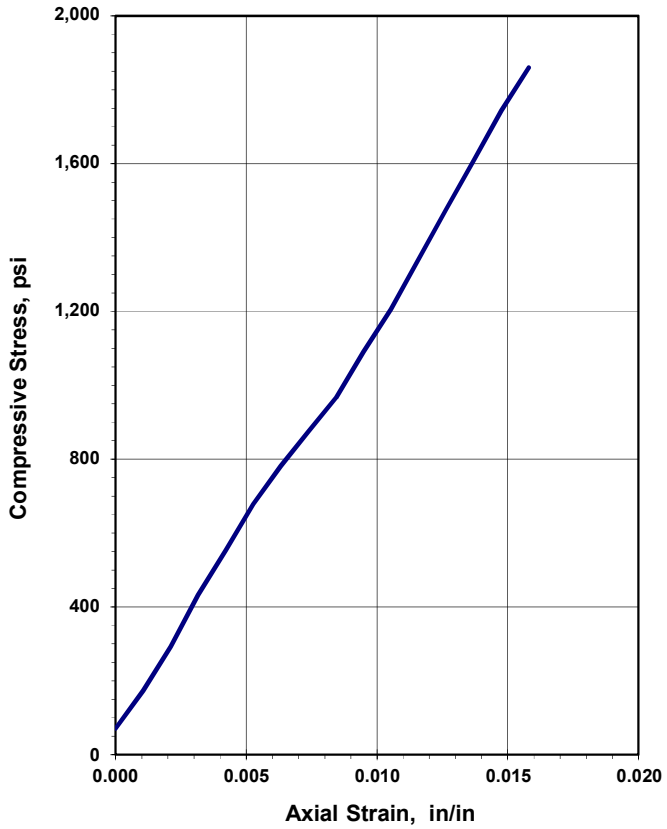
Rock Description: Shale with sandstone laminae, dark gray and gray, very fine-grained.
Rock Formation: Berea Sandstone/Bedford Shale

Boring No.:	B-47	
Sample No:	HQ-18	
Depth (ft):	94.5	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	45.6	lbs/sec
Testing Time:	179	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.745	in
Average Diameter:	2.365	in
Length to diameter ratio:	2.006	
Cross Sectional Area:	4.393	in^2
Volume:	0.0121	ft^3
Failure Load:	8,171	lbs
Axial Strain at Failure:	0.0158	in/in
Compressive Strength:	1,860	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

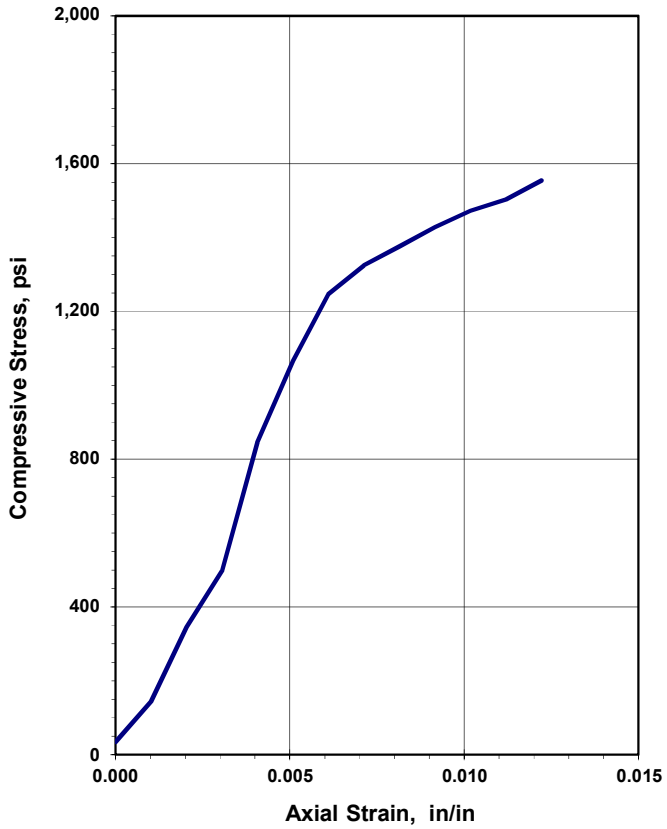
Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/2/2019
Test Performed by: EM/KL

Rock Description: Shale, dark gray, very fine-grained, trace siltstone laminae.
Rock Formation: Bedford Shale

Boring No.:	B-47		Average Length:	4.912	in
Sample No:	HQ-28		Average Diameter:	2.385	in
Depth (ft):	143.6	feet	Length to diameter ratio:	2.060	
Moisture condition:	as received		Cross Sectional Area:	4.468	in^2
			Volume:	0.0127	ft^3
Testing Temperature:	25	°C			
Rate of Loading:	39.5	lbs/sec	Failure Load:	6,944	lbs
Testing Time:	176	sec	Axial Strain at Failure:	0.0122	in/in
(Rate 2-15 minutes to failure)			Compressive Strength:	1,554	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Engineering Consultants

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Unconfined Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: Big Walnut San.Trunk Sew. PH2
Project No.: W-15-012
Date of Testing: 7/2/2019
Test Performed by: EM/KL

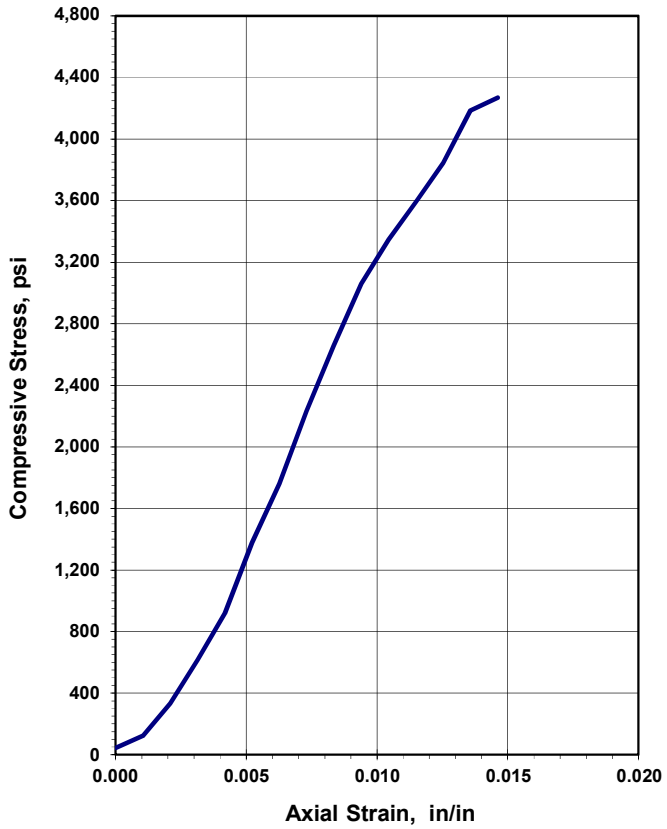
Rock Description: Shale, black, very fine-grained, clayey, pyritic.
Rock Formation: Ohio Shale

Boring No.:	B-47	
Sample No:	HQ-34	
Depth (ft):	167.3	feet
Moisture condition:	as received	
Testing Temperature:	25	°C
Rate of Loading:	106.5	lbs/sec
Testing Time:	179	sec
(Rate 2-15 minutes to failure)		

Average Length:	4.789	in
Average Diameter:	2.385	in
Length to diameter ratio:	2.008	
Cross Sectional Area:	4.468	in^2
Volume:	0.0124	ft^3
Failure Load:	19,071	lbs
Axial Strain at Failure:	0.0146	in/in
Compressive Strength:	4,269	psi

Sample Preparation: Per ASTM D4543

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

J.2 UNIAXIAL COMPRESSIVE LABORATORY RESULTS

Earth Mechanics Institute

Client:

Project:

Date:

Colorado School of Mines

Mining Engineering Department

ASTM D7012

Sample ID	Rock Type	Average Length	Average Diameter	Length to Diameter Ratio	Density	Failure Load	Uniaxial Compressive Strength			Static Elastic Constants			Notes *(Failure type)*
							Failure Stress	UCS (2:1)		Young's Modulus		Poisson's Ratio	
		(in)	(in)		(lb/ft^3)	(lbs)	σ_c (psi)	(psi)	(MPa)	(ksi)	(GPa)		
B-16-HQ-6 @ 148.1-148.9	Sedimentary	5.110	2.391	2.1	161	39,071	8,705	8,848	61.0	1,183	8.2	0.28	Non - Structural
B-16-HQ-7 @ 153.8-154.4	Sedimentary	5.276	2.385	2.2	151	32,614	7,303	7,450	51.4	1,090	7.5	0.28	Non - Structural
B-22-HQ-5 @ 151.6-152.5	Sedimentary	5.050	2.353	2.1	168	35,100	8,072	8,208	56.6	1,009	7.0	0.31	Non - Structural
B-39-HQ-6 @ 154.6-155.5	Sedimentary	5.108	2.392	2.1	170	38,019	8,457	8,594	59.3	1,335	9.2	0.27	Non - Structural
B-39-HQ-7 @ 158.7-159.5	Sedimentary	5.126	2.393	2.1	154	25,106	5,582	5,675	39.1	579	4.0	0.33	Non - Structural
B-40-HQ-5 @ 27.8-28.8	Sedimentary	5.180	2.393	2.2	145	73,221	16,273	16,562	114.2	2,844	19.6	0.32	Non - Structural
B-40-HQ-28 @ 141.1-141.9	Sedimentary	5.199	2.395	2.2	164	11,304	2,508	2,553	17.6	158	1.1	0.32	Non - Structural
B-40-HQ-30 @ 153.6-154.3	Sedimentary	5.155	2.392	2.2	152	25,900	5,761	5,861	40.4	527	3.6	0.20	Non - Structural
B-40-HQ-32 @ 163.2-164.1	Sedimentary	5.106	2.397	2.1	142	33,008	7,315	7,432	51.2	508	3.5	0.20	Non - Structural
B-41-HQ-33 @ 170.0-171.0	Sedimentary	5.054	2.391	2.1	154	25,396	5,658	5,745	39.6	852	5.9	0.19	Non - Structural
B-46-HQ-20 @ 149.3-150.1	Sedimentary	5.115	2.397	2.1	151	28,254	6,264	6,366	43.9	822	5.7	0.26	Non - Structural

$$UCS_{2:1 correction} = \frac{\sigma_c}{0.88 + 0.222(\frac{d}{l})}$$

EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

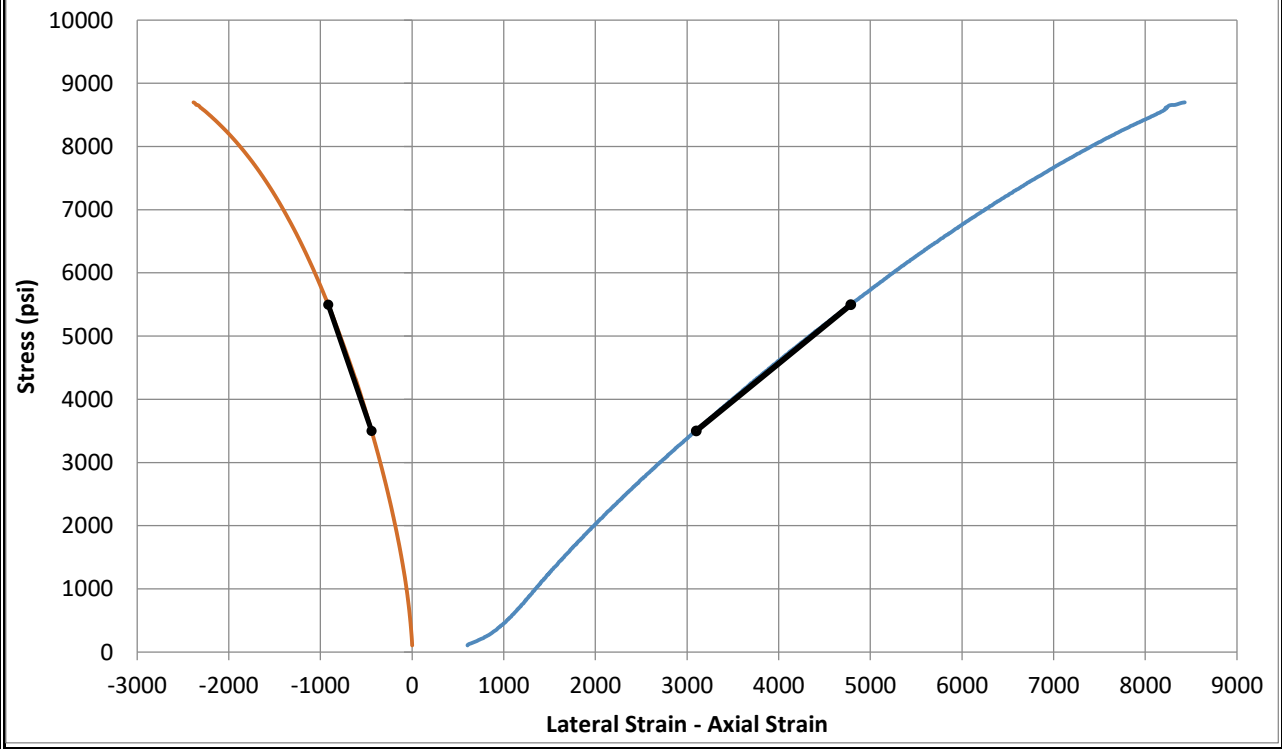
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-16-HQ-6 @ 148.1-148.9
File Name: B-16-HQ-6 @ 148.1-148.9_US(
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.110	12.98	2.391	6.07	2.1	161	2.58	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
39,071	8,705	8,848	61.0	1,183	8.2	0.28	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

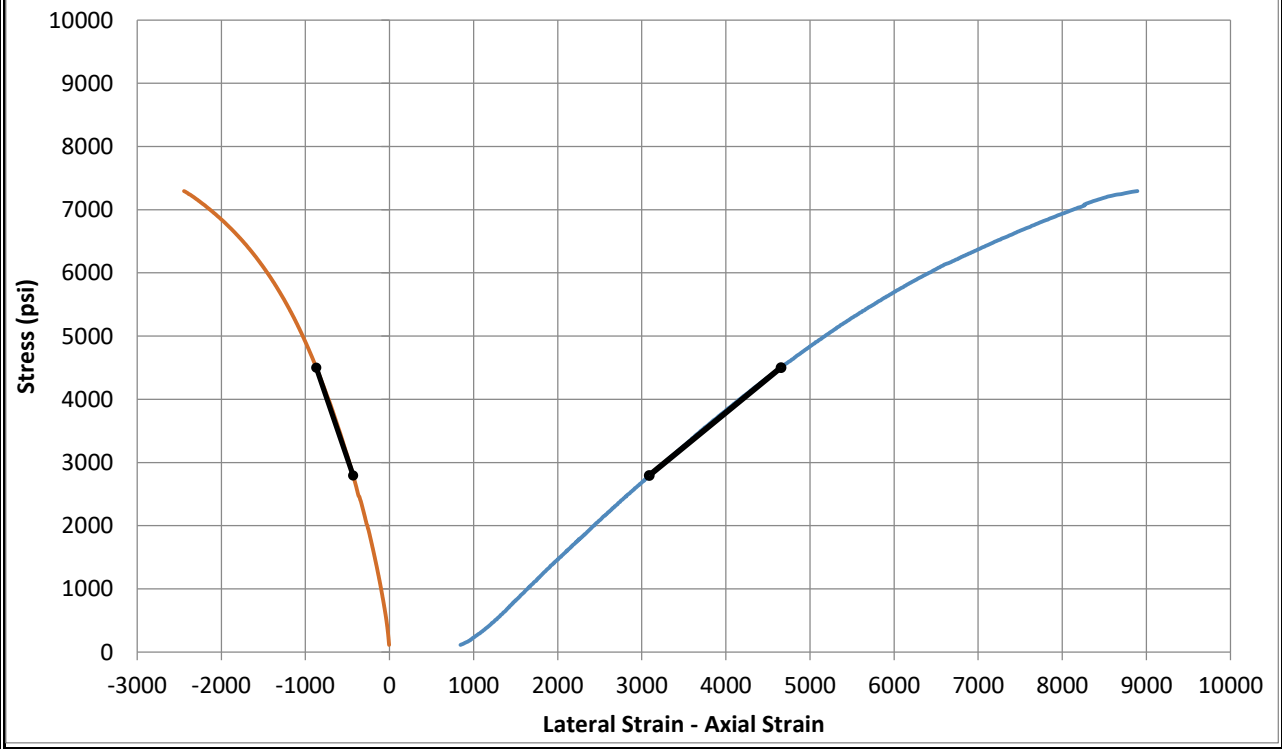
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-16-HQ-7 @ 153.8-154.4
File Name: B-16-HQ-7 @ 153.8-154.4_US(
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.276	13.40	2.385	6.06	2.2	151	2.42	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
32,614	7,303	7,450	51.4	1,090	7.5	0.28	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν
ft/s	m/s	ft/s	m/s	ksi	GPa	
N/A	N/A	N/A	N/A	N/A	N/A	N/A



Earth Mechanics Institute
Client: Resource International
Project: Big Walnut
Date: 5/16/2018

Colorado School of Mines
Mining Engineering Department

ASTM D7012

Sample ID	Rock Type	Average Length	Average Diameter	Length to Diameter Ratio	Density	Failure Load	Uniaxial Compressive Strength			Static Elastic Constants			Notes *(Failure type)*
							Failure Stress	UCS (2:1)		Young's Modulus		Poisson's Ratio	
		(in)	(in)		(lb/ft^3)	(lbs)	σ_c (psi)	(psi)	(MPa)	(ksi)	(GPa)		
B-18-NQ-11 @ 149.2-150.0	Sedimentary	5.009	1.960	2.6	172	19,780	6,559	6,784	46.8	681	4.7	0.18	Non - Structural
B-18-NQ-13 @ 162.0-163.1	Sedimentary	4.125	1.974	2.1	157	29,599	9,676	9,812	67.6	1,344	9.3	0.24	Non - Structural

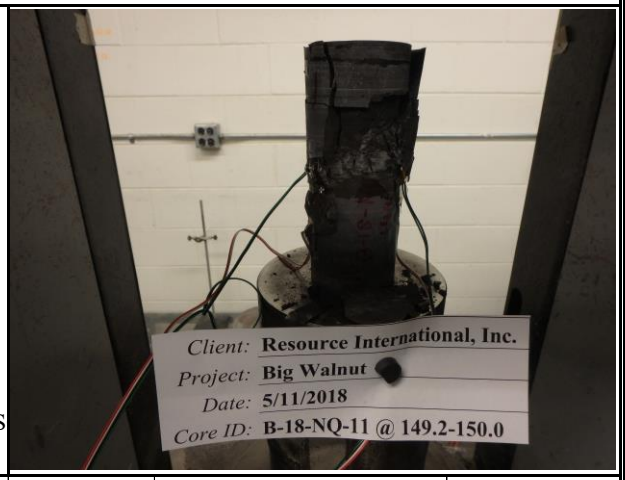
$$UCS_{2:1 correction} = \frac{\sigma_c}{0.88 + 0.222(\frac{d}{l})}$$

EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

Uniaxial Compressive Strength - ASTM D7012

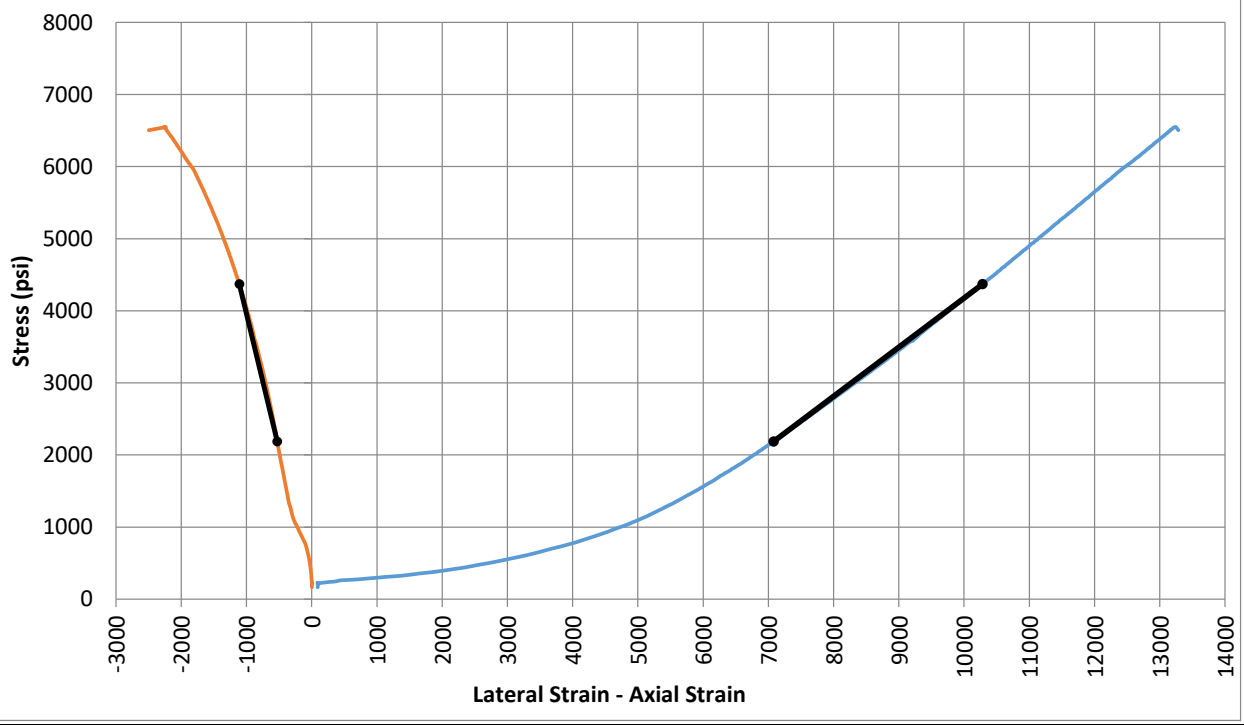
Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 5/11/2018
Data Reduced By: OF
Date Reduced: 5/16/2018
Core ID: B-18-NQ-11 @ 149.2-150.0
File Name: B-18-NQ-11 @ 149.2-150.0_US
EMI Project No.: 342



Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.009	12.72	1.960	4.98	2.6	172	2.75	

Failure Load	Failure Stress	UCS 2:1		Static E		Static ν	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
19,780	6,559	6,784	46.8	681	4.7	0.18	Non - Structural

Note: Axial strain gauges approaches non-linear deformation beyond +/-3400 strain but the loading continued until the failure point.
Axial strain have been calculated based on the machine displacement data and calibrated with strain gauges.
Sample had open joints perpendicular to the direction of loading that were glued together for running the test.



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

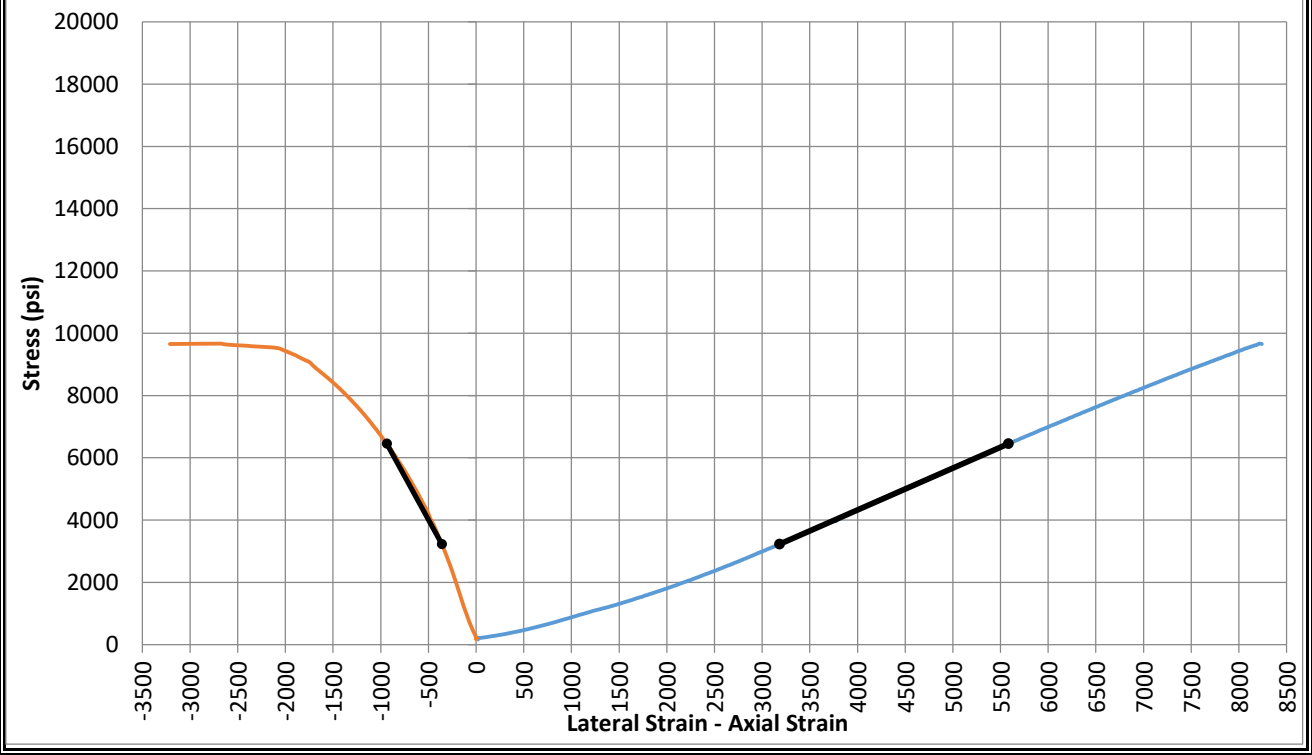
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 5/11/2018
Data Reduced By: OF
Date Reduced: 5/16/2018
Core ID: B-18-NQ-13 @ 162.0-163.1
File Name: B-18-NQ-13 @ 162.0-163.1_US
EMI Project No.: 342

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
4.125	10.48	1.974	5.01	2.1	157	2.51	

Failure Load	Failure Stress	UCS 2:1		Static E		Static ν	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
29,599	9,676	9,812	67.6	1,344	9.3	0.24	Non - Structural

Note: Axial strain gauges approaches non-linear deformation beyond +/-3400 strain but the loading continued until the failure point.
Axial strain have been calculated based on the machine displacement data and calibrated with strain gauges.



Earth Mechanics Institute

Client: Resource International

Project: Big Walnut

Date: 7/23/2018

Colorado School of Mines

Mining Engineering Department

ASTM D7012

Sample ID	Rock Type	Average Length	Average Diameter	Length to Diameter Ratio	Density	Failure Load	Uniaxial Compressive Strength			Static Elastic Constants			Notes *(Failure type)*
							Failure Stress	UCS (2:1)		Young's Modulus		Poisson's Ratio	
		(in)	(in)		(lb/ft^3)	(lbs)	σ_c (psi)	(psi)	(MPa)	(ksi)	(GPa)		
B-44-NQ-19 @ 165.0-166.3	Sedimentary	4.145	1.982	2.1	161	33,490	10,860	11,013	75.9	1,189	8.2	0.18	Non - Structural
B-31-HQ-19 @ 173.0-174.3	Sedimentary	4.264	1.985	2.1	139	37,208	12,017	12,220	84.3	1,016	7.0	0.21	Non - Structural
B-20-HQ-15 @ 148.2-149.5	Sedimentary	5.237	2.400	2.2	138	44,190	9,768	9,950	68.6	880	6.1	0.17	Non - Structural
B-27-NQ-17 @ 166.7-167.3*	Sedimentary	3.235	1.994	1.6	170	7,708	2,468	2,427	16.7	4,501	31.0	0.13	Structural

*Static E and ν have been calculated based on the linear portion of the acquired data that is incomplete thus unreliable.

$$UCS_{2:1 correction} = \frac{\sigma_c}{0.88 + 0.222(\frac{d}{l})}$$

EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

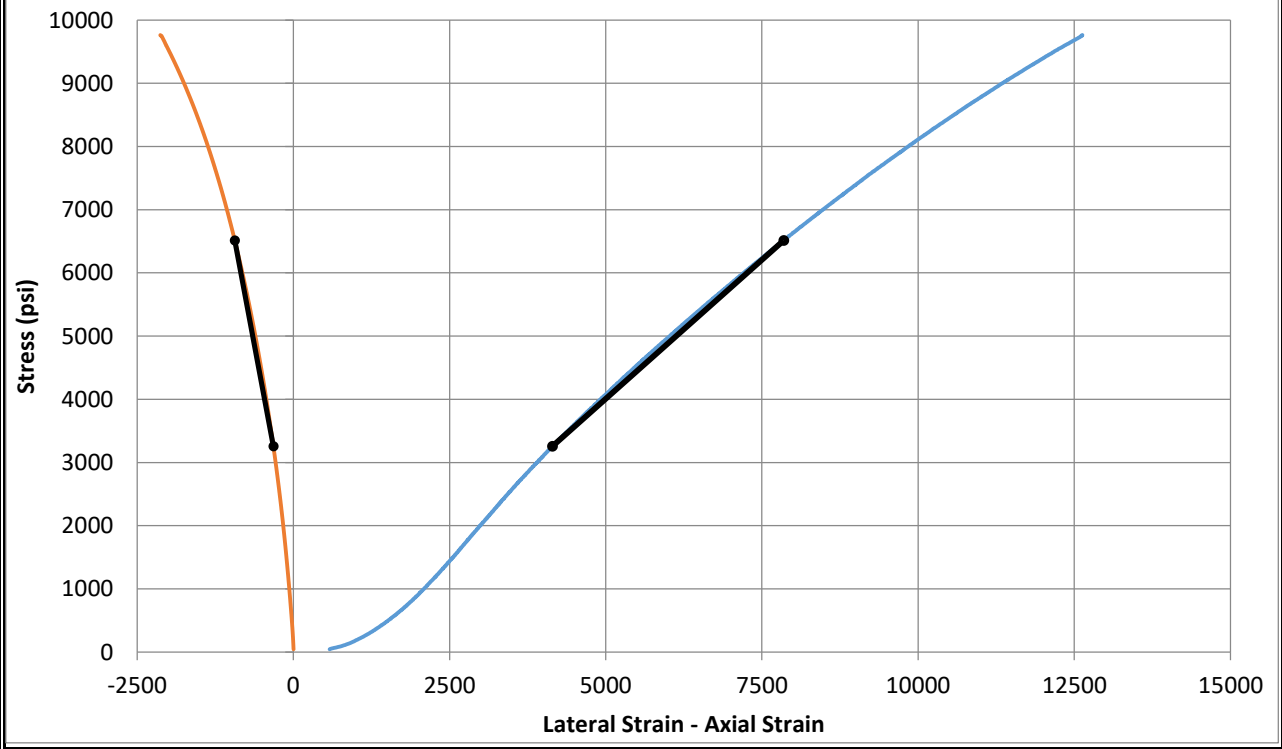
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 7/20/2018
Data Reduced By: OF
Date Reduced: 7/20/2018
Core ID: B-20-HQ-15 @ 148.2-149.5
File Name: B-20-HQ-15 @ 148.2-149.5_US
EMI Project No.: 347

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.237	13.30	2.400	6.10	2.2	138	2.20	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
44,190	9,768	9,950	68.6	880	6.1	0.17	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

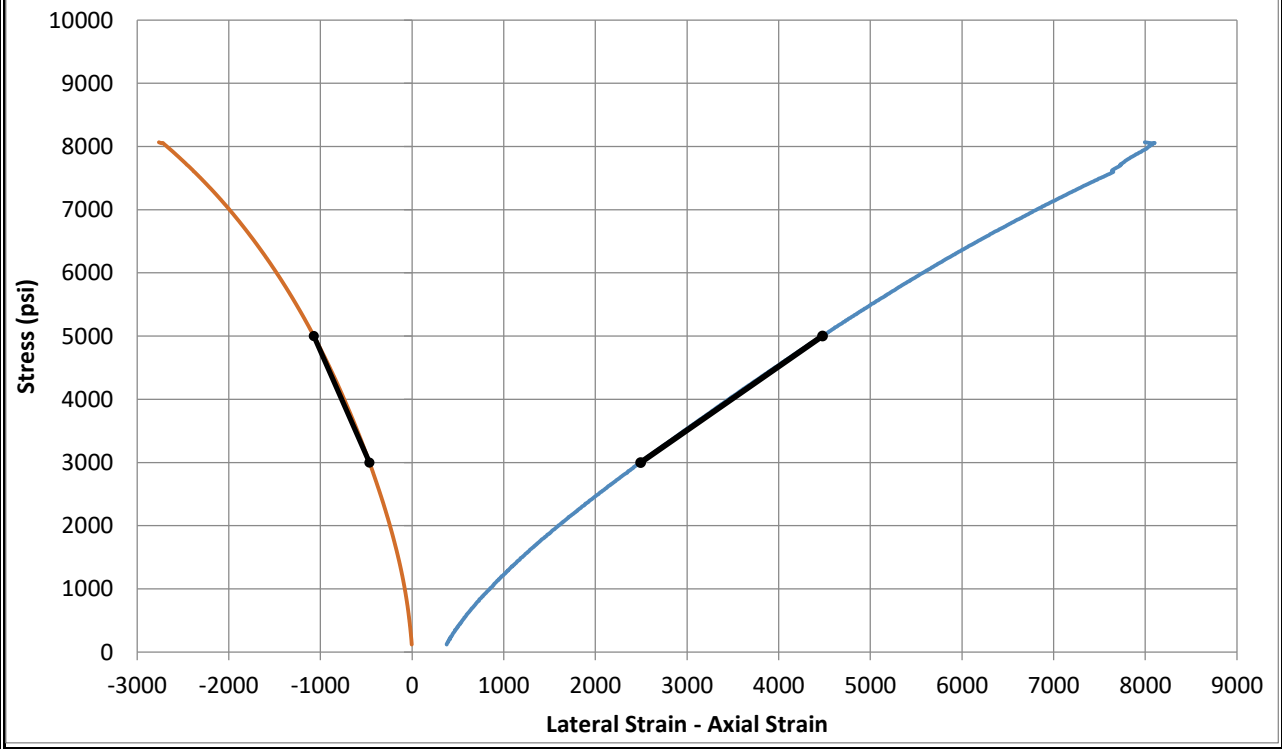
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-22-HQ-5 @ 151.6-152.5
File Name: B-22-HQ-5 @ 151.6-152.5_US(
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.050	12.83	2.353	5.98	2.1	168	2.69	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
35,100	8,072	8,208	56.6	1,009	7.0	0.31	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν
ft/s	m/s	ft/s	m/s	ksi	GPa	
N/A	N/A	N/A	N/A	N/A	N/A	N/A



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

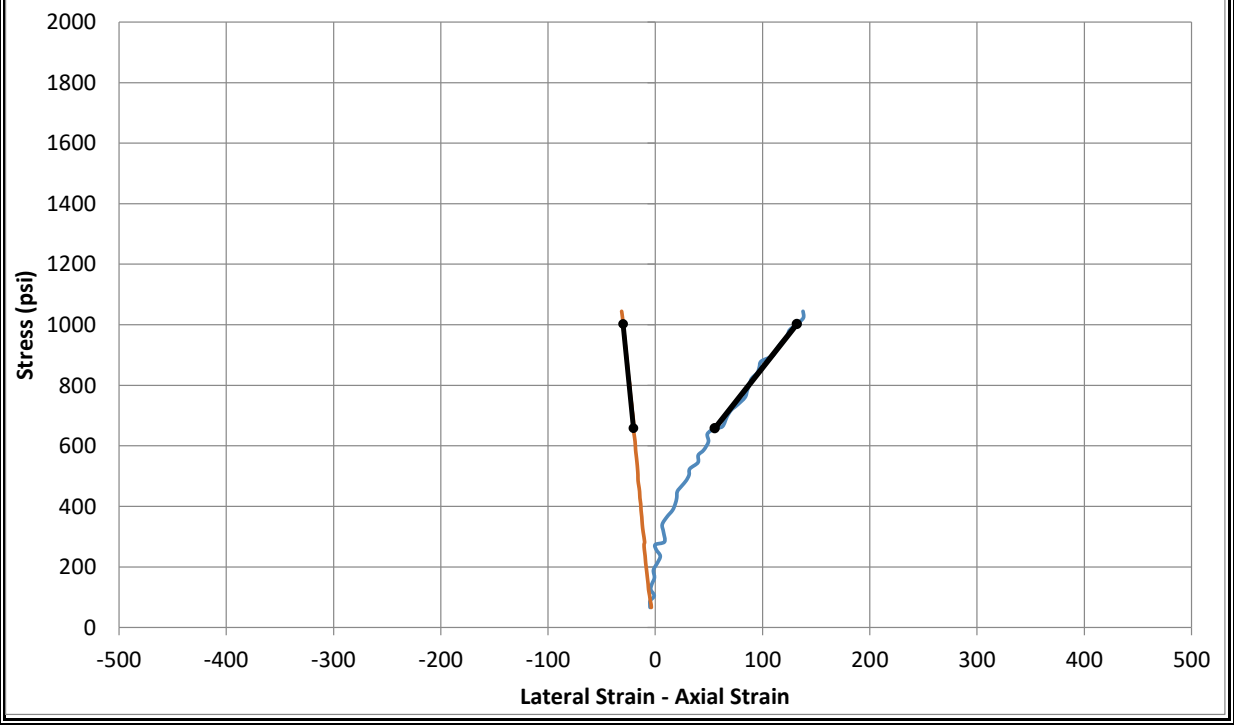
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 7/20/2018
Data Reduced By: OF
Date Reduced: 7/20/2018
Core ID: B-27-NQ-17 @ 166.7-167.3
File Name: B-27-NQ-17 @ 166.7-167.3_US
EMI Project No.: 347

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
3.235	8.22	1.994	5.06	1.6	170	2.73	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus*		Static Poisson's Ratio*	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
7,708	2,468	2,427	16.7	4,501	31.0	0.13	Structural

Note:
The flatness of top and bottom surface of sample doesn't meet the standard ASTM 7012 because of existing foliation.
L/D ratio (1.6) doesn't meet the ASTM 7012.
Strain gauges malfunctioned because there was movement of joints on the sides of the sample.
***Static E and v have been calculated based on the linear portion of the acquired data that is incomplete thus unreliable.**



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

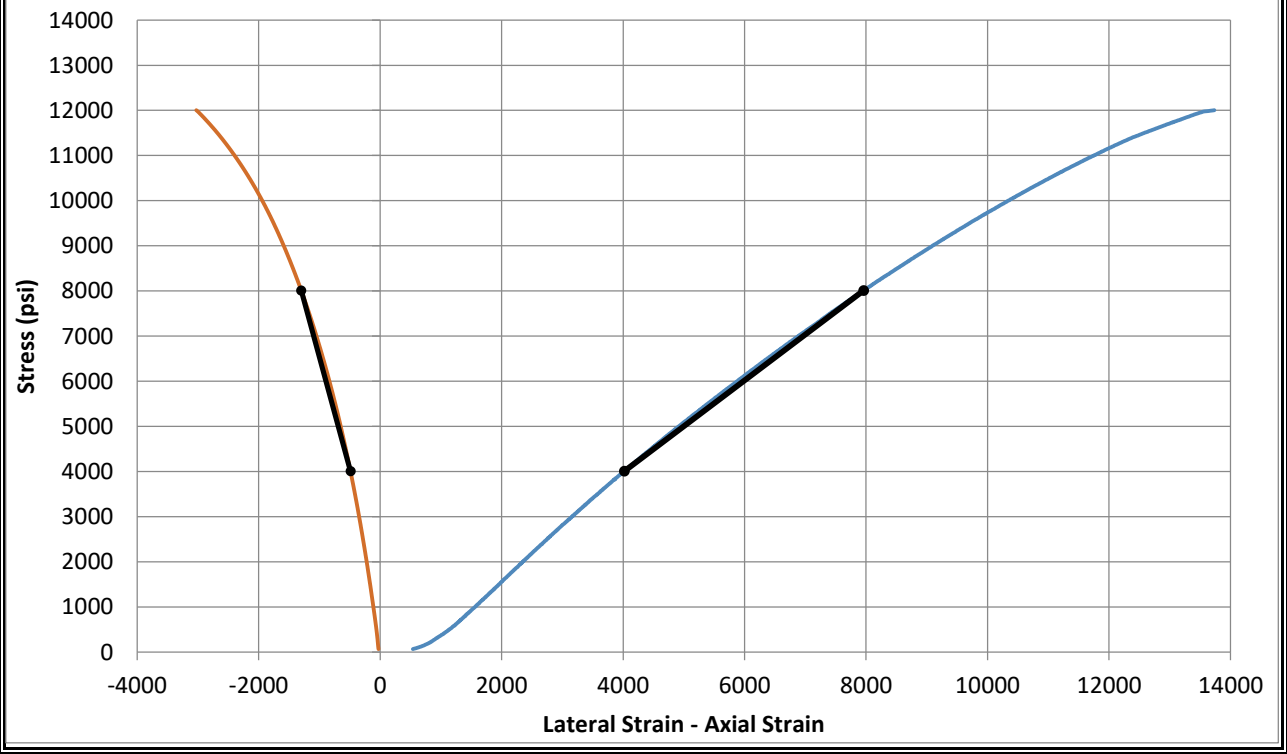
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 7/20/2018
Data Reduced By: OF
Date Reduced: 7/20/2018
Core ID: B-31-HQ-19 @ 173.0-174.3
File Name: B-31-HQ-19 @ 173.0-174.3_US
EMI Project No.: 347

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
4.264	10.83	1.985	5.04	2.1	139	2.22	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
37,208	12,017	12,220	84.3	1,016	7.0	0.21	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

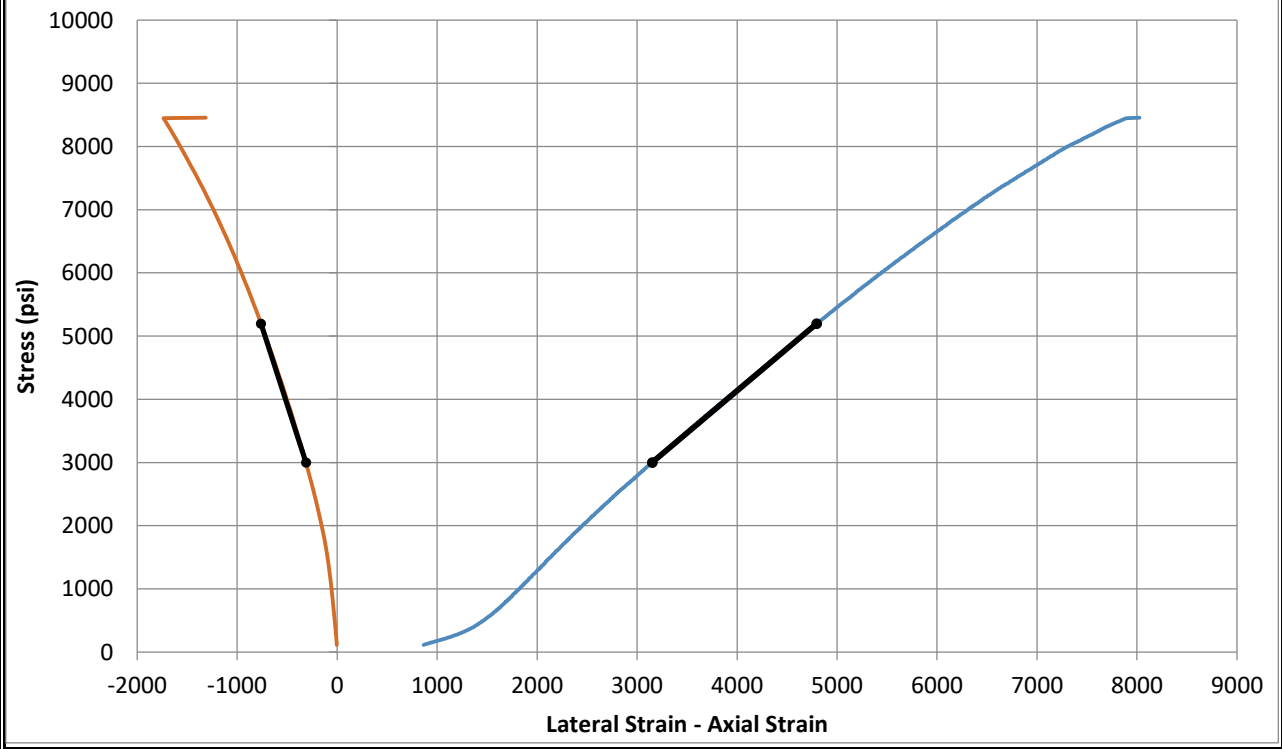
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-39-HQ-6 @ 154.6-155.5
File Name: B-39-HQ-6 @ 154.6-155.5_US(
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.108	12.97	2.392	6.08	2.1	170	2.72	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
38,019	8,457	8,594	59.3	1,335	9.2	0.27	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν
ft/s	m/s	ft/s	m/s	ksi	GPa	
N/A	N/A	N/A	N/A	N/A	N/A	N/A



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

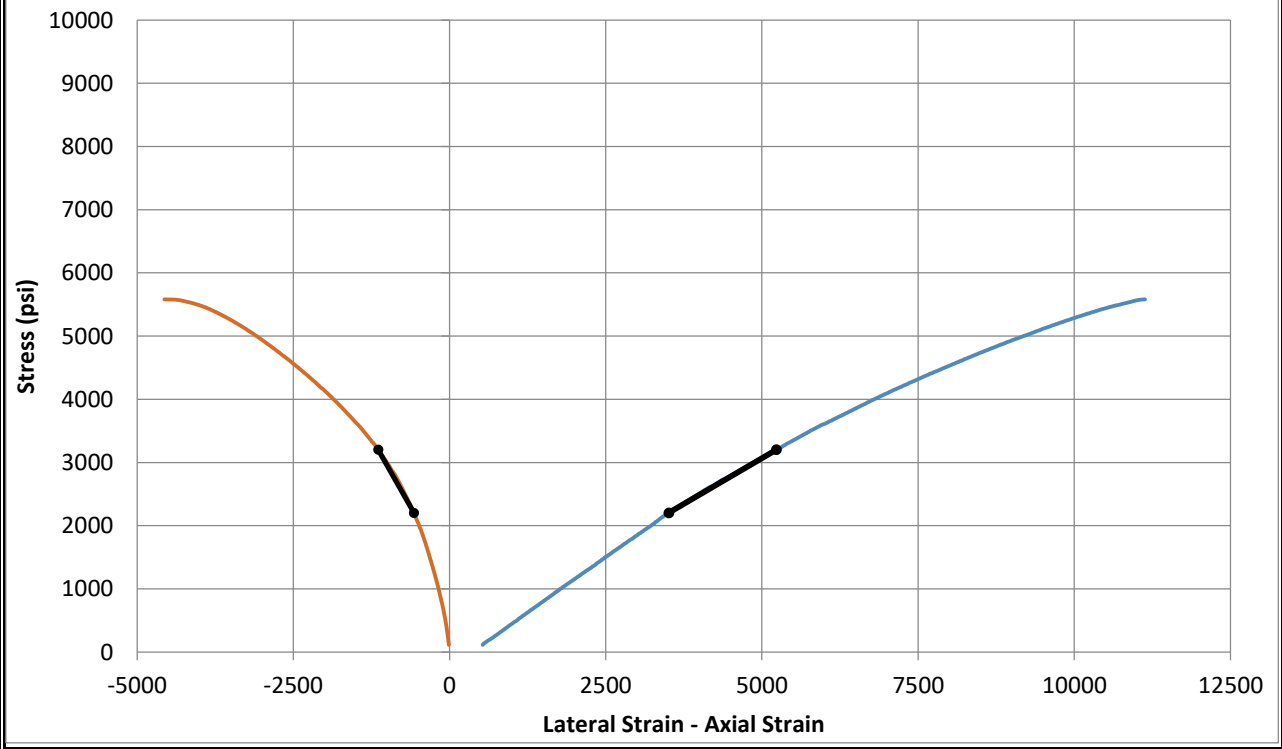
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-39-HQ-7 @ 158.7-159.5
File Name: B-39-HQ-7 @ 158.7-159.5_USG **EMI**
Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.126	13.02	2.393	6.08	2.1	154	2.46	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
25,106	5,582	5,675	39.1	579	4.0	0.33	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



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Mining Engineering Department, CSM

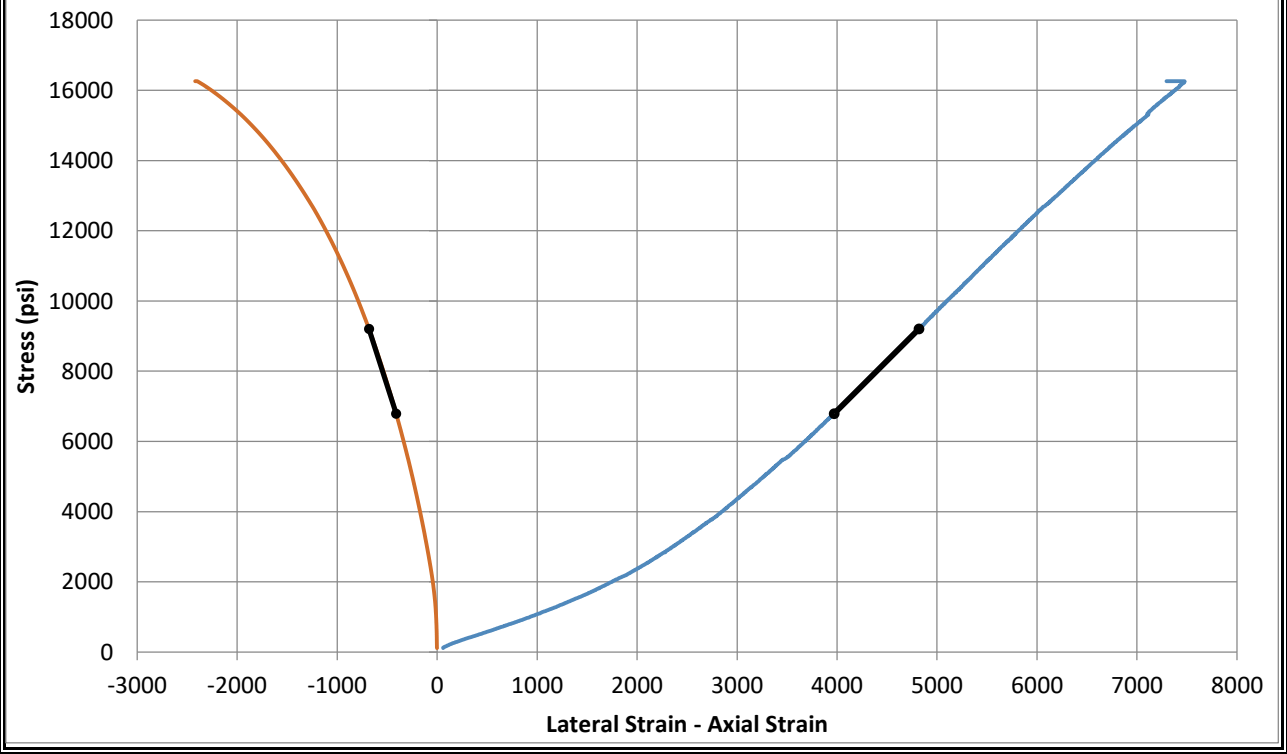
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-40-HQ-5 @ 27.8-28.8
File Name: B-40-HQ-5 @ 27.8-28.8_USG
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.180	13.16	2.393	6.08	2.2	145	2.32	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
73,221	16,273	16,562	114.2	2,844	19.6	0.32	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν
ft/s	m/s	ft/s	m/s	ksi	GPa	
N/A	N/A	N/A	N/A	N/A	N/A	N/A



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

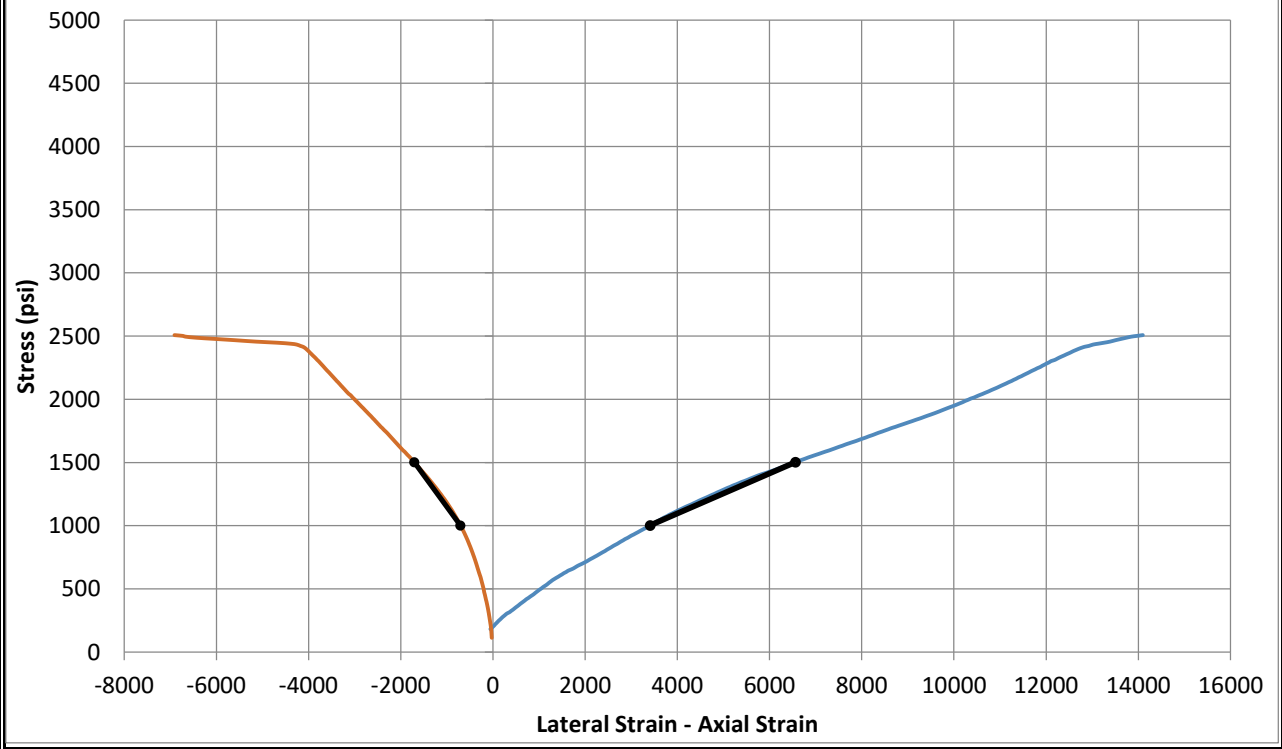
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-40-HQ-28 @ 141.1-141.9
File Name: B-40-HQ-28 @ 141.1-141.9_US
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.199	13.21	2.395	6.08	2.2	164	2.63	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
11,304	2,508	2,553	17.6	158	1.1	0.32	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

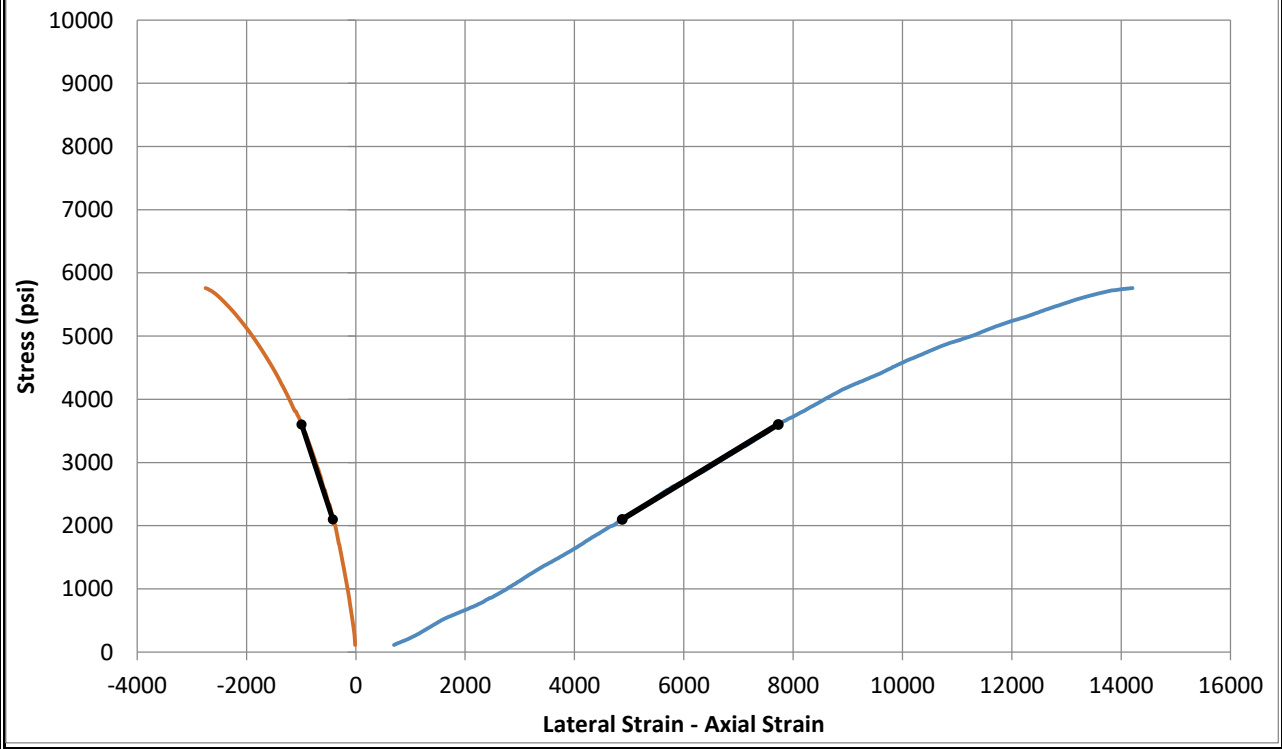
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-40-HQ-30 @ 153.6-154.3
File Name: B-40-HQ-30 @ 153.6-154.3_US
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.155	13.09	2.392	6.08	2.2	152	2.44	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
25,900	5,761	5,861	40.4	527	3.6	0.20	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

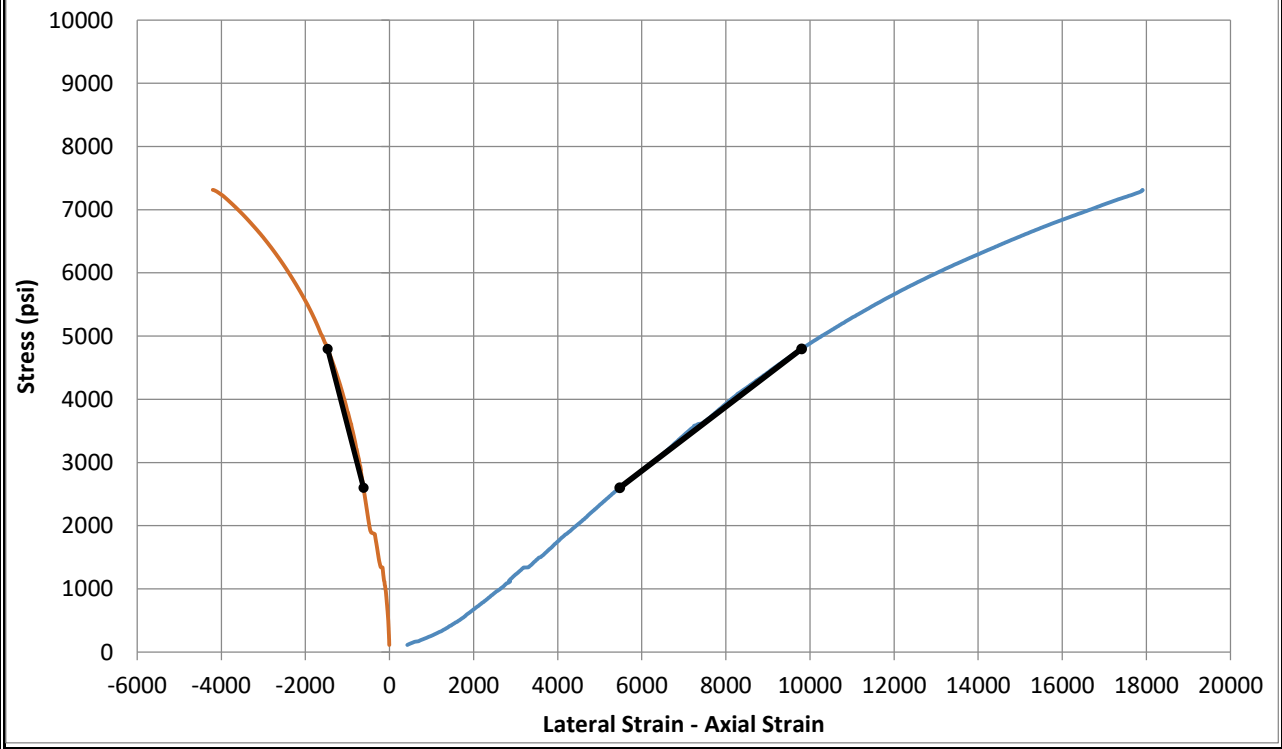
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-40-HQ-32 @ 163.2-164.1
File Name: B-40-HQ-32 @ 163.2-164.1_US
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.106	12.97	2.397	6.09	2.1	142	2.28	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
33,008	7,315	7,432	51.2	508	3.5	0.20	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

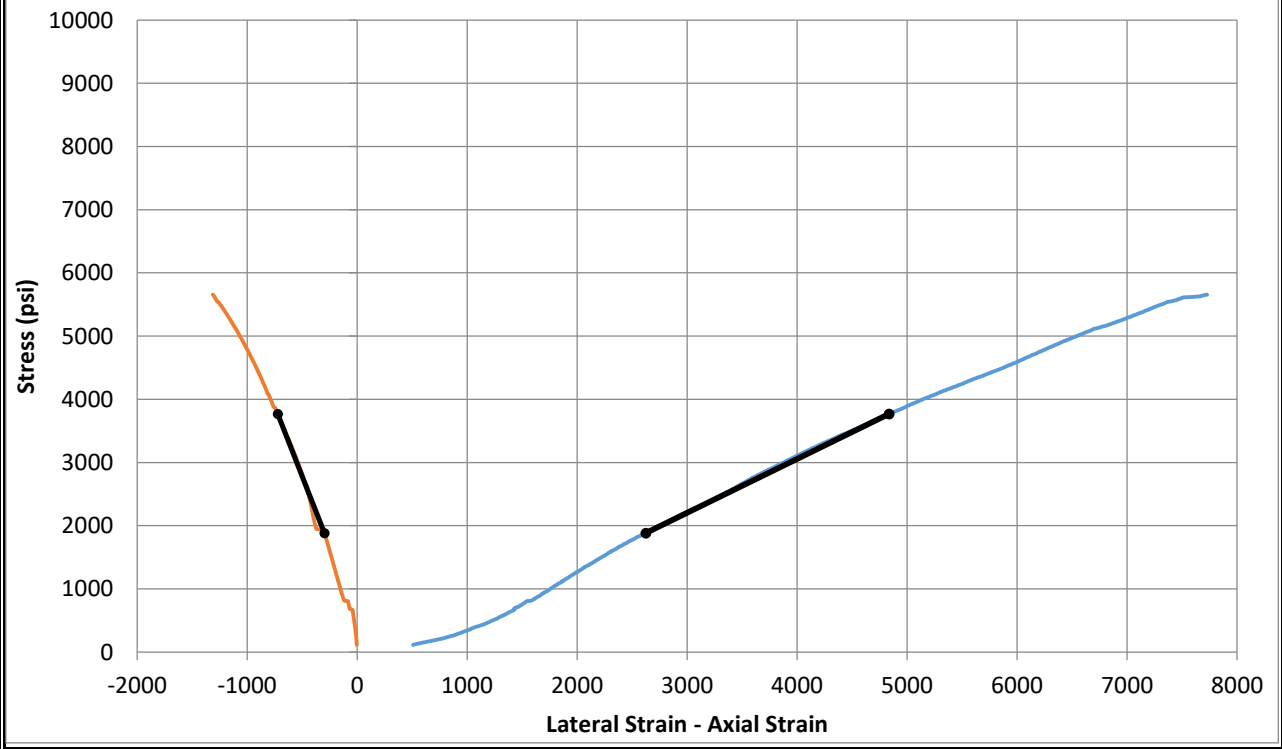
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-41-HQ-33 @ 170.0-171.0
File Name: B-41-HQ-33 @ 170.0-171.0_US
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.054	12.84	2.391	6.07	2.1	154	2.46	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
25,396	5,658	5,745	39.6	852	5.9	0.19	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

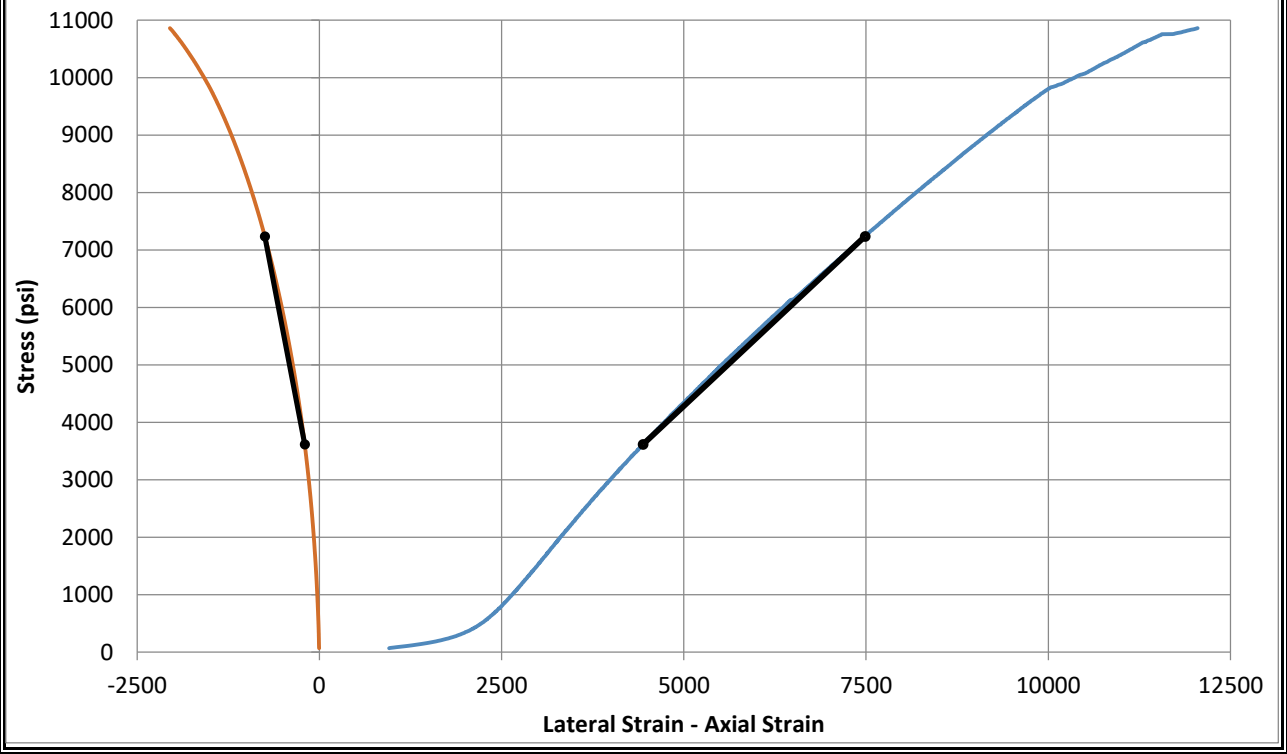
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: OF-AK
Date Tested: 7/20/2018
Data Reduced By: OF
Date Reduced: 7/20/2018
Core ID: B-44-NQ-19 @ 165.0-166.3
File Name: B-44-NQ-19 @ 165.0-166.3_US
EMI Project No.: 347

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
4.145	10.53	1.982	5.03	2.1	161	2.58	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
33,490	10,860	11,013	75.9	1,189	8.2	0.18	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



EARTH MECHANICS INSTITUTE

Mining Engineering Department, CSM

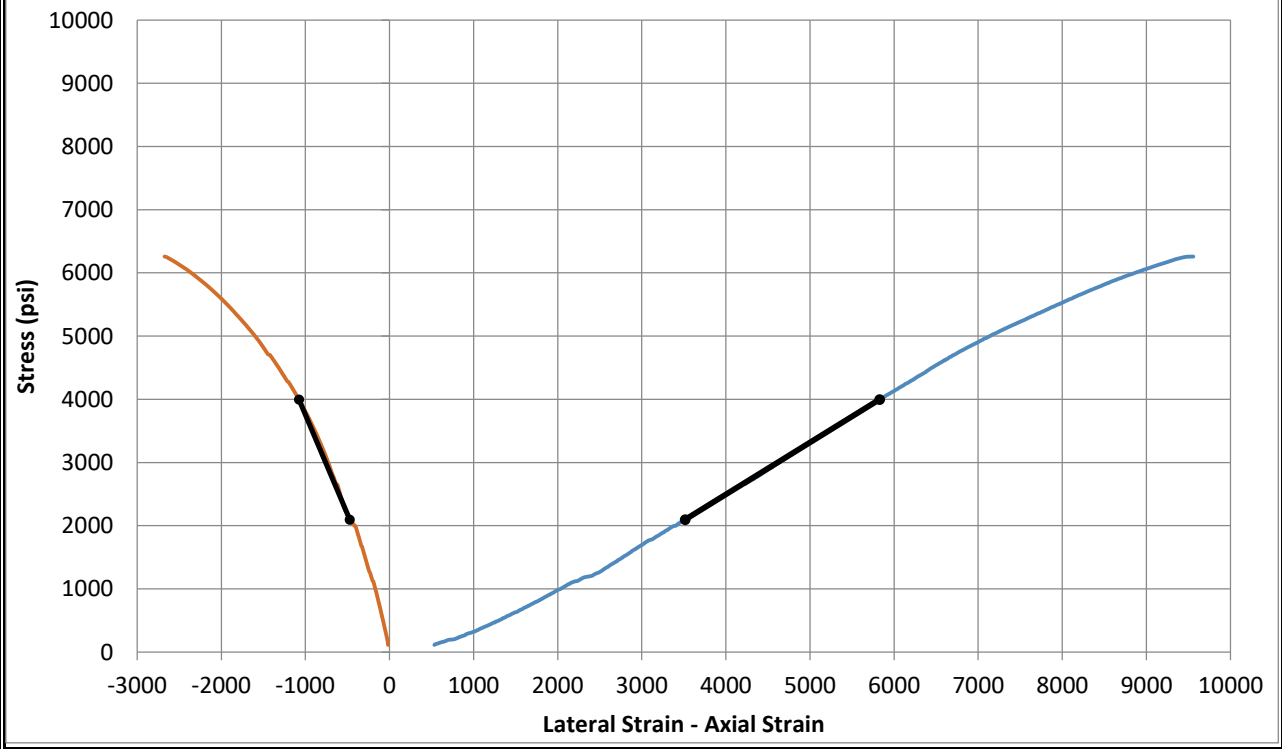
Uniaxial Compressive Strength - ASTM D7012

Client: Resource International
Project: Big Walnut Round
Location: N/A
Rock Type: Sedimentary
Rock Name: N/A
Characteristics: N/A
Test Performed By: TMV
Date Tested: 8/16/2018
Data Reduced By: Of
Date Reduced: 8/17/2018
Core ID: B-46-HQ-20 @ 149.3-150.1
File Name: B-46-HQ-20 @ 149.3-150.1_US
EMI Project No.: 362

Core Length		Core Diameter		L/D Ratio	Density		
in	cm	in	cm		lb/ft^3	g/cm^3	
5.115	12.99	2.397	6.09	2.1	151	2.43	

Failure Load	Failure Stress	UCS 2:1		Static Elastic Modulus		Static Poisson's Ratio	Failure Mode
lbf	psi	psi	MPa	ksi	GPa		
28,254	6,264	6,366	43.9	822	5.7	0.26	Non - Structural

P - Wave		S - Wave		Dynamic E		Dynamic ν	
ft/s	m/s	ft/s	m/s	ksi	GPa		
N/A	N/A	N/A	N/A	N/A	N/A	N/A	



J.3 SPLITTING TENSILE LABORATORY RESULTS

Stantec

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-16	HQ-6	147.4	STS-1	0.790	2.4	1438	483

STS-1

L/D
0.33

Remarks:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-16	HQ-7	155.4	STS-1	0.890	2.4	1524	454

STS-1

L/D
0.37

Remarks:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/18/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-18	NQ-12	151.1	STS-1	1.005	1.969	2779	894
B-18	NQ-13	163.5	STS-2	0.925	1.982	1976	686

STS-1

L/D = 0.51

STS-2

L/D = 0.47

Remarks:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-19	HQ-18	150.0	STS-1	0.968	2.339	1613	454

STS-1

L/D
0.41

Remarks:

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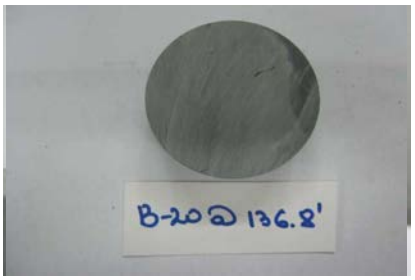
Cincinnati, Ohio 45242
Phone (513) 769-6998

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	5/21/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

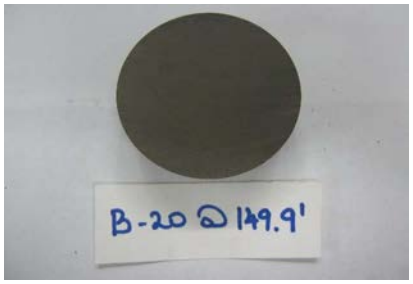
Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-20	HQ-13	136.8	STS-1	1.109	2.393	2779	667
B-20	HQ-15	149.9	STS-2	0.925	1.982	1976	686

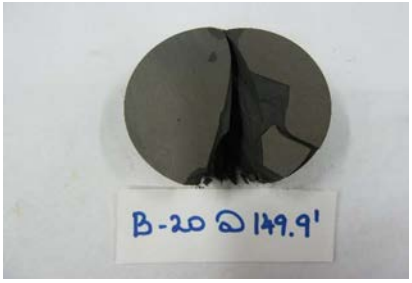
STS-1



L/D
0.47

STS-2





L/D
0.47

Remarks: _____

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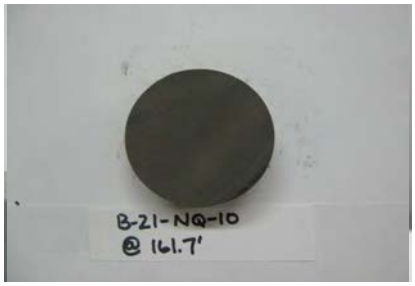
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-21	NQ-10	161.7	STS-1	0.972	1.974	2590	859

STS-1



L/D
0.49

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-22	HQ-5	154.2	STS-1	1.241	2.332	2731	601

STS-1

L/D
0.53

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-24	HQ-15	160.7	STS-1	1.002	2.36	2066	556

STS-1

L/D
0.42

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-24	HQ-16	164.8	STS-1	1.039	2.343	2363	618

STS-1

L/D
0.44

Remarks:

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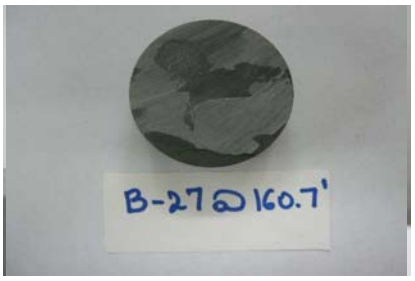
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 5/21/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-27	NQ-16	160.7	STS-1	0.996	1.973	1434	465
B-27	NQ-17	172.4	STS-2	0.989	1.998	2275	733

STS-1



L/D
0.50

STS-2

L/D
0.49

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	5/21/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-29	NQ-18	169.1	STS-1	0.930	1.984	1960.5	676

STS-1

L/D
0.47

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	5/21/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-31	HQ-20	175.2	STS-1	1.057	1.986	2852	865

STS-1

L/D
0.53

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 5/21/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-33	NQ-18	178.3	STS-1	1.015	1.989	3373	1064

STS-1

L/D
0.51

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	7/25/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-36	HQ-4	159.8	STS-1	1.001	2.341	1728	469

STS-1

L/D
0.43

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

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Phone (513) 769-6998

Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

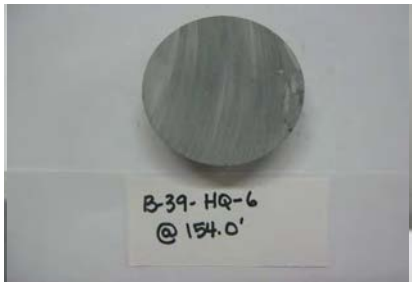
Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-39	HQ-6	154.0	STS-1	1.055	2.399	2430	611

STS-1



L/D
0.44

Remarks:

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Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-39	HQ-7	159.9	STS-1	1.009	2.403	1071	281

STS-1

L/D
0.42

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

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Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-5	26.4	STS-1	1.150	2.391	3754	869

STS-1

L/D
0.48

Remarks:

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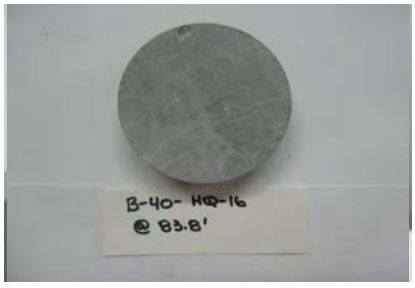
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-16	83.8	STS-1	1.009	2.398	1180	310

STS-1



L/D
0.42

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	7/25/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-22	113.2	STS-1	0.890	2.396	312	93

STS-1

L/D
0.37

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-26	133.2	STS-1	1.312	2.399	1803	365

STS-1

L/D
0.55

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-28	144.0	STS-1	1.241	2.402	1606	343

STS-1

L/D
0.52

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

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Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

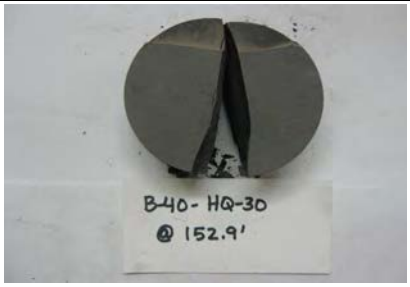
Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-30	152.9	STS-1	1.209	2.388	1825	402

STS-1



L/D
0.51

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

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Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

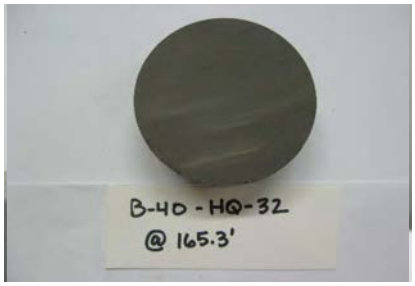
Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-40	HQ-32	165.3	STS-1	1.312	2.404	2489	502

STS-1



L/D
0.55

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-16	HQ-6	169.3	STS-1	1.007	2.4	1591	419

STS-1

L/D
0.42

Remarks:

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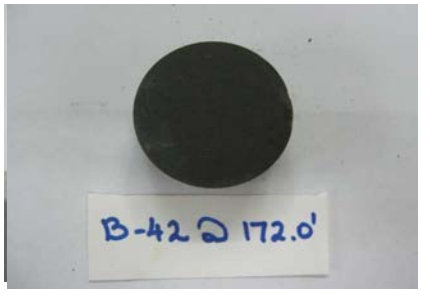
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 5/21/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-42	NQ-18	172.0	STS-1	1.032	1.998	2304	711

STS-1



L/D
0.52

Remarks:

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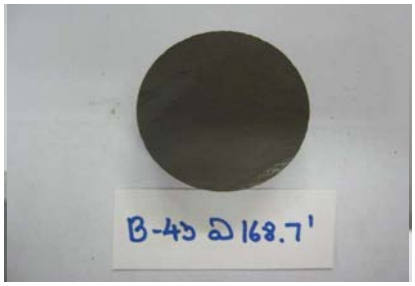
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project:	Big Walnut Sanitary Sewer Ext. - PH 2
Project No.:	W-15-012
Date of Testing:	5/21/2018
Test Performed by:	E.M.
Moisture condition:	As received
Load Rate:	2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-43	HQ-21	168.7	STS-1	1.082	2.267	2413	626

STS-1



L/D
0.48

Remarks:

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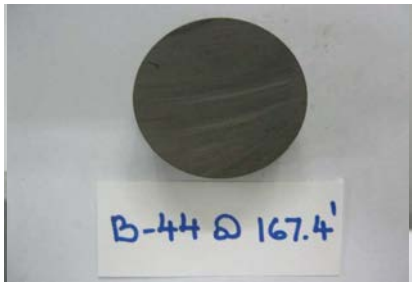
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 5/21/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-44	NQ-19	167.4	STS-1	1.019	1.985	2198	692

STS-1



L/D
0.51

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

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4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Project: Big Walnut Sanitary Sewer Ext. - PH 2

Project No.: W-15-012

Date of Testing: 7/25/2018

Test Performed by: E.M.

Moisture condition: As received

Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-45	HQ-5	150.9	STS-1	0.890	2.326	1543	475

STS-1

L/D
0.38

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/25/2018

Test Performed by: E.M.
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-46	HQ-20	148.4	STS-1	1.104	2.4	1189	286

STS-1

L/D
0.46

Remarks:

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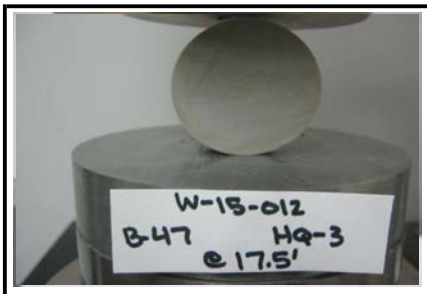
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/2/2019

Rock Description: Sandstone; light gray, very fine-grained to fine grained (Berea Sandstone).
Test Performed by: KL
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-47	HQ-3	17.5	STS-1	1.093	2.387	1665.9	406

STS-1



L/D
0.46

Remarks:

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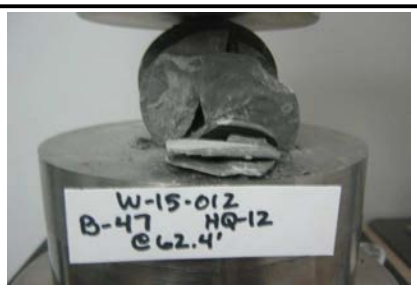
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/2/2019

Rock Description: Interbedded Shale/Sandstone/Siltstone; gray and dark gray, very fine grained (Berea SST/Bedford SH).
Test Performed by: KL
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-47	HQ-12	62.4	STS-1	1.194	2.366	998.5	225

STS-1



L/D
0.50

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/2/2019

Rock Description: Shale, trace siltstone, gray, very fine-grained (Berea SST/Bedford SH).
Test Performed by: KL
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-47	HQ-19	96.9	STS-1	1.121	2.376	991.7	237

STS-1

L/D
0.47

Remarks:

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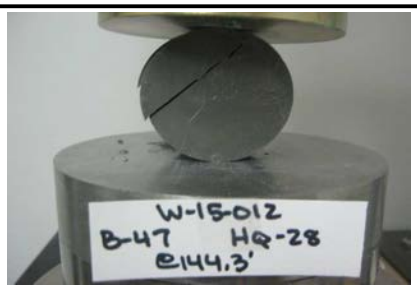
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/2/2019

Rock Description: Shale, dark gray, very fine-grained (Bedford Shale).
Test Performed by: KL
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-47	HQ-28	144.3	STS-1	1.187	2.388	1218	274

STS-1



L/D
0.50

Remarks:

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Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D-3967

Project: Big Walnut Sanitary Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 7/2/2019

Rock Description: Shale, black, very fine grained, pyritic (Ohio Shale).
Test Performed by: KL
Moisture condition: As received
Load Rate: 2.0 % / min.

Boring ID	Sample ID	Depth, ft	Test No.	Thickness, in	Diameter, in	Failure Load (P), lb.	Splitting Tensile Strength, psi
B-47	HQ-34	170.0	STS-1	1.058	2.381	1443.8	365

STS-1

L/D
0.44

Remarks:

J.4 SLAKE DURABILITY LABORATORY RESULTS

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut
Project No: W-15-012
Date: 7/2/2018
Boring No. B-16
Sample ID: HQ-6 (146.6-147.2)
Technician: Nick Calendine
Sample Description: Shale, blue-blueish gray, slightly to unweathered, soft, laminated to thin bedded.

Initial Moisture Content:

Drum/Container ID: (1) Mass of Drum:	1191.70
Mass of Drum + Sample (wet)	1729.20
Mass of Drum + Sample (oven dried)	1717.10
Mass of sample (oven dried):	525.40
Moisture Content of Sample:	2.30

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1732.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1713.3	Start:	26.4
Mass of sample (oven dried):	521.6	Finish:	25.9
Moisture Content of Sample:	3.64	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1727.7	Water Temp:	
Mass of Drum + Sample (oven dried)	1701	Start:	20.2
Mass of sample (oven dried):	509.30	Finish:	20.2
Moisture Content of Sample:	5.24	Time:	10:00:00

Slake Durability Index:	96.94
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-16
Project No:	W-15-012	Sample ID:	HQ-6 (149.0-149.5)
Date:	7/2/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, moderately hard, laminated to thin bedded.

Initial Moisture Content:

Drum/Container ID: (2) Mass of Drum:	1190.90
Mass of Drum + Sample (wet)	1714.70
Mass of Drum + Sample (oven dried)	1703.50
Mass of sample (oven dried):	512.60
Moisture Content of Sample:	2.18

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1725.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1698.5	Start:	26.6
Mass of sample (oven dried):	507.6	Finish:	26
Moisture Content of Sample:	5.24	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1718.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1681.8	Start:	20.5
Mass of sample (oven dried):	490.90	Finish:	20.5
Moisture Content of Sample:	7.54	Time:	10:00:00

Slake Durability Index:	95.77
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut Sanitary Trunk Ext.PH2	Boring No.	B-18
Project No:	W-15-012	Sample ID:	NQ-12 (151.9-152.5')
Date:	4/17/2018	Technician:	J.Hoyt

Sample Description: Bluish gray Shale, soft, slightly weathered, flat bedded, fresh rock.

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1192.10
Mass of Drum + Sample (wet)	1734.30
Mass of Drum + Sample (oven dried)	1723.40
Mass of sample (oven dried):	531.30
Moisture Content of Sample:	2.05

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1735.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1716.2	Start:	20.5
Mass of sample (oven dried):	524.1	Finish:	20.5
Moisture Content of Sample:	3.66	Time:	10:00:07

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1726.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1704.1	Start:	20.3
Mass of sample (oven dried):	512.00	Finish:	21.0
Moisture Content of Sample:	4.38	Time:	10:00:00

Slake Durability Index:	96.37
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut Sanitary Trunk Ext.PH2	Boring No.	B-18
Project No:	W-15-012	Sample ID:	NQ-13 (161.4-162.0')
Date:	4/17/2018	Technician:	J.Hoyt

Sample Description: Black Shale, moderately hard, slightly weathered, laminated, fresh rock.

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1191.00
Mass of Drum + Sample (wet)	1689.70
Mass of Drum + Sample (oven dried)	1680.50
Mass of sample (oven dried):	489.50
Moisture Content of Sample:	1.88

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1694.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1676.9	Start:	21.1
Mass of sample (oven dried):	485.9	Finish:	20.8
Moisture Content of Sample:	3.62	Time:	10:00:07

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1691.6	Water Temp:	
Mass of Drum + Sample (oven dried)	1673.1	Start:	20.3
Mass of sample (oven dried):	482.10	Finish:	21.0
Moisture Content of Sample:	3.84	Time:	10:00:00

Slake Durability Index:	98.49
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-19
Project No:	W-15-012	Sample ID:	HQ-18 (150.1'-150.7')
Date:	7/16/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray to black, slightly weathered, mod. hard to hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1256.70
Mass of Drum + Sample (wet)	1784.00
Mass of Drum + Sample (oven dried)	1775.00
Mass of sample (oven dried):	518.30
Moisture Content of Sample:	1.74

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1791.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1771.5	Start:	20.7
Mass of sample (oven dried):	514.8	Finish:	20.6
Moisture Content of Sample:	3.85	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1788.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1764.4	Start:	18.7
Mass of sample (oven dried):	507.70	Finish:	18.8
Moisture Content of Sample:	4.75	Time:	10:00:00

Slake Durability Index:	97.95
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2
Project No: W-15-012
Date: 5/11/2018
Boring No. B-20
Sample ID: HQ-13 (135.8-136.7')
Technician: C.Straub
Sample Description: Gray Shale, soft, unweathered, thin bedded, flat bedded, moderately fractured.

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1191.50
Mass of Drum + Sample (wet)	1714.70
Mass of Drum + Sample (oven dried)	1708.20
Mass of sample (oven dried):	516.70
Moisture Content of Sample:	1.26

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1711	Water Temp:	
Mass of Drum + Sample (oven dried)	1693.7	Start:	24.3
Mass of sample (oven dried):	502.2	Finish:	24.4
Moisture Content of Sample:	3.44	Time:	10:01:04

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1686.6	Water Temp:	
Mass of Drum + Sample (oven dried)	1665.2	Start:	23.6
Mass of sample (oven dried):	473.70	Finish:	23.7
Moisture Content of Sample:	4.52	Time:	10:00:35

Slake Durability Index:	91.68
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2
Project No: W-15-012
Date: 5/11/2018
Boring No. B-20
Sample ID: HQ-16 (150.7-152.0')
Technician: C.Straub
Sample Description: Black Shale, moderately hard, unweathered, thin bedded, flat bedded, mod. fractured.

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1190.70
Mass of Drum + Sample (wet)	1721.10
Mass of Drum + Sample (oven dried)	1713.70
Mass of sample (oven dried):	523.00
Moisture Content of Sample:	1.41

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1722.6	Water Temp:	
Mass of Drum + Sample (oven dried)	1713	Start:	24.4
Mass of sample (oven dried):	522.3	Finish:	24.5
Moisture Content of Sample:	1.84	Time:	10:01:04

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1726.0	Water Temp:	
Mass of Drum + Sample (oven dried)	1712.4	Start:	23.6
Mass of sample (oven dried):	521.70	Finish:	23.6
Moisture Content of Sample:	2.61	Time:	10:00:35

Slake Durability Index:	99.75
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-21
Project No:	W-15-012	Sample ID:	NQ-8 (152.4'-153.2')
Date:	7/16/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray, moderately hard, moderately weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: (1) Mass of Drum:	1191.60
Mass of Drum + Sample (wet)	1714.80
Mass of Drum + Sample (oven dried)	1702.70
Mass of sample (oven dried):	511.10
Moisture Content of Sample:	2.37

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1692.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1670.8	Start:	20.7
Mass of sample (oven dried):	479.2	Finish:	20.6
Moisture Content of Sample:	4.51	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1662.6	Water Temp:	
Mass of Drum + Sample (oven dried)	1638.2	Start:	18.7
Mass of sample (oven dried):	446.60	Finish:	18.8
Moisture Content of Sample:	5.46	Time:	10:00:00

Slake Durability Index:	87.38
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-21
Project No:	W-15-012	Sample ID:	NQ-9 & 10 (160.0'-161.4')
Date:	7/12/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray to black, hard, slightly weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1257.10
Mass of Drum + Sample (wet)	1732.30
Mass of Drum + Sample (oven dried)	1725.80
Mass of sample (oven dried):	468.70
Moisture Content of Sample:	1.39

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1736.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1721	Start:	21.1
Mass of sample (oven dried):	463.9	Finish:	20.9
Moisture Content of Sample:	3.34	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1733.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1716.5	Start:	19.5
Mass of sample (oven dried):	459.40	Finish:	19.8
Moisture Content of Sample:	3.77	Time:	10:00:00

Slake Durability Index:	98.02
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-22
Project No:	W-15-012	Sample ID:	HQ-5 (152.5'-153.8')
Date:	7/16/2018	Technician:	Nick Calendine

Sample Description: Shale, gray, mod. to highly weathered, soft to mod. hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (2) Mass of Drum:	1190.70
Mass of Drum + Sample (wet)	1748.40
Mass of Drum + Sample (oven dried)	1741.90
Mass of sample (oven dried):	551.20
Moisture Content of Sample:	1.18

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1744.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1721.7	Start:	20.7
Mass of sample (oven dried):	531	Finish:	20.6
Moisture Content of Sample:	4.27	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1729.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1703.1	Start:	18.9
Mass of sample (oven dried):	512.40	Finish:	19.1
Moisture Content of Sample:	5.09	Time:	10:00:00

Slake Durability Index:	92.96
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut Sanitary Trunk Ext.PH2	Boring No.	B-23
Project No:	W-15-012	Sample ID:	HQ-11 (158.0-159.0')
Date:	4/23/2018	Technician:	J.Hoyt

Sample Description: Gray Shale, soft to moderately hard, slightly weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1190.90
Mass of Drum + Sample (wet)	1734.60
Mass of Drum + Sample (oven dried)	1729.90
Mass of sample (oven dried):	539.00
Moisture Content of Sample:	0.87

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1742.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1722.4	Start:	21.0
Mass of sample (oven dried):	531.5	Finish:	21.0
Moisture Content of Sample:	3.76	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1729.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1706.1	Start:	20.9
Mass of sample (oven dried):	515.20	Finish:	21.2
Moisture Content of Sample:	4.50	Time:	10:00:00

Slake Durability Index:	95.58
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut Sanitary Trunk Ext.PH2	Boring No.	B-23
Project No:	W-15-012	Sample ID:	HQ-13 (166.6-167.3')
Date:	4/23/2018	Technician:	J.Hoyt

Sample Description: Black Shale, moderately hard, slightly weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1192.70
Mass of Drum + Sample (wet)	1720.60
Mass of Drum + Sample (oven dried)	1716.50
Mass of sample (oven dried):	523.80
Moisture Content of Sample:	0.78

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1726.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1712.8	Start:	21.1
Mass of sample (oven dried):	520.1	Finish:	21.1
Moisture Content of Sample:	2.69	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1726.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1711.7	Start:	20.9
Mass of sample (oven dried):	519.00	Finish:	21.2
Moisture Content of Sample:	2.81	Time:	10:00:00

Slake Durability Index:	99.08
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-24
Project No:	W-15-012	Sample ID:	HQ-15 (159.5-160.5)
Date:	7/9/2018	Technician:	Nick Calendine

Sample Description: Shale, gray, soft to mod. hard, mod. to highly weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1257.00
Mass of Drum + Sample (wet)	1745.20
Mass of Drum + Sample (oven dried)	1739.30
Mass of sample (oven dried):	482.30
Moisture Content of Sample:	1.22

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1738.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1721.9	Start:	21.8
Mass of sample (oven dried):	464.9	Finish:	21.7
Moisture Content of Sample:	3.66	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1736.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1711	Start:	19.8
Mass of sample (oven dried):	454.00	Finish:	20.0
Moisture Content of Sample:	5.55	Time:	10:00:00

Slake Durability Index:	94.13
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-24
Project No:	W-15-012	Sample ID:	HQ-16 (163.4-164.4)
Date:	7/9/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray to black, mod. hard, slightly weathered, thin bedded.

Initial Moisture Content:

Drum/Container ID: (1) Mass of Drum:	1191.70
Mass of Drum + Sample (wet)	1713.20
Mass of Drum + Sample (oven dried)	1704.90
Mass of sample (oven dried):	513.20
Moisture Content of Sample:	1.62

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1718.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1694.6	Start:	21.8
Mass of sample (oven dried):	502.9	Finish:	21.7
Moisture Content of Sample:	4.81	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1712.7	Water Temp:	
Mass of Drum + Sample (oven dried)	1680.2	Start:	19.9
Mass of sample (oven dried):	488.50	Finish:	20.1
Moisture Content of Sample:	6.65	Time:	10:00:00

Slake Durability Index:	95.19
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2 — Boring No. B-27
Project No: W-15-012 — Sample ID: NQ-16 (164.6-165.6')
Date: 5/11/2018 — Technician: C.Straub
Sample Description: Gray Shale, soft, mod. weathered, thin bedded, flat bedded, moderately fractured.

Initial Moisture Content:

Drum/Container ID: 3 Mass of Drum:	1257.20
Mass of Drum + Sample (wet)	1748.00
Mass of Drum + Sample (oven dried)	1743.70
Mass of sample (oven dried):	486.50
Moisture Content of Sample:	0.88

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1744.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1731.1	Start:	24.4
Mass of sample (oven dried):	473.9	Finish:	24.5
Moisture Content of Sample:	2.76	Time:	10:01:04

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1734.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1718.8	Start:	23.7
Mass of sample (oven dried):	461.60	Finish:	23.7
Moisture Content of Sample:	3.47	Time:	10:00:35

Slake Durability Index:	94.88
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2 — Boring No. B-27
Project No: W-15-012 — Sample ID: NQ-17 (171.0-172.3')
Date: 5/11/2018 — Technician: C.Straub
Sample Description: Black Shale, unweathered, moderately hard, thin bedded, unfract. to slightly fractured.

Initial Moisture Content:

Drum/Container ID: 4 Mass of Drum:	1257.20
Mass of Drum + Sample (wet)	1762.60
Mass of Drum + Sample (oven dried)	1754.50
Mass of sample (oven dried):	497.30
Moisture Content of Sample:	1.63

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1763.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1751	Start:	25.7
Mass of sample (oven dried):	493.8	Finish:	25.6
Moisture Content of Sample:	2.49	Time:	10:01:04

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1760.7	Water Temp:	
Mass of Drum + Sample (oven dried)	1745.7	Start:	23.6
Mass of sample (oven dried):	488.50	Finish:	23.6
Moisture Content of Sample:	3.07	Time:	10:00:35

Slake Durability Index:	98.23
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2 — Boring No. B-29
Project No: W-15-012 — Sample ID: NQ-18 (171.3-172.0')
Date: 5/16/2018 — Technician: C.Straub
Sample Description: Black Shale, unweathered, moderatley hard, thin bedded, flat bedded, unfractured.

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1191.60
Mass of Drum + Sample (wet)	1736.30
Mass of Drum + Sample (oven dried)	1722.70
Mass of sample (oven dried):	531.10
Moisture Content of Sample:	2.56

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1736.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1719.3	Start:	24.0
Mass of sample (oven dried):	527.7	Finish:	24.0
Moisture Content of Sample:	3.34	Time:	10:00:13

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1732.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1714.7	Start:	23.6
Mass of sample (oven dried):	523.10	Finish:	23.5
Moisture Content of Sample:	3.46	Time:	10:00:02

Slake Durability Index:	98.49
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2 — Boring No. B-31
Project No: W-15-012 — Sample ID: NQ-20 (176.0-176.9')
Date: 5/16/2018 — Technician: C.Straub
Sample Description: Black Shale, mod. hard, unweathered, laminated to thin bedded, flat bedded, unfract.

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1190.70
Mass of Drum + Sample (wet)	1730.30
Mass of Drum + Sample (oven dried)	1722.20
Mass of sample (oven dried):	531.50
Moisture Content of Sample:	1.52

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1737	Water Temp:	
Mass of Drum + Sample (oven dried)	1719.3	Start:	24.0
Mass of sample (oven dried):	528.6	Finish:	24.0
Moisture Content of Sample:	3.35	Time:	10:00:13

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1732.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1716.4	Start:	23.6
Mass of sample (oven dried):	525.70	Finish:	23.5
Moisture Content of Sample:	3.04	Time:	10:00:02

Slake Durability Index:	98.91
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2
Project No: W-15-012
Date: 5/16/2018
Boring No. B-33
Sample ID: NQ-18 & 19 (180.1-181.5')
Technician: C.Straub
Sample Description: Black Shale, moderately hard, unweathered, thin bedded, flat bedded, unfract.

Initial Moisture Content:

Drum/Container ID: 3 Mass of Drum:	1257.00
Mass of Drum + Sample (wet)	1792.60
Mass of Drum + Sample (oven dried)	1787.80
Mass of sample (oven dried):	530.80
Moisture Content of Sample:	0.90

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1800.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1785.6	Start:	24.1
Mass of sample (oven dried):	528.6	Finish:	24.0
Moisture Content of Sample:	2.89	Time:	10:00:13

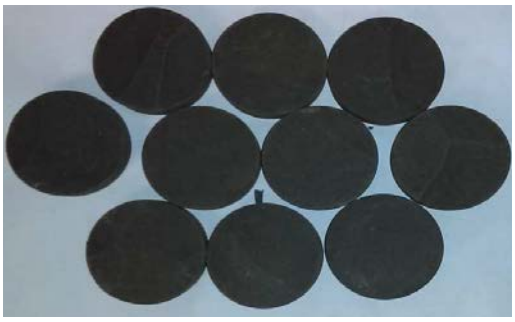
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1794.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1783.2	Start:	23.6
Mass of sample (oven dried):	526.20	Finish:	23.5
Moisture Content of Sample:	2.15	Time:	10:00:02

Slake Durability Index:	99.13
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-36
Project No:	W-15-012	Sample ID:	HQ-4 (158.5-159.4')
Date:	7/9/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray to black, slightly to mod. weathered, mod. hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (1) Mass of Drum:	1191.80
Mass of Drum + Sample (wet)	1725.90
Mass of Drum + Sample (oven dried)	1716.50
Mass of sample (oven dried):	524.70
Moisture Content of Sample:	1.79

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1730.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1704.9	Start:	21.1
Mass of sample (oven dried):	513.1	Finish:	20.9
Moisture Content of Sample:	4.91	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1720.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1696	Start:	19.6
Mass of sample (oven dried):	504.20	Finish:	19.8
Moisture Content of Sample:	4.78	Time:	10:00:00

Slake Durability Index:	96.09
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-38
Project No:	W-15-012	Sample ID:	HQ-12 (109.5'-110.5')
Date:	7/16/2018	Technician:	Nick Calendine

Sample Description: Shale, red, slightly to mod. weathered, mod. hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (4) Mass of Drum:	1256.50
Mass of Drum + Sample (wet)	1779.00
Mass of Drum + Sample (oven dried)	1768.70
Mass of sample (oven dried):	512.20
Moisture Content of Sample:	2.01

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1657	Water Temp:	
Mass of Drum + Sample (oven dried)	1624	Start:	20.7
Mass of sample (oven dried):	367.5	Finish:	20.6
Moisture Content of Sample:	8.98	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1430.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1398.8	Start:	18.9
Mass of sample (oven dried):	142.30	Finish:	19.1
Moisture Content of Sample:	22.21	Time:	10:00:00

Slake Durability Index:	27.78
Type	Type III

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-39
Project No:	W-15-012	Sample ID:	HQ-7 (155.5-156.3')
Date:	7/2/2018	Technician:	Nick Calendine

Sample Description: Shale, blueish gray, slightly weathered, soft, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1257.20
Mass of Drum + Sample (wet)	1786.40
Mass of Drum + Sample (oven dried)	1773.80
Mass of sample (oven dried):	516.60
Moisture Content of Sample:	2.44

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1789.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1772.7	Start:	26.2
Mass of sample (oven dried):	515.5	Finish:	25.9
Moisture Content of Sample:	3.20	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1781.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1757.4	Start:	20.1
Mass of sample (oven dried):	500.20	Finish:	20.0
Moisture Content of Sample:	4.90	Time:	10:00:00

Slake Durability Index:	96.83
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-39
Project No:	W-15-012	Sample ID:	HQ-7/HQ-8 (160.1-161.2')
Date:	7/2/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, moderately hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (4) Mass of Drum:	1257.10
Mass of Drum + Sample (wet)	1755.00
Mass of Drum + Sample (oven dried)	1740.40
Mass of sample (oven dried):	483.30
Moisture Content of Sample:	3.02

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1753.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1738.7	Start:	25.9
Mass of sample (oven dried):	481.6	Finish:	25.4
Moisture Content of Sample:	2.99	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1759.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1736.2	Start:	20.5
Mass of sample (oven dried):	479.10	Finish:	20.4
Moisture Content of Sample:	4.84	Time:	10:00:00

Slake Durability Index:	99.13
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-40
Project No:	W-15-012	Sample ID:	HQ-22 (111.5'-112.5')
Date:	7/23/2018	Technician:	Nick Calendine

Sample Description: Shale, red, unweathered, soft, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1257.10
Mass of Drum + Sample (wet)	1830.80
Mass of Drum + Sample (oven dried)	1812.60
Mass of sample (oven dried):	555.50
Moisture Content of Sample:	3.28

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1617.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1584.1	Start:	20.9
Mass of sample (oven dried):	327	Finish:	20.7
Moisture Content of Sample:	10.09	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1481.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1444.1	Start:	20.2
Mass of sample (oven dried):	187.00	Finish:	20.4
Moisture Content of Sample:	19.84	Time:	10:00:00

Slake Durability Index:	33.66
Type	Type III

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-40
Project No:	W-15-012	Sample ID:	HQ-26 (131.5'-132.5')
Date:	7/12/2018	Technician:	Nick Calendine

Sample Description: Shale, blue with red bands, unweathered, soft, flat bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1191.00
Mass of Drum + Sample (wet)	1721.80
Mass of Drum + Sample (oven dried)	1706.80
Mass of sample (oven dried):	515.80
Moisture Content of Sample:	2.91

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1671.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1636.2	Start:	21.2
Mass of sample (oven dried):	445.2	Finish:	21.1
Moisture Content of Sample:	7.86	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1578.0	Water Temp:	
Mass of Drum + Sample (oven dried)	1541.5	Start:	19.7
Mass of sample (oven dried):	350.50	Finish:	20.1
Moisture Content of Sample:	10.41	Time:	10:00:00

Slake Durability Index:	67.95
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-40
Project No:	W-15-012	Sample ID:	HQ-28 (140.5 - 141.1)
Date:	7/9/2018	Technician:	Nick Calendine

Sample Description: Shale, gray, unweathered, soft, flat bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1190.90
Mass of Drum + Sample (wet)	1736.60
Mass of Drum + Sample (oven dried)	1718.20
Mass of sample (oven dried):	527.30
Moisture Content of Sample:	3.49

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1681.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1658	Start:	21.8
Mass of sample (oven dried):	467.1	Finish:	21.8
Moisture Content of Sample:	5.12	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1572.6	Water Temp:	
Mass of Drum + Sample (oven dried)	1538.9	Start:	20.1
Mass of sample (oven dried):	348.00	Finish:	20.4
Moisture Content of Sample:	9.68	Time:	10:00:00

Slake Durability Index:	66.00
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-40
Project No:	W-15-012	Sample ID:	HQ-30 (154.3 - 155)
Date:	7/9/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, moderately hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (3) Mass of Drum:	1256.90
Mass of Drum + Sample (wet)	1767.40
Mass of Drum + Sample (oven dried)	1753.10
Mass of sample (oven dried):	496.20
Moisture Content of Sample:	2.88

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1768.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1752.2	Start:	21.8
Mass of sample (oven dried):	495.3	Finish:	21.7
Moisture Content of Sample:	3.27	Time:	10:00:00

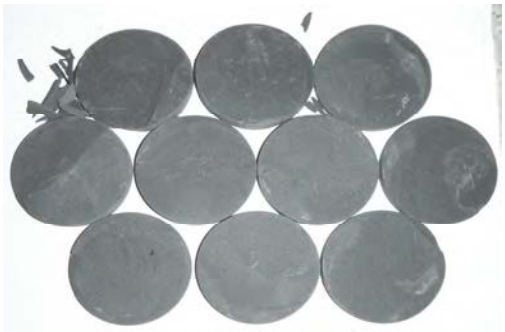
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1767.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1751.2	Start:	20.2
Mass of sample (oven dried):	494.30	Finish:	20.3
Moisture Content of Sample:	3.38	Time:	10:00:00

Slake Durability Index:	99.62
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-40
Project No:	W-15-012	Sample ID:	HQ-33 (167.6-168.5')
Date:	7/23/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, moderately hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (1) Mass of Drum:	1192.00
Mass of Drum + Sample (wet)	1708.60
Mass of Drum + Sample (oven dried)	1694.70
Mass of sample (oven dried):	502.70
Moisture Content of Sample:	2.77

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1710.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1693.4	Start:	20.9
Mass of sample (oven dried):	501.4	Finish:	20.8
Moisture Content of Sample:	3.41	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1709.7	Water Temp:	
Mass of Drum + Sample (oven dried)	1690.5	Start:	20.2
Mass of sample (oven dried):	498.50	Finish:	20.4
Moisture Content of Sample:	3.85	Time:	10:00:00

Slake Durability Index:	99.16
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-41
Project No:	W-15-012	Sample ID:	HQ-32 (167.5'-168.5')
Date:	7/12/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, moderately hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (4) Mass of Drum:	1256.90
Mass of Drum + Sample (wet)	1788.60
Mass of Drum + Sample (oven dried)	1775.70
Mass of sample (oven dried):	518.80
Moisture Content of Sample:	2.49

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1791	Water Temp:	
Mass of Drum + Sample (oven dried)	1773.4	Start:	21.2
Mass of sample (oven dried):	516.5	Finish:	21.0
Moisture Content of Sample:	3.41	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1789.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1771.3	Start:	19.7
Mass of sample (oven dried):	514.40	Finish:	20.0
Moisture Content of Sample:	3.50	Time:	10:00:00

Slake Durability Index:	99.15
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2 | Boring No. B-42
Project No: W-15-012 | Sample ID: NQ-18 (172.6-173.7')
Date: 5/16/2018 | Technician: C.Straub
Sample Description: Black Shale, moderately hard to soft, unweathered, thin bedded, mod. to slightly fract.

Initial Moisture Content:

Drum/Container ID: 4 Mass of Drum:	1256.90
Mass of Drum + Sample (wet)	1801.60
Mass of Drum + Sample (oven dried)	1791.00
Mass of sample (oven dried):	534.10
Moisture Content of Sample:	1.98

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1805.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1788.8	Start:	24.0
Mass of sample (oven dried):	531.9	Finish:	23.9
Moisture Content of Sample:	3.10	Time:	10:00:13

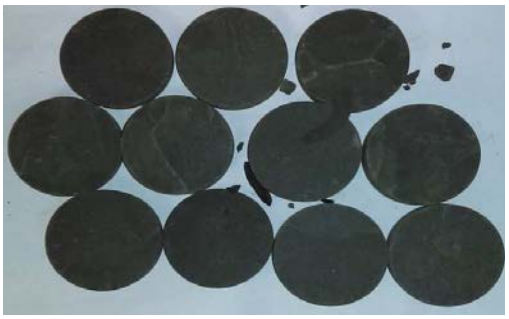
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1800.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1786.4	Start:	23.5
Mass of sample (oven dried):	529.50	Finish:	23.4
Moisture Content of Sample:	2.74	Time:	10:00:02

Slake Durability Index:	99.14
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2
Project No: W-15-012
Date: 5/21/2018
Boring No. B-43
Sample ID: HQ-21 (169.7-170.8')
Technician: C.Straub
Sample Description: Black Shale, slightly to mod. weathered, mod. hard, thin bedded, mod. to highly fract.

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1191.60
Mass of Drum + Sample (wet)	1686.80
Mass of Drum + Sample (oven dried)	1680.50
Mass of sample (oven dried):	488.90
Moisture Content of Sample:	1.29

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1692.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1676.7	Start:	22.6
Mass of sample (oven dried):	485.1	Finish:	22.6
Moisture Content of Sample:	3.24	Time:	10:00:07

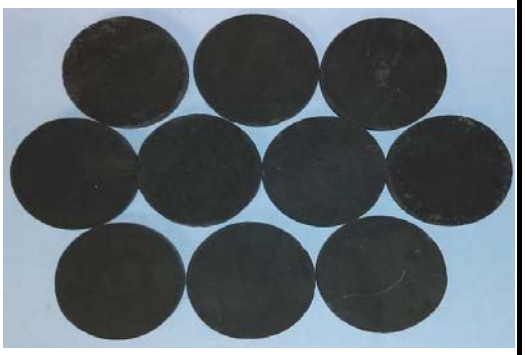
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1686.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1673.5	Start:	22.1
Mass of sample (oven dried):	481.90	Finish:	22.0
Moisture Content of Sample:	2.76	Time:	10:00:33

Slake Durability Index:	98.57
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project: Big Walnut Sanitary Trunk Ext.PH2
Boring No. B-44
Project No: W-15-012
Sample ID: NQ-19 (168.6-169.8')
Date: 5/21/2018
Technician: C.Straub
Sample Description: Dark gray and black Shale, unweathered, soft to mod. hard, thin bedded, mod. fract.

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1190.60
Mass of Drum + Sample (wet)	1734.40
Mass of Drum + Sample (oven dried)	1719.60
Mass of sample (oven dried):	529.00
Moisture Content of Sample:	2.80

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1733.9	Water Temp:	
Mass of Drum + Sample (oven dried)	1716.7	Start:	22.9
Mass of sample (oven dried):	526.1	Finish:	22.8
Moisture Content of Sample:	3.27	Time:	10:00:07

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1728.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1715	Start:	22.2
Mass of sample (oven dried):	524.40	Finish:	22.1
Moisture Content of Sample:	2.56	Time:	10:00:33

Slake Durability Index:	99.13
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-45
Project No:	W-15-012	Sample ID:	HQ-5 (149.5'-150.3')
Date:	7/23/2018	Technician:	Nick Calendine

Sample Description: Shale, dark gray to black, slightly weathered, moderately hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (2) Mass of Drum:	1191.00
Mass of Drum + Sample (wet)	1745.50
Mass of Drum + Sample (oven dried)	1734.50
Mass of sample (oven dried):	543.50
Moisture Content of Sample:	2.02

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1744.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1716.1	Start:	21
Mass of sample (oven dried):	525.1	Finish:	20.9
Moisture Content of Sample:	5.41	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1735.4	Water Temp:	
Mass of Drum + Sample (oven dried)	1697	Start:	20.4
Mass of sample (oven dried):	506.00	Finish:	20.6
Moisture Content of Sample:	7.59	Time:	10:00:00

Slake Durability Index:	93.10
Type	Type II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-46
Project No:	W-15-012	Sample ID:	HQ-20 (146.8'-147.5')
Date:	7/23/2018	Technician:	Nick Calendine

Sample Description: Shale, black, unweathered, soft to mod. hard, thin bedded.

Initial Moisture Content:

Drum/Container ID: (4) Mass of Drum:	1256.90
Mass of Drum + Sample (wet)	1798.50
Mass of Drum + Sample (oven dried)	1783.70
Mass of sample (oven dried):	526.80
Moisture Content of Sample:	2.81

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1803.1	Water Temp:	
Mass of Drum + Sample (oven dried)	1782.4	Start:	21
Mass of sample (oven dried):	525.5	Finish:	20.8
Moisture Content of Sample:	3.94	Time:	10:00:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1804.5	Water Temp:	
Mass of Drum + Sample (oven dried)	1778.1	Start:	20.3
Mass of sample (oven dried):	521.20	Finish:	20.5
Moisture Content of Sample:	5.07	Time:	10:00:00

Slake Durability Index:	98.94
Type	Type I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-47
Project No:	W-15-012	Sample ID:	HQ-19 96.2' - 96.9'
Date:	7/2/2019	Technician:	K. Sarven

Sample Description: Shale interbedded with sandstone and siltstone (Berea Sandstone/Bedford Shale)

Initial Moisture Content:

Drum/Container ID:	Mass of Drum:	1191.40
Mass of Drum + Sample (wet)		1733.90
Mass of Drum + Sample (oven dried)		1713.70
Mass of sample (oven dried):		522.30
Moisture Content of Sample:		3.87

Data After 1st Cycle:

		Water Temp:	
Mass of Drum + Sample (wet)	1718.8		
Mass of Drum + Sample (oven dried)	1700.3	Start:	24
Mass of sample (oven dried):	508.9	Finish:	24.4
Moisture Content of Sample:	3.64	Time:	9:59:00

Data After 2nd Cycle:

		Water Temp:	
Mass of Drum + Sample (wet)	1671.7		
Mass of Drum + Sample (oven dried)	1651	Start:	20.9
Mass of sample (oven dried):	459.60	Finish:	20.9
Moisture Content of Sample:	4.50	Time:	9:59:00

Slake Durability Index:	88.00
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-47
Project No:	W-15-012	Sample ID:	HQ-28 / 144.7' - 145.3'
Date:	7/2/2019	Technician:	K. Sarven
Sample Description:	Shale, dark gray (Bedford Shale)		

Initial Moisture Content:

Drum/Container ID:	Mass of Drum:	1190.70
Mass of Drum + Sample (wet)		1704.40
Mass of Drum + Sample (oven dried)		1690.20
Mass of sample (oven dried):		499.50
Moisture Content of Sample:		2.84

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1649.8	Water Temp:	
Mass of Drum + Sample (oven dried)	1630.6	Start:	24.1
Mass of sample (oven dried):	439.9	Finish:	24.4
Moisture Content of Sample:	4.36	Time:	9:59:00

Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1561.3	Water Temp:	
Mass of Drum + Sample (oven dried)	1536.4	Start:	21.1
Mass of sample (oven dried):	345.70	Finish:	21.1
Moisture Content of Sample:	7.20	Time:	9:59:00

Slake Durability Index:	69.21
Type	II

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	Big Walnut	Boring No.	B-47
Project No:	W-15-012	Sample ID:	HQ-34 / 169.3' - 170.0'
Date:	7/2/2019	Technician:	K. Sarven
Sample Description:	Shale, black (Ohio Shale)		

Initial Moisture Content:

Drum/Container ID:	Mass of Drum:	1256.80
Mass of Drum + Sample (wet)		1782.80
Mass of Drum + Sample (oven dried)		1769.90
Mass of sample (oven dried):		513.10
Moisture Content of Sample:		2.51

Data After 1st Cycle:

		Water Temp:	
Mass of Drum + Sample (wet)	1778.5		
Mass of Drum + Sample (oven dried)	1768.8	Start:	24.1
Mass of sample (oven dried):	512	Finish:	24.4
Moisture Content of Sample:	1.89	Time:	10:00:00

Data After 2nd Cycle:

		Water Temp:	
Mass of Drum + Sample (wet)	1781.4		
Mass of Drum + Sample (oven dried)	1765.7	Start:	21.3
Mass of sample (oven dried):	508.90	Finish:	21.3
Moisture Content of Sample:	3.09	Time:	10:00:00

Slake Durability Index:	99.18
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

J.5 POINT LOAD LABORATORY RESULTS

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, blue to blueish gray, unweathered, soft, laminated to thin bedded.

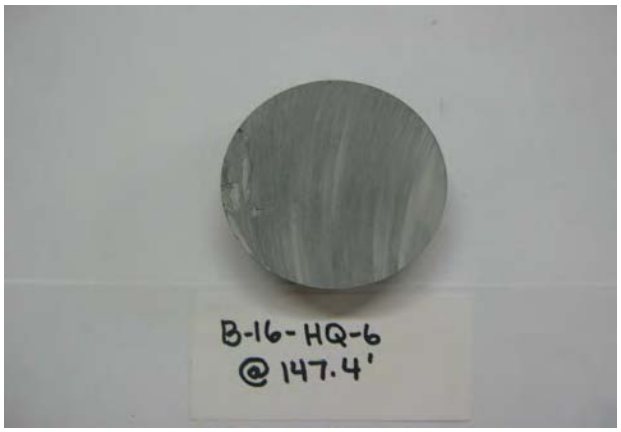
Boring No.:	B-16	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-6	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	147.4	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.95	60.90	60.92	60.92
Length: ("D")	24.09	24.25	24.19	24.18

Measurements:

"D"	24.18			
"W"	60.92	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	3870			
F (correction factor):	1.20			
Is:	**0.70**	MPa	**101.11**	psi
Is(50):	**0.83**	MPa	**120.99**	psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, blue to blueish gray, unweathered, soft, laminated to thin bedded.

Boring No.:	B-16	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-6	Direction of Loading:	Diametral (Parallel)
Depth (ft):	147.2	Moisture condition:	As received
Source of sample:	Drilled		

Diameter:("D")	60.85	60.86	60.86	60.86
Length: ("2 L")	61.72	61.80	61.84	61.79

Measurements:

"D", mm:	60.86			
"L", mm:	30.89	(L>0.5D)		
De^2:	3704			
De:	60.86			
Failure Load (N):	1935			
F (correction factor):	1.09			
	1.09			
Is:	**0.52**	MPa	**75.78**	psi
Is(50):	**0.57**	MPa	**82.78**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, laminated to thin bedded.

Boring No.:	B-16	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-7	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	155.3	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	60.91	60.89	60.88	60.89
		Length: ("D")	23.95	24.21	24.3	24.15

Measurements:

"D"	24.15		
"W"	60.89	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3860		
F (correction factor):	1.20		
Is:	**0.70**	MPa	**100.85** psi
Is(50):	**0.83**	MPa	**120.68** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, laminated to thin bedded.

Boring No.:	B-16	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-7	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	155.0	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	60.87	60.85	60.81	60.84
		Length: ("2 L")	62.29	62.21	62.32	62.27

Measurements:

"D", mm:	60.84		
"L", mm:	31.14	(L>0.5D)	
De^2:	3702		
De:	60.84		
Failure Load (N):	570		
F (correction factor):	1.09		
	1.09		
Is:	**0.15**	MPa	**22.33** psi
Is(50):	**0.17**	MPa	**24.39** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Bluish-gray Shale, soft, slightly weathered, flat bedded, fresh rock.

Boring No.: B-18
Sample No: NQ-12
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	150.8	48.0	25.9	10595	1,585	39.8	0.90	6.69	6.03
2	d ∥	150.4	NA	48.0	2785	2,307	48.0	0.98	1.21	1.19

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Bluish-gray Shale, soft, slightly weathered, flat bedded, fresh rock.

Boring No.:	B-18	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-12	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	150.8	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	48	48.05	48.06	48.04
		Length: ("D")	26.02	25.88	25.83	25.91

Measurements:

"D"	25.91		
"W"	48.04	(0.3W<D<W)	
De^2:	1585		
De:	39.81		
A:	1245		
Failure Load (N):	10595		
F (correction factor):	0.90		
Is:	**6.69**	MPa	**969.69** psi
Is(50):	**6.03**	MPa	**875.15** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Bluish-gray Shale, soft, slightly weathered, flat bedded, fresh rock.

Boring No.:	B-18	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-12	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	150.4	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	48.02	48.05	48.01	48.03
		Length: ("2 L")	109.92	109.94	109.95	109.94

Measurements:

"D", mm:	48.03	
"L", mm:	54.97	(L>0.5D)
De^2:	2307	
De:	48.03	
Failure Load (N):	2785	
F (correction factor):	0.98	

Is:	**1.21**	MPa	**175.12**	psi
Is(50):	**1.19**	MPa	**171.98**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, slightly weathered, laminated, fresh rock.

Boring No.: B-18
Sample No: NQ-13
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	160.4	48.2	25.4	4090	1,558	39.5	0.90	2.63	2.36
2	d ∥	160.8	NA	48.4	560	2,346	48.4	0.99	0.24	0.24

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, slightly weathered, laminated, fresh rock.

Boring No.:	B-18	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-13	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	160.4	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	48.19	48.21	48.2	48.20
		Length: ("D")	25.35	25.43	25.32	25.37

Measurements:

"D"	25.37		
"W"	48.20	(0.3W<D<W)	
De^2:	1557		
De:	39.46		
A:	1223		
Failure Load (N):	4090		
F (correction factor):	0.90		
Is:	**2.63**	MPa	**381.05** psi
Is(50):	**2.36**	MPa	**342.53** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, slightly weathered, laminated, fresh rock.

Boring No.:	B-18	Test Apparatus:	Forney-LA 0080				
Sample No:	NQ-13	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	160.8	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	48.42	48.45	48.43	48.43	
		Length: ("2 L")	78.64	78.65	78.62	78.64	

Measurements:

"D", mm:	48.43	
"L", mm:	39.32	(L>0.5D)
De^2:	2346	
De:	48.43	
Failure Load (N):	560	
F (correction factor):	0.99	

Is:	**0.24**	MPa	**34.62**	psi
Is(50):	**0.24**	MPa	**34.13**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, moderately hard to hard, thin bedded.

Boring No.:	B-19	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-18	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	149.9	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	59.73	59.79	59.77	59.76
		Length: ("D")	20.97	20.98	20.97	20.97

Measurements:

"D"	20.97		
"W"	59.76	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3945		
F (correction factor):	1.20		
Is:	**0.71**	MPa	**103.07** psi
Is(50):	**0.85**	MPa	**123.33** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, moderately hard to hard, thin bedded.

Boring No.:	B-19	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-18	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	149.6	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	59.26	59.29	59.27	59.27
		Length: ("2 L")	59.31	59.38	59.36	59.35

Measurements:

"D", mm:	59.27		
"L", mm:	29.68	(L>0.5D)	
De^2:	3513		
De:	59.27		
Failure Load (N):	225		
F (correction factor):	1.08		
	1.08		
Is:	**0.06**	MPa	**9.29** psi
Is(50):	**0.07**	MPa	**10.03** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

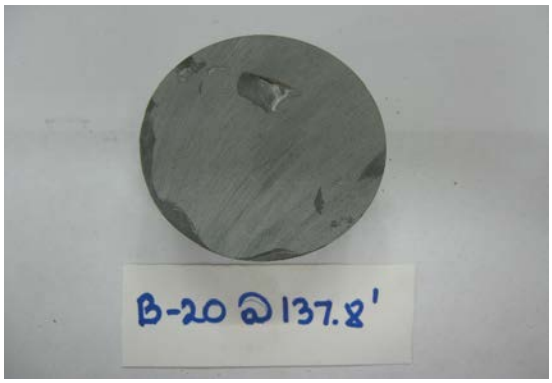
Rock Description: Gray Shale, soft, unweathered, thin bedded, flat bedded, moderately fractured.

Boring No.:	B-20	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-13	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	137.8	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	61.11	61.08	61.12	61.10	
		Length: ("D")	74.51	74.58	74.49	74.53	

Measurements:

"D"	74.53			
"W"	61.10	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	2565			
F (correction factor):	1.20			
Is:	**0.46**	MPa	**67.01**	psi
Is(50):	**0.55**	MPa	**80.19**	psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Gray Shale, soft, unweathered, thin bedded, flat bedded, moderately fractured.

Boring No.:	B-20	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-13	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	137.5	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	61.11	61.08	61.12	61.10	
		Length: ("2 L")	74.51	74.58	74.49	74.53	

Measurements:

"D", mm:	61.10		
"L", mm:	37.26	(L>0.5D)	
De^2:	3734		
De:	61.10		
Failure Load (N):	1285		
F (correction factor):	1.09		
	1.09		
Is:	**0.34**	MPa	**49.92** psi
Is(50):	**0.38**	MPa	**54.63** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, thin bedded, flat bedded, moderately fractured.

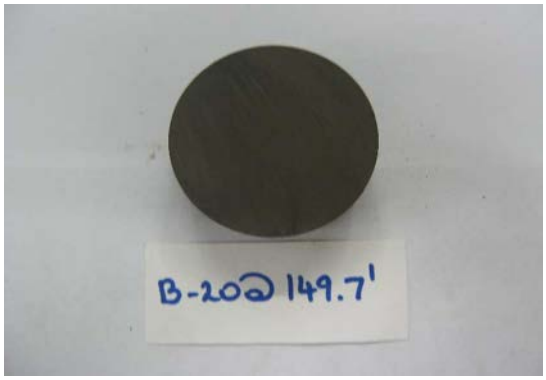
Boring No.:	B-20	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-15	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	149.7	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.98	60.99	60.91	60.96
Length: ("D")	29.24	29.34	29.3	29.29

Measurements:

"D"	29.29		
"W"	60.96	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	4320		
F (correction factor):	1.20		
Is:	**0.78**	MPa	**112.87** psi
Is(50):	**0.93**	MPa	**135.06** psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, thin bedded, flat bedded, moderately fractured.

Boring No.:	B-20
Sample No:	HQ-15
Depth (ft):	150.1
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	60.98	60.99	60.91	60.96
Length: ("2 L")	93.59	93.41	93.61	93.54

Measurements:

"D", mm:	60.96	
"L", mm:	46.77	(L>0.5D)
De^2:	3716	
De:	60.96	
Failure Load (N):	3770	
F (correction factor):	1.09	

Is:	**1.01**	MPa	**147.14**	psi
Is(50):	**1.11**	MPa	**160.87**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, hard, thin bedded.

Boring No.:	B-21	Test Apparatus:	Forney-LA 0080				
Sample No:	NQ-10	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	161.8	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	50.18	50.17	50.1	50.15	
		Length: ("D")	25.28	25.23	25.31	25.27	

Measurements:

"D"	25.27		
"W"	50.15	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	5660		
F (correction factor):	1.20		
Is:	**1.02**	MPa	**147.88** psi
Is(50):	**1.22**	MPa	**176.95** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, hard, thin bedded.

Boring No.:	B-21	Test Apparatus:	Forney-LA 0080				
Sample No:	NQ-10	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	161.5	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	50.12	50.17	50.13	50.14	
		Length: ("2 L")	68.49	69.14	68.52	68.72	

Measurements:

"D", mm:	50.14			
"L", mm:	34.36	(L>0.5D)		
De^2:	2514			
De:	50.14			
Failure Load (N):	940			
F (correction factor):	1.00			
	1.00			
Is:	**0.37**	MPa	**54.23**	psi
Is(50):	**0.37**	MPa	**54.30**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/8/2019
Test Performed by: EM/KL

Rock Description: Ohio Shale, black, unweathered, medium hard to hard, pyritic.

Boring No.:	B-21B	Test Apparatus:	Forney-LA 0080
Sample No:	RC-5	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	157.9	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	93.28	92.93	91.88	92.70
Length: ("D")	46.47	47.35	43.35	45.72

Measurements:

"D"	45.72		
"W"	92.70	(0.3W<D<W)	
De^2:	5396		
De:	73.46		
A:	4238		
Failure Load (N):	3520		
F (correction factor):	1.19		
Is:	**0.65**	MPa	**94.60** psi
Is(50):	**0.78**	MPa	**112.49** psi

Before Test

After Test

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/8/2019
Test Performed by: EM/KL

Rock Description: Ohio Shale, black, unweathered, medium hard to hard, pyritic.

Boring No.:	B-21B	Test Apparatus:	Forney-LA 0080
Sample No:	RC-5	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	158.1	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	93.67	92.42	92.97	93.02
Length: ("D")	45.46	46.18	43.65	45.10

Measurements:

"D"	45.10			
"W"	93.02	(0.3W<D<W)		
De^2:	5341			
De:	73.08			
A:	4195			
Failure Load (N):	3240			
F (correction factor):	1.19			
Is:	**0.61**	MPa	**87.98**	psi
Is(50):	**0.72**	MPa	**104.37**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/8/2019
Test Performed by: EM/KL

Rock Description: Ohio Shale, black, unweathered, medium hard to hard, pyritic.

Boring No.:	B-21B
Sample No:	RC-5
Depth (ft):	159.9
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Axial (Perpendicular)			
Moisture condition:	As received			
Diameter: ("W")	93.63	94.62	93.35	93.87
Length: ("D")	48.15	47.89	48.15	48.06

Measurements:

"D"	48.06			
"W"	93.87	(0.3W<D<W)		
De^2:	5744			
De:	75.79			
A:	4512			
Failure Load (N):	3770			
F (correction factor):	1.21			
Is:	**0.66**	MPa	**95.19**	psi
Is(50):	**0.79**	MPa	**114.78**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/8/2019
Test Performed by: EM/KL

Rock Description: Ohio Shale, black, unweathered, medium hard to hard, pyritic.

Boring No.:	B-21B	Test Apparatus:	Forney-LA 0080
Sample No:	RC-5	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	161.9	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	93.75	93.62	92.93	93.43
Length: ("D")	46.04	46.40	47.48	46.64

Measurements:

"D"	46.64			
"W"	93.43	(0.3W<D<W)		
De^2:	5548			
De:	74.49			
A:	4358			
Failure Load (N):	4070			
F (correction factor):	1.20			
Is:	**0.73**	MPa	**106.39**	psi
Is(50):	**0.88**	MPa	**127.29**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, moderately to highly weathered, soft to moderately hard, thin bedded.

Boring No.:	B-22	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-5	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	154.1	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	57.00	56.96	56.9	56.95
Length: ("D")	25.09	24.41	24.36	24.62

Measurements:

"D"	24.62		
"W"	56.95	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3865		
F (correction factor):	1.20		
Is:	**0.70**	MPa	**100.98** psi
Is(50):	**0.83**	MPa	**120.83** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, moderately to highly weathered, soft to moderately hard, thin bedded.

Boring No.:	B-22	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-5	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	153.9	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	59.06	59.07	58.93	59.02
		Length: ("2 L")	71.36	71.42	71.4	71.39

Measurements:

"D", mm:	59.02		
"L", mm:	35.70	(L>0.5D)	
De^2:	3483		
De:	59.02		
Failure Load (N):	730		
F (correction factor):	1.08		
	1.08		
Is:	**0.21**	MPa	**30.40** psi
Is(50):	**0.23**	MPa	**32.75** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Gray Shale, soft to moderately hard, slightly to mod. weathered, thin bedded.

Boring No.: B-23
Sample No: HQ-10
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	155.0	58.1	29.0	9485	2,150	46.4	0.97	4.41	4.26
2	d ∥	154.7	NA	55.1	5005	3,037	55.1	1.04	1.65	1.72

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

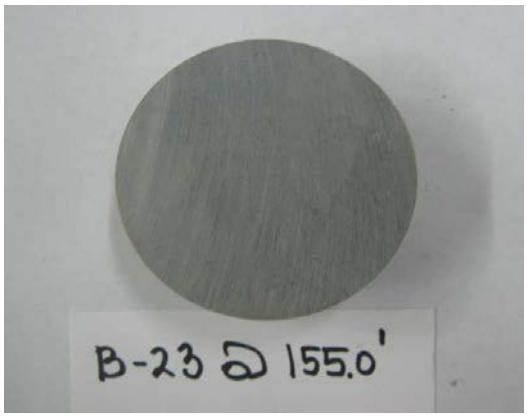
Rock Description: Gray Shale, soft to moderately hard, slightly to mod. weathered, thin bedded.

Boring No.:	B-23	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-10	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	155.0	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	58.16	58.16	58.09	58.14	
		Length: ("D")	29.03	29.06	29.04	29.04	

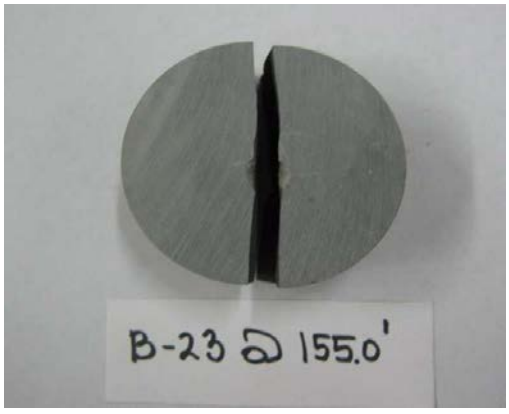
Measurements:

"D"	29.04			
"W"	58.14	(0.3W<D<W)		
De^2:	2150			
De:	46.37			
A:	1688			
Failure Load (N):	9485			
F (correction factor):	0.97			
Is:	**4.41**	MPa	**639.90**	psi
Is(50):	**4.26**	MPa	**618.54**	psi

Before Test



After Test



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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Gray Shale, soft to moderately hard, slightly to mod. weathered, thin bedded.

Boring No.:	B-23	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-10	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	154.7	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	55.01	55.17	55.16	55.11
		Length: ("2 L")	58.57	58.62	58.61	58.60

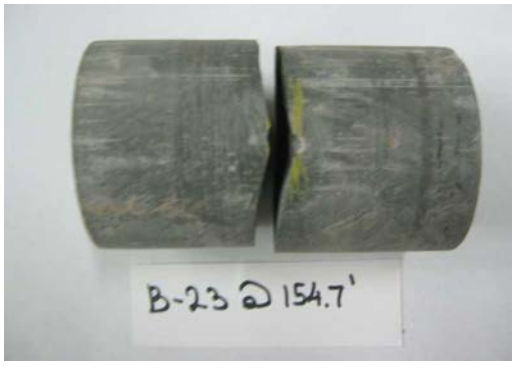
Measurements:

"D", mm:	55.11	
"L", mm:	29.30	(L>0.5D)
De^2:	3037	
De:	55.11	
Failure Load (N):	5005	
F (correction factor):	1.04	

Is:	**1.65**	MPa	**238.99**	psi
Is(50):	**1.72**	MPa	**249.69**	psi

Before Test

After Test



REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Dark gray Shale, moderately hard, slightly to mod. weathered, thin bedded.

Boring No.: B-23
Sample No: HQ-13
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	168.9	55.8	29.4	10195	2,090	45.7	0.96	4.88	4.68
2	d ∥	169.5	NA	55.1	1380	3,037	55.1	1.04	0.45	0.47

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Dark gray Shale, moderately hard, slightly to mod. weathered, thin bedded.

Boring No.:	B-23	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-13	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	168.9	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	55.82	55.80	55.86	55.83	
		Length: ("D")	29.39	29.54	29.29	29.41	

Measurements:

"D"	29.41			
"W"	55.83	(0.3W<D<W)		
De^2:	2090			
De:	45.72			
A:	1642			
Failure Load (N):	10195			
F (correction factor):	0.96			
Is:	**4.88**	MPa	**707.41**	psi
Is(50):	**4.68**	MPa	**679.48**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - PH 2
Project No.: W-15-012
Date of Testing: 4/23/2018
Test Performed by: E.M.

Rock Description: Dark gray Shale, moderately hard, slightly to mod. weathered, thin bedded.

Boring No.:	B-23	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-13	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	169.5	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	55.01	55.17	55.16	55.11
		Length: ("2 L")	65.61	65.62	65.59	65.61

Measurements:

"D", mm:	55.11	
"L", mm:	32.80	(L>0.5D)
De^2:	3037	
De:	55.11	
Failure Load (N):	1380	
F (correction factor):	1.04	

Is:	**0.45**	MPa	**65.89**	psi
Is(50):	**0.47**	MPa	**68.85**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, moderately to highly weathered, soft to moderately hard, thin bedded.

Boring No.:	B-24	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-15	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	160.8	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	59.91	59.96	59.98	59.95
		Length: ("D")	24.95	24.98	24.97	24.97

Measurements:

"D"	24.97		
"W"	59.95	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	7090		
F (correction factor):	1.20		
Is:	**1.28**	MPa	**185.24** psi
Is(50):	**1.53**	MPa	**221.66** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, moderately to highly weathered, soft to moderately hard, thin bedded.

Boring No.:	B-24	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-15	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	160.5	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	59.92	59.93	59.91	59.92
		Length: ("2 L")	63.92	63.93	63.98	63.94

Measurements:

"D", mm:	59.92		
"L", mm:	31.97	(L>0.5D)	
De^2:	3590		
De:	59.92		
Failure Load (N):	750		
F (correction factor):	1.08		
	1.08		
Is:	**0.21**	MPa	**30.30** psi
Is(50):	**0.23**	MPa	**32.87** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, moderately hard, thin bedded.

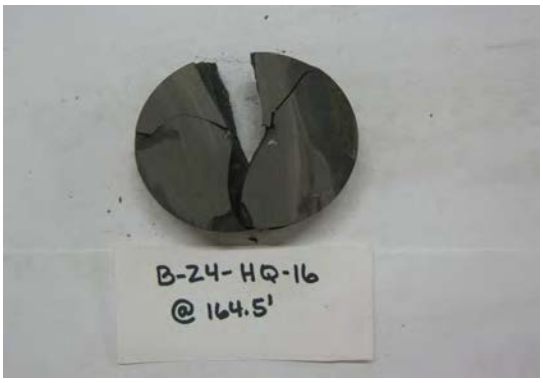
Boring No.:	B-24	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-16	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	164.5	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	59.7	59.65	59.77	59.71	
		Length: ("D")	22.4	21.06	21.36	21.61	

Measurements:

"D"	21.61			
"W"	59.71	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	1890			
F (correction factor):	1.20			
Is:	**0.34**	MPa	**49.38**	psi
Is(50):	**0.41**	MPa	**59.09**	psi

Before Test

After Test



REMARKS: **No intact specimen available for Diametral Test.**

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2

Project No.: W-15-012

Date of Testing: 5/21/2018

Test Performed by: E.M.

Rock Description: Gray Shale, slightly weathered, moderately hard, thin bedded, unfractured to slightly fractured.

Boring No.: B-27

Sample No: NQ-16

Moisture condition: As received

Test Apparatus: Forney-LA 0080

Serial Number: A125/AZ/0014

Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	161.2	50.0	25.8	1820	1,640	40.5	0.91	1.11	1.01
2	d ∥	160.9	NA	50.1	410	2,507	50.1	1.00	0.16	0.16

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Gray Shale, slightly weathered, moderately hard, thin bedded, unfractured to slightly fractured.

Boring No.:	B-27	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-16	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	161.2	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	50.01	49.98	49.98	49.99
		Length: ("D")	25.76	25.81	25.74	25.77

Measurements:

"D"	25.77		
"W"	49.99	(0.3W<D<W)	
De^2:	1640		
De:	40.50		
A:	1288		
Failure Load (N):	1820		
F (correction factor):	0.91		
Is:	**1.11**	MPa	**160.93** psi
Is(50):	**1.01**	MPa	**146.37** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Gray Shale, slightly weathered, moderately hard, thin bedded, unfractured to slightly fractured.

Boring No.:	B-27
Sample No:	NQ-16
Depth (ft):	160.9
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	50.03	50.08	50.1	50.07
Length: ("2 L")	53.34	53.41	53.38	53.38

Measurements:

"D", mm:	50.07	
"L", mm:	26.69	(L>0.5D)
De^2:	2507	
De:	50.07	
Failure Load (N):	410	
F (correction factor):	1.00	

Is:	**0.16**	MPa	**23.72**	psi
Is(50):	**0.16**	MPa	**23.73**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2

Project No.: W-15-012

Date of Testing: 5/21/2018

Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, unfractured to slighty fractured.

Boring No.: B-27

Sample No: NQ-17

Moisture condition: As received

Test Apparatus: Forney-LA 0080

Serial Number: A125/AZ/0014

Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	174.5	50.5	25.1	4450	1,614	40.2	0.91	2.76	2.50
2	d ∥	174.2	NA	50.7	610	2,569	50.7	1.01	0.24	0.24

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks: _____

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, unfractured to slighty fractured.

Boring No.:	B-27	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-17	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	174.5	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	50.51	50.57	50.49	50.52
		Length: ("D")	25.35	24.93	24.97	25.08

Measurements:

"D"	25.08			
"W"	50.52	(0.3W<D<W)		
De^2:	1614			
De:	40.17			
A:	1267			
Failure Load (N):	4450			
F (correction factor):	0.91			
Is:	**2.76**	MPa	**399.99**	psi
Is(50):	**2.50**	MPa	**362.47**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, unfractured to slighty fractured.

Boring No.:	B-27	Test Apparatus:	Forney-LA 0080				
Sample No:	NQ-17	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	174.2	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	50.72	50.69	50.64	50.68	
		Length: ("2 L")	56.02	56.12	56.08	56.07	

Measurements:

"D", mm:	50.68	
"L", mm:	28.04	(L>0.5D)
De^2:	2569	
De:	50.68	
Failure Load (N):	610	
F (correction factor):	1.01	

Is:	**0.24**	MPa	**34.44**	psi
Is(50):	**0.24**	MPa	**34.65**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, flat bedded, unfractured.

Boring No.: B-29
Sample No: NQ-18
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	170.2	50.6	26.1	3080	1,683	41.0	0.91	1.83	1.67
2	d ∥	169.9	NA	50.5	1920	2,553	50.5	1.00	0.75	0.76

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, flat bedded, unfractured.

Boring No.:	B-29	Test Apparatus:	Forney-LA 0080
Sample No:	NQ-18	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	170.2	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	50.62	50.61	50.6	50.61
Length: ("D")	26.22	26.12	26.02	26.12

Measurements:

"D"	26.12			
"W"	50.61	(0.3W<D<W)		
De^2:	1683			
De:	41.03			
A:	1322			
Failure Load (N):	3080			
F (correction factor):	0.91			
Is:	**1.83**	MPa	**265.41**	psi
Is(50):	**1.67**	MPa	**242.80**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard, thin bedded, flat bedded, unfractured.

Boring No.:	B-29
Sample No:	NQ-18
Depth (ft):	169.9
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	50.46	50.55	50.58	50.53
Length: ("2 L")	58.11	58.21	58.19	58.17

Measurements:

"D", mm:	50.53	
"L", mm:	29.09	(L>0.5D)
De^2:	2553	
De:	50.53	
Failure Load (N):	1920	
F (correction factor):	1.00	

Is:	**0.75**	MPa	**109.06**	psi
Is(50):	**0.76**	MPa	**109.58**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, laminated to thin bedded, flat bedded, unfractured.

Boring No.: B-31
Sample No: HQ-20
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	175.5	50.4	27.5	7125	1,766	42.0	0.92	4.03	3.73
2	d ∥	175.3	NA	50.3	520	2,532	50.3	1.00	0.21	0.21

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, laminated to thin bedded, flat bedded, unfractured.

Boring No.:	B-31	Test Apparatus:	Forney-LA 0080
Sample No:	NQ-20	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	175.5	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	50.44	50.38	50.42	50.41
Length: ("D")	27.56	27.46	27.51	27.51

Measurements:

"D"	27.51			
"W"	50.41	(0.3W<D<W)		
De^2:	1766			
De:	42.02			
A:	1387			
Failure Load (N):	7125			
F (correction factor):	0.92			
Is:	**4.03**	MPa	**585.22**	psi
Is(50):	**3.73**	MPa	**541.19**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, laminated to thin bedded, flat bedded, unfractured.

Boring No.:	B-31	Test Apparatus:	Forney-LA 0080
Sample No:	NQ-20	Direction of Loading:	Diametral (Parallel)
Depth (ft):	175.3	Moisture condition:	As received
Source of sample:	Drilled		

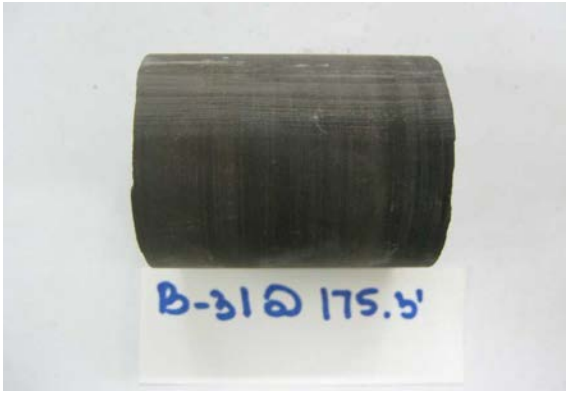
Diameter:("D")	50.36	50.28	50.32	50.32
Length: ("2 L")	59.48	59.52	59.6	59.53

Measurements:

"D", mm:	50.32	
"L", mm:	29.77	(L>0.5D)
De^2:	2532	
De:	50.32	
Failure Load (N):	520	
F (correction factor):	1.00	

Is:	**0.21**	MPa	**29.79**	psi
Is(50):	**0.21**	MPa	**29.87**	psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, thin bedded, unfractured, flat bedded.

Boring No.: B-33
Sample No: NQ-18
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	178.6	50.3	26.2	7125	1,680	41.0	0.91	4.24	3.88
2	d ∥	178.0	NA	50.3	2810	2,531	50.3	1.00	1.11	1.11

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks: _____

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, thin bedded, unfractured, flat bedded.

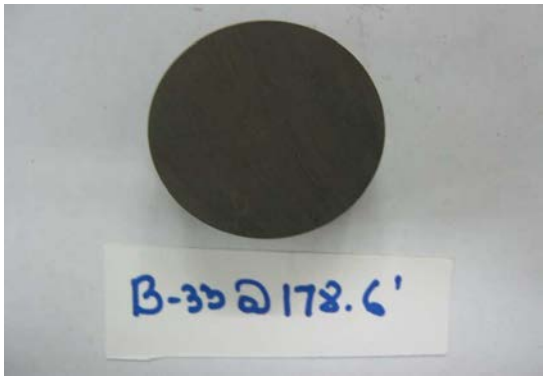
Boring No.:	B-33	Test Apparatus:	Forney-LA 0080
Sample No:	NQ-18	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	178.6	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	50.28	50.26	50.28	50.27
Length: ("D")	26.29	26.23	26.22	26.25

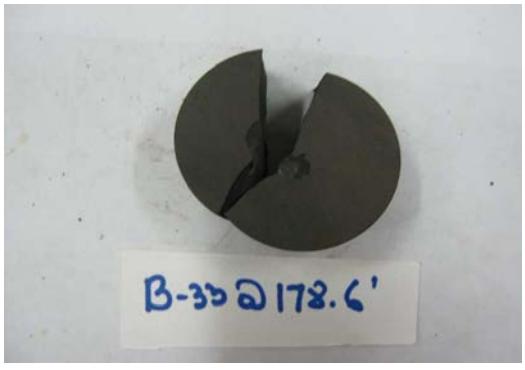
Measurements:

"D"	26.25		
"W"	50.27	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	7125		
F (correction factor):	1.20		
Is:	**1.28**	MPa	**186.15** psi
Is(50):	**1.54**	MPa	**222.75** psi

Before Test



After Test



REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, moderately hard, unweathered, thin bedded, unfractured, flat bedded.

Boring No.:	B-33
Sample No:	NQ-18
Depth (ft):	178.0
Source of sample:	Drilled

Test Apparatus: Forney-LA 0080
Direction of Loading: Diametral (Parallel)
Moisture condition: As received

Diameter:("D")	50.31	50.27	50.34	50.31
Length: ("2 L")	78.23	78.44	78.29	78.32

Measurements:

"D", mm:	50.31	
"L", mm:	39.16	(L>0.5D)
De^2:	2531	
De:	50.31	
Failure Load (N):	2810	
F (correction factor):	1.00	

Is:	**1.11**	MPa	**161.04**	psi
Is(50):	**1.11**	MPa	**161.48**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

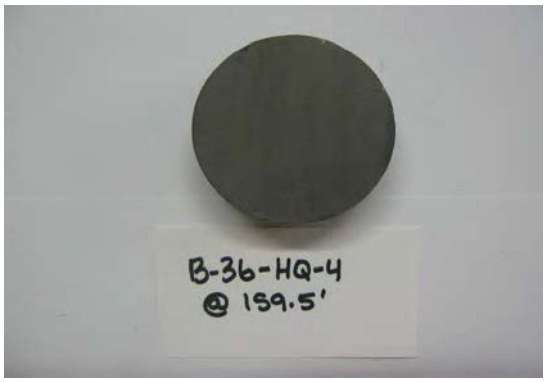
Rock Description: Shale, dark gray to black, slightly to moderately weathered, moderately hard, thin bedded.

Boring No.:	B-36	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-4	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	159.5	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	58.93	58.96	58.9	58.93	
		Length: ("D")	25.07	25.50	25.59	25.39	

Measurements:

"D"	25.39		
"W"	58.93	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3470		
F (correction factor):	1.20		
Is:	**0.63**	MPa	**90.66** psi
Is(50):	**0.75**	MPa	**108.48** psi

Before Test



After Test

REMARKS: **No intact specimen available for Diametral Test.**

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, blueish gray, unweathered to slightly weathered, soft, thin bedded.

Boring No.:	B-39	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-6	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	153.8	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	60.86	60.88	60.86	60.87
		Length: ("D")	24.83	24.85	24.87	24.85

Measurements:

"D"	24.85			
"W"	60.87	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	3930			
F (correction factor):	1.20			
Is:	**0.71**	MPa	**102.68**	psi
Is(50):	**0.85**	MPa	**122.87**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, blueish gray, unweathered to slightly weathered, soft, thin bedded.

Boring No.:	B-39	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-6	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	153.6	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	60.94	60.88	60.84	60.89	
		Length: ("2 L")	66.15	66.10	66.14	66.13	

Measurements:

"D", mm:	60.89		
"L", mm:	33.07	(L>0.5D)	
De^2:	3707		
De:	60.89		
Failure Load (N):	1395		
F (correction factor):	1.09		
	1.09		
Is:	**0.38**	MPa	**54.58** psi
Is(50):	**0.41**	MPa	**59.64** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

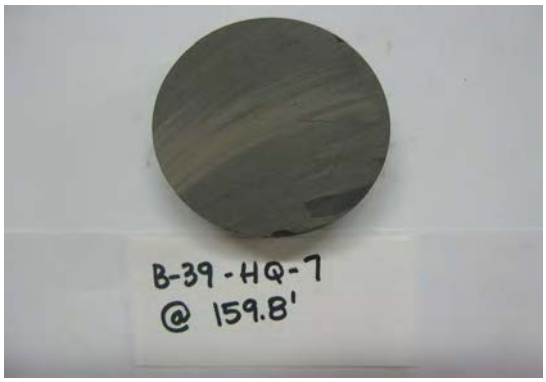
Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-39	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-7	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	159.8	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	60.92	60.94	60.92	60.93	
		Length: ("D")	24.21	24.26	24.27	24.25	

Measurements:

"D"	24.25			
"W"	60.93	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	1085			
F (correction factor):	1.20			
Is:	**0.20**	MPa	**28.35**	psi
Is(50):	**0.23**	MPa	**33.92**	psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-39	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-7	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	159.6	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	60.98	61.04	61.03	61.02
		Length: ("2 L")	75.3	75.32	75.39	75.34

Measurements:

"D", mm:	61.02		
"L", mm:	37.67	(L>0.5D)	
De^2:	3723		
De:	61.02		
Failure Load (N):	2085		
F (correction factor):	1.09		
	1.09		
Is:	**0.56**	MPa	**81.23** psi
Is(50):	**0.61**	MPa	**88.84** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Sandstone, gray, slightly to unweathered, moderately hard, medium to fine grained, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-5	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	26.3	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.66	60.73	60.72	60.70
Length: ("D")	29.25	29.20	29.19	29.21

Measurements:

"D"	29.21			
"W"	60.70	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	12035			
F (correction factor):	1.20			
Is:	**2.17**	MPa	**314.43**	psi
Is(50):	**2.59**	MPa	**376.26**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Sandstone, gray, slightly to unweathered, moderately hard, medium to fine grained, thin bedded.

Boring No.:	B-40		Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-5		Direction of Loading:	Diametral (Parallel)			
Depth (ft):	26.0		Moisture condition:	As received			
Source of sample:	Drilled		Diameter:("D")	60.77	60.74	60.81	60.77
			Length: ("2 L")	76.31	76.83	76.53	76.56

Measurements:

"D", mm:	60.77			
"L", mm:	38.28	(L>0.5D)		
De^2:	3693			
De:	60.77			
Failure Load (N):	13940			
F (correction factor):	1.09			
	1.09			
Is:	**3.77**	MPa	**547.42**	psi
Is(50):	**4.12**	MPa	**597.66**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Interbedded shale and sandstone (55%/45%); Shale, dark gray, unweathered, soft, thin bedded; Sandstone, light gray, unweathered, moderately hard, medium to fine grained, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-16	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	83.6	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	60.9	61.00	60.93	60.94
		Length: ("D")	23.99	24.07	23.98	24.01

Measurements:

"D"	24.01		
"W"	60.94	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	1390		
F (correction factor):	1.20		
Is:	**0.25**	MPa	**36.32** psi
Is(50):	**0.30**	MPa	**43.46** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Interbedded shale and sandstone (55%/45%); Shale, dark gray, unweathered, soft, thin bedded; Sandstone, light gray, unweathered, moderately hard, medium to fine grained, thin bedded.

Boring No.: B-40
Sample No: HQ-16
Depth (ft): 83.3
Source of sample: Drilled

Test Apparatus: Forney-LA 0080
Direction of Loading: Diametral (Parallel)
Moisture condition: As received

Diameter:("D")	60.12	60.06	60.05	60.08
Length: ("2 L")	61.36	60.96	61.05	61.12

Measurements:

"D", mm:	60.08		
"L", mm:	30.56	(L>0.5D)	
De^2:	3609		
De:	60.08		
Failure Load (N):	480		
F (correction factor):	1.09		
	1.09		
Is:	**0.13**	MPa	**19.29** psi
Is(50):	**0.14**	MPa	**20.95** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, red, unweathered, soft, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-22	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	112.5	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.67	60.68	60.7	60.68
Length: ("D")	23.97	23.98	23.99	23.98

Measurements:

"D"	23.98			
"W"	60.68	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	570			
F (correction factor):	1.20			
Is:	**0.10**	MPa	**14.89**	psi
Is(50):	**0.12**	MPa	**17.82**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, red, unweathered, soft, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-22	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	112.9	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	60.88	60.86	60.89	60.88
		Length: ("2 L")	65.59	65.87	65.96	65.81

Measurements:

"D", mm:	60.88		
"L", mm:	32.90	(L>0.5D)	
De^2:	3706		
De:	60.88		
Failure Load (N):	345		
F (correction factor):	1.09		
	1.09		
Is:	**0.09**	MPa	**13.50** psi
Is(50):	**0.10**	MPa	**14.75** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: 7/26/2018
Date of Testing: 5/21/2018
Test Performed by: EM/KL

Rock Description: Shale, blue with red bands, unweathered, soft, flat bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-26	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	133.1	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.88	60.90	60.91	60.90
Length: ("D")	26.7	27.21	26.78	26.90

Measurements:

"D"	26.90		
"W"	60.90	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	1000		
F (correction factor):	1.20		
Is:	**0.18**	MPa	**26.13** psi
Is(50):	**0.22**	MPa	**31.26** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, blue with red bands, unweathered, soft, flat bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-26	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	132.8	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	60.98	60.96	60.93	60.96
		Length: ("2 L")	66.17	66.20	66.1	66.16

Measurements:

"D", mm:	60.96		
"L", mm:	33.08	(L>0.5D)	
De^2:	3716		
De:	60.96		
Failure Load (N):	835		
F (correction factor):	1.09		
	1.09		
Is:	**0.22**	MPa	**32.59** psi
Is(50):	**0.25**	MPa	**35.63** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, unweathered, soft, flat bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-28	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	143.9	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	61	61.11	60.99	61.03
Length: ("D")	25.94	26.21	26.19	26.11

Measurements:

"D"	26.11			
"W"	61.03	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	1055			
F (correction factor):	1.20			
Is:	**0.19**	MPa	**27.56**	psi
Is(50):	**0.23**	MPa	**32.98**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, gray, unweathered, soft, flat bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-28	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	143.7	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	61.06	61.00	61.02	61.03
		Length: ("2 L")	61.12	61.25	61.28	61.22

Measurements:

"D", mm:	61.03		
"L", mm:	30.61	(L>0.5D)	
De^2:	3724		
De:	61.03		
Failure Load (N):	275		
F (correction factor):	1.09		
	1.09		
Is:	**0.07**	MPa	**10.71** psi
Is(50):	**0.08**	MPa	**11.71** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

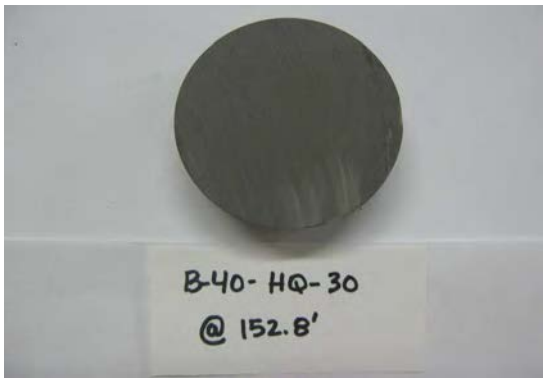
Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-30	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	152.8	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	61.05	61.06	61.02	61.04
		Length: ("D")	26.61	26.87	26.59	26.69

Measurements:

"D"	26.69		
"W"	61.04	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	2150		
F (correction factor):	1.20		
Is:	**0.39**	MPa	**56.17** psi
Is(50):	**0.46**	MPa	**67.22** psi

Before Test



After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-30	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	152.5	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	61.09	60.97	61.03	61.03
		Length: ("2 L")	65.02	64.94	64.89	64.95

Measurements:

"D", mm:	61.03		
"L", mm:	32.48	(L>0.5D)	
De^2:	3725		
De:	61.03		
Failure Load (N):	2885		
F (correction factor):	1.09		
	1.09		
Is:	**0.77**	MPa	**112.34** psi
Is(50):	**0.85**	MPa	**122.88** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-40	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-32	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	165.1	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	60.99	60.95	60.98	60.97
		Length: ("D")	28.48	28.33	28.39	28.40

Measurements:

"D"	28.40			
"W"	60.97	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	3775			
F (correction factor):	1.20			
Is:	**0.68**	MPa	**98.63**	psi
Is(50):	**0.81**	MPa	**118.02**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-40
Sample No:	HQ-32
Depth (ft):	164.8
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	61	61.05	61.03	61.03
Length: ("2 L")	81.98	81.92	82.02	81.97

Measurements:

"D", mm:	61.03		
"L", mm:	40.99	(L>0.5D)	
De^2:	3724		
De:	61.03		
Failure Load (N):	2120		
F (correction factor):	1.09		
	1.09		
Is:	**0.57**	MPa	**82.56** psi
Is(50):	**0.62**	MPa	**90.31** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.: B-41
Sample No: HQ-32
Depth (ft): 169.2
Source of sample: Drilled

Test Apparatus: Forney-LA 0080
Direction of Loading: Axial (Perpendicular)
Moisture condition: As received

Diameter: ("W")	60.82	60.84	60.83	60.83
Length: ("D")	23.39	23.37	23.38	23.38

Measurements:

"D"	23.38		
"W"	60.83	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3420		
F (correction factor):	1.20		
Is:	**0.62**	MPa	**89.35** psi
Is(50):	**0.74**	MPa	**106.92** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, moderately hard, thin bedded.

Boring No.:	B-41	Test Apparatus:	Forney-LA 0080			
Sample No:	HQ-32	Direction of Loading:	Diametral (Parallel)			
Depth (ft):	169.0	Moisture condition:	As received			
Source of sample:	Drilled	Diameter:("D")	60.88	60.81	60.89	60.86
		Length: ("2 L")	69.54	69.37	69.4	69.44

Measurements:

"D", mm:	60.86		
"L", mm:	34.72	(L>0.5D)	
De^2:	3704		
De:	60.86		
Failure Load (N):	2540		
F (correction factor):	1.09		
	1.09		
Is:	**0.69**	MPa	**99.46** psi
Is(50):	**0.75**	MPa	**108.66** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, moderately hard to soft, thin bedded, flat bedded, moderately to slightly fractured.

Boring No.: B-42
Sample No: NQ-18
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	171.9	50.3	26.8	3885	1,714	41.4	0.92	2.27	2.08
2	d ∥	171.6	NA	50.4	1020	2,540	50.4	1.00	0.40	0.40

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, mod. hard to soft, thin bedded, flat bedded, mod. to slightly fractured.

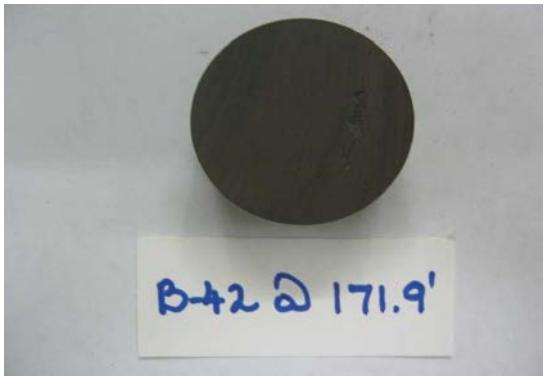
Boring No.:	B-42
Sample No:	NQ-18
Depth (ft):	171.9
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Axial (Perpendicular)			
Moisture condition:	As received			
Diameter: ("W")	50.33	50.32	50.35	50.33
Length: ("D")	26.77	26.78	26.7	26.75

Measurements:

"D"	26.75		
"W"	50.33	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	3885		
F (correction factor):	1.20		
Is:	**0.70**	MPa	**101.50** psi
Is(50):	**0.84**	MPa	**121.46** psi

Before Test



After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, unweathered, mod. hard to soft, thin bedded, flat bedded, mod. to slightly fractured.

Boring No.:	B-42
Sample No:	NQ-18
Depth (ft):	171.6
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	50.39	50.42	50.38	50.40
Length: ("2 L")	58.82	58.92	58.97	58.90

Measurements:

"D", mm:	50.40	
"L", mm:	29.45	(L>0.5D)
De^2:	2540	
De:	50.40	
Failure Load (N):	1020	
F (correction factor):	1.00	

Is:	**0.40**	MPa	**58.25**	psi
Is(50):	**0.40**	MPa	**58.46**	psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, slightly to mod. weathered, mod. hard, thin bedded, flat bedded, mod. to highly fractured.

Boring No.: B-43
Sample No: HQ-21
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	168.9	57.9	26.3	5965	1,937	44.0	0.94	3.08	2.91
2	d ∥	169.3	NA	57.5	265	3,311	57.5	1.07	0.08	0.09

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks: _____

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, slightly to mod. weathered, mod. hard, thin bedded, flat bedded, mod. to highly fractured.

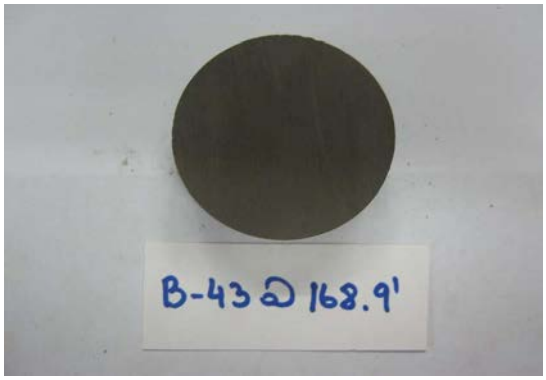
Boring No.:	B-43	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-21	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	168.9	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	57.87	57.90	57.86	57.88
Length: ("D")	26.46	26.23	26.18	26.29

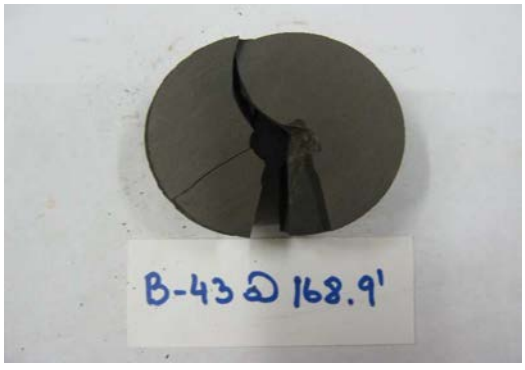
Measurements:

"D"	26.29			
"W"	57.88	(0.3W<D<W)		
De^2:	5551			
De:	74.51			
A:	4360			
Failure Load (N):	5965			
F (correction factor):	1.20			
Is:	**1.07**	MPa	**155.85**	psi
Is(50):	**1.29**	MPa	**186.49**	psi

Before Test



After Test



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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Black Shale, slightly to mod. weathered, mod. hard, thin bedded, flat bedded, mod. to highly fractured.

Boring No.:	B-43
Sample No:	HQ-21
Depth (ft):	169.3
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	57.58	57.42	57.62	57.54
Length: ("2 L")	85.85	85.74	85.46	85.68

Measurements:

"D", mm:	57.54	
"L", mm:	42.84	(L>0.5D)
De^2:	3311	
De:	57.54	
Failure Load (N):	265	
F (correction factor):	1.07	

Is:	**0.08**	MPa	**11.61**	psi
Is(50):	**0.09**	MPa	**12.37**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Dark gray and black Shale, unweathered, soft to moderately hard, thin bedded, moderately fractured.

Boring No.: B-44
Sample No: NQ-19
Moisture condition: As received

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2018

Sample No.	Test Type	Depth (ft)	Width (W) (mm)	Diameter (D) (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (Mpa)	$Is_{(50)}$ (Mpa)
1	a ⊥	168.0	50.3	25.3	2565	1,621	40.3	0.91	1.58	1.44
2	d ∥	167.6	NA	50.5	1285	2,552	50.5	1.00	0.50	0.51

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Remarks: _____

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

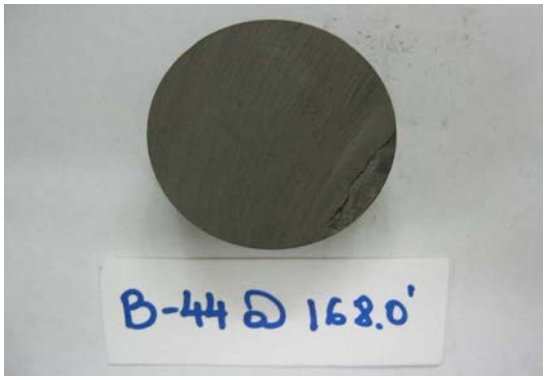
Rock Description: Dark gray and black Shale, unweathered, soft to moderately hard, thin bedded, moderately fractured.

Boring No.:	B-44	Test Apparatus:	Forney-LA 0080			
Sample No:	NQ-19	Direction of Loading:	Axial (Perpendicular)			
Depth (ft):	168.0	Moisture condition:	As received			
Source of sample:	Drilled	Diameter: ("W")	50.33	50.32	50.35	50.33
		Length: ("D")	25.33	25.28	25.29	25.30

Measurements:

"D"	25.30		
"W"	50.33	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	2565		
F (correction factor):	1.20		
Is:	**0.46**	MPa	**67.01** psi
Is(50):	**0.55**	MPa	**80.19** psi

Before Test



After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 5/21/2018
Test Performed by: E.M.

Rock Description: Dark gray and black Shale, unweathered, soft to moderately hard, thin bedded, moderately fractured.

Boring No.:	B-44
Sample No:	NQ-19
Depth (ft):	167.6
Source of sample:	Drilled

Test Apparatus:	Forney-LA 0080			
Direction of Loading:	Diametral (Parallel)			
Moisture condition:	As received			
Diameter:("D")	50.52	50.49	50.55	50.52
Length: ("2 L")	77.44	77.38	77.49	77.44

Measurements:

"D", mm:	50.52	
"L", mm:	38.72	(L>0.5D)
De^2:	2552	
De:	50.52	
Failure Load (N):	1285	
F (correction factor):	1.00	

Is:	**0.50**	MPa	**73.02**	psi
Is(50):	**0.51**	MPa	**73.36**	psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, moderately hard, thin bedded.

Boring No.:	B-45	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-5	Direction of Loading:	Axial (Perpendicular)				
Depth (ft):	150.7	Moisture condition:	As received				
Source of sample:	Drilled	Diameter: ("W")	58.65	58.73	58.7	58.69	
		Length: ("D")	21.73	21.57	21.69	21.66	

Measurements:

"D"	21.66		
"W"	58.69	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	2190		
F (correction factor):	1.20		
Is:	**0.39**	MPa	**57.22** psi
Is(50):	**0.47**	MPa	**68.47** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, dark gray to black, slightly weathered, moderately hard, thin bedded.

Boring No.:	B-45	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-5	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	150.4	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	60.93	60.94	61.01	60.96	
		Length: ("2 L")	46.95	47.05	46.97	46.99	

Measurements:

"D", mm:	60.96		
"L", mm:	23.50	(L>0.5D)	
De^2:	3716		
De:	60.96		
Failure Load (N):	530		
F (correction factor):	1.09		
	1.09		
Is:	**0.14**	MPa	**20.69** psi
Is(50):	**0.16**	MPa	**22.62** psi

Before Test

After Test

REMARKS:

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, soft to moderately hard, thin bedded.

Boring No.:	B-46	Test Apparatus:	Forney-LA 0080
Sample No:	HQ-20	Direction of Loading:	Axial (Perpendicular)
Depth (ft):	148.2	Moisture condition:	As received
Source of sample:	Drilled		

Diameter: ("W")	60.93	60.95	60.97	60.95
Length: ("D")	21.49	21.50	21.51	21.50

Measurements:

"D"	21.50		
"W"	60.95	(0.3W<D<W)	
De^2:	5551		
De:	74.51		
A:	4360		
Failure Load (N):	2070		
F (correction factor):	1.20		
Is:	**0.37**	MPa	**54.08** psi
Is(50):	**0.45**	MPa	**64.72** psi

Before Test

After Test

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Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: Big Walnut Sanitary Trunk Sewer Ext. - Phase 2
Project No.: W-15-012
Date of Testing: 7/26/2018
Test Performed by: EM/KL

Rock Description: Shale, black, unweathered, soft to moderately hard, thin bedded.

Boring No.:	B-46	Test Apparatus:	Forney-LA 0080				
Sample No:	HQ-20	Direction of Loading:	Diametral (Parallel)				
Depth (ft):	147.9	Moisture condition:	As received				
Source of sample:	Drilled	Diameter:("D")	60.92	60.95	60.97	60.95	
		Length: ("2 L")	63.31	62.95	62.97	63.08	

Measurements:

"D", mm:	60.95		
"L", mm:	31.54	(L>0.5D)	
De^2:	3714		
De:	60.95		
Failure Load (N):	235		
F (correction factor):	1.09		
	1.09		
Is:	**0.06**	MPa	**9.18** psi
Is(50):	**0.07**	MPa	**10.03** psi

Before Test

After Test

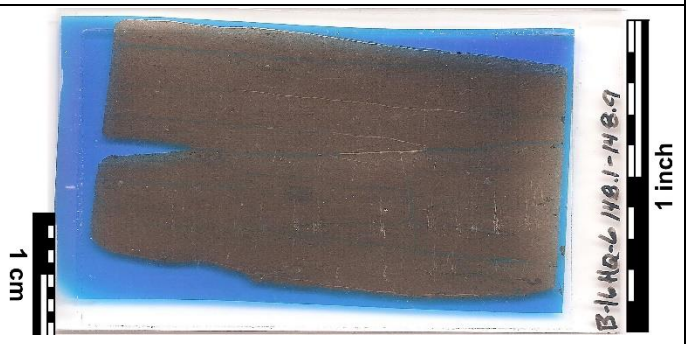
REMARKS:

J.6 PETROGRAPHY LABORATORY RESULTS

Sample: **B-16-HQ-6 @ 148.1-148.9**

Macroscopic sample description	**Medium gray pyritic shale** 70% gray color dry, 90% gray wet fissile mudstone. 4 mm average thickness between shale partings with wavy surfaces. 2-3 mm long, <0.5 mm thick pyrite concretions elongate along shale partings. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Homogenous distribution of rounded quartz silt in brown mica-clay mud matrix. Very fine-grained pyrite disseminated throughout concentrated mostly in very large aggregates.		
Constituent minerals	Quartz	46%	20% as 20-40 µm equant, rounded grains evenly disseminated throughout, remainder as finer-grained portion of mud matrix
	Muscovite	32%	60 µm detrital grains with high second-order interference, <10 µm highly birefringent component of mud matrix
	Kaolinite	17%	<1 µm first-order gray component of mud matrix
	Pyrite	4%	10 µm equant grains that form bedding-parallel aggregates up to 4 mm long
	Kerogen	1%	amorphous brown material in mud matrix, no distinct fossils
Porosity	0% intergranular porosity and <0.1% fracture porosity		
Heterogeneity	Fissile shaley parting		

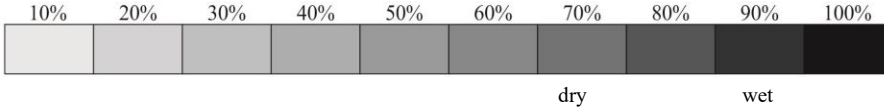
Billet of medium gray pyritic shale
Note pyrite throughout sample (e.g., arrow)



Thin section slide of medium gray pyritic shale
Faintly bedded due to slight quartz silt variations. Blue epoxy impregnation indicates <0.1% porosity – mostly along shale partings.

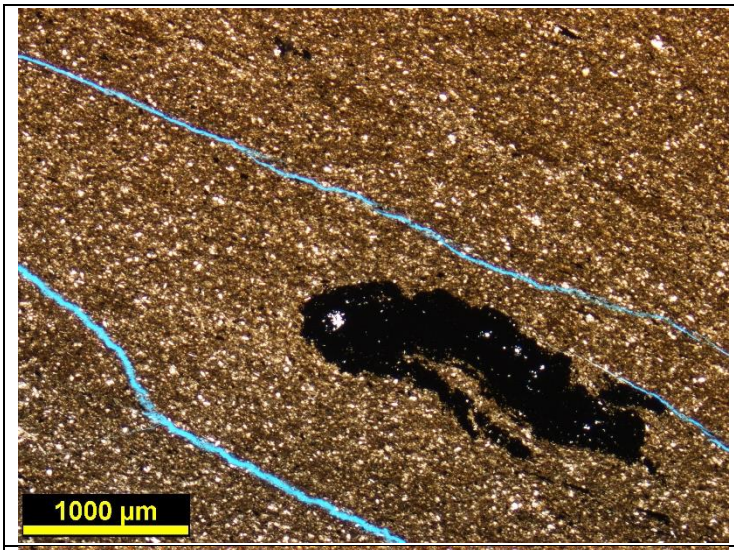
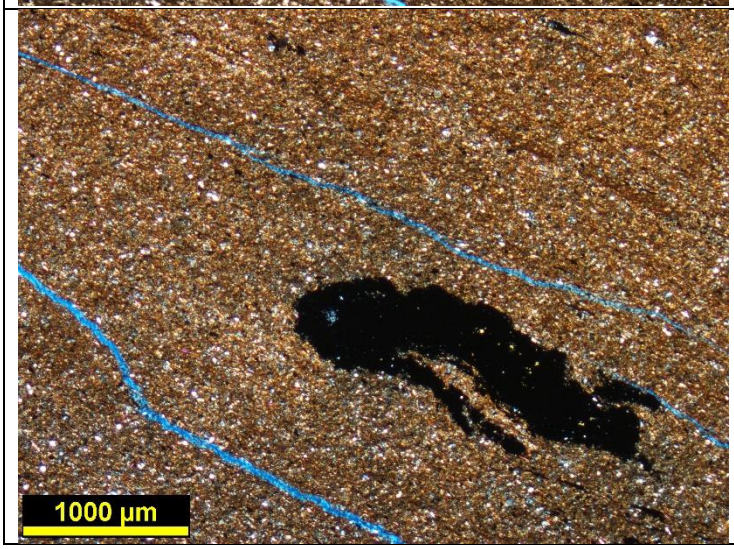
	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.7	0.8
Al_2O_3	17.0	19.6
SiO_2	58.8	67.9
P_2O_5	0.1	0.1
SO_2	1.1	1.2
K_2O	3.4	4.0
CaO	0.3	0.3
TiO_2	0.8	1.0
FeO	3.9	4.5
Total	86.5	100.0

Photograph of cut drill core of medium gray pyritic shale. Note imperfectly planar parting.



Kurt Friehauf, Ph.D., P.G. – friehauf@kutztown.edu

Sample: **B-16-HQ-6 @ 148.1-148.9**

	Plane-polarized photomicrograph of main body of sample showing mostly homogenous quartz silt (white)-mud matrix with local dark brown wisps of clay-rich material parallel to bedding. Black shape is aggregate of diagenetic pyrite. Blue epoxy fills fractures.
	Cross-polarized photomicrograph of same spot on slide documenting first-order gray interference of quartz silt (gray) and higher-order interference of micas in mud matrix.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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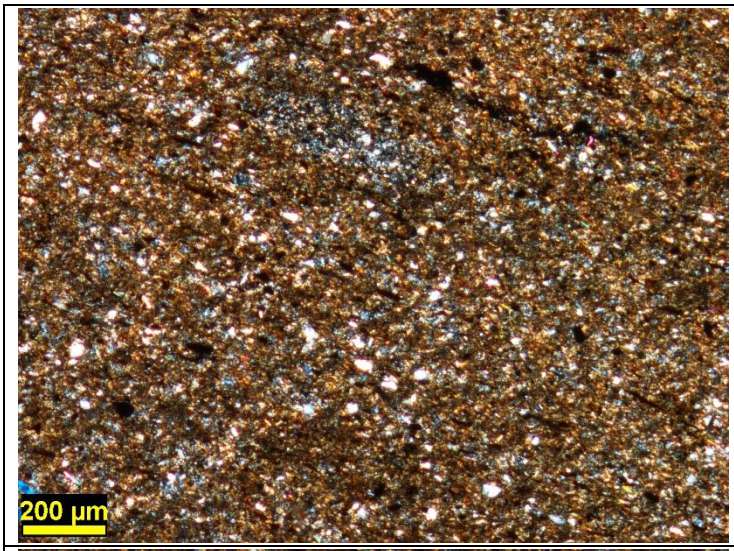
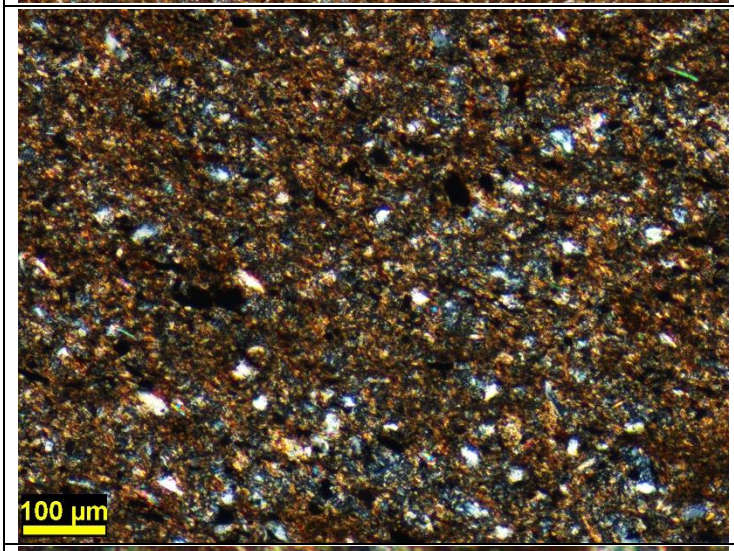
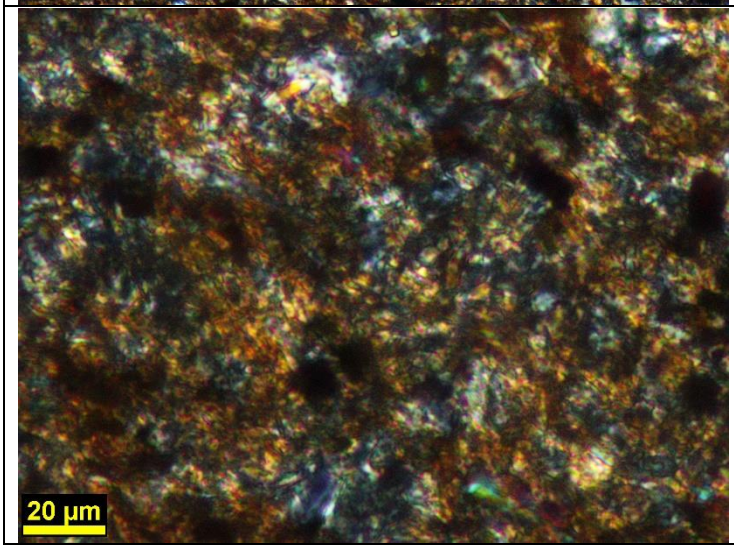
Sample: **B-16-HQ-6 @ 148.1-148.9**

	Cross-polarized photomicrograph of mudstone matrix with small quartz silt pod (top center gray). Very fine-grained pyrite disseminated throughout sample (black).
	Cross-polarized photomicrograph detailing homogenous mixture of quartz silt (equant large gray/white grains) with very fine-grained mica (brown/yellow with hints of bright colors) and clay (gray "static"). Very fine-grained disseminated opaque pyrite grains (black) throughout sample. Bright green flake at top right is detrital muscovite grain.
	Cross-polarized photomicrograph at very high magnification of mica-clay mud matrix. Clay is gray flakey material. Brown/yellow is very fine-grained mica with richer brown macerals of organic carbon.

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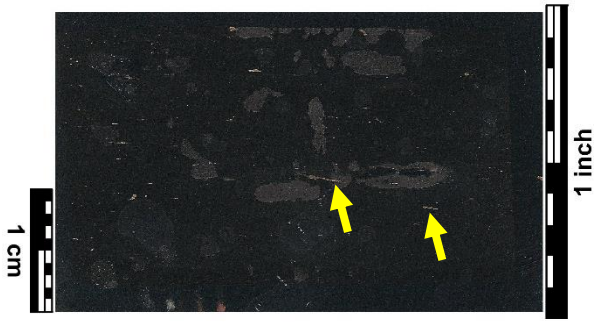
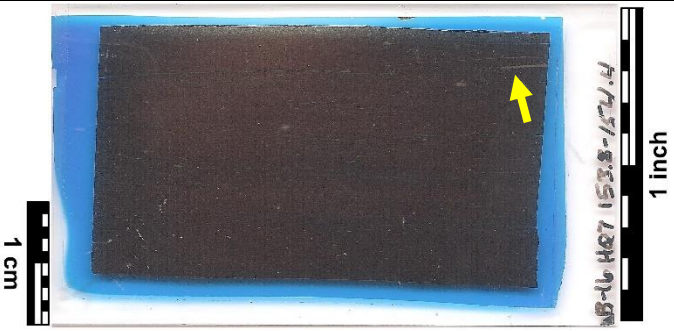
Sample: **B-16-HQ-7 @ 153.8-154.4**

Macroscopic sample description	**Medium gray pyritic shale** 70% gray color dry, 90% gray wet highly fissile mudstone. 6 mm average thickness between shale partings with planar surfaces. Sparse 1-2 mm long pyrite concentrations along shale partings seen on polished surface, but not distinct on unpolished surfaces. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Homogenous distribution of equant, irregularly-shaped quartz silt in dark brown mica-clay mud matrix. Organic carbon as wavy linear or loop-shaped yellow fossil material, red flakes, and amorphous brown kerogen in matrix. Very fine-grained pyrite primarily as mm-scale wisps along bedding.		
Constituent minerals	Quartz	44%	20% as 20-40 µm equant, irregularly-shaped grains evenly disseminated throughout, remainder as very fine-grained component in mud matrix
	Muscovite	35%	<1% 60 µm detrital grains with high second-order interference, most as <10 µm highly birefringent component of mud matrix
	Kaolinite	16%	<1 µm first-order gray component of mud matrix
	Pyrite	2%	<20 µm equant grains disseminated throughout, clustering to form 1,000 µm long x 100 µm thick aggregates along bedding
	Kerogen	3%	thin, yellow, 100 µm long wavy/loop-shaped plant fossil fragments, sparser <60µm red flakes, and amorphous brown material in mud matrix
Porosity	0% intergranular porosity and <0.1% fracture porosity		
Heterogeneity	Strongly fissile along planar shale partings		



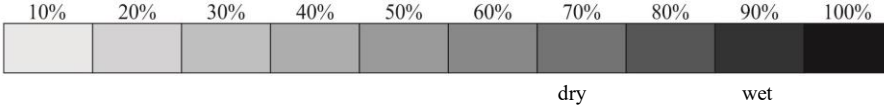
Billet of medium gray pyritic shale
Massive dark gray when wet shale. Pyrite wisps along bedding (e.g., arrow). Light gray blobs are air



Thin section slide of medium gray pyritic shale
Fissile, but massive mudstone with pyrite along partings. Blue epoxy impregnation indicates <0.1% porosity along shale partings.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.6	0.7
Al_2O_3	16.2	19.9
SiO_2	52.9	65.2
P_2O_5	0.1	0.1
SO_2	2.0	2.5
K_2O	3.4	4.2
CaO	0.2	0.3
TiO_2	0.8	1.0
FeO	4.4	5.4
Total	81.2	100.0

Photograph of cut drill core of medium gray pyritic shale. Note very planar shaley parting.



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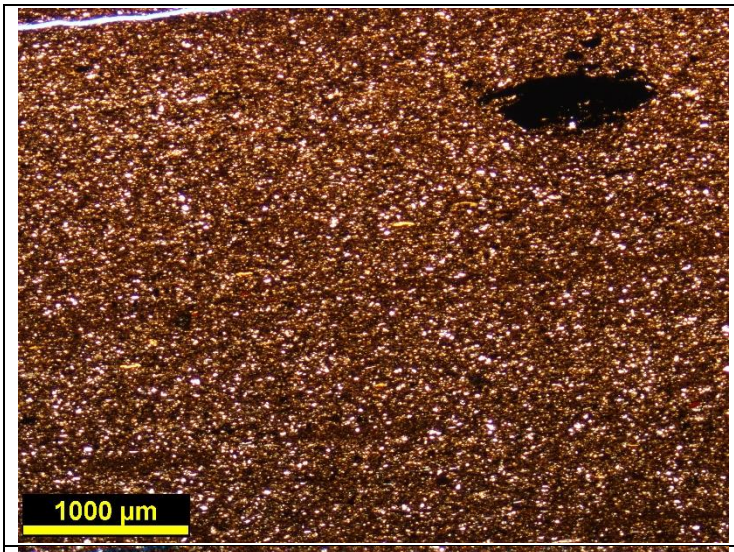
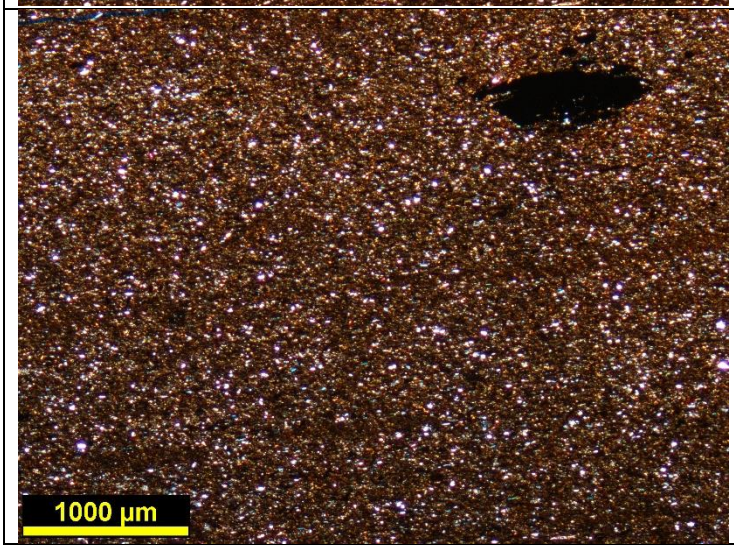
Sample: **B-16-HQ-7 @ 153.8-154.4**

	Plane-polarized photomicrograph of main body of sample documenting moderately high organic carbon content (yellow and red fragments plus rich brown in matrix). Quartz silt content (white dots) also moderately high for a shale (enough to technically classify rock as siltstone). Opaque aggregate of pyrite grains (black) near top right. Blue line at top left is epoxy-filled parting fracture.
	Cross-polarized photomicrograph of same spot on slide showing first-order interference (gray/white) in most white grains in image above, but also abundant blue, red, yellow grains of detrital muscovite.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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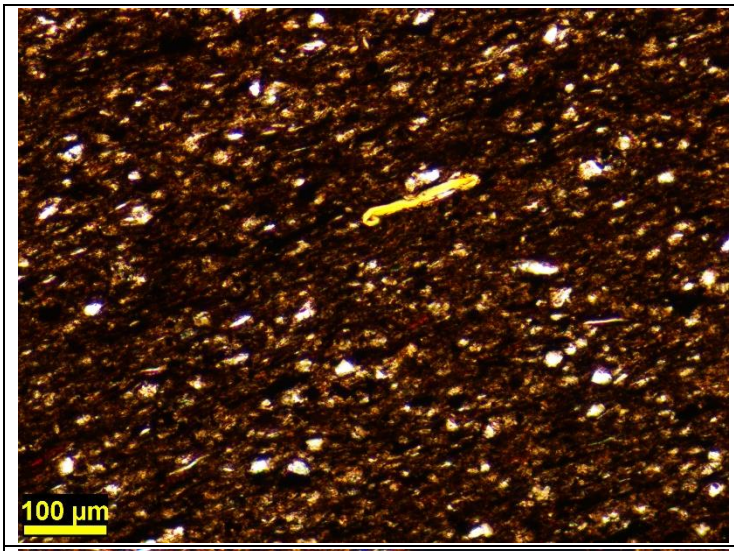
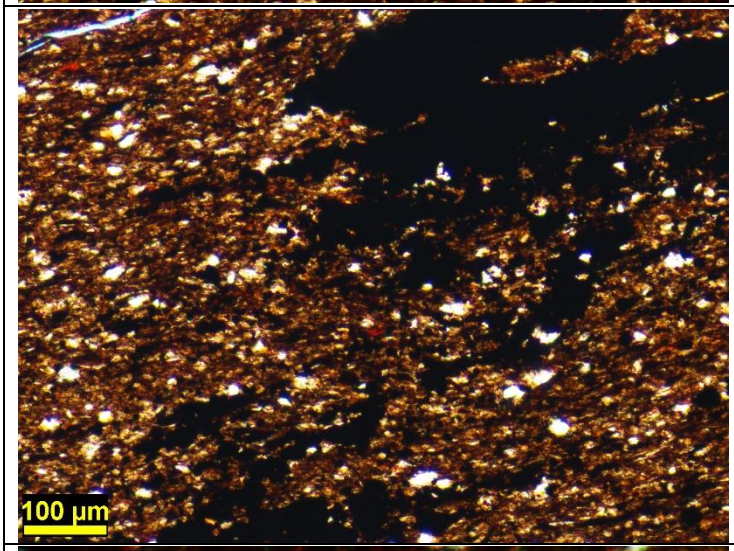
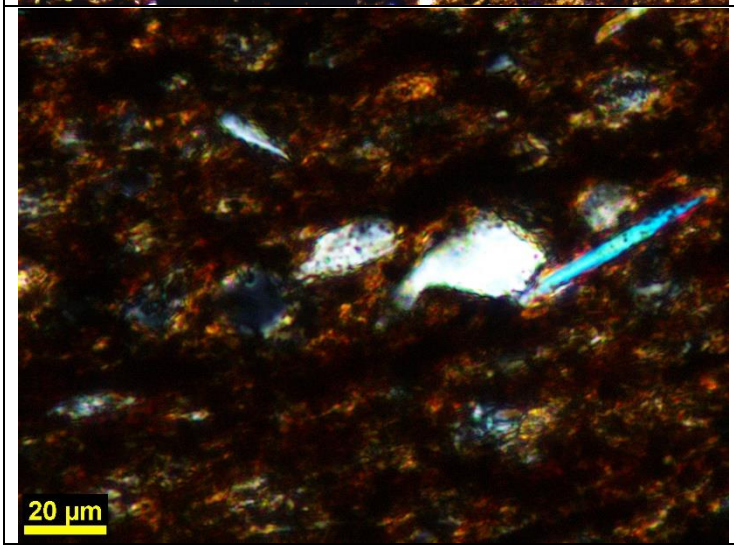
Sample: **B-16-HQ-7 @ 153.8-154.4**

	Plane-polarized photomicrograph of yellow plant leaf organic carbon maceral embedded in muddy matrix that is rich in brown kerogen. Minor red grains are also organic carbon. Equant white grains are quartz silt. Linear white grains are detrital muscovite.
	Plane-polarized photomicrograph of cluster of diagenetic pyrite grains that extend from main cluster along shaley foliation. Red flake macerals and brown amorphous kerogen-rich mud matrix do not change with proximity to pyrite aggregate. Equant white grains are quartz silt. Blue epoxy-filled fracture at top left.
	Cross-polarized photomicrograph at very high magnification of quartz silt grains (white/gray) and 50 µm detrital muscovite flake in illite-clay-kerogen-rich mud matrix too fine-grained to measure with precision.

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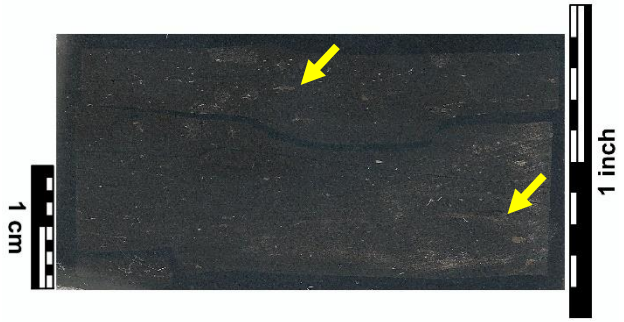
Sample: **B-19-HQ-18 @ 148.7-149.5**

Macroscopic sample description	**Medium gray pyritic shale** 80% gray color dry, 90% gray wet very highly fissile mudstone. 4 mm average thickness between shale partings with wavy surfaces. <1 mm equant disseminated pyrite and 1 mm hairline pyrite along shaley parting. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Variably rounded quartz silt in brown mica-clay mud matrix. Very fine-grained pyrite disseminated throughout concentrated mostly in very large aggregates, but also as clusters of perfectly spherical microconcretions within open spaces filled with optically-continuous quartz. Mm-long lenses of slightly darker clay-rich mud.		
Constituent minerals	Quartz	46%	20% as 20-40 µm equant, rounded grains evenly disseminated throughout, small portion as optically-continuous anhedral "cement" between spherical pyrite concretions, remainder as fine-grained material in mud matrix.
	Muscovite	35%	60 µm detrital grains with high second-order interference, <10 µm highly birefringent component of mud matrix
	Kaolinite	15%	<1 µm first-order gray component of mud matrix
	Pyrite	3%	<20 µm individual grains forming 500-1000 µm equant and bedding-parallel aggregates, two occurrences of perfectly spherical <20 µm grains formed in open space voids filled with quartz
	Kerogen	1%	amorphous brown material in mud matrix and extremely sparse yellow wavy fossil fragments
Porosity	0% intergranular porosity and <0.1% fracture porosity		
Heterogeneity	Very strongly fissile shaley parting		

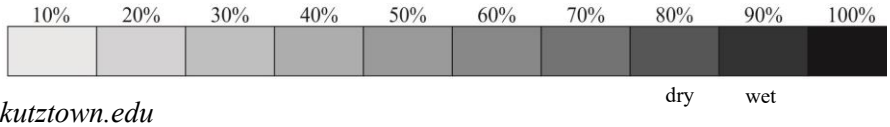


Billet of medium gray pyritic shale
Pyrite "slips" along shaley parting (e.g., arrow)

Thin section slide of medium gray pyritic shale
Homogenous fissile mudstone.
Blue epoxy impregnation indicates <0.1% porosity along shaley parting, but no visible intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.5	0.6
Al_2O_3	15.6	19.4
SiO_2	53.9	66.9
P_2O_5	0.1	0.1
SO_2	1.2	1.5
K_2O	3.4	4.2
CaO	0.2	0.3
TiO_2	0.8	1.0
FeO	4.3	5.3
Total	80.5	100.0

Photograph of cut drill core of medium gray pyritic shale. Note wavy shaley parting on upper surface. Sample breaks very easily along shaley parting.



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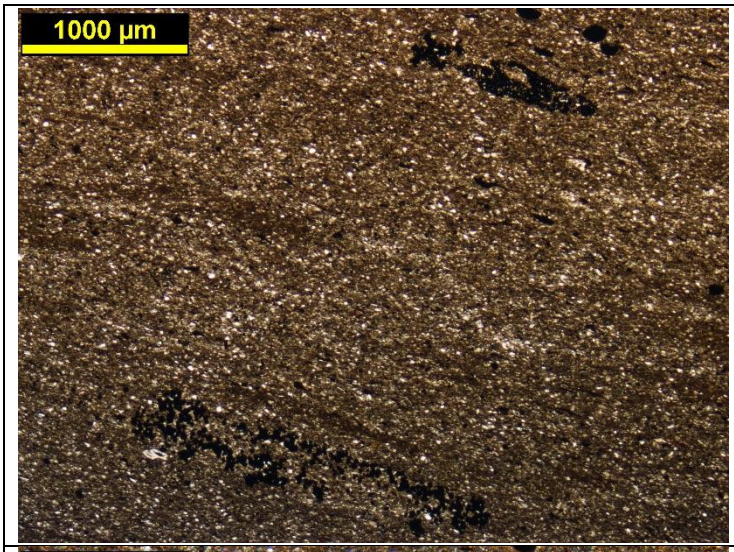
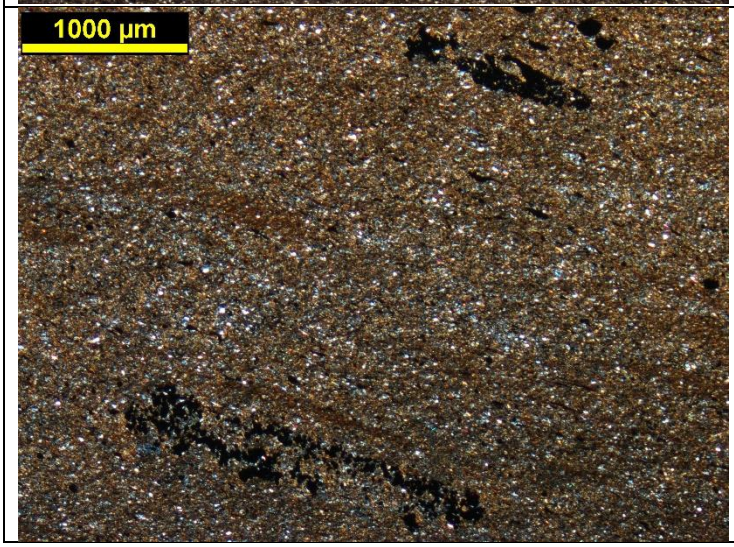
Sample: **B-19-HQ-18 @ 148.7-149.5**

	Plane-polarized photomicrograph of main body of sample documenting occurrence of diagenetic pyrite (opaque black dots near bottom of image) as clusters of very fine cubes and denser clusters possibly replacing fossil grains (black near top). Subordinate quartz silt (white dots) in clay-mica-rich mudstone matrix throughout. Slight mottling may be minor bioturbation.
	Cross-polarized photomicrograph of same spot on slide documenting first-order interference colors of quartz silt (grays) in mudstone matrix with higher-order interference micas (brown/yellow) mixed with clay.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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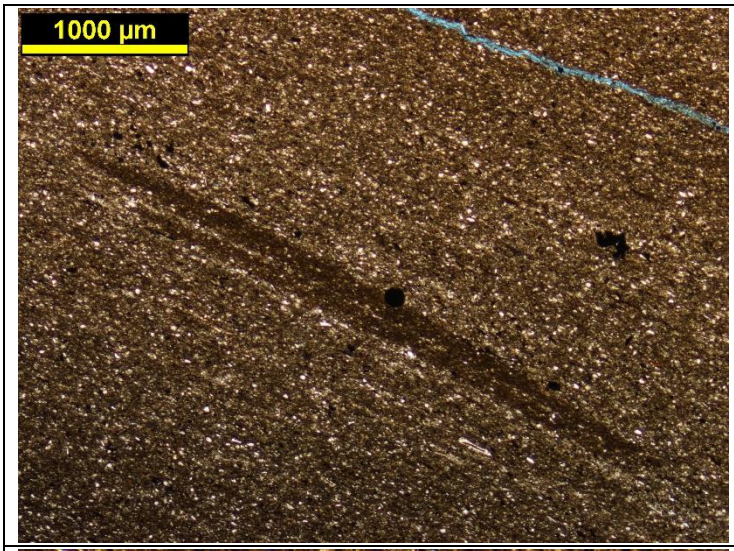
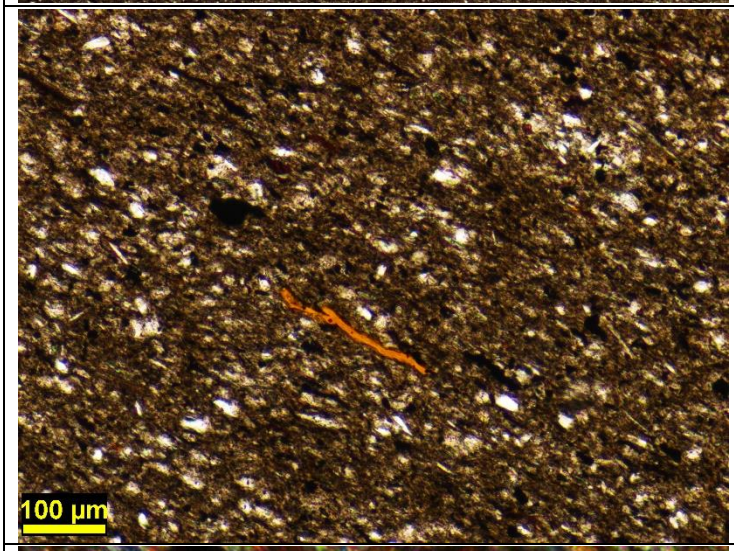
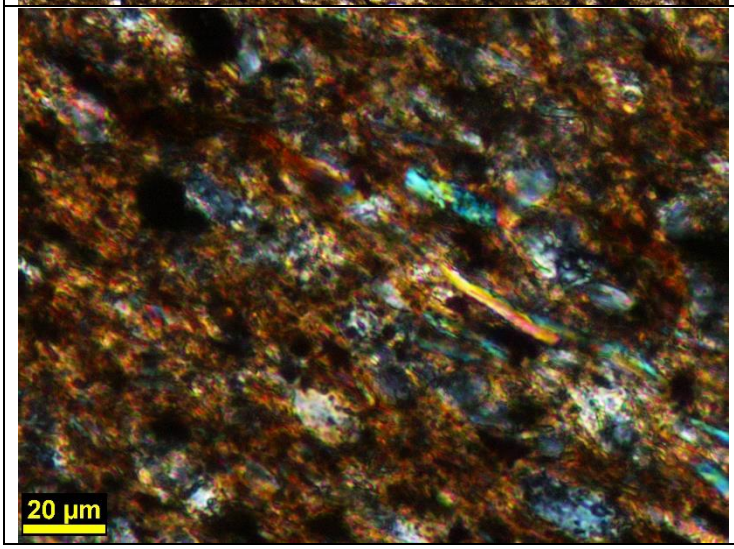
Sample: **B-19-HQ-18 @ 148.7-149.5**

	Plane-polarized photomicrograph of linear brown clay-rich streak. Smaller versions of these occur throughout the sample. Black is opaque pyrite. Blue is epoxy-filled shaley parting fracture.
	Plane-polarized photomicrograph of minor occurrence of fossil-shaped organic carbon maceral (branching orange) in silt-mud matrix. Quartz silt (round white) and detrital muscovite (linear white spines) with opaque black pyrite. Green grains are fine-grained chlorite.
	Cross-polarized photomicrograph at very high magnification of detrital muscovite (linear bright colors) and quartz silt (round gray grains) in very fine-grained clay-illite mixture (brown).

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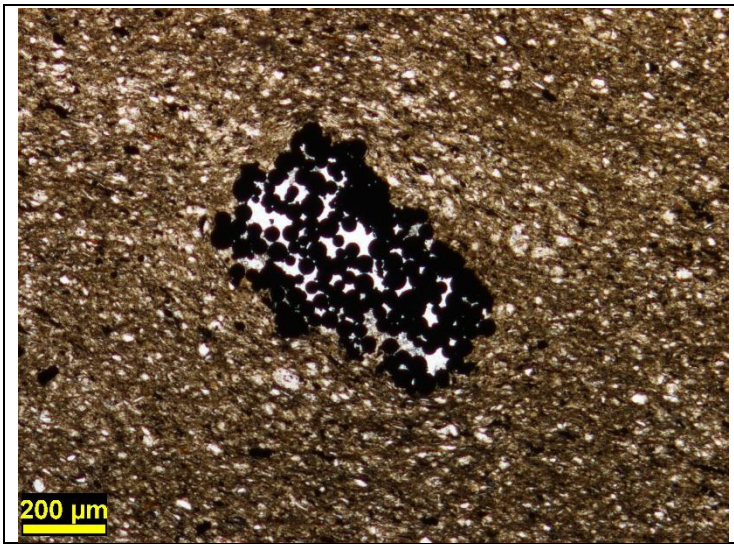
Sample: **B-19-HQ-18 @ 148.7-149.5**



Plane-polarized photomicrograph of very unusual aggregate of spherical pyrite concretions (black) formed inside rectangular hole. White material between spheres is quartz that is single, optically-continuous crystal.

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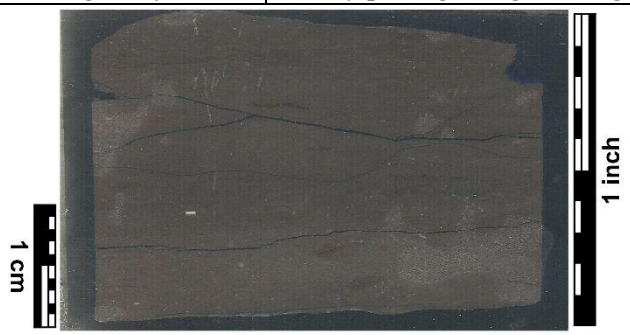
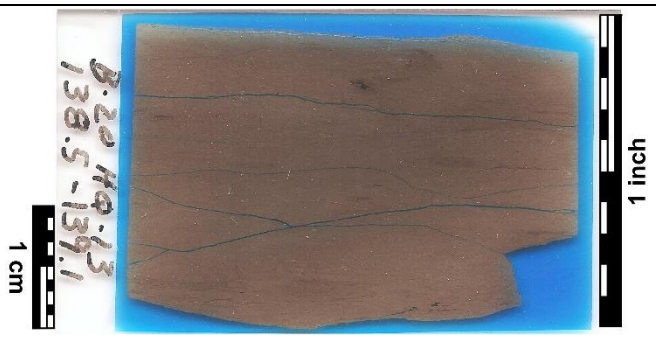
Sample: **B-20 HQ-13 @ 138.5-139.1**

Macroscopic sample description	**Gray shale** Medium-gray fissile mudstone with irregular breaks spaced 5 mm. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Quartz silt suspended in very pale brown mud matrix. Hook-shaped, rectangular hoop-shaped dark red organic carbon macerals plus finer disseminated brownish-red organic macerals plus anhedral pyrite.		
Constituent minerals	Quartz silt	4%	<30 µm equant anhedral grains suspended in mud
	Quartz mud	53%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	13%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	27%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	2%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	<1%	20 µm equant, disseminated
	Organic	1%	<150 µm macerals plus finer-grained in mud matrix
Porosity	0% observable intergranular porosity and <1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		



Billet of gray shale
Mudstone with irregular parting along bedding highlighted by blue epoxy impregnation.



Thin section slide of gray shale
Shale parts along irregular surfaces. 1 mm aggregate of very fine-grained pyrite near top center.
Blue epoxy impregnation indicates 0% observable intergranular porosity, but detectable fracture porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.6
MgO	4.1	5.3
Al_2O_3	25.8	33.2
SiO_2	39.7	51.1
P_2O_5	0.1	0.2
SO_2	1.6	2.1
K_2O	1.9	2.4
CaO	0.1	0.2
TiO_2	0.5	0.7
FeO	3.3	4.3
Total	77.7	100.0

Photograph of cut drill core of gray shale. Note irregular topography of parting surface.

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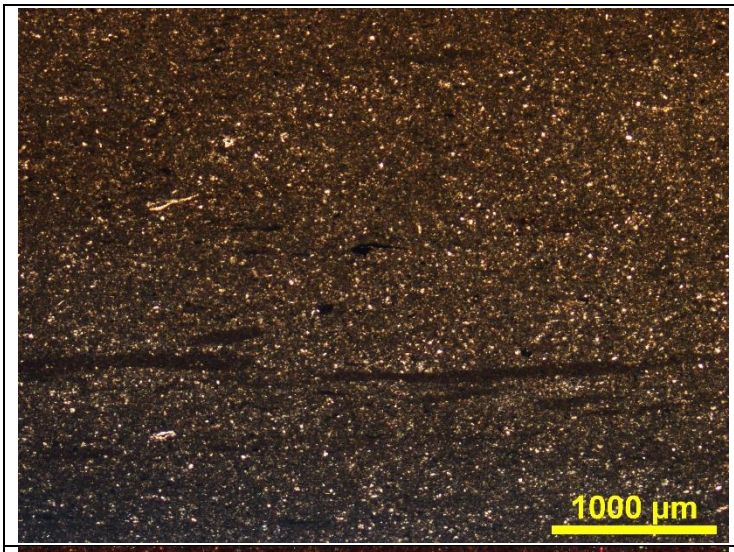
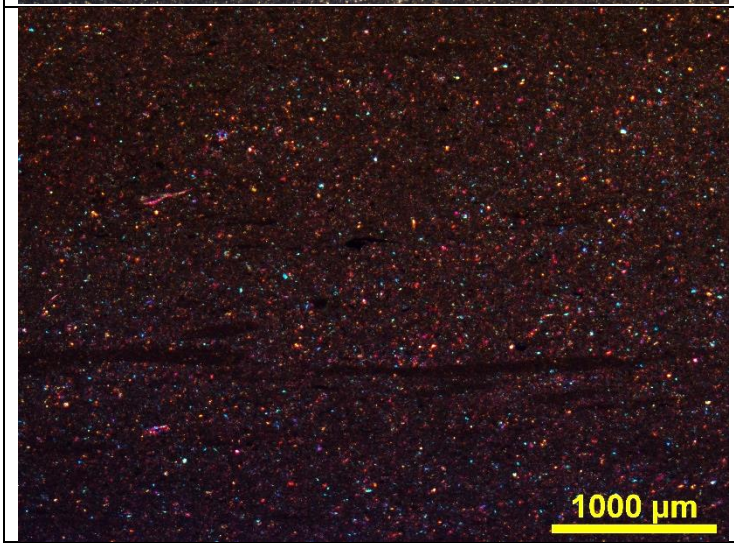
Sample: **B-20 HQ-13 @ 138.5-139.1**

	Plane-polarized photomicrograph of main body of sample documenting relative silt:clay proportions, sparse opaque grains (black), and bedding
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) documenting of same spot on slide silt grains are quartz (blues/yellows).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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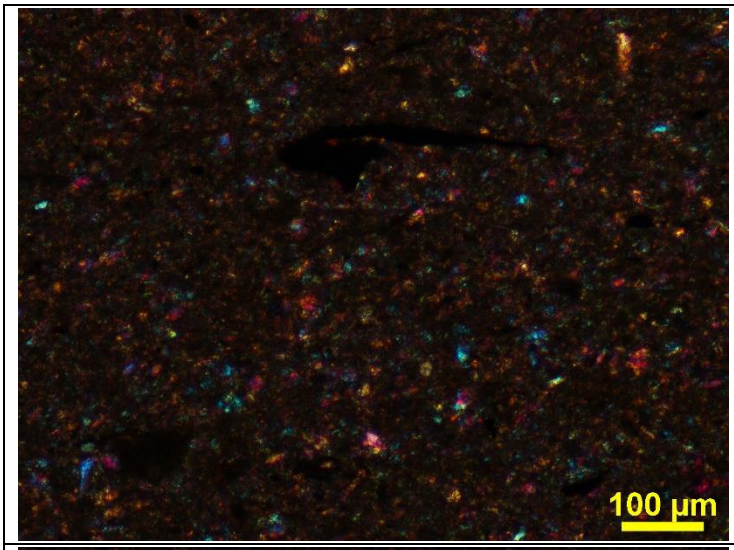
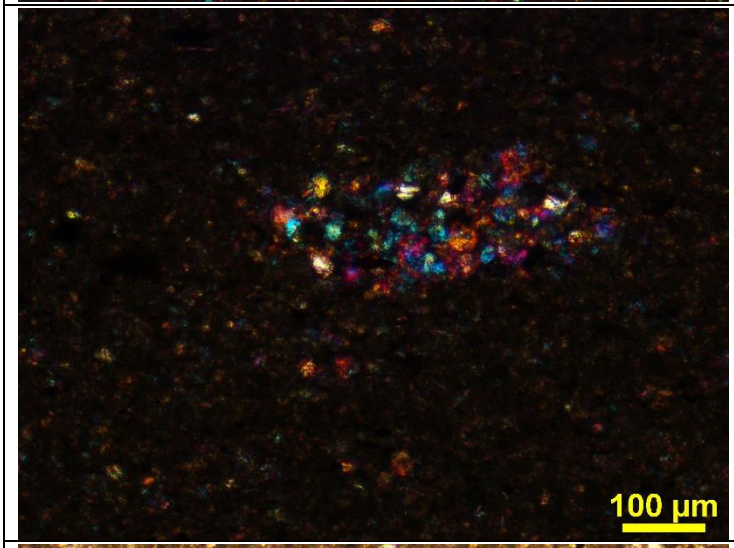
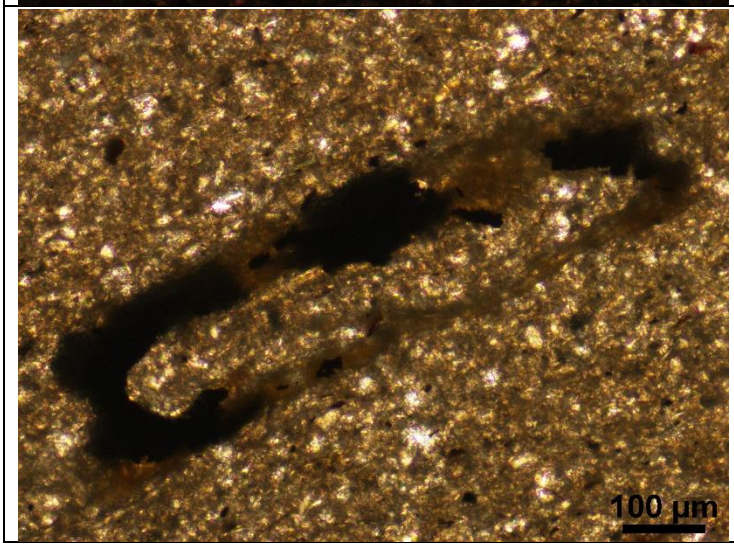
Sample: **B-20 HQ-13 @ 138.5-139.1**

	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) detailing quartz silt (blues/yellows), hook-shaped opaque organic carbon maceral and high order interference colors of fine-grained muscovite in groundmass.
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) of small quartz silt aggregate – possibly piece of sandstone deposited in original mud.
	Plane-polarized photomicrograph detailing organic carbon maceral with “biological” shape. Black may be either dense organic carbon phase or ultra-fine pyrite (too small to determine optically with unpolished sample).

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Sample: **B-20 HQ-15 @ 148.2-149.5**

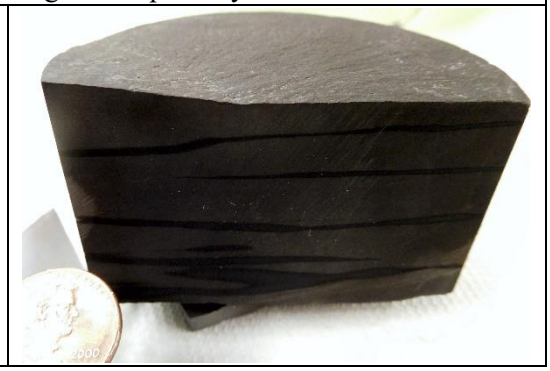
Macroscopic sample description	**Black shale** Black fissile mudstone with very planar breaks spaced 10 mm. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description:	Fine-grained mud matrix dark red-brown with fine-grained organic matter suspending disseminated quartz silt and larger bright yellow elongate hook-shaped carbon macerals (fossil leaf material?) and minor fine-grained pyrite		
Constituent minerals	Quartz silt	1%	<30 µm equant anhedral grains suspended in mud
	Quartz mud	46%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	11%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	34%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	2%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 µm equant, disseminated
	Organic	5%	100-200 µm bright yellow, isotropic macerals plus finer-grained red-brown matter in mud matrix
Porosity:	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity:	Shaley parting along bedding		

Billet of black shale
Homogeneous black mudstone. Light gray air bubble on surface.

Thin section slide of black shale
Homogeneous black mudstone with notch along shaley parting. Blue epoxy impregnation indicates 0% observable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.8
MgO	0.4	0.5
Al_2O_3	13.6	17.9
SiO_2	50.1	66.0
P_2O_5	0.0	0.1
SO_2	2.6	3.4
K_2O	3.1	4.1
CaO	0.2	0.3
TiO_2	0.7	0.9
FeO	4.6	6.1
Total	75.9	100.0

Photograph of cut drill core of black shale. Shaley parting on cut surface highlighted by soaking with water, then drying face. Note very planar breaks along parting (e.g., top surface).



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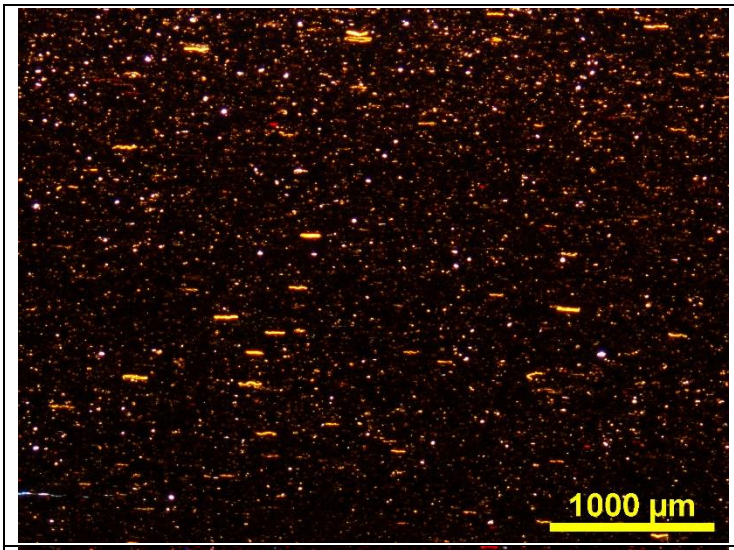
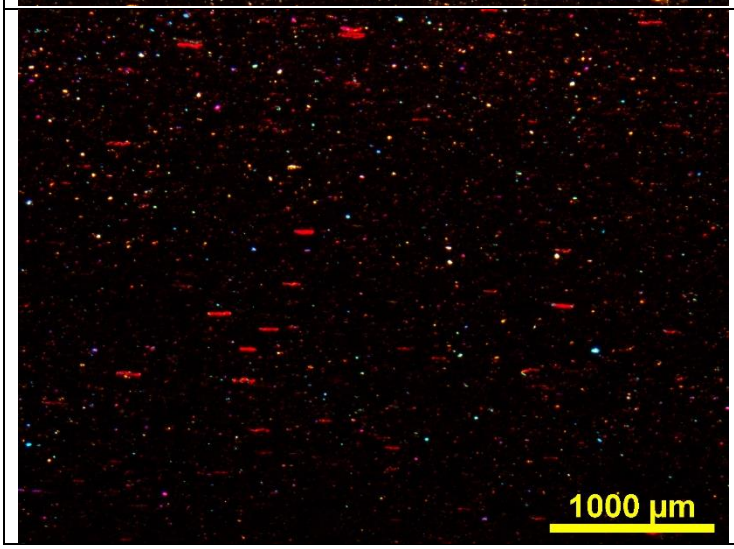
Sample: **B-20 HQ-15 @ 148.2-149.5**



Plane-polarized photomicrograph of main body of sample documenting very high organic carbon content both as reddish-brown mass in mud matrix plus as larger yellow loop-shaped macerals (fossil leaf matter?). White quartz silt disseminated throughout.



Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide showing isotropic nature of organic macerals (red), and quartz composition of silt grains (yellow/blue).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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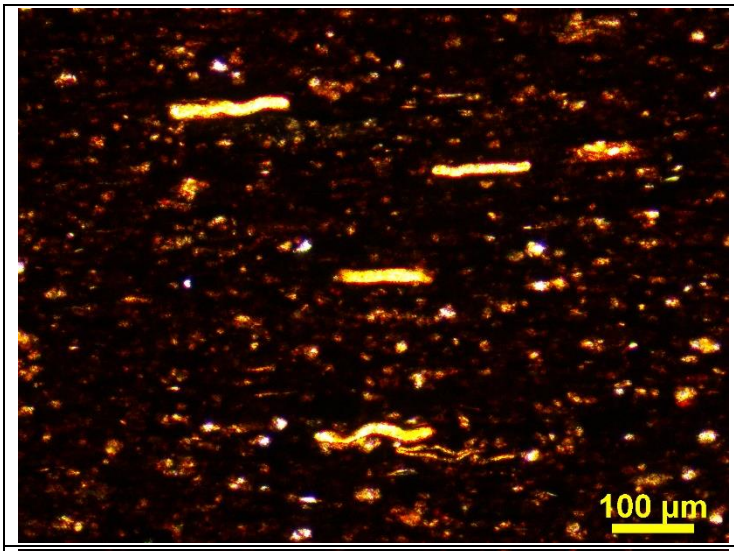
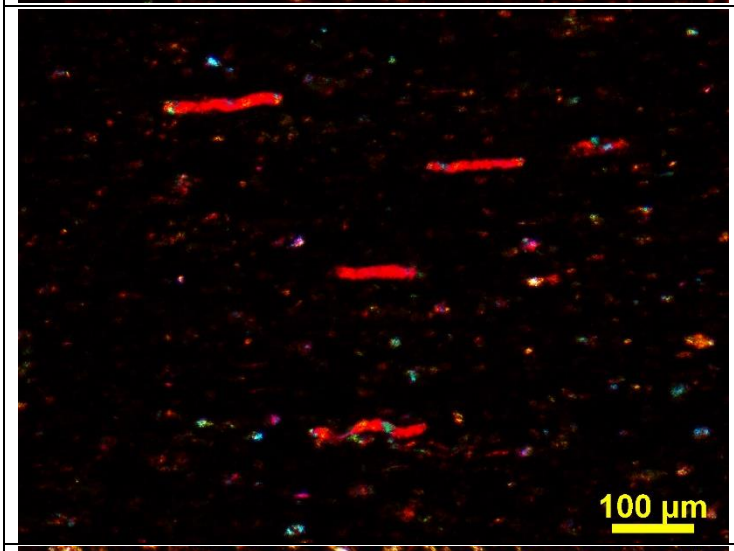
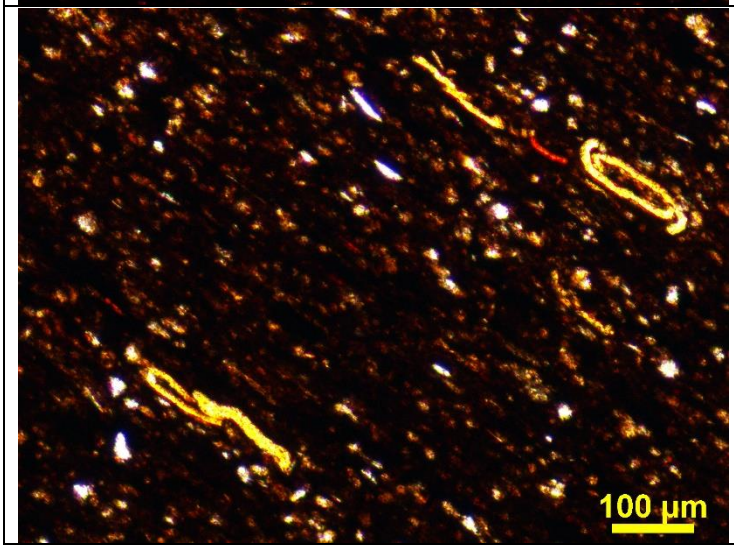
Sample: **B-20 HQ-15 @ 148.2-149.5**

	Plane-polarized photomicrograph detailing yellow organic carbon macerals in an organic carbon-rich mud matrix. White dots are fine-grained quartz silt.
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) of the same spot on slide as above documenting isotropic nature of organic carbon (red) and quartz silt (yellow/blue).
	Plane-polarized photomicrograph detailing interlocking hook shapes of yellow organic carbon macerals. White is quartz silt. Note red-brown organic matter darkening the mud matrix in which silt and fossil (leaves?) are suspended.

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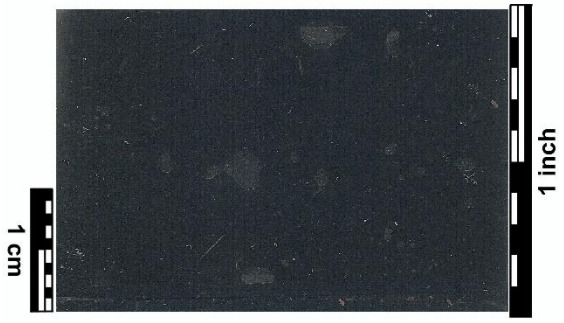
Sample: **B-21-NQ-10 @ 161.9-162.4**

Macroscopic sample description	**Black shale** 80% gray color dry, 100% black wet highly fissile shale with bedding 85º to core axis. 5 mm average thickness between shale partings with planar surfaces. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Dark brown organic carbon-rich mudstone with abundant bedding-aligned yellow fossil plant macerals, red flake organic carbon macerals, and pervasive brown kerogen throughout mud matrix. Quartz silt homogeneously disseminated throughout. Trace pyrite as isolated equant grains.		
Constituent minerals	Quartz	46%	5% as 20 µm equant silt grains suspended in mud matrix, remainder as portion of matrix
	Muscovite	40%	sparse <120 µm detrital flakes, mostly as fine mud matrix
	Kaolinite	7%	<1 µm Al-rich portion of mud matrix indistinct due to kerogen staining
	Pyrite	<0.5%	<50 µm isolated equant disseminated grains visible only by engaging condenser lens
	Kerogen	7%	3% as 80-120 µm wavy and loop-shaped yellow plant fossils parallel to bedding, 1% as <50 µm red flakes, and 3% as amorphous brown material in mud matrix
Porosity	0% intergranular porosity and <0.1% fracture porosity		
Heterogeneity	Very strongly fissile, breaking along planar shaley parting		

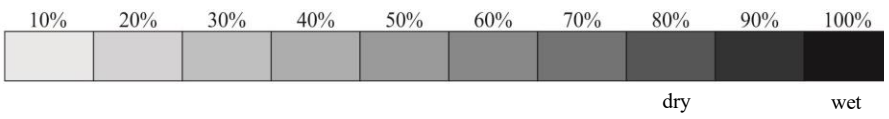


Billet of black shale
Sample so dark that very difficult to distinguish from encasing nearly-black blue epoxy. Gray splotches are air bubbles on surface.

Thin section slide of black shale
Nearly opaque black shale – no pyrite visible.
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.8
MgO	0.2	0.3
Al_2O_3	10.9	17.7
SiO_2	39.5	63.9
P_2O_5	0.0	0.1
SO_2	2.4	3.9
K_2O	2.9	4.7
CaO	0.2	0.2
TiO_2	0.6	1.0
FeO	4.5	7.3
Total	61.7	100.0

Photograph of cut drill core of black shale. Note nearly planar shale parting.



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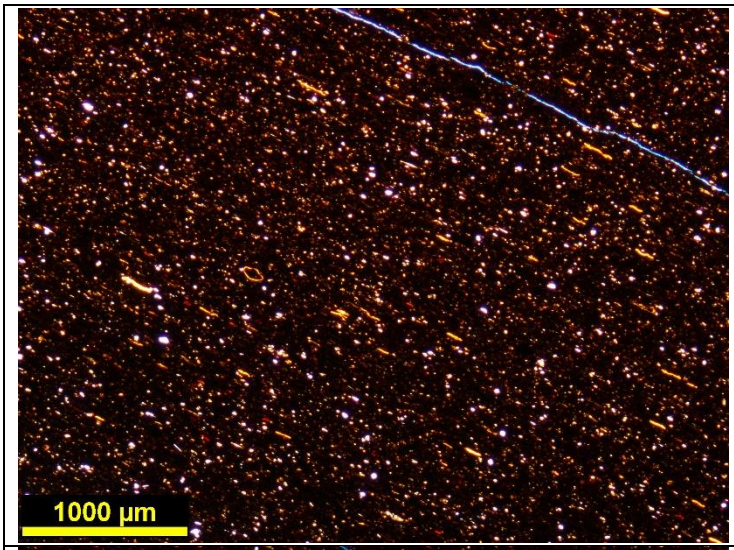
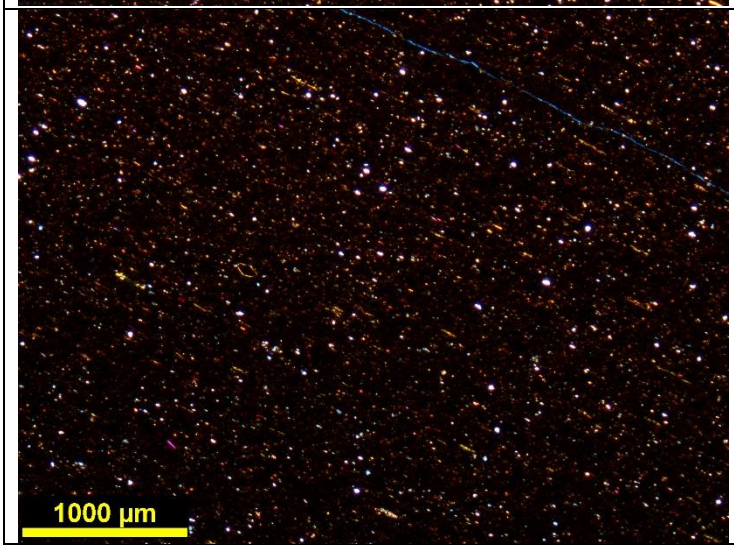
Sample: **B-21-NQ-10 @ 161.9-162.4**



Plane-polarized photomicrograph of main body of sample documenting very high organic content making the sample nearly opaque brown. Yellow linear and loop shapes are organic carbon macerals after plant material. Red dots are different composition organic macerals. White spots are quartz silt grains. Blue line is epoxy-impregnated shale parting fracture.



Cross-polarized photomicrograph of same spot on slide showing slightly anisotropic nature of yellow kerogen macerals after plant fossils. Bright blues, yellows, and pinks are muscovite mica flakes with high birefringence.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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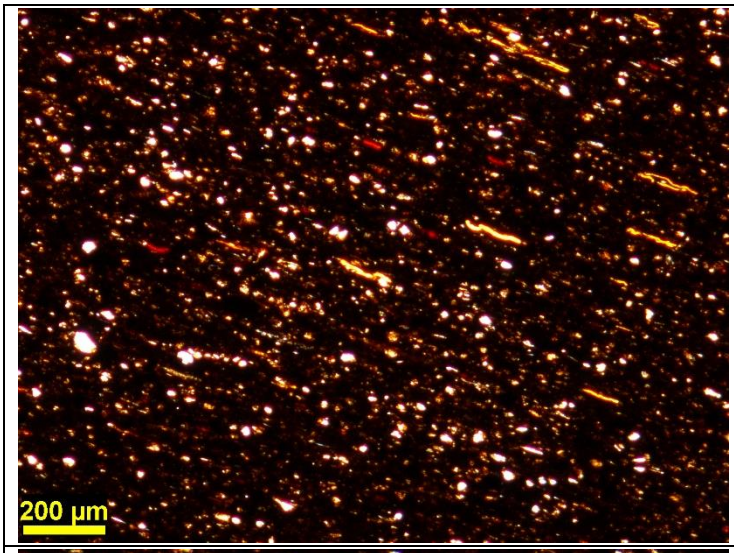
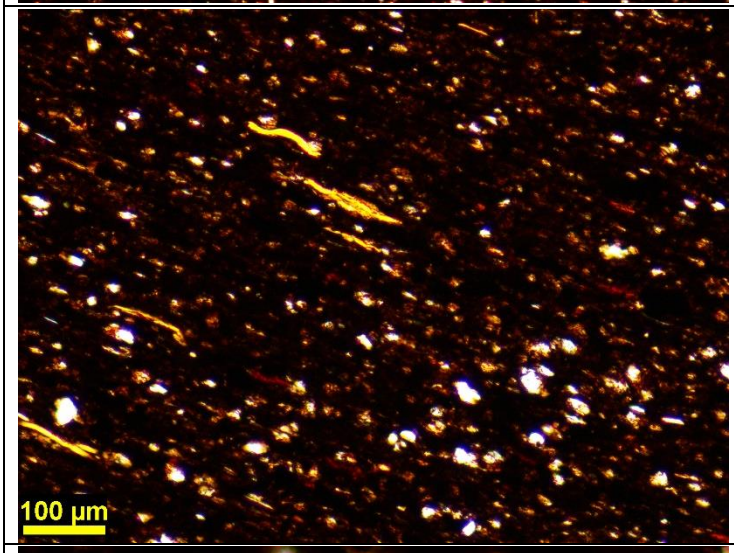
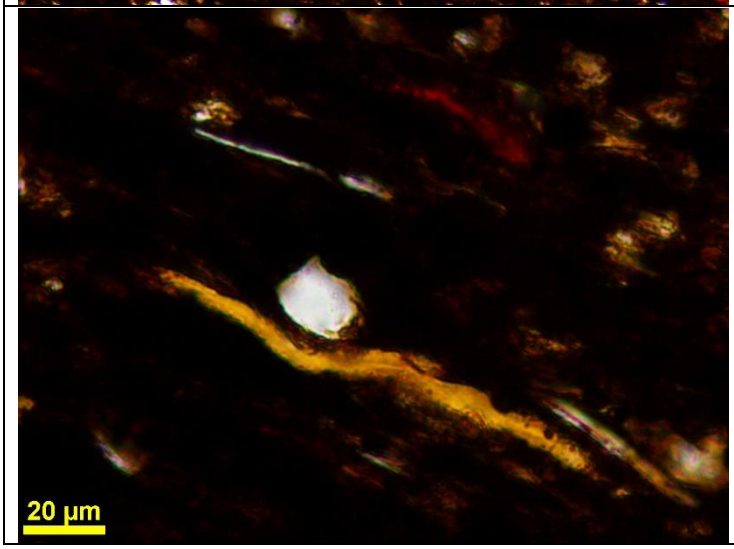
Sample: **B-21-NQ-10 @ 161.9-162.4**

	Plane-polarized photomicrograph of three types of organic material in this sample: 1) elongate yellow squiggly linear and loop-shaped plant parts, 2) simpler elongate red macerals, and 3) very fine-grained kerogen saturating the mudstone matrix. White spots are quartz silt grains.
	Plane-polarized photomicrograph detailing shapes of three kerogen maceral types. White spots are quartz silt grains.
	Plane-polarized photomicrograph at very high magnification documenting 20 µm round quartz silt (white), 100 µm mica (colorful linears), and larger yellow and red kerogen macerals.

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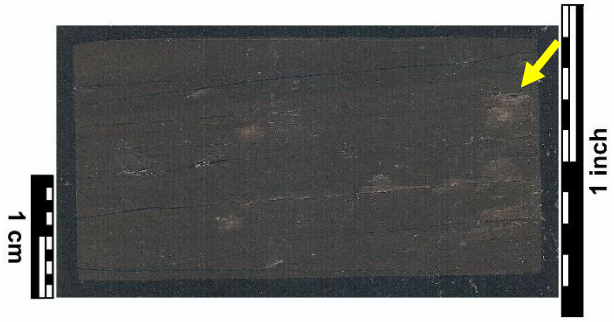
Sample: **B-22-HQ-5 @ 151.6-152.5**

Macroscopic sample description	**Medium gray shale** 70% gray color dry, 90% gray wet very highly fissile shale. 3 mm average thickness between shale partings with wavy surfaces. Several 1-mm ovoid spots on cut surface swell when wet, but most of sample non-absorbent. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	200 µm thick sets of siltstone with weakly graded bedding within mica-clay-dominant silt-poor shale. Minor organic material as nearly opaque brown/red angular flakes.		
Constituent minerals	Quartz	42%	5% as 20-40 µm detrital silt concentrated in 50-100 µm laminae with weakly-developed graded bedding, remainder as fine-grained component in mud matrix
	Muscovite	39%	60 µm detrital grains with high second-order interference mostly in quartz-silt rich laminae, <10 µm highly birefringent component of mud matrix
	Kaolinite	19%	<1 µm first-order gray component of mud matrix
	Opaque	<0.1%	10 µm disseminated equant opaque mineral – probably pyrite, but glass surface prevents reflect light analysis
	Kerogen	<1%	three 100 µm yellow wavy fossil fragments in slide remainder is <10 µm angular to equant brown fragments
	Chlorite	<1%	10 µm green flakes
Porosity	0% intergranular porosity and <0.1% fracture porosity along parting		
Heterogeneity	Very highly fissile shaley parting		

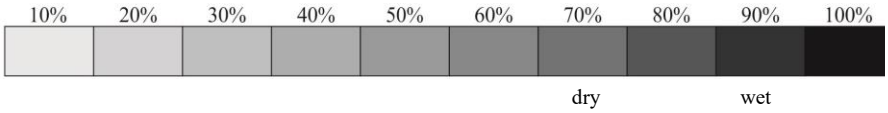


Billet of medium gray shale
Highly fissile shale with epoxy impregnating parting fractures. Light brown spots (e.g., arrow) are equant zones that absorbed water anomalously.

Thin section slide of medium gray shale
Thin white quartz silt-rich beds (e.g., arrow) in quartz-silt-poor strongly laminated shale
Blue epoxy impregnation indicates <0.1% porosity along shaley parting.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.5	0.7
Al_2O_3	17.0	21.7
SiO_2	50.3	64.2
P_2O_5	0.1	0.1
SO_2	0.4	0.5
K_2O	3.5	4.5
CaO	0.2	0.3
TiO_2	0.8	1.0
FeO	4.9	6.3
Total	78.4	100.0

Photograph of cut drill core of medium gray shale.
Note very wavy shaley parting surface.



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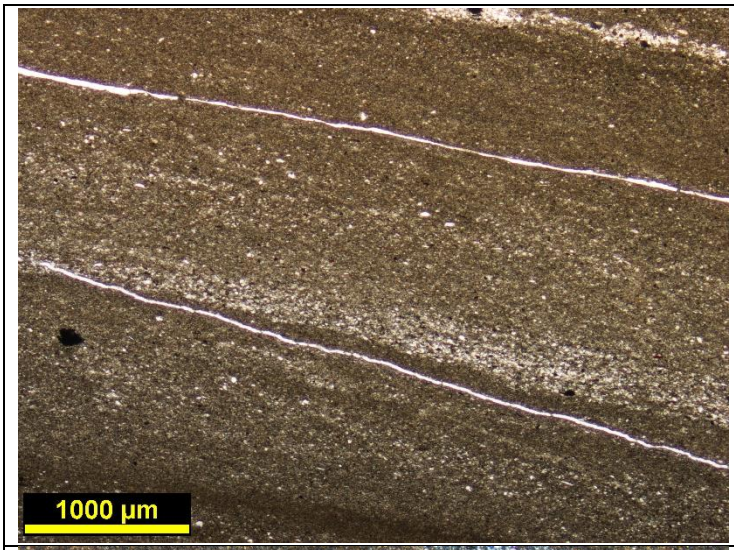
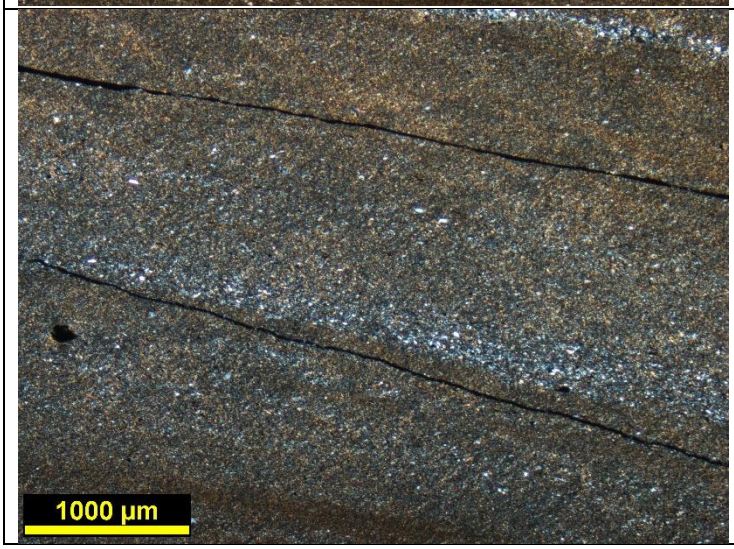
Sample: **B-22-HQ-5 @ 151.6-152.5**

	Plane-polarized photomicrograph of main body of sample documenting graded bedding in quartz silt layers (white granular), presence of opaque pyrite (black), and subparallel shaley parting (continuous white lines). Clay-mica-rich muds are brown in this illumination.
	Cross-polarized photomicrograph of same spot on slide documenting first-order gray interference of quartz silt (i.e., not carbonate), and higher order interference of micas in main mud matrix. Open space parting on shale is black in this illumination because air/epoxy is isotropic.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

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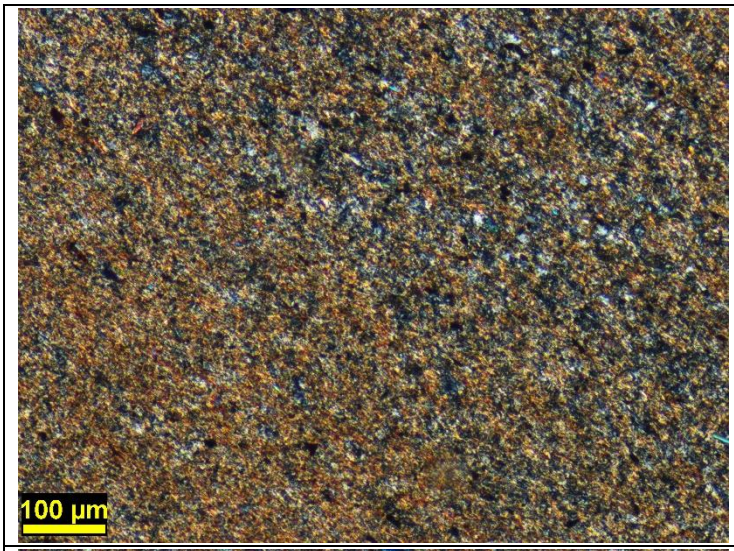
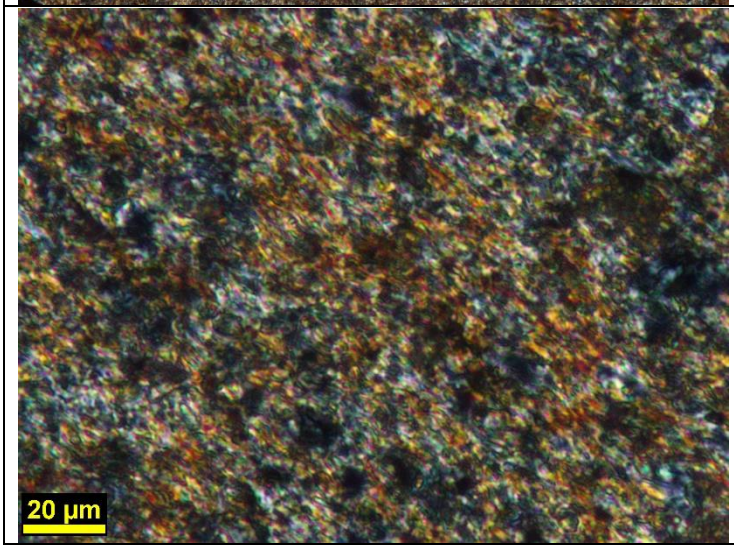
Sample: **B-22-HQ-5 @ 151.6-152.5**

	Cross-polarized photomicrograph of gradational boundary between silt-richer bed (upper right half) within predominantly clay-mica-rich mudstone (lower left half).
	Cross-polarized photomicrograph of quartz-rich silt bed (grays) with opaque black pyrite grains within main body of clay-mica-rich mudstone. Blue line near top of image is epoxy-filled fracture.
	Cross-polarized photomicrograph at very high magnification of main mudstone matrix documenting abundance of high birefringence micas (browns/yellows/reds/greens) intermixed with low birefringence clays and quartz (gray).

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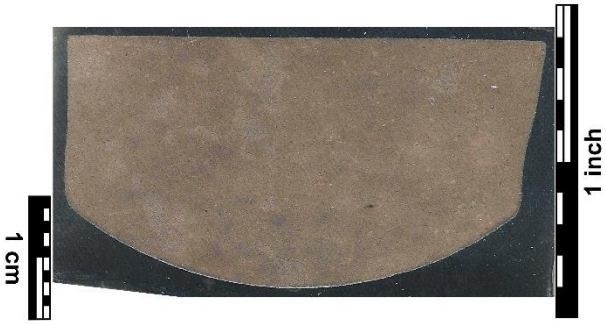
Sample: **B-23-HQ-11 @ 156.6-157.0**

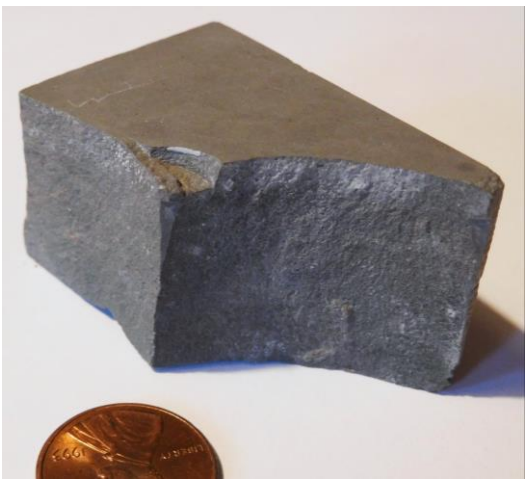
Macroscopic sample description	**Massive gray siltstone** Isotropic, homogeneous light gray siltstone lacking any bedding or other foliation textures. Broken surfaces display joint plume asperities. Scratches easily with steel. Very faintly magnetic. No reaction with acid.		
Brief petrographic description:	Dense, isotropic, homogeneous matrix of sub-micron clay minerals suspending poorly-sorted, rounded quartz silt grains. Minor disseminated very fine-grained equant opaque grains locally cluster in 20 µm aggregates possibly magnetite.		
Constituent minerals	clay	89%	< 1 µm includes intimately intermixed illite (green with second-order birefringence) > chlorite (green with brown extinction) > subordinate kaolinite (low birefringence light brown)
	quartz	10%	10-40 µm anhedral, rounded silt grains with pitted surfaces disseminated throughout mud matrix
	opaque	1%	< 1 µm grains disseminated sparsely throughout mud matrix, locally as 20 µm aggregates. Very faint pull of Nd swivel magnet suggests micron-scale detrital magnetite rather than pyrite. Iron, but low sulfur in chemical analysis supports this. Some opaque grains have slightly translucent red rims suggesting clastic jasper chert silt (?)
Porosity:	0% intergranular porosity and 0% fracture porosity		
Heterogeneity:	none		



Billet of massive gray siltstone
Siltstone lacks bedding or other macroscopic sedimentary textures (e.g., no bioturbation).

Thin section slide of massive gray siltstone
Featureless isotropic and homogeneous siltstone. Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.4	0.5
MgO	2.0	2.4
Al_2O_3	11.1	13.4
SiO_2	49.9	60.2
P_2O_5	0.1	0.2
SO_2	0.5	0.6
K_2O	2.0	2.4
CaO	0.9	1.1
TiO_2	0.7	0.9
FeO*	15.2	18.4
Total	83.0	100.0



Oblique view of massive gray siltstone
Planar surface is saw cut. Rock appears isotropic and homogeneous (i.e., massive).

** iron content in analysis is suspect*

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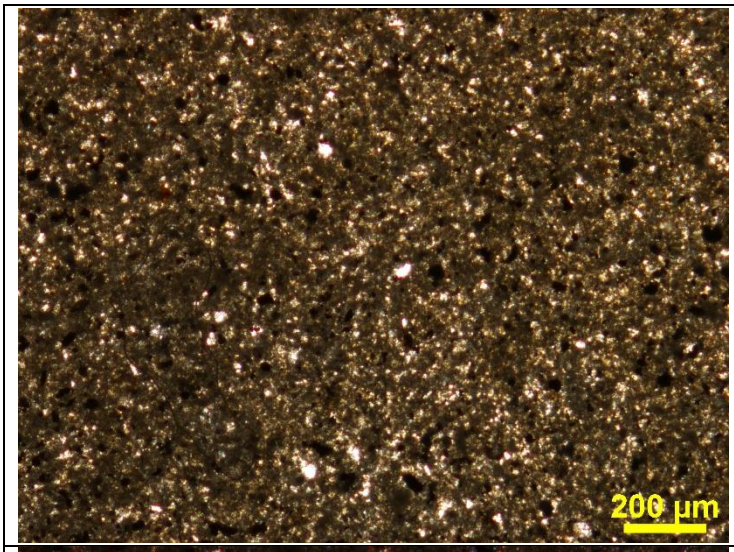
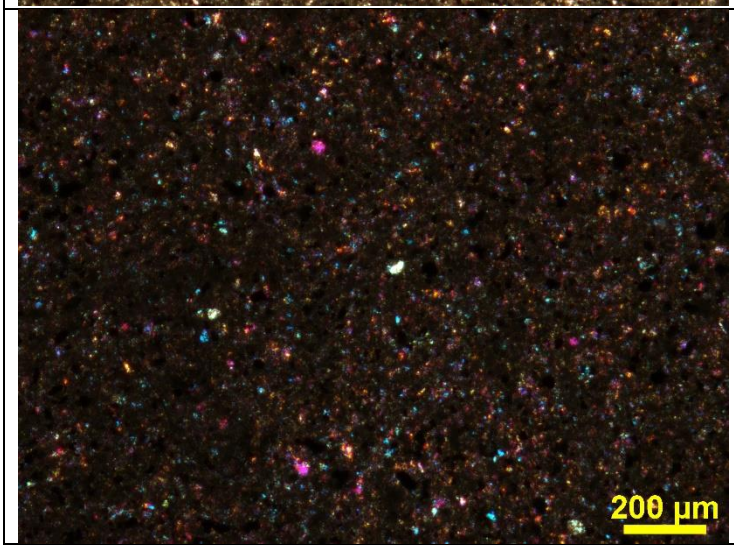
Sample: **B-23-HQ-11 @ 156.6-157.0**

	Plane-polarized photomicrograph of main body of sample showing homogenous quartz silt (white) and opaque (black = magnetite?) in mud matrix that completely lacks bedding.
	Cross-polarized photomicrograph with gypsum plate inserted of same spot on slide verifying white grains above (blue/yellow in this illumination) are quartz.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

Because pelitic rocks (i.e., rocks originating as mud, including shales, slates, phyllites, and schists) contain multiple mineral phases composed of the same primary elements (K, Al, and Si) in varying proportions, bulk chemical data from XRF cannot be used to objectively estimate the proportions of micas, aluminosilicates, and feldspars. Relative proportions of minerals were therefore determined by visual comparison with standardized estimation charts.

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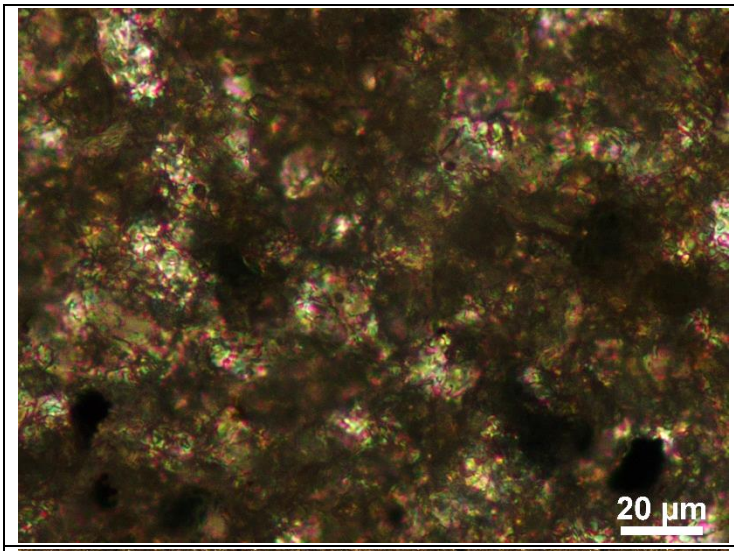
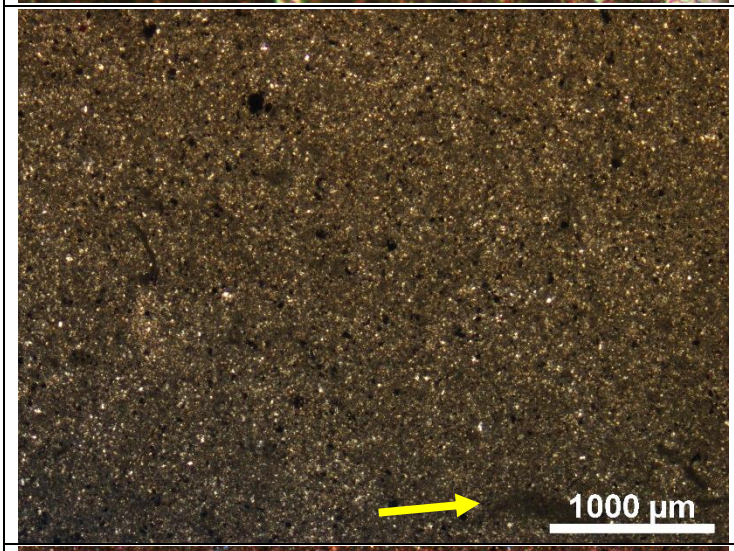
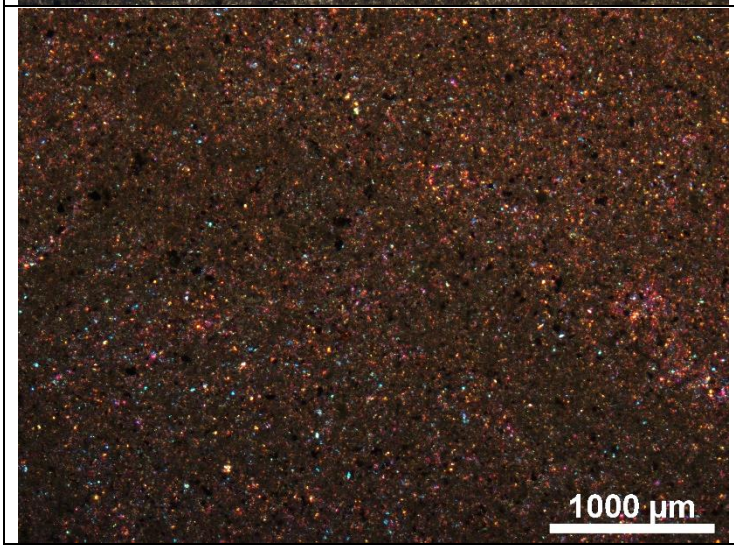
Sample: **B-23-HQ-11 @ 156.6-157.0**

	Plane-polarized photomicrograph at high magnification showing green color of illite (green) portion of mud between 20 µm quartz silt grains (white). Embayments on the outline of the 15 µm opaque grain (black lower right) suggest it is an aggregate of <1 µm grains – either framboidal pyrite or magnetite.
	Plane-polarized photomicrograph at low magnification showing minor local heterogeneities due to bioturbation (arrow), but overall very homogeneous sample in terms of mineralogy, grain size, and grain orientation.
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) at low magnification showing faint variations of quartz silt:clay content, most likely due to bioturbation.

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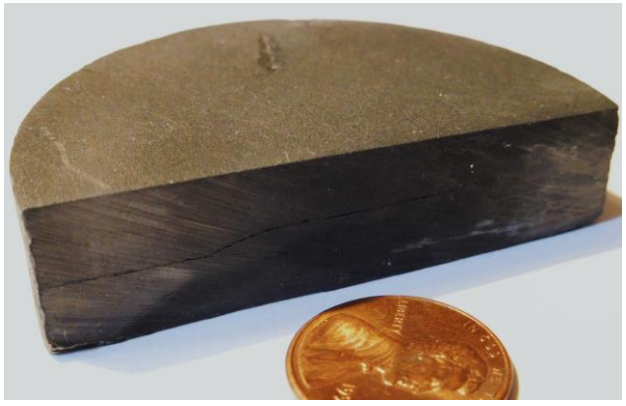
Sample: **B-23-HQ-13 @ 171.2-171.6**

Macroscopic sample description	**Black shale** Distinctly fissile black mudstone, parting on imperfectly-flat surfaces (shale, not slate). Reflections off detrital sub-millimeter mica flakes on bedding planes perpendicular to core axis. No other macroscopically-identifiable minerals or textures. Scratches easily with steel. Non-magnetic. No reaction with acid.		
Brief petrographic description:	Reddish-brown organic carbon-rich mud matrix of clay and kerogen supporting sparsely-disseminated quartz silt, isolated anhedral opaque pyrite grains, and detrital muscovite flakes. 200 µm concentric circular amorphous yellow carbon fossils throughout.		
Constituent minerals	clay	92%	nanometer-scale (submicroscopic) reddish-brown matrix material that behaves isotropically because grains too small to distinguish and random orientation of grains cancel optics from one another
	kerogen	6%	<200 µm amorphous nearly opaque, dark reddish-brown equant- to elongate, irregular shapes and spines after fossil plant fragments *plus* 200 µm consistent size, circular amorphous yellow fossil grains with weak concentric layers
	quartz	1%	<20 µm rounded silt grains disseminated throughout mud matrix
	pyrite	1%	<20 µm equant anhedral opaque grains disseminated sparsely throughout mud matrix
	muscovite	<0.5%	20 µm detrital grains randomly disseminated
Porosity:	0% intergranular porosity and 0 % fracture porosity		
Heterogeneity:	strong, imperfectly-flat shaley parting along bedding		

Billet of black shale
Featureless mudstone cut parallel to bedding.
Gray splotches in image are air bubbles on wetted surface. White specks are mica reflections.

Thin section slide of black shale
Dense, homogeneous, isotropic black mudstone cut parallel to bedding.
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.7	0.9
Al_2O_3	15.4	17.9
SiO_2	55.7	65.0
P_2O_5	0.1	0.1
SO_2	3.8	4.5
K_2O	3.8	4.4
CaO	0.3	0.3
TiO_2	0.8	0.9
FeO	4.6	5.3
Total	85.7	100.0



Oblique view of black shale core sample
Note strong parting on bedding perpendicular to core axis. Sweeping lines on cut surface are saw marks.

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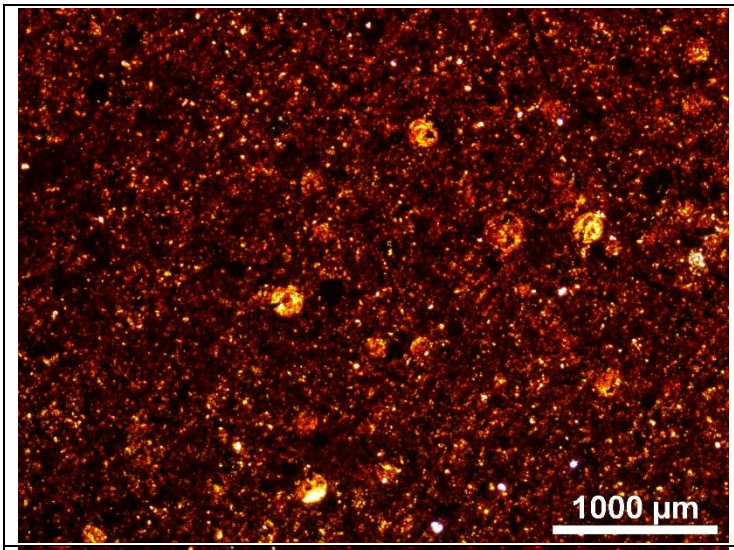
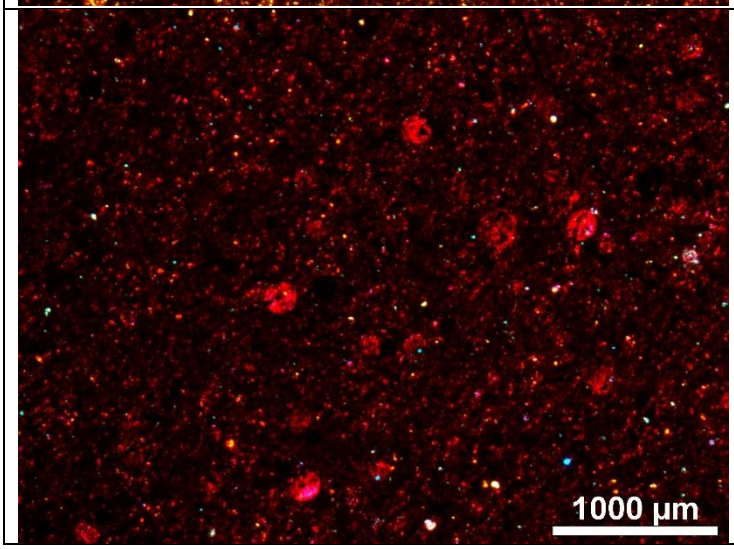
Sample: **B-23-HQ-13 @ 171.2-171.6**

	Plane-polarized photomicrograph of main body of sample sparsity of quartz silt (white) in matrix of clay + organic carbon (kerogen) macerals. Slide cut approximately parallel to bedding. Circular yellow features are unidentified fossil grains (?)
	Cross-polarized photomicrograph with gypsum plate inserted of same spot on slide identifying bright specks as quartz silt (yellows/blues) and documenting isotropic nature of yellow circular fossil features (i.e., non-crystalline).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

Because pelitic rocks (i.e., rocks originating as mud, including shales, slates, phyllites, and schists) contain multiple mineral phases composed of the same primary elements (K, Al, and Si) in varying proportions, bulk chemical data from XRF cannot be used to objectively estimate the proportions of micas, aluminosilicates, and feldspars. Relative proportions of minerals were therefore determined by visual comparison with standardized estimation charts.

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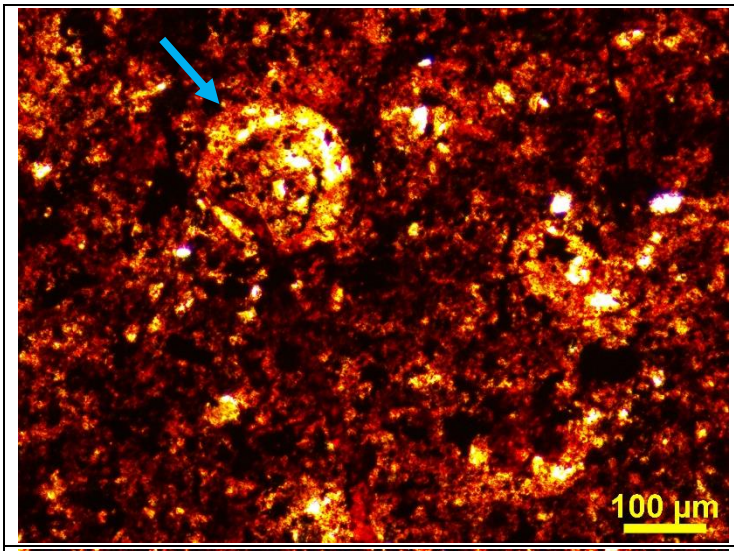
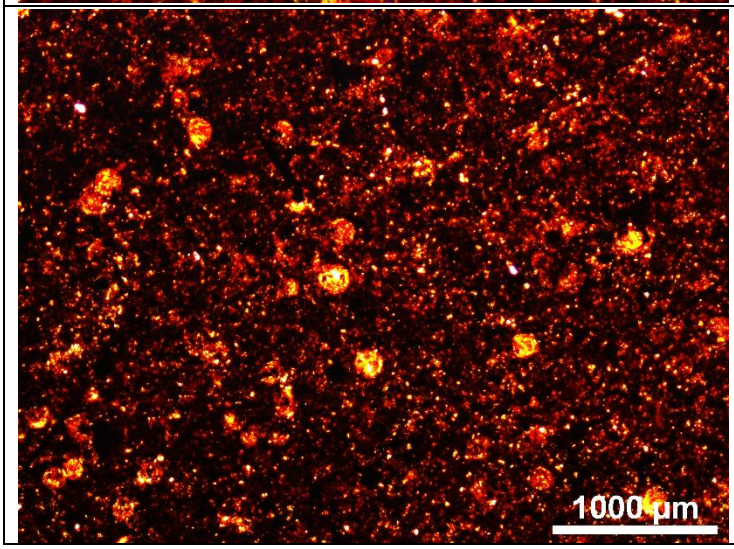
Sample: **B-23-HQ-13 @ 171.2-171.6**

	Plane-polarized photomicrograph at high magnification of circular fossil features. Note slight concentricity of yellow fossil indicated by arrow. White grains are quartz silt. Opaque (black) grains are organic carbon macerals.
	Plane-polarized photomicrograph showing abundance and consistent size of circular yellow fossil grains, paucity of quartz silt (white), and occurrence of elongate, irregular, and spine-shaped organic carbon macerals (black) suggestive of plant fossil fragments.

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Sample: **B-24-HQ-16 @ 165.1-165.6**

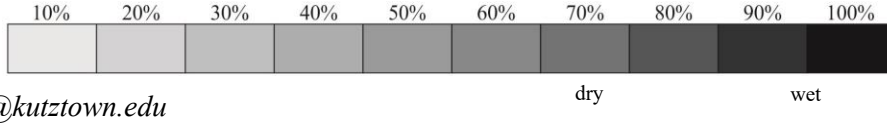
Macroscopic sample description	**Dark gray weakly pyritic shale** 70% gray color dry, 95% gray wet highly fissile shale with 2 mm average thickness between partings along wavy surfaces. <1 mm pyrite slips elongate along bedding. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Homogenous distribution of equant, irregularly-shaped relatively sparse quartz silt in dark brown mica-clay mud matrix. Organic carbon as red flakes and amorphous brown kerogen in matrix. Spherical microconcretions of pyrite cluster in some voids with optically-continuous quartz infilling, but most pyrite is mm-scale clusters of fine-grained pyrite grains. Several loop-shaped fossils replaced by fine-grained mineral (clay?). Possible insect wing fossils.		
Constituent minerals	Quartz	43%	7% as 20-40 μm equant, rounded silt grains evenly distributed throughout mud matrix, remainder as very fine-grained component of mud matrix.
	Muscovite	37%	<80 μm detrital grains with high second-order interference, <10 μm highly birefringent component of mud matrix
	Kaolinite	15%	<1 μm first-order gray component of mud matrix
	Pyrite	2%	<50 μm grains forming 100-1,000 μm massive aggregates with gradational boundaries. Seven occurrences of perfectly spherical <20 μm grains formed in open space voids filled with optically-continuous quartz (distinct from common aggregates).
	Kerogen	3%	amorphous brown in mud matrix, 0.5% as red flake fossils
Porosity	0% intergranular porosity and <0.1% fracture porosity		
Heterogeneity	strong shaley parting along very wavy surfaces		

Billet of dark gray weakly pyritic shale
Sample nearly as dark as epoxy.

Thin section slide of dark gray weakly pyritic shale
Nearly opaque with organic material. Note wavy shaley parting. Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.4	0.5
Al_2O_3	15.4	20.1
SiO_2	49.3	64.4
P_2O_5	0.0	0.1
SO_2	1.9	2.4
K_2O	3.5	4.5
CaO	0.3	0.4
TiO_2	0.8	1.0
FeO	4.4	5.7
Total	76.6	100.0

Photograph of cut drill core of dark gray weakly pyritic shale. Note very wavy, irregular shape of parting surface (top).



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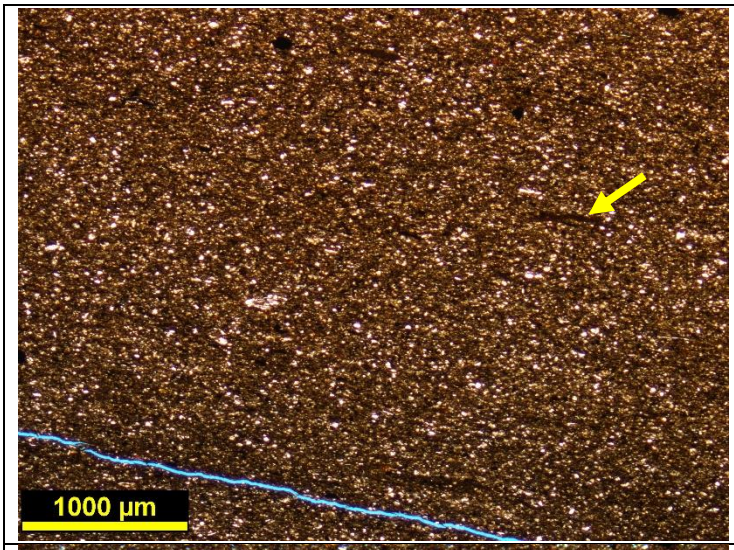
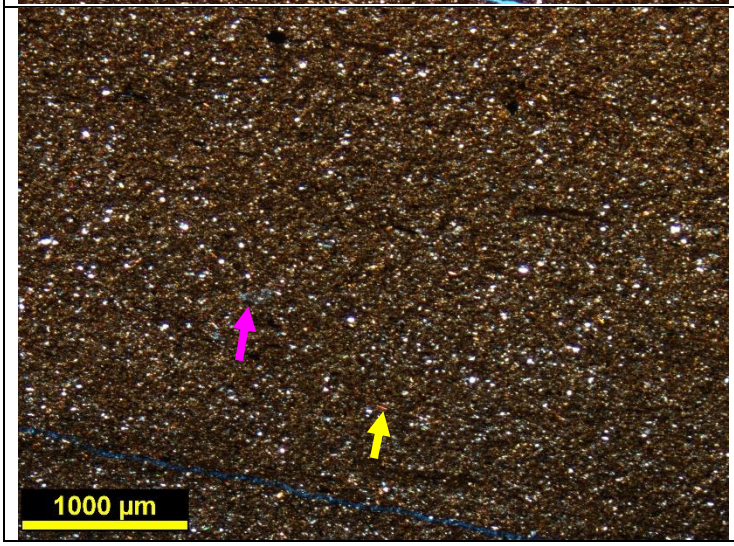
Sample: **B-24-HQ-16 @ 165.1-165.6**

	Plane-polarized photomicrograph of main body of sample showing occurrence of long red organic carbon macerals (e.g., arrow), and even distribution of quartz silt (white) in mica-clay mud matrix. Blue line near bottom is epoxy-impregnated shale parting fracture.
	Cross-polarized photomicrograph of same spot on slide documenting isotropic nature of red organic carbon macerals, first-order gray interference of equant grains of quartz silt, and occurrence of brightly-colored (highly birefringent) detrital muscovite flakes (e.g., yellow arrow). Note that loop-shaped fossil is filled with low-birefringence anisotropic mineral (pink arrow) – either extremely fine-grained quartz or kaolinite.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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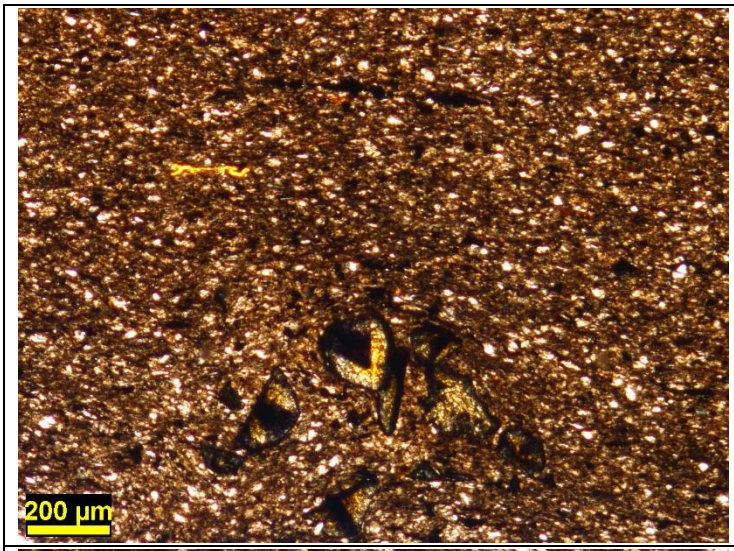
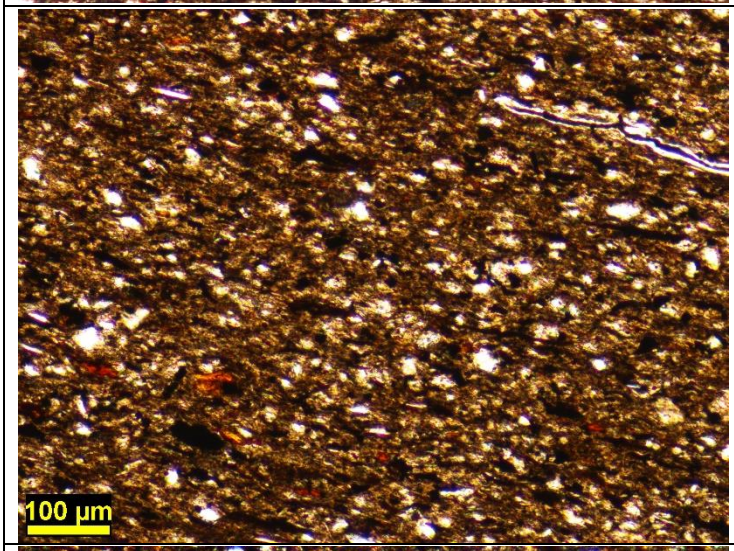
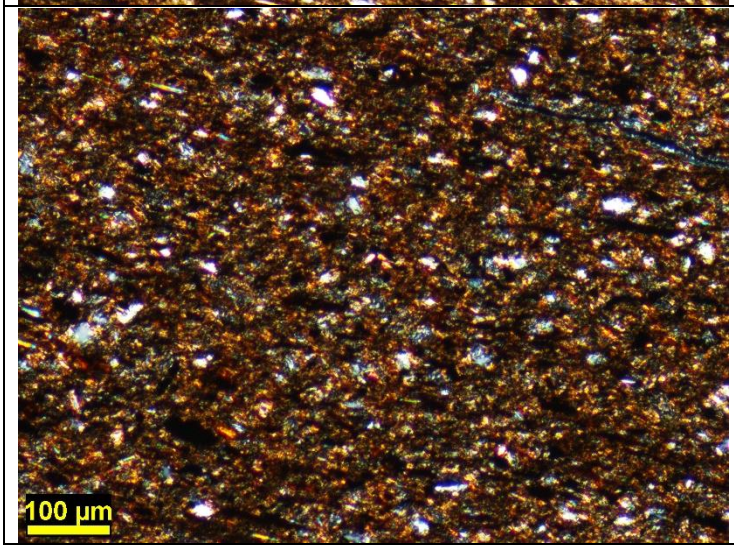
Sample: **B-24-HQ-16 @ 165.1-165.6**

	Plane-polarized photomicrograph of cluster of large fossil fragments with webbed internal structure and thick reinforcing outer rims – (leaves? Insect wings?) More common organic carbon macerals occur as wavy sometimes branching/looping grains (upper left) or red flakes (e.g., top center). White grains are quartz silt and black isolated grains disseminated pyrite (opaque).
	Plane -polarized photomicrograph detailing quartz silt (equant white), detrital mica (white slivers), organic carbon macerals (red and nearly opaque brown), and mica-clay-rich matrix. Note flattened loop-shaped fossil in upper right which is similar in shape to many yellow kerogen macerals. Compare with image below.
	Cross-polarized photomicrograph of same spot on slide showing high birefringence colors of micas in mud matrix, red internal reflections in red carbon macerals, bright primary interference colors of detrital muscovite, and infilling of loop-shaped fossil fragment in upper right by very fine-grained low-birefringence mineral (quartz or clay).

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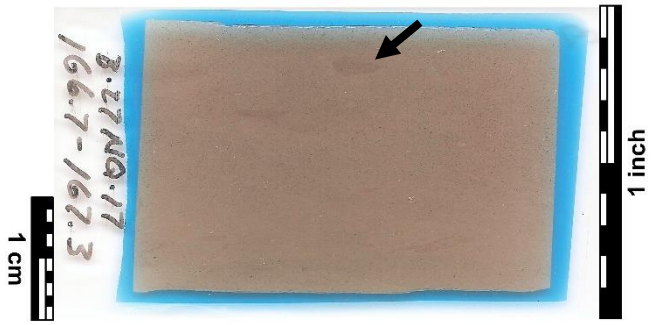
Sample: **B-27 NQ-17 @ 166.7-167.3**

Macroscopic sample description	**Olive siltstone** Olive green/brown massive siltstone with non-fissile 2-mm thick laminae. 1-3 mm ovoid chips of darker mud with elongate axis parallel to presumed bedding. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Massive mudstone lacking distinct internal lamination containing quartz silt and branching root-like fossil material suspended in pale brown mud. Very fine-grained pyrite disseminated throughout.		
Constituent minerals	Quartz silt	4%	<30 μm equant, concentrations relative to mud vary spatially
	Quartz mud	53%	<5 μm granules in mud *(proportion calculated chemically)*
	Kaolinite	13%	<1 μm in mud *(proportion calculated chemically)*
	Muscovite	22%	<5 μm flakes in mud *(proportion calculated chemically)*
	Chlorite	4%	<5 μm flakes in mud *(proportion calculated chemically)*
	Pyrite	3%	20 μm equant, disseminated
	Organic	1%	200-1,000 μm pale-brown branching macerals with very high aspect ratio (plant roots?) plus finer-grained red flakes in mud matrix
Porosity	0% observable intergranular porosity and 0% fracture porosity		
Heterogeneity	none		

Billet of olive siltstone
Massive olive brown siltstone with isolated 2-mm lensoidal dark brown mud clasts



Thin section slide of olive siltstone
Isolated 2-mm lensoidal dark brown mud clasts (arrow) in massive siltstone. Blue epoxy impregnation indicates 0% observable porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	1.2	1.5
Al_2O_3	11.0	13.3
SiO_2	52.8	63.7
P_2O_5	0.1	0.1
SO_2	1.0	1.2
K_2O	2.1	2.5
CaO	0.6	0.8
TiO_2	0.7	0.9
FeO	12.8	15.5
Total	82.9	100.0

Photograph of cut drill core of olive siltstone. Sample lacks shaley parting (top and bottom surfaces cut by rock saw). Bedding discontinuous/lens-shaped.

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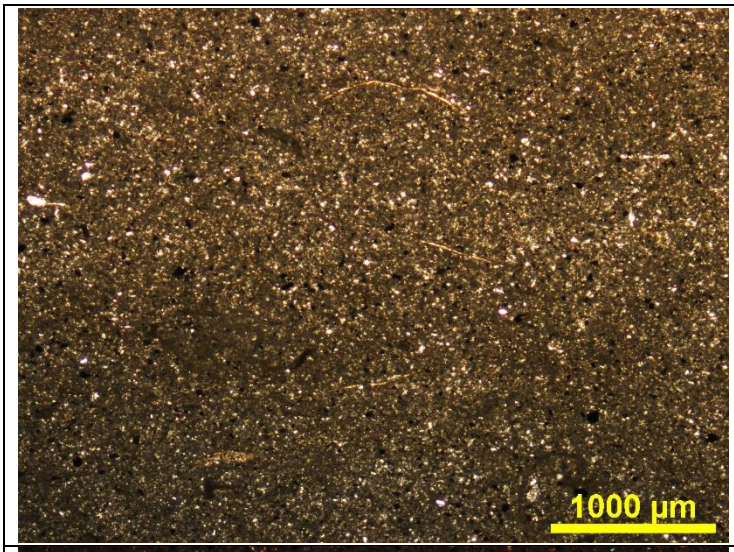
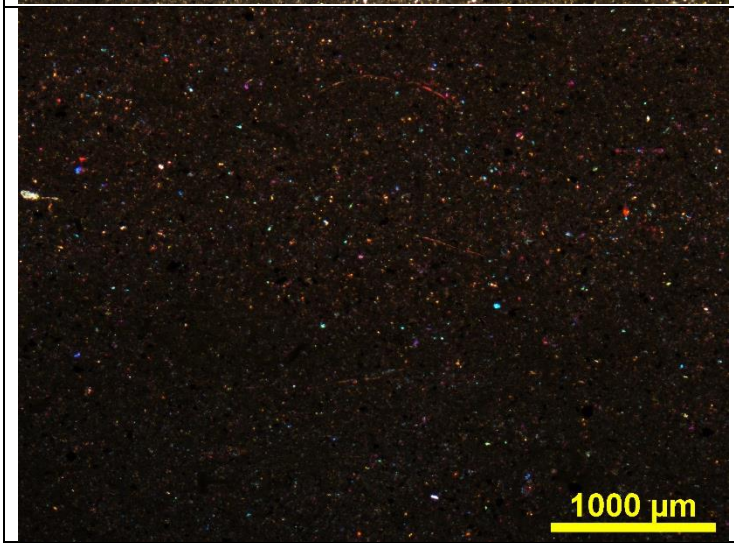
Sample: **B-27 NQ-17 @ 166.7-167.3**



Plane-polarized photomicrograph of main body of sample documenting relatively high content of evenly-disseminated fine-grained opaque pyrite (black) in light-colored mud organic carbon-poor matrix. White quartz silt grains locally vary in concentration – possible bioturbation. Long white/yellow grains are fossil matter.



Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting quartz composition of silt (yellow/blue), isotropic nature of long fossil matter (red), and variations in ultra-fine quartz:clay proportions in mud matrix (clay-rich has increased opacity and less quartz silt).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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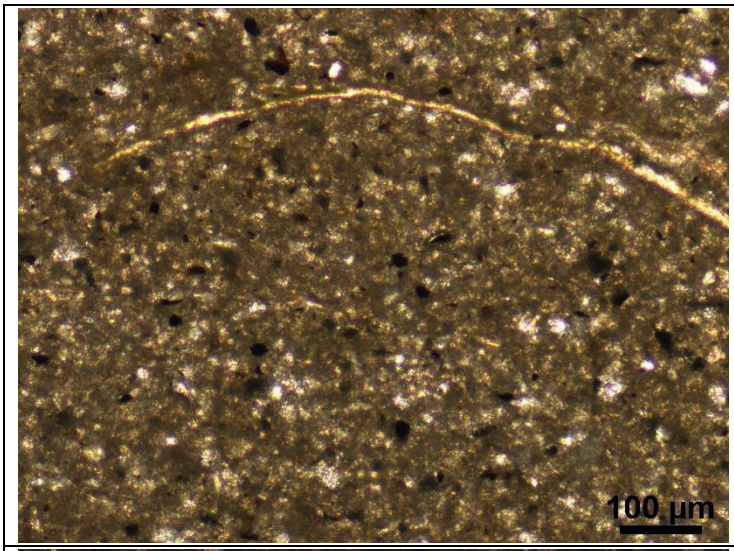
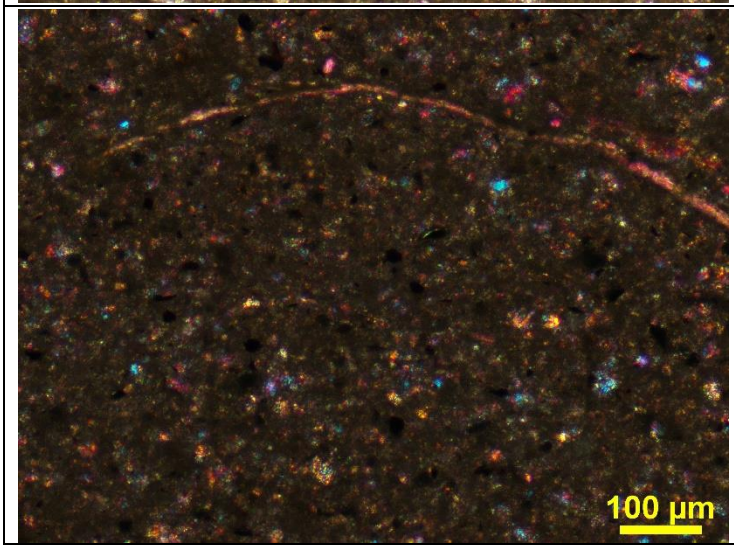
Sample: **B-27 NQ-17 @ 166.7-167.3**

	Plane-polarized photomicrograph at high magnification of branching fossil. White quartz silt and black opaque pyrite disseminated throughout. Note very dark red flakes of organic carbon also present throughout.
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) documenting mineralogy of quartz silt (yellow/blue), and pink extinct nature of isotropic branching fossil fragment.

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Sample: **B-27 NQ-17 @ 173.1-173.7**

Macroscopic sample description	**Black shale** Black fissile mudstone with irregular breaks spaced 4 mm. Reflections of very fine-grained muscovite/illite on bedding surfaces. Very minor fine-grained pyrite along parting. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description:	Dark brown organic-carbon-rich mud matrix suspending disseminated quartz silt. Mud matrix has sparse disseminated fine-grained pyrite concentrating as thin aggregates along bedding. Organic carbon also as bright yellow sinusoidal elongate macerals (plant fossils?)		
Constituent minerals	Quartz silt	5%	<30 µm equant anhedral grains suspended in mud
	Quartz mud	43%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	13%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	32%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	1%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 µm equant, disseminated
	Organic	4%	<200-µm-long, bright yellow, elongate, sinusoidal macerals with rounded ends plus finer-grained red matter in mud matrix
Porosity:	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity:	Shaley parting along bedding		

Billet of black shale
Homogeneous black mudstone with very fine-grained pyrite along some shaley partings

Thin section slide of black shale
Very fine-grained pyrite disseminated and along shaley parting. Blue epoxy impregnation indicates 0% observable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.7
MgO	0.4	0.5
Al_2O_3	14.7	19.1
SiO_2	51.3	66.6
P_2O_5	0.1	0.1
SO_2	1.6	2.1
K_2O	3.2	4.1
CaO	0.1	0.2
TiO_2	0.8	1.0
FeO	4.2	5.5
Total	77.0	100.0

Photograph of cut drill core of black shale. Shaley parting on cut surface highlighted by soaking with water, then drying face. Note irregular wavy breaks along bedding seen in parting and topography of top of sample broken along shaley parting (i.e., not perfectly planar).

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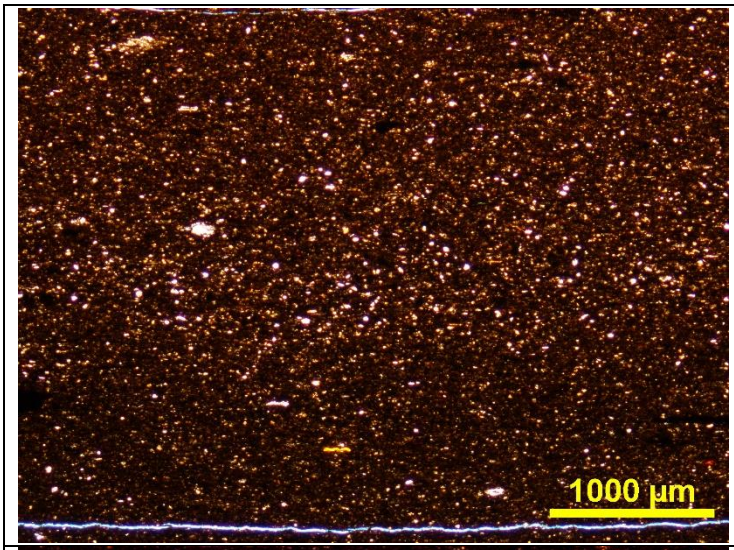
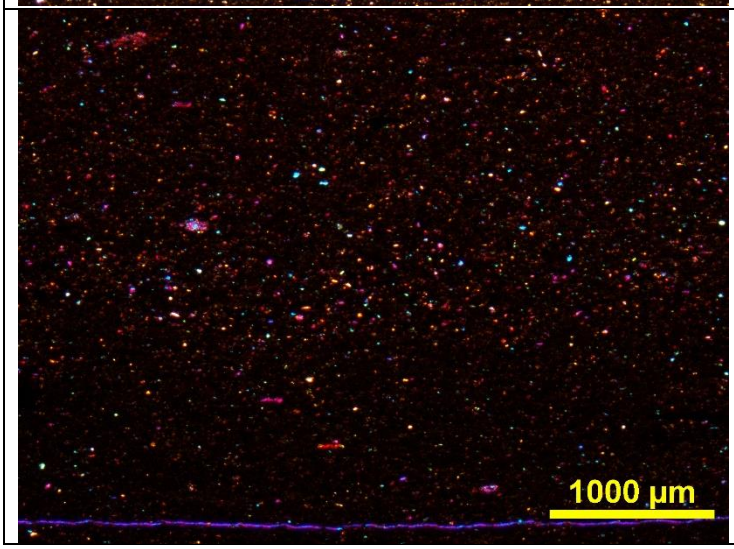
Sample: **B-27 NQ-17 @ 173.1-173.7**



Plane-polarized photomicrograph of main body of sample documenting silt content (white) varying to define bedding, occurrence of bright yellow organic macerals (e.g., bottom center), and disseminated fine grained pyrite (black) throughout. Note concentrations of pyrite as 100-200 µm aggregates near bottom left edge of image. Blue line near bottom of image is epoxy-filled parting fracture.



Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting quartz composition of silt (yellow/blue) and isotropic nature of organic carbon macerals (red/pink).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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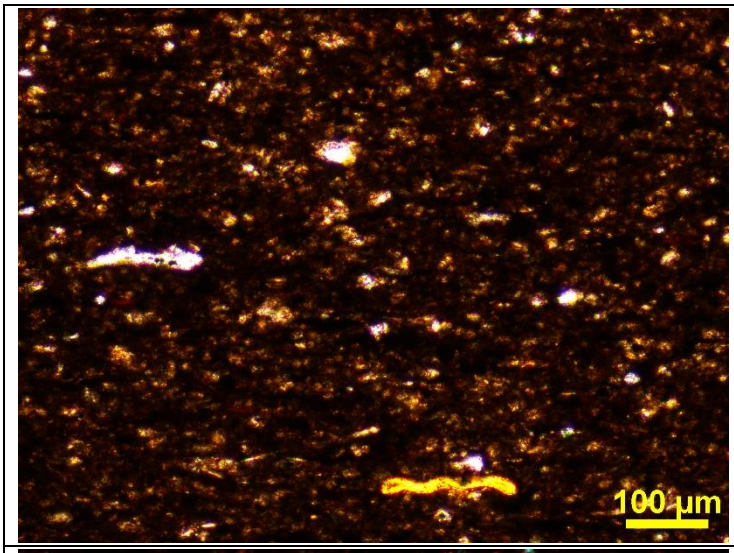
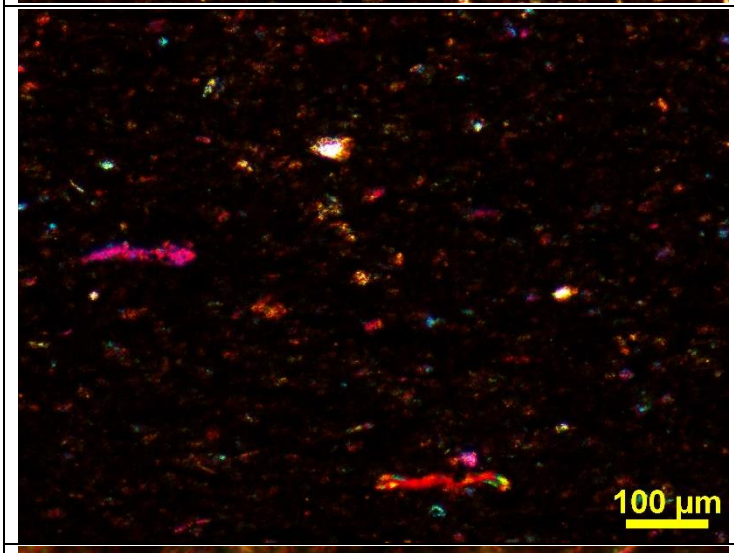
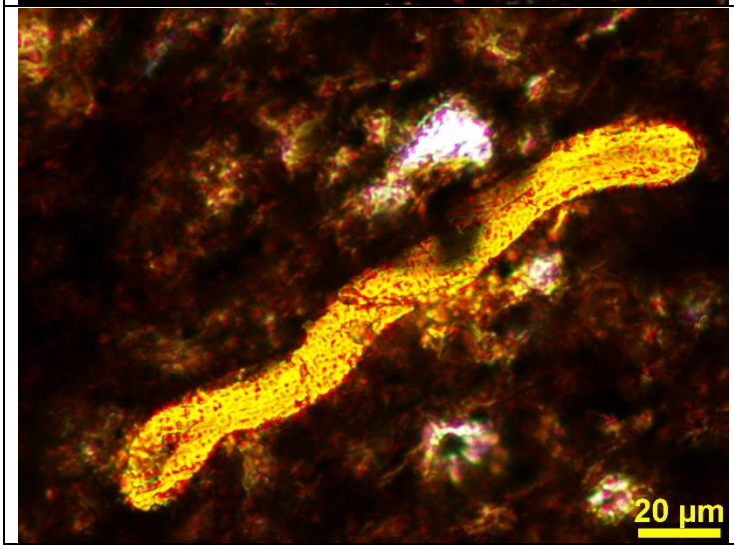
Sample: **B-27 NQ-17 @ 173.1-173.7**

	Plane-polarized photomicrograph at high magnification detailing angular nature of quartz silt, organic carbon-rich dark mud matrix, and occurrence of bright yellow, sinusoidal, looped organic carbon macerals (plant fossil?)
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) of same spot documenting quartz silt (yellow/blue) and isotropic nature of organic carbon macerals. Large bright yellow maceral not completely isotropic (contains yellow, blue, green interference colors near ends) which may be quartz silt behind maceral grain.
	Plane-polarized photomicrograph at high magnification detailing typical shape of yellow organic carbon maceral. Maceral is roughly 200 µm (0.008 inches) long. For comparison, human hair is generally 20-180 µm wide, so this maceral grain is as *long* as human hair is *wide*!

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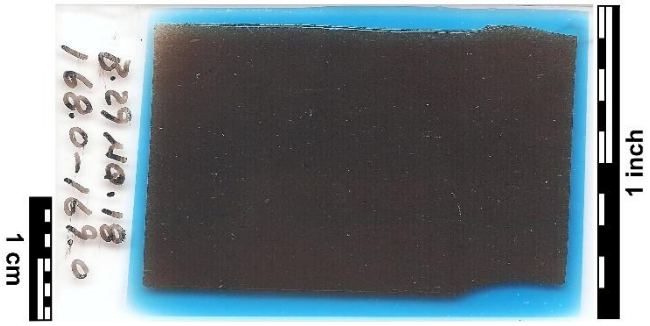
Sample: **B-29 NQ-18 @ 168.0-169.0**

Macroscopic sample description	**Dark gray shale** Dark gray fissile mudstone with irregular breaks spaced 4 mm. Very fine-grained pyrite along parting. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Organic carbon-rich mud matrix suspending rounded quartz silt, disseminated fine-grained pyrite that locally clumps to form larger aggregates, and larger sinusoidal yellow organic carbon macerals (fossil plant material?)		
Constituent minerals	Quartz silt	5%	<30 µm
	Quartz mud	44%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	14%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	31%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	2%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 µm equant, disseminated throughout and locally concentrated as >200 µm aggregates
	Organic	4%	300-µm-long, bright yellow, elongate, sinusoidal macerals with rounded ends plus finer-grained red matter in mud matrix
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		

Billet of dark gray shale
Homogeneous mudstone with very fine-grained pyrite (light spots) disseminated and along bedding.



Thin section slide of dark gray shale
Very fine-grained pyrite disseminated throughout. Blue epoxy impregnation indicates 0% observable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.5	0.6
Al_2O_3	14.6	18.6
SiO_2	52.3	66.5
P_2O_5	0.1	0.1
SO_2	2.1	2.7
K_2O	3.1	3.9
CaO	0.2	0.2
TiO_2	0.7	0.9
FeO	4.6	5.8
Total	78.6	100.0

Photograph of cut drill core of dark gray shale. Shaley parting on cut surface highlighted by soaking with water, then drying face. Parting is nearly planar. Top and bottom of sample are flat where cut by rock saw (i.e., not shaley parting).

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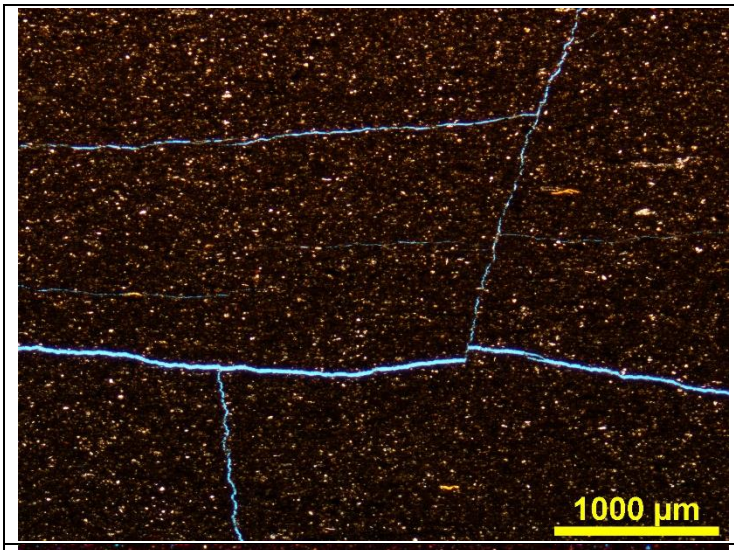
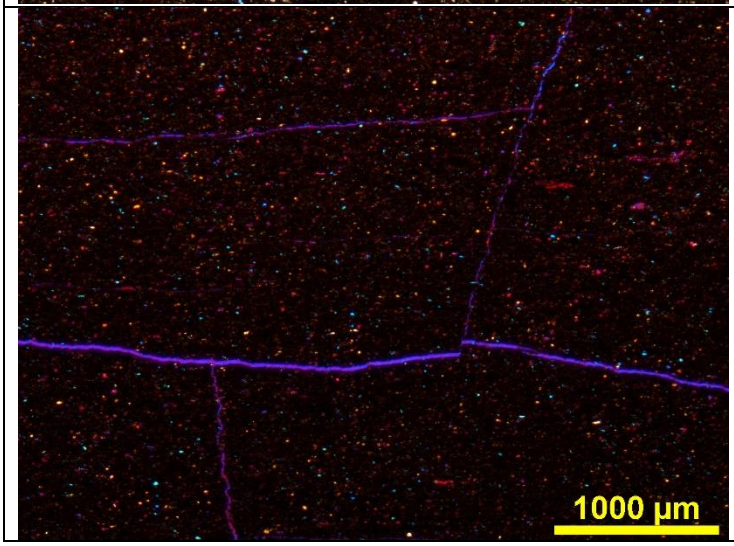
Sample: **B-29 NQ-18 @ 168.0-169.0**

	Plane-polarized photomicrograph of main body of sample documenting even dissemination of quartz silt (white), high brown organic carbon content of mud matrix, occurrence of elongate, bright yellow organic carbon macerals, and friable nature of sample (highlighted by blue epoxy impregnating fractures both along bedding and cross-cutting bedding).
	Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt is quartz (yellow/blue), and organic carbon macerals are isotropic (red).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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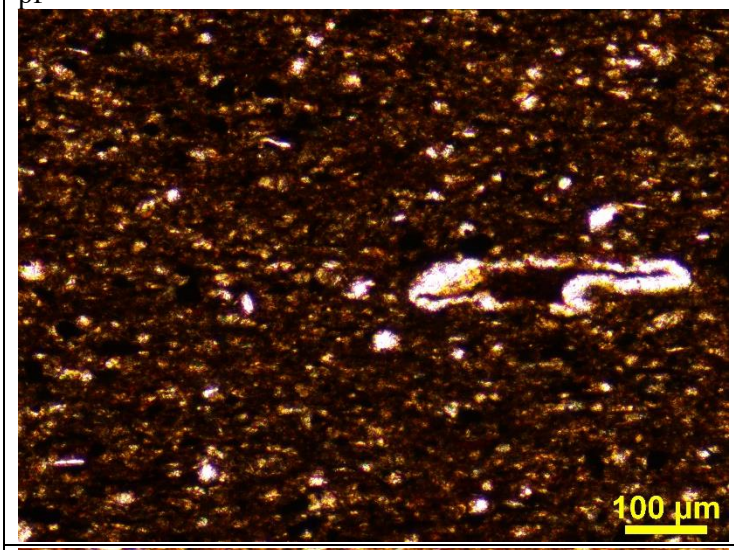
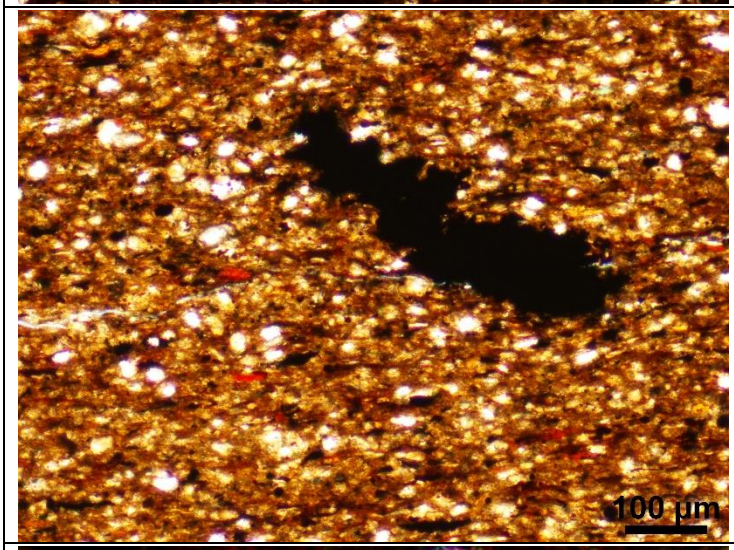
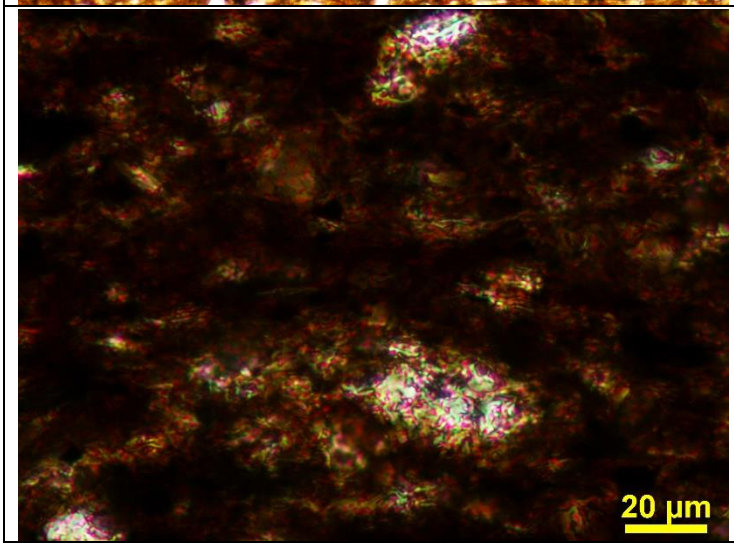
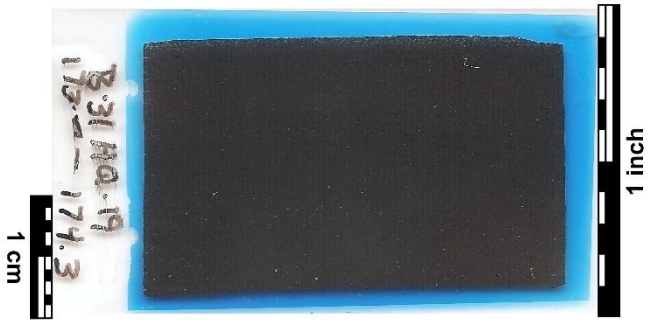
Sample: **B-29 NQ-18 @ 168.0-169.0**

pf 	Plane-polarized photomicrograph at high magnification of a white variation of the fossil material. Sample is isotropic (black in cross-polarized light, pink with gypsum plate inserted) and may be a typical yellow maceral plucked out of sample during thin section grinding leaving a hole of the characteristic shape. Traces of yellow material along the edges of the white zone support this hypothesis. Equant white grains are quartz silt.
	Plane-polarized photomicrograph at high magnification with condenser lens engaged for maximum brightness documenting tendency for very fine-grained pyrite grains to form larger aggregates. Red organic carbon macerals normally opaque in appearance under normal lighting intensities.
	Plane-polarized photomicrograph detailing quartz silt grain size and slightly elongate rounded shape.

Sample: **B-31 HQ-19 @ 173.0-174.3**

Macroscopic sample description	**Dark gray shale** Dark gray, fissile mudstone with irregular breaks spaced 8 mm. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Organic carbon-rich mud matrix suspending rounded quartz silt and very abundant larger carbon macerals of two varieties: bright yellow elongate sinusoidal (plant fossils?) and dark red oval grains (other plant fossils?). Trace disseminated fine-grained pyrite.		
Constituent minerals	Quartz silt	5%	<30 µm
	Quartz mud	38%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	18%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	32%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	1%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 µm equant, disseminated
	Organic	5%	200-250-µm-long, bright yellow, elongate, sinusoidal macerals with rounded ends plus <300 µm ovoid dark red macerals plus finer-grained red/brown material in mud matrix
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		

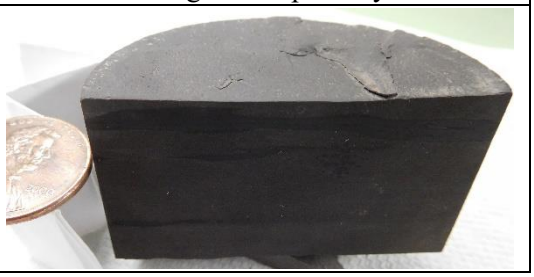
Billet of dark gray shale
Homogeneous mudstone. Gray patches are air bubbles on sample surface.



Thin section slide of dark gray shale
Homogeneous dark mudstone. Blue epoxy impregnation indicates 0% observable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.4	0.5
Al_2O_3	16.2	20.3
SiO_2	49.1	61.6
P_2O_5	0.0	0.1
SO_2	3.9	4.9
K_2O	3.2	4.0
CaO	0.0	0.0
TiO_2	0.6	0.8
FeO	5.6	7.1
Total	79.6	100.0

Photograph of cut drill core of dark gray shale. Shaley parting on cut surface highlighted by soaking with water, then drying face. Parting is nearly planar with only minor undulations.



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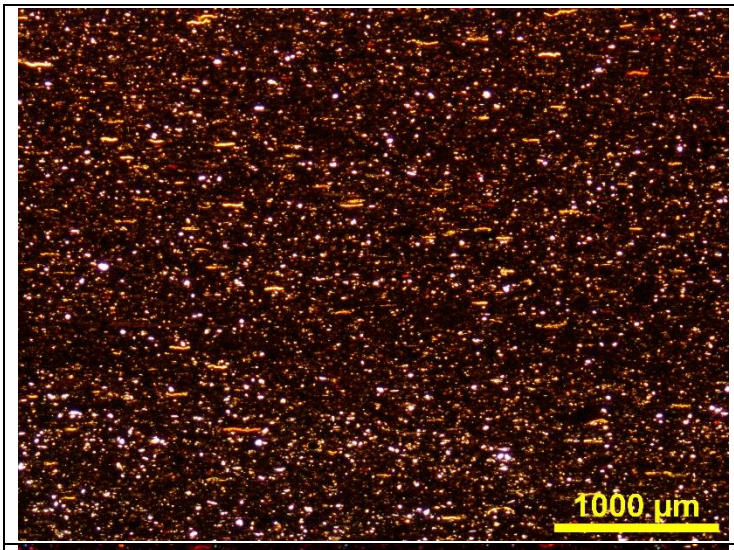
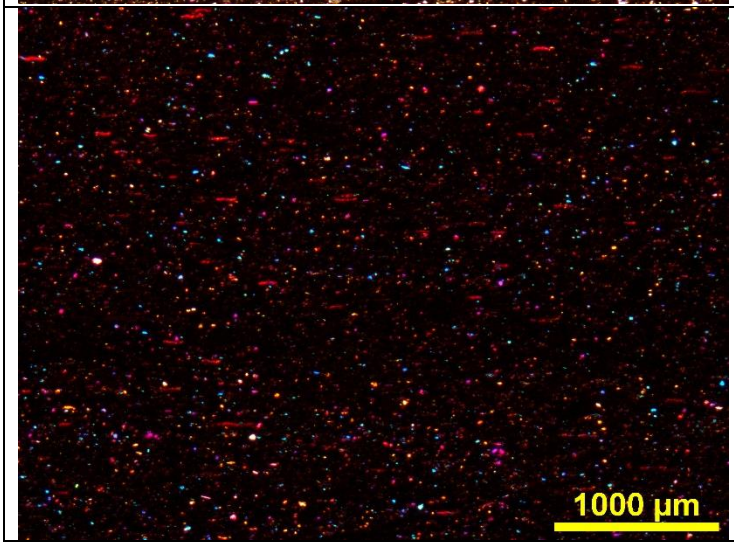
Sample: **B-31 HQ-19 @ 173.0-174.3**

	Plane-polarized photomicrograph of main body of sample documenting high organic carbon content both as reddish-brown mass in mud matrix and as abundant elongate bright yellow macerals. Abundant quartz silt (white), plus sparse disseminated very fine-grained pyrite throughout (black).
	Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt grains are quartz (yellow/blue) and organic carbon macerals are isotropic (red).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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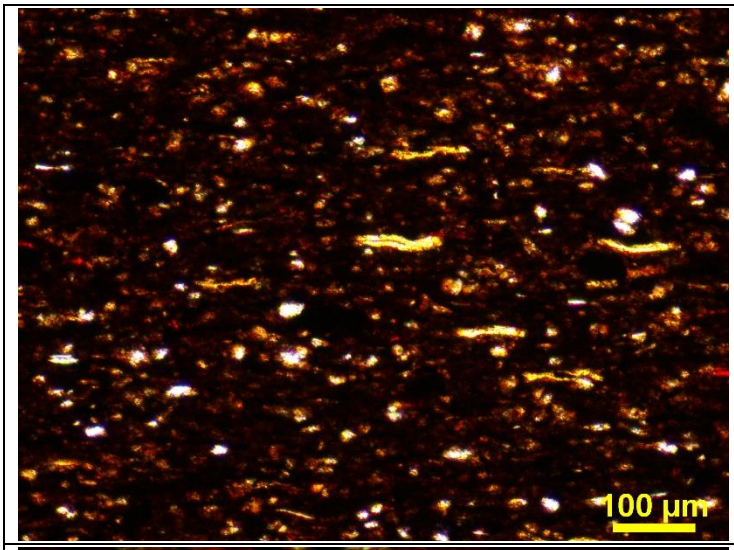
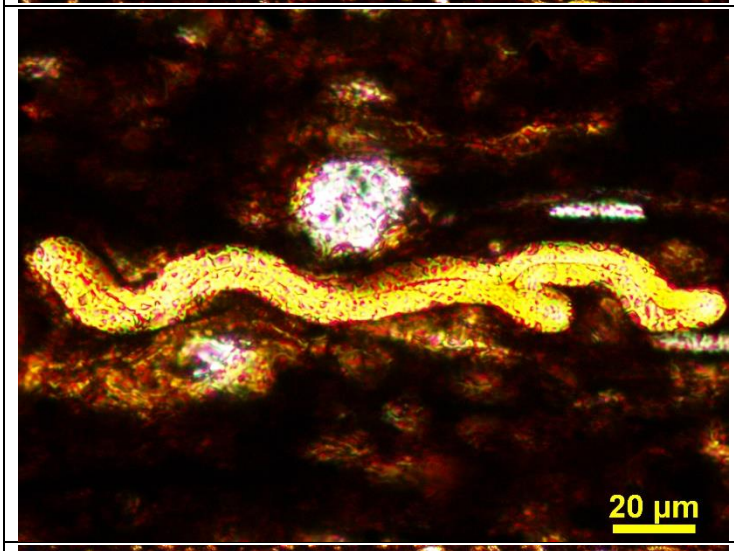
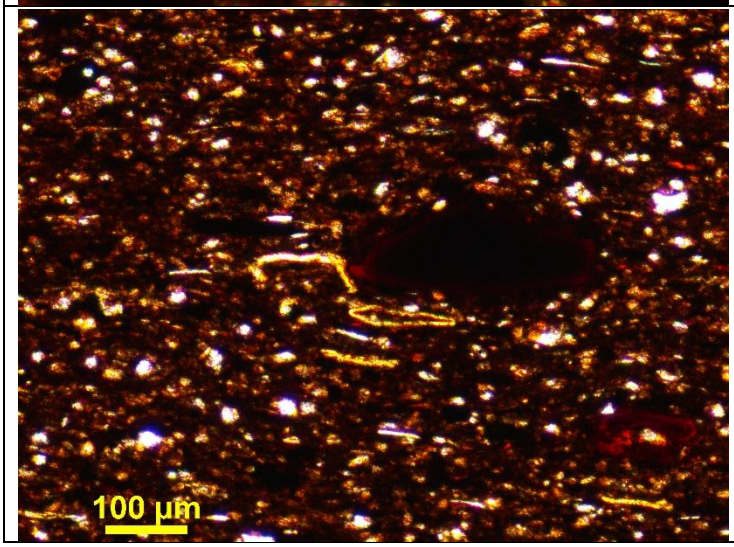
Sample: **B-31 HQ-19 @ 173.0-174.3**

	Plane-polarized photomicrograph at higher magnification showing parallel-aligned, consistent-size, bright yellow, highly-elongate, hoop-shaped organic carbon macerals (plant fossils?) and white quartz silt grains. Red in matrix due to different form of organic carbon.
	Plane-polarized photomicrograph detailing shape of bright yellow organic carbon maceral with branching shape. White grain is quartz silt grain (0.001 inches diameter).
	Plane-polarized photomicrograph comparing bright yellow macerals with red carbon macerals. White grains are quartz silt.

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Sample: **B-33 NQ-18 @ 179.2-180.1**

Macroscopic sample description	**Pyritiferous shale** Black fissile mudstone with irregular breaks spaced 3 mm. Very fine-grained pyrite forming mm-thick concretion along parting. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Organic carbon-rich mud matrix suspending very sparse quartz silt and abundant bright-yellow elongate sinusoidal (plant fossils?). Disseminated fine-grained pyrite in mud and as large aggregates of fine-grained pyrite with gradational boundaries transitioning to overlying/underlying mudstone.		
Constituent minerals	Quartz silt	1%	<30 μm equant
	Quartz mud	38%	<5 μm granules in mud *(proportion calculated chemically)*
	Kaolinite	19%	<1 μm in mud *(proportion calculated chemically)*
	Muscovite	33%	<5 μm flakes in mud *(proportion calculated chemically)*
	Chlorite	2%	<5 μm flakes in mud *(proportion calculated chemically)*
	Pyrite	2%	20 μm equant, disseminated throughout mud matrix and forming very large massive aggregates of small crystals. Massive aggregates have gradational transitions with underlying mudstone.
	Organic	4%	200-250-μm-long, bright yellow, elongate, sinusoidal macerals with rounded ends plus <300 μm ovoid dark red macerals plus finer-grained red/brown material in mud matrix
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding with pyrite concretions		

Billet of pyritiferous shale
Light pinch/swell layer is concretionary aggregate of very fine-grained pyrite.

Thin section slide of pyritiferous shale
Shaley parting highlighted by blue epoxy.
Blue epoxy impregnation indicates 0% macroscopic intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.8
MgO	0.5	0.6
Al_2O_3	16.0	19.9
SiO_2	47.4	59.3
P_2O_5	0.1	0.1
SO_2	5.6	7.0
K_2O	3.1	3.9
CaO	0.1	0.1
TiO_2	0.6	0.8
FeO	6.1	7.6
Total	80.0	100.0

Photograph of cut drill core of pyritiferous shale. Note high fissility with irregular/non-planar parting, and concentration of pyrite along some partings (arrow).

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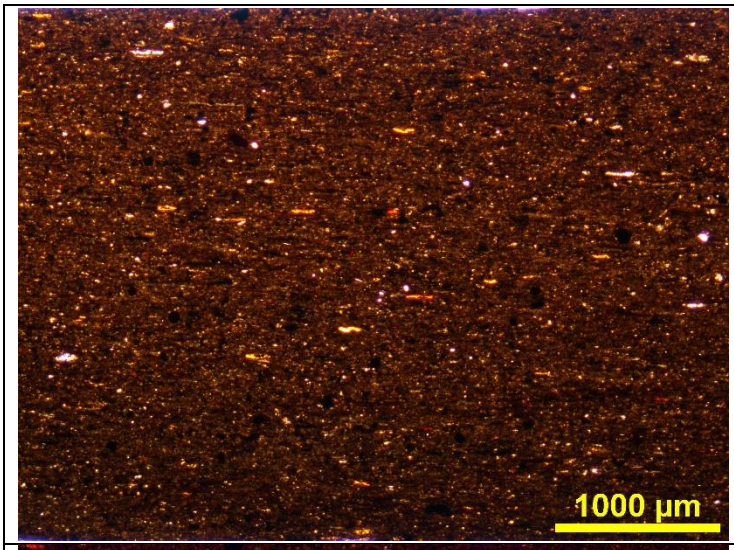
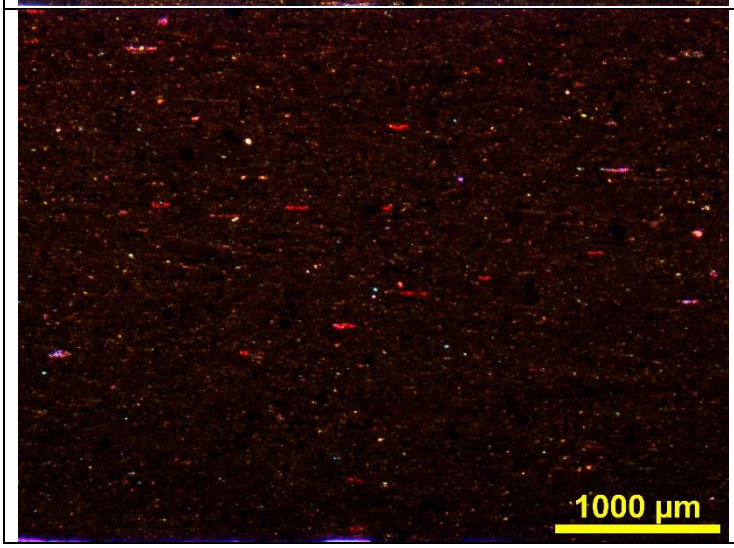
Sample: **B-33 NQ-18 @ 179.2-180.1**

	Plane-polarized photomicrograph of main body of sample documenting low quartz silt content (white), high disseminated opaque pyrite (black), and moderately high abundance of parallel, bright yellow organic carbon macerals in carbon-rich mud matrix.
	Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt is quartz (yellow/blue) and carbon macerals are isotropic.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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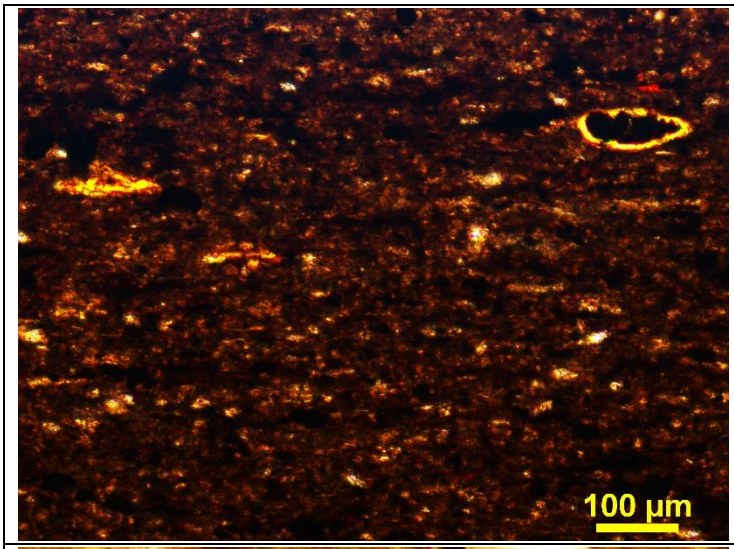
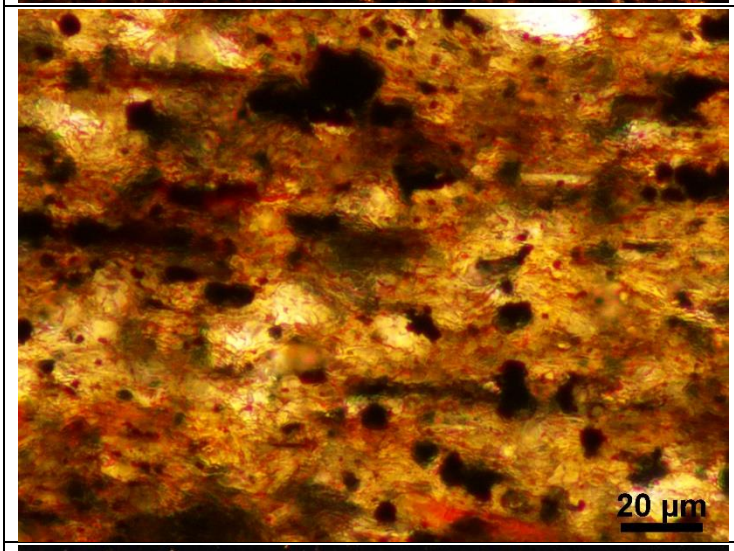
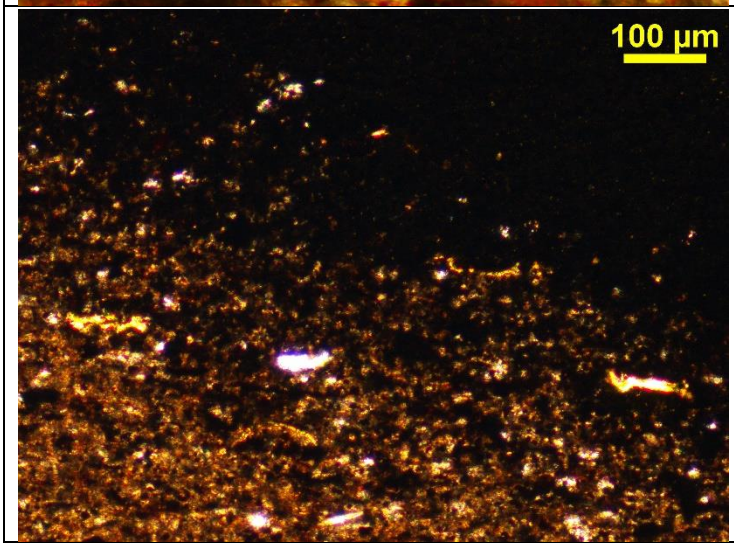
Sample: **B-33 NQ-18 @ 179.2-180.1**

	Plane-polarized photomicrograph detailing enclosed shapes of yellow organic carbon macerals, presence of red variety of organic carbon, and sparseness of quartz silt grains. Black opaque grains are pyrite.
	Plane-polarized photomicrograph at very high magnification with condenser lens engaged for maximum brightness to distinguish between truly opaque (black) pyrite and nearly-opaque organic carbon macerals (reddish brown).
	Plane-polarized photomicrograph of the edge of one of the large lensoidal pyrite aggregates along bedding. Note how pyrite aggregate is gradational from nearly pure pyrite (top right) to progressively less pyrite with increasing mud matrix toward the lower left (into underlying shale layer).

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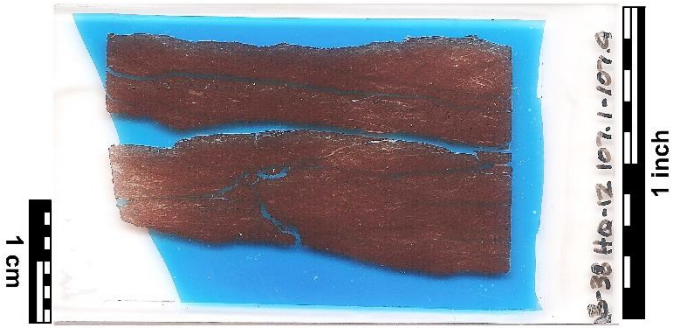
Sample: **B-38-HQ-12 @ 107.1-107.9**

Macroscopic sample description	**Maroon siltstone** Very friable maroon red siltstone that swells quickly upon wetting. Sample parts along bedding to form chips, but in inconsistent, non-planar way. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Chaotic maroon hematite-rich clay-mica mud suspending sparse angular quartz silt. Trace green chlorite disseminated throughout.		
Constituent minerals	Quartz	40%	3% 40 μm highly angular quartz silt grains, remainder as <5 μm silt component of mud matrix
	Muscovite	38%	1% <20 μm detrital grains, with remainder as very fine-grained high birefringence component of mud matrix
	Kaolinite	20%	<1 μm indistinct due to heavy hematite staining, estimated based on XRF chemical analysis
	Hematite	2%	<<1 μm pigment giving sample deep maroon color and observed as high iron content in XRF analysis without accompanying high sulfur analysis.
	Chlorite	<<0.1%	5-10 μm bright green flakes with brown interference colors
Porosity	0% intergranular porosity and 4% fracture porosity		
Heterogeneity	Weak shaley parting, but highly friable and swells when wet		

Billet of maroon siltstone
Very friable and swells quickly when wetted, forming red mud paste.



Thin section slide of maroon siltstone
Homogeneous with weakly-developed bedding. Blue epoxy impregnation indicates high fracture porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.8	0.9
Al_2O_3	18.7	22.1
SiO_2	52.1	61.6
P_2O_5	0.1	0.1
SO_2	0.8	0.9
K_2O	3.8	4.5
CaO	0.7	0.9
TiO_2	0.9	1.1
FeO	6.0	7.1
Total	84.6	100.0

Photograph of cut drill core of maroon siltstone. Sample is extremely friable. Sample swells when wet, popping out of epoxy block (see below).

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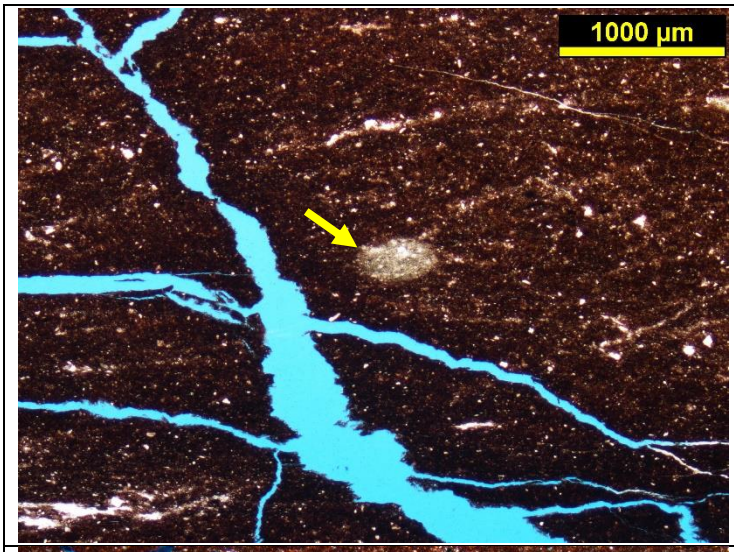
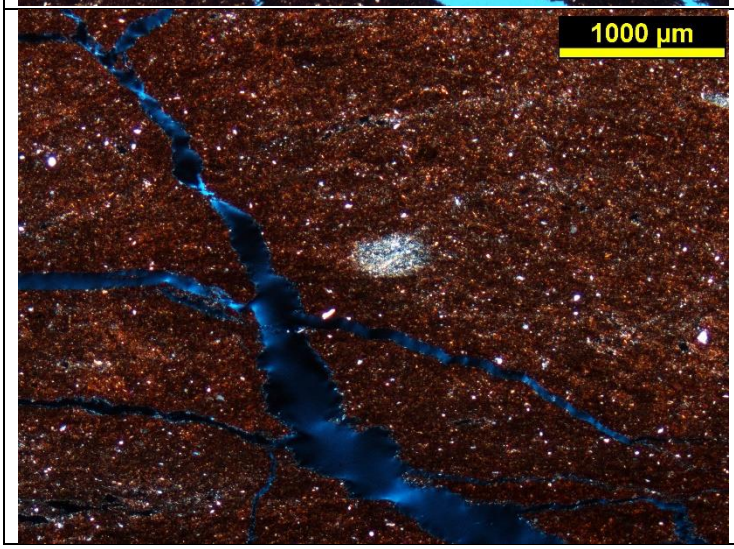
Sample: **B-38-HQ-12 @ 107.1-107.9**

	Plane-polarized photomicrograph of main body of sample showing lack of consistent lamination in massive mud-supported siltstone. Blue epoxy impregnates fractures. Small white grains in red hematite-rich mud matrix are quartz silt. Arrow indicates round quartz silt-rich grain with distinctly more quartz-rich composition (i.e., not reduction spot, rather is polycrystalline grain).
	Cross-polarized photomicrograph of same spot on slide showing high birefringence of micas in mud matrix (very tiny yellow flakes) and quartz-rich composition of oval spot.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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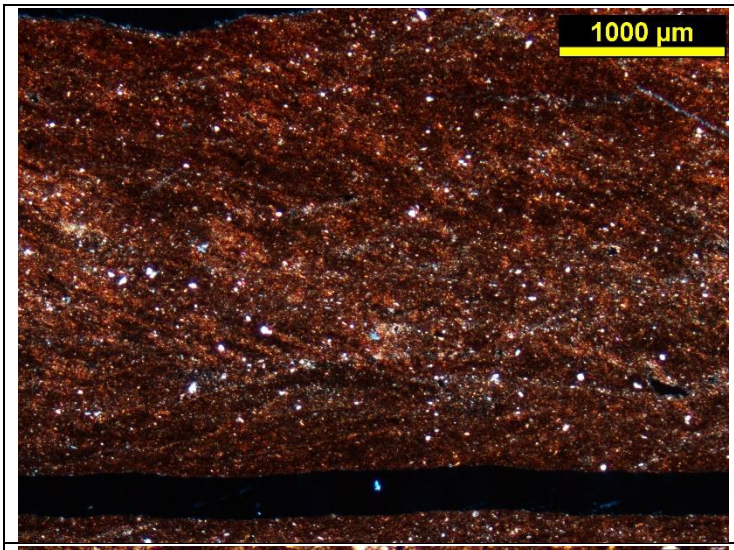
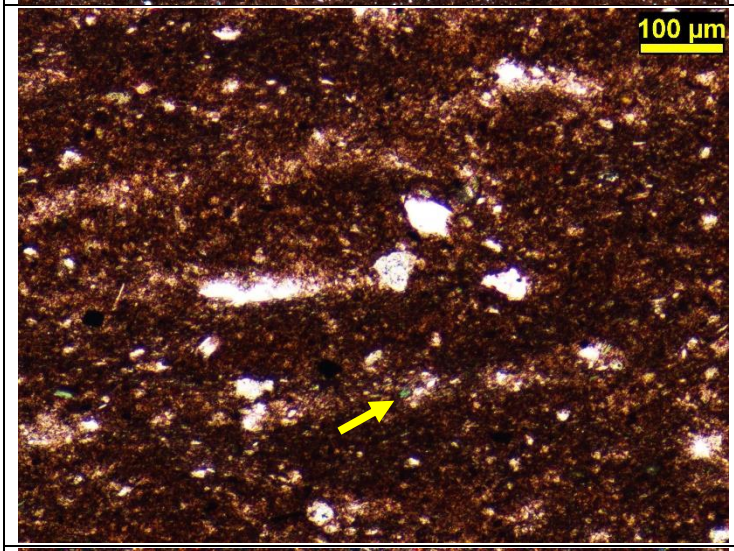
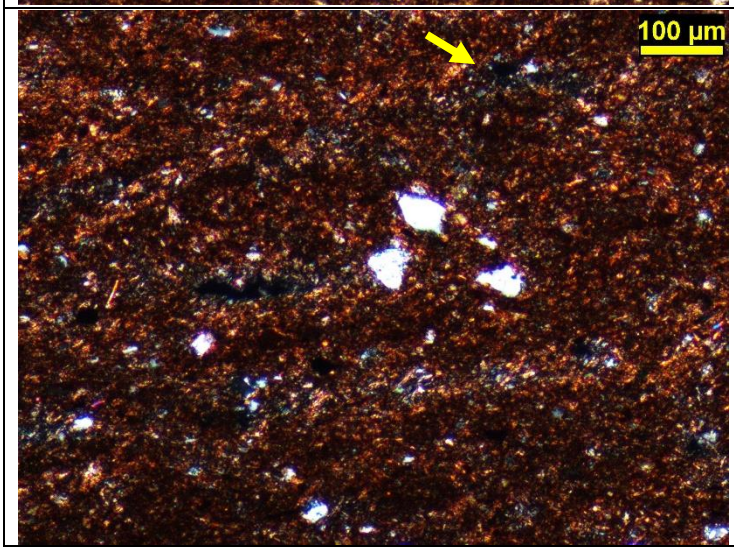
Sample: **B-38-HQ-12 @ 107.1-107.9**

	Cross-polarized photomicrograph of very faintly-developed cross laminations (upper third of image with beds sloping down to right).
	Plane-polarized photomicrograph at high magnification of quartz silt (sharply-bounded white grains), bright green chlorite grains (e.g., arrow), and unknown opaque cubes (black).
	Cross-polarized photomicrograph of same spot on slide showing angular nature of quartz silt grains (white). Note that white spots in image above are lined with fine-grained low-birefringence clay (e.g., arrow).

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Sample: **B-39-HQ-6 @ 154.6-155.5**

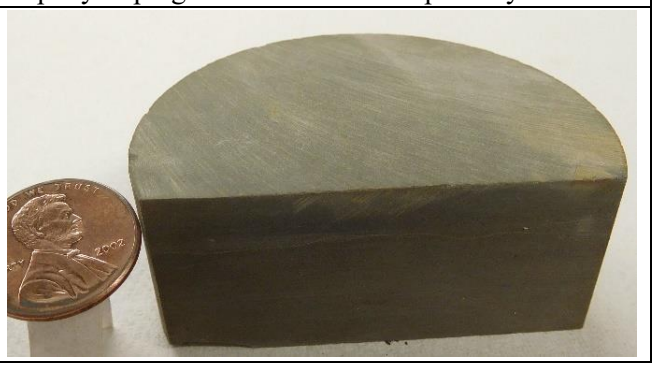
Macroscopic sample description	**Light gray siltstone** Massive light gray (40 gray color dry, 60% gray wet) fine-grained siltstone lacking lamination or fissile shale partings. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Bimodal grain size of sparse coarse quartz silt suspended in extremely fine-grained quartz silt-dominated matrix with subordinate mica/clay mud. Trace disseminated very fine-grained pyrite. Fossil plant material as kerogen. Possible dolomite replacement (?) of one fossil or primary carbonate bivalve fossil.		
Constituent minerals	Quartz	57%	3% 10-50 µm angular coarser silt suspended in remainder as <5 µm matrix material
	Muscovite	25%	<1% 20 µm green detrital flakes with high birefringence, remainder as subordinate high-birefringence component of matrix
	Kaolinite	17%	<1 µm first-order gray component of mud matrix
	Pyrite	<0.1%	<5 µm isolated anhedral opaque grains disseminated without clustering
	Dolomite	<0.1%	<5 µm extremely high birefringence "pseudo-fibrous" mineral of which large fossil fragments consist
	Kerogen	<0.1%	amorphous dark brown fossil material
Porosity	0% intergranular porosity and 0% fracture porosity		
Heterogeneity	none		

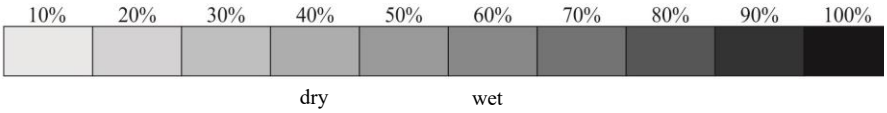
Billet of light gray siltstone
Massive siltstone without well-defined laminations.

Thin section slide of light gray siltstone
Slight grain size variation defines bedding (arrow)
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.6
MgO	1.9	2.2
Al_2O_3	12.0	14.1
SiO_2	54.2	63.7
P_2O_5	0.1	0.1
SO_2	0.4	0.4
K_2O	2.2	2.6
CaO	0.7	0.8
TiO_2	0.7	0.9
FeO	12.5	14.6
Total	85.2	100.0

Photograph of cut drill core of light gray siltstone. Bedding defined by single parting and slight color differences, but lacks distinct laminations or parting. Top surface flat due to saw cut.





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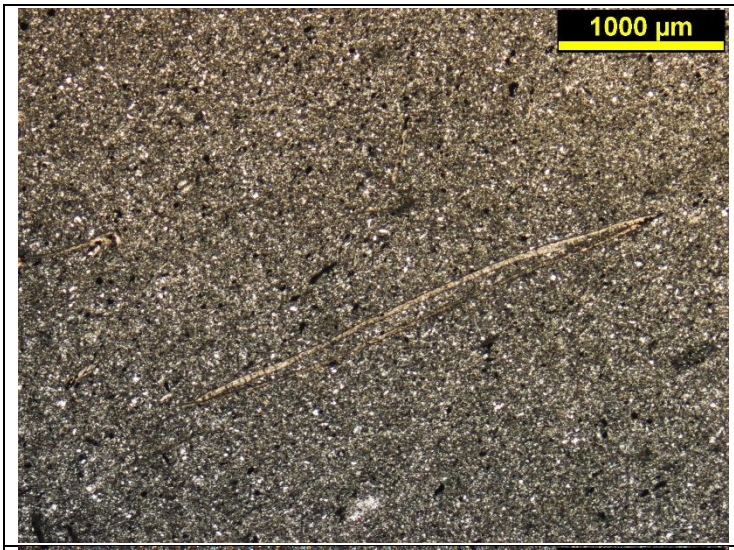
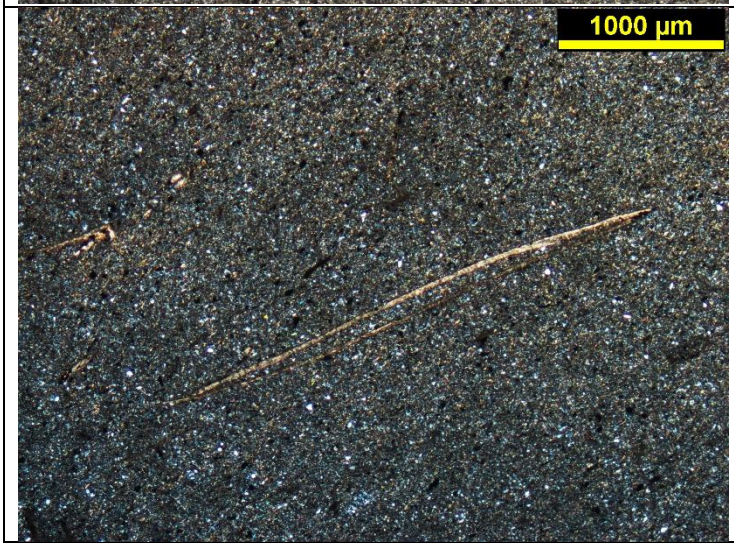
Sample: **B-39-HQ-6 @ 154.6-155.5**

	Plane-polarized photomicrograph of main body of sample with large and several smaller fossils. Note that although fossils have high aspect ratio, they not all aligned, suggesting rapid deposition. Very fine-grained disseminated black grains are opaques (yellow metallic luster in slide observed with hand lens suggests pyrite).
	Cross-polarized photomicrograph of same spot on slide showing fossil material is anisotropic (extremely high birefringence suggests ultrafine-grained carbonate?) Note abundance of first-order gray very fine-grained quartz silt (gray) relative to high-birefringence micas.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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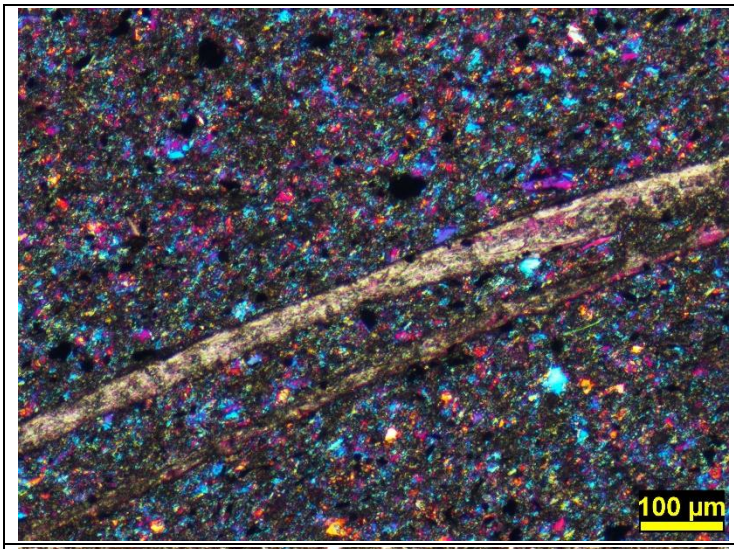
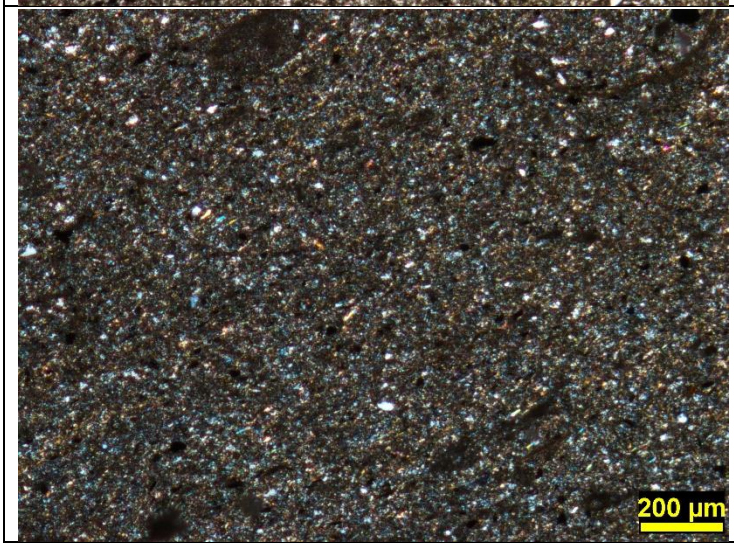
Sample: **B-39-HQ-6 @ 154.6-155.5**

	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) detail of large fossil showing extremely high-order interference colors of fossil material (carbonate? Sample does not react with acid, so dolomite?). Quartz silt appears bright blue or yellow in this illumination. Black grains are opaque pyrite. Long green flakes are detrital muscovite and matrix between quartz silt composed of mixture of highly birefringent micas plus minor clay.
	Plane-polarized photomicrograph of fossil fragment composed of amorphous organic carbon (kerogen). Quartz silt (equant white), detrital muscovite (white splinters), fine-grained micaceous-clay matrix (gray-green), and disseminated very fined-grained pyrite throughout. Blue line is epoxy-filled fracture.
	Cross-polarized photomicrograph of variety of organic carbon fossils suspended in very fine-grained quartz silt with subordinate mica in matrix.

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Sample: **B-39-HQ-7 @ 158.7-159.5**

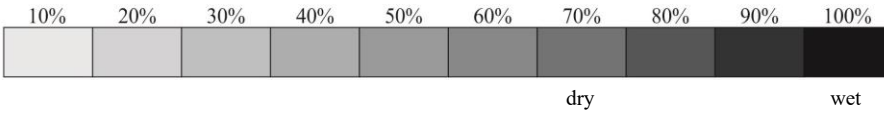
Macroscopic sample description	**Medium gray shale** 70% gray color dry, 100% gray wet moderately fissile shale with traces of pyrite as isolated equant grains and along bedding. 5 mm average thickness between partings with planar surfaces. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Sparse angular quartz silt grains suspended in fine-grained mica-dominant mud matrix. Organic carbon primarily as amorphous component of matrix, but also as distinct red and yellow fossil macerals. Trace disseminated very fine-grained pyrite locally forming bedding-parallel aggregates.		
Constituent minerals	Quartz	45%	5% as 50 μm angular equant silt grains randomly disseminated throughout the remainder which occurs as component of matrix
	Muscovite	34%	<1% as 20-100 μm detrital flakes aligned parallel to bedding, remainder as high-birefringence component of mud matrix that goes extinct when bedding aligned parallel to microscope's polarization
	Kaolinite	17%	<1 μm low-birefringence component of mud matrix
	Pyrite	<1%	10 μm anhedral opaque disseminated grains and as <700 μm aggregates of <10 μm grains with quartz-filled voids
	Kerogen	4%	<0.1% as 100 μm yellow flattened loop-shaped fossils, 0.5% as red flake macerals, remainder as amorphous brown in matrix
Porosity	0% intergranular porosity and <0.1% fracture porosity along shale parting		
Heterogeneity	highly fissile shale partings		

Billet of medium gray shale
Wet sample almost as dark as epoxy. Gray splotches are air bubbles on surface.

Thin section slide of medium gray shale
Widely-spaced shale parting distinct.
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.6	0.7
Al_2O_3	16.7	19.8
SiO_2	55.8	66.3
P_2O_5	0.1	0.1
SO_2	1.6	1.9
K_2O	3.4	4.1
CaO	0.2	0.2
TiO_2	0.8	1.0
FeO	4.4	5.3
Total	84.2	100.0

Photograph of cut drill core of medium gray shale.
Top surface is cut by saw, but parting in middle of sample is planar.



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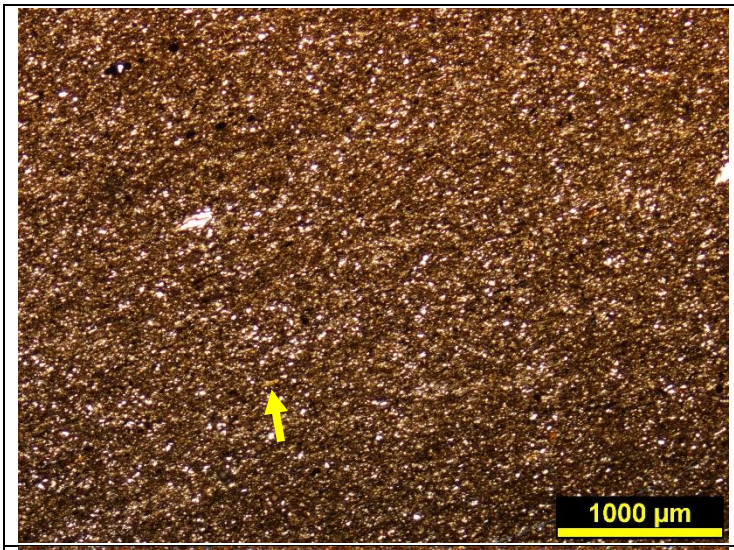
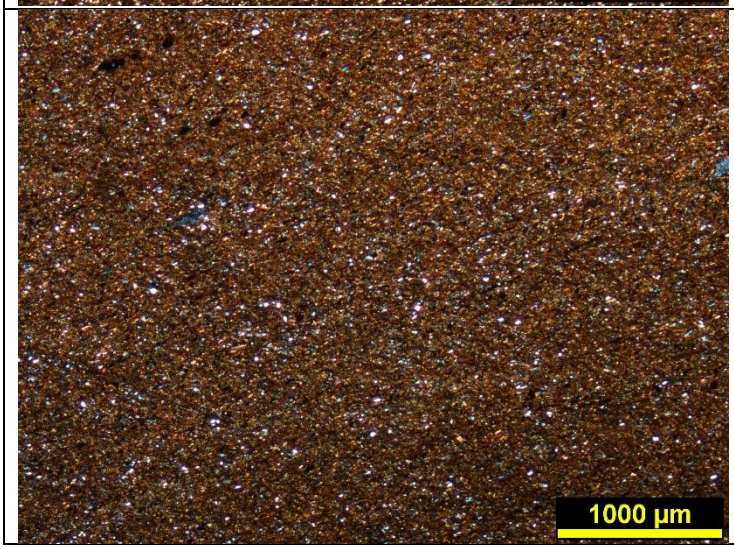
Sample: **B-39-HQ-7 @ 158.7-159.5**

	Plane-polarized photomicrograph of main body of sample documenting very low pyrite content as isolated grains (larger aggregates not shown here). Quartz silt (discrete white grains) homogenously disseminated throughout mud matrix. Sparse orange and red flakes, and yellow squashed-loop fossil (arrow) kerogen macerals throughout.
	Cross-polarized photomicrograph of same spot on slide showing high-order interference colors of majority of matrix (mica component), and sparseness of detrital muscovite (brightly-colored splinters). Quartz silt is gray/white in this illumination.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

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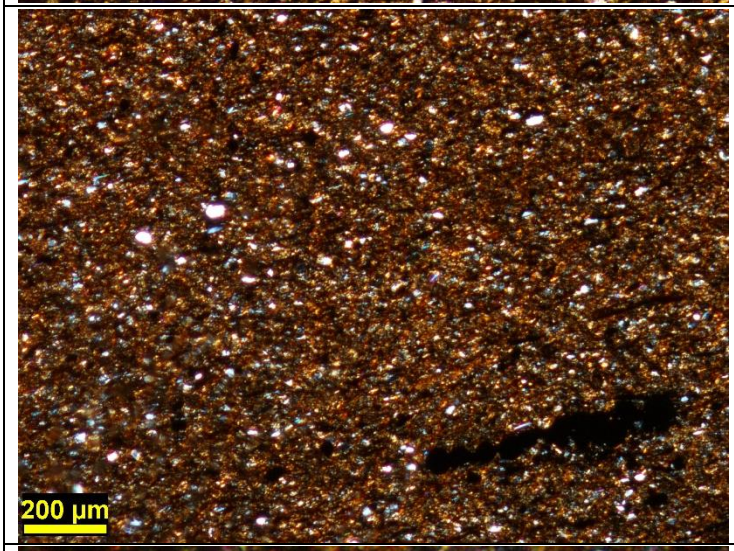
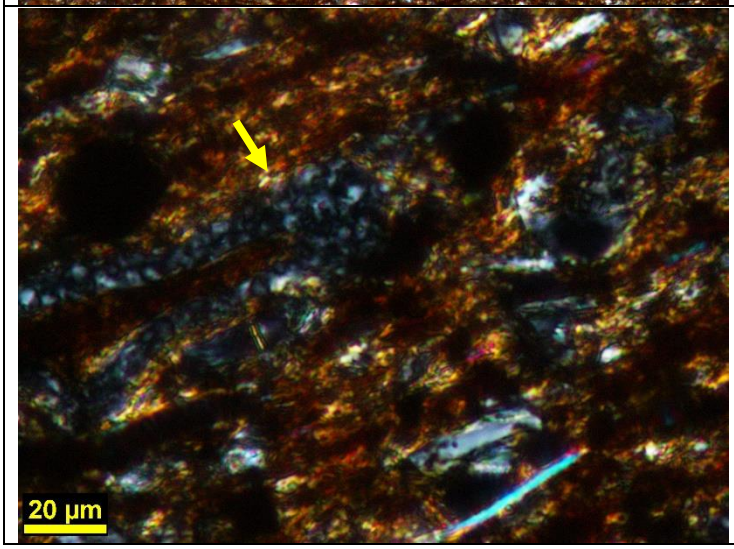
Sample: **B-39-HQ-7 @ 158.7-159.5**

	Plane-polarized photomicrograph detail of yellow squashed-loop kerogen fossil. Note distinctly separate red flake kerogen macerals (e.g., arrow), and brown amorphous kerogen mixed with mica/clay mud matrix. White grains are quartz silt.
	Cross-polarized photomicrograph of aggregate of fine-grained pyrite aligned parallel to bedding. Micas in matrix have high birefringence (yellows/golden), dominating matrix mineralogy. Large white grains are quartz silt.
	Cross-polarized photomicrograph at very high magnification of low-birefringence clay-filled fossil cavity (arrow). Brightly-colored material mixed with brown is mica in mud matrix. Detrital muscovite flake at bottom of image (blue). Note highly angular shape of quartz silt grain above detrital muscovite flake.

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Sample: **B-40-HQ-5 @ 27.8-28.8**

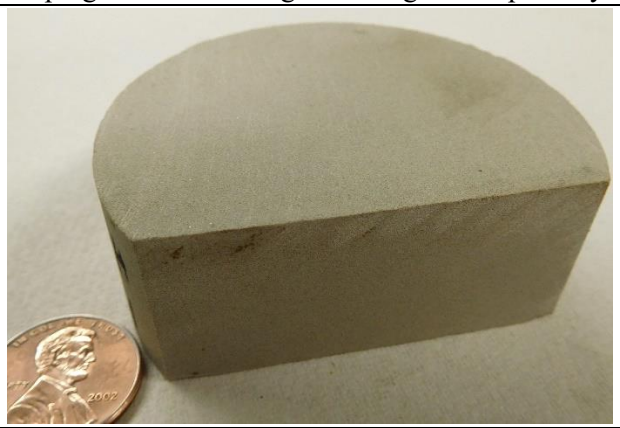
Macroscopic sample description	**Very fine-grained quartz arenite sandstone** 20% gray color dry, 40% gray wet, very well-sorted, very fine-grained quartz arenite with no visible mud matrix. No distinct bedding – homogeneous and isotropic. Nonmagnetic. Scratches with steel scribe, but also hard/abrasive enough to use as whetstone (cementation is too weak for commercial use). No visible reaction with acid.		
Brief petrographic description	Extremely well-sorted, highly-angular, very fine-grained quartz sand with minimal clay/mica matrix. Anhedral dolomite occurs as discrete grains (detrital?). Very fine-grained pyrite and discrete spheroidal amorphous brown kerogen masses disseminated evenly throughout.		
Constituent minerals	Quartz	85%	30-100 µm very highly angular fine sand, minimal overgrowths/cement
	Muscovite	8%	<0.5% 100-300 µm detrital flakes, remainder as 5-10 µm matrix grains
	Kaolinite	5%	<1 µm detectable by XRF composition (Al_2O_3 content) as part of first-order gray matrix between sand grains
	Dolomite	1%	100 µm anhedral, extreme birefringence, distinct detrital grains (i.e., not cement)
	Pyrite	1%	20-50 µm equant opaque, brassy yellow in reflected light
	Kerogen	<0.5%	amorphous brown material in round 100 µm ovoid masses with diffuse boundaries
Porosity	8% intergranular porosity and 0% fracture porosity		
Heterogeneity	none		

Billet of fine-grained quartz arenite sandstone
Homogeneous, completely lacking lamination or other bedding features

Thin section slide of fine-grained quartz arenite sandstone
Note very consistent grain size (well-sorted) and blue epoxy impregnation indicating 8% intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.6
MgO	1.0	1.1
Al_2O_3	4.7	5.2
SiO_2	81.3	89.8
P_2O_5	0.1	0.1
SO_2	0.3	0.3
K_2O	0.9	1.0
CaO	0.2	0.3
TiO_2	0.6	0.7
FeO	0.9	1.0
Total	90.5	100.0

Photograph of cut drill core of fine-grained quartz arenite sandstone. Note lack of bedding laminations or other sedimentary textures. Sloping lines near top of sample are saw marks.



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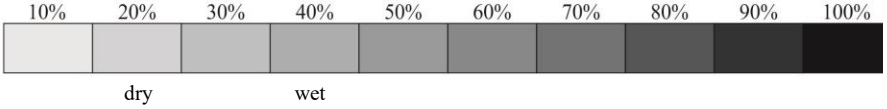
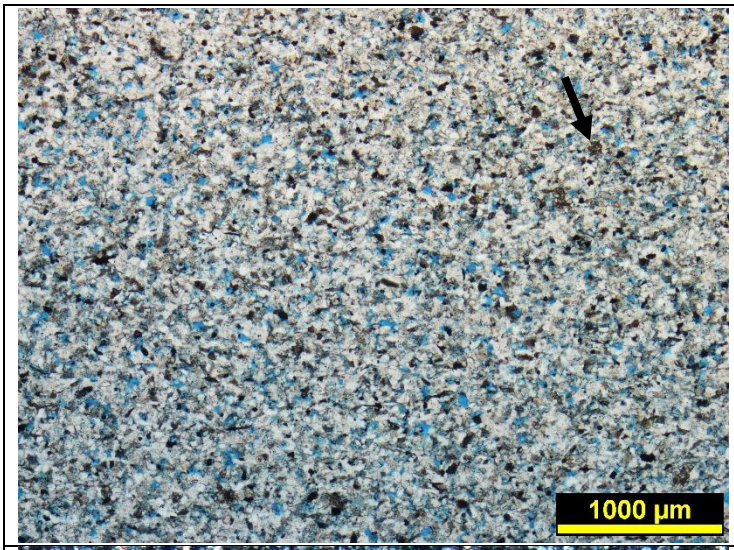
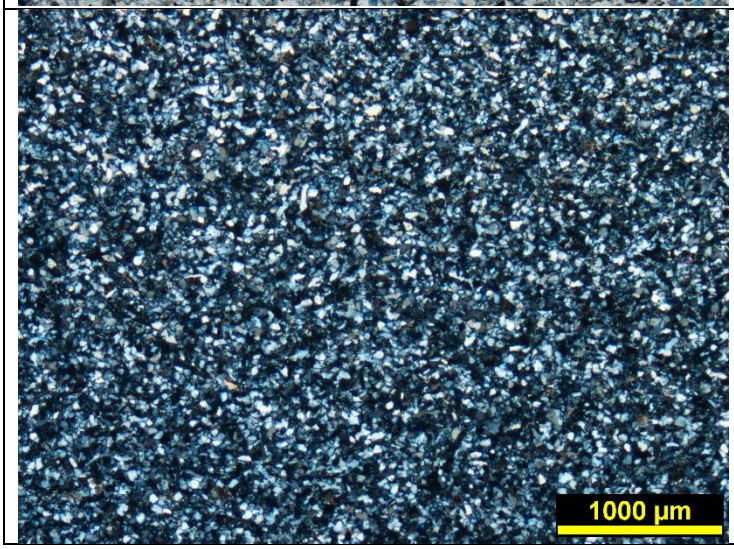


Sample: **B-40-HQ-5 @ 27.8-28.8**

	Plane-polarized photomicrograph of main body of sample documenting high intergranular porosity (highlighted by blue epoxy), homogeneous, non-laminated nature of sample, and very high quartz content (white). Darker brown grains are carbonate (e.g., arrow).
	Cross-polarized photomicrograph of same spot on slide showing uniform, well-sorted fine-grained quartz sand composition (grays) with sparse high-birefringence grains (khaki-colored = carbonate).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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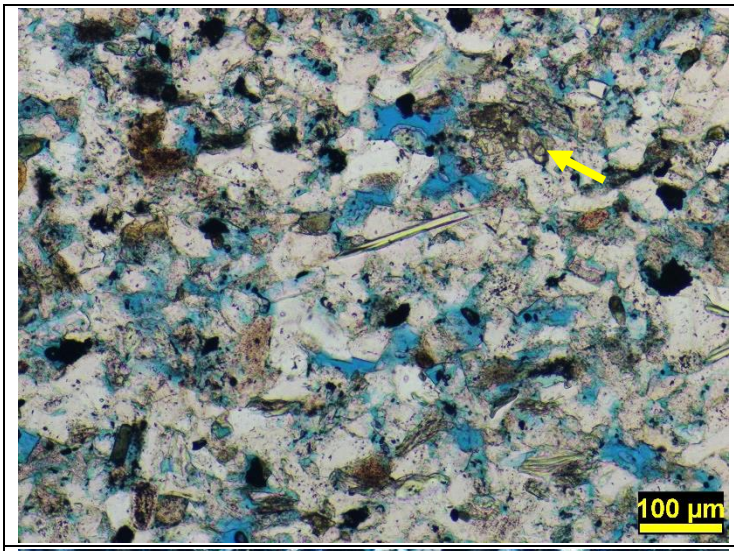
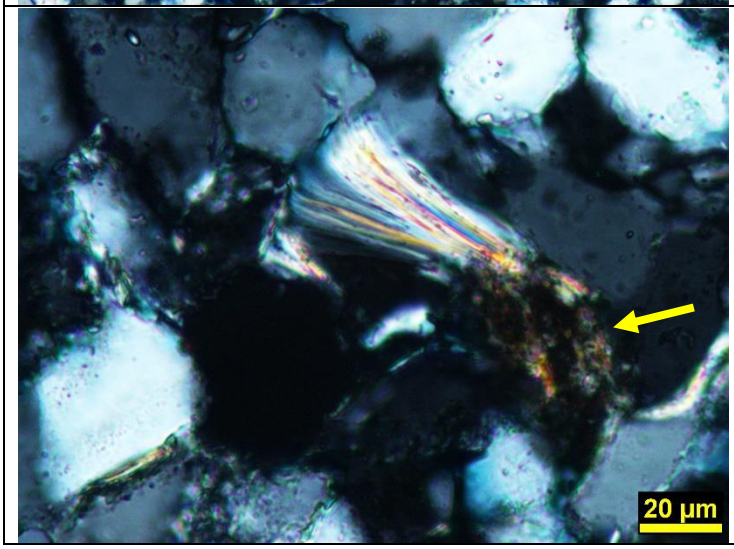
Sample: **B-40-HQ-5 @ 27.8-28.8**

	Plane-polarized photomicrograph documenting high intergranular porosity (blue epoxy) between quartz sand (white) grains. Light green linear flake in center is detrital muscovite. Muddy khaki-colored grains (e.g., arrow) are carbonate. Lack of reaction with acid suggests dolomite rather than calcite. Black grains are opaque pyrite. Brown smudges are amorphous organic carbon (kerogen).
	Cross-polarized photomicrograph of same spot on slide showing very high order interference colors of anhedral dolomite grains (arrow) and detrital muscovite (orange/blue splinter in center).
	Cross-polarized photomicrograph at very high magnification documenting grain size of finer component of quartz sand/silt, muscovite (“hair” brightly-colored grain in center), and discrete amorphous kerogen maceral (arrow).

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Sample: **B-40-HQ-16 & 17 @ 84.8-85.6**

Macroscopic sample description	**Light gray shaley siltstone** 50% gray color dry, 70% gray wet highly fissile shale with 7 mm average thickness between partings with irregular surfaces. Sample swells when wet to form tiny splinters that puff out of epoxy billet. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Alternating, sharply-bounded, sub-mm laminae of highly angular quartz silt and mica-clay mudstone. Evenly disseminated very fine-grained opaque magnetite/martite.		
Constituent minerals	Quartz	43%	20-30 μm equant, highly-angular, moderately-sorted first-order gray interference grains concentrated in silt-rich, mica-clay-poor 200-1,000 μm thick laminae, minor component as <2 μm grains in mud-rich laminae with very sparse, isolated 50-100 μm grains
	Muscovite	38%	<0.1% as 50 μm detrital flakes, remainder as dominant mineral in mud matrix with high birefringence and parallel extinction
	Kaolinite	17%	<1 μm low-birefringence component of mud matrix
	Magnetite	1%	10-40 μm anhedral equant opaque grains, black metallic in billet, no magnetism detected with swivel magnet either due to sparseness or oxidation of magnetite to hematite pseudomorph (martite), or high Fe with low S content in XRF chemical analysis supportive evidence
	Chlorite	<0.1%	10-20 μm flakes in 100 μm clots – green with brown-green extinction
Porosity	0% intergranular porosity and 0% fracture porosity		
Heterogeneity	strongly fissile shaley parting that's further weakened by swelling when wet		

Billet of light gray shaley siltstone
Clay-rich layers swelled when wet and plucked from billet, leaving quartz silt layers as ridges.

Thin section slide of light gray shaley siltstone
White quartz silt laminae alternate with brown clay-mica mud. Note black opaque minerals are too fine to see at this magnification.
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.8
MgO	0.5	0.7
Al_2O_3	14.8	19.8
SiO_2	46.5	61.9
P_2O_5	0.1	0.1
SO_2	0.2	0.3
K_2O	3.2	4.2
CaO	0.4	0.6
TiO_2	0.8	1.1
FeO	7.9	10.6
Total	75.0	100.0

Photograph of cut drill core of light gray shaley siltstone. Note wavy shale parting and slight color banding due to variations in silt content between laminae.

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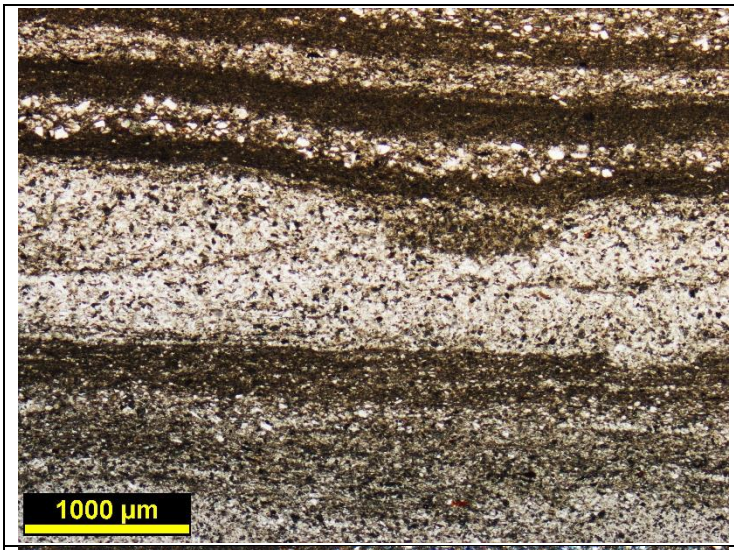
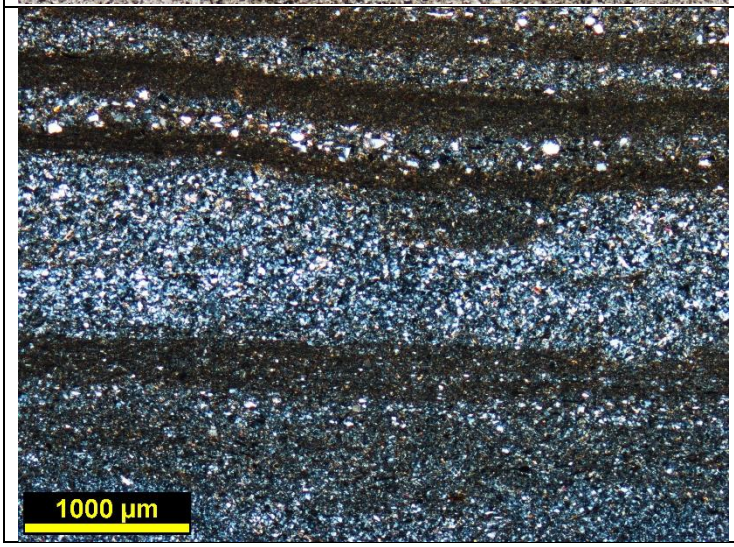
Sample: **B-40-HQ-16 & 17 @ 84.8-85.6**

	Plane-polarized photomicrograph of main body of sample documenting sharply distinct mica-clay-rich (brown) and quartz silt-rich laminae (white).
	Cross-polarized photomicrograph of same spot on slide showing high birefringence of micas in muddy laminae (brown/yellow), and sparsity of micas in quartz silt laminae (brightly-colored grains in field of white/gray/black specks).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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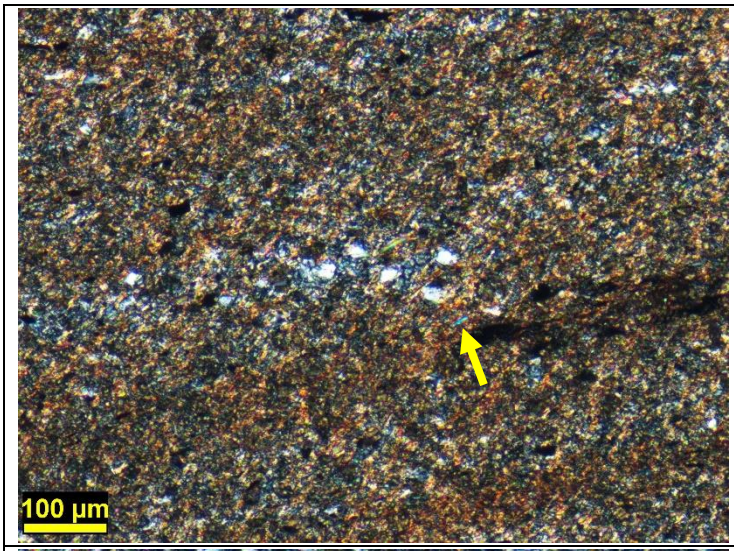
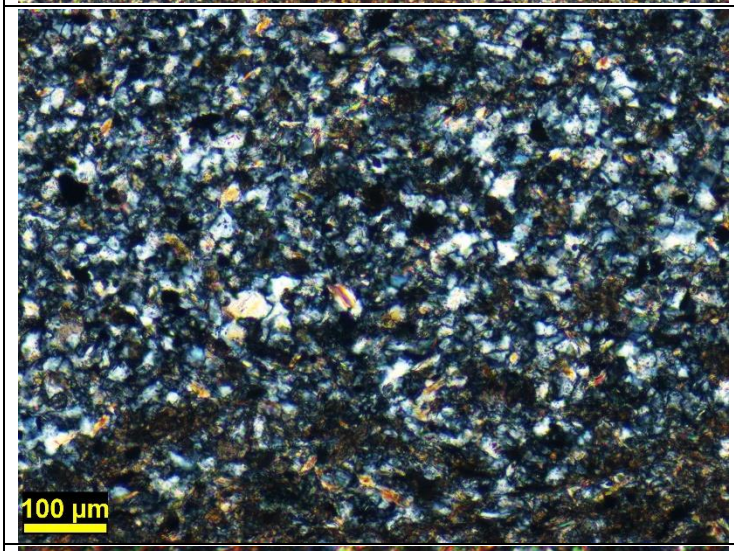
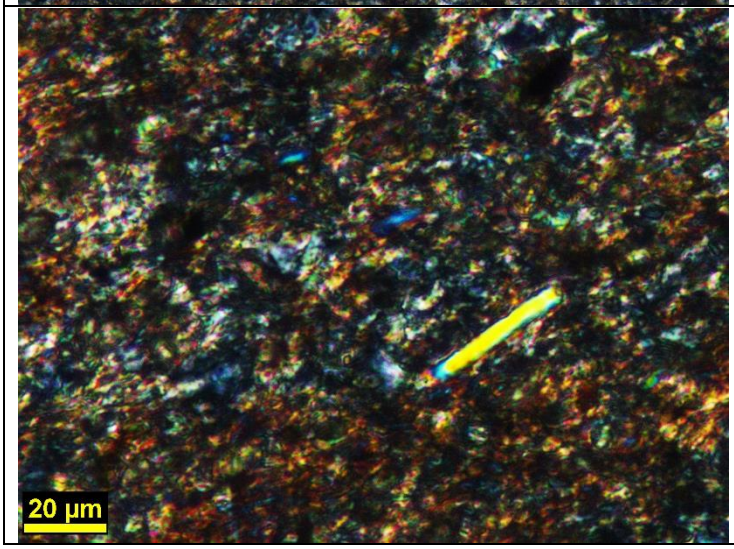
Sample: **B-40-HQ-16 & 17 @ 84.8-85.6**

	Cross-polarized photomicrograph of mud-rich layer showing isolated quartz silt grains (five white grains in center), abundance of very fine-grained mica (yellow/brown/red speckling) with sparse larger detrital muscovite flakes (arrow) intermixed with very fine-grained quartz and clay (grays in fine groundmass). Opaque grains (black) of uncertain mineralogy – black in reflected light – possibly magnetite (too sparse to draw Nd swivel magnetite or possibly altered to hematite pseudomorphs after magnetite [i.e., martized]). High iron content in chemical analysis without coincidently high sulfur content supports magnetite/hematite ID.
	Cross-polarized photomicrograph of quartz silt-rich lamina showing dominance of quartz (grays/whites) with subordinate micas (bright colors) and opaque grains (black). Opaque grains only slightly enriched in silt layers relative to mud layers.
	Cross-polarized photomicrograph at high magnification of detrital muscovite flake (yellow) in typical mica-rich mud matrix (micas are brown/colorful grains). Gray grains are low-birefringence clays and extremely fine-grained quartz.

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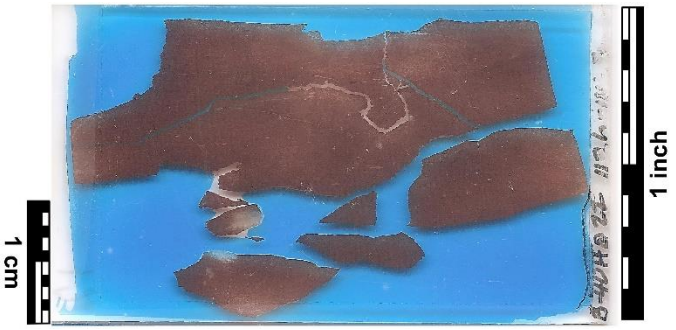
Sample: **B-40-HQ-22 @ 113.6-114.5**

Macroscopic sample description	**Maroon mudstone** Very friable maroon mudstone that crumbles into 1 cm chips with irregular surfaces. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Fine quartz silt evenly disseminated in red hematite-stained mica-clay mud matrix. Fine-silt-sized detrital muscovite flakes throughout. Local sharply-bounded darker zones of marginally higher mud content due to bioturbation.		
Constituent minerals	Quartz	44%	5% as 10-25 μm equant angular silt grains, remainder as <1 μm component of mud matrix
	Muscovite	33%	1% 20-40 μm detrital flakes, remainder is <5 μm highly birefringent component of mud matrix
	Kaolinite	21%	<1 μm first-order gray component of mud matrix
	Hematite	2%	<<1 μm stain pervading mud matrix, plus very rarely as <8 μm translucent red crystals
Porosity	0% intergranular porosity and 2% fracture porosity (within chips provided)		
Heterogeneity	Highly friable with tendency to break into chips		

Billet of maroon mudstone
Sample so friable that multiple chips impregnated into epoxy block to make slide.



Thin section slide of maroon mudstone
Homogenous mudstone lacking lamination
Blue epoxy impregnation indicates 0% intergranular porosity and some fracture porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.4	0.6
Al_2O_3	16.1	20.2
SiO_2	51.5	64.7
P_2O_5	0.0	0.1
SO_2	0.2	0.2
K_2O	3.0	3.8
CaO	0.1	0.1
TiO_2	0.9	1.1
FeO	6.8	8.5
Total	79.6	100.0

Photograph of cut drill core of maroon mudstone. Sample breaks very unevenly due to complete lack of bedding textures.

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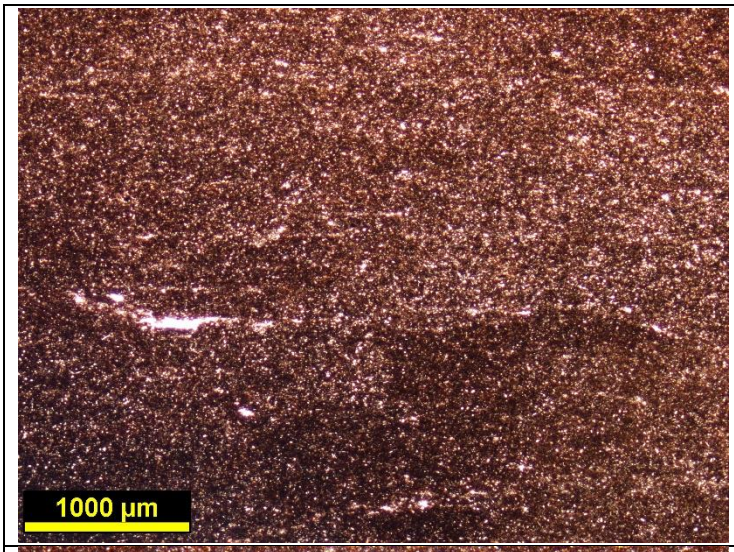
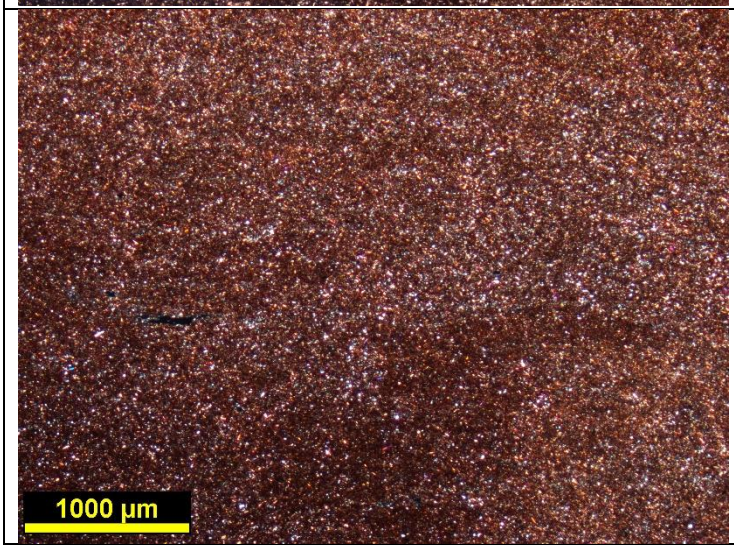
Sample: **B-40-HQ-22 @ 113.6-114.5**

	Plane-polarized photomicrograph of main body of sample documenting homogeneous nature of quartz silt (white) suspended in red mud. Local variations in darkness likely due to bioturbation.
	Cross-polarized photomicrograph of same spot on slide showing high birefringence of micas (bright colors) in mudstone matrix. Quartz silt content is slightly less in dark bioturbation zone (bottom center).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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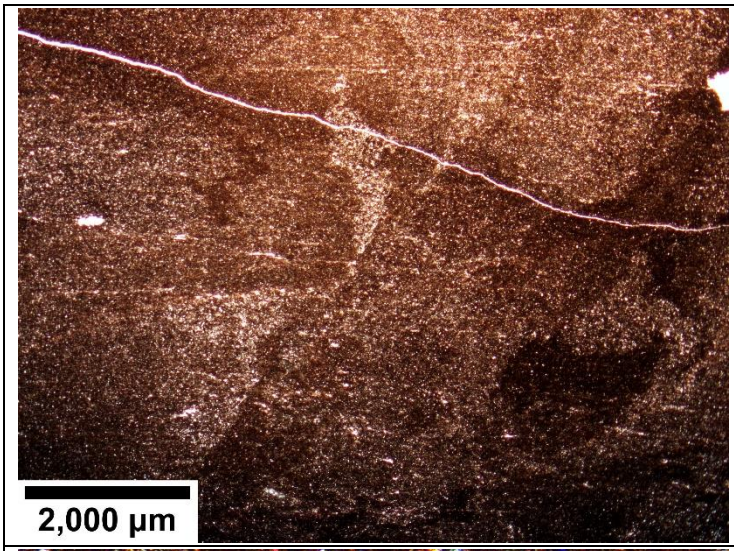
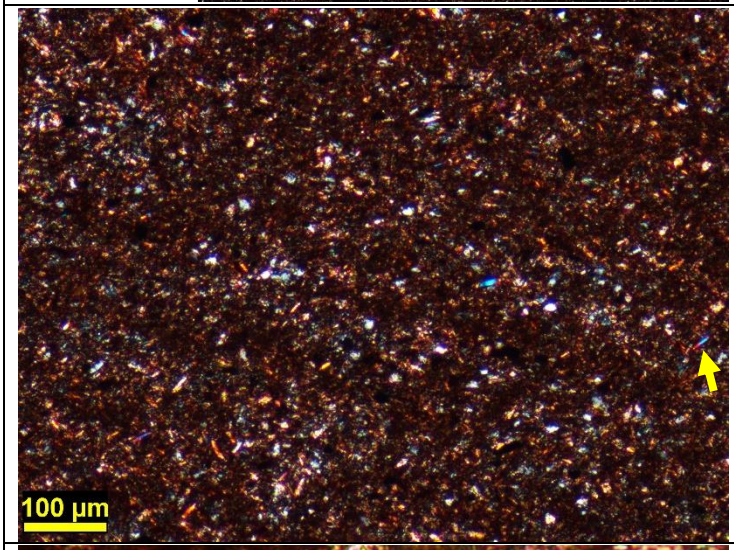
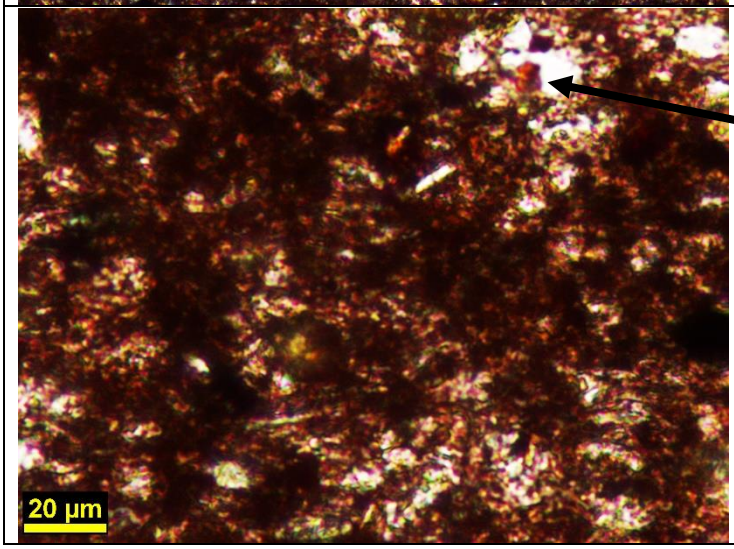
Sample: **B-40-HQ-22 @ 113.6-114.5**

	Plane-polarized photomicrograph of sample at very low magnification to show the patchy nature of the sample. Although overall homogeneous, 1-2 mm patches are slightly darker due to higher clay and hematite content. Bright line crossing image is open fracture.
	Cross-polarized photomicrograph documenting high mica (yellow/brown) content of mud matrix and large detrital mica flakes throughout (blues/reds – e.g., arrow). Quartz silt is white in this illumination.
	Plane-polarized photomicrograph at very high magnification of mud matrix showing pervasive ultra-fine-grained hematite throughout, as well as 10 µm crystals (e.g., arrow). Green flakes are clean muscovite mica grains – part of mud matrix component of sample.

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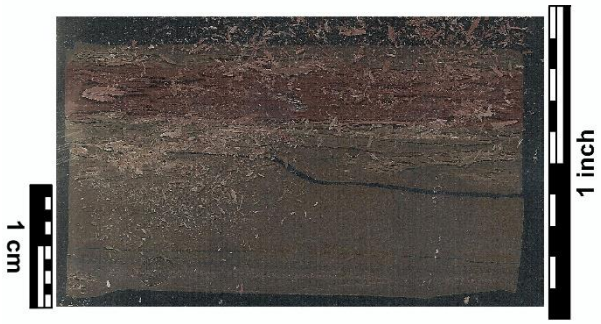
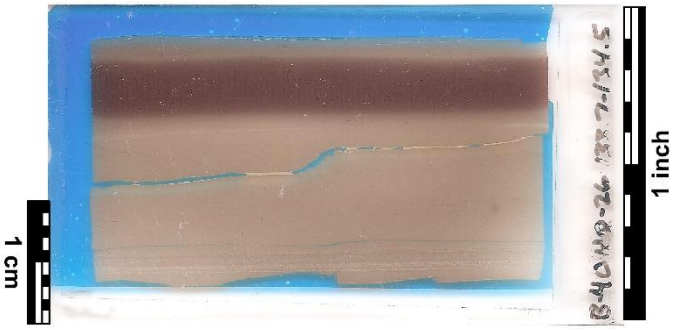
Sample: **B-40-HQ-26 @ 133.7-134.5**

Macroscopic sample description	**Medium gray shale** 70% gray color dry, 80% gray wet very highly fissile shale with 4 mm average thickness between partings on irregular surfaces. Contact with red shale sharp. Red shale portion swells when wet to form splinters that protrude from epoxy, but gray portion does not swell. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Alternating 100-200 μm laminae of angular very fine-grained quartz silt and laminae of mica-clay-rich mud. Fine-grained micas in mud are optically aligned due to compaction parallel to bedding lamination. Disseminated very fined-grained equant opaque grains of magnetite or hematite pseudomorphs after hematite.		
Constituent minerals	Quartz	37%	5% as 50-100 μm very highly-angular silt grains concentrated in 100-200 μm-thick laminae, remainder as low birefringence component of mud matrix.
	Muscovite	37%	1-2% as 75-100 μm detrital flakes, remainder as <10 μm high-birefringence component of mud matrix that goes extinct simultaneously due to alignment during compaction.
	Kaolinite	24%	<1 μm part of low-birefringence component of mud matrix
	Magnetite	2%	5-10 μm equant opaque black grains disseminated throughout with slight concentration in quartz silt-rich layers. High iron with low sulfur XRF analysis suggests magnetite or, in light of lack of detectible magnetism, hematite pseudomorphing magnetite (martite) rather than equant pyrite.
	Kerogen	<0.1%	20 μm equant, amorphous, diffusely-bounded reddish-brown
Porosity	0% intergranular porosity and 1% fracture porosity		
Heterogeneity	highly fissile shale parting, sample is contact between two color units		



Billet of medium gray shale
Upper red portion highly friable – especially when wet, forming splinters that fall out of billet. Lower gray portion less absorbent.



Thin section slide of medium gray shale
Contact between lower gray shale and upper red shale. Note gradational nature. White bands near bottom are quartz silt laminae. Blue epoxy impregnation indicates 0% porosity, but fracture porosity along bedding.

	wt%	*norm. wt%*
Na_2O	0.6	0.8
MgO	0.4	0.6
Al_2O_3	16.0	21.6
SiO_2	43.1	58.0
P_2O_5	0.1	0.1
SO_2	0.1	0.2
K_2O	3.0	4.1
CaO	0.4	0.5
TiO_2	0.7	1.0
FeO	9.8	13.1
Total	74.3	100.0

Photograph of cut drill core of medium gray shale. Upper surface broken along shale parting is irregular/non-planar.

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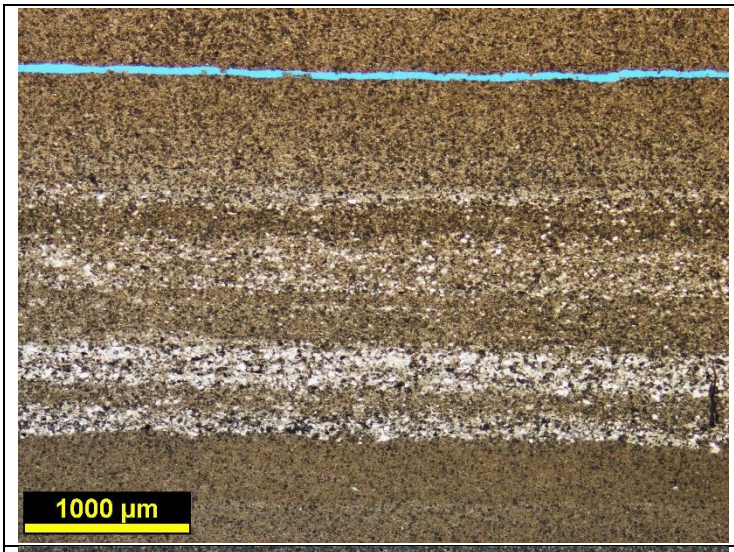
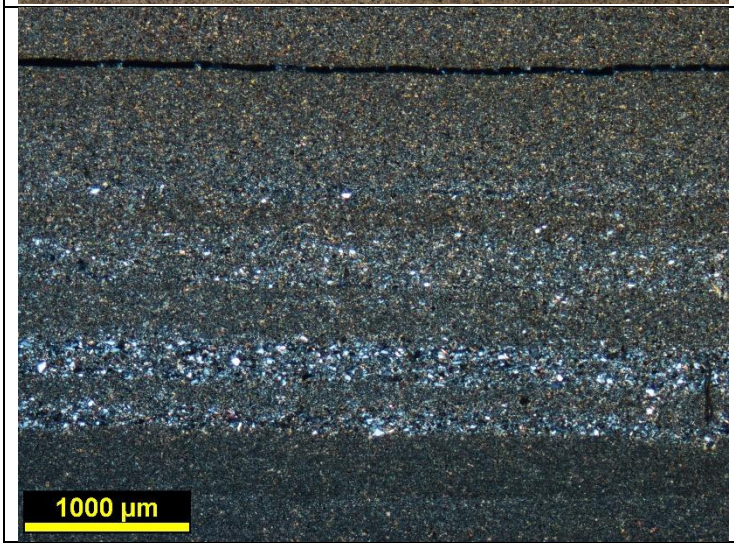
Sample: **B-40-HQ-26 @ 133.7-134.5**



Plane-polarized photomicrograph of lower part of main body of sample documenting distinct quartz silt-rich laminae alternating with mica-clay mud. Blue line is epoxy-filled fracture along bedding.



Cross-polarized photomicrograph of same spot on slide showing first-order gray interference colors of quartz silt interspersed with lesser amounts of highly-birefringent micas (bright blue/yellow/red colors).

Micas in mud-rich laminae are largely extinct in this orientation (because micas compressed parallel to one another parallel to bedding compaction).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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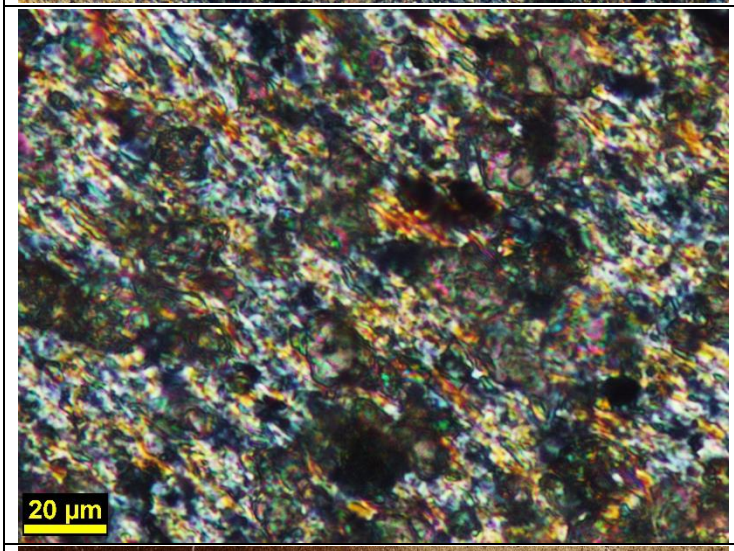
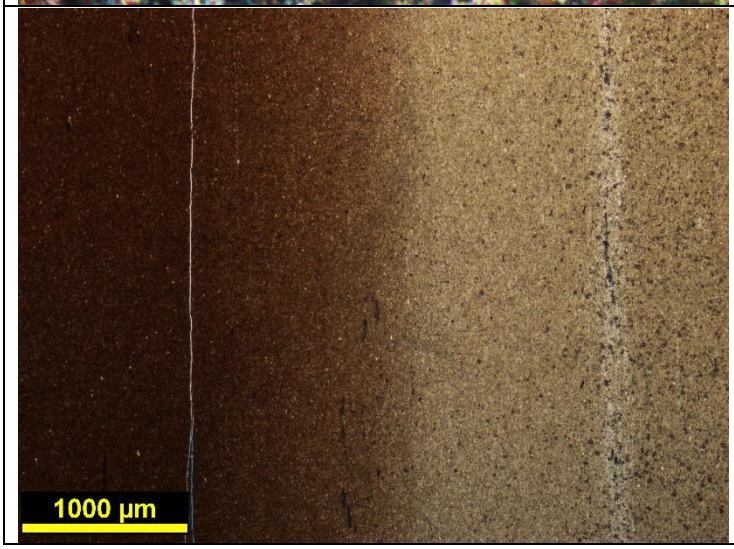
Sample: **B-40-HQ-26 @ 133.7-134.5**

	Cross -polarized photomicrograph of quartz silt-rich lamination (gray blocky grains) interlayered with mica-rich mud layers (honey/red higher-order interference colors). Muscovite mica flakes 100 µm long (blue/yellow/red) are detrital grains. Bedding rotated to 45º in this image, but sample was cut perpendicular to core axis.
	Cross-polarized photomicrograph at very high magnification documenting intergrown matrix of micas (brown/red/higher-order colors) with ultra-fine-grained quartz and clay (grays). Amorphous brown smudge in center is likely organic material.
	Cross-polarized photomicrograph of gradational boundary between maroon shale (left) and gray shale (right). Light band in gray shale layer is silt-rich lamination. Opaque grains (black) show slight concentration in quartz silt band and in gray shale.

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Sample: **B-40-HQ-28 @ 141.1-141.9**

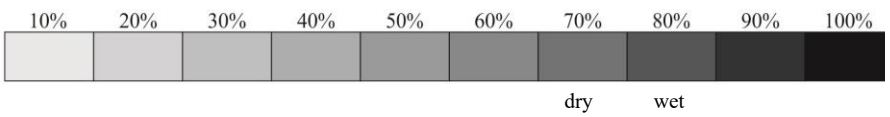
Macroscopic sample description	**Very fissile medium gray shale** 70% gray color dry, 80% gray wet very highly fissile shale with 2 mm average thickness between partings with wavy surfaces. Sample swells when wet to form splinters that protrude from epoxy. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Alternating minor quartz silt-rich laminae with mica-clay-rich mudstone. Micas in mud matrix strongly aligned parallel to bedding.		
Constituent minerals	Quartz	41%	2% as 10-25 μm anhedral, angular, equant silt concentrated in 100 μm-thick laminae, remainder as clay-sized particles in mud matrix
	Muscovite	38%	1% as 50 μm greenish detrital flakes aligned parallel to bedding, remainder as high-birefringence component of mud matrix
	Kaolinite	19%	<1 μm low-birefringence (gray) component of mud matrix
	Chlorite	<1%	<10 μm green flakes with anomalous brown extinction
	Pyrite	<0.5%	10-20 μm anhedral opaque grains
	Kerogen	1%	diffuse, amorphous brown material in mud matrix and small red macerals
Porosity	0% intergranular porosity and <1% fracture porosity		
Heterogeneity	Very high fissility augmented by swelling reaction with water		

Billet of medium gray shale
Sample rapidly absorbed water and puffed out of epoxy as splinters

Thin section slide of medium gray shale
Very thin lamination with white quartz silt-bearing layers. Blue epoxy impregnation indicates 0% intergranular porosity, but fracture porosity along parting.

	wt%	*norm. wt%*
Na_2O	0.5	0.7
MgO	0.2	0.3
Al_2O_3	15.0	21.6
SiO_2	44.9	64.7
P_2O_5	0.0	0.0
SO_2	0.2	0.2
K_2O	3.1	4.5
CaO	0.1	0.2
TiO_2	0.8	1.1
FeO	4.6	6.6
Total	69.4	100.0

Photograph of cut drill core of very fissile, medium gray shale. Close spacing between partings that break along wavy surfaces.



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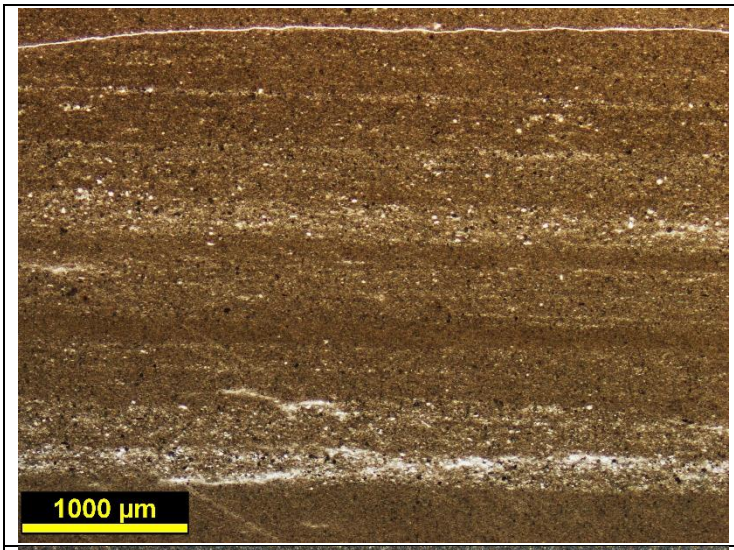
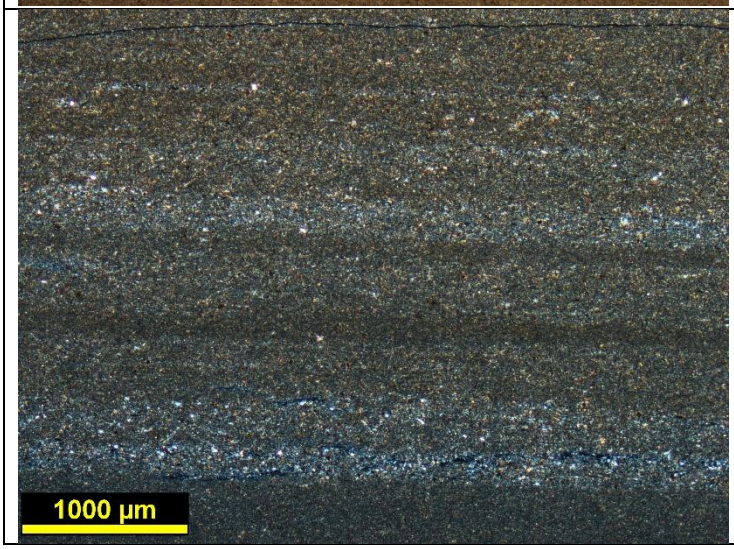
Sample: **B-40-HQ-28 @ 141.1-141.9**

	Plane-polarized photomicrograph of main body of sample showing laminations resulting from variations in quartz silt:mica-clay mud ratios. White layers and spots are quartz-rich. Bright white line along top is fracture along bedding (shaley parting).
	Cross-polarized photomicrograph of same spot on slide documenting dominance of low-birefringence (gray) quartz in quartz silt layers. Micas in mud-rich laminae are mostly at extinction in this image because bedding is oriented E-W, parallel to microscope polarization.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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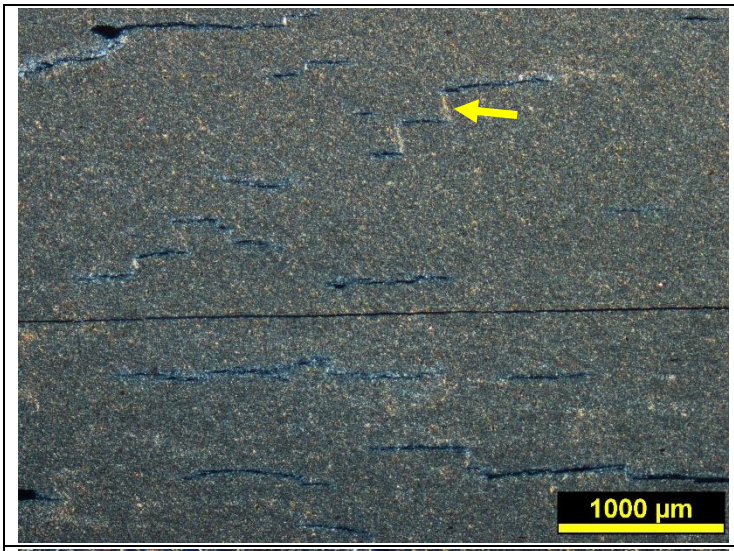
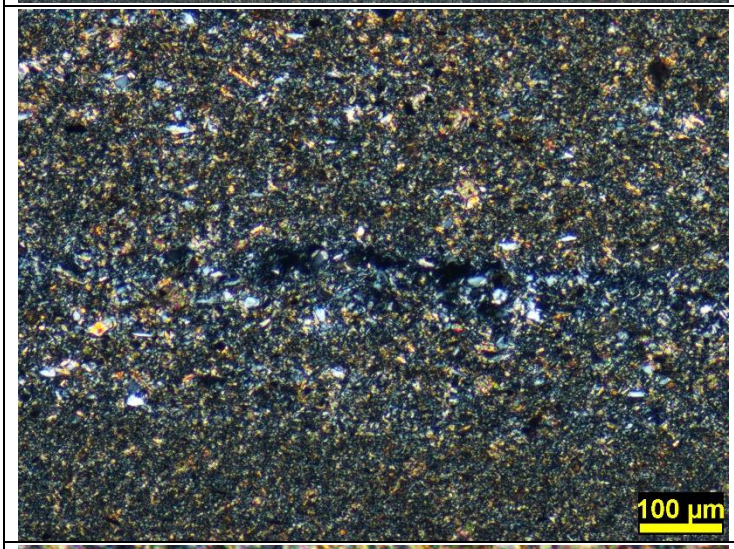
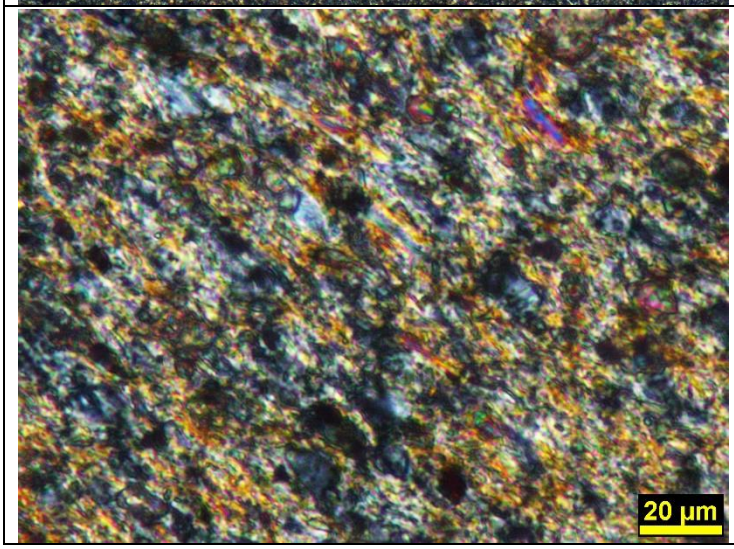
Sample: **B-40-HQ-28 @ 141.1-141.9**

	Cross-polarized photomicrograph of shale parting (horizontal lines) with perpendicular stepped deformation transfers. Note how micas in mud matrix are realigned to "vertical" along transfer (e.g., arrow) in response to stress so they are not at optical extinction like most of the micas in this view.
	Cross-polarized photomicrograph of clay-rich lens with subordinate quartz silt Note low order interference colors of clay compared to main body of sample which is mica-rich (yellow/red and higher-order interference).
	Cross-polarized photomicrograph documenting mica-dominant composition of mud layer. Micas oriented at 45º so not at extinction, displaying their high birefringence. Gray blocky grains are quartz silt. Finer gray material is mixture of ultra-fine quartz plus low-birefringence clay.

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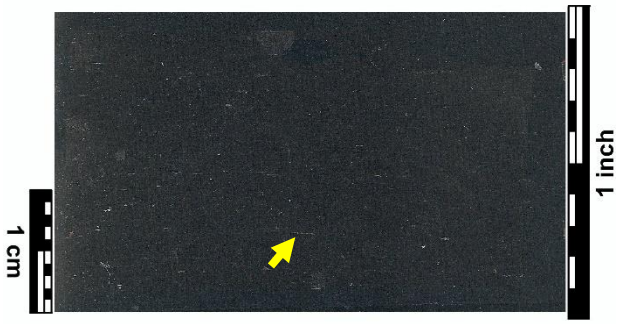
Sample: **B-40-HQ-30 @ 153.6-154.3**

Macroscopic sample description	**Dark gray pyritic carbon-rich shale** 80% gray color dry, 100% gray (black) when wet, fissile shale with 6 mm average thickness between partings with wavy surfaces. Sub-mm pyrite along bedding. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Organic carbon-rich mudstone with sparse, evenly-disseminated quartz silt and detrital muscovite set in mica-dominant mud matrix. Most kerogen as amorphous brown material integrated into mud matrix, but ruby-red macerals common, and distinct yellow fossil grains present.		
Constituent minerals	Quartz	47%	3% as 20-30 µm equant angular silt, remainder as fine-grained component in mud matrix
	Muscovite	37%	1% as 50-100 µm bedding-parallel detrital flakes, remainder as high-birefringence component of mud matrix
	Kaolinite	10%	<1 µm low-birefringence (gray) component of mud matrix
	Pyrite	1%	10-20 µm subhedral cubes clustered in elongate aggregates parallel to bedding
	Kerogen	5%	primarily as brown-reddish brown amorphous material permeating mud matrix, 1% as 20-150 µm red angular macerals, very sparse 150 µm squashed-loop shaped yellow fossil grains
Porosity	0% intergranular porosity and <1% fracture porosity		
Heterogeneity	Homogeneous, but fissile		

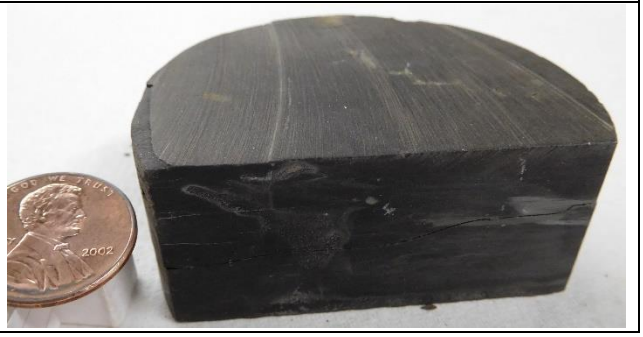


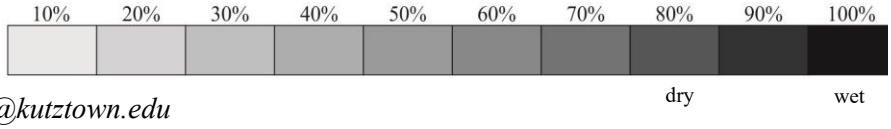
Billet of dark gray pyritic carbon-rich shale
Sample very dark when wet. Pyrite along bedding (e.g., arrow).

Thin section slide of dark gray pyritic carbon-rich shale
Sample's high organic carbon content makes almost opaque. Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.8
MgO	0.3	0.4
Al_2O_3	12.4	18.1
SiO_2	45.1	65.8
P_2O_5	0.0	0.0
SO_2	1.8	2.7
K_2O	3.0	4.4
CaO	0.1	0.2
TiO_2	0.7	1.1
FeO	4.5	6.6
Total	68.6	100.0

Photograph of cut drill core of dark gray pyritic carbon-rich shale.
Top surface is flat due to saw cut. Shaley partings along which sample breaks are wavy.





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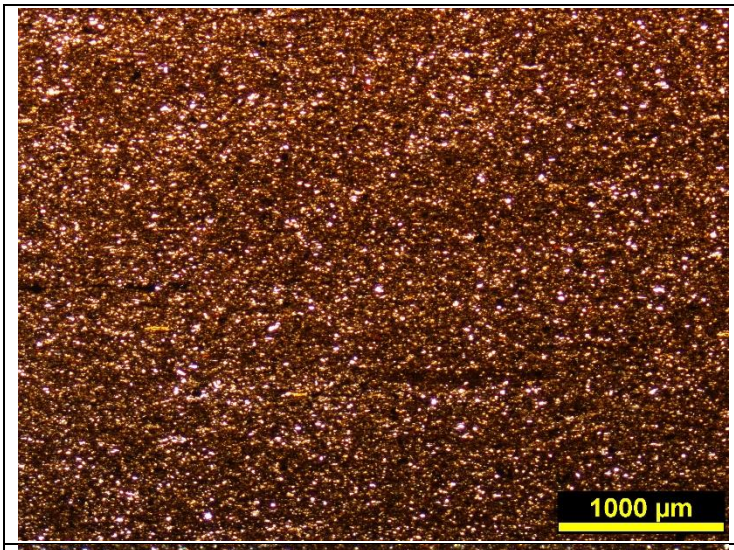
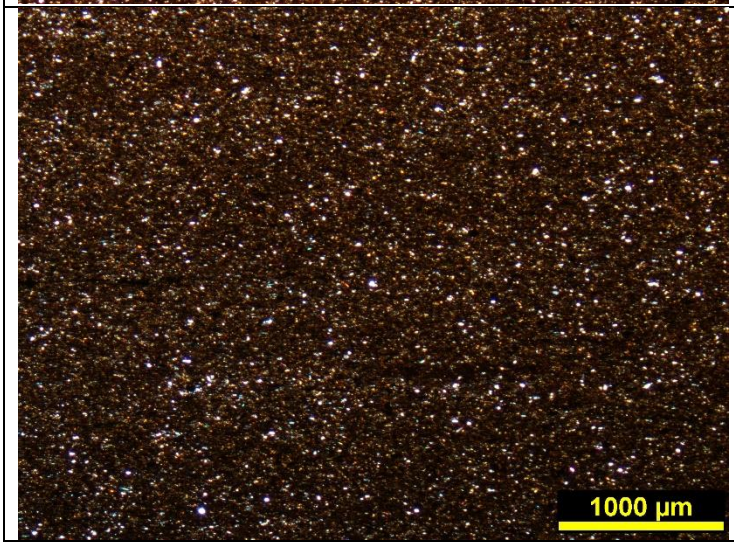
Sample: **B-40-HQ-30 @ 153.6-154.3**

	Plane-polarized photomicrograph of main body of sample documenting very high organic carbon content, visible here as amorphous brown material in main matrix, linear yellow fossils, and equant red macerals. White grains are quartz silt. Black is pyrite concentrated along bedding (near left edge).
	Cross-polarized photomicrograph of same spot on slide documenting most white grains throughout have low birefringence (white/gray = quartz), but some have higher-order interference colors (blue/yellow/red = micas). Matrix dark with amorphous, isotropic organic carbon (kerogen).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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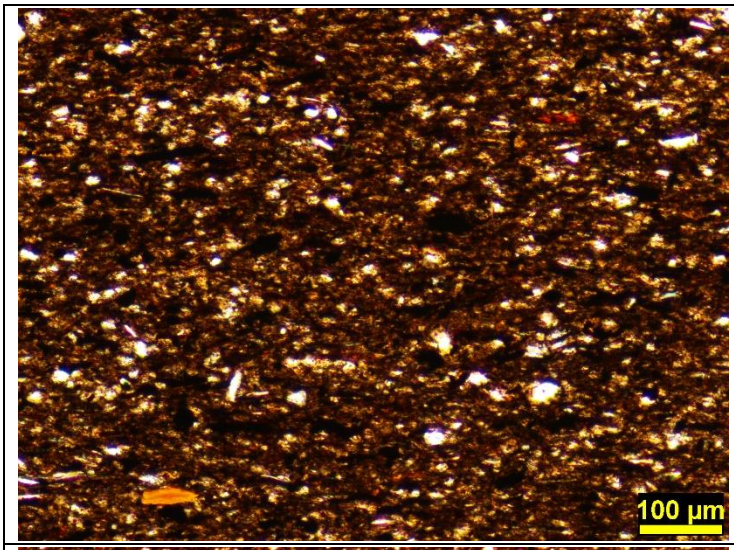
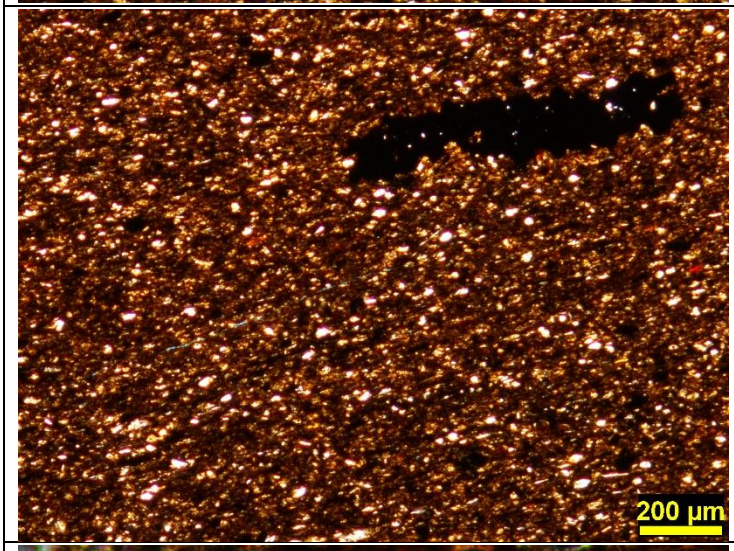
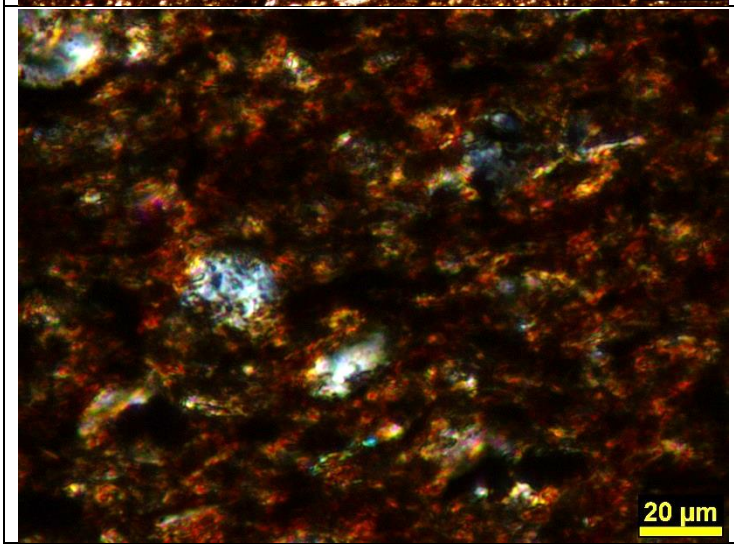
Sample: **B-40-HQ-30 @ 153.6-154.3**

	Plane-polarized photomicrograph of main body at higher magnification documenting three occurrences of organic carbon: amorphous brown material in matrix, squashed loop-shaped yellow fossils, and red macerals. Note also the highly angular nature of quartz silt (blocky white), and presence of bedding-parallel detrital muscovite flakes (white lines). Black grains are opaque pyrite.
	Plane-polarized photomicrograph of pyrite occurring as 10-20 µm subhedral cubes clustered in elongate aggregates parallel to bedding. No correlation observed between surrounding mineralogy and locations of where pyrite nucleated. Red kerogen macerals also distinct.
	Cross-polarized photomicrograph at very high magnification of mud matrix documenting mica-rich mud matrix with very fine-grained quartz silt (blocky white) and pervasive saturation with brownish-red kerogen.

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Sample: **B-40-HQ-32 @ 163.2-164.1**

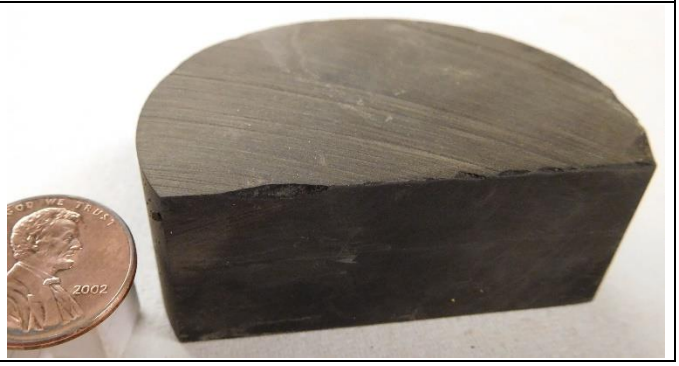
Macroscopic sample description	**Dark gray pyritic carbon-rich shale** 80% gray color dry, 100% gray (black) when wet fissile shale with blocky 8 mm average thickness between partings with wavy surfaces. Discrete sub-mm pyrite grains. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Very kerogen-rich mudstone with sparse evenly-disseminated quartz silt. Bedding-parallel aligned yellow fossil carbon macerals, elongate red carbon macerals, and very sparse detrital muscovite flakes define bedding, but compositionally homogeneous. Disseminated pyrite throughout not aggregated into larger masses.		
Constituent minerals	Quartz	45%	3% as <60 μm equant angular silt, remainder as fine-grained component in mud matrix
	Muscovite	35%	1% as 50-100 μm bedding-parallel detrital flakes, remainder as high-birefringence component of mud matrix
	Kaolinite	10%	<1 μm low-birefringence (gray) component of mud matrix
	Pyrite	2%	<50 μm subhedral cubes randomly disseminated throughout
	Kerogen	9%	5% as 150 μm squashed-loop shaped yellow fossil grains, 1% as 20-150 μm red angular macerals, remainder as brown-reddish brown amorphous material permeating mud matrix to nearly opaque.
Porosity	0% intergranular porosity and 0% fracture porosity		
Heterogeneity	Homogeneous, but fissile		

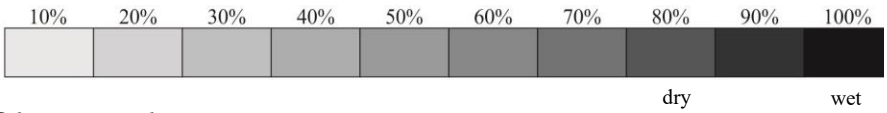
Billet of dark gray pyritic carbon-rich shale
Black-when-wet shale

Thin section slide of dark gray pyritic carbon-rich shale
No distinct compositional laminations. Sample nearly opaque due to very high organic carbon content.
Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.4	0.5
Al_2O_3	13.5	17.8
SiO_2	48.7	64.5
P_2O_5	0.0	0.1
SO_2	3.3	4.4
K_2O	3.2	4.2
CaO	0.2	0.3
TiO_2	0.7	0.9
FeO	4.9	6.5
Total	75.5	100.0

Photograph of cut drill core of dark gray pyritic carbon-rich shale. Top surface flat due to saw cut (lines are saw marks). Sample parts in middle along wavy bedding perpendicular to core axis.





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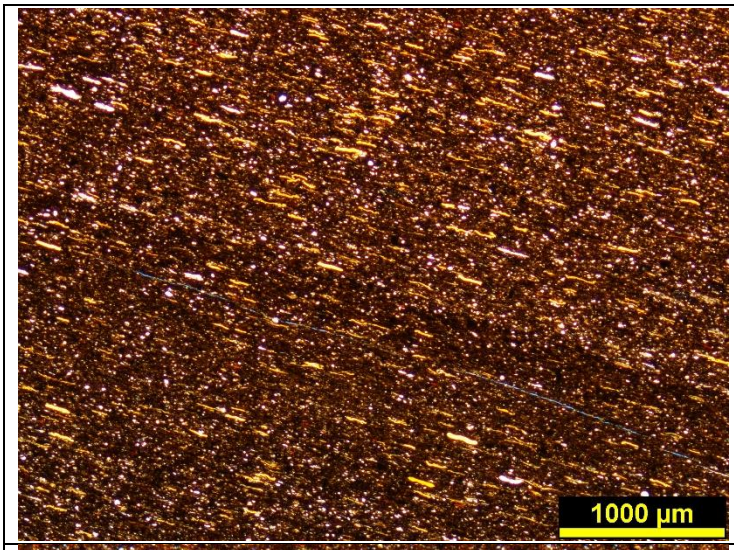
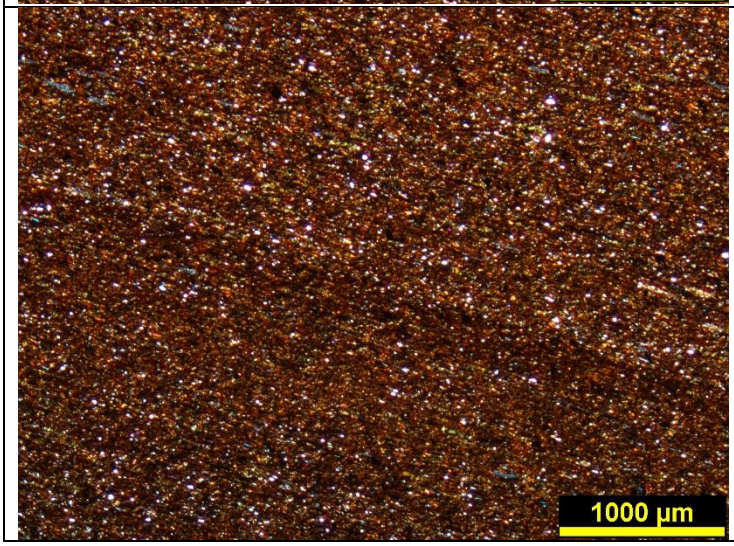
Sample: **B-40-HQ-32 @ 163.2-164.1**

	Plane-polarized photomicrograph of main body of sample documenting very high organic carbon (kerogen) content of sample. Abundant yellow fossil macerals and pervasive permeating amorphous brown kerogen in matrix. Red macerals also distinct. Black opaque pyrite grains aligned along bedding near center of image. Quartz silt homogeneously disseminated throughout.
	Cross-polarized photomicrograph of same spot on slide showing all kerogen types optically isotropic. White grains throughout are quartz silt with low birefringence (white/gray), but high-birefringence micas (blue/red/bright yellow) also present throughout.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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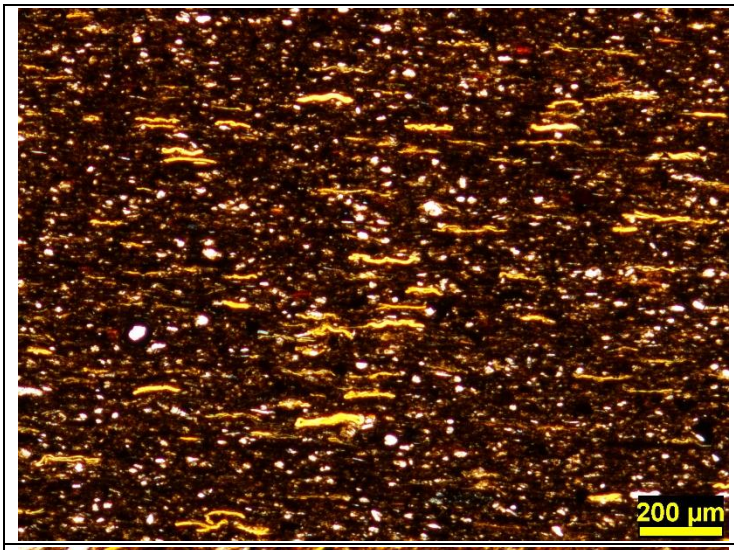
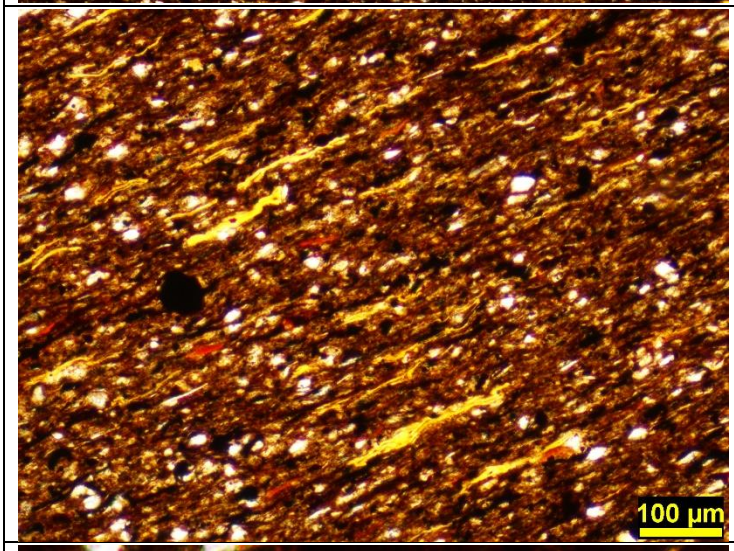
Sample: **B-40-HQ-32 @ 163.2-164.1**

	Plane-polarized photomicrograph detailing abundant yellow fossil kerogen macerals aligned parallel to bedding. Grains are all either squashed loop shapes or wavy lines with rounded ends (i.e., completely compressed loops). Red macerals are equant to elongate and have distinctly different shapes. Matrix is dark brown due to pervasive amorphous brown kerogen. White dots are quartz silt evenly disseminated throughout.
	Plane-polarized photomicrograph documenting with light source on maximum to see through darkly-colored kerogen-rich matrix and so reveal truly opaque equant grains of very fine-grained pyrite (black) disseminated throughout. Yellow and red kerogen macerals, plus equant white quartz silt and linear white detrital muscovite micas also visible in this image.
	Plane-polarized photomicrograph at high magnification of squashed-loop shaped yellow fossil carbon. Note consistency of thickness of each side of the loop and non-crystalline nature of the material. White mica flake above/right and white quartz silt grain above/left. Dense brown color of surrounding matrix due to amorphous kerogen.

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Sample: **B-41-HQ-33 @ 170.0-171.0**

Macroscopic sample description	**Dark gray pyritic shale** 80% gray color dry, 100% gray (black) when wet, highly fissile shale with 5 mm average thickness between partings with wavy surfaces. Minor pyrite elongate along bedding. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Very kerogen-rich mudstone with sparse evenly-disseminated quartz silt. Matrix dark with diffuse, amorphous brown kerogen. Elongate ruby red carbon macerals are bedding-parallel and dominate the discrete kerogen maceral population. Lesser amounts of yellow fossil carbon macerals also present. Disseminated pyrite throughout and as larger aggregates along bedding.		
Constituent minerals	Quartz	45%	3% as <30 µm equant angular silt randomly disseminated throughout sample (no distinct silt-rich layers), remainder as fine-grained component in mud matrix
	Muscovite	34%	1% as 20-30 µm bedding-parallel detrital flakes, remainder as high-birefringence component of mud matrix with strong alignment parallel to bedding (entire matrix of sample goes extinct when bedding aligned parallel to microscopes polarization).
	Kaolinite	13%	<1 µm low-birefringence (gray) component of mud matrix
	Pyrite	2%	<50 µm anhedral equant opaque grains disseminated throughout sample and locally clustered along bedding as 1,000 µm aggregates
	Kerogen	7%	1% as 150-200 µm squashed-loop shaped yellow fossil grains, 2% as 20-150 µm elongate to equant ruby red macerals, remainder as brown-reddish brown amorphous material permeating mud matrix.
Porosity	0% intergranular porosity and 0% fracture porosity		
Heterogeneity	Homogeneous, but fissile		

Billet of dark gray pyritic shale

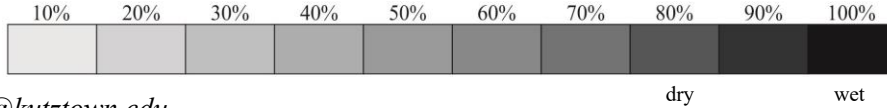
Black when wet homogeneous shale

Thin section slide of dark gray pyritic shale

Homogeneous mudstone lacking distinct laminations, nearly opaque due to high organic carbon content. Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.7
MgO	0.3	0.5
Al_2O_3	13.6	18.5
SiO_2	48.3	65.5
P_2O_5	0.0	0.1
SO_2	2.2	3.0
K_2O	3.1	4.2
CaO	0.2	0.2
TiO_2	0.7	1.0
FeO	4.7	6.4
Total	73.8	100.0

Photograph of cut drill core of dark gray pyritic shale. Top surface flat due to rock saw cut (lines are saw marks). Sample breaks in middle along wavy parting.



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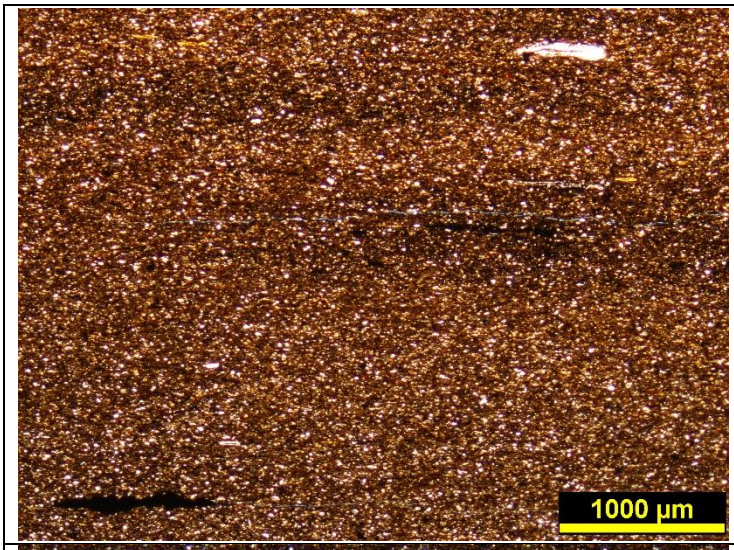
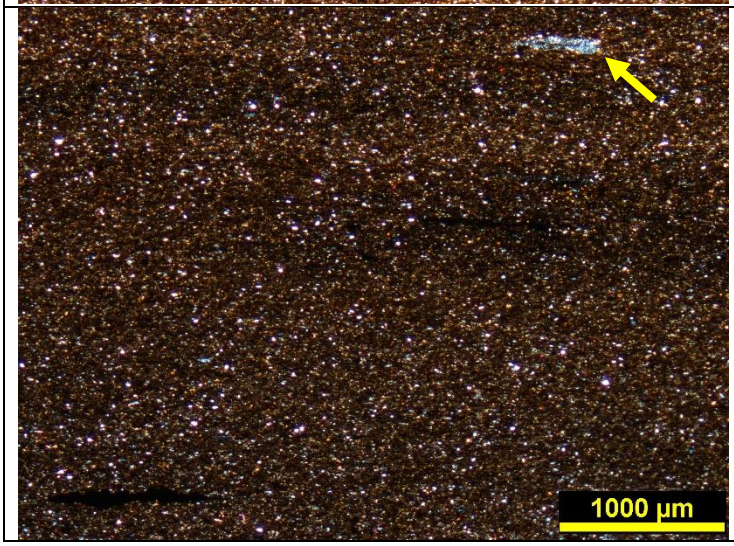
Sample: **B-41-HQ-33 @ 170.0-171.0**

	Plane-polarized photomicrograph of main body of sample showing homogeneous quartz silt suspended in mica-clay-rich mud matrix (brown) and pyrite formed along bedding planes (black). Matrix brown due to diffuse amorphous organic carbon (kerogen). Kerogen also present as very sparse squashed-loop yellow fossils and ruby red macerals. Small white grains throughout are quartz silt and detrital muscovite.
	Cross-polarized photomicrograph of same spot on slide documenting dominance of low-birefringence quartz as white grains in image above (whites/grays), but also presence of high-birefringence muscovite flakes (blues/reds). Large patch of low-birefringence (gray) clay and quartz concentrated in loop-like structure (arrow).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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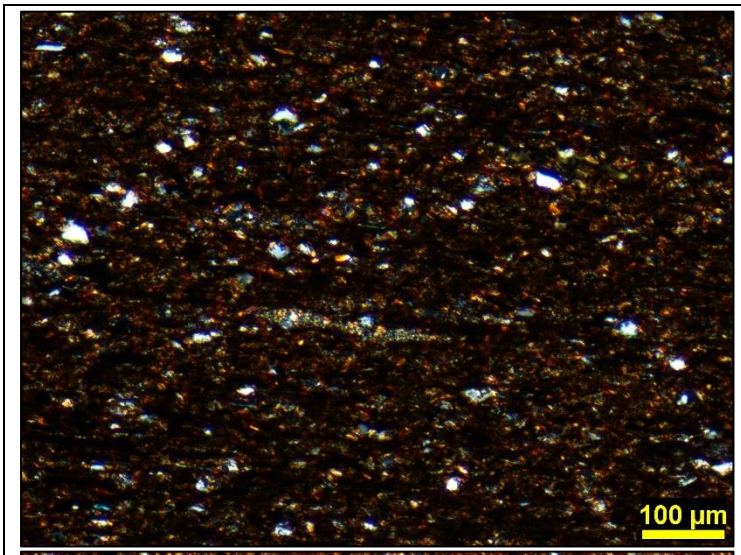
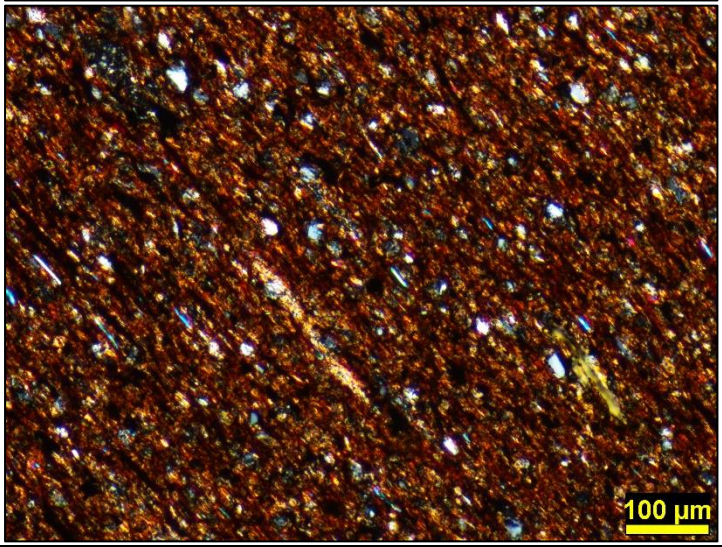
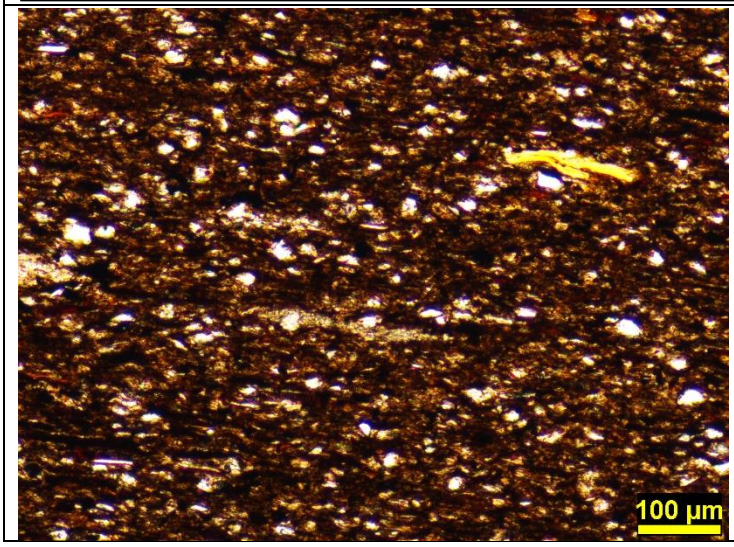
Sample: **B-41-HQ-33 @ 170.0-171.0**





Cross-polarized photomicrograph of same spot on slide rotated 45º. Bedding is "vertical" on this page (elongate silt lens is parallel to bedding). Image on top is dark because micas in mud matrix are aligned parallel to the microscopes polarizing filters and are thus extinct. Image on bottom is bright because micas are not aligned with planes of polarization. This demonstrates a high degree of alignment of extremely fine-grained micas in mud matrix parallel to bedding.

Greenish amber grain in bottom right of lower image is large yellow kerogen maceral. White/gray grains are quartz silt.



Plane -polarized photomicrograph of three occurrences of kerogen: diffuse amorphous brown material in matrix, discrete elongate ruby-red macerals, and sparser squashed-loop-shaped yellow fossil grains. Quartz silt (blocky white) and detrital muscovite flakes (linear white) randomly disseminated throughout sample. Black grains are opaque pyrite.

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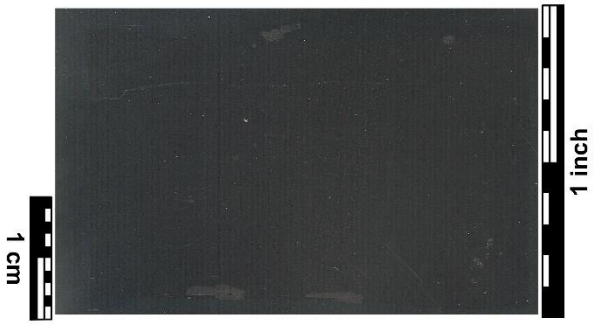
Sample: **B-42 NQ-18 @ 170.0-171.1**

Macroscopic sample description	**Black shale** Black only weakly fissile mudstone with very planar breaks spaced 6 mm. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Organic carbon-rich mud matrix suspending rounded quartz silt and carbon macerals of two varieties: large bright-yellow elongate sinusoidal loops (plant fossils?) and finer-grained, dark red, equant grains (plant fossil fragments?) Trace disseminated fine-grained pyrite.		
Constituent minerals	Quartz silt	2%	<30 μm round, disseminated
	Quartz mud	45%	<5 μm granules in mud *(proportion calculated chemically)*
	Kaolinite	11%	<1 μm in mud *(proportion calculated chemically)*
	Muscovite	34%	<5 μm flakes in mud *(proportion calculated chemically)*
	Chlorite	1%	<5 μm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 μm equant, disseminated
	Organic	5%	100-250-μm-long, bright yellow, elongate, sinusoidal macerals with consistent size range, plus 20-50 μm equant dark red macerals, plus finer-grained red/brown material in mud matrix
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		

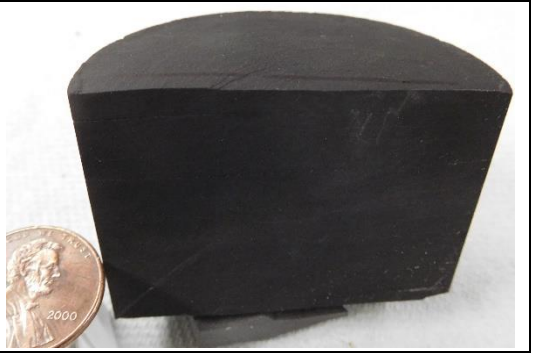


Billet of black shale
Massive black mudstone

Thin section slide of black shale
Homogeneous dark mudstone. Blue epoxy impregnation indicates 0% observable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.7
MgO	0.3	0.5
Al_2O_3	13.6	18.1
SiO_2	48.7	65.0
P_2O_5	0.1	0.1
SO_2	3.0	3.9
K_2O	3.1	4.2
CaO	0.1	0.2
TiO_2	0.7	0.9
FeO	4.8	6.4
Total	74.9	100.0

Photograph of cut drill core of black shale. Note lack of strong fissility – rock does not break easily along bedding. Top surface flat from rock saw cut, not bedding parting. Note lack of water seeping from parting.



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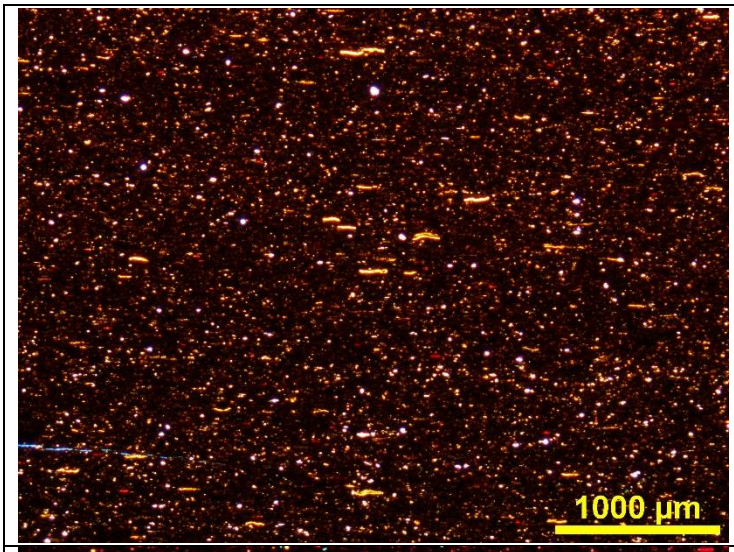
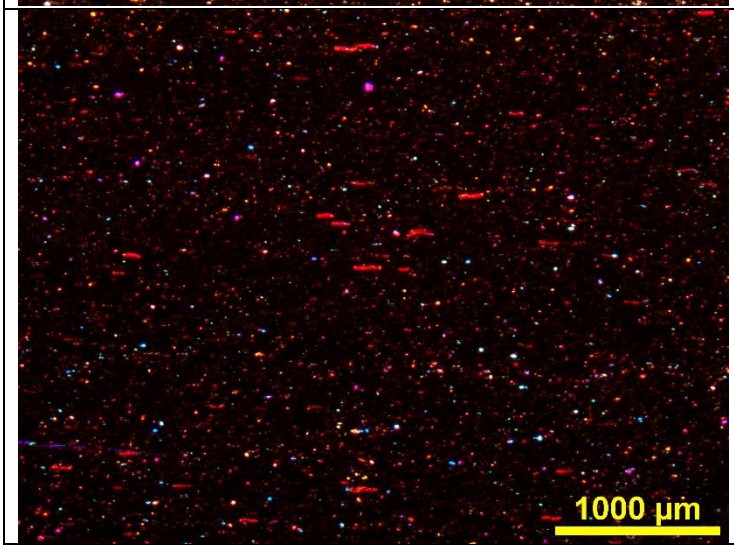
Sample: **B-42 NQ-18 @ 170.0-171.1**

	Plane-polarized photomicrograph of main body of sample documenting high organic content, abundant bright yellow elongate organic carbon macerals (plant fossils?), red organic carbon macerals, and moderate sparsity of quartz silt grains (white).
	Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt grains are quartz (yellow/blue) and organic carbon is isotropic (non-crystalline).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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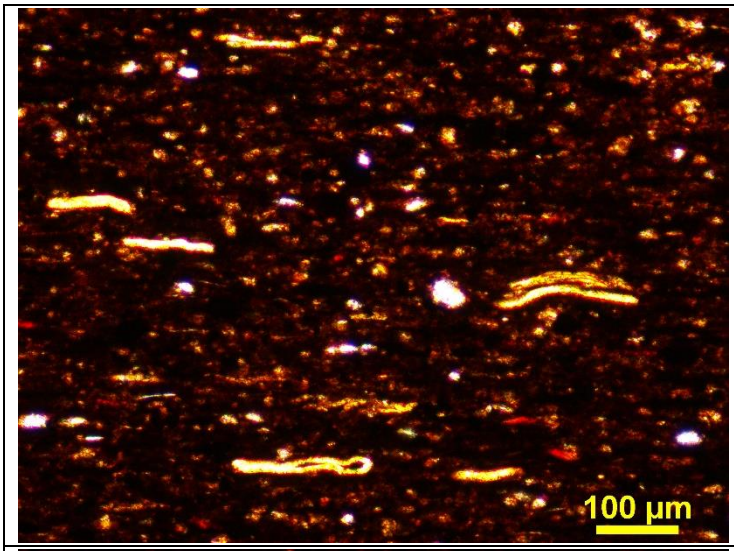
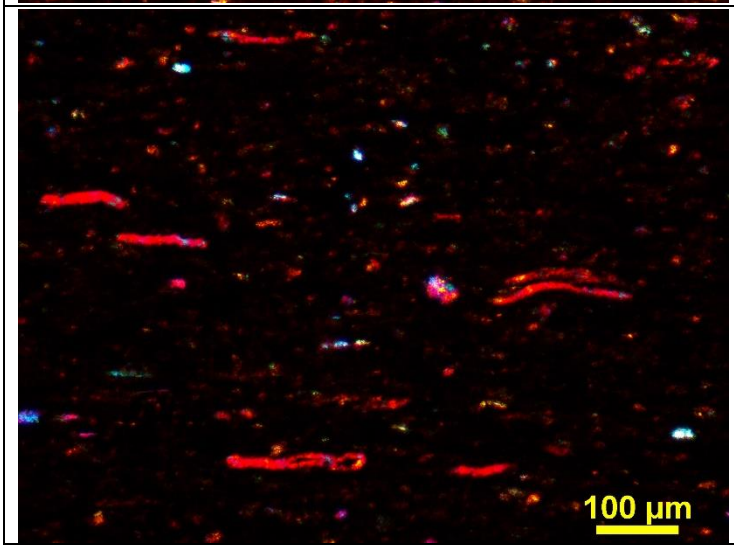
Sample: **B-42 NQ-18 @ 170.0-171.1**

	Plane-polarized photomicrograph of elongate bright-yellow organic carbon macerals, red carbon macerals, and white quartz silt in an organic carbon-rich mud matrix.
	Cross-polarized photomicrograph with gypsum plate (540 nm additional retardation) of same view documenting isotropy of carbon macerals and augmented low-order interference colors of sparse quartz silt (yellow/blue).

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Sample: **B-43 HQ-21 @ 167.2-167.9**

Macroscopic sample description	**Brown shale** Very dark brown fissile mudstone with almost slate-like perfectly planar parting spaced 6 mm. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Very abundant bright-yellow organic carbon macerals with consistent size and characteristic wavy elongate shape suspended in dark mud matrix with moderately low quartz silt content. Mud matrix contains reddish-brown carbon intermixed with clays and birefringent micas (muscovite? illite?)		
Constituent minerals	Quartz silt	2%	<30 µm equant, disseminated
	Quartz mud	46%	<5 µm granules in mud *(proportion calculated chemically)*
	Kaolinite	9%	<1 µm in mud *(proportion calculated chemically)*
	Muscovite	32%	<5 µm flakes in mud *(proportion calculated chemically)*
	Chlorite	2%	<5 µm flakes in mud *(proportion calculated chemically)*
	Pyrite	1%	20 µm equant, disseminated
	Organic	8%	100-250-µm-long, bright yellow, elongate, sinusoidal macerals with looped, rounded ends plus <20 µm reddish-brown flakes
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		

Billet of brown shale
Homogenous mudstone with faintly visible parting along bedding.

Thin section slide of brown shale
Shale parts along irregular surfaces. 1 mm aggregate of very fine-grained pyrite near top center.
Blue epoxy impregnation indicates 0% observable intergranular porosity, but detectable fracture porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.8
MgO	0.4	0.6
Al_2O_3	12.9	16.9
SiO_2	50.4	66.0
P_2O_5	0.0	0.1
SO_2	3.3	4.3
K_2O	3.1	4.1
CaO	0.3	0.4
TiO_2	0.6	0.8
FeO	4.6	6.1
Total	76.4	100.0

Photograph of cut drill core of brown shale. Note strong tendency to break along shaley parting and flat break with only minor offset on top.

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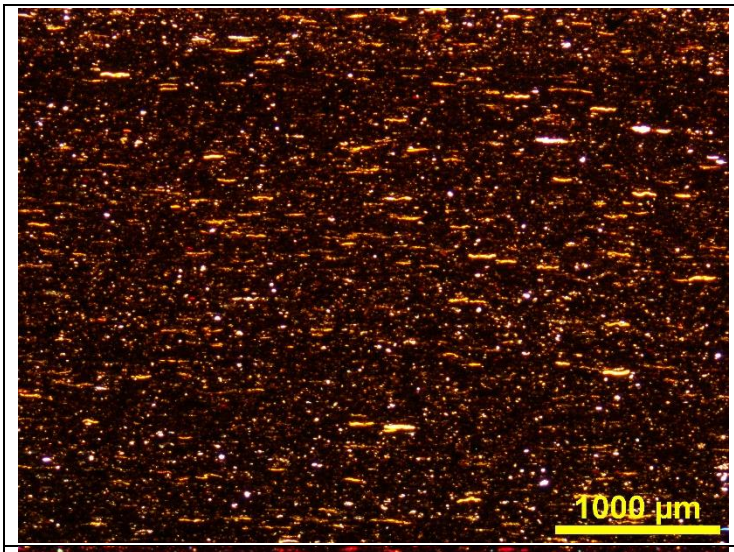
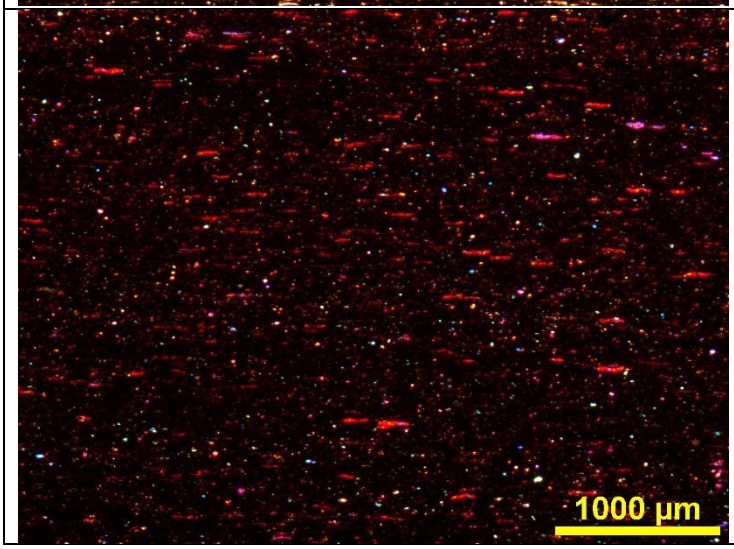
Sample: **B-43 HQ-21 @ 167.2-167.9**

	Plane-polarized photomicrograph of main body of sample documenting very high abundance of bright-yellow elongate organic carbon macerals, equant finer-grained red carbon macerals, moderate quartz silt content (white), and dark mud matrix.
	Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt grains are quartz (yellow/blue) and organic carbon is isotropic (red/pink).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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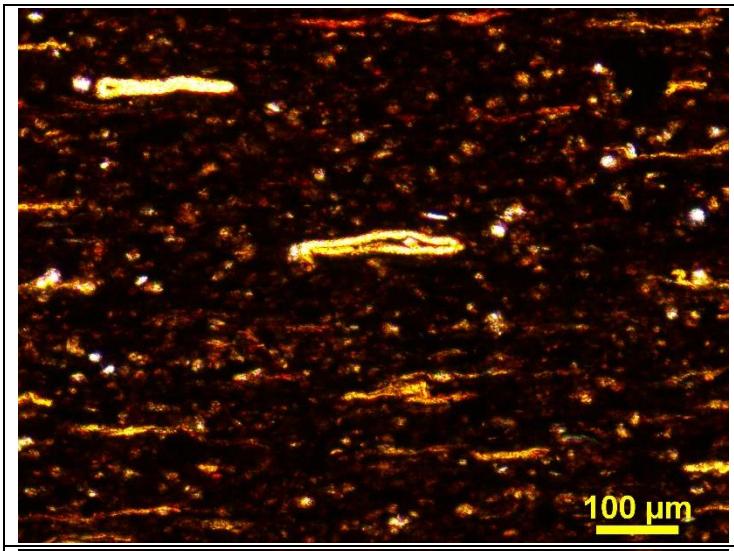
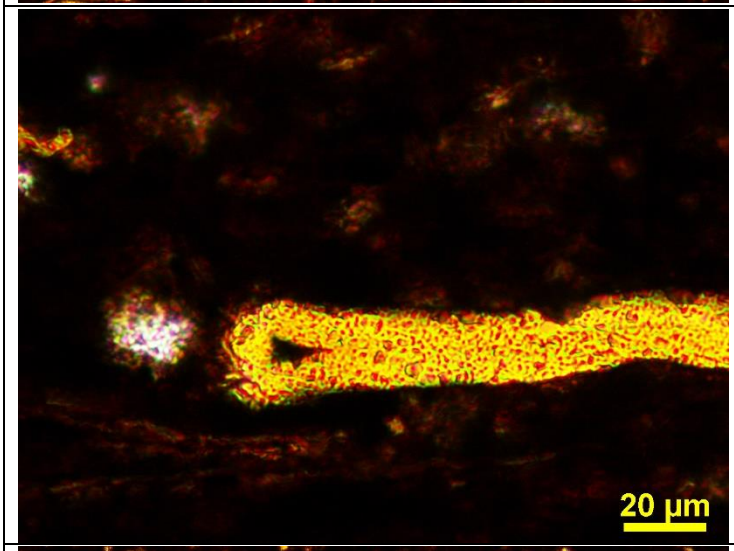
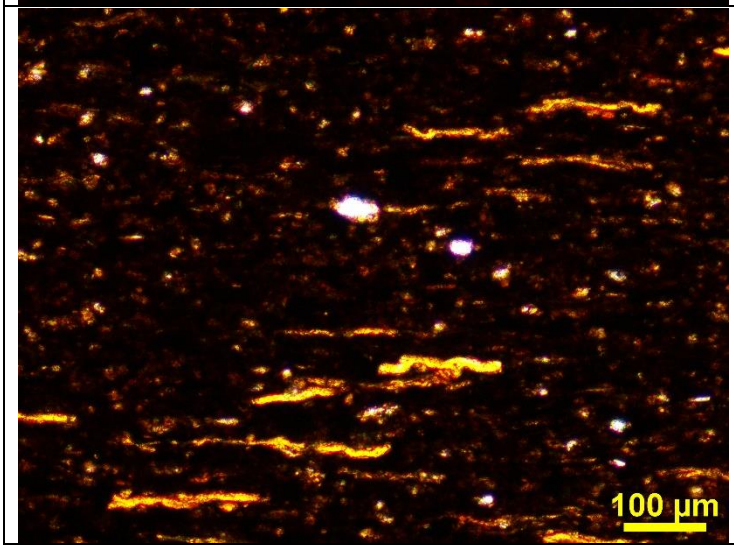
Sample: **B-43 HQ-21 @ 167.2-167.9**

	Plane-polarized photomicrograph at high magnification showing elongate, slightly sinusoidal, loop shape of bright-yellow organic carbon macerals. Quartz silt (white) sparse and matrix mud red/dark brown with finer-grained organic carbon mixed with clays.
	Plane-polarized photomicrograph at very high magnification of end of bright-yellow organic carbon maceral showing very typical loop shape. White grain at end of maceral is quartz silt 0.008 inches in diameter.
	Plane-polarized photomicrograph of bright-yellow organic carbon macerals showing very consistent size and characteristic sinusoidal/wavy shape (possibly due to uneven compression of originally flat leaves in mud when rock lithified – i.e., variations in quartz silt made different parts of mud more/less compressible, so flexible organic "leaves" conformed accordingly?) White grains are quartz silt.

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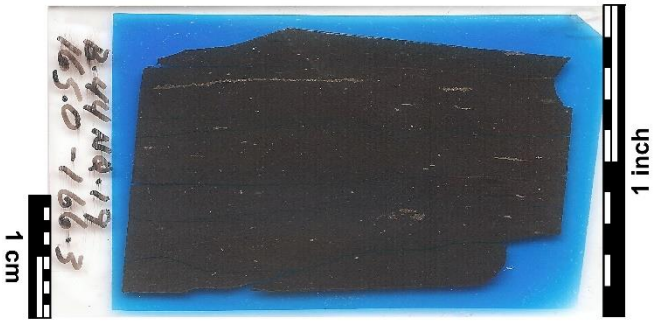
Sample: **B-44 NQ-19 @ 165.0-166.3**

Macroscopic sample description	**Black shale** Black, very fissile mudstone with irregular breaks spaced 5 mm. Sample crumbles if not handled gently. Very fine-grained pyrite along parting. Scratches easily with steel scribe. No reaction with acid.		
Brief petrographic description	Dark brown mud matrix supporting evenly-disseminated equant quartz silt grains. Red flake-shaped carbon is only discrete maceral present. Disseminated very fine-grained pyrite cubes locally coalesce as large, bedding-elongate aggregates. Large 100-300 μm thick x 1-4 millimeter-long, bedding-parallel clay-rich/silt/poor chips in matrix.		
Constituent minerals	Quartz silt	5%	<30 μm equant disseminated
	Quartz mud	44%	<5 μm granules in mud *(proportion calculated chemically)*
	Kaolinite	15%	<1 μm in mud *(proportion calculated chemically)*
	Muscovite	32%	<5 μm flakes in mud *(proportion calculated chemically)*
	Chlorite	1%	<5 μm flakes in mud *(proportion calculated chemically)*
	Pyrite	2%	20 μm equant, disseminated, locally forming aggregates 300 x 1,000 μm in size
	Organic	2%	<100 μm red flake macerals plus finer-grained in mud matrix
Porosity	0% observable intergranular porosity and <<1% fracture porosity along shaley partings		
Heterogeneity	Shaley parting along bedding		

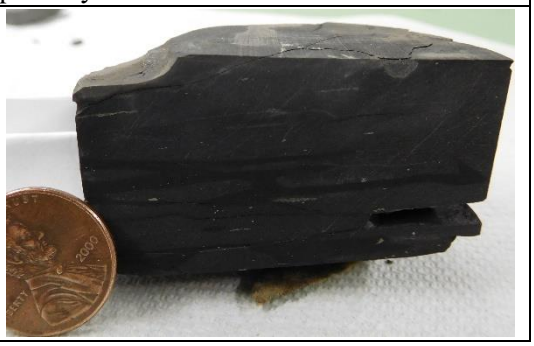
Billet of black shale
Pyrite along bedding (bright white traces) in otherwise homogenous mudstone. Gray splotches are air bubbles on scanned sample surface.



Thin section slide of black shale
Note pyrite concentrations along bedding (light) and blue epoxy impregnation in shaley parting, but 0% detectable intergranular porosity.

	wt%	*norm. wt%*
Na_2O	0.5	0.7
MgO	0.4	0.5
Al_2O_3	15.0	19.1
SiO_2	52.5	66.9
P_2O_5	0.0	0.1
SO_2	1.5	1.9
K_2O	3.2	4.0
CaO	0.1	0.2
TiO_2	0.8	1.0
FeO	4.4	5.6
Total	78.5	100.0

Photograph of cut drill core of black shale. Shaley parting on cut surface highlighted by soaking with water, then drying face. Note irregular wavy breaks along bedding seen in parting and topography of top of sample broken along shaley parting (i.e., not perfectly planar).



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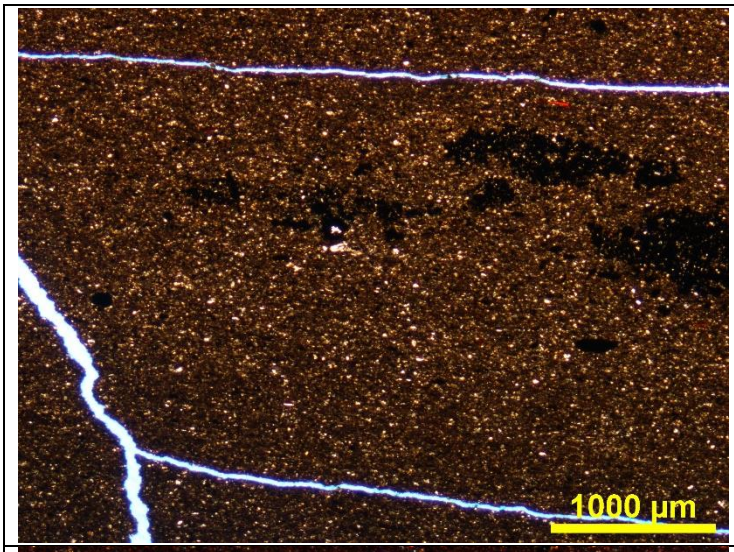
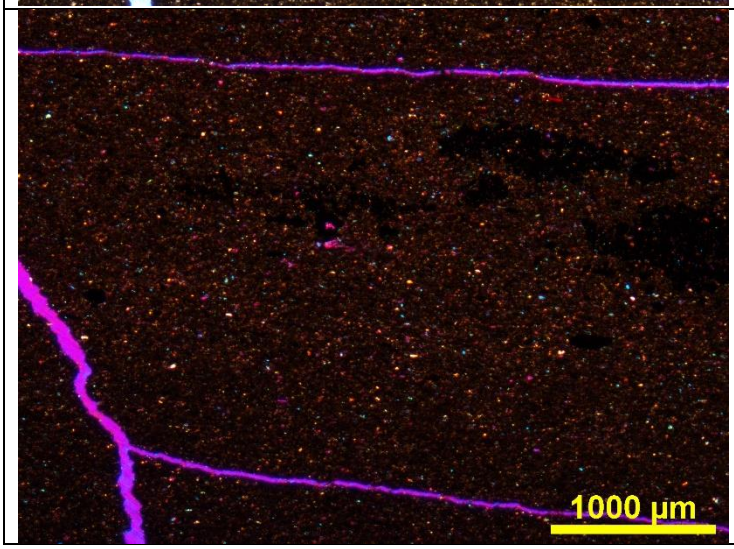
Sample: **B-44 NQ-19 @ 165.0-166.3**



Plane-polarized photomicrograph of main body of sample documenting moderately high quartz silt content (white), high abundance of very fined-grained pyrite forming nearly massive mm-wide aggregates (opaque black), and traces of red organic carbon macerals in dark brown, carbon-rich mud matrix. Blue lines are fractures filled with epoxy.



Cross-polarized photomicrograph with gypsum plate inserted (540 nm additional retardation) of same spot on slide documenting silt grains are quartz (yellow/blue).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens.

Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg). Three 60-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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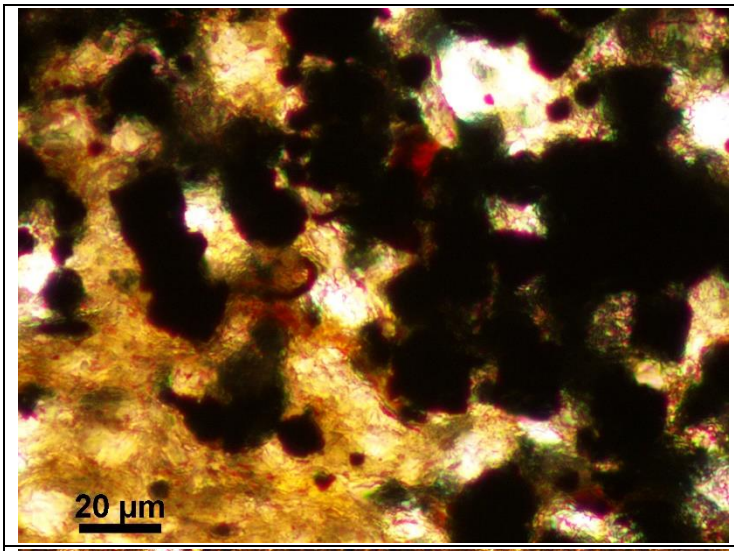
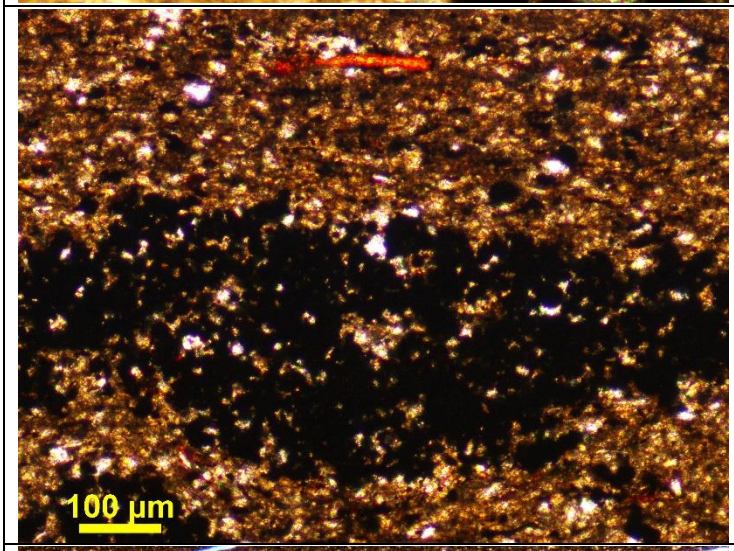
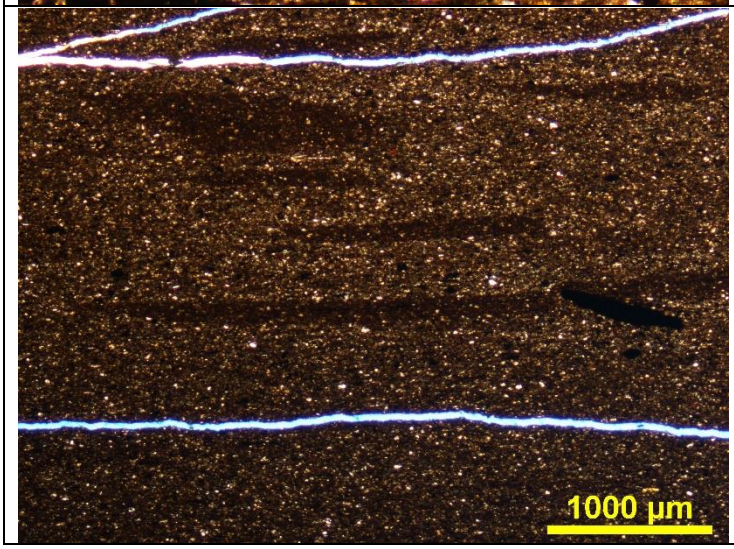
Sample: **B-44 NQ-19 @ 165.0-166.3**

	Plane-polarized photomicrograph at very high magnification with condenser lens engaged for maximum illumination to distinguish truly-opaque pyrite (black) from nearly-opaque organic carbon macerals. Pyrite forms 20 µm cubes that coalesce to form large, nearly pure aggregates. Yellow grains intermixed with pyrite are either chlorite (probable) or nontronite clay (less likely, but not impossible). Red is organic carbon.
	Plane-polarized photomicrograph at high magnification of pyrite aggregate with no difference in white quartz silt content compared to adjacent mudstone. Red grains are organic carbon macerals.
	Plane-polarized photomicrograph at low magnification showing discrete, bedding-parallel, dark-brown muddy chips deposited within shale. Black is opaque pyrite aggregate. Blue epoxy fills bedding-parallel fractures.

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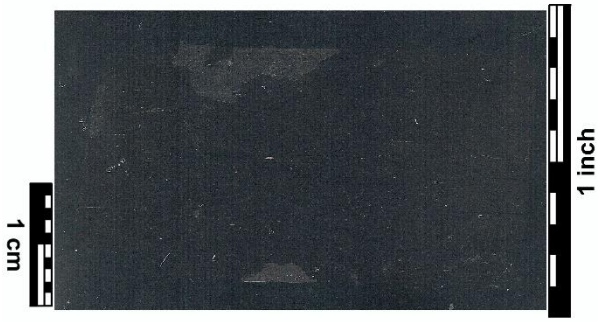
Sample: **B-45-HQ-5 @ 151.2-151.6**

Macroscopic sample description	**Dark gray pyritic shale** 80% gray color dry, 100% gray (black) when wet, highly fissile shale with 4 mm average thickness between partings on wavy surfaces. Thin wisps of pyrite along bedding. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Homogeneous mixture of sparse very fine-grained angular quartz silt in mica-clay matrix. Matrix is very rich in diffuse amorphous brown organic carbon. Red kerogen macerals throughout with single 1-mm fossil grain. Pyrite disseminated throughout and aggregated along bedding. Trace green chlorite.		
Constituent minerals	Quartz	44%	4% as <30 µm equant angular silt, remainder as fine-grained component in mud matrix – no stratigraphic variations in silt content (homogeneous)
	Muscovite	33%	1% as 50 µm bedding-parallel detrital flakes, remainder as high-birefringence component of mud matrix that goes extinct together due to grain alignment parallel to bedding
	Kaolinite	16%	<1 µm low-birefringence (gray) component of mud matrix
	Pyrite	2%	<50 µm anhedral equant opaque grains randomly disseminated throughout and concentrated as >800 µm aggregates along bedding.
	Kerogen	5%	2% as 20-150 µm red angular macerals (one 1,000 µm fossil), remainder as brown-reddish brown amorphous material permeating mud matrix to nearly opaque. Only trace 150 µm squashed-loop-shaped yellow fossil grains.
	Chlorite	<0.5%	<25 µm bright green flakes randomly disseminated
Porosity	0% intergranular porosity and 1% fracture porosity along parting		
Heterogeneity	Homogeneous composition, but fissile		



Billet of dark gray pyritic shale

Sample black when wet. Gray shapes are air bubbles on surface.

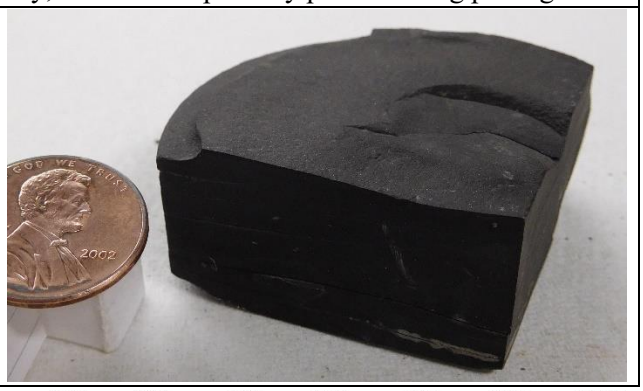
Thin section slide of dark gray pyritic shale

1 mm round pyrite grains (arrow)

Blue epoxy impregnation indicates 0% intergranular porosity, but fracture porosity present along parting.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.8	0.9
Al_2O_3	16.3	19.4
SiO_2	55.3	65.9
P_2O_5	0.1	0.1
SO_2	2.2	2.7
K_2O	3.4	4.1
CaO	0.2	0.2
TiO_2	0.8	0.9
FeO	4.4	5.2
Total	84.0	100.0

Photograph of cut drill core of dark gray pyritic shale. Top surface is shale parting with wavy surface. Pyrite concentrated along bedding visible near bottom of sample on cut surface.



10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

dry wet

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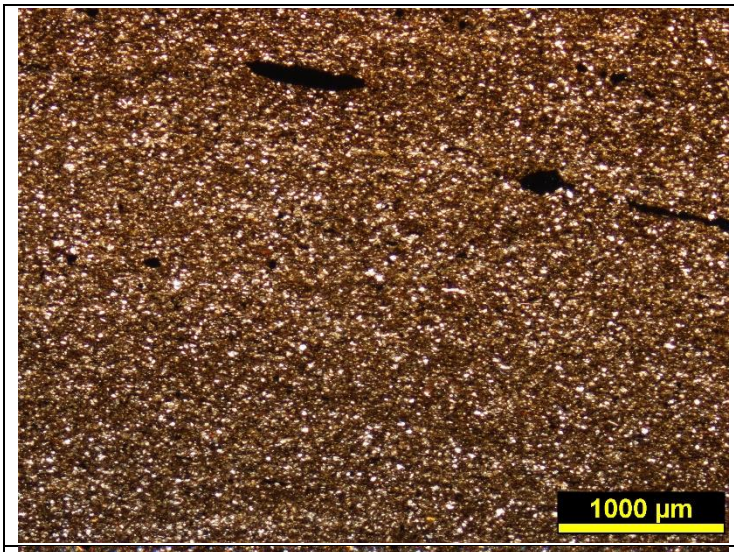
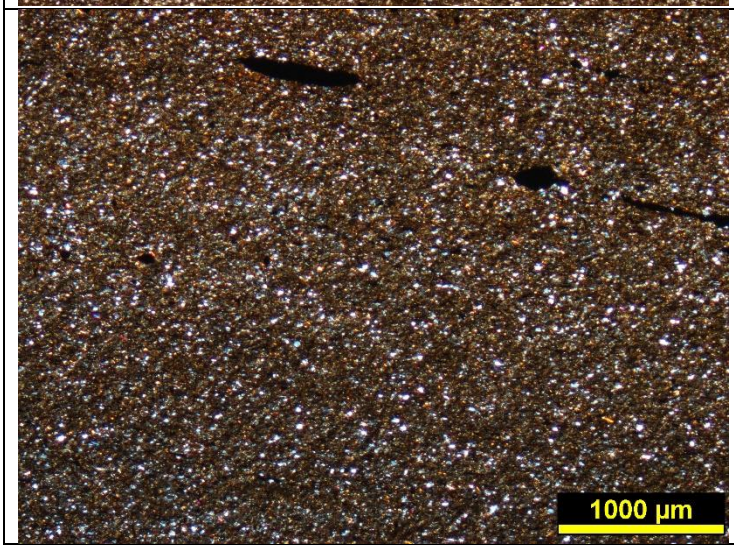
Sample: **B-45-HQ-5 @ 151.2-151.6**

	Plane-polarized photomicrograph of main body of sample showing opaque (black) pyrite aggregates along bedding with minor disseminated isolated grains in homogeneous quartz silt-mud matrix. White grains are quartz silt (equant) and detrital muscovite (lines). Minor red kerogen macerals present, plus diffuse amorphous brown kerogen in matrix.
	Cross-polarized photomicrograph of same spot on slide distinguishing quartz silt grains (equant white/gray) from detrital muscovite (yellow/red linear grains). Mud matrix is sparkly brown due to abundant very fine-grained micas.

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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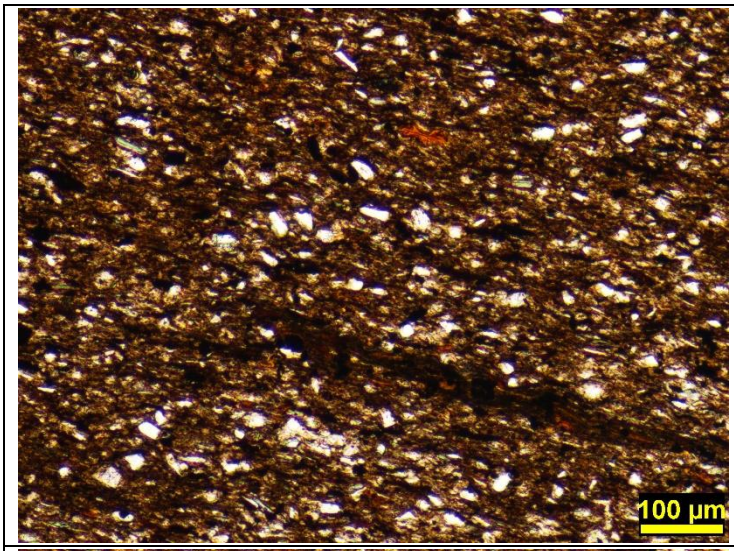
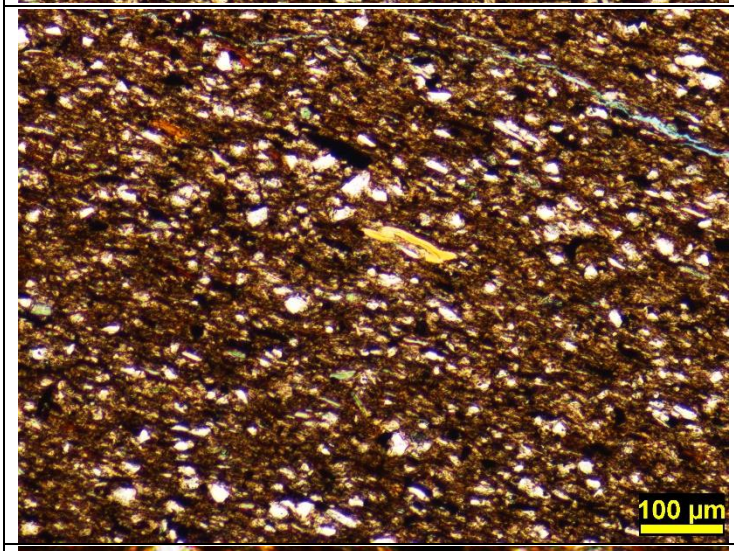
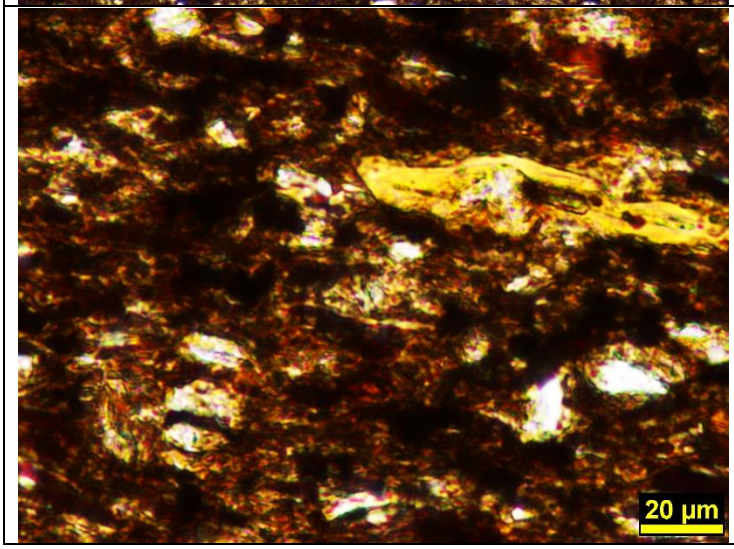
Sample: **B-45-HQ-5 @ 151.2-151.6**

	Plane-polarized photomicrograph detailing diffuse brown kerogen throughout mud matrix and distinct red macerals, including an unusually large red maceral (fossil). Quartz silt (equant white) and detrital muscovite (linear white) disseminated evenly throughout. Truly black grains are opaque fine-grained pyrite.
	Plane-polarized photomicrograph documenting traces of fracture porosity along shale parting (blue in upper right corner), and trace occurrence of wavy yellow fossil kerogen (center). Black grains are opaque pyrite.
	Plane-polarized photomicrograph at very high magnification detailing squashed-loop shape of yellow kerogen grains (fossils). Red kerogen macerals very distinctly different shape. Mica-clay-rich mud matrix between silt particles is rich in diffuse, amorphous brown kerogen.

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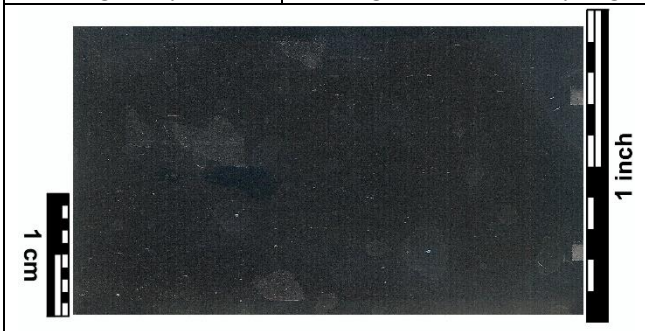
Sample: **B-46-HQ-20 @ 149.3-150.1**

Macroscopic sample description	**Black pyritic shale** 90% gray color dry, 100% gray (black) when wet highly fissile carbon-rich shale with 5 mm average thickness between partings with wavy surfaces. Pyrite as isolated grains and elongate wisps along bedding. Nonmagnetic. Scratches easily with steel scribe. No visible reaction with acid.		
Brief petrographic description	Homogeneous mudstone with sparse, evenly-disseminated quartz silt and detrital muscovite set in organic carbon-rich mica-dominant mud matrix. Most kerogen as amorphous brown material. Elongate, angular red kerogen macerals common, and wavy yellow fossil grains rare. Pyrite both evenly disseminated throughout and as bedding-parallel aggregates of very fine-grain size.		
Constituent minerals	Quartz	44%	5% as <30 μm equant angular to rounded silt, remainder as fine-grained component in mud matrix
	Muscovite	34%	2% as 50-100 μm bedding-parallel detrital flakes, remainder as high-birefringence component of mud matrix
	Kaolinite	16%	<1 μm low-birefringence (gray) component of mud matrix
	Pyrite	2%	<20 μm anhedral equant isolated grains randomly disseminated throughout and as 300-500 μm elongate aggregates bedding-parallel
	Kerogen	5%	2% as <100 μm red elongate angular macerals, remainder as brown-reddish brown amorphous material permeating mud matrix to nearly opaque. Only trace 100-200 μm squashed-loop shaped yellow fossil grains.
	Chlorite	<1%	<30 μm flakes randomly disseminated, aligned with bedding
Porosity	0% intergranular porosity and 0% fracture porosity		
Heterogeneity	Homogeneous, but very highly fissile		



Billet of black pyritic shale

Gray splotches = air bubbles on surface

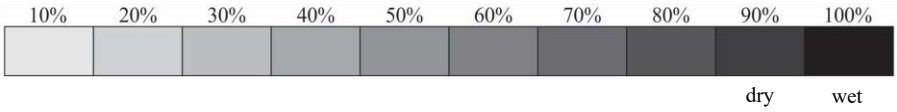
Thin section slide of black pyritic shale

Homogeneous, nearly opaque with organic carbon

Blue epoxy impregnation indicates 0% porosity.

	wt%	*norm. wt%*
Na_2O	0.6	0.7
MgO	0.5	0.7
Al_2O_3	15.6	19.5
SiO_2	52.6	65.6
P_2O_5	0.1	0.1
SO_2	2.0	2.5
K_2O	3.3	4.1
CaO	0.2	0.3
TiO_2	0.8	0.9
FeO	4.5	5.6
Total	80.1	100.0

Photograph of cut drill core of black pyritic shale. Top surface flat due to rock saw cut (lines are saw marks). Cut side shows shaley parting is wavy and sample is very highly fissile.



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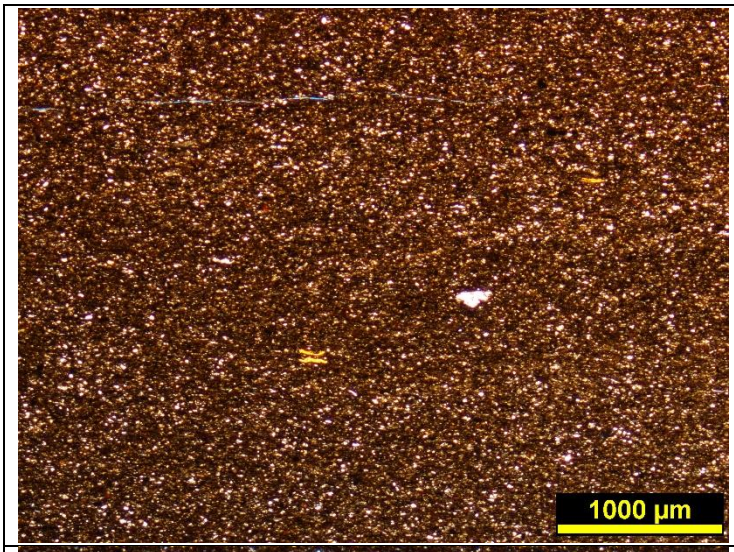
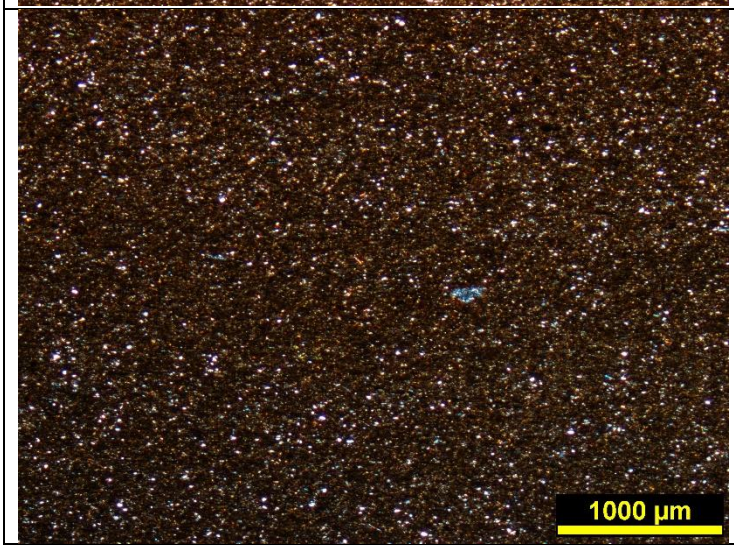
Sample: **B-46-HQ-20 @ 149.3-150.1**

	Plane-polarized photomicrograph of main body of sample documenting high amorphous brown kerogen content of mica-clay matrix, homogeneous nature of sample with evenly-disseminated quartz silt (white), and presence of both red and wavy-yellow kerogen macerals.
	Cross-polarized photomicrograph of same spot on slide showing first-order interference gray/white of disseminated quartz silt, higher-order colors of detrital mica flakes (blue/yellow/green).

Analytical methods

Billets and cut core samples were sanded smooth with 400-grit carborundum abrasive, examined with hand lens. Grayscale compared visually to chart as % black both dry and wet. Thin section analysis used a Nikon Pol600 polarized light petrographic microscope (both plane- and cross-polarized light).

Chemical analyses were done using a silicon drift detector Bruker Tracer IV-SD portable XRF with vacuum attachment for improved analysis of light elements (Na and Mg) using a mudstone standard. Three 30-seconds spot analyses with 2x4 mm analytical window were averaged to estimate the bulk rock composition using earth materials standards. Oxide weight percent values were calculated from raw elemental weight percent values on a molar basis, allocating oxygen to balance charges. Portable XRF analyses are an objective, quantitative evaluation of the bulk chemical composition and are accurate, but generally with only ± 2-4% precision – typical of normal rock variability.

The proportions of extremely fine-grained minerals in shale cannot be objectively determined optically because the particles of intermixed quartz, clay, mica, and lithic fragments in the silt and mud are too small to be resolved. The relative proportions of quartz, clay, and mica in mudstone can, however, be approximated based on the chemical composition of the sample if one assumes the clay mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) the mica is muscovite ($KAl_3Si_3O_{10}(OH)_2$), chlorite is end-member clinochlore composition ($Mg_5Al_2Si_3O_{10}(OH)_8$), and first-order gray silt grains are quartz (SiO_2). These are reasonable approximations in most shales that do not display swelling characteristics (indicating presence of other clay species). The volumetric proportions of chlorite, muscovite, kaolinite, and clay-size quartz are constrained by the Mg, K, Al, and Si contents, respectively. Relative proportions of quartz silt and opaque grains were determined by visual comparison with standardized estimation charts, then the proportions of quartz, clay, mica, and chlorite in mud calculated based on chemical analysis.

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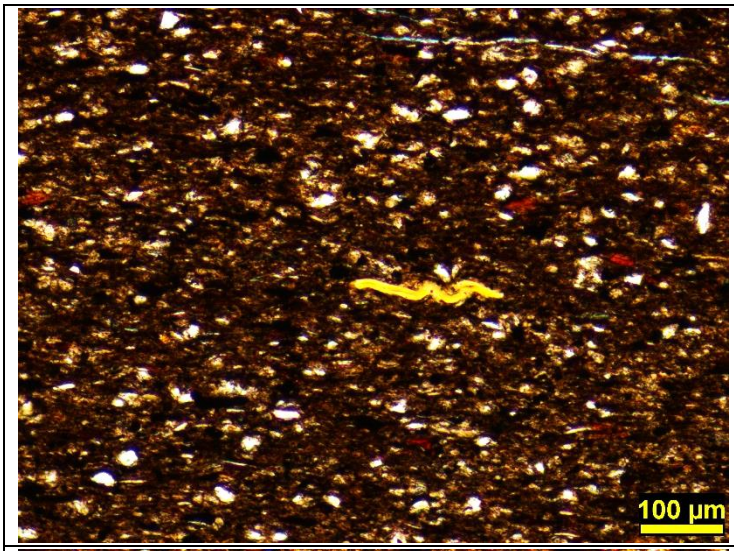
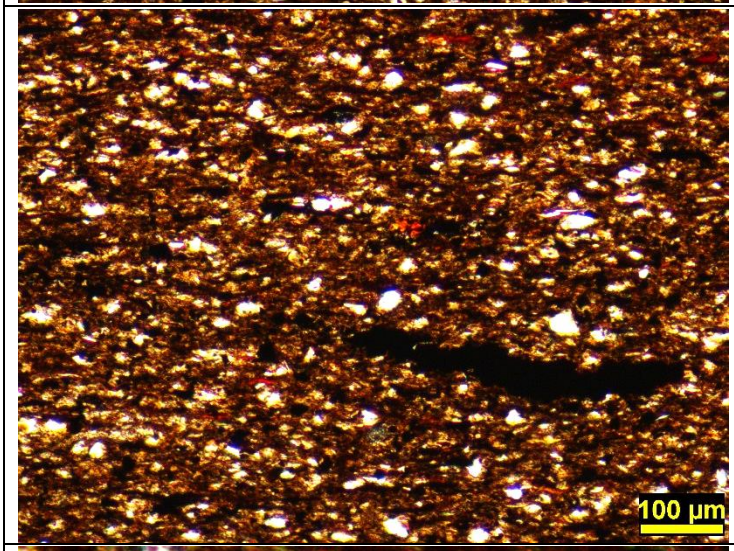
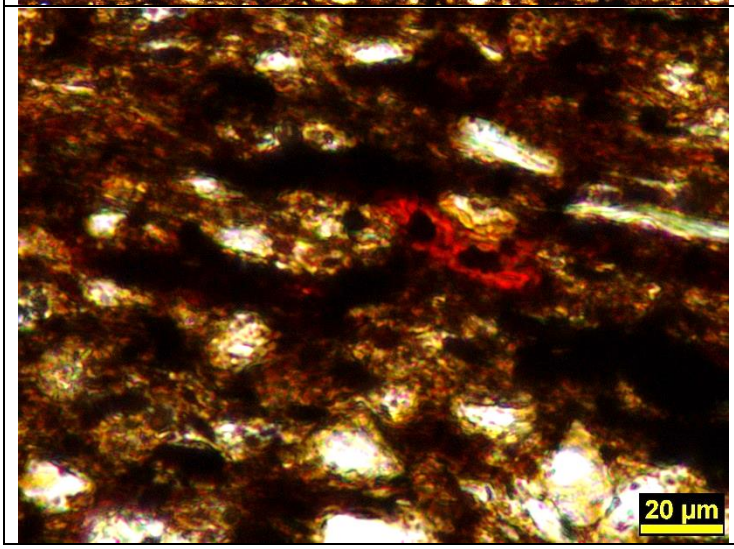
Sample: **B-46-HQ-20 @ 149.3-150.1**

	Plane-polarized photomicrograph detailing wavy yellow organic carbon fossil (center) and surrounding red kerogen macerals in dark brown matrix of mica-clay and diffuse brown kerogen. Very fine-grained disseminated pyrite is opaque black grains. Bright green flake is chlorite.
	Plane-polarized photomicrograph with light on maximum setting to illuminate through dark organic carbon-rich matrix to document occurrence of truly opaque black disseminated pyrite as isolated very <20 µm equant grains, and as larger bedding-parallel aggregates of those grains (large black feature in lower right). Discrete, sharp boundaries of red kerogen macerals distinctly visible. Quartz silt and detrital muscovite flakes (blocky white and linear white flakes, respectively).
	Plane-polarized photomicrograph at very high magnification detailing sharp-edged red type of kerogen maceral. Surrounding mud matrix is dark due to presence of diffuse brown kerogen.

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J.7 CERCHAR LABORATORY RESULTS

Earth Mechanics Institute

Client: Resource International

Project: Big Walnut

Date: 5/2/2018

Colorado School of Mines

Mining Engineering Department

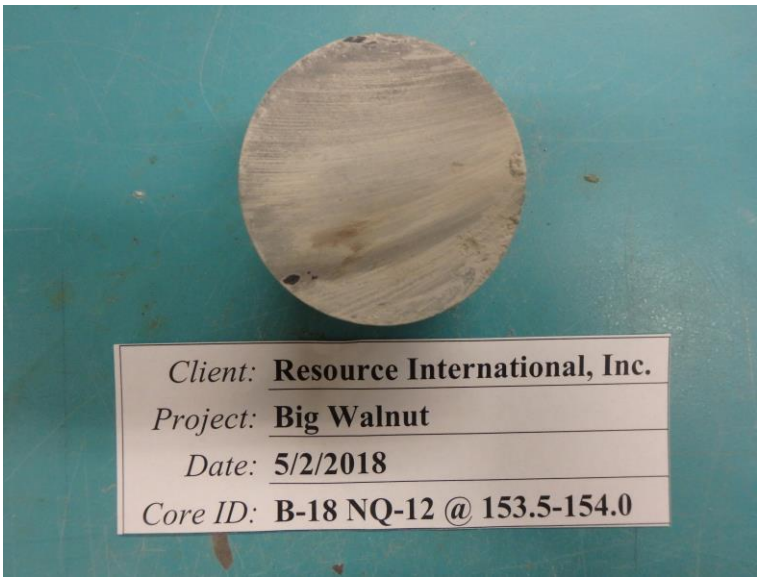
ASTM D7625

Sample ID	Rock Type	Cerchar Abrasivity Index
B-18 NQ-12 @ 153.5-154.0	Sedimentary	0.3
B-18 NQ-13 @ 162.0-163.1	Sedimentary	0.5
B-23 NQ-11 @ 156.6-157.0	Sedimentary	0.4
B-23 HQ-11 @ 171.2-171.6	Sedimentary	0.5

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/2/2018

Sample ID: B-18 NQ-12 @ 153.5-154.0



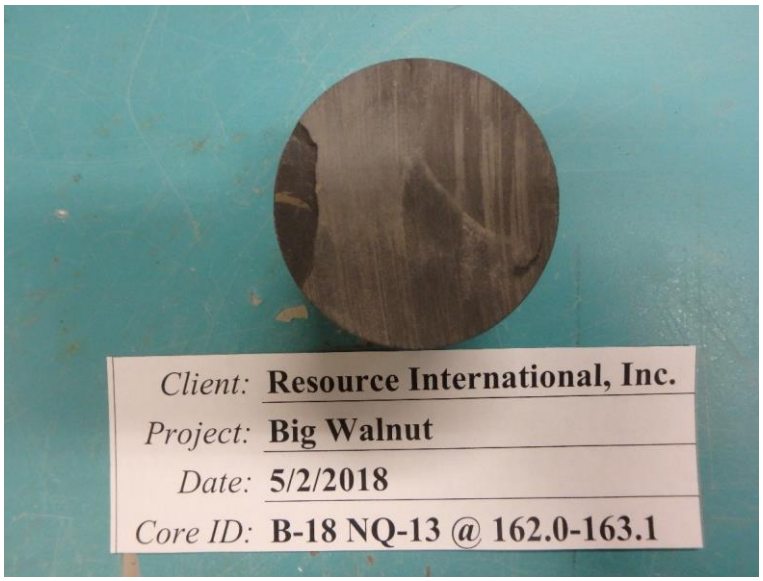
Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/2/2018

Sample ID: B-18 NQ-13 @ 162.0-163.1



Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/2/2018

Sample ID: B-23 HQ-11 @ 156.6-157.0

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/2/2018

Sample ID: B-23 HQ-13 @ 171.2-171.6

Before

After

Earth Mechanics Institute

Client: Resource International

Project: Big Walnut

Date: 6/4/2018

Colorado School of Mines

Mining Engineering Department

ASTM D7625

Sample ID	Rock Type	Cerchar Abrasivity Index (CAIs)*
B-20-HQ-12 @ 133.1-133.4	Sedimentary	0.4
B-20-HQ-15 @ 148.2-149.5	Sedimentary	0.5
B-27-NQ-17 @ 166.7-167.3	Sedimentary	0.5
B-27-NQ-17 @ 173.7-174.2	Sedimentary	0.4
B-29-NQ-18 @ 168.0-169.0	Sedimentary	0.4
B-31-HQ-19 @ 173.0-174.3	Sedimentary	0.5
B-33-NQ-18 @ 179.2-180.1	Sedimentary	0.4
B-42-NQ-18 @ 170.0-171.1	Sedimentary	0.4
B-43-HQ-21 @ 167.2-167.9	Sedimentary	0.5
B-44-NQ-19 @ 165.0-166.3	Sedimentary	0.5

* CERCHAR tests have been run on saw cut surface. No correction factor has been added to the results.

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-20-HQ-12 @ 133.1-133.4

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-20-HQ-15 @ 148.2-149.5

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-27-NQ-17 @ 166.7-167.3

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-27-NQ-17 @ 173.7-174.2

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-29-NQ-18 @ 168.0-169.0

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-31-HQ-19 @ 173.0-174.3

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-33-NQ-18 @ 179.2-180.1

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-42-NQ-18 @ 170.0-171.1

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-43-HQ-21 @ 167.2-167.9

Before

After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International, Inc.
Project Name: Big Walnut
Date: 5/31/2018

Sample ID: B-44-NQ-19 @ 165.0-166.3

Before

After

Earth Mechanics Institute

Client: Resource International

Project: Big Walnut

Date: 7/20/2018

Colorado School of Mines

Mining Engineering Department

ASTM D7625

Sample ID	Rock Type	Cerchar Abrasivity Index (CAIs)*
B-16-HQ-6 @ 148.1-148.9	Sedimentary	0.3
B-16-HQ-7 @ 153.8-154.4	Sedimentary	0.3
B-19-HQ-18 @148.7-149.5	Sedimentary	0.3
B-21-HQ-10 @ 161.9-162.4	Sedimentary	0.4
B-22-HQ-5 @ 151.6-152.5	Sedimentary	0.2
B-24-HQ-16 @ 165.1-165.6	Sedimentary	0.3
B-38-HQ-12 @ 107.1-107.9	Sedimentary	0.3
B-39-HQ-6 @ 154.6-155.5	Sedimentary	0.4
B-39-HQ-7 @ 157.7-159.5	Sedimentary	0.4
B-40-HQ-5 @ 27.8-28.8	Sedimentary	1.0

*** CERCHAR tests have been run on saw cut surface. No correction factor has been added to the results.**

Earth Mechanics Institute

Client: Resource International

Project: Big Walnut

Date: 7/30/2018

Colorado School of Mines

Mining Engineering Department

ASTM D7625

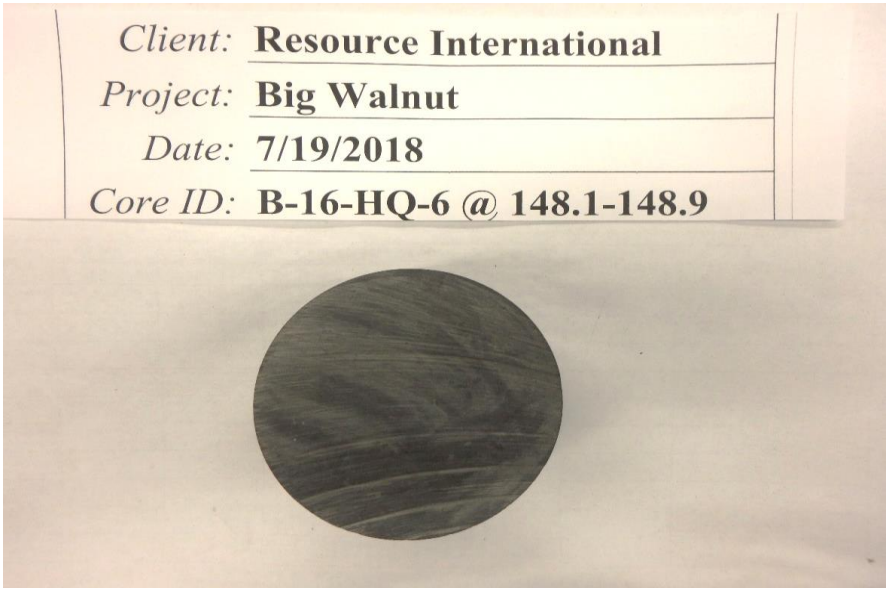
Sample ID	Rock Type	Cerchar Abrasivity Index (CAIs)*
B-40-HQ-16-17 @ 84.8-85.6	Sedimentary	0.4
B-40-HQ-22 @ 113.6-114.5	Sedimentary	0.4
B-40-HQ-26 @ 133.7-134.5	Sedimentary	0.5
B-40-HQ-28 @ 141.1-141.9	Sedimentary	0.3
B-40-HQ-30 @ 153.6-154.3	Sedimentary	0.4
B-40-HQ-32 @ 163.2-164.1	Sedimentary	0.4
B-41-HQ-33 @ 170.0-171.0	Sedimentary	0.5
B-45-HQ-5 @ 151.2-151.6	Sedimentary	0.4
B-46-HQ-20 @ 149.3-150.1	Sedimentary	0.5

*** CERCHAR tests have been run on saw cut surface. No correction factor has been added to the results.**

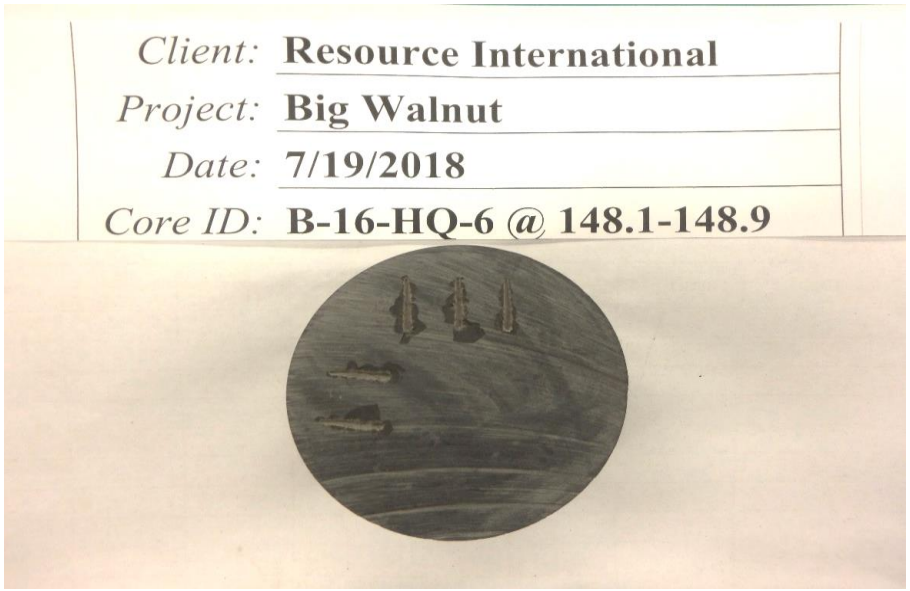
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-16-HQ-6 @ 148.1-148.9



Before

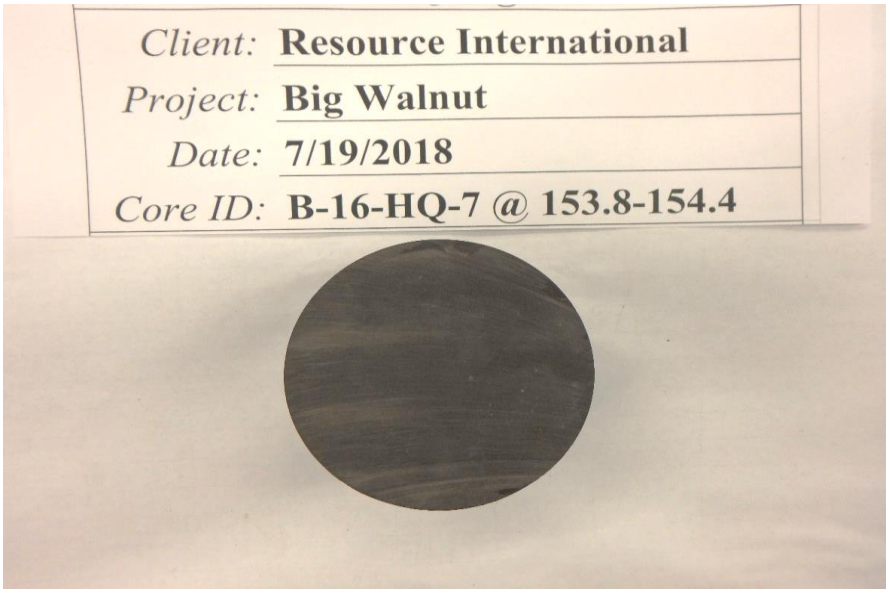


After

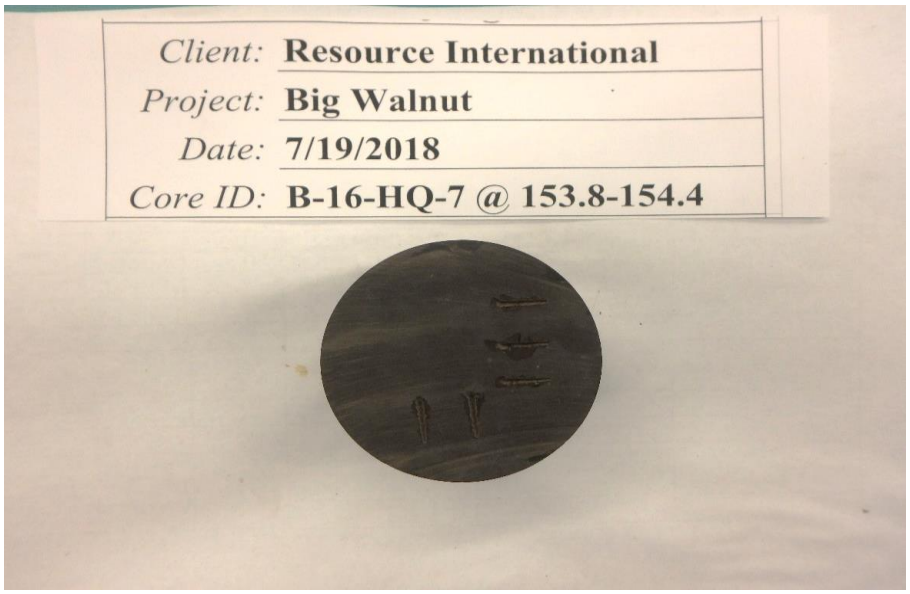
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-16-HQ-7 @ 153.8-154.4



Before

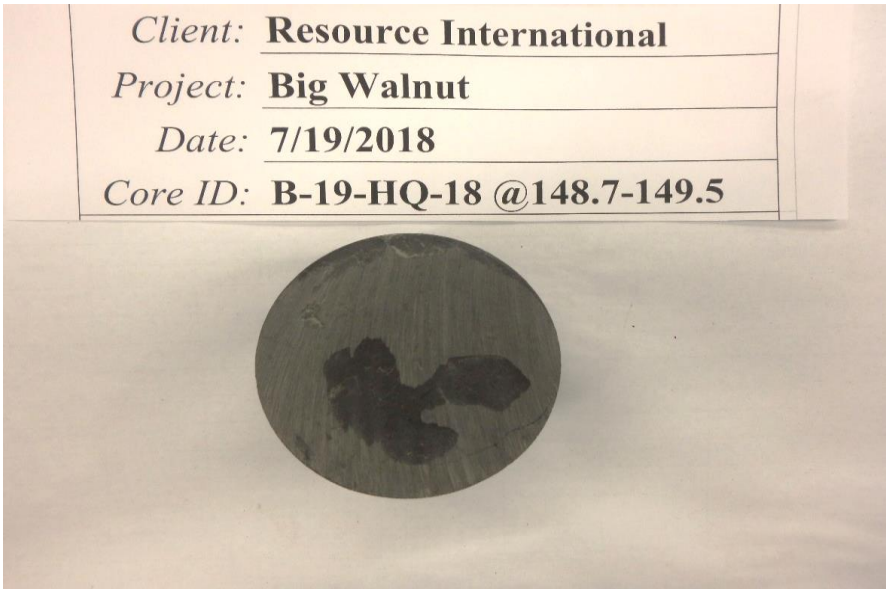


After

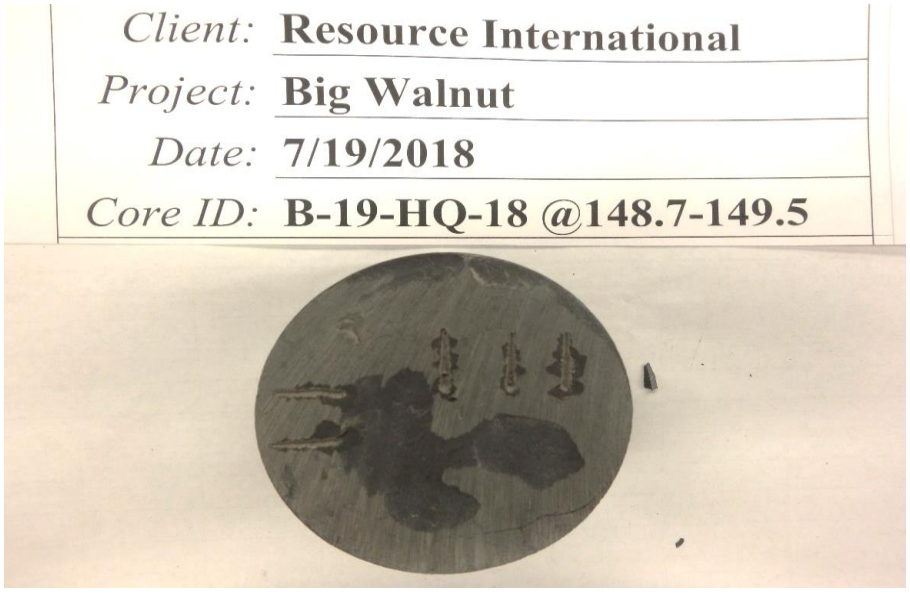
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-19-HQ-18 @148.7-149.5



Before

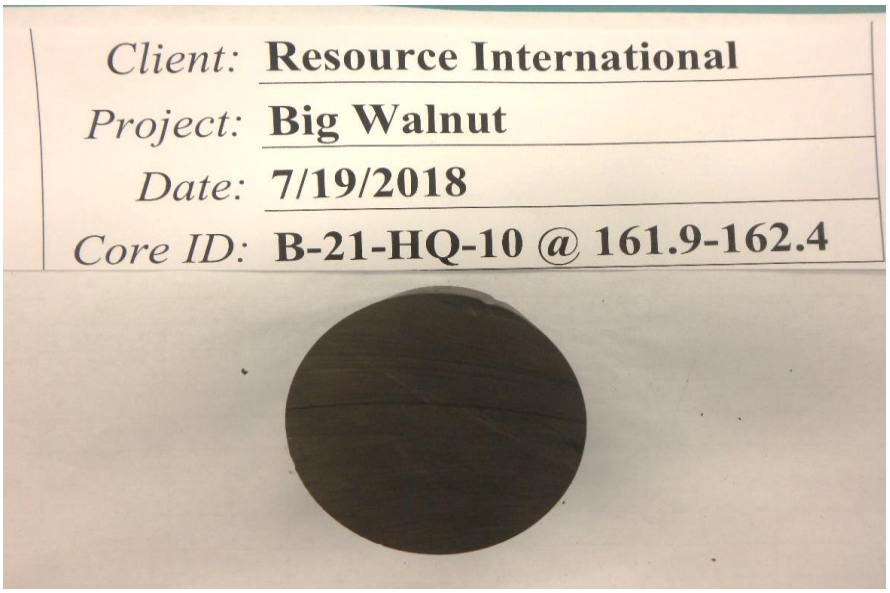


After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-21-HQ-10 @ 161.9-162.4



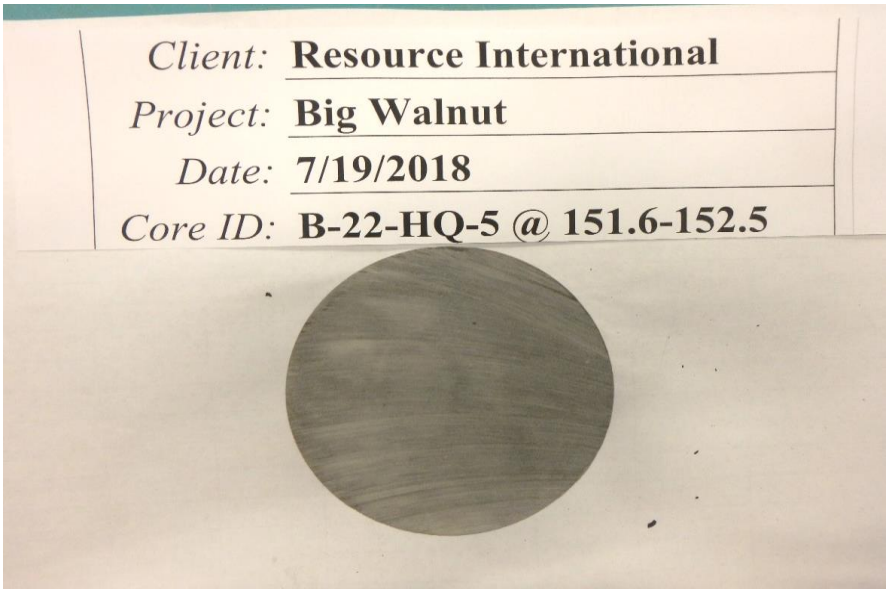
Before

After

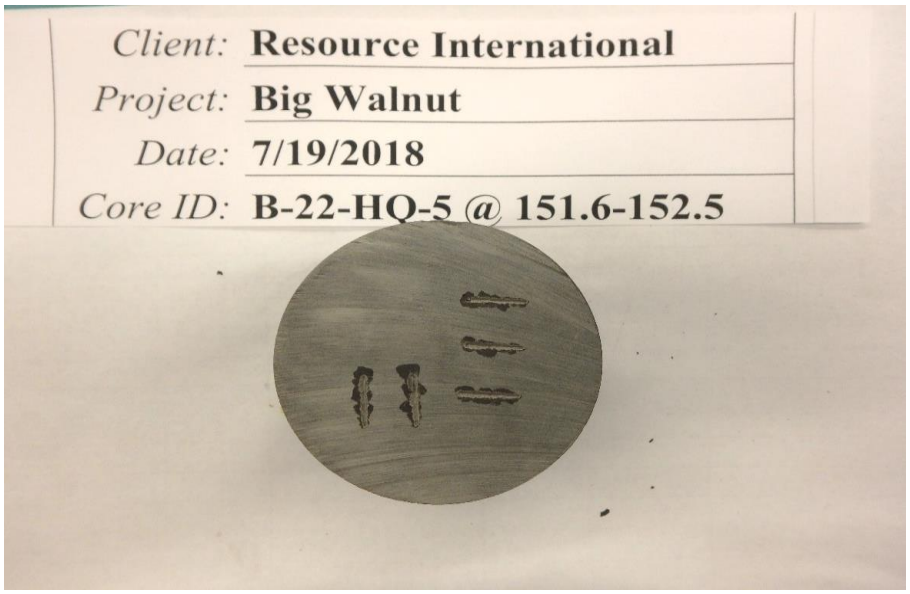
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-22-HQ-5 @ 151.6-152.5



Before



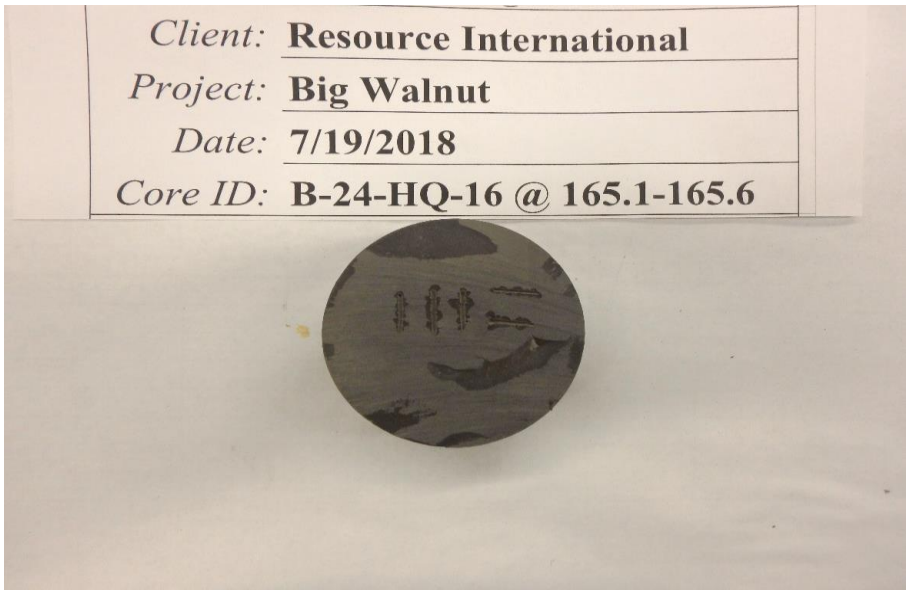
After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-24-HQ-16 @ 165.1-165.6

Before

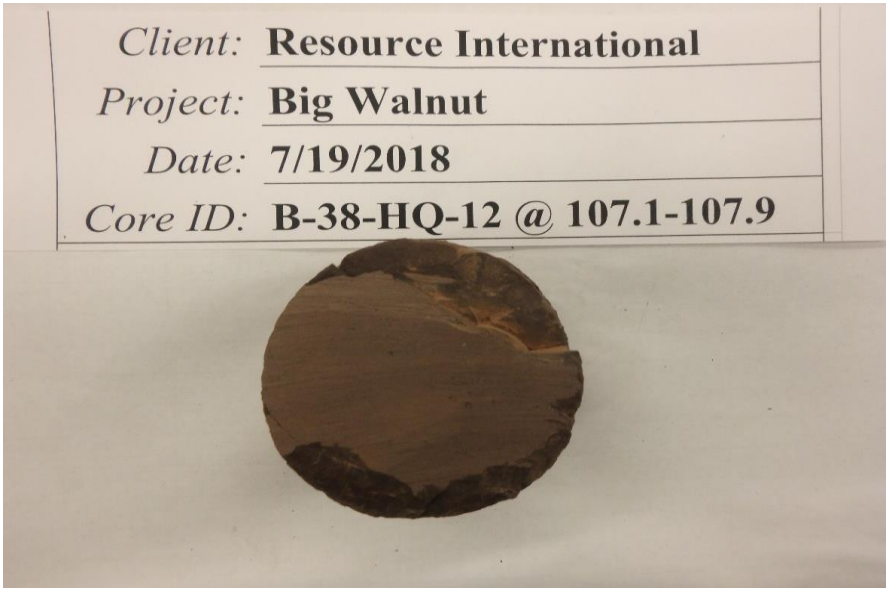


After

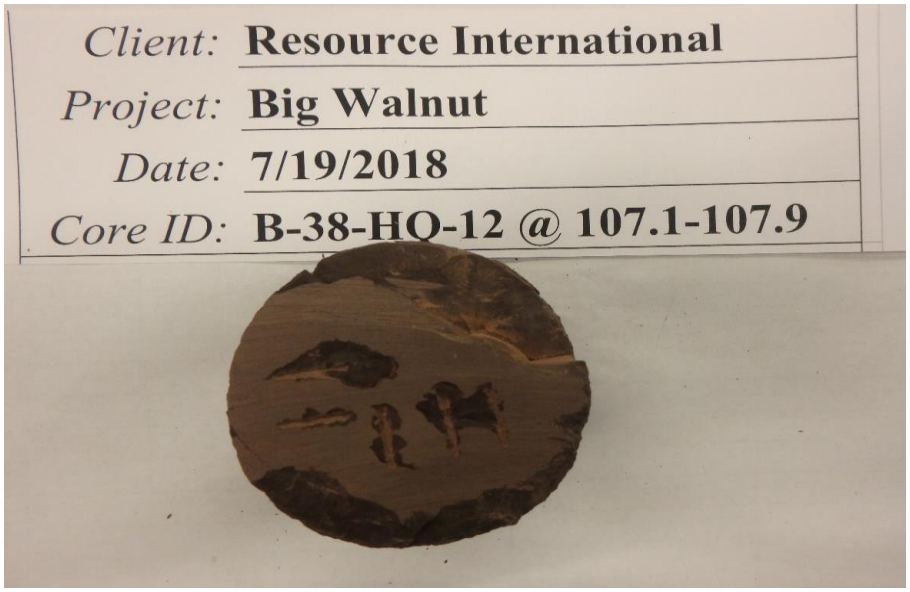
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/20/2018

Sample ID: B-38-HQ-12 @ 107.1-107.9



Before

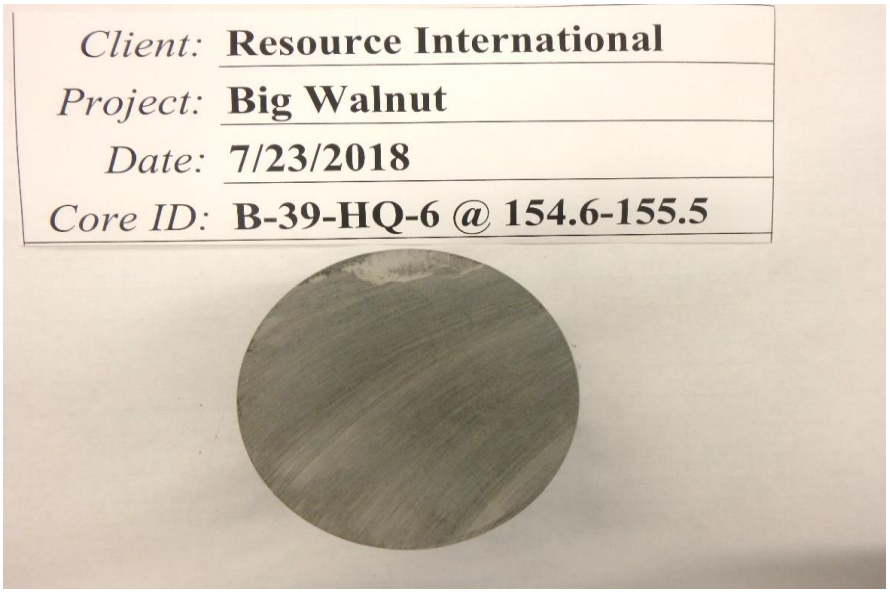


After

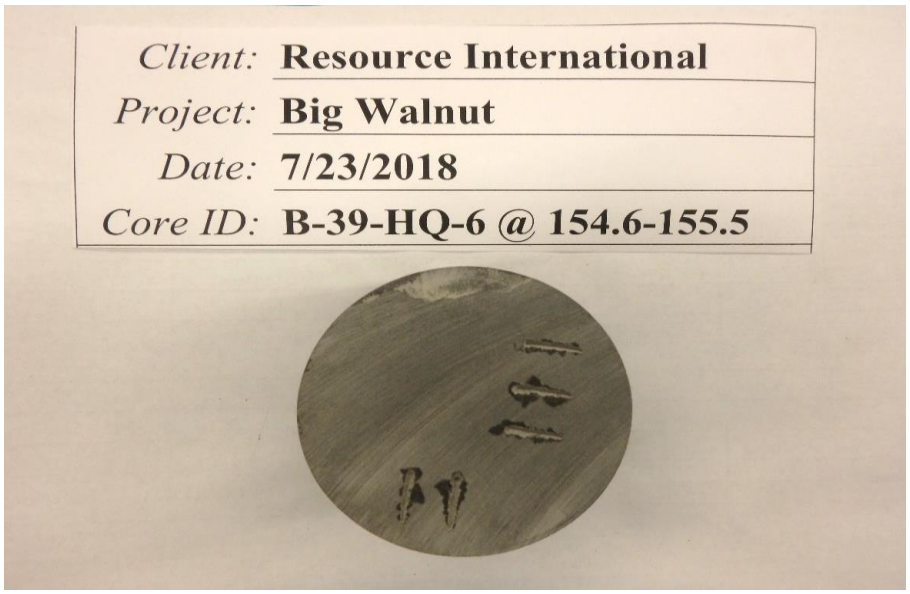
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/25/2018

Sample ID: B-39-HQ-6 @ 154.6-155.5



Before

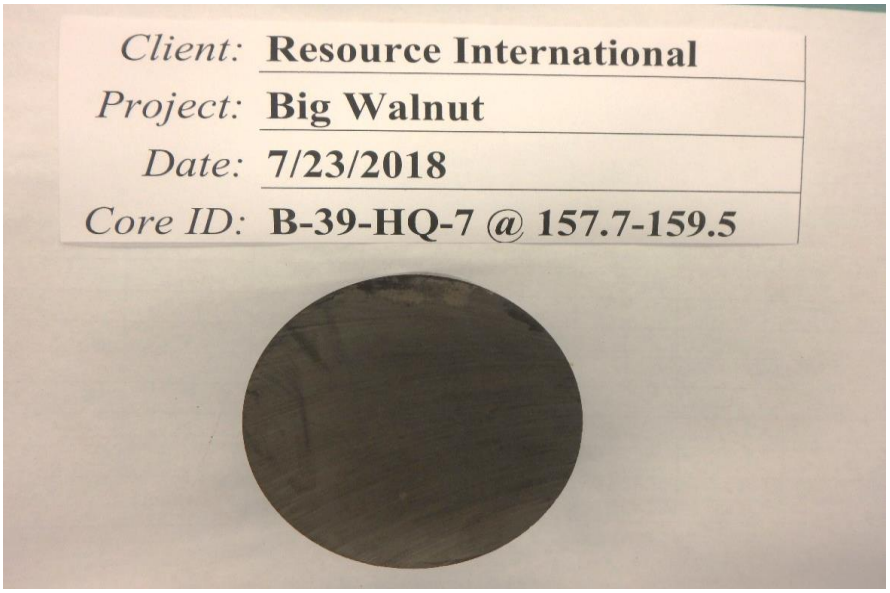


After

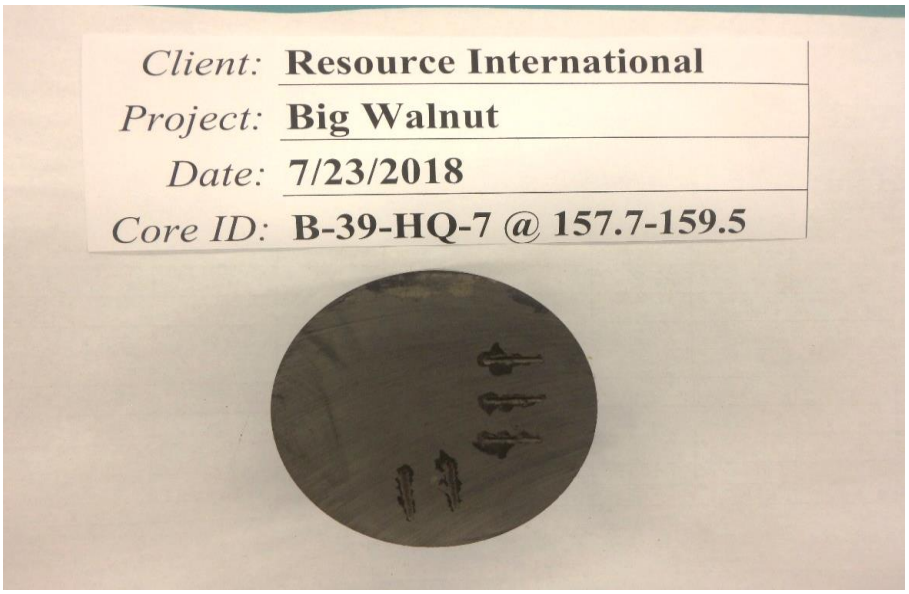
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/25/2018

Sample ID: B-39-HQ-7 @ 157.7-159.5



Before

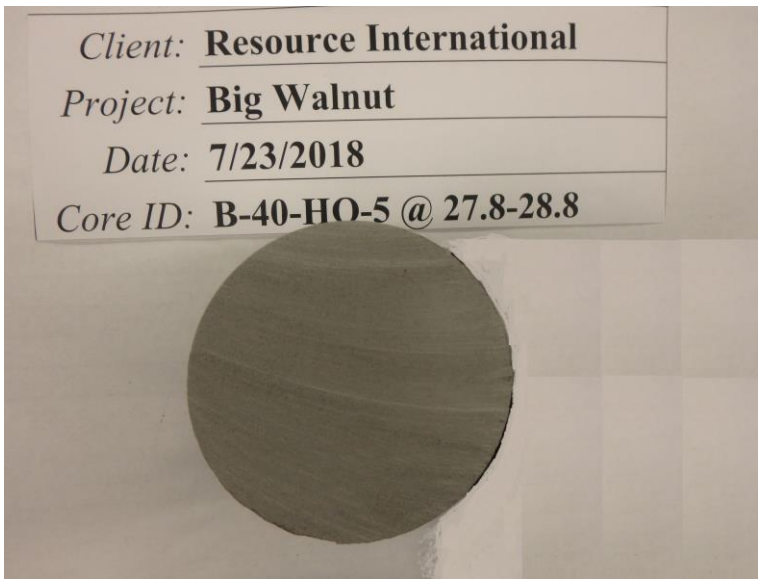


After

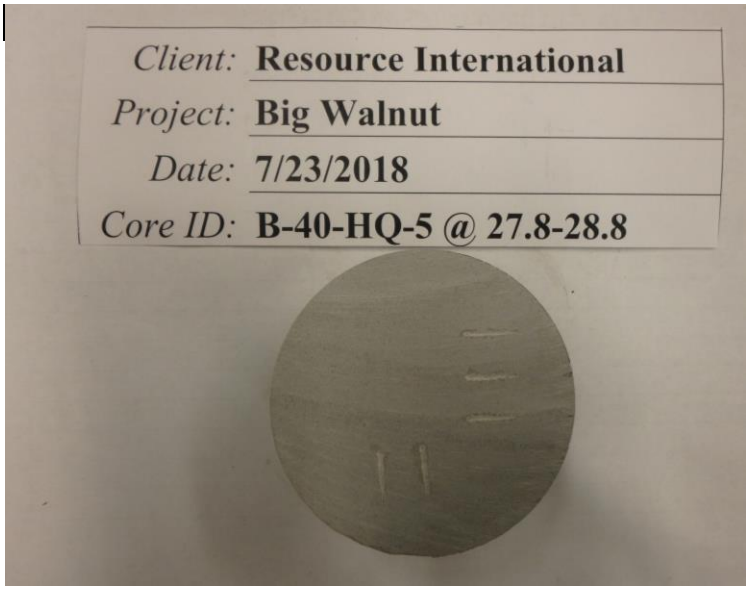
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/25/2018

Sample ID: B-40-HQ-5 @ 27.8-28.8



Before

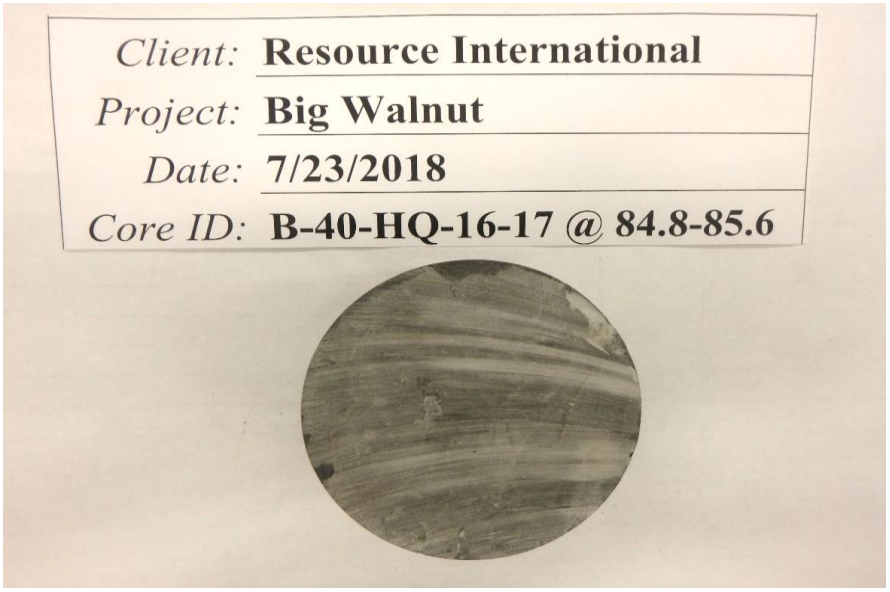


After

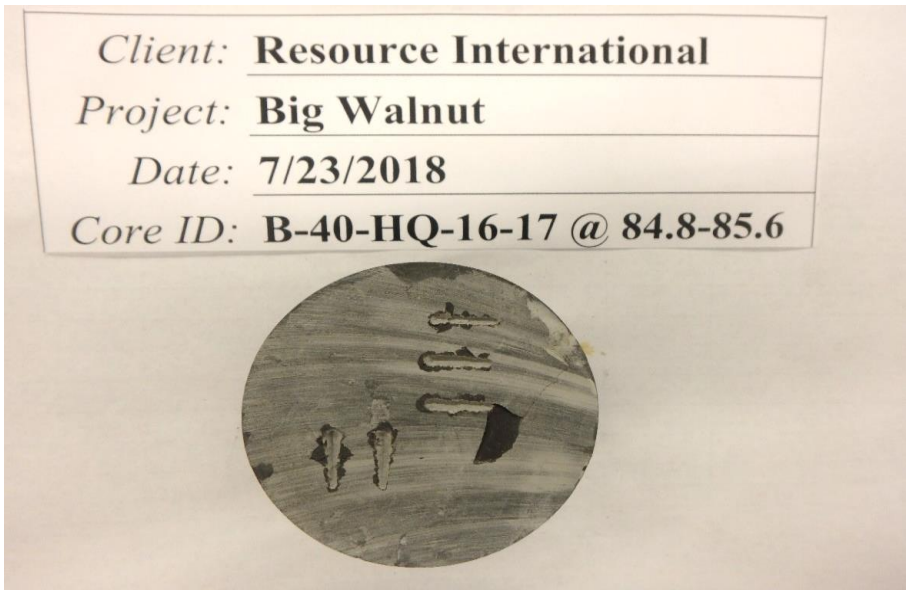
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/25/2018

Sample ID: B-40-HQ-16-17 @ 84.8-85.6



Before

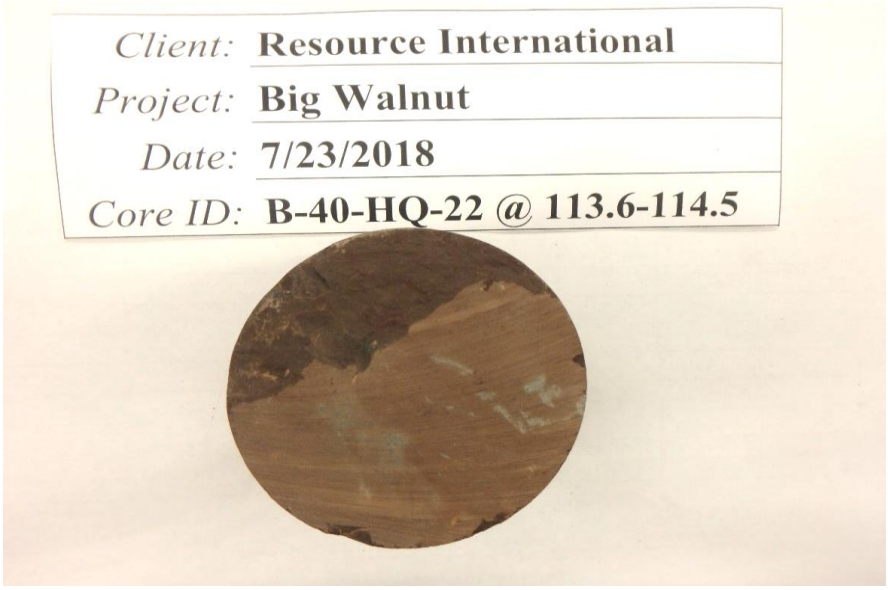


After

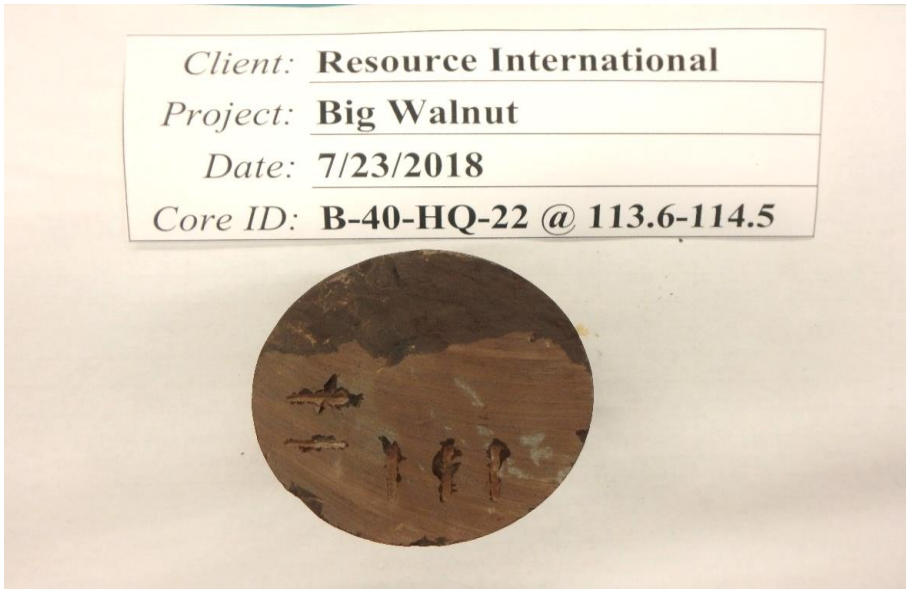
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/25/2018

Sample ID: B-40-HQ-22 @ 113.6-114.5



Before

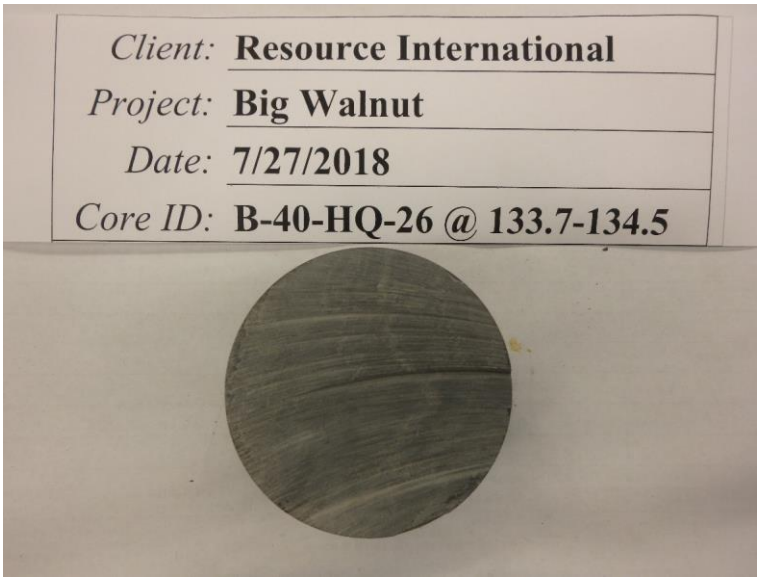


After

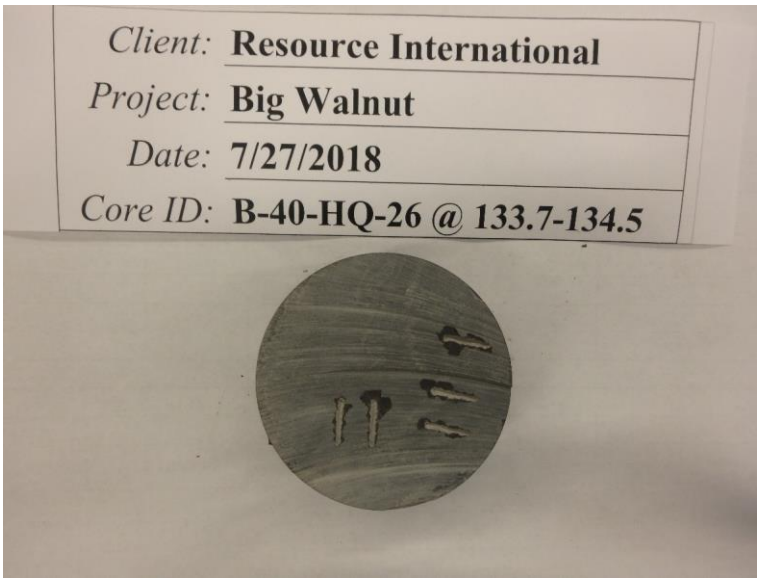
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-40-HQ-26 @ 133.7-134.5



Before

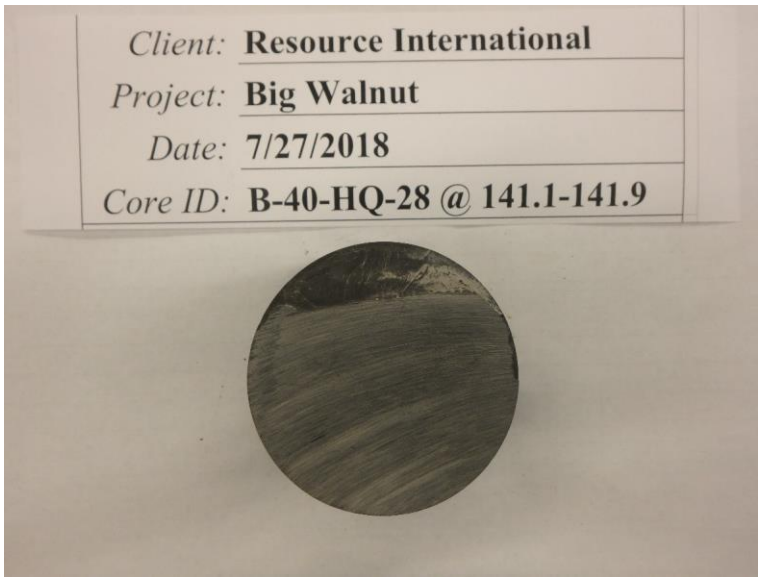


After

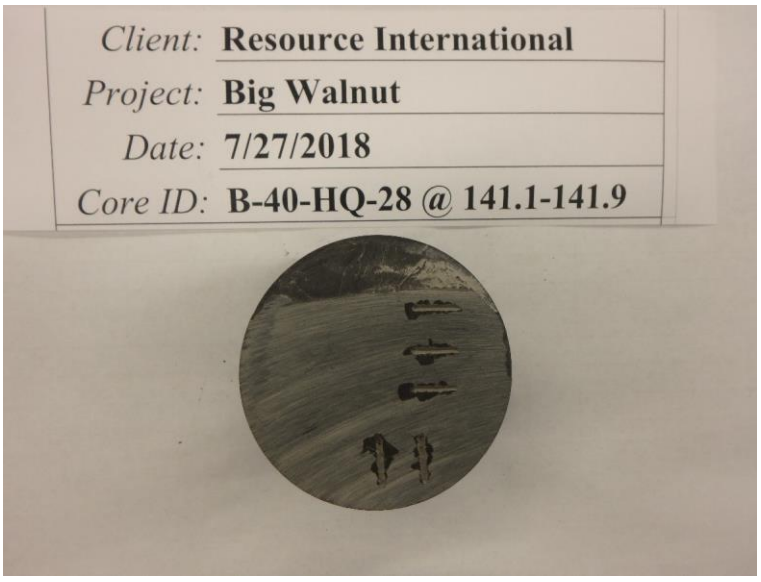
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-40-HQ-28 @ 141.1-141.9



Before

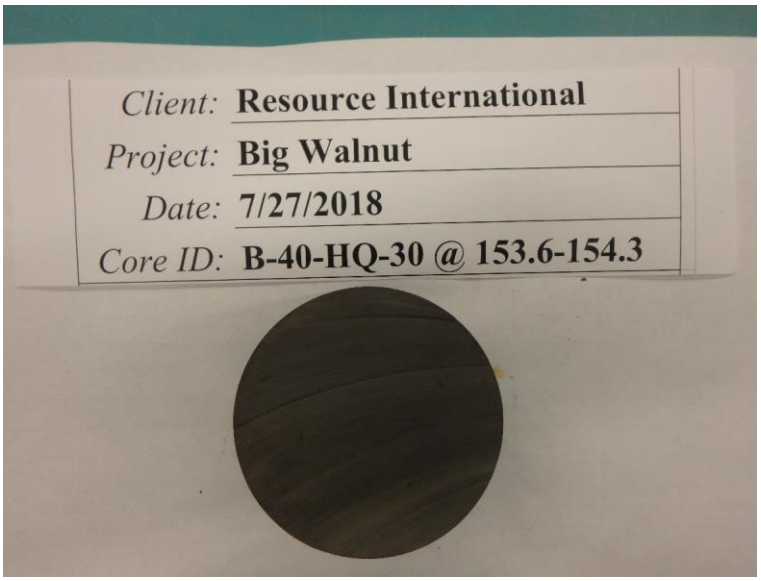


After

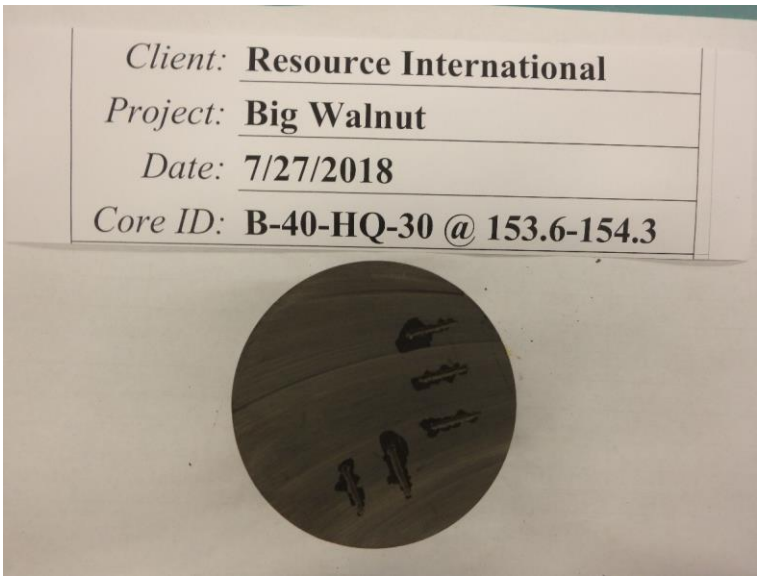
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-40-HQ-30 @ 153.6-154.3



Before

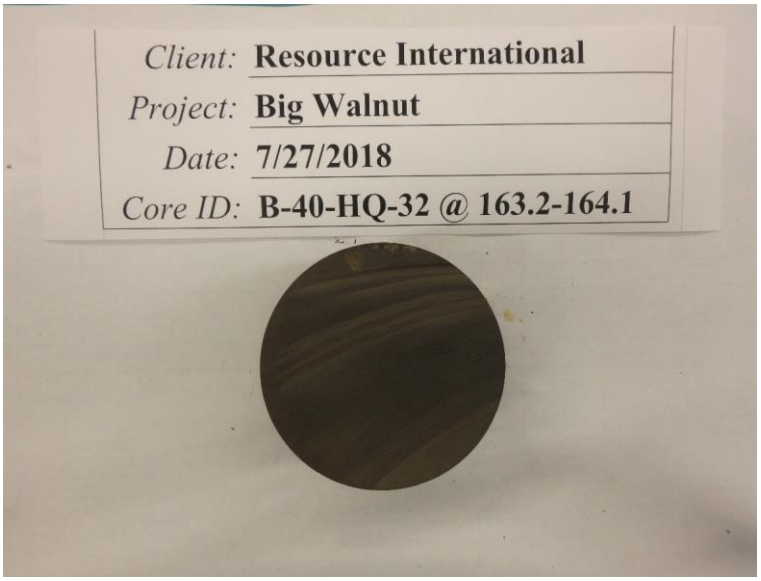


After

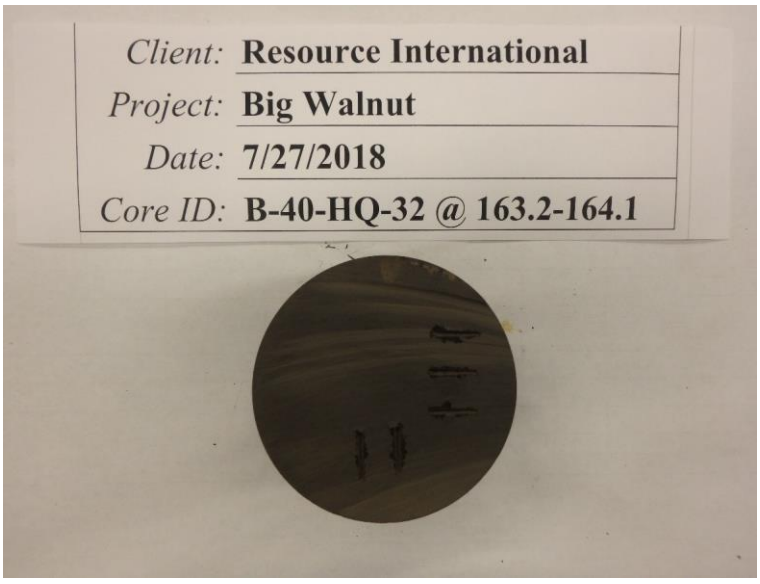
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-40-HQ-32 @ 163.2-164.1



Before

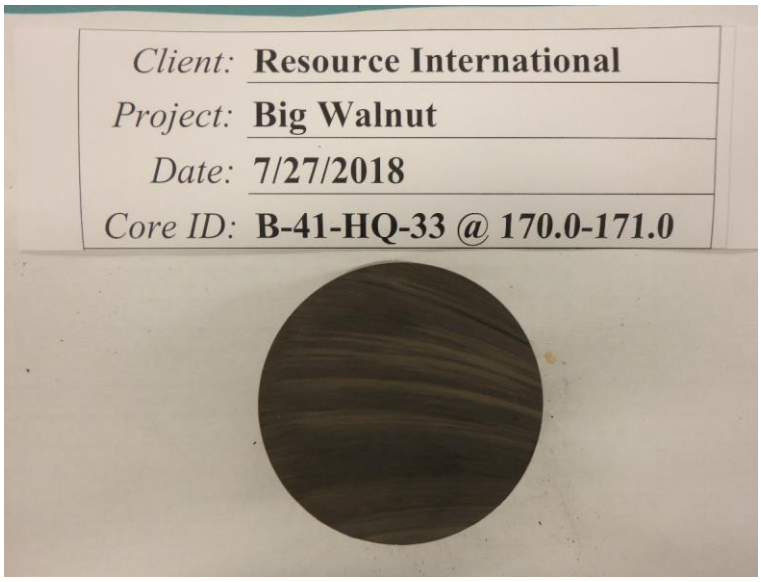


After

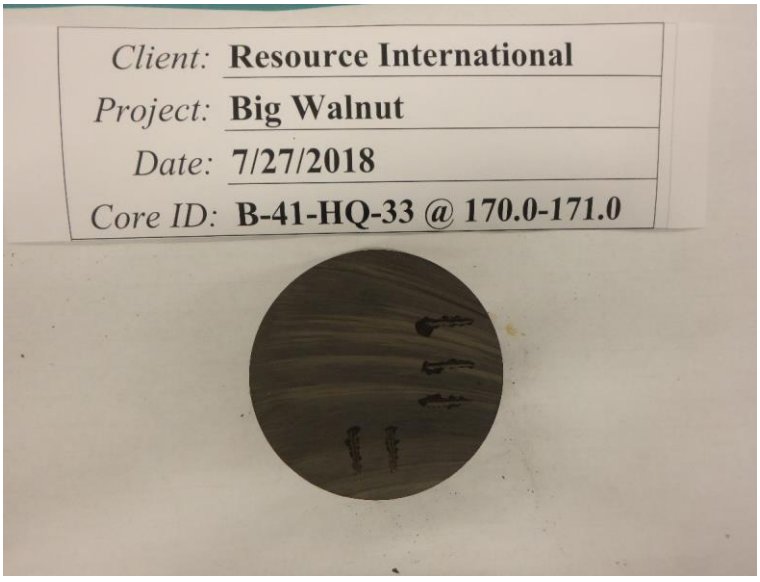
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-41-HQ-33 @ 170.0-171.0



Before

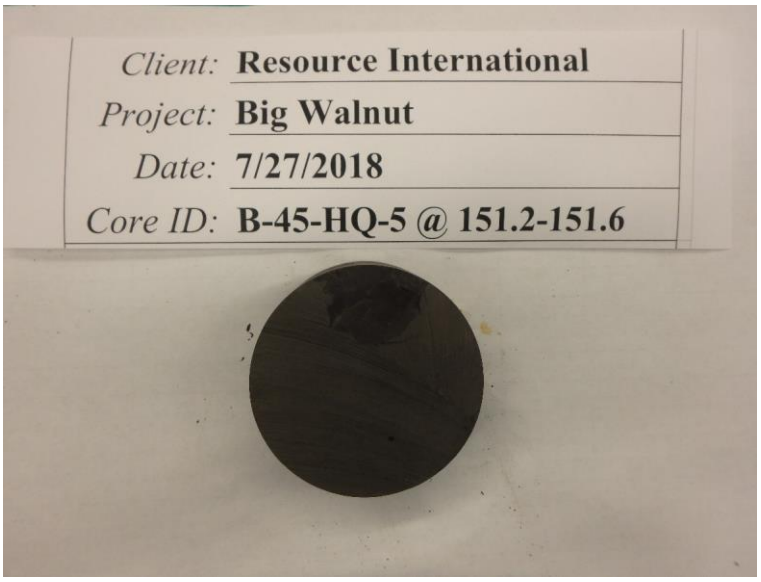


After

Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-45-HQ-5 @ 151.2-151.6



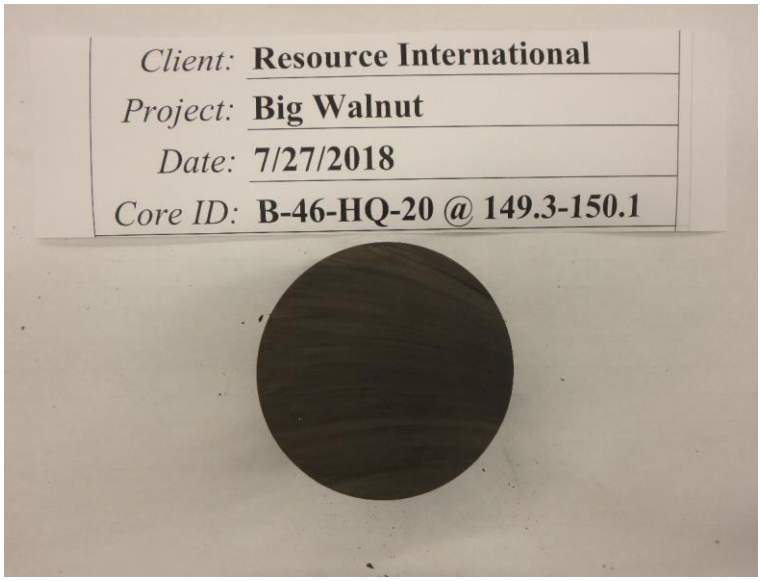
Before

After

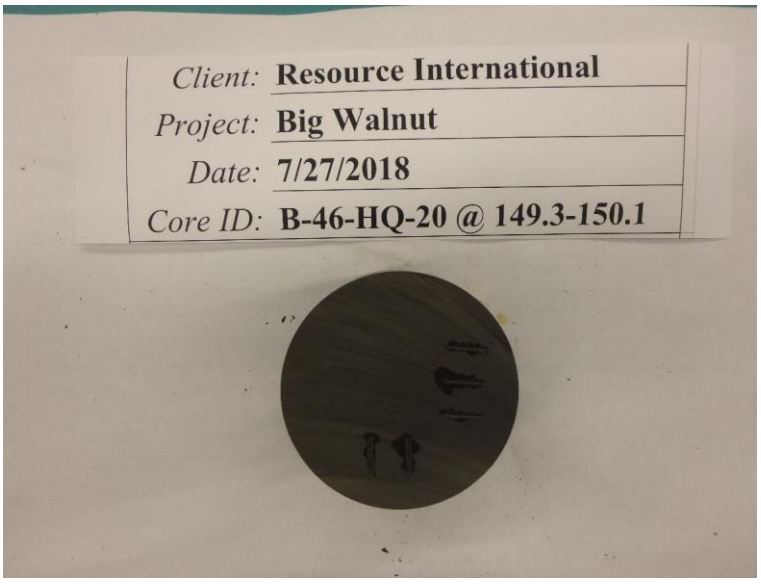
Pictures of Sample Before and After
Cerchar Abrasivity Index

Client Name: Resource International
Project Name: Big Walnut
Date: 7/27/2018

Sample ID: B-46-HQ-20 @ 149.3-150.1



Before



After

J.8 SINTEF LABORATORY RESULTS

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 5/15/2018

Project: Big Walnut EMI # 342

Core ID: B-18 NQ-11 @ 140.0-150.0

Characteristics:

Density (g/cm3): 2.6

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

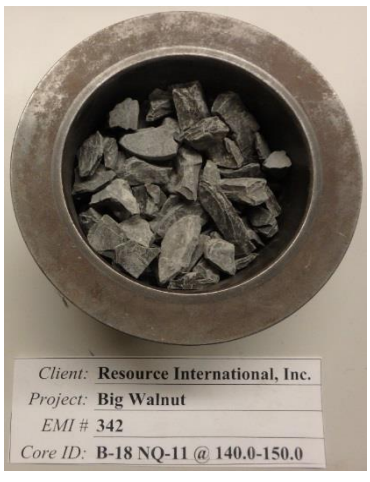
Frozen: No

S20 (%): 67.9 DRI 78.69

SJ (1/10 mm): 79.7

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	65.0	61		
2	70.7	82		
3		87		
4		65		
5		104		
6				
Mean	67.9	79.7	78.69	DRI Category: Very high
Stdev	4.0	17.3		

S20 Picture



Operator: OF-AK Date: 5/15/18

Supervisor: O F Date: ____

Principal Investigator: J R Date: 5/15/18

Colorado School of Mines
Earth Mechanics Institute

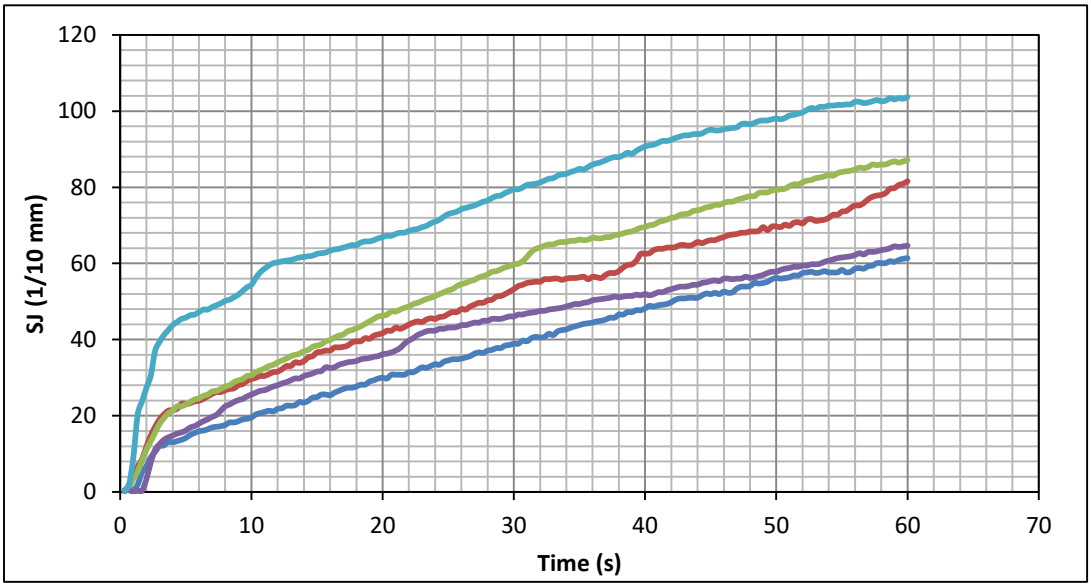
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 5/15/2018

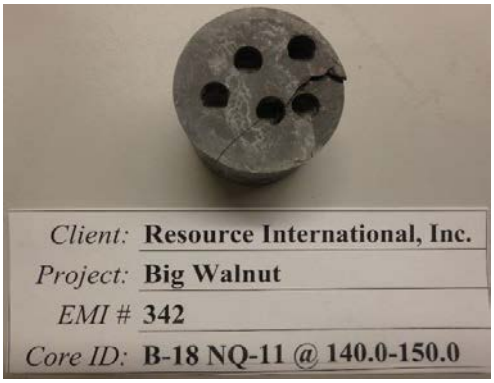
Project: Big Walnut EMI # 342

Core ID: B-18 NQ-11 @ 140.0-150.0

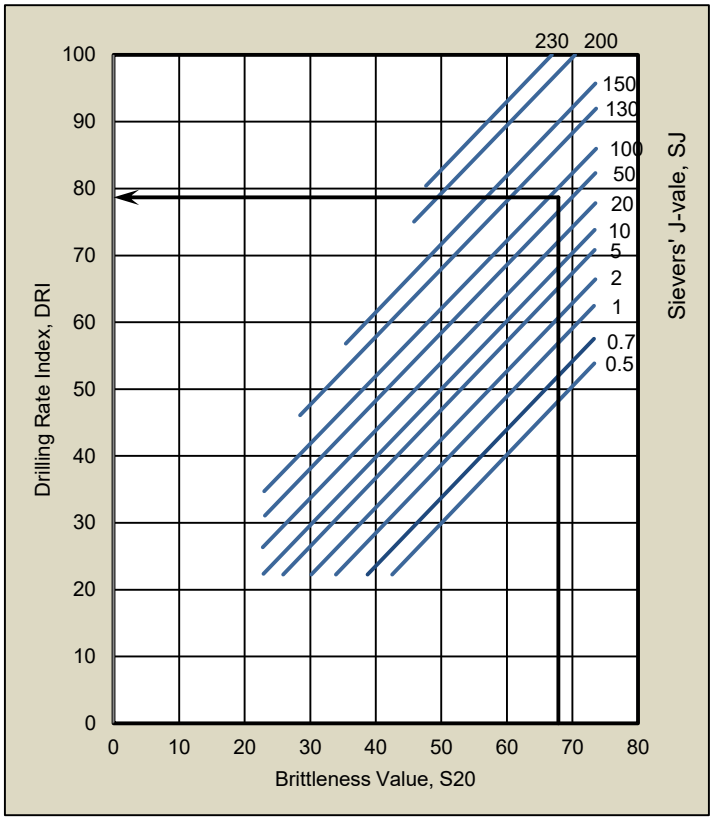
Sievers' J-Values Chart



SJ Picture



S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	***
Extremely High	≥ 86.0	

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	***
Extremely High	≥ 83	

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Earth Mechanics Institute

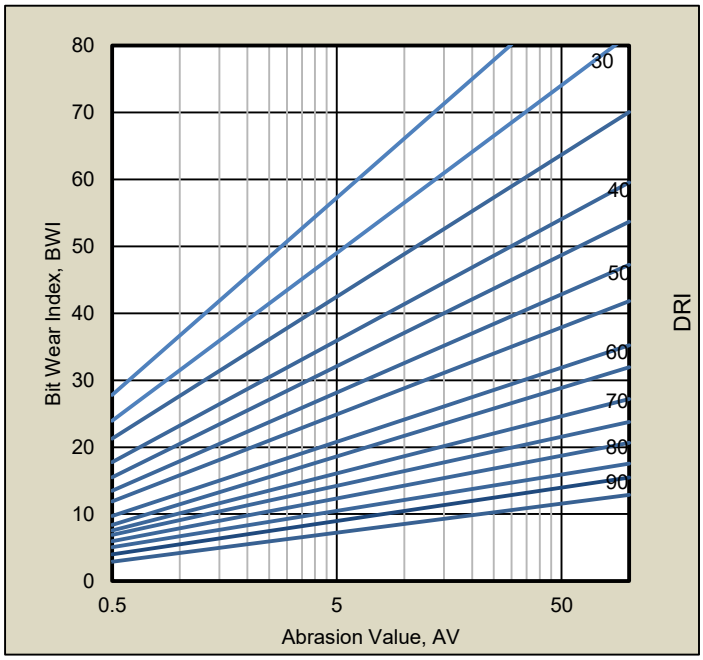
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 5/15/2018
Project: Big Walnut
EMI # 342
Core ID: B-18 NQ-11 @ 140.0-150.0
Characteristics:

AV (mg): 0.1
BWI: 2.8
AVS (mg): 0.4
CLI: 106.1

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.1	0.3			
2	0.2	0.5			
3					
4					
5					
Mean	0.15	0.40	2.8	106.1	
Stdev					CLI Category: Extremely High

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods",
Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods",
Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	
Extremely High	≥ 75	***

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 5/15/2018

Project: Big Walnut EMI # 342

Core ID: B-18 NQ-11 @ 140.0-150.0

Characteristics:

Summary:

Parameter	Unit	Value
S20		67.9
SJ	(1/10 mm)	79.7
DRI		78.7
AV	(mg)	0.1
AVS	(mg)	0.4
BWI		2.8
CLI		106.1

Note: for AVS < 0.1: AVS = 0.1

Note:

Operator: OF-AK Date: 5/15/18

Supervisor: OF Date:

Principal Investigator: J R Date: 5/15/18

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 5/15/2018

Project: Big Walnut EMI # 342

Core ID: B-18 NQ-13 @ 160.0-170.0

Characteristics:

Density (g/cm3): 2.3

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

Frozen: No

S20 (%): 57.7 DRI 69.05

SJ (1/10 mm): 88.5

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	49.7	78		
2	58.1	97		
3	65.4	98		
4		88		
5		81		
6				
Mean	57.7	88.5	69.05	DRI Category: Very high
Stdev	7.9	8.9		

S20 Picture

Operator: O F-AK Date: 5/15/18

Supervisor: O F Date: ____

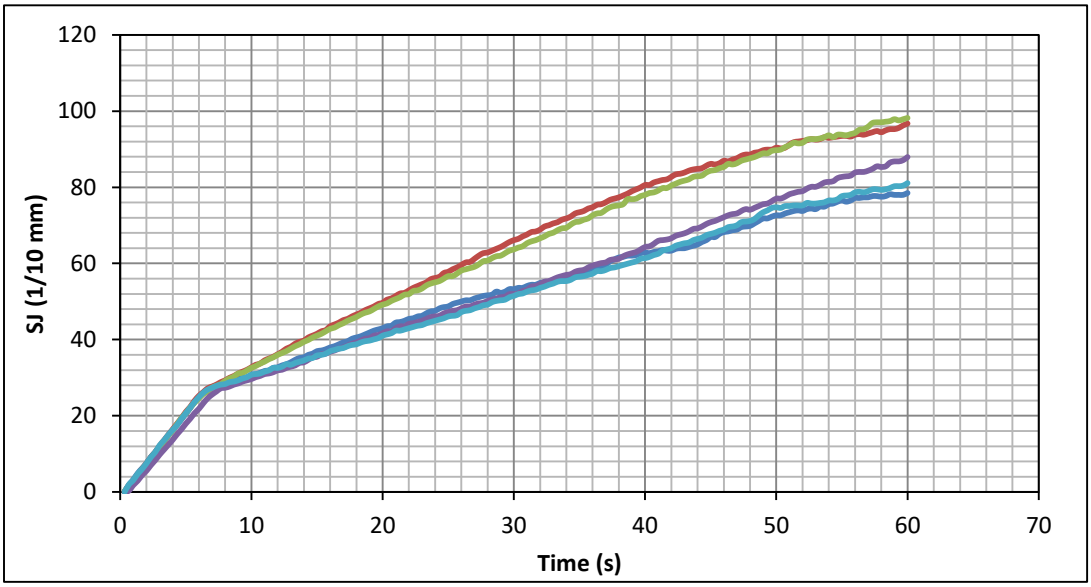
Principal Investigator: J R Date: 5/15/18

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

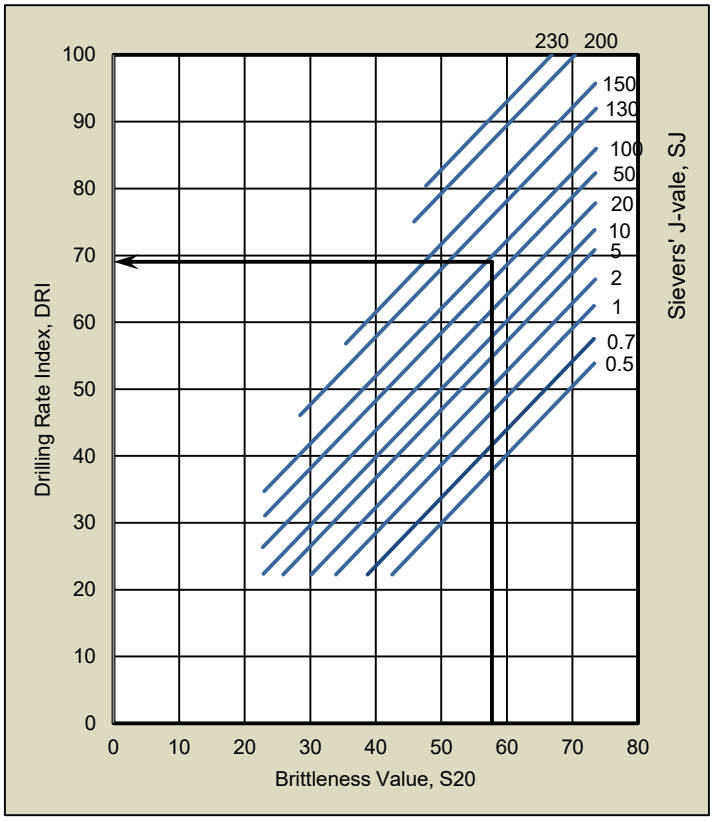
Client: Resource International, Inc.
Date: 5/15/2018
Project: Big Walnut
EMI # 342
Core ID: B-18 NQ-13 @ 160.0-170.0

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	***
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	
Extremely High	≥ 86.0	***

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	***
Very High	70 - 82	
Extremely High	≥ 83	

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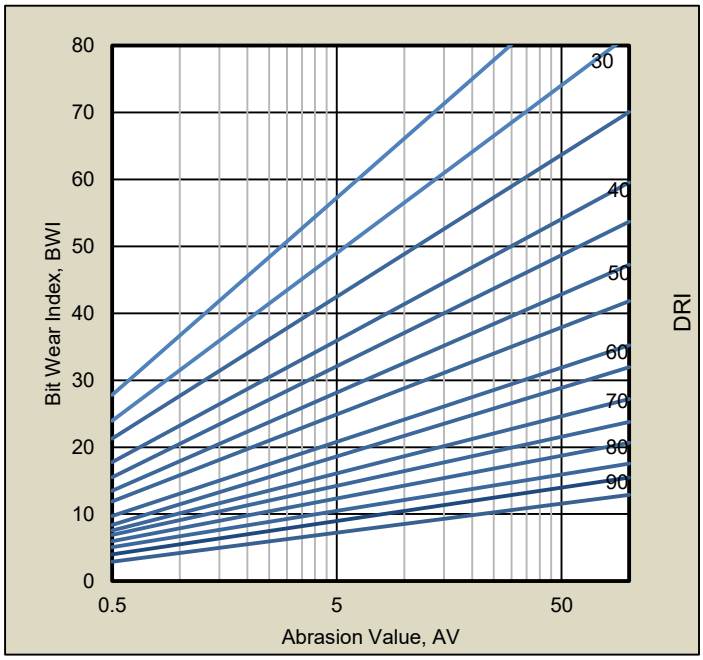
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 5/15/2018
Project: Big Walnut
EMI # 342
Core ID: B-18 NQ-13 @ 160.0-170.0
Characteristics:

AV (mg): 0.1
BWI: 1.4
AVS (mg): 2.4
CLI: 55.4

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.1	2.5			
2	0.1	2.3			
3					
4					
5					
Mean	0.10	2.40	1.4	55.4	
Stdev					CLI Category: Very high

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	***
Extremely High	≥ 75	

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Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 5/15/2018

Project: Big Walnut EMI # 342

Core ID: B-18 NQ-13 @ 160.0-170.0

Characteristics:

Summary:

Parameter	Unit	Value
S20		57.7
SJ	(1/10 mm)	88.5
DRI		69.1
AV	(mg)	0.1
AVS	(mg)	2.4
BWI		1.4
CLI		55.4

Note: for AVS < 0.1: AVS = 0.1

Note:

Operator: O F-AK Date: 5/15/18

Supervisor: OF Date:

Principal Investigator: J R Date: 5/15/18

Colorado School of Mines
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Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-20-HQ-12&13 @ 133.4-135.8

Characteristics:

Density (g/cm3): 2.7

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

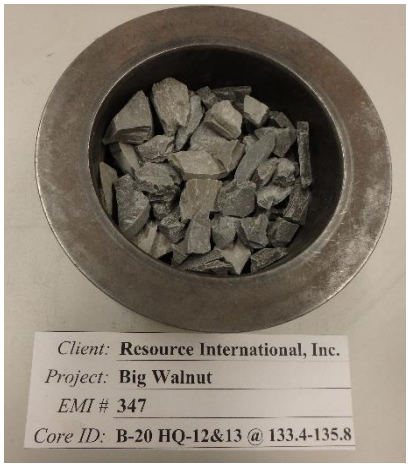
Frozen: No

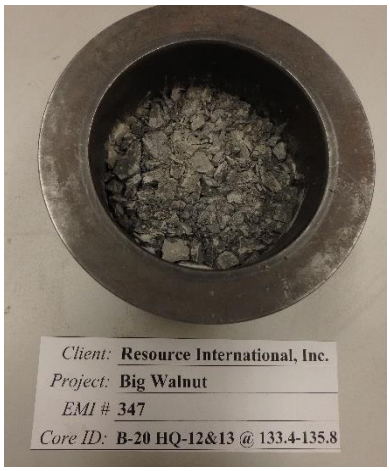
S20 (%): 66.4 DRI 79.47

SJ (1/10 mm): 104.0

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	67.3	96		
2	65.5	75		
3		88		
4		126		
5		135		
6				
Mean	66.4	104.0	79.47	DRI Category: Very high
Stdev	1.3	25.6		

S20 Picture





Operator: O F-AK Date: 6/14/18

Supervisor: O F Date:

Principal Investigator: J R Date: 6/14/18

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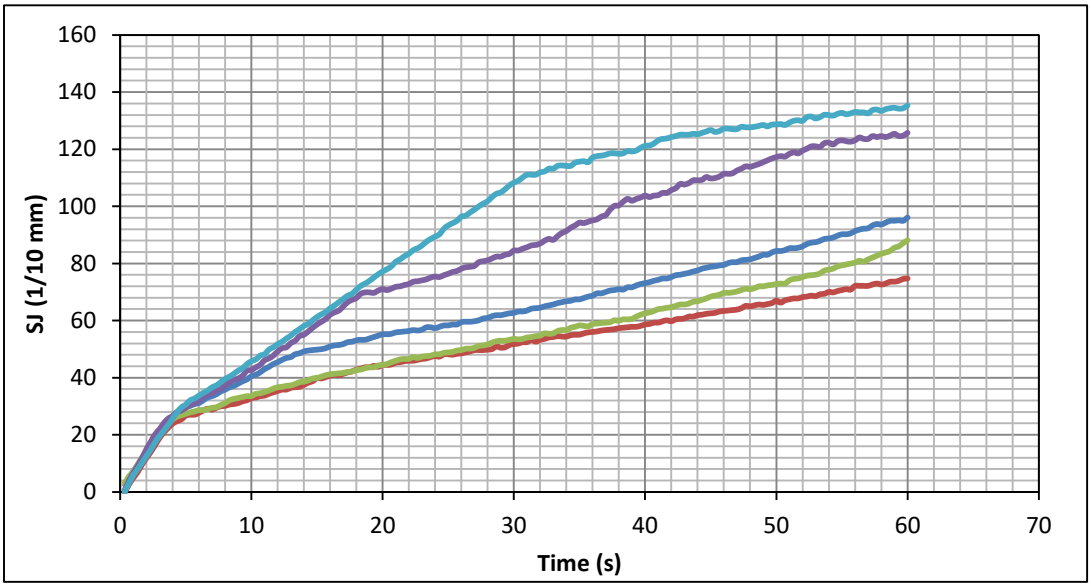
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

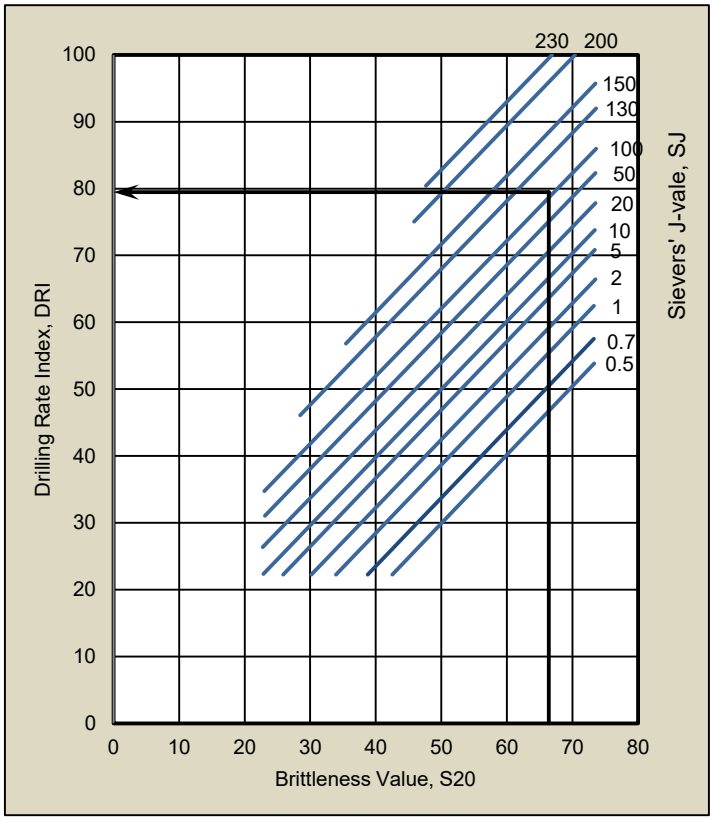
Core ID: B-20-HQ-12&13 @ 133.4-135.8

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	
Extremely High	≥ 86.0	***

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	***
Extremely High	≥ 83	

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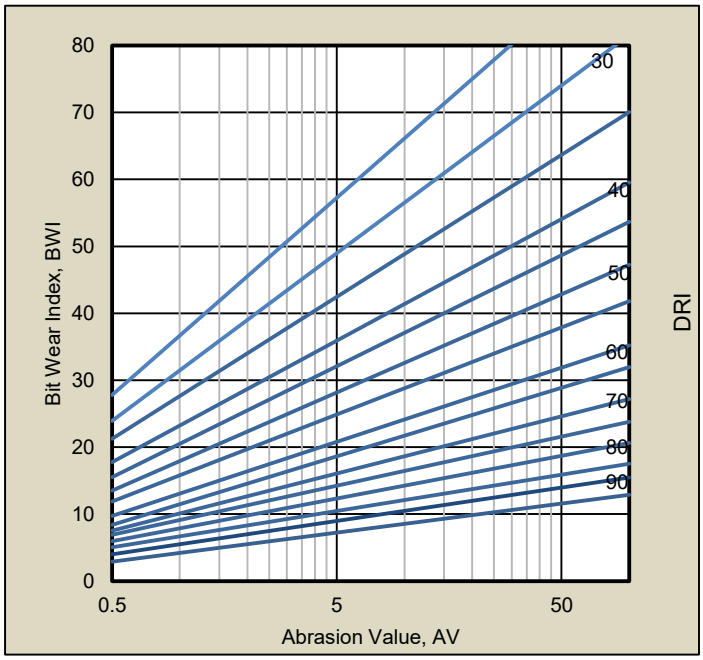
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-20-HQ-12&13 @ 133.4-135.8
Characteristics:

AV (mg): 0.2
BWI: 3.5
AVS (mg): 0.1
CLI: 200.3

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.2	0.1			
2	0.2	0.1			
3					
4					
5					
Mean	0.20	0.10	3.5	200.3	
Stdev					CLI Category: Extremely High

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	
Extremely High	≥ 75	***

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-20-HQ-12&13 @ 133.4-135.8

Characteristics:

Summary:

Parameter	Unit	Value
S20		66.4
SJ	(1/10 mm)	104.0
DRI		79.5
AV	(mg)	0.2
AVS	(mg)	0.1
BWI		3.5
CLI		200.3

Note: for AVS < 0.1: AVS = 0.1

Note:
6 Sj test were performed. 5 tests were acceptable.

Operator: O F-AK Date: 8/22/18

Supervisor: OF Date:

Principal Investigator: J R Date: 8/22/18

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-20-HQ-14&15 @ 145.0-148.2

Characteristics:

Density (g/cm3): 2.3

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

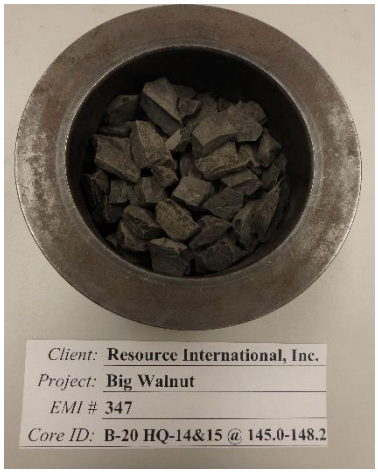
Frozen: No

S20 (%): 68.3 DRI 83.96

SJ (1/10 mm): 116.7

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	66.1	204		
2	67.8	83		
3	71.1	71		
4		109		
5				
6				
Mean	68.3	116.7	83.96	DRI Category: Extremely High
Stdev	2.6	60.6		

S20 Picture



Operator: O F-AK Date: 6/14/18

Supervisor: O F Date:

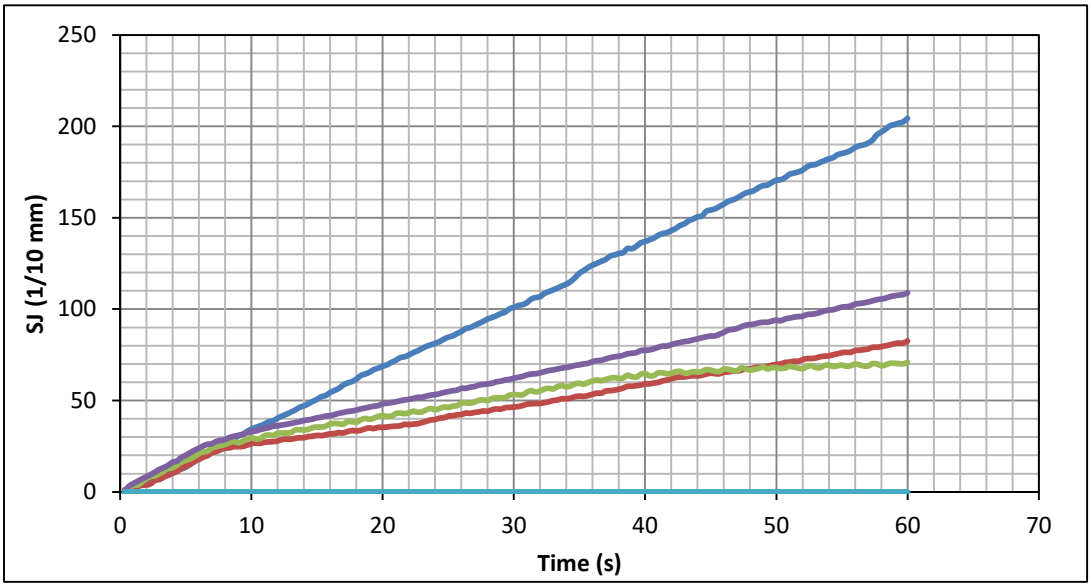
Principal Investigator: J R Date: 6/14/18

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

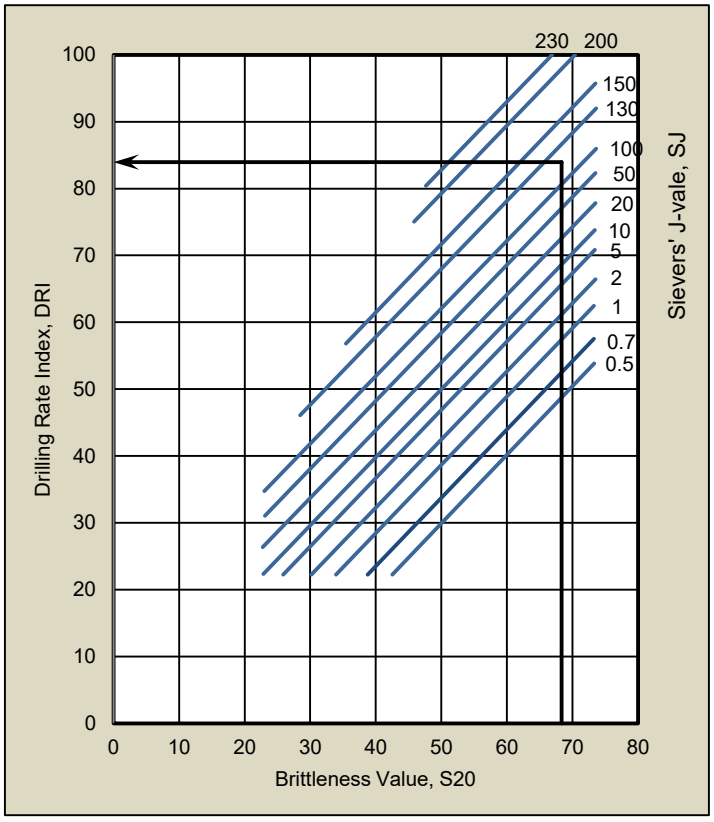
Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-20-HQ-14&15 @ 145.0-148.2

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	
Extremely High	≥ 86.0	***

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	
Extremely High	≥ 83	***

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

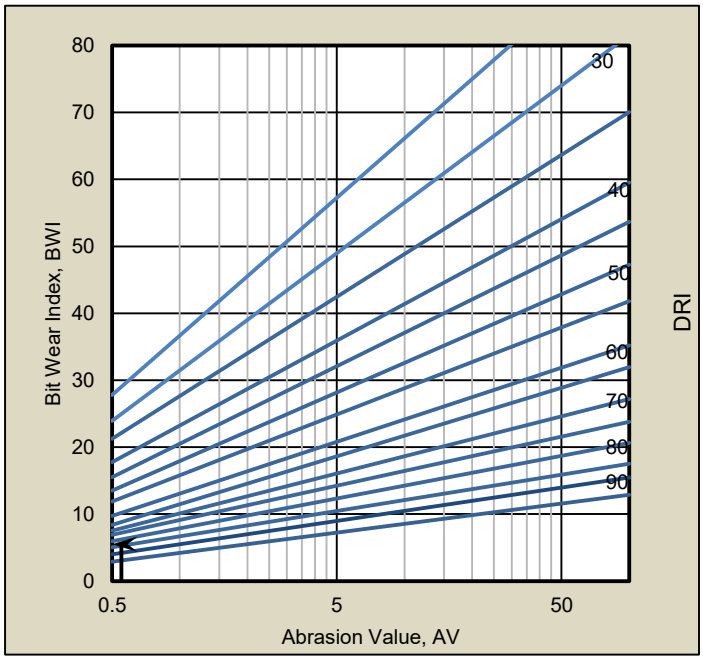
Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-20-HQ-14&15 @ 145.0-148.2
Characteristics:

AV (mg): 0.6
BWI: 5.5

AVS (mg): 2.3
CLI: 62.2

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.4	3.6			
2	0.7	1.1			
3					
4					
5					
Mean	0.55	2.35	5.5	62.2	
Stdev					CLI Category: Very high

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	***
Extremely High	≥ 75	

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-20-HQ-14&15 @ 145.0-148.2

Characteristics:

Summary:

Parameter	Unit	Value
S20		68.3
SJ	(1/10 mm)	116.7
DRI		84.0
AV	(mg)	0.6
AVS	(mg)	2.3
BWI		5.5
CLI		62.2

Note: for AVS < 0.1: AVS = 0.1

Note:
8 Sj tests were performed. 4 tests were acceptable.

Operator: O F-AK Date: 8/22/18

Supervisor: OF Date:

Principal Investigator: J R Date: 8/22/18

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-27-NQ-16 @ 161.3-164.6

Characteristics:

Density (g/cm3): 2.5

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

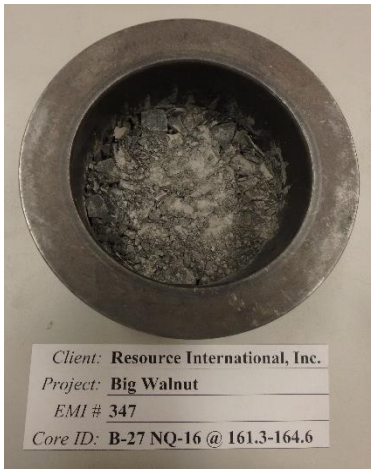
Frozen: No

S20 (%): 71.6 DRI 83.61

SJ (1/10 mm): 96.2

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	73.9	84		
2	69.2	109		
3				
4				
5				
6				
Mean	71.6	96.2	83.61	DRI Category: Extremely High
Stdev	3.4	18.0		

S20 Picture



Operator: O F-AK Date: 6/14/18

Supervisor: O F Date: ____

Principal Investigator: J R Date: 6/14/18

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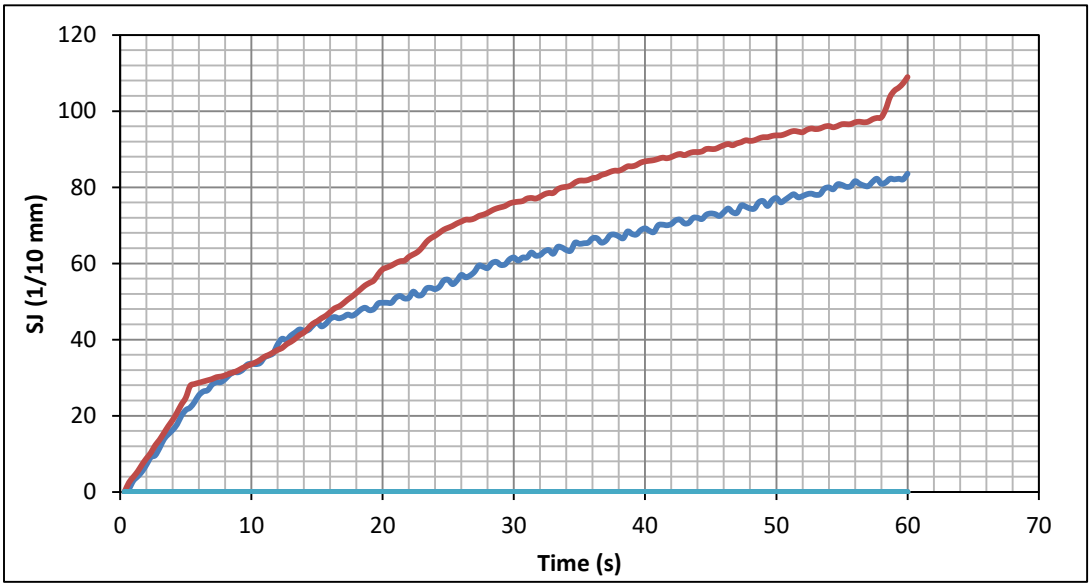
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

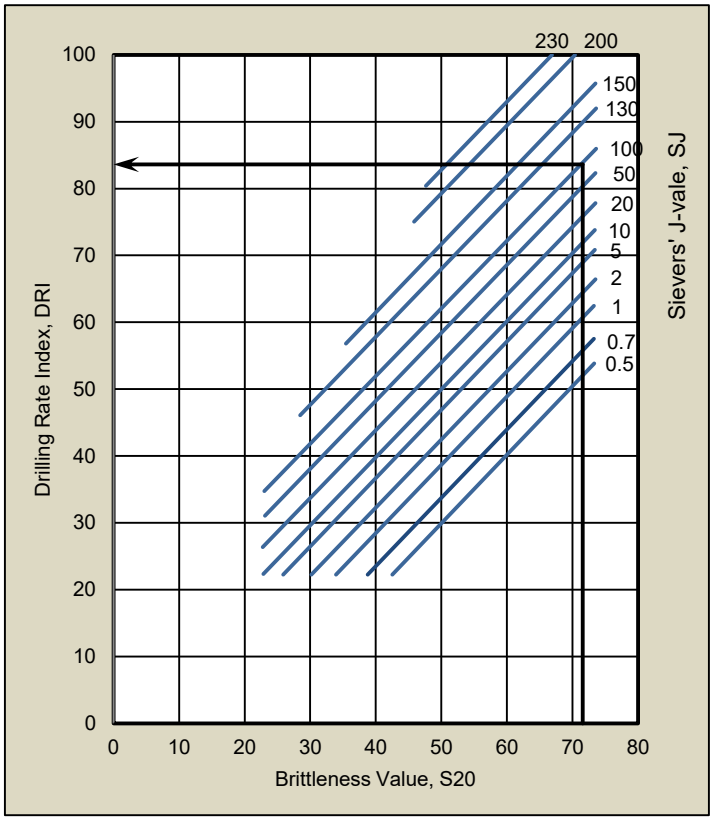
Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-27-NQ-16 @ 161.3-164.6

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	
Extremely High	≥ 86.0	***

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	
Extremely High	≥ 83	***

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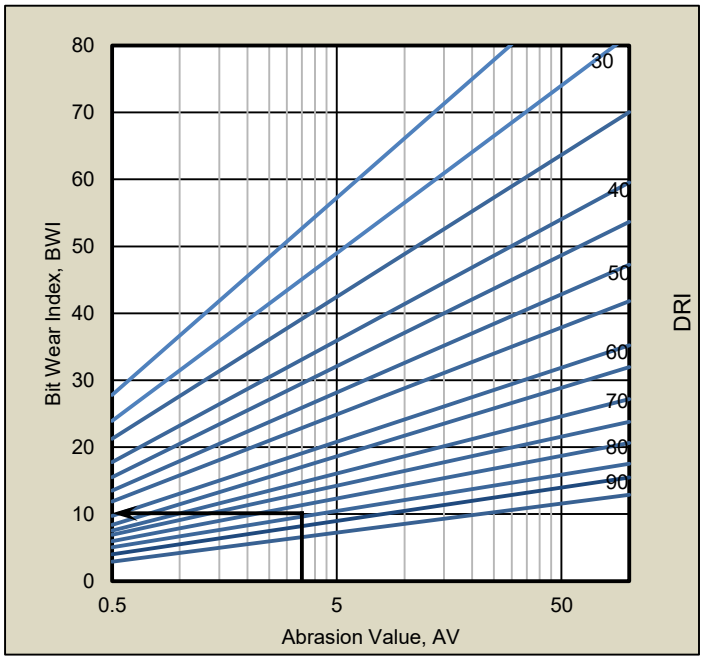
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-27-NQ-16 @ 161.3-164.6
Characteristics:

AV (mg): 3.5
BWI: 10.1
AVS (mg): 0.2
CLI: 166.4

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	6.2	0.2			
2	0.8	0.1			
3					
4					
5					
Mean	3.50	0.15	10.1	166.4	
Stdev					CLI Category: Extremely High

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	
Very Low	11 - 20	***
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	
Extremely High	≥ 75	***

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Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-27-NQ-16 @ 161.3-164.6

Characteristics:

Summary:

Parameter	Unit	Value
S20		71.6
SJ	(1/10 mm)	96.2
DRI		83.6
AV	(mg)	3.5
AVS	(mg)	0.2
BWI		10.1
CLI		166.4

Note: for AVS < 0.1: AVS = 0.1

Note:
6 Sj tests were performed, only 2 tests were acceptable. Sample broke during the tests because of existing foliation.

Operator: O F-AK Date: 8/22/18

Supervisor: OF Date:

Principal Investigator: J R Date: 8/22/18

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Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-27-NQ-17&18 @ 174.5-178.6

Characteristics:

Density (g/cm3): 2.1

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

Frozen: No

S20 (%): 63.8 DRI 74.72

SJ (1/10 mm): 81.8

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	64.1	78		
2	65.2	82		
3	62.1	89		
4		85		
5		74		
6				
Mean	63.8	81.8	74.72	DRI Category: Very high
Stdev	1.6	5.8		

S20 Picture

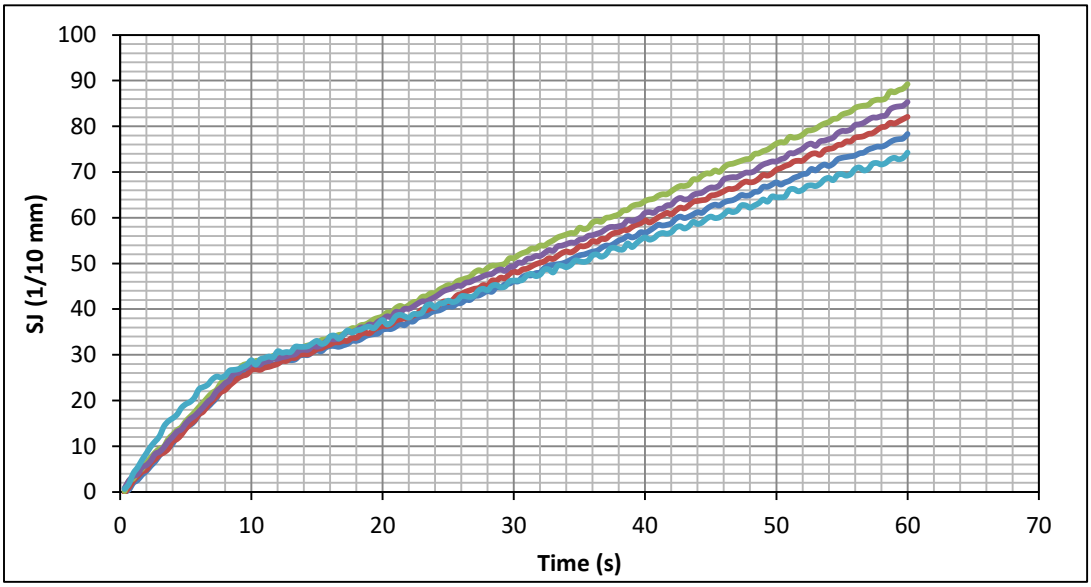
Operator: O F-AK Date: 6/14/18

Supervisor: O F Date:

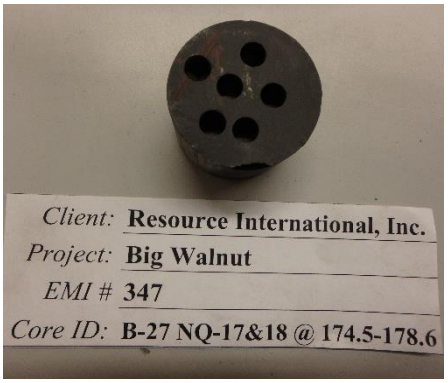
Principal Investigator: J R Date: 6/14/18

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-27-NQ-17&18 @ 174.5-178.6

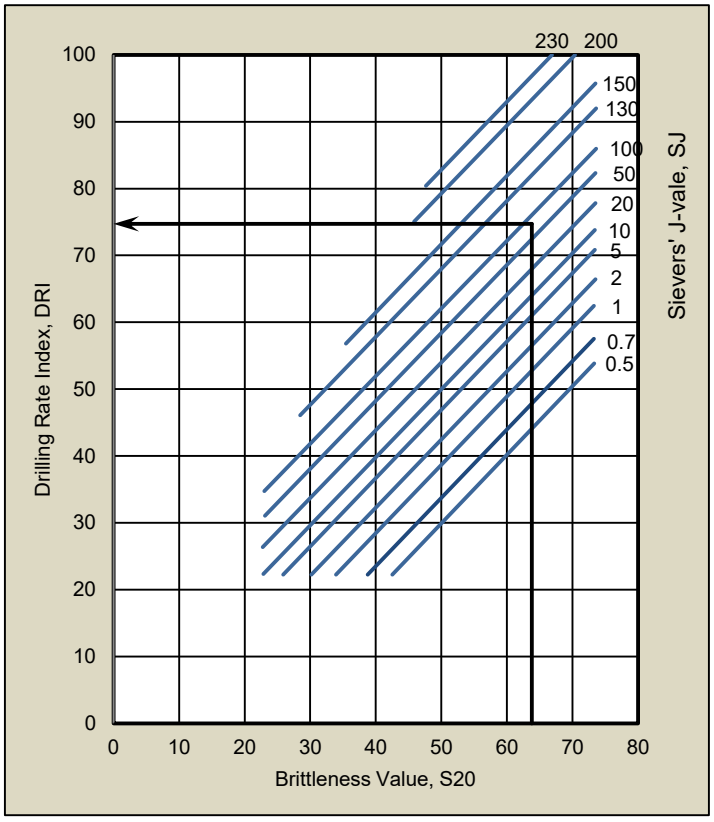
Sievers' J-Values Chart



SJ Picture



S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	***
Extremely High	≥ 66.0	

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	***
Extremely High	≥ 86.0	

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	***
Extremely High	≥ 83	

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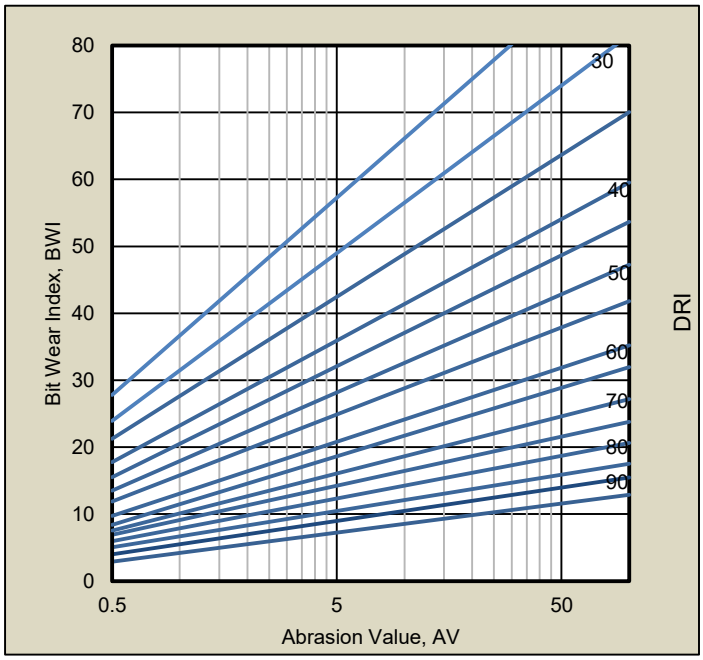
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-27-NQ-17&18 @ 174.5-178.6
Characteristics:

AV (mg): 0.5
BWI: 7.0
AVS (mg): 3.0
CLI: 49.4

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.7	2.8			
2	0.3	3.2			
3					
4					
5					
Mean	0.50	3.00	7.0	49.4	
Stdev					CLI Category: Very high

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	***
Extremely High	≥ 75	

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-27-NQ-17&18 @ 174.5-178.6

Characteristics:

Summary:

Parameter	Unit	Value
S20		63.8
SJ	(1/10 mm)	81.8
DRI		74.7
AV	(mg)	0.5
AVS	(mg)	3.0
BWI		7.0
CLI		49.4

Note: for AVS < 0.1: AVS = 0.1

Note:
6 Sj tests were performed, 5 tests were acceptable

Operator: O F-AK Date: 8/22/18

Supervisor: OF Date:

Principal Investigator: J R Date: 8/22/18

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-33-NQ-18 @ 173.9-178

Characteristics:

Density (g/cm3): 2.2

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

Frozen: No

S20 (%): 66.9 DRI 77.51

SJ (1/10 mm): 76.5

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	60.1	67		
2	64.8	74		
3	75.8	93		
4		72		
5				
6				
Mean	66.9	76.5	77.51	DRI Category: Very high
Stdev	8.1	11.1		

S20 Picture

Operator: O F-AK Date: 6/14/18

Supervisor: O F Date:

Principal Investigator: J R Date: 6/14/18

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Earth Mechanics Institute

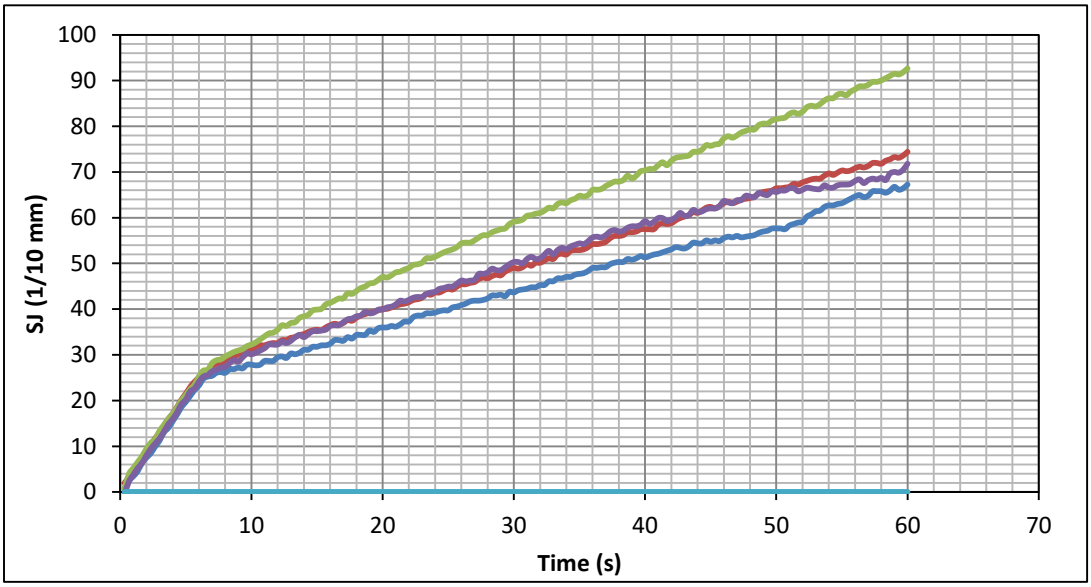
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

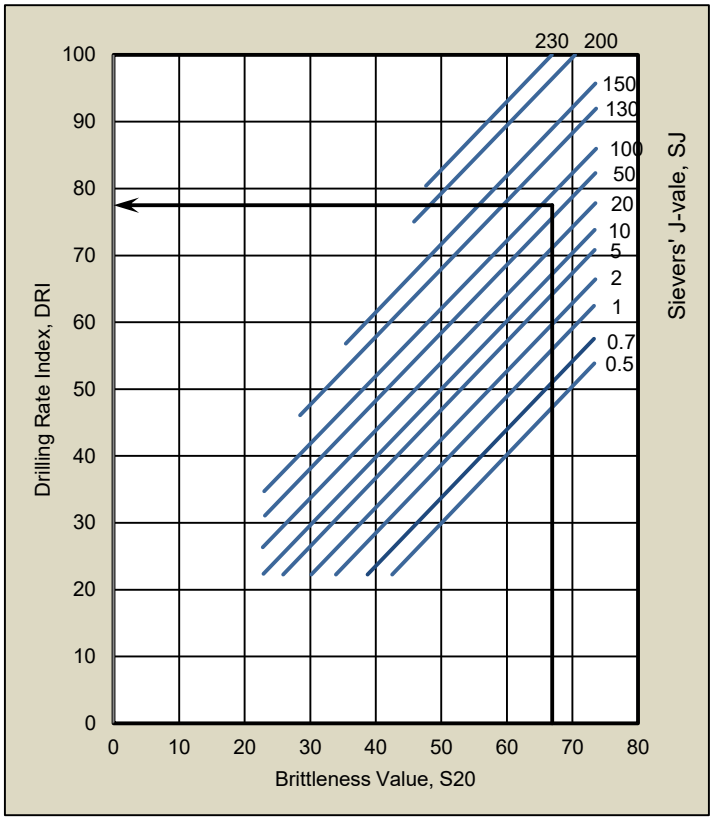
Core ID: B-33-NQ-18 @ 173.9-178

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	***
Extremely High	≥ 86.0	

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	***
Extremely High	≥ 83	

Colorado School of Mines
Earth Mechanics Institute

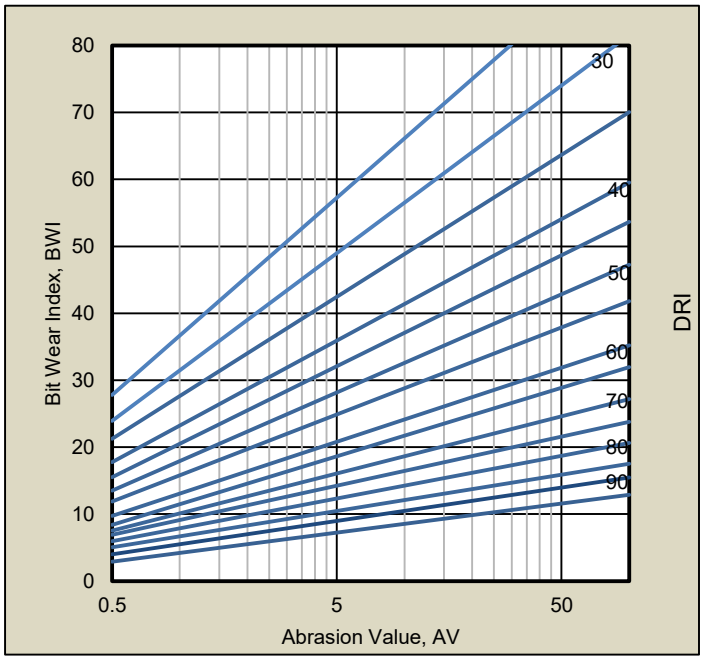
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-33-NQ-18 @ 173.9-178
Characteristics:

AV (mg): 0.3
BWI: 4.9
AVS (mg): 2.1
CLI: 55.7

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	0.5	2.6			
2	0.1	1.5			
3					
4					
5					
Mean	0.30	2.05	4.9	55.7	
Stdev					CLI Category: Very high

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	***
Extremely High	≥ 75	

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Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-33-NQ-18 @ 173.9-178

Characteristics:

Summary:

Parameter	Unit	Value
S20		66.9
SJ	(1/10 mm)	76.5
DRI		77.5
AV	(mg)	0.3
AVS	(mg)	2.1
BWI		4.9
CLI		55.7

Note: for AVS < 0.1: AVS = 0.1

Note:
5 Sj tests were performed, 4 testS were acceptable.

Operator: O F-AK Date: 8/22/15

Supervisor: OF Date:

Principal Investigator: J R Date: 8/22/15

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-43 -HQ-21 @ 171.2-174.3

Characteristics:

Density (g/cm3): 2.4

Moisture Condition:

As-received ____ Air-Dried X Oven-dried ____ Saturated ____

Frozen: No

S20 (%): 67.3 DRI 83.06

SJ (1/10 mm): 117.5

Test No.	S20 (%)	SJ (1/10 mm)	DRI	Comments
1	66.1	105		
2	65.5	126		
3	70.3	122		
4		111		
5		125		
6				
Mean	67.3	117.5	83.06	DRI Category: Extremely High
Stdev	2.6	9.4		

S20 Picture

Operator: O F-AK Date: 6/14/18

Supervisor: O F Date:

Principal Investigator: J R Date: 6/14/18

Colorado School of Mines
Earth Mechanics Institute

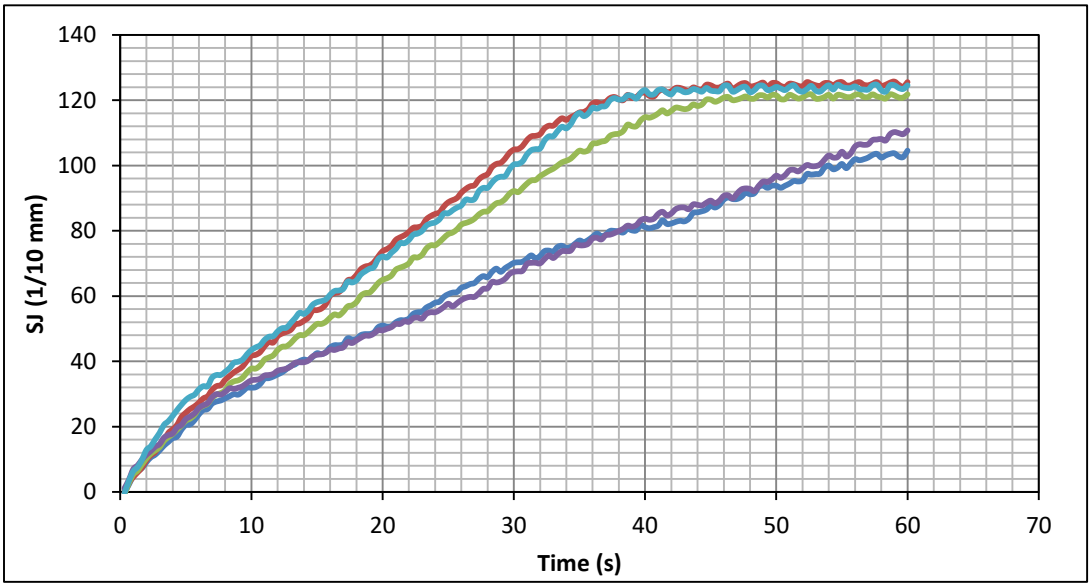
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

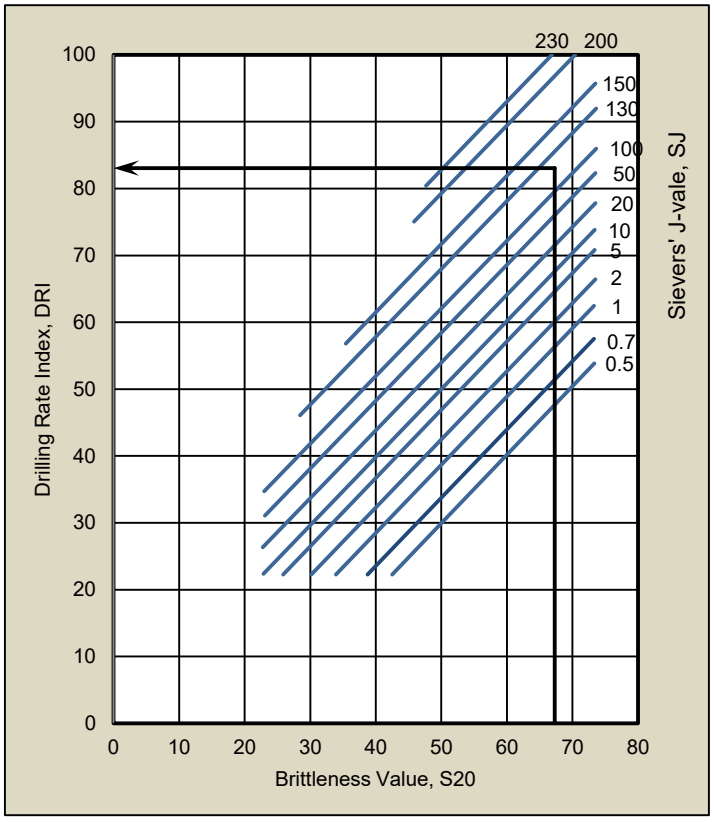
Core ID: B-43 -HQ-21 @ 171.2-174.3

Sievers' J-Values Chart



SJ Picture

S20-SJ-DRI Chart



Classification of S20 Value based on 3001 tested samples in Norwegian Database.

Category	Brittleness Value (%)	Sample Category
Extremely Low	≤ 29.0	
Very Low	29.1 - 34.9	
Low	35.0 - 40.9	
Medium	41.0 - 50.9	
High	51.0 - 59.9	
Very High	60.0 - 65.9	
Extremely High	≥ 66.0	***

Classification of Sievers' J-Values based on 2770 tested samples in Norwegian Database.

Category	Sievers' J Value (1/10 mm)	Sample Category
Extremely Low	≤ 2	
Very Low	2.0 - 3.9	
Low	4.0 - 6.9	
Medium	7.0 - 18.9	
High	19.0 - 55.9	
Very High	56.0 - 85.9	
Extremely High	≥ 86.0	***

Classification of Drilling Rate Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	DRI Value	Sample Category
Extremely Low	≤ 25	
Very Low	26 - 32	
Low	33 - 42	
Medium	43 - 57	
High	58 - 69	
Very High	70 - 82	
Extremely High	≥ 83	***

Colorado School of Mines
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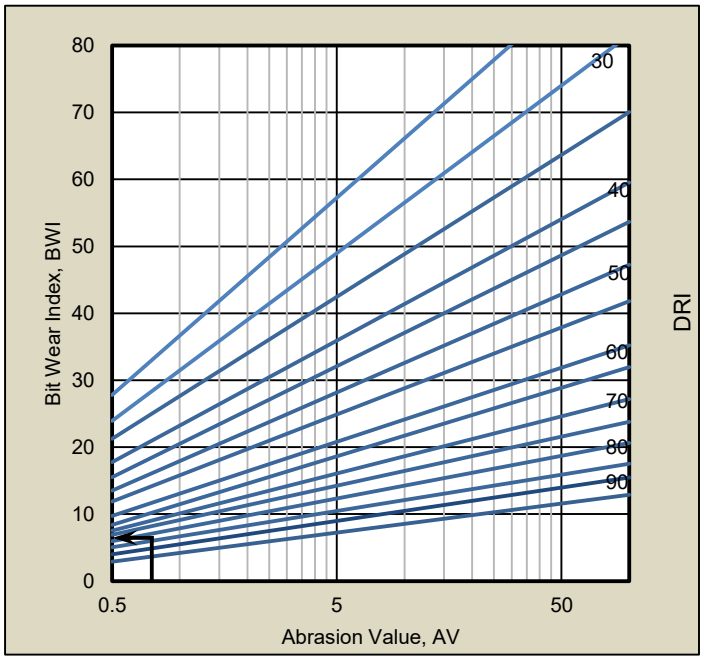
Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client: Resource International, Inc.
Date: 6/14/2018
Project: Big Walnut
EMI # 347
Core ID: B-43 -HQ-21 @ 171.2-174.3
Characteristics:

AV (mg): 0.7
BWI: 6.4
AVS (mg): 2.3
CLI: 62.3

Test No.	AV (mg)	AVS (mg)	BWI	CLI	Comments
1	1.0	2.2			
2	0.5	2.5			
3					
4					
5					
Mean	0.75	2.35	6.4	62.3	
Stdev					CLI Category: Very high

Note: for AVS < 0.1: AVS = 0.1



Classification of AV based on the suggested guidelines by NTNU/SINTEF.

Category	AV (mg)	Sample Category
Extremely Low	≤ 1.0	***
Very Low	1.1 - 3.9	
Low	4.0 - 10.9	
Medium	11.0 - 27.9	
High	28.0 - 41.9	
Very High	42.0 - 57.9	
Extremely High	≥ 58.0	

Classification of AVS based on the suggested guidelines by NTNU/SINTEF.

Category	AVS (mg)	Sample Category
Extremely Low	≤ 1.0	
Very Low	1.1 - 3.9	***
Low	4.0 - 12.9	
Medium	13.0 - 25.9	
High	26.0 - 35.9	
Very High	36.0 - 43.9	
Extremely High	≥ 44.0	

Classification of Bit Wear Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	BWI Value	Sample Category
Extremely Low	≤ 10	***
Very Low	11 - 20	
Low	21 - 30	
Medium	31 - 44	
High	45 - 55	
Very High	56 - 69	
Extremely High	≥ 70	

Classification of Cutter Life Index™ according to "13A-98 DRILLABILITY Test Methods", Dept. of Civil and Transport Engineering, NTNU.

Category	CLI Value	Sample Category
Extremely Low	< 5	
Very Low	5 - 5.9	
Low	6 - 7.9	
Medium	8 - 14.9	
High	15 - 34	
Very High	35 - 74	***
Extremely High	≥ 75	

Colorado School of Mines
Earth Mechanics Institute

Rock Drillability Test
According to guidelines of
NTNU and SINTEF

Client Resource International, Inc. Date: 6/14/2018

Project: Big Walnut EMI # 347

Core ID: B-43 -HQ-21 @ 171.2-174.3

Characteristics:

Summary:

Parameter	Unit	Value
S20		67.3
SJ	(1/10 mm)	117.5
DRI		83.1
AV	(mg)	0.7
AVS	(mg)	2.3
BWI		6.4
CLI		62.3

Note: for AVS < 0.1: AVS = 0.1

Note:

Operator: O F-AK Date: 6/14/18

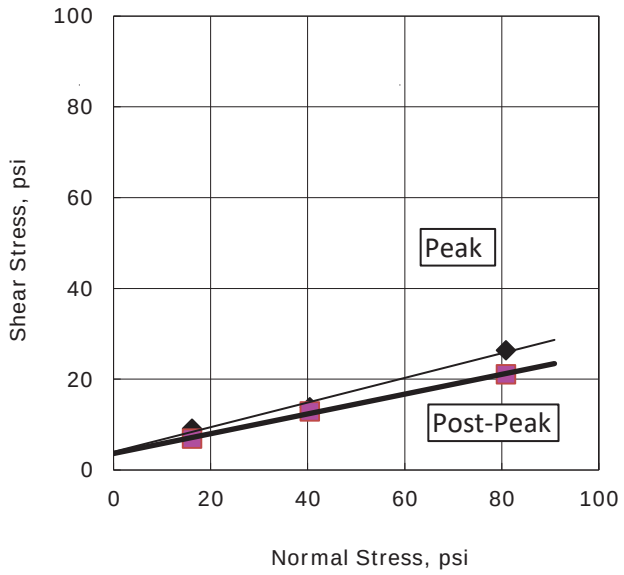
Supervisor: OF Date:

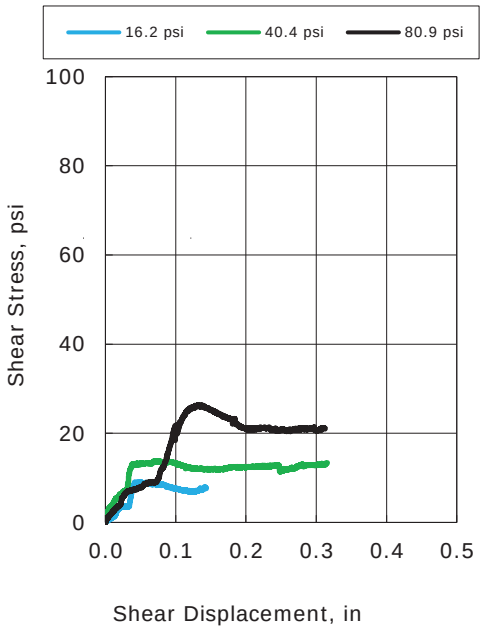
Principal Investigator: J R Date: 6/14/18

J.9 DIRECT SHEAR LABORATORY RESULTS

Client:	Resource International, Inc.
Project Name:	Big Walnut
Project Location:	Ohio
GTX #:	308582
Start Date:	7/10/2019
End Date:	7/11/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	B-47
Sample ID:	HQ-31
Depth, ft:	152.4-152.9
Visual Description:	Rock Core with open joint

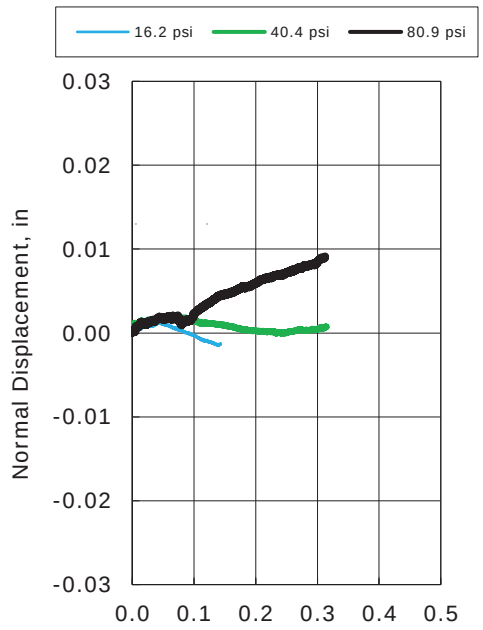
Sliding Friction Test of Rock by ASTM D5607





Test No.:	SF-1	SF-2	SF-3
Specimen Diameter, in:	2.38	2.38	2.38
Specimen Length, in:	1.65	1.65	1.65
Specimen Mass, grams:	314	314	314
Specimen Area, in^2:	4.46	4.46	4.46
Specimen Bulk Density, pcf	162	162	162
Shear Plane Area, in^2	4.67	4.67	4.67
Normal Stress, psi:	16.2	40.4	80.9
Peak Shear Stress, psi:	9.1	13.8	26.4
Post Peak Shear Stress, psi:	6.9	12.9	21.1
Horiz. Displacement Rate, in/min:	0.005	0.005	0.005

Peak Friction Angle:	**15.2**		
Peak Cohesive Intercept, psi:	**4.0**		
Post-Peak Friction Angle:	**12.3**		
Post-Peak Cohesive Intercept, psi:	**3.6**		
JRC Roughness	4-6	4-6	4-6



Notes:

Specimen cut to length using diamond tipped saw blade.
Tested at as-received moisture content and density.
'Hydro-Stone Super X' encapsulating compound used to mount specimen in test rings.
Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

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Start Date:	7/10/2019
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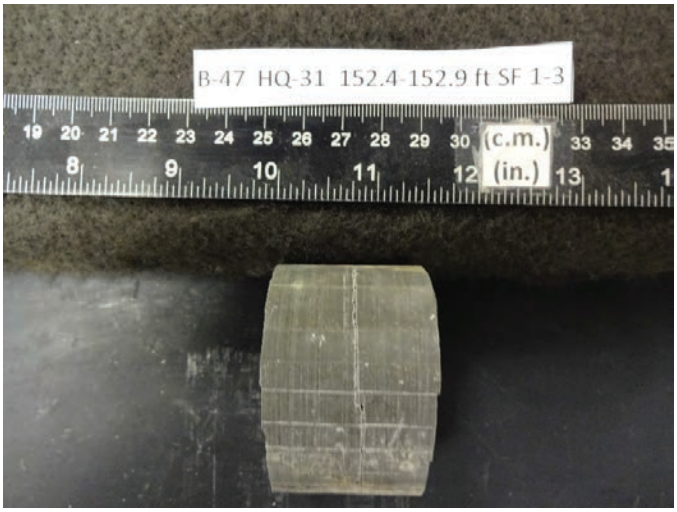
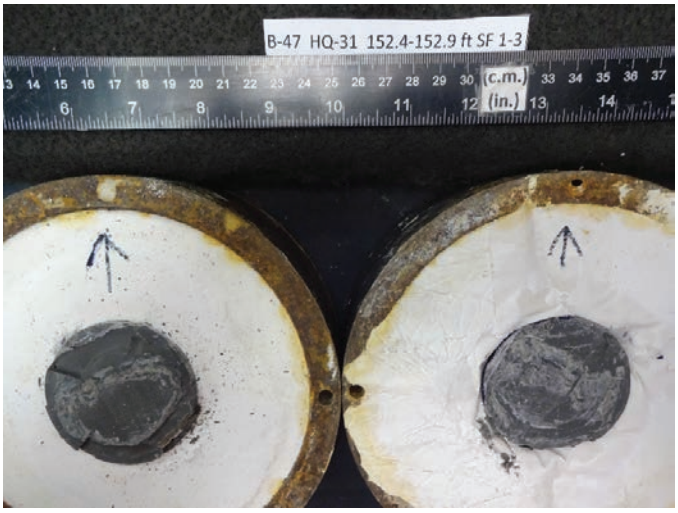
Tested By:	tlm
Checked By:	jsc
Boring ID:	B-47
Sample ID:	HQ-31
Depth, ft:	152.4-152.9
Visual Description:	Rock Core with open joint



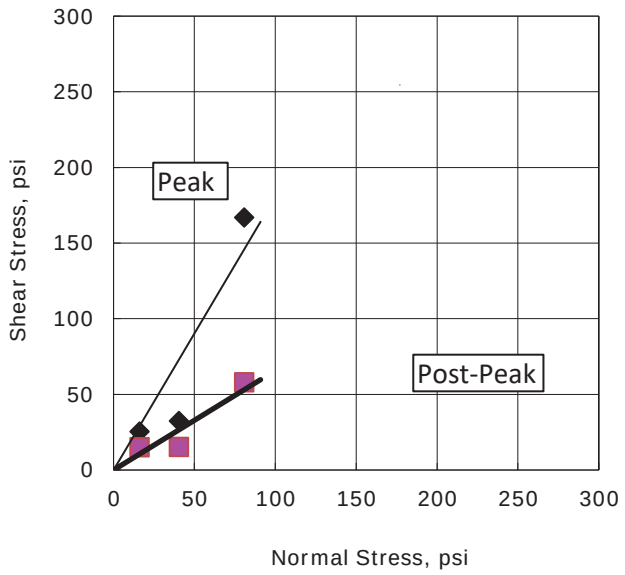
Pre-Test

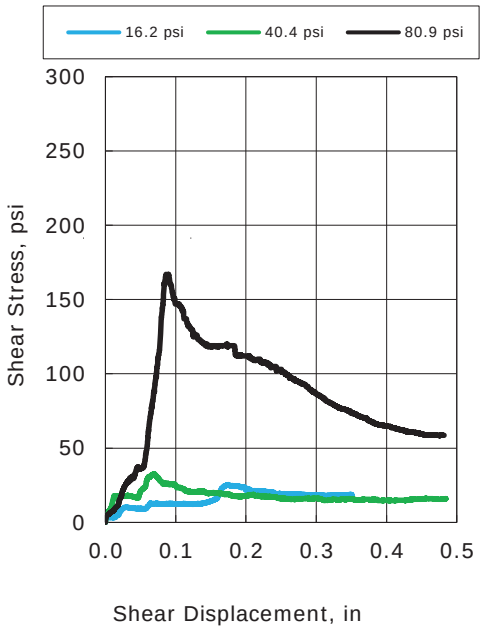


Post-Test

Client:	Resource International, Inc.
Project Name:	Big Walnut
Project Location:	Ohio
GTX #:	308582
Start Date:	7/10/2019
End Date:	7/10/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	B-47
Sample ID:	HQ-32
Depth, ft:	156.80-157.06
Visual Description:	Rock Core

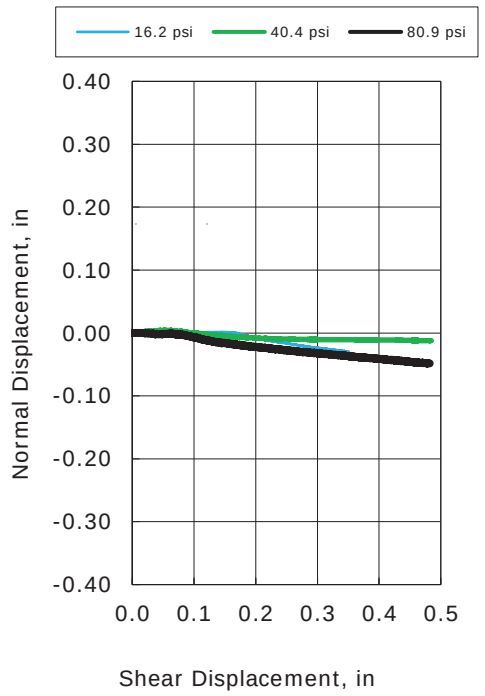
Direct Shear Test of Rock by ASTM D5607





Test No.:	DS-1	DS-2	DS-3
Specimen Diameter, in:	2.38	2.37	2.36
Specimen Length, in:	3.32	2.91	2.69
Specimen Mass, grams:	697	563	516
Specimen Area, in^2:	4.46	4.42	4.39
Specimen Bulk Density, pcf	179	167	166
Shear Plane Area, in^2	4.46	4.42	4.39
Normal Stress, psi:	16.2	40.4	80.9
Peak Shear Stress, psi:	25.5	32.5	167
Post Peak Shear Stress, psi:	15.0	15.3	57.9
Horiz. Displacement Rate, in/min:	0.005	0.005	0.005

Peak Friction Angle:	**61.0**		
Peak Cohesive Intercept, psi:	**0**		
Post-Peak Friction Angle:	**33.3**		
Post-Peak Cohesive Intercept, psi:	**0**		
JRC Roughness	4-6	2-4	8-10

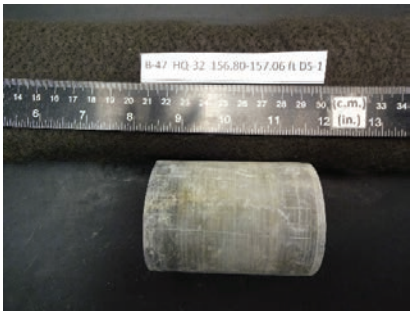


Notes:

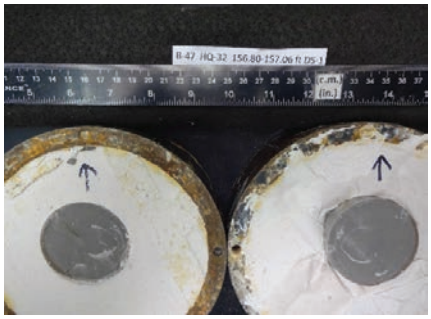
Specimen cut to length using diamond tipped saw blade.
Tested at as-received moisture content and density.
'Hydro-Stone Super X' encapsulating compound used to mount specimen in test rings.
Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Client:	Resource International, Inc.
Project Name:	Big Walnut
Project Location:	Ohio
GTX #:	308582
Start Date:	7/10/2019
End Date:	7/10/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	B-47
Sample ID:	HQ-32
Depth, ft:	156.80-157.06
Visual Description:	Rock Core

Point 1
Normal Stress, psi:
16.17

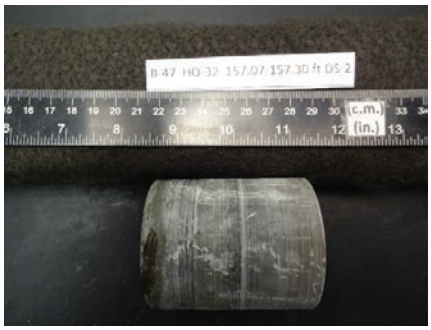


Pre-Test

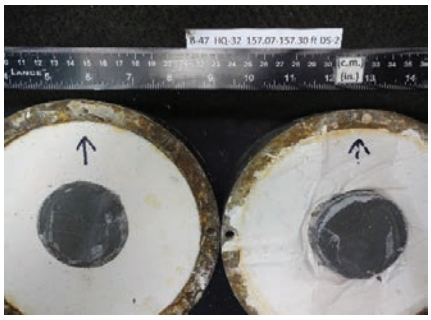


Post-Test

Point 2
Normal Stress, psi:
40.43

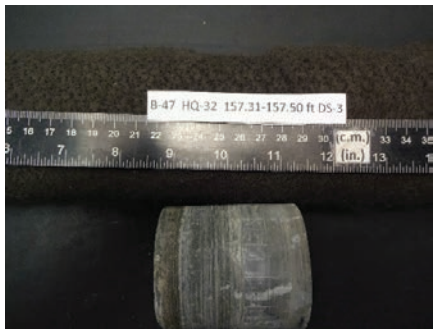


Pre-Test

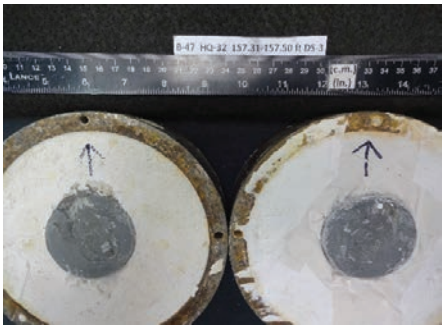


Post-Test

Point 3
Normal Stress, psi:
80.86



Pre-Test



Post-Test

J.10 PH LABORATORY RESULTS

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

pH of Soils

(ASTM D4972 Method A)

Project: Big Walnut Sanitary Trunk Extension PH2
Project No.: W-15-012
Boring Drilled: Drilled 4/3/19-4/5/19 by Cascade Drilling
Boring Method: Sonic Drilling, angled boring

pH testing date: 7/12/2019
Material tested: P10 material

Boring	Sample ID	Depth (feet)	Date Tested	pH in water	pH in calcium chloride sol.	Temperature (C^o)
B-21B	RC-3	167.0	7/12/2019	3.78	3.22	24.5
B-21B	Soil Pocket	168.0-170.5	7/12/2019	3.94	3.71	24.2
B-21B	Soil Pocket	170.5-173.0	7/12/2019	4.06	3.90	24.2

Remarks: Samples were obtained from stored but previously opened soil bags and rock core box on 7/9/19.