



DOE-EMCHAR-012 Rev. 1

**Geotechnical Report for Data Gap
Characterization at the Proposed Outfall 200
Mercury Treatment Facility Sites**

Prepared by:
CTI and Associates for
Strata-G, LLC
2027 Castaic Lane
Knoxville, TN 37932
Telephone: (865) 934.3400
Facsimile: (865) 934.3439



Prepared for:
U.S. Department of Energy, Oak Ridge
P.O. Box 2001
Oak Ridge, TN 37831

January 4, 2017



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1.0 INTRODUCTION

1.1 BACKGROUND

The U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee. The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: the East Tennessee Technology Park (formerly the K-25 site); the Oak Ridge National Laboratory (ORNL); and the Y-12 National Security Complex (Y-12). The DOE, Oak Ridge Environmental Management office (OREM) proposes to construct a surface water treatment facility, Outfall 200 Mercury Treatment Facility, within the footprint of Y-12. The area proposed for construction of the Outfall 200 Mercury Treatment Facility is located in the south-central to south-eastern portion of the Y-12 site, as shown in Figure 1.

Historical missions of Y-12 have resulted in the release of mercury and other contaminants to the environment and contamination has been identified in soil, sediment, surface water, groundwater, buildings, drains, and sumps. Mercury continues to be released into the Upper East Fork Poplar Creek (UEFPC) from point (discrete) and non-point (diffuse) sources within Y-12. Mercury enters UEFPC from direct erosion of contaminated soil, migration of dissolved mercury through storm drains and several outfalls, and through shallow groundwater. The West End Mercury Area consists of former mercury use buildings located in the west end of the Y-12 main plant area, including mercury contaminated soils and storm sewers in the immediate vicinity. Residual mercury in the seventy year-old deteriorating storm drain infrastructure, infiltrating groundwater, and sediment-bound mercury are remobilized and transported through the storm drain network through Outfall 200 into the UEFPC. UEFPC and the Maynardville Limestone provide conduits for contaminant migration. Because of the toxicity and mobility of mercury contamination, several mercury source areas were identified as containing principal threat wastes per EPA guidance and were the focus of the Phase I Record of Decision (ROD) (DOE 2002).

Currently, the mercury contamination is considered the greatest environmental risk on the DOE ORR (it should be noted that the Phase II ROD for UEFPC [DOE 2006] included additional contaminants of concern such as cadmium, uranium, polychlorinated biphenyl compounds [PCBs], several radionuclides, and volatile organic compounds [VOCs]). The primary pathway of concern is surface water because the UEFPC flows directly from the Y-12 complex through the city of Oak Ridge. During 1998–2000, DOE prepared Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Remedial Investigation/Feasibility Study documents for the UEFPC Characterization Area focused on potential source units (i.e. areas of soil contamination and groundwater plumes) that potentially contribute to the transport of contaminants within and from the Characterization Area. In 2002, the UEFPC Characterization Area Phase I ROD (DOE 2002) was signed, outlining future cleanup actions.

Discharges from the West End Mercury Area are primary point source contributors to mercury flux in UEFPC. Outfall 200 is the integration point for storm sewer effluent entering UEFPC; and under dry weather (base) flow conditions is consistently the largest single source of mercury to the creek (URS/CH2M Oak Ridge LLC [UCOR] 2013).

Over the past two decades, DOE has implemented a series of projects that have reduced the concentrations of mercury measured at the site boundary at Station 17, the Y-12 National Pollutant Discharge Elimination System (NPDES) permit compliance point. While mercury concentrations in water at Station 17 have declined, the concentrations continue to exceed the surface water concentration goal specified in the UEFPC Characterization Area Phase I ROD. Until the West End Mercury Area discharge is collected and treated, mercury will continue to impact the sediment in UEFPC.

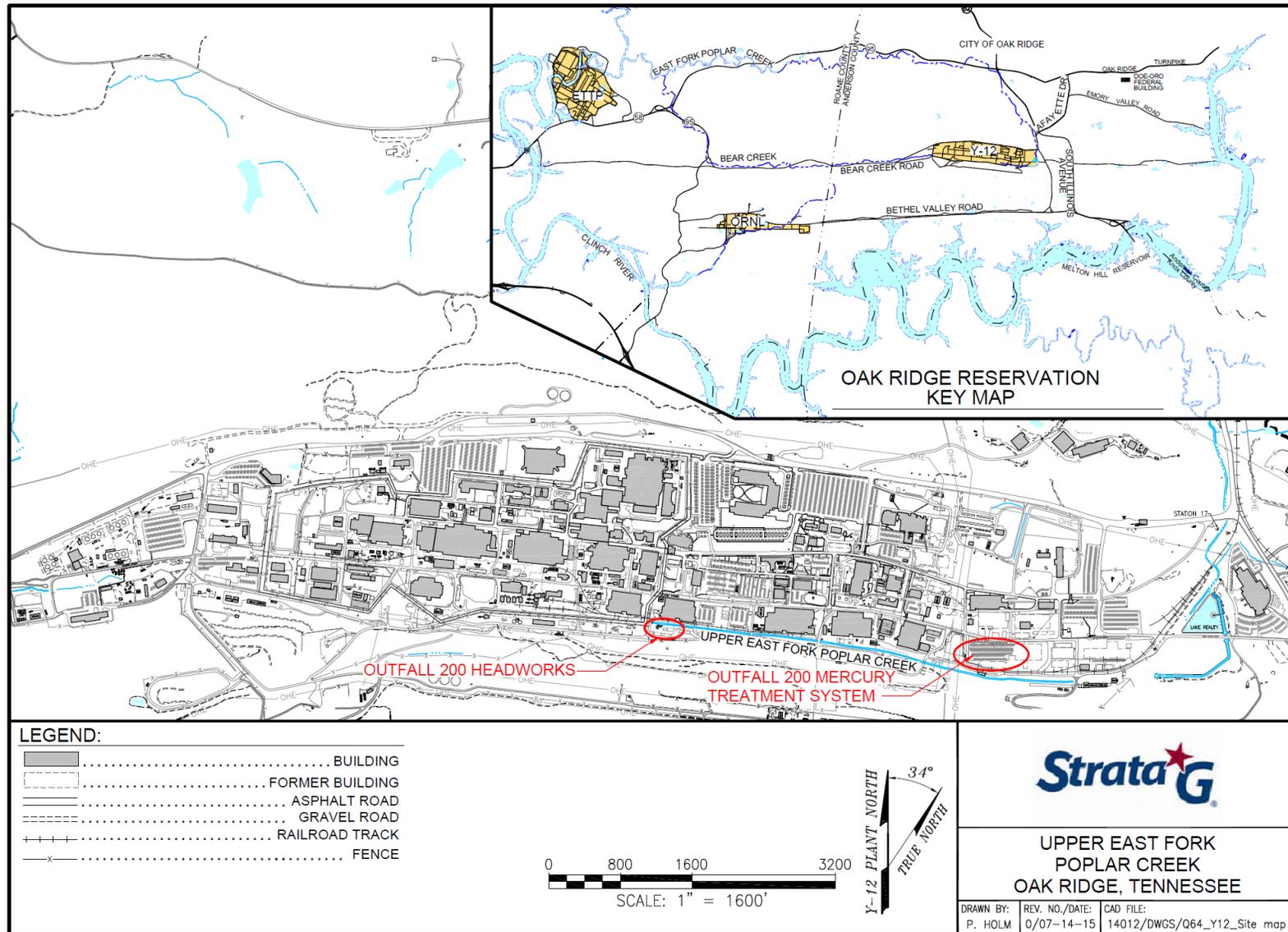


Figure 1. General location of the proposed Outfall 200 Mercury Treatment Facility.

Several significant measures are being implemented to address mercury flux in UEFPC. The National Nuclear Security Administration submitted plans to relocate and/or reduce raw water addition to UEFPC based on previous studies that showed a reduction in flow augmentation can achieve a corresponding reduction in mercury flux in UEFPC (DOE 2009). Additionally, DOE's OREM has proposed and completed the conceptual design for a surface water treatment facility, the Outfall 200 Mercury Treatment Facility which will significantly reduce mercury loading to UEFPC.

1.2 SITE DESCRIPTION

The project site is located in the south-central portion of Y-12. Specifically, the project consists of two separate areas: the headworks area and the Mercury Treatment Facility area. The headworks area is located south of the Building 9204-1 and treatment facility area is located in the southeastern quadrant of the intersection of B Road and Second Street (former Building 9720-8 site). The headworks area will include a weir intake structure, grit removal chamber, storage tanks, and pumping station located adjacent to Outfall 200. The treatment facility will include an equalization tank, chemical reaction tanks, inclined plate clarifiers, clarifier effluent tank, treatment building, treated water tank, chemical storage, and various utilities located at the 9720-8 slab. These two areas will be connected with an above grade pipeline located along the south side of UEFPC.

The headworks area generally slopes gently downhill from the south to the UEFPC located on the north side of the project. The headworks area currently consists of bare earth, gravel, short grassed areas, remnants of past construction (building foundations and slabs), and multiple overhead utility lines. The treatment facility area generally slopes downhill from the north to the UEFPC located on the south side of the project. The treatment facility area currently consists of asphalt paved and concrete parking/drive areas, a non-operational rail-line, and graveled areas.

The Outfall 200 Mercury Treatment Facility areas are underlain by a relatively thin interval of clayey overburden soil which then overlies bedrock of the Conasauga Group (Upper Cambrian Age). The soil overburden thickness is typically less than 20 feet thick but it can be highly variable (DOE 1998). Specifically, the site is underlain by the Maynardville Limestone formation (see Figure 2), a member of the Conasauga Group. The Maynardville Limestone is composed of light gray to tan, massive-to-thinly-bedded limestone with lesser amounts of dolostone (USGS). In the Y-12 Plant area, the Maynardville Limestone varies from 418 to 450 feet in thickness. The Maynardville Limestone is soluble and dips to the southeast which has led to an irregular bedrock surface. Previous geotechnical drilling at the Outfall 200 area included rock coring in 29 borings (GEOServices 2016). The rock core obtained during coring operations revealed the underlying bedrock consisted of dark gray and gray limestone and dolomite with fractured and weathered zones. The recovery percentages and the rock quality designation (RQD) of the rock cores ranged from 0 to 100 percent, indicating a rock quality of very poor to excellent. During this previous phase of geotechnical characterization, multiple voids were encountered within the bedrock ranging from 2 inches to 10 feet in thickness.

1.3 SCOPE AND PURPOSE

DOE proposes to construct a treatment facility and associated headworks to address mercury at Outfall 200 and the UEFPC. A previous geotechnical investigation report (GEOServices 2016) documented soil and rock conditions at the site to support the design of this treatment facility and headworks. The purpose of this geotechnical investigation was to characterize the subsurface conditions to address remaining geotechnical data gaps to support final design for the treatment facility. The primary emphasis of the characterization was the depth to bedrock, presence and size of voids, and the nature of infilling of any voids.

Tasks under this scope included: performing rock coring at 22 locations; evaluating rock core and RQD; performing borehole geophysical logging; and delivering a technical report to DOE. This report provides field data and geophysical logging results for the geotechnical investigation conducted. The following sections of this report present discussions of the field exploration and site conditions. Following the text of this report, Appendix A presents the drilling logs and Appendix B presents a summary of the geophysical logging. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. No engineering recommendations, or designs, for foundation support of any proposed structures are provided.

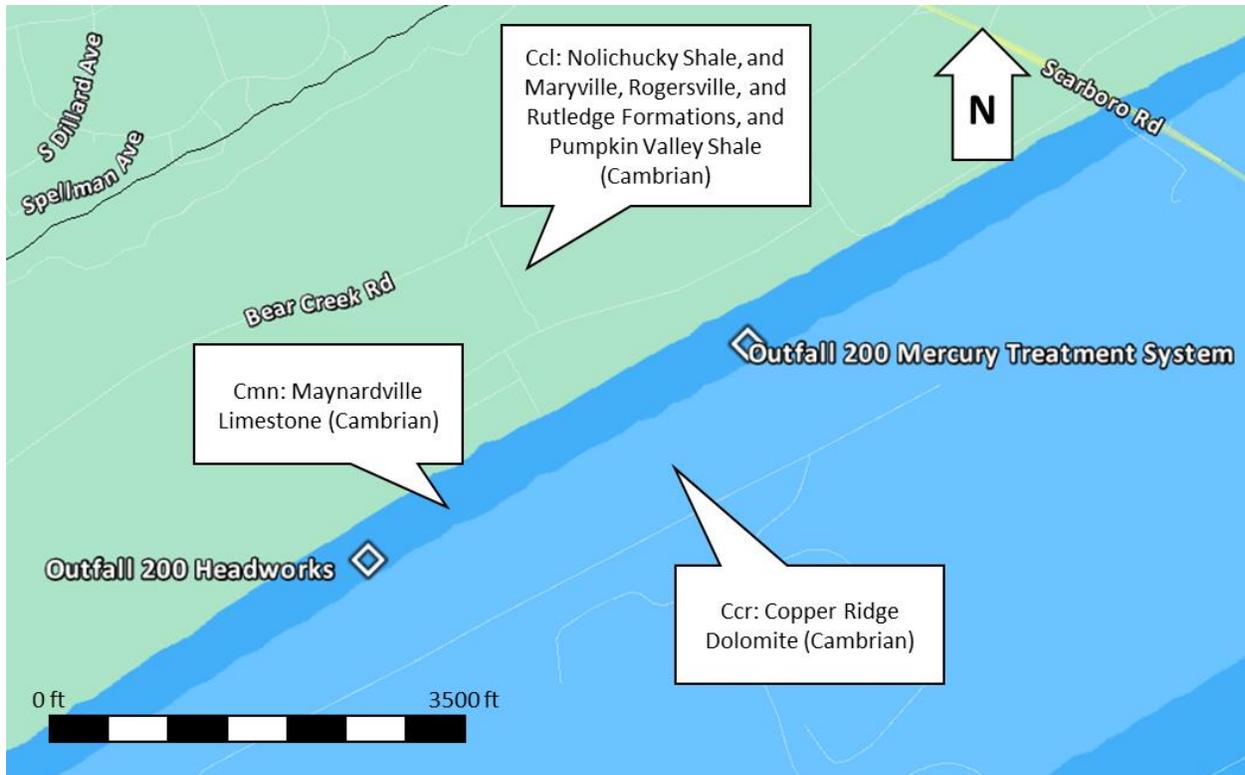


Figure 2. Generalized Geology near Project Site (from United States Geological Survey)

2.0 CHARACTERIZATION PROGRAMS

2.1 GEOTECHNICAL FIELD INVESTIGATION

Prior to mobilizing drilling equipment, Strata-G and Tri-State Drilling, Inc. performed site visits to visually inspect the site surface conditions, note obstructions, and to mark the boring locations. Overhead power lines in the vicinity of Borings B-01 through B-04 were noted and addressed through lock-out/tag-out procedures. Several borings were relocated due to surface obstructions as noted in Section 3.3. The boring locations were provided by DOE and located in the field by Strata-G personnel. The surveyed as-drilled locations of the soil borings, determined by civil survey, are shown on the Boring Location Plan, included in Appendix C.

The subsurface investigation consisted of drilling 22 soil and rock borings at the subject site, designated as Borings B-01 through B-22. The number, depth, and general locations of the soil borings were originally selected by the Outfall 200 MTF design contractor. Field adjustment to the total drilling depth was made as necessary to ensure each boring reached the minimum required boring depth and the minimum penetration into rock (25 feet), per the project statement of work. Boring B-13 was terminated for reasons discussed in Section 3.3.

The drilling operations were performed by Tri-State Drilling, Inc., under the direction of Strata-G and observed by CTI and Associates, Inc., on November 3 – November 23, 2016 utilizing a truck-mounted drill rig. The soil borings were advanced using plugged hollow-stem augers until auger refusal and the depth noted accordingly. Rock coring was conducted using an HQ (2 7/8-inch) wireline system. When drilling through soil, auger cuttings were observed and logged according to visual inspection. No soil samples were obtained. When drilling through rock, core samples were obtained continuously, except where recovery was disrupted by encountered voids and loose materials, as described in the drilling logs (Appendix A). After completion of the drilling operations, an HW (4 1/2-inch) temporary casing was driven to auger refusal to facilitate geophysical logging at select borings. After the completion of geophysical logging (where applicable – see section 2.2) the boreholes were backfilled with a cement-bentonite grout mixture. In most locations, bentonite pellets were used to facilitate grouting above significant voids. Initial plans were to add an amount of grout up to 2.5-times the borehole volume and then use bentonite pellets in boreholes that required more material. After attempting to grout the first seven boreholes at the proposed treatment facility site, it was decided to add no more than 1.25-times the borehole volume prior to using the bentonite pellets (grout added to boreholes B-15, B-17, B-19, B-20, B-21, B-22 and the initial B-20 borehole required more than 2.5 times the borehole volume). The only boreholes that maintained the grout level within the upper 10-ft of the borehole following pumping were boreholes B-1, B-2, B-4, B-8, B-11, and B-12.

Soil and rock conditions observed in the test borings have been logged and are presented on the drilling logs included in Appendix A. These logs contain the detailed record of the observations made on site during drilling and should be consulted to understand the observations made with respect to encountered rock and voids during coring operations in each boring location. To aid in understanding the data presented on the drilling logs, “General Notes for Soil/Rock Classification,” describing nomenclature used in soil and rock descriptions, are included in Appendix D.

2.2 GEOPHYSICAL LOGGING PROGRAM

The geophysical logging program was directed towards collecting information to assist in identifying the presence, and size where possible, of voids and fractures in the bedrock, and determine the nature of void infilling. All geophysical logging was performed in general accordance with applicable ASTM test method standards. The geophysical logging included:

- Caliper logging (ASTM D6167)
- Natural gamma logging (ASTM D6274)

For this investigation, a Mount Sopris Matrix II logging system and Mount Sopris downhole probes were used. Tools were lowered to borehole using a winch with a single conductor cable. The caliper tool would be lowered to depth and data would be collected as the tool was raised. The gamma tool collected information in both directions of travel. The geophysical logging data were analyzed and processed using WellCAD software.

Caliper logging is used to generate a profile of the borehole diameter with depth. The tool measures the borehole diameter using three spring-loaded arms. Narrow enlargements in the borehole diameter can, in most cases, be attributed to fractures. Caliper logging can be conducted above and below the water table.

Natural gamma tools measure the gamma radiation from the formation. These logs can be used to discriminate between different formations by utilizing variations in the concentration of naturally occurring radioactive isotopes such as potassium, uranium and thorium. These logs are particularly useful for locating clay and shale formations since radioactive elements tend to concentrate in these types of materials. Natural gamma logging can be conducted in both cased and uncased boreholes, water-filled and dry.

DOE and the Outfall 200 MTF design contractor recommended logging eight boreholes along with an alternative in the event there were difficulties getting the probes to depth in a boring. There were initial concerns with whether the open boreholes would remain open and on November 8, 2016, a 1-inch diameter PVC pipe was run down three borings to determine if they were still open to the bottom of the borehole. The pipe reached bottom in all three borings, but it was evident the bottom portion of the borings contained thicker mud or debris. The team discussed the possibility of placing temporary casing in the boreholes which would have eliminated the ability to run a caliper log. However, it was decided to proceed with the open borehole logging as the caliper log data was needed.

Geophysical logging was conducted on November 15-16, 2016. Some of the boreholes selected for logging had obstructions or cave-ins and some were not completely vertical due to difficulties encountered with drilling through multiple voids. Decisions on which boreholes to log were made in consultation with the Outfall 200 MTF design contractor representative on site. Table 1 provides a list of recommended boreholes versus actual boreholes logged. Some factors prevented the recommended boreholes from being logged or precluded logging of the full depth of the boreholes. Because of several factors, including the lighter weight of the logging tools being lowered on a cable compared to the 1-inch PVC used to test the borehole integrity, length of the logging tools, and presence of voids (or other issues related to borehole integrity), only a few borings could be logged to total depth. The configuration of the downhole probes would occasionally not allow advancement through soft materials. Significant voids identified in the geotechnical boring logs also caused difficulty in geophysical logging.

Table 1. Boreholes Selected for Geophysical Logging

Recommended Borehole	Actual Borehole Logged	Approximate Depth Logged
B-1 ^a	B-2	59 ft.
B-3 ^a	B-4	38 ft.
B-6	B-6	34 ft.
B-7	B-7	59 ft. ^b
B-9	B-9	52 ft.
B-10	B-10	51 ft. ^c
B-21	B-21	43 ft.
B-22	B-22	60 ft.
B-5 ^a (alternate)	B-11	54 ft.

^a Boreholes B-1, B-3, and B-5 had obstructions at shallow depths and were not logged

^b In borehole B-7, the caliper tool reached 59 ft. but the gamma tool could only reach approximately 40 ft.

^c In borehole B-10, the gamma tool reached 51 ft. but the caliper tool could only reach approximately 26 ft.

Geophysical logs are provided in Appendix B.

3.0 GENERAL SUBSURFACE CONDITIONS

3.1 ENCOUNTERED SOIL AND ROCK CONDITIONS

As discussed in Section 1.0, the Outfall 200 Mercury Treatment Facility areas are underlain by a relatively thin interval (5 To 26 feet) of clayey overburden soil which then overlies the Maynardville Limestone formation –massive-to-thinly-bedded limestone with lesser amounts of dolostone. Depth to auger refusal and depth to top of rock are recorded on the drilling logs (Appendix A) and summarized in Table 2. As noted in previous investigations, recovered rock cores consisted of dark gray and gray limestone and dolostone with fractured and weathered zones. The recovery percentages and the RQD of the rock cores varied significantly throughout this geotechnical data gap investigation.

Table 2. Depth to Top of Bedrock/Auger Refusal

Borehole	As-Built Surface Elevation (ft. amsl.)	Depth to Auger Refusal (ft.)	Depth to Top of Rock (ft.)	Elevation of Top of Rock (ft. amsl.)
B-1	935.6	10.8	11.8	923.8
B-2	935.2	8	8.2	927.0
B-3	935.7	4.7	4.7	931.0
B-4	935.6	5.5	5.5	930.1
B-5	937.4	20.5	20.6	916.8
B-6	935.6	7.1*	15	920.6
B-7	936.0	17.8	17.8	918.2
B-8	935.1	19	18.8	916.3
B-9	935.6	22	24.6	911.0
B-10	935.7	17.2	17.2	918.5
B-11	935.5	20.9	21.9	913.6
B-12	935.7	27	26.3	909.4
B-14	935.8	26.8	26.5	909.3
B-15	926.4	18.5	18.6	907.8
B-16	926.6	17.3	17.2	909.4
B-17	926.4	16	16.1	910.3
B-18	926.3	7*	20.3	906.0
B-19	926.4	18	17.8	908.6
B-20A	926.0	5.3*	21.6	904.4
B-21	926.4	18.1	17.9	908.5
B-22	926.1	17.6	17.4	908.7

* Indicates locations where drillers switched to rock coring after encountering a boulder

3.2 ENCOUNTERED VOIDS

Voids in the rock were encountered in most of the borings. Table 3 summarizes the depth intervals where voids were encountered and characteristics of the void(s). Detailed information about the depth interval and character of voids is presented on the drillings logs (Appendix A).

Table 3. Void Intervals in Borings (B-1 through B-9)

Borehole	Void Interval(s) (feet below ground surface)		Infilling/Other Characteristics
B-1	16.7	17.2	No infilling
B-2	9.9	10.1	Some brown silty clay*, trace sand infilling
	11.8	12.1	Some brown silty clay*, trace sand infilling
B-3	12.2	14	Brown medium stiff silty clay with highly fractured rock. Driller's report: mud seam at 12.5'
	37.3	37.8	No infilling
B-4	7.8	11.4	Some highly fractured rock with medium stiff to stiff brown silty clay infilling*
	11.4	16.4	Some highly fractured rock with medium stiff to stiff brown silty clay infilling*
B-5	22.1	22.8	Some intensely fractured rock with medium stiff to stiff brown clay infilling
	33.8	34.9	No infilling
	36.1	38.2	Some intensely fractured rock, no infilling
	39.1	39.4	Some intensely fractured rock, no infilling
	52.2	52.5	No infilling
B-6	38.6	40.4	No infilling
	54.7	55.7	No infilling. Driller's report: likely lost core piece from 54.7' to 55.7'
	55.7	55.8	Some intensely fractured rock with grayish brown silty clay infilling
	58	59.2	Some intensely fractured rock with medium stiff grayish brown silty clay infilling
B-7	32.6	34.9	No infilling**
	35.6	40.5	No infilling*
	45	46.1	Some intensely fractured rock, no infilling
	59.1	62.7	Some soft gray clay infilling
B-8	30.4	30.8	No infilling
B-9	21.7	24.6	No infilling**. Driller's report: likely edge of cavity with brown silty clay infilling from overburden
	36.2	37.3	Some intensely fractured rock, no infilling**. Driller's report: mud seam
	45.7	49	No infilling*. Driller's report: likely lost core piece from 46.2' to 46.6'
	55.9	57.4	No infilling

Notes: *possible clay infilling also indicated by geophysical logs
**possible open void also indicated by geophysical logs

Table 3 (continued). Void Intervals in Borings (B-10 through B-18)

Borehole	Void Interval(s) (feet below ground surface)		Infilling/Other Characteristics
B-10	19.3	23.2	No infilling*
	25.4	27.5	Intensely fractured rock with soft brown silty clay infilling. Driller's report: likely lost core piece from 26.3' to 27.4'
	28.2	29.9	No infilling
	35.8	36.1	No infilling
	37	39.1	Some soft brown silty clay infilling* with highly fractured rock
	58.5	58.6	Some gray clay infilling with intensely fractured rock
B-11	20.9	21.9	Some brown clayey silt infilling* with intensely fractured rock
B-12	33.8	34.6	No infilling
B-14	55	55.1	No infilling
	58.8	59.7	No infilling
B-15	20.2	20.5	No infilling
	20.9	25.9	No infilling**. Driller's report: likely on the edge of cavity
	30.8	32.2	Some intensely fractured rock, no infilling
	34.4	35.9	No infilling
	35.9	47.1	No infilling
B-16	49	49.5	No infilling
	30.4	31	No infilling
	40.5	42.4	No infilling
B-17	47	48.6	Some highly fractured rock, no infilling
	32.3	35	Intensely fractured rock, no infilling. Driller's report: possible brown silty sand infilling
	35.4	36.3	No infilling recovered. Driller's report: possible brown silty sand infilling
B-18	49.3	50.7	No infilling recovered. Driller's report: possible brown silty clay infilling
	8.4	20.3	No recovery. Driller's report: possible overburden soil of grayish brown silty clay, began coring when boulder encountered
	20.3	20.9	No infilling. Driller's report: made contact with possible pinnacled rock from 20.3' to 20.9'
	20.9	22.2	Some very soft brown silty clay infilling with intensely fractured rock
	22.6	27.2	No infilling
	34.4	35.9	No infilling

Notes: *possible clay infilling also indicated by geophysical logs
**possible open void also indicated by geophysical logs

Table 3 (continued). Void Intervals in Borings (B-19 through B-22)

Borehole	Void Interval(s) (feet below ground surface)		Infilling/Other Characteristics
B-19	22.4	23.5	No infilling
	28	30.8	Some intensely fractured rock, no infilling
	41.1	41.3	Some highly fractured rock, no infilling
	44.3	51.2	Some highly fractured rock, no infilling. Driller's report: likely reached pinnacle at 51.2'
B-20A	6.6	9.9	Some intensely fractured rock, no infilling recovered; possible soil beneath boulder
	11.6	21.6	Medium Stiff brown silty clay with intensely fractured rock; likely part of overburden soil
	25.9	26.9	Soft grayish brown silty clay infilling
	30.2	31.6	No infilling
	34.5	40.3	No infilling
B-21	22.9	24	No infilling*
	28.4	29.4	No infilling**
B-22	33	35.3	No infilling**. Driller's report: likely edge of rock

Notes: *possible clay infilling also indicated by geophysical logs
**possible open void also indicated by geophysical logs

3.3 OTHER OBSERVATIONS

During the course of soil boring and rock coring activities, the following additional observations were made for each of the following borings:

- B-1: Shifted boring 9 feet south of original location due to access restrictions.
- B-2: Shifted boring 10 feet south of original location due to access restrictions. Hydraulic leak detected after auger refusal. Ended drilling to resume drilling on the next day, following repairs. No changes in boring noted between days.
- B-3: Shifted boring 9.7 feet south of original location due to access restrictions.
- B-4: Shifted boring approximately 10 feet south of original location due to access restrictions.
- B-5: Shifted boring 2 feet east/downhill of original location due to access restrictions. Added bentonite to drilling fluid to blind highly permeable overburden soils previously causing fluid loss.
- B-6: Shifted boring 1.5 feet east/downhill of original location due to access restrictions.
- B-8: On run #4, return drilling fluid was clean, despite drilling mud being used for drilling.
- B-10: While coring B-10, noticed drilling fluid (water) coming out of B-11, which had a casing from the top of rock with 4.5' stickup above ground surface. It was postulated that the fluid travelled from the moderately weathered portions of B-11 in interval 37.8' to 38.4', because this interval is about the same depth of the void encountered in B-10 from 37' to 39.1'.
- B-11: Original location of B-11 had concrete underneath gravel; moved boring 4 feet east of original location.
- B-13: Was terminated at 3 feet depth due to a concrete obstruction. After relocating 15 feet east, another concrete obstruction was encountered at the same depth during drilling. Drilling at location B-13 was therefore discontinued.
- B-15: Brown muddy water was recovered in drilling fluid tank from void encountered in Run #1.

- B-18: Top of rock was indicated as 20.3' although auger refusal was at 8.4' due to encountering a boulder at 8.4'. Although there was no recovery using the HQ wireline system after encountering the boulder, the drillers reported that overburden soil was encountered.
- B-20: While drilling B-20, encountered a heavy gaged steel pipe at a depth of 10.5'. Drilling did not break the pipe. Abandoned hole and appropriate site representatives visited to consult on where the new boring should be drilled.
- B-20A: Shifted boring 3 feet west of B-20 location due to encountering a buried utility at the original location. At a depth between 6.6' to 11.6', the driller smelled a scent similar to lighter fluid and stopped drilling until the problem was resolved. Top of rock was indicated as 21.6' although auger refusal was at 5.3' due to encountering a boulder at 5.3'. Although there was no recovery using the HQ wireline system after encountering the boulder, the drillers reported that overburden soil was encountered.
- B-22: Industrial hygienist detected trichloroethylene (TCE) above acceptable levels in soil. Halted operations and continued on the next workday. No detection the next day.

3.4 HEADCUT ERODIBILITY INDEX

The engineering analysis consisted of calculating the headcut erodibility index (USDA Headcut Erodibility Index Manual 2001) for the rock encountered during the rock core drilling activities performed at the site. This information is presented to aid readers of this report in their assessment of anticipated working conditions when excavating at the site. The headcut erodibility index predicts the effort required for excavation of the rock, expressed in flywheel horsepower (hp), based on the strength of the rock, the RQD, the roughness and size of the joints in the rock, and the ground structure of joints in the rock strata. The calculation of the headcut erodibility index was performed for the top 5-foot interval from two representative core runs – one with relatively weathered and jointed rock and one with relatively intact rock – in order to bracket the anticipated excavation conditions based on the rock cores performed. The calculation of the headcut erodibility index is explained below.

The dimensionless headcut erodibility index is the scalar product of four indices and is calculated using Equation 1 (USDA Headcut Erodibility Index Manual 2001).

$$K_h = M_s \times K_b \times K_d \times J_s \quad (1)$$

where

K_h = headcut erodibility index

M_s = material strength number of the earth material

K_b = block or particle size number

K_d = discontinuity or interparticle bond shear strength number

J_s = relative ground structure number

3.4.1 Material Strength Number

The dimensionless material strength number (M_s) for rocks is approximately defined using the uniaxial compressive strength (UCS) of rocks by Equation 2.

$$M_s = UCS \quad \text{for } UCS > 10 \text{ MPa} \quad (2)$$

where

UCS = uniaxial compressive strength of the intact rock sample [MPa]

The range of UCS values determined from laboratory testing performed by GEOSerives (2016) is used in this analysis to determine the overall range of anticipated headcut erodibility index (K_h) values. GEOSerives (2016) tested selected rock cores and obtained values of UCS between 59 and 142 MPa. For this analysis, a value of 59 MPa is paired with the low RQD value and a value of 142 MPa is paired with the high RQD value to obtain the maximum and minimum estimates of K_h .

3.4.2 Block or Particle Size Number

For rocks, the primary method to calculate the block number (K_b) is using Equation 3.

$$K_b = \frac{RQD}{J_n} \quad (3)$$

where

RQD = rock quality designation [%]

J_n = joint set number

The RQD of all core runs was calculated as explained in the earlier sections and the results are presented in Appendix A. The joint set number is a scale factor accounting for the shape of the material units or the relative occurrence of different joint sets (USDA Headcut Erodibility Index Manual 2001). The joint set number of each core run was assigned in accordance with the USDA Headcut Erodibility Index Manual (2001) and is presented in Table 4.

3.4.3 Discontinuity or Interparticle Bond Shear Strength Number

The discontinuity or interparticle bond shear strength number (K_d) is calculated using Equation 4.

$$K_d = \frac{J_r}{J_a} \quad (4)$$

where

J_r = joint roughness number

J_a = joint alteration number

The joint roughness number represents the degree of roughness of opposing faces of a rock discontinuity and the joint alteration number represents the degree of alteration of the materials that form the faces. General observations of the joint roughness and degree of alteration of materials were made during rock coring. Rock coring illustrations on the written boring logs provided further insight to these values. Both numbers were obtained from tables presented in the USDA Headcut Erodibility Index Manual (2001) and are presented in Table 4.

3.4.4 Relative Ground Structure Number

The relative ground structure number (J_s) represents the orientation of the effective dip of the least favorable discontinuity with respect to spillway flow. Most of the joint sets encountered at the site were inclined to about 40 degrees. The index, J_s was accordingly selected for a representative core run, per USDA Headcut Erodibility Index Manual (2001) and is presented in Table 4.

The four indices were assigned to the representative core runs and the headcut erodibility index was calculated. In accordance with USDA Engineering Classification Manual (2012), each representative core run was assigned an excavation class and the minimum horsepower rating of equipment needed for rock excavation. All the relevant parameters for this analysis are presented in Table 4.

Based on the information presented in Table 4 and field observations during the geotechnical investigation, it was determined that the rock encountered at the project site can be excavated using conventional equipment with a minimum flywheel horsepower rating of 500, assuming equipment is heavy-duty, track-type backhoe or tractor equipped with a single tine, rear-mounted ripper (USDA Engineering Classification Manual 2012).

Table 4. Calculation of Headcut Erodibility Index, K_h
(USDA Engineering Classification Manual 2012, USDA Headcut Erodibility Index Manual 2001)

Location	Core Run #	M_s	K_b			K_d			J_s	K_h	Excavation Class	Min. Equipment Power (hp)
			RQD	J_n	RQD/ J_n	J_r	J_a	J_r/J_a				
B-3	1	142	100%	1	100	1.5	1	1.5	1	21,300	Drilling and blasting	>500
B-7	1	59	31%	2.73	11.36	1.5	1	1.5	0.49	492	Very hard ripping	>350

4.0 REFERENCES

- GEOServices 2016. *Report of Limited Geotechnical Exploration, Outfall 200 Mercury Treatment Facility – Oak Ridge, Tennessee.*
- U.S. Department of Agriculture 2001. Headcut Erodibility Index Manual. “Chapter 52 – Field Procedures Guide for the Headcut Erodibility Index”, Part 628 Dams, National Engineering Handbook, Natural Resources Conservation Service, Revised March 2001.
- U.S. Department of Agriculture 2012. Engineering Classification Manual. “Chapter 4 – Engineering Classification of Rock Materials”, Part 631 Geology, National Engineering Handbook, Natural Resources Conservation Service, Issued January 2012.
- U.S. Department of Energy (DOE) 1998. *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge Tennessee*, DOE/OR/01-1641/V2&D2, Appendix C.
- DOE 2002. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge Tennessee*, DOE/OR/01-1951&D3.
- DOE 2006. *Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge Tennessee*, DOE/OR/01-2229&D3.
- DOE 2009. *Controlling Mercury Source Zones to Surface Water: Initial Results of Pilot Studies at the Y-12 National Security Complex*, ORNL/TM-2009/035, January 2009.
- U.S. Geological Survey. <http://mrddata.usgs.gov/geology/state/state.php?state=TN>. Accessed January 2016.
- URS/CH2M Oak Ridge LLC (UCOR) 2013. *Conceptual Design for Outfall 200 Mercury Treatment Facility*, Final Report. January 2013.

**GEOTECHNICAL REPORT FOR DATA GAP
CHARACTERIZATION AT THE PROPOSED OUTFALL 200
MERCURY TREATMENT FACILITY SITES**
January 2017

Appendix A – Boring Logs

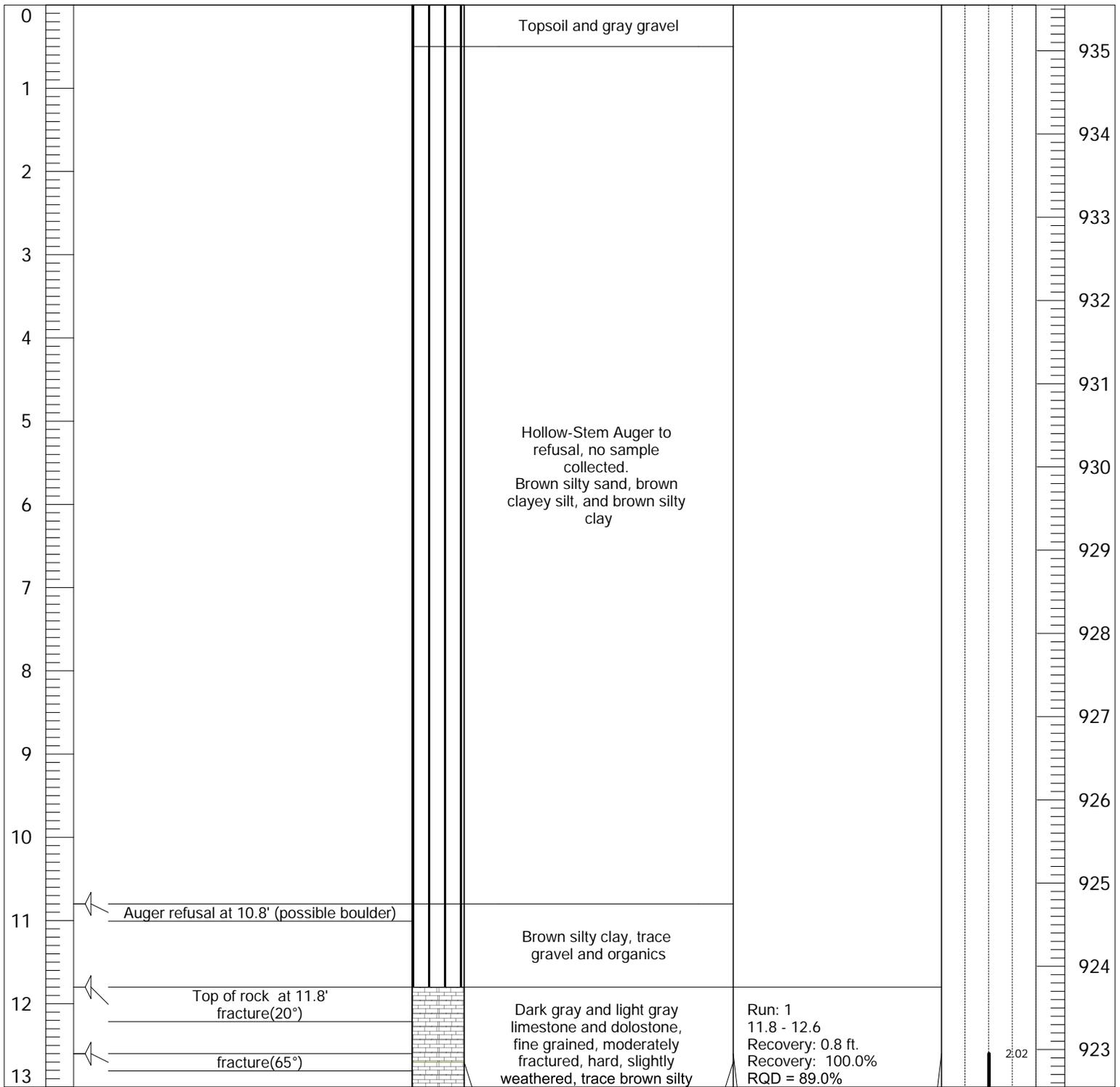


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/10/2016
 Time Started: 7:30 AM Completed: 11:18 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-01

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29296.34
 Easting: 57771.68
 Ground Elevation: 935.55

Notes:
 Backfilled with grout using tremie method
 Page 1 of 5

Legend

- soil
- dolostone
- limestone
- void

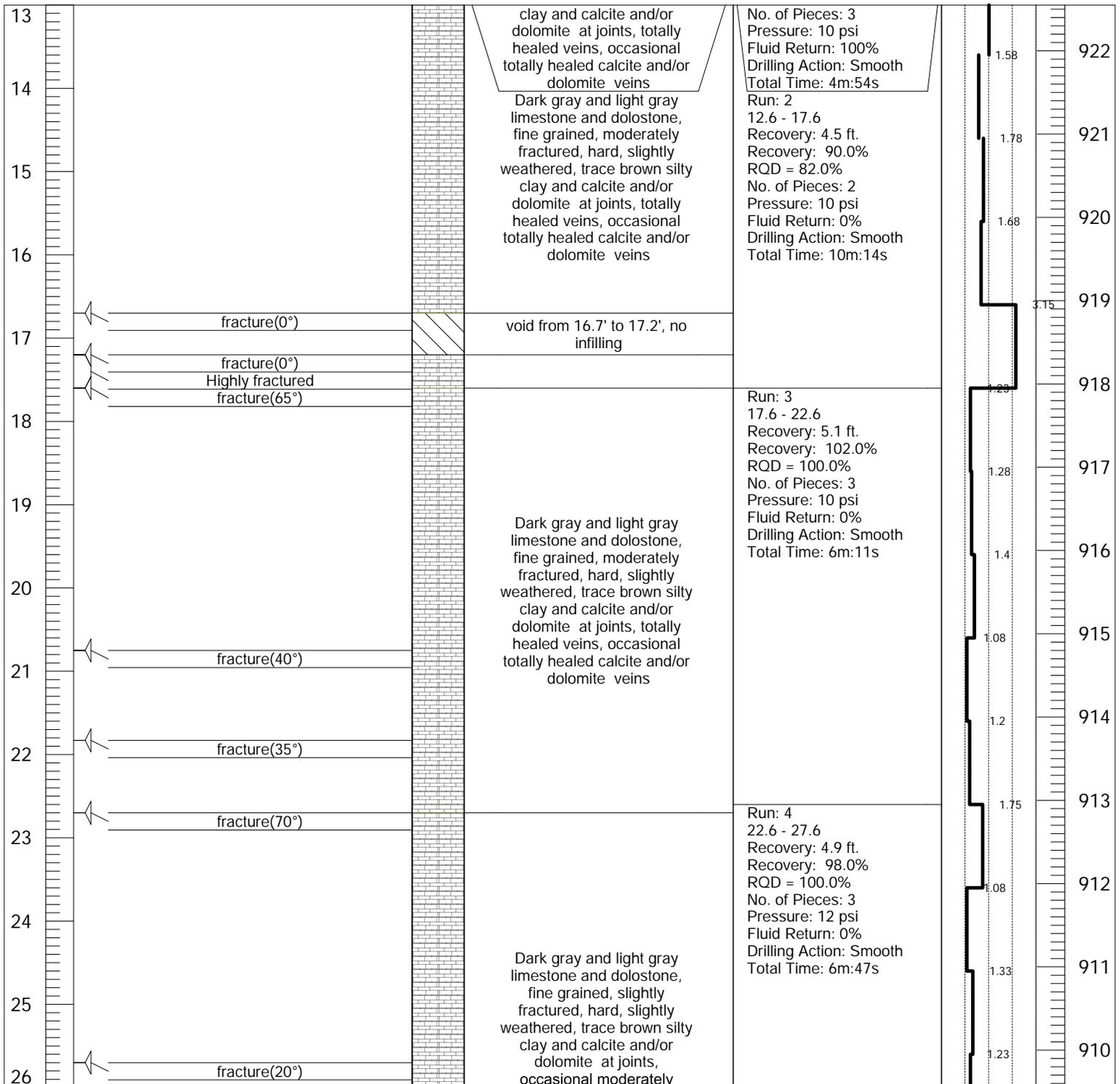


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/10/2016
 Time Started: 7:30 AM Completed: 11:18 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-01

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Mostly Cloudy 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29296.34
 Easting: 57771.68
 Ground Elevation: 935.55

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

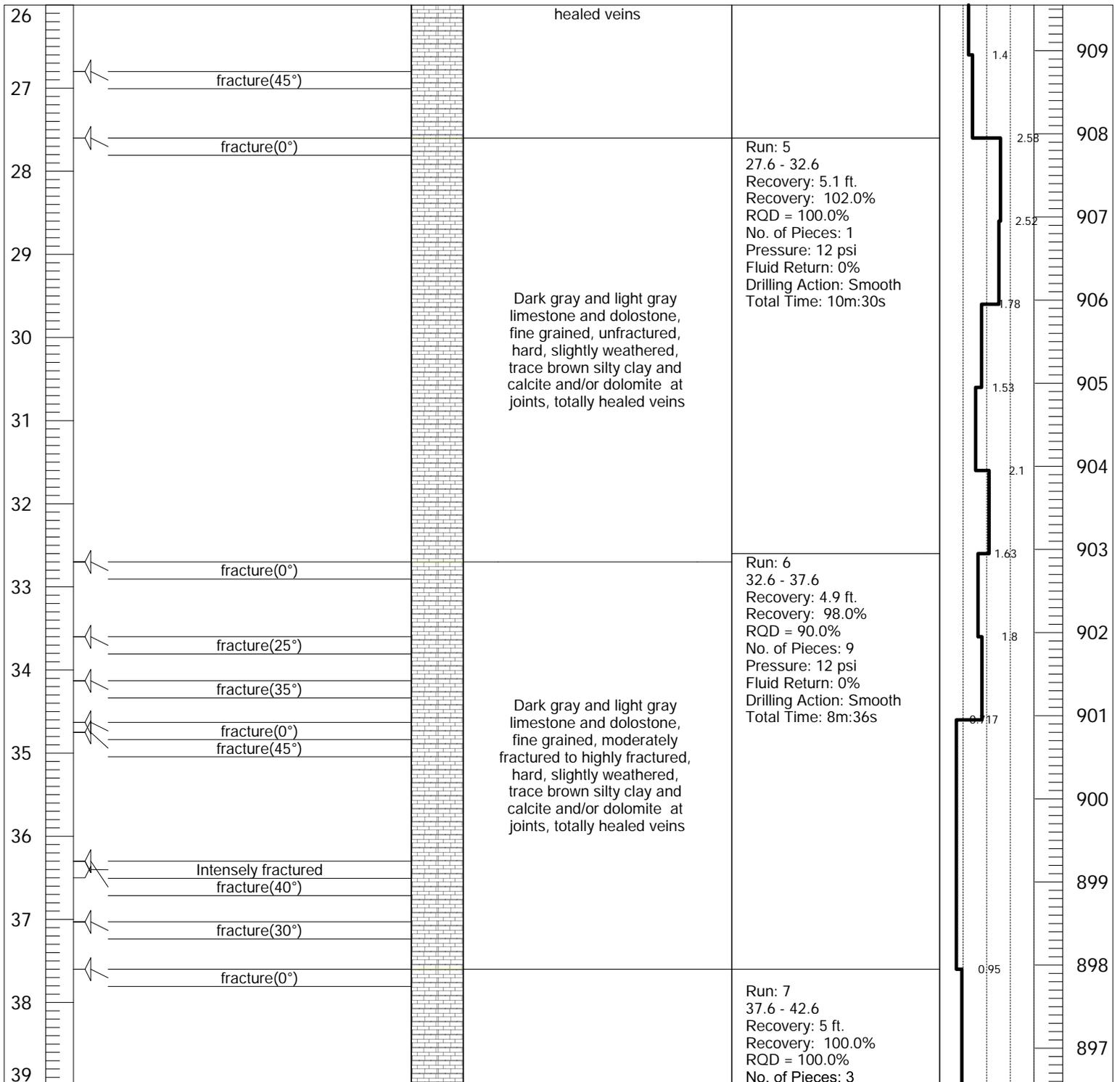


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/10/2016
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Drilling Subcontractor: Tri-State Drilling, Inc.,
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 Drill Rig Model: CME 55
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 Weather: Mostly Cloudy 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



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 + Some of total time not recorded

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 Easting: 57771.68
 Ground Elevation: 935.55

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



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 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

39					896
40	fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Pressure: 12 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 4m:57s	1	895
41	fracture(0°)				894
42				1.07	893
43	fracture(0°) fracture(45°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Run: 8 42.6 - 47.6 Recovery: 4.9 ft. Recovery: 98.0% RQD = 93.0% No. of Pieces: 5 Pressure: 12 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:24s	1.08	892
44	fracture(20°)				891
45	fracture(20°)				890
46					889
47	fracture(25°) Intensely fractured fracture(0°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, occasional moderately healed veins	Run: 9 47.6 - 52.6 Recovery: 4.9 ft. Recovery: 98.0% RQD = 98.0% No. of Pieces: 2 Pressure: 12 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 4m:37s	0.923	888
48	fracture(15°)				887
49					886
50	fracture(15°)				885
51					884
52					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29296.34
 Easting: 57771.68
 Ground Elevation: 935.55

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

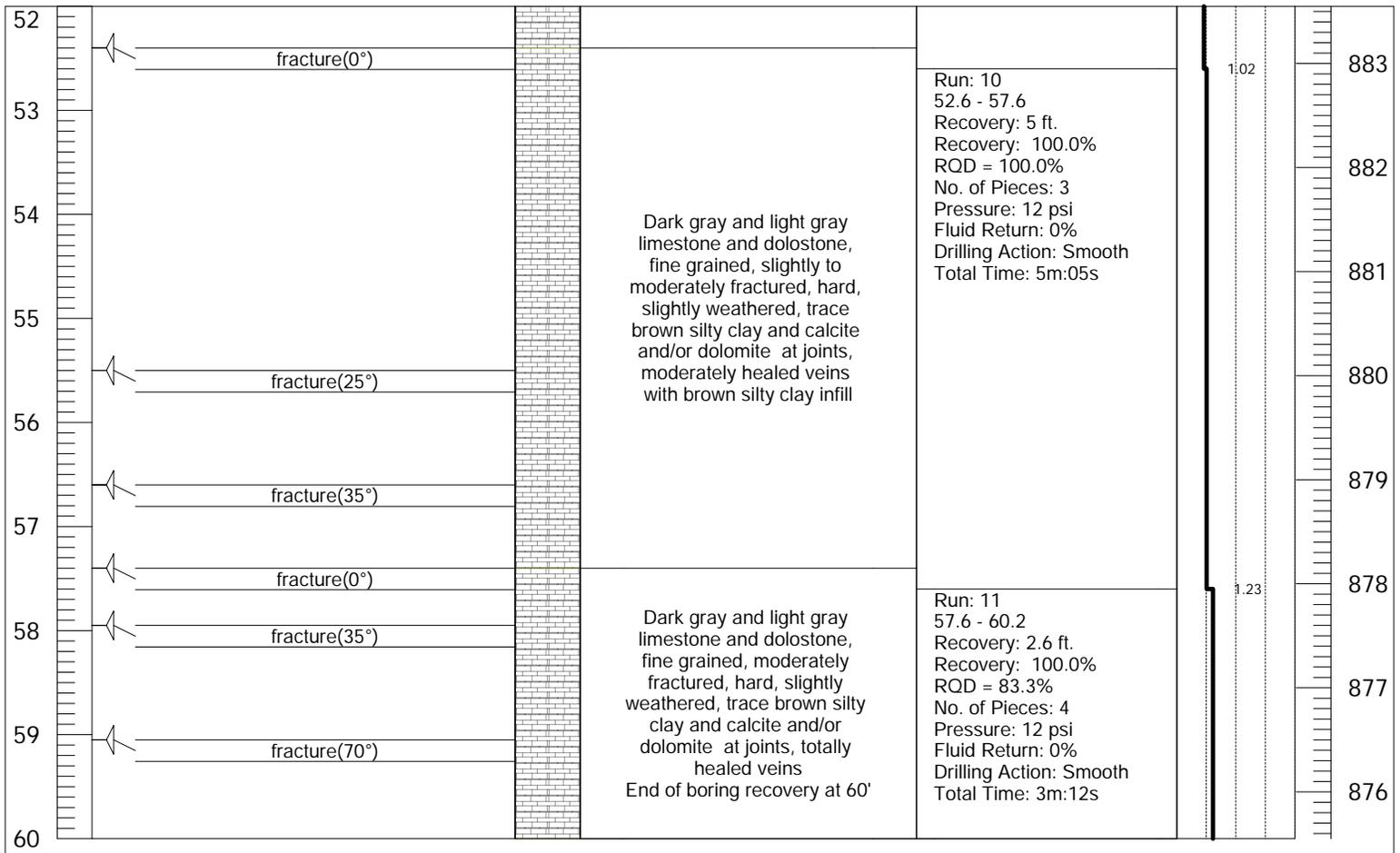


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/10/2016
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 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-01

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29296.34
 Easting: 57771.68
 Ground Elevation: 935.55

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

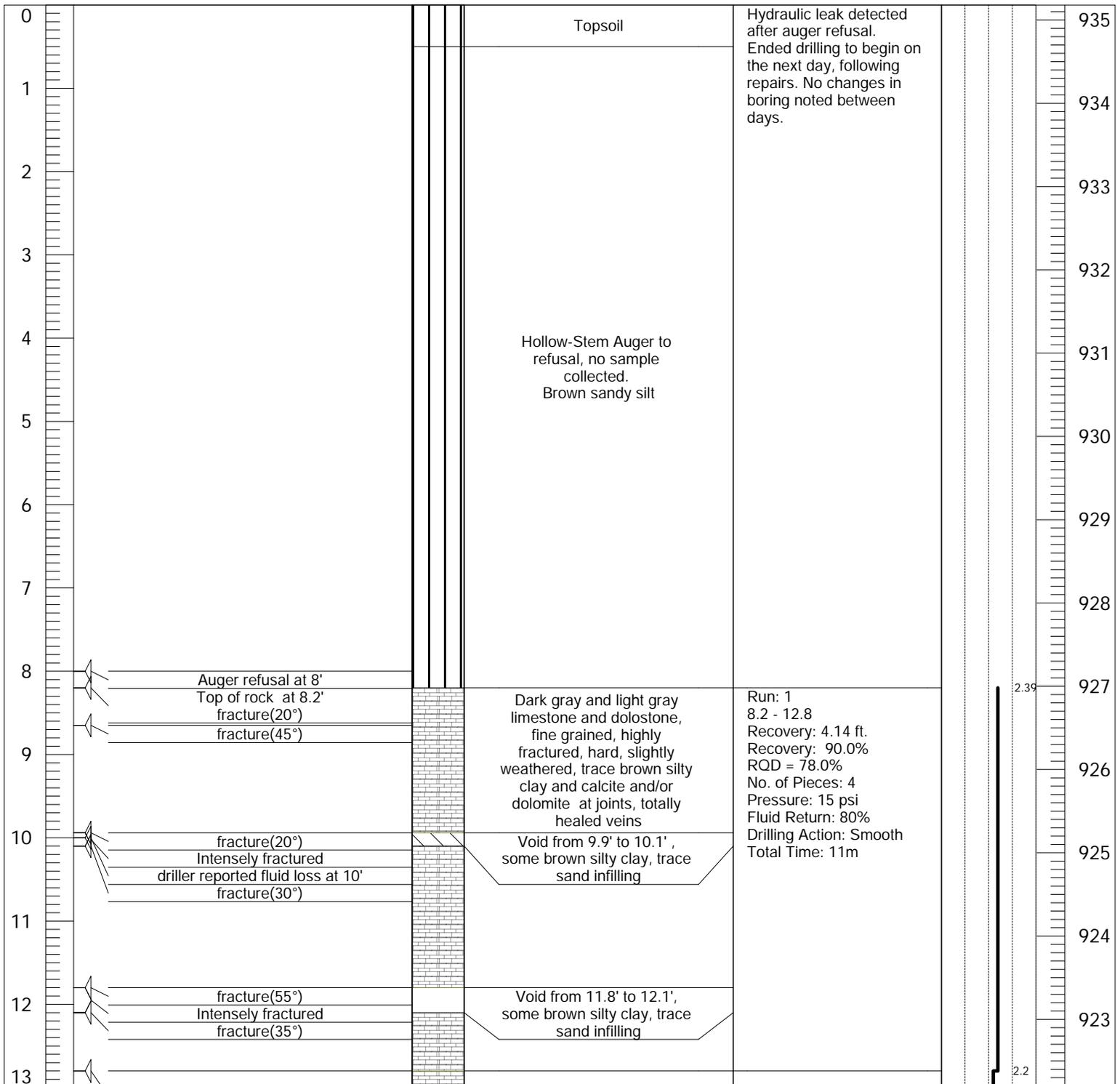


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/7/2016 Completed: 11/8/2016
 Time Started: 3:30 PM Completed: 11:47 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-02

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29291.32
 Easting: 57808.49
 Ground Elevation: 935.18

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/7/2016 Completed: 11/8/2016
 Time Started: 3:30 PM Completed: 11:47 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-02

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

13	fracture(0°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Run: 2 12.8 - 17.8 Recovery: 4.9 ft. Recovery: 98.0% RQD = 98.0% No. of Pieces: 2 Pressure: 75 psi Fluid Return: 80% Drilling Action: Smooth Total Time: 11m	2	922
14					921
15	fracture(15°)				920
16					919
17					918
18	fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Run: 3 17.8 - 22.8 Recovery: 5.18 ft. Recovery: 103.6% RQD = 96.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 15m	3	917
19	fracture(20°)				916
20					915
21					914
22	fracture(40°) Highly fractured				913
23	Highly fractured				912
24	fracture(45°) fracture(0°) fracture(50°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or	Run: 4 22.8 - 27.8 Recovery: 5.05 ft. Recovery: 101.0% RQD = 1.0% No. of Pieces: 4 Pressure: 25 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 6m	1.18	911
25	fracture(35°)				910
26				1.18	

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29291.32
 Easting: 57808.49
 Ground Elevation: 935.18

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

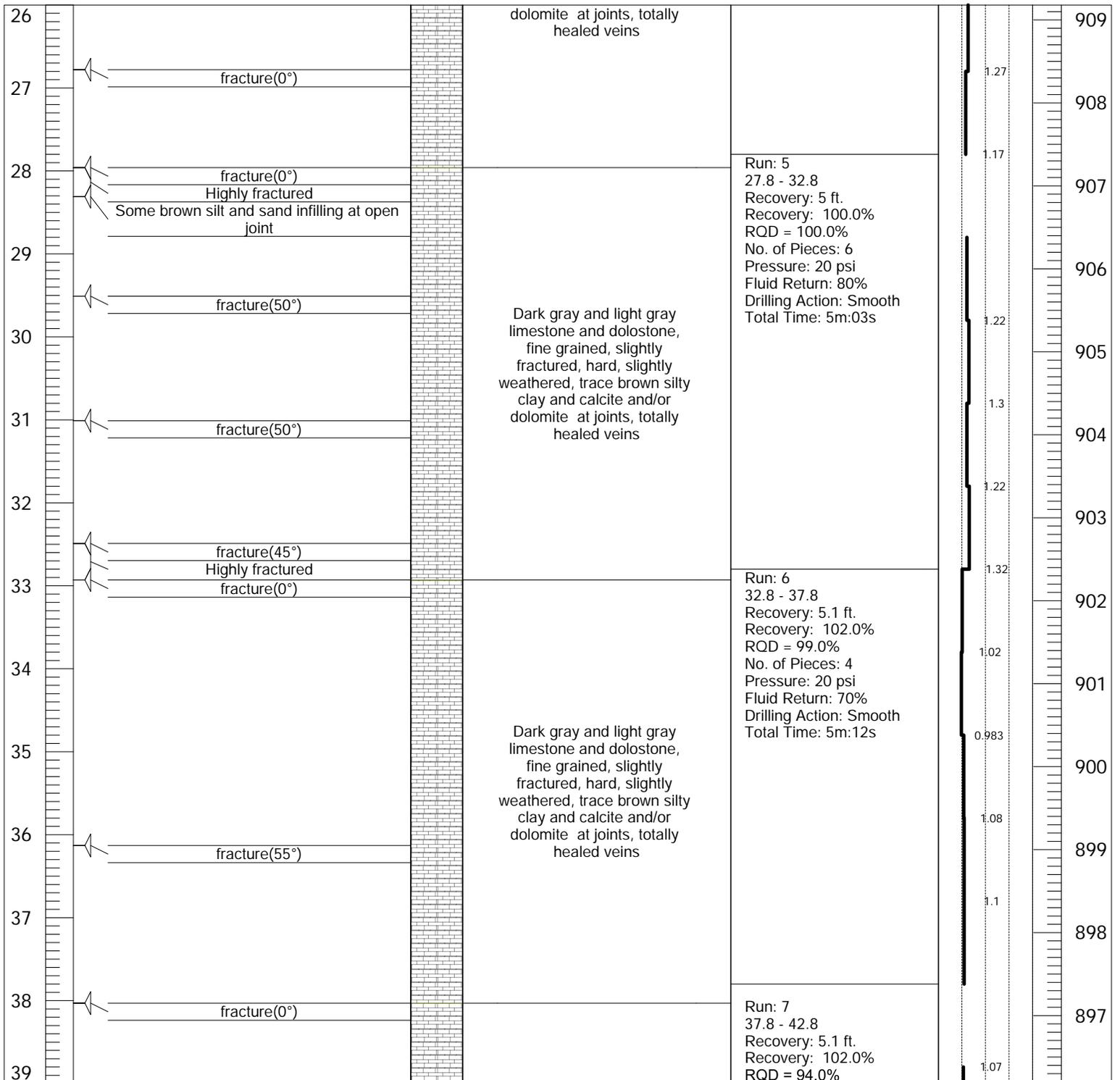


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/7/2016 Completed: 11/8/2016
 Time Started: 3:30 PM Completed: 11:47 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-02

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29291.32
 Easting: 57808.49
 Ground Elevation: 935.18

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

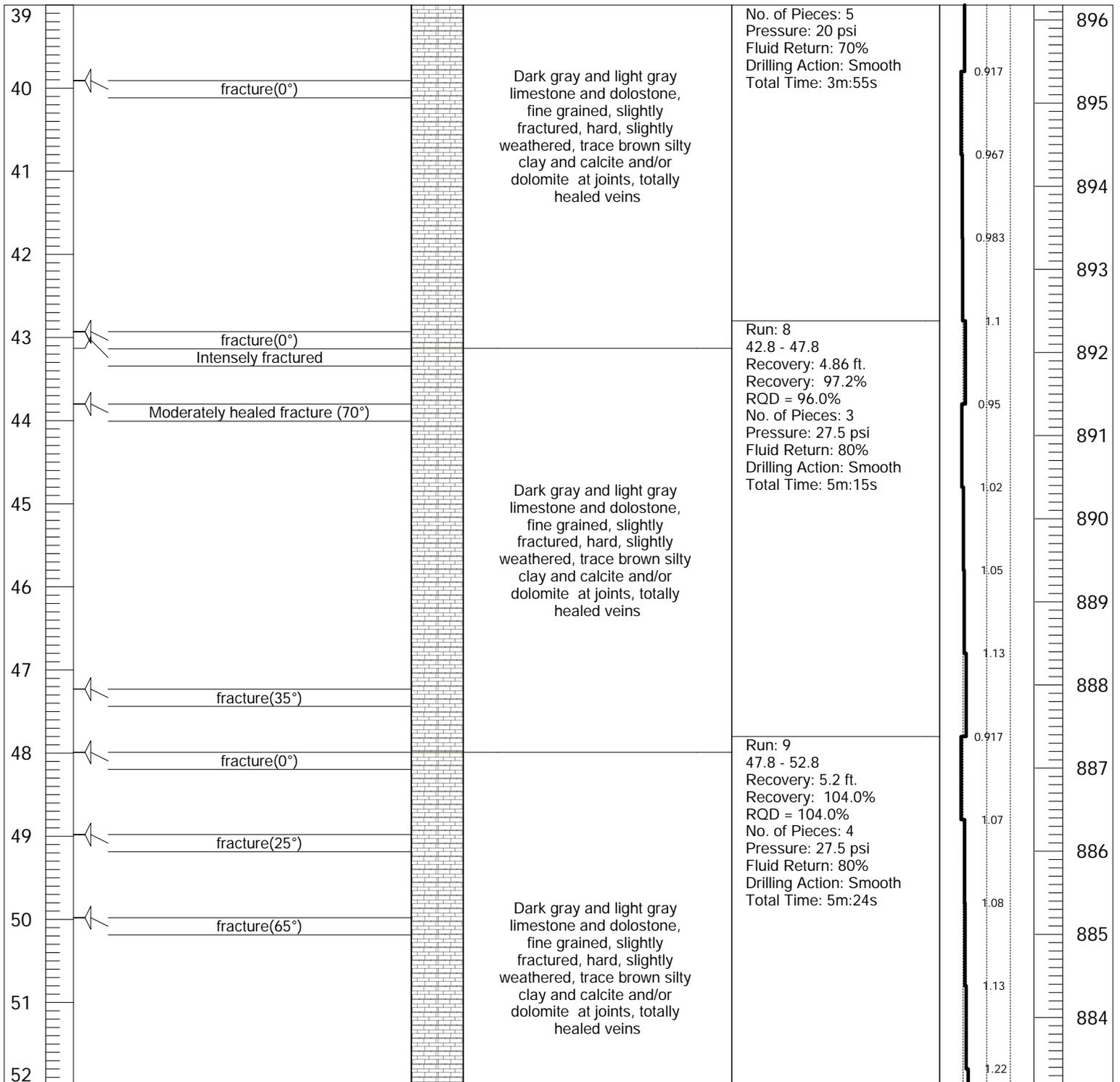


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/7/2016 Completed: 11/8/2016
 Time Started: 3:30 PM Completed: 11:47 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-02

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29291.32
 Easting: 57808.49
 Ground Elevation: 935.18

Notes:
 Backfilled with grout using tremie method

Legend

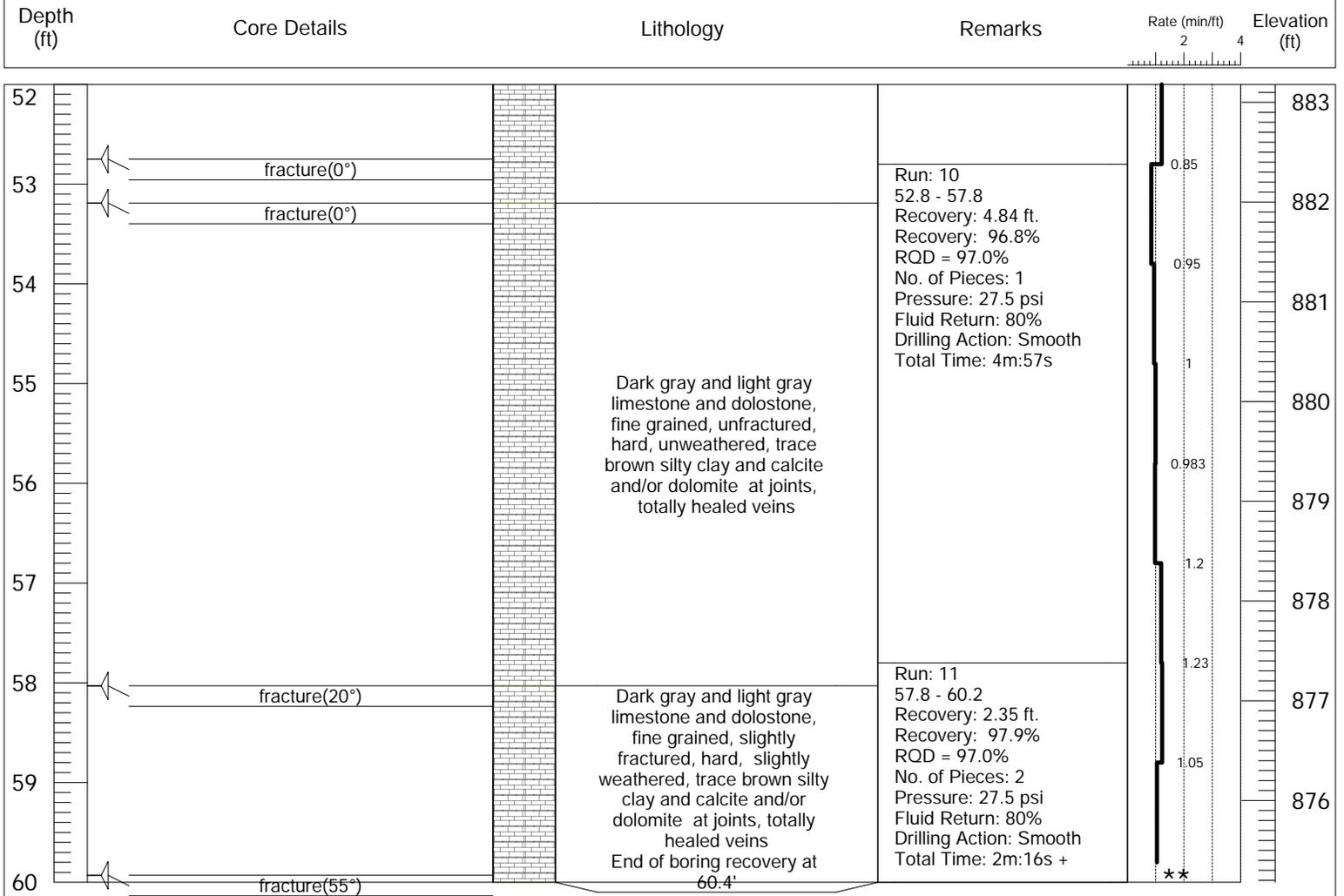
	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/7/2016 Completed: 11/8/2016
 Time Started: 3:30 PM Completed: 11:47 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-02

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29291.32
 Easting: 57808.49
 Ground Elevation: 935.18

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

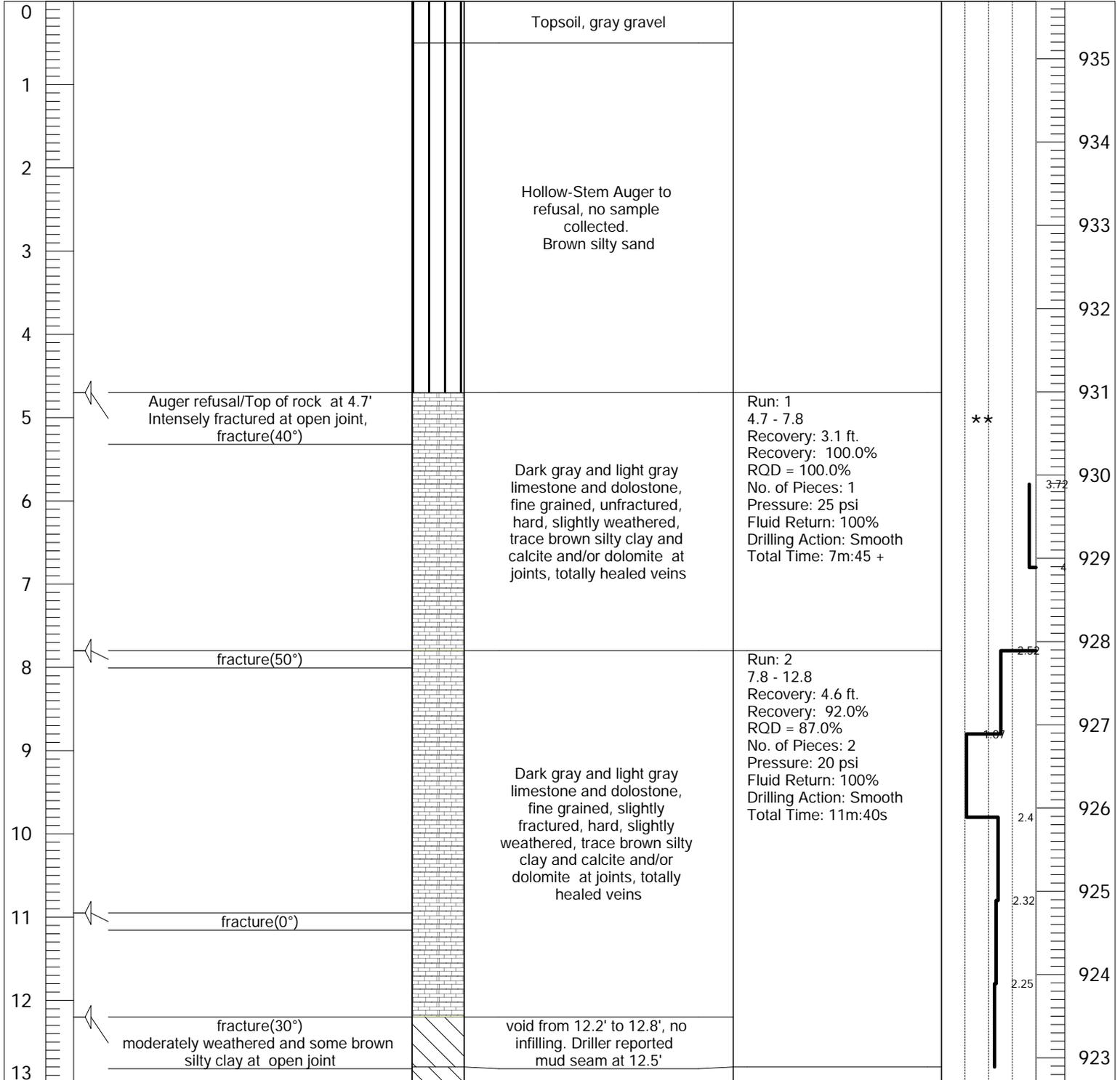


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/8/2016 Completed: 11/9/2016
 Time Started: 2:40 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-03

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29286.06
 Easting: 57836.83
 Ground Elevation: 935.69

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/8/2016 Completed: 11/9/2016
 Time Started: 2:40 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-03

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Mostly Cloudy 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
13		void from 12.8' to 14', brown medium stiff silty clay infilling with intensely fractured rock	Run: 3 12.8 - 17.8 Recovery: 3.9 ft. Recovery: 78.0% RQD = 47.0% No. of Pieces: 5 Pressure: 20 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 6m:43s	2.15	922
14	fracture(55°) some brown medium stiff silty clay and intensely fractured rock at open joint	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins		1.42	921
15	fracture(45°) some brown silty clay at open joint			1.57	920
16	fracture(35°)			1.58	919
17	fracture(60°)			1.02	918
18	fracture(25°)			Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins	Run: 4 17.8 - 22.8 Recovery: 4.95 ft. Recovery: 99.0% RQD = 97.0% No. of Pieces: 5 Pressure: 20 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 5m:59
20	fracture(0°)	1.15	915		
21	fracture(0°)	1.15	914		
22	Intensely fractured fracture(40°) fracture(20°)	1.15	913		
23	fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally	Run: 5 22.8 - 27.8 Recovery: 5 ft. Recovery: 100.0% RQD = 91.0% No. of Pieces: 5 Pressure: 20 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 7m:37s	2.05	912
24	fracture(30°)			1.27	911
25	Brown silty clay staining fracture(60°)			1.08	910
26					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29286.06
 Easting: 57836.83
 Ground Elevation: 935.69

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void

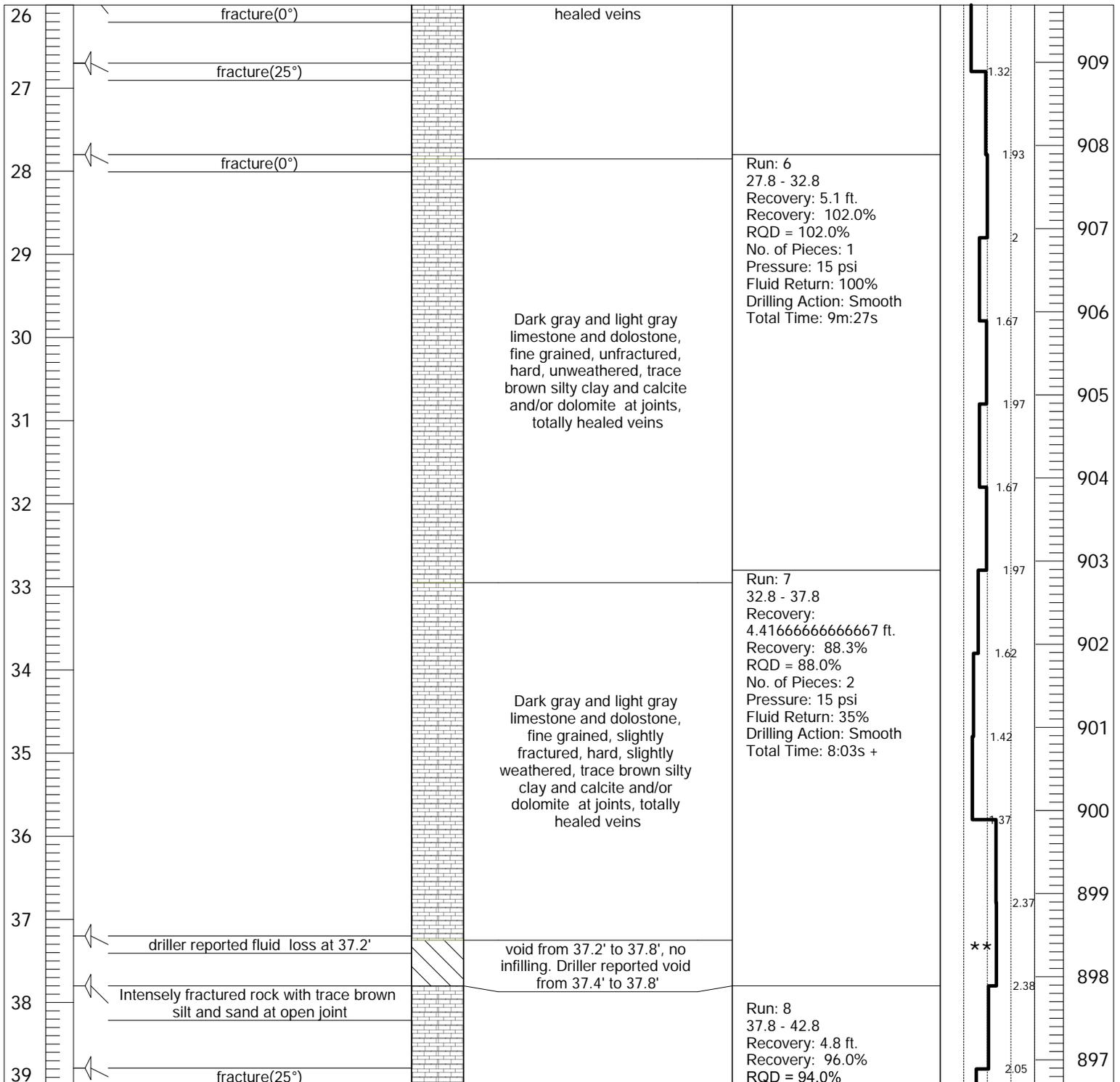


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/8/2016 Completed: 11/9/2016
 Time Started: 2:40 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-03

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29286.06
 Easting: 57836.83
 Ground Elevation: 935.69

Notes:
 Backfilled with grout using tremie method

Legend	
	soil
	dolostone
	limestone
	void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/8/2016 Completed: 11/9/2016
 Time Started: 2:40 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-03

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

39					
40	fracture(0°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	No. of Pieces: 8 Pressure: 40 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:59s	1.53	896
41	fracture(0°)			1.65	895
42				1.85	894
43	fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Run: 9 42.8 - 47.8 Recovery: 5.2 ft. Recovery: 104.0% RQD = 103.0% No. of Pieces: 1 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:18s	1.92	893
44	Frequent moderately weathered veins with brown silty clay infilling			1.65	892
45					891
46		Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins	Run: 10 47.8 - 52.8 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 2 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:11s		890
47					889
48	fracture(0°)				888
49	Partly healed vein				887
50					886
51					885
52					884

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29286.06
 Easting: 57836.83
 Ground Elevation: 935.69

Notes:

Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/8/2016 Completed: 11/9/2016
 Time Started: 2:40 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-03

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Cloudy 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)		
52	fracture(0°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silt, brown sand, and calcite and/or dolomite at joints, totally healed veins	Run: 11 52.8 - 57.8 Recovery: 5 ft. Recovery: 100.0% RQD = 90.8% No. of Pieces: 7 Pressure: 65 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:42s	1.83	883		
53	Highly fractured fracture(0°) Intensely fractured					1.87	882
54						2.22	881
55		Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, unweathered, trace brown silt, brown clay, and calcite and/or dolomite at joints, totally healed veins End of boring recovery at 60.2'	Run: 12 57.8 - 60.25 Recovery: 2.45 ft. Recovery: 100.0% RQD = 97.0% No. of Pieces: 2 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 3m:20s	2.07	880		
56	Frequent moderately weathered veins with trace brown silt and sand infilling					1.6	879
57		Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, unweathered, trace brown silt, brown clay, and calcite and/or dolomite at joints, totally healed veins End of boring recovery at 60.2'		1.98	878		
58	Mechanical breaks fracture(0°) fracture(0°)					1.52	877
59						0.833	876
60							

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29286.06
 Easting: 57836.83
 Ground Elevation: 935.69

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void

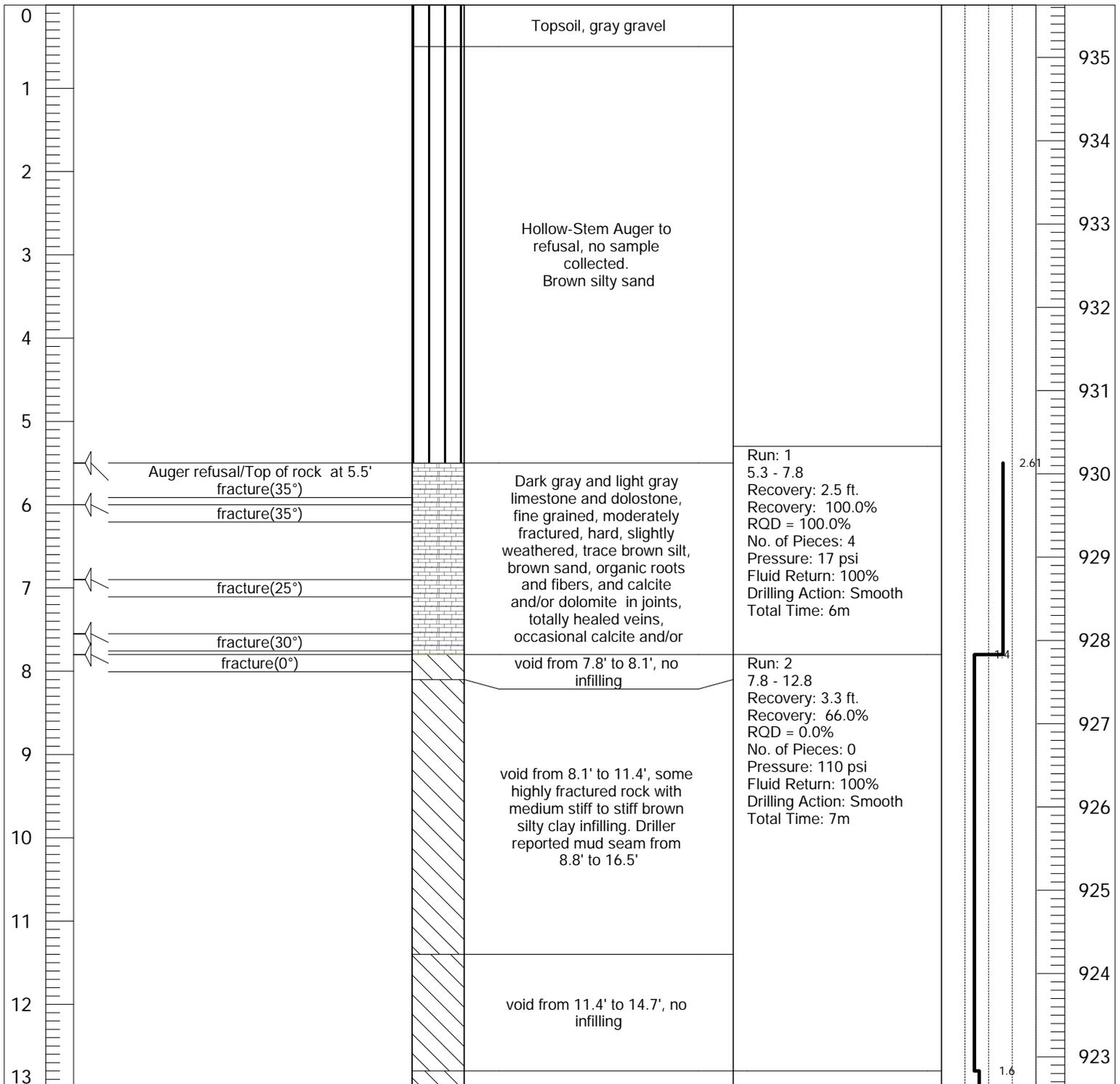


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/9/2016 Completed: 11/9/2016
 Time Started: 10:30 AM Completed: 3:16 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-04

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29279.81
 Easting: 57900.48
 Ground Elevation: 935.63

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

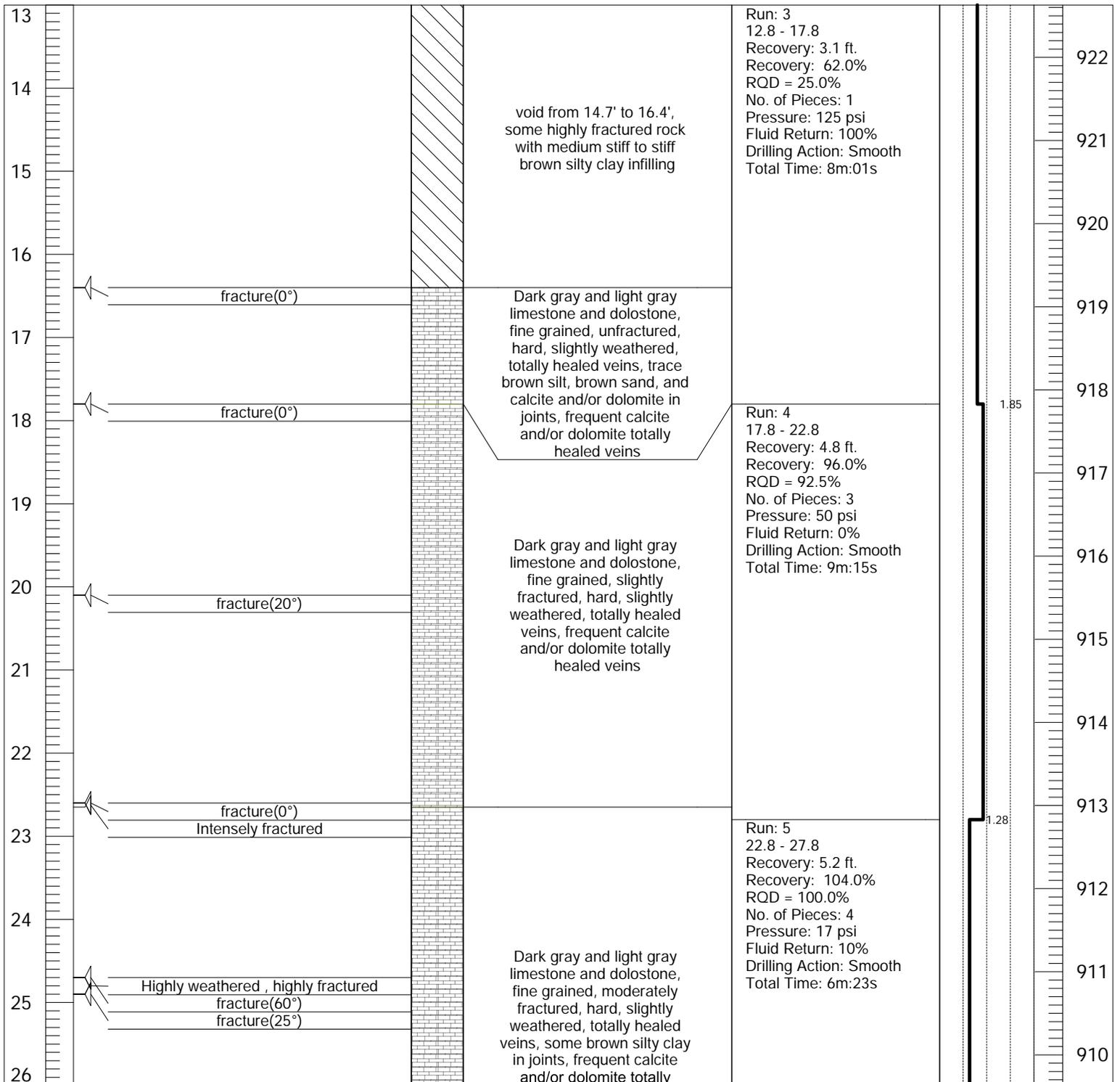


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/9/2016 Completed: 11/9/2016
 Time Started: 10:30 AM Completed: 3:16 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-04

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29279.81
 Easting: 57900.48
 Ground Elevation: 935.63

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/9/2016 Completed: 11/9/2016
 Time Started: 10:30 AM Completed: 3:16 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-04

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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26		healed veins			909
27	fracture(30°)				908
28	fracture(30°)				907
29		Dark gray and light gray limestone and dolostone, fine grained, slightly to moderately fractured, hard, slightly weathered, totally healed veins, trace brown silty clay in joints, frequent calcite and/or dolomite totally healed veins	Run: 6 27.8 - 32.8 Recovery: 5.13 ft. Recovery: 102.6% RQD = 101.7% No. of Pieces: 3 Pressure: 18 psi Fluid Return: 30% Drilling Action: Smooth Total Time: 6m:49s	1.36	906
30					905
31					904
32	fracture(65°)				903
	Intensely fractured				902
33	fracture(0°)				901
34		Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins	Run: 7 32.8 - 37.8 Recovery: 4.85 ft. Recovery: 97.0% RQD = 97.0% No. of Pieces: 3 Pressure: 17 psi Fluid Return: 30% Drilling Action: Smooth Total Time: 6m	1.2	900
35	fracture(30°)				899
	Highly fractured				898
36	fracture(0°)				897
37					
38	fracture(0°)				
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29279.81
 Easting: 57900.48
 Ground Elevation: 935.63

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/9/2016 Completed: 11/9/2016
 Time Started: 10:30 AM Completed: 3:16 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-04

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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39					
40	Intensely fractured fracture(50°)	Dark gray and light gray limestone and dolostone, fine grained, moderately to highly fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins	No. of Pieces: 5 Pressure: 17 psi Fluid Return: 35% Drilling Action: Smooth Total Time: 6m	1.2	896
	fracture(35°)				895
41	Slightly fractured				894
42					
43	fracture(50°)	Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins	Run: 9 42.8 - 47.8 Recovery: 5.15 ft. Recovery: 103.0% ROD = 100.0% No. of Pieces: 2 Pressure: 17 psi Fluid Return: 35% Drilling Action: Smooth Total Time: 5m:45s	1.2	893
	fracture(50°)				892
44					891
45					
46	fracture(67°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins	Run: 10 47.8 - 52.8 Recovery: 5.05 ft. Recovery: 101.0% ROD = 100.0% No. of Pieces: 4 Pressure: 17 psi Fluid Return: 35% Drilling Action: Smooth Total Time: 5m:50s	1.15	890
47					889
48	fracture(35°)				888
49					
50	fracture(40°) Highly fractured fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins			887
					886
51	fracture(65°)				885
52					884

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29279.81
 Easting: 57900.48
 Ground Elevation: 935.63

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/9/2016 Completed: 11/9/2016
 Time Started: 10:30 AM Completed: 3:16 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-04

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52					883
53	fracture(0°) Highly fractured fracture(20°)	Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins	Run: 11 52.8 - 57.8 Recovery: 4.95 ft. Recovery: 99.0% RQD = 94.0% No. of Pieces: 6 Pressure: 17 psi Fluid Return: 35% Drilling Action: Smooth Total Time: 6m:01s	1.17	882
54					881
55					880
56	fracture(25°)				879
57	fracture(35°)				878
58	fracture(40°)	Dark gray and light gray limestone and dolostone, fine grained, slightly to moderately fractured, hard, moderately weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins End of boring recovery at 60.6'	Run: 12 57.8 - 60.5 Recovery: 2.65 ft. Recovery: 98.1% RQD = 93.0% No. of Pieces: 3 Pressure: 17 psi Fluid Return: 40% Drilling Action: Smooth Total Time: 3m:19s	1.2	877
59					876
60	fracture(50°)			1.23	

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29279.81
 Easting: 57900.48
 Ground Elevation: 935.63

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/11/2016 Completed: 11/11/2016
 Time Started: 9:36 AM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-05

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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0		Overgrown weeds, gray gravel	Added bentonite to drilling fluid to blind highly permeable overburden soils previously causing fluid loss.		937
1					936
2					935
3					934
4					933
5					932
6					931
7					930
8					929
9					928
10		Hollow-Stem Auger to refusal, no sample collected.			927
11		Dark brown silty sand, and brown sandy silt with organics			926
12					925
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29254.65
 Easting: 57740.14
 Ground Elevation: 937.38

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

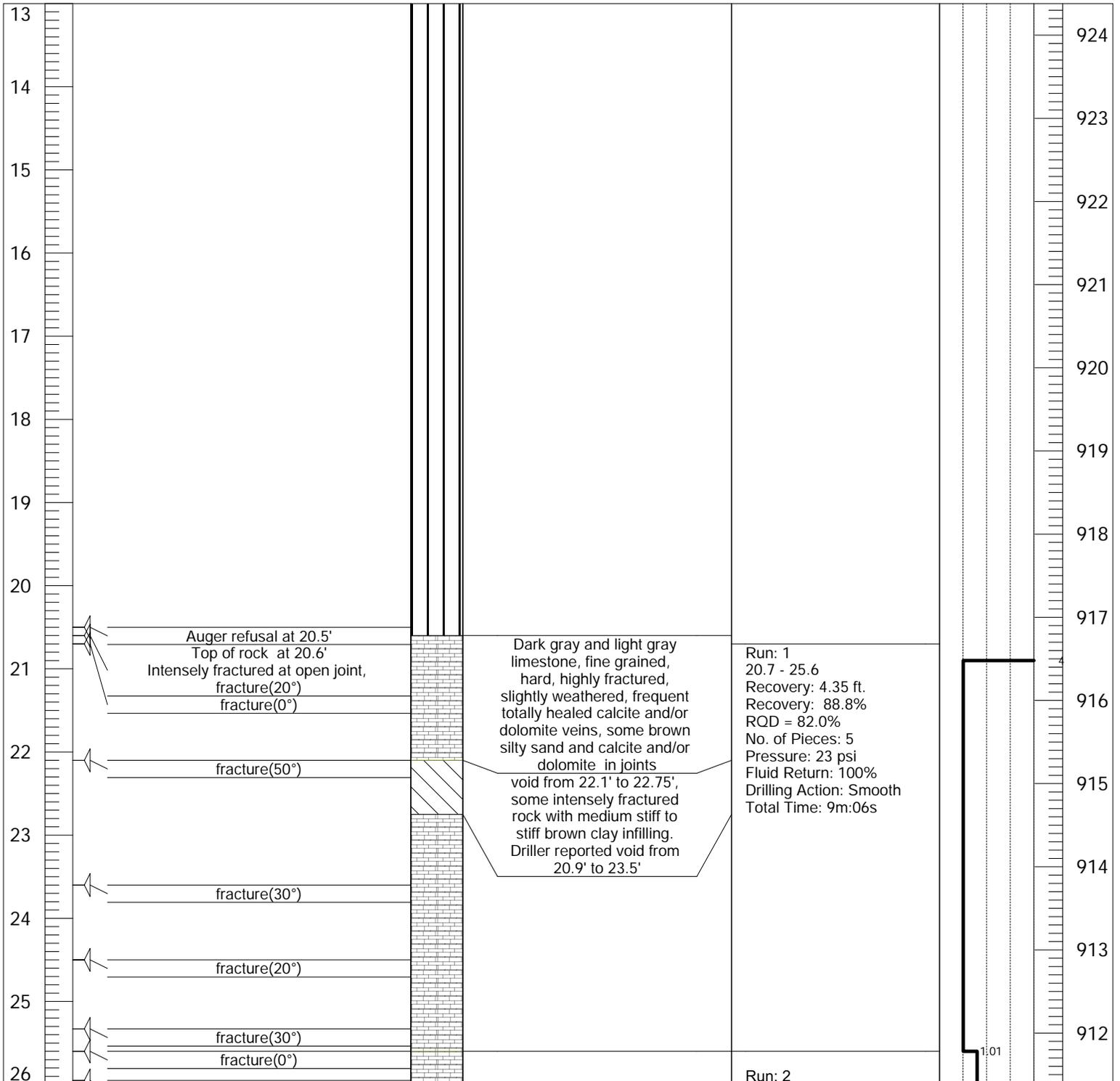


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/11/2016 Completed: 11/11/2016
 Time Started: 9:36 AM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-05

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29254.65
 Easting: 57740.14
 Ground Elevation: 937.38

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/11/2016 Completed: 11/11/2016
 Time Started: 9:36 AM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-05

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(48°)	Dark gray and light gray limestone, fine grained, hard, highly fractured, slightly weathered, frequent totally healed calcite and/or dolomite veins, some brown silty sand and calcite and/or dolomite in joints	25.6 - 30.6 Recovery: 4.9 ft. Recovery: 98.0% RQD = 59.2% No. of Pieces: 6 Pressure: 18 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 8m	2	911
27	fracture(65°) fracture(20°)				
28	fracture(20°)				
30	fracture(0°) fracture(0°)	Dark gray and light gray limestone, fine grained, hard, moderately fractured, moderately weathered, frequent totally healed stylolite veins, frequent moderately healed veins with brown silty clay infilling	Run: 3 30.6 - 35.6 Recovery: 3.8 ft. Recovery: 76.0% RQD = 76.0% No. of Pieces: 2 Pressure: 18 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 12m	1.6	907
31	fracture(60°)				
34	fracture(0°)	void from 33.8' to 34.9', no infilling. Driller reported void from 33' to 35'			903
35	fracture(0°) Highly fractured	Dark gray and light gray limestone, fine grained, hard, highly fractured, moderately weathered, frequent totally healed stylolite veins with brown silty clay infilling void from 36.1' to 38.2', some intensely fractured rock, no infilling. Driller reported void from 36.1' to 38.2'	Run: 4 35.6 - 40.6 Recovery: 2.9 ft. Recovery: 58.0% RQD = 35.0% No. of Pieces: 10 Pressure: 18 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 9m:24s	2.4	902
36	fracture(0°) fracture(0°) fracture(55°) Intensely fractured rock at open joint				
37	fracture(30°)				
39					899

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29254.65
 Easting: 57740.14
 Ground Elevation: 937.38

Notes:
 Backfilled with grout using tremie method

	soil		dolostone		limestone
	void				

Legend



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/11/2016 Completed: 11/11/2016
 Time Started: 9:36 AM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-05

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(0°) Intensely fractured rock at open joint	void from 39.05' to 39.4', some intensely fractured rock, no infilling			898
40	fracture(25°) fracture(50°)	Light gray dolostone, fine grained, intensely fractured, occasional moderately healed veins with brown silty clay infilling			897
41	fracture(0°) fracture(35°) Moderately fractured		Run: 5 40.6 - 45.6 Recovery: 5 ft. Recovery: 100.0% RQD = 90.0% No. of Pieces: 8 Pressure: 18 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 9m:26s	1.88	896
42	fracture(40°)				895
43	fracture(0°) fracture(0°)	Light gray dolostone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling			894
44	fracture(25°) fracture(20°) fracture(25°)				893
45	Moderately fractured				892
46	fracture(20°)		Run: 6 45.6 - 50.6 Recovery: 5 ft. Recovery: 100.0% RQD = 95.0% No. of Pieces: 4 Pressure: 18 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 5m:45s	1.89	891
47	fracture(45°) fracture(40°) Highly weathered to 50% diameter fracture(60°)				890
48		Light gray dolostone, fine grained, highly to slightly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling			889
49					888
50					887
51	fracture(0°) fracture(30°)		Run: 7 50.6 - 55.6 Recovery: 4.3 ft. Recovery: 86.0% RQD = 82.0% No. of Pieces: 10	1.15	886
52	fracture(25°)	Light gray dolostone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling, some calcite and/or dolomite in joint, trace			

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29254.65
 Easting: 57740.14
 Ground Elevation: 937.38

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/11/2016 Completed: 11/11/2016
 Time Started: 9:36 AM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-05

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 57°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(45°) Intensely fractured rock at open joint fracture(0°)	brown silty clay void from 52.2' to 52.5', no infilling	Pressure: 18 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:25s		885
53	fracture(45°)	Light gray and dark gray limestone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling, some stylolite in joints, some calcite and/or dolomite in joints	Run: 8 55.6 - 60.6 Recovery: 5 ft. Recovery: 100.0% RQD = 96.0% No. of Pieces: 9 Pressure: 45 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:52s	1.48	884
54	fracture(40°)				883
55	fracture(60°) Intensely fractured				882
56	fracture(35°)				881
57	fracture(0°) fracture(0°)	Light gray and dark gray limestone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling, some stylolite in joints, some calcite and/or dolomite in joints End of boring recovery at 60.6'		1.77	880
58	fracture(0°) fracture(30°)				879
59					878
60					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29254.65
 Easting: 57740.14
 Ground Elevation: 937.38

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void

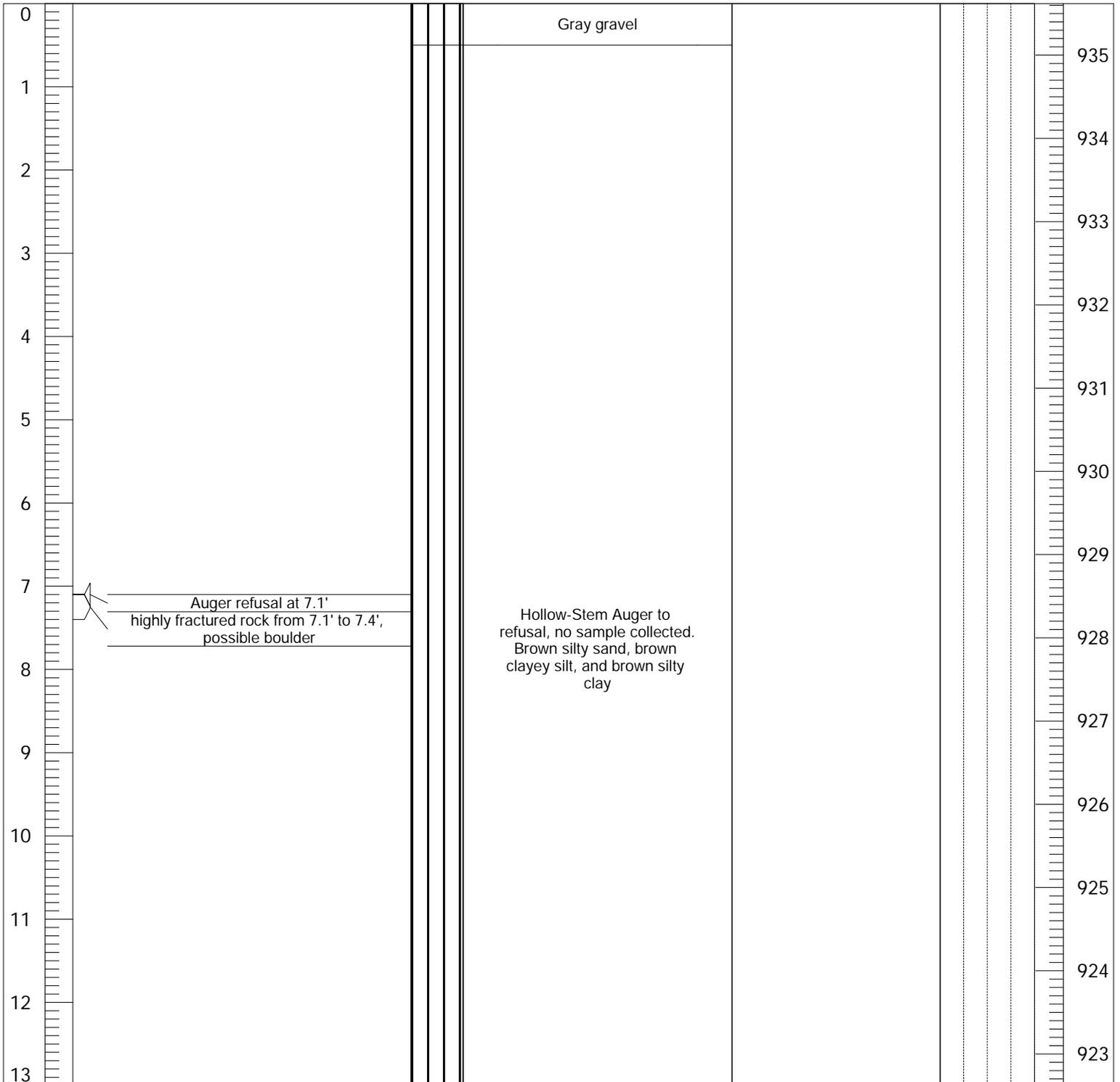


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/11/2016
 Time Started: 1:05 PM Completed: 8:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-06

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29262.71
 Easting: 57758.68
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/11/2016
 Time Started: 1:05 PM Completed: 8:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-06

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Mostly Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
13					922
14	driller reported fluid loss at 14'				921
15	Intensely fractured, highly weathered rock with brown silty clay Top of rock at 15' fracture(40°) Highly fractured fracture(20°)	Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, trace brown silty clay in joints, totally healed veins, occasional totally healed calcite and/or dolomite veins	Run: 1 15 - 17.7 Recovery: 2.7 ft. Recovery: 100.0% ROD = 89.5% No. of Pieces: 4 Pressure: 17 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 9m:25s	3.49	920
16	fracture(45°)				919
17					918
18	fracture(50°) Highly fractured fracture(0°)	Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, trace brown silty clay in joints, totally healed veins, occasional totally healed calcite and/or dolomite veins	Run: 2 17.7 - 22.7 Recovery: 5 ft. Recovery: 100.0% ROD = 93.0% No. of Pieces: 8 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:27s	1.46	917
19	fracture(45°)				916
20	fracture(0°) Highly fractured fracture(45°)				915
21	fracture(25°)				914
22	fracture(30°)				913
23	fracture(15°)		Run: 3 22.7 - 27.7 Recovery: 5.2 ft. Recovery: 104.0% ROD = 102.0% No. of Pieces: 3 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:07s	1.22	912
24	fracture(30°)				911
25		Dark gray and light gray limestone and dolostone, fine grained, hard, slightly fractured, slightly weathered, trace brown silty clay in joints, totally healed veins, frequent calcite			910
26					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29262.71
 Easting: 57758.68
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

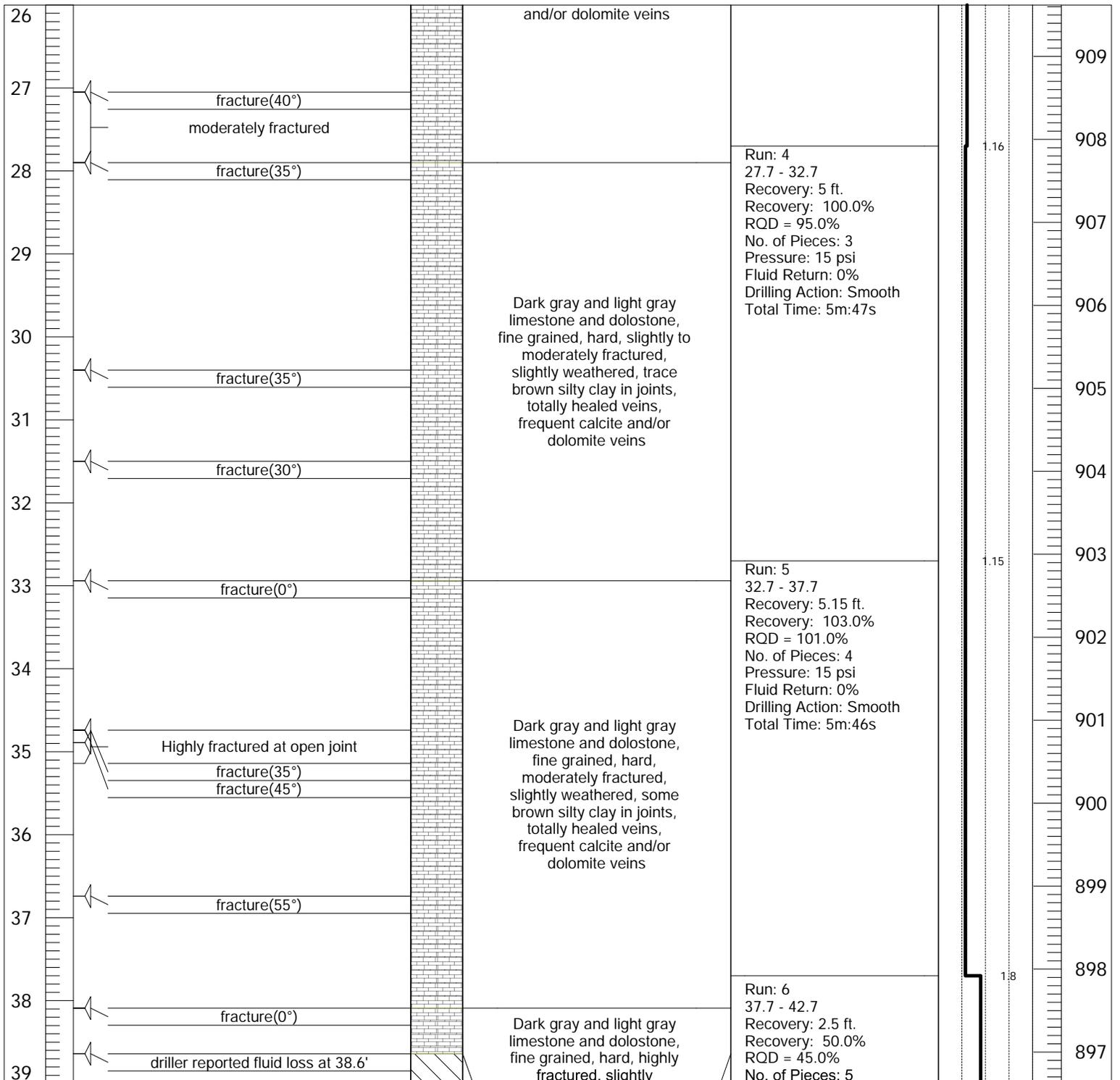


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/11/2016
 Time Started: 1:05 PM Completed: 8:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-06

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29262.71
 Easting: 57758.68
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/11/2016
 Time Started: 1:05 PM Completed: 8:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-06

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39			Pressure: 10 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 9m		896
40		weathered, some brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins void from 38.6' to 40.4', no infilling. Driller reported void from 38.4' to 40.9'			895
41	fracture(20°)	Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, slightly weathered, some brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins	Run: 7 42.7 - 47.7 Recovery: 5.3 ft. Recovery: 106.0% RQD = 84.0% No. of Pieces: 5 Pressure: 10 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:08s +	1.63	894
42	Highly fractured fracture(35°)				893
43	fracture(40°)				892
44	fracture(45°)				891
45		Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, slightly weathered, some brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins	Run: 8 47.7 - 52.7 Recovery: 3.5 ft. Recovery: 70.0% RQD = 62.0% No. of Pieces: 5 Pressure: 10 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:32s	1.51	890
46	Highly fractured				889
47	fracture(30°) fracture(0°) Highly weathered to 50% diameter, edge of cavity				**
48	Highly weathered to 1.5" diameter, edge of cavity Driller reported lost circulation/blocked at 46.6', recovered core Intensely fractured rock with brown silty clay at open joint	Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, highly weathered, with silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins Core coated in brown silty clay, likely edge of cavity			887
49	fracture(20°) fracture(50°)				886
50		void from 50.9' to 52.2', some intensely fractured rock, no infilling. Driller reported void from 51.1' to			885
51	Highly fractured, highly weathered, edge of cavity				884
52	Highly fractured				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29262.71
 Easting: 57758.68
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

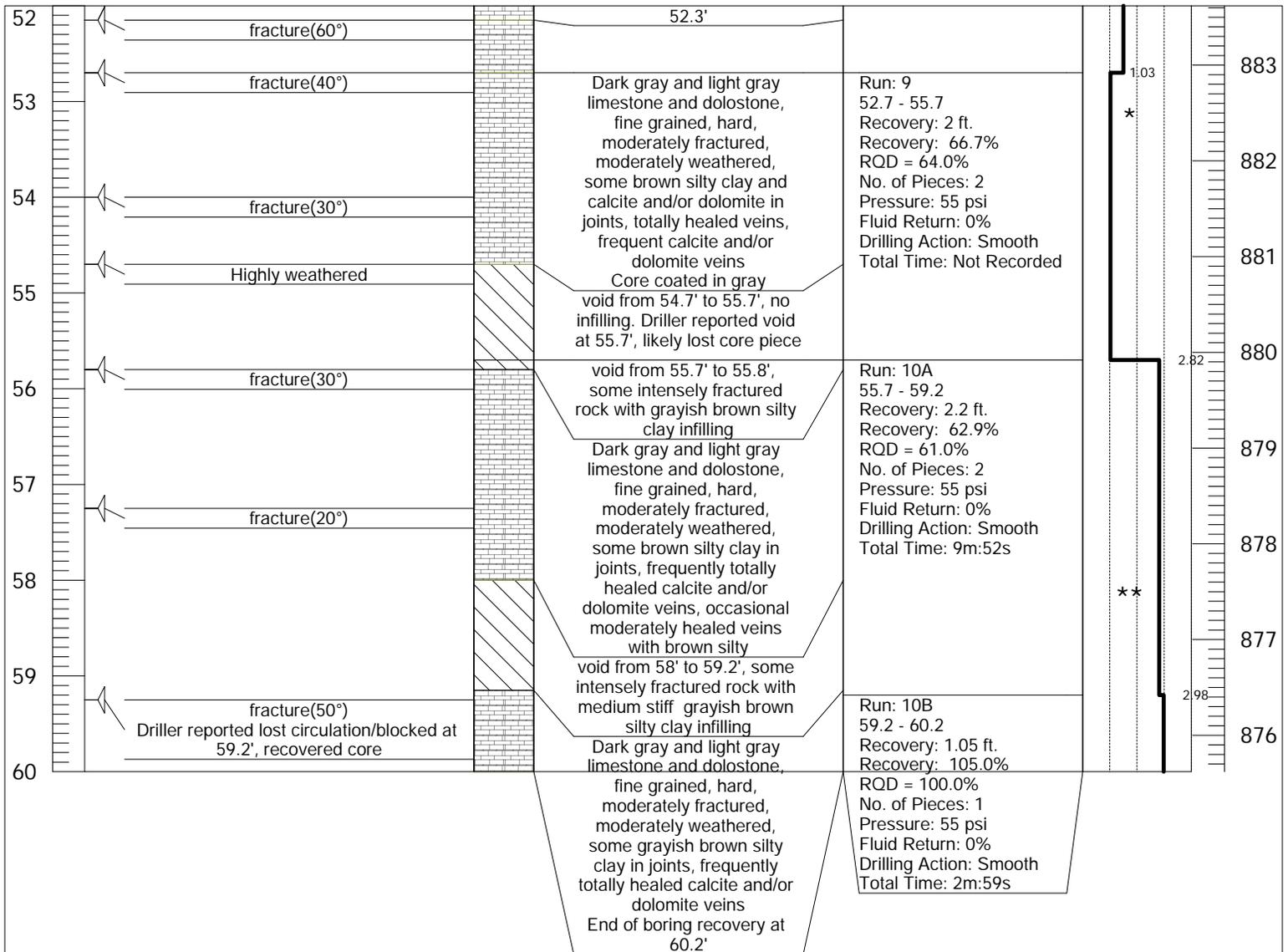


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/10/2016 Completed: 11/11/2016
 Time Started: 1:05 PM Completed: 8:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-06

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29262.71
 Easting: 57758.68
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void

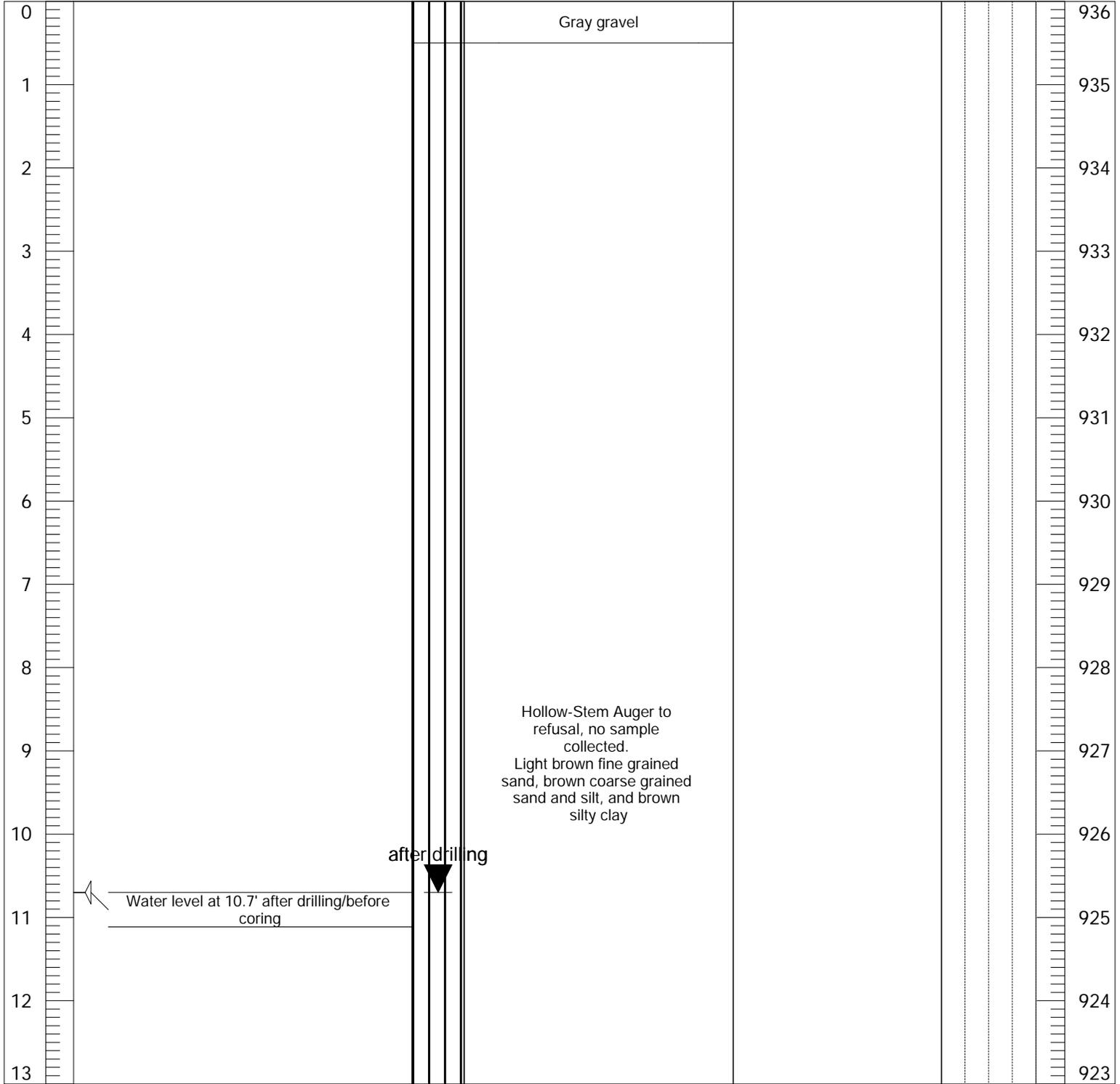


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/3/2016 Completed: 11/4/2016
 Time Started: 2:02 PM Completed: 10:30 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-07

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29234.8
 Easting: 57760.81
 Ground Elevation: 936

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

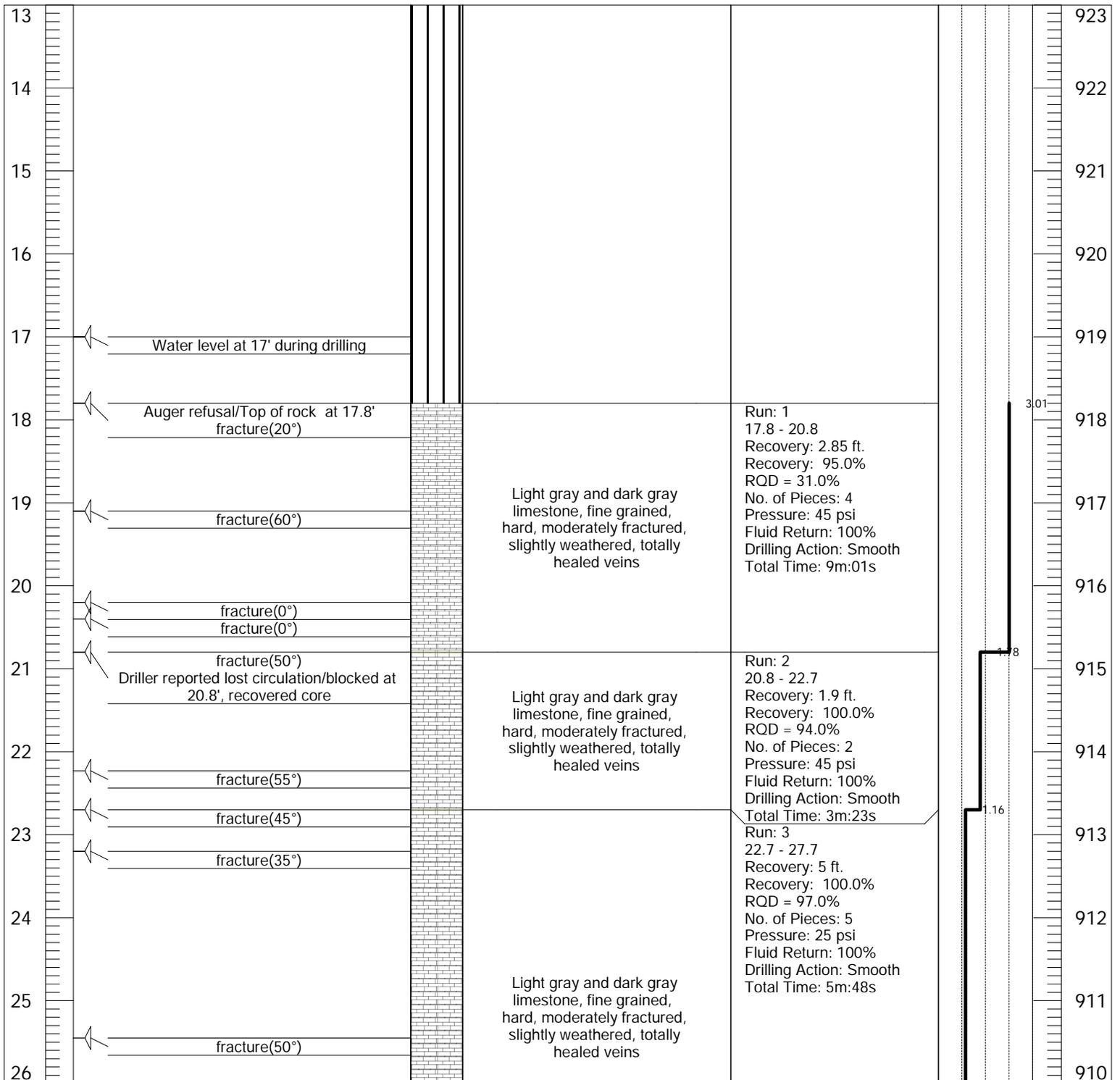


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/3/2016 Completed: 11/4/2016
 Time Started: 2:02 PM Completed: 10:30 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-07

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29234.8
 Easting: 57760.81
 Ground Elevation: 936

Notes:
 Backfilled with grout using tremie method

Legend

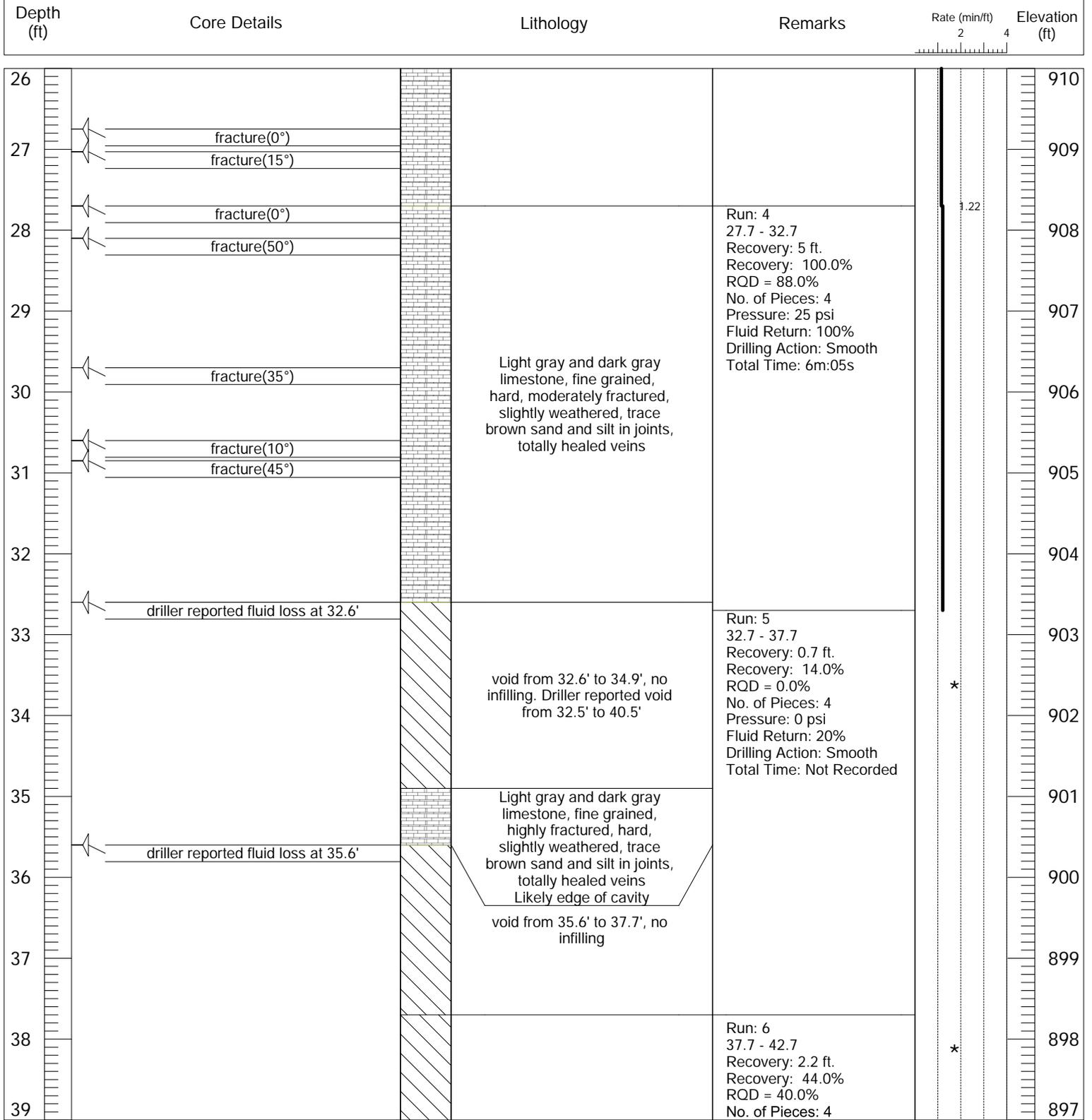
	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/3/2016 Completed: 11/4/2016
 Time Started: 2:02 PM Completed: 10:30 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-07

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 61°F



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29234.8
 Easting: 57760.81
 Ground Elevation: 936

Notes:
 Backfilled with grout using tremie method
 Page 3 of 5

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/3/2016 Completed: 11/4/2016
 Time Started: 2:02 PM Completed: 10:30 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-07

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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39		void from 37.7' to 40.5', no infilling	Pressure: 15 psi Fluid Return: 10% Drilling Action: Smooth Total Time: Not Recorded		897
40	fracture(40°)				896
41		Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins, trace calcite and/or dolomite in joints			895
42					894
43	fracture(0°) some soft gray clay at open joint		Run: 7 42.7 - 45.2 Recovery: 2.5 ft. Recovery: 100.0% RQD = 45.0% No. of Pieces: 7 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m:47s +	*	893
44	fracture(30°)	Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, slightly weathered, totally healed veins			892
45	fracture(15°) Intensely fractured rock at open joint Driller reported fluid loss at 45' Driller reported lost circulation/blocked at 45.2', recovered core	void from 44.95' to 45.2', some intensely fractured rock, no infilling. Driller reported void from 45.2' to 46.1'	Run: 8 45.2 - 47.7 Recovery: 1.55 ft. Recovery: 62.0% RQD = 32.0% No. of Pieces: 1 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 4m:17s +		891
46	fracture(0°)	void from 45.2' to 46.1', some intensely fractured rock, no infilling. Driller reported void from 45.2' to 46.1'			890
47					889
48	fracture(0°)		Run: 9 47.7 - 51.85 Recovery: 4.15 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 9m:02s	1.71	888
49	fracture(15°)	Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, totally healed veins, slightly weathered			887
50	fracture(0°)				886
51	fracture(20°)				885
52				2.18	884

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29234.8
 Easting: 57760.81
 Ground Elevation: 936

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/3/2016 Completed: 11/4/2016
 Time Started: 2:02 PM Completed: 10:30 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-07

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 61°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(10°)	Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, totally healed veins, slightly weathered	Run: 10 51.85 - 52.7 Recovery: 0.85 ft. Recovery: 100.0% ROD = 0.0% No. of Pieces: 1 Pressure: 0 psi Fluid Return: 0% Drilling Action: Smooth Total Time: Not Recorded	*	884
53	fracture(25°)				883
54	fracture(15°)				882
55		Light gray and dark gray limestone and dolostone, fine grained, hard, slightly to moderately fractured, slightly weathered, totally healed veins	Run: 11 52.7 - 57.7 Recovery: 5 ft. Recovery: 100.0% ROD = 0.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:22s		881
56	fracture(20°)				880
57					879
58	fracture(0°) fracture(10°) fracture (angle not provided, >0°)	Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins with trace brown silt in joints	Run: 12 57.7 - 62.7 Recovery: 2.35 ft. Recovery: 47.0% ROD = 91.0% No. of Pieces: 3 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 1m:41s+	1.07	878
59	fracture (angle not provided, >0°) Driller reported fluid loss at 59.1'				877
60		void from 59.1' to 60.8', some soft gray clay infilling. Driller reported void from 59.1' to 62.7'		0.337	876

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29234.8
 Easting: 57760.81
 Ground Elevation: 936

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/19/2016
 Time Started: 2:50 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-08

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 73°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft) 2 4	Elevation (ft)
------------	--------------	-----------	---------	----------------------	----------------

0		Gray gravel			935
1					934
2					933
3					932
4					931
5					930
6					929
7					928
8					927
9					926
10		Hollow-Stem Auger to refusal, no sample collected. brown silty clay			925
11					924
12					923
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29268.14
 Easting: 57781.86
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

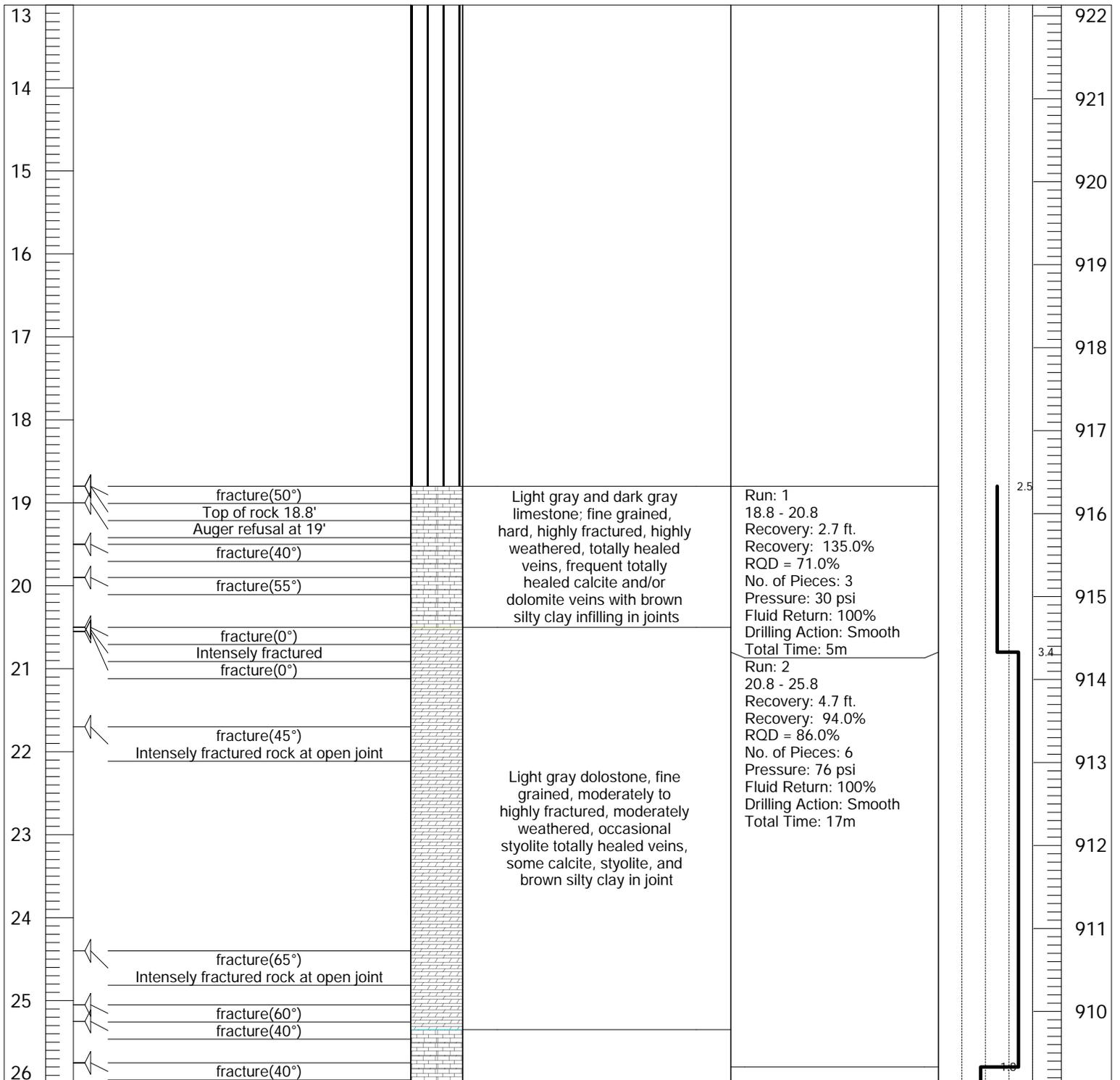


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/19/2016
 Time Started: 2:50 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-08

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 73°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29268.14
 Easting: 57781.86
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/19/2016
 Time Started: 2:50 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-08

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 73°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)			
26	fracture(35°)	Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, moderately weathered, frequently totally healed veins with brown silty clay infilling	Run: 3 25.8 - 30.8 Recovery: 5.1 ft. Recovery: 102.0% RQD = 96.0% No. of Pieces: 5 Pressure: 76 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 9m	2	909			
27	fracture(20°)				908			
28	fracture(15°)				907			
29	fracture(15°)				906			
30	fracture(50°)				905			
31	driller reported fluid loss at 30.6'				void from 30.4' to 30.8', no infilling. Driller reported void from 30.6' to 30.8'	Run: 4 30.8 - 35.8 Recovery: 4.6 ft. Recovery: 92.0% RQD = 85.0% No. of Pieces: 10 Pressure: 60 psi Fluid Return: 90% On run #4, return drilling fluid was clean, despite drilling mud being used for drilling. Drilling Action: Smooth Total Time: 11m	2.2	904
32	fracture(15°)				Dark gray and light gray limestone and dolostone, fine grained, hard, moderately to highly fractured, moderately weathered, frequently totally healed stylolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints	On run #4, return drilling fluid was clean, despite drilling mud being used for drilling. Drilling Action: Smooth Total Time: 11m	2	903
33	fracture(20°)							902
34	fracture(45°)							901
34	fracture(45°)							901
34	fracture(0°)	901						
34	fracture(50°)	901						
35	fracture(25°)	900						
35	fracture(0°)	900						
36	fracture(30°)	Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, moderately weathered, frequently totally healed stylolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints	Run: 5 35.8 - 40.8 Recovery: 4.9 ft. Recovery: 98.0% RQD = 82.0% No. of Pieces: 2 Pressure: 42 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 10m	2				899
36	fracture(60°)							899
37	moderately fractured				898			
37	fracture(15°)				898			
38	moderately fractured	Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, moderately weathered, frequently totally healed stylolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints	Run: 5 35.8 - 40.8 Recovery: 4.9 ft. Recovery: 98.0% RQD = 82.0% No. of Pieces: 2 Pressure: 42 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 10m	2	897			
38	fracture(45°)				897			
39								

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29268.14
 Easting: 57781.86
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/19/2016
 Time Started: 2:50 PM Completed: 8:54 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-08

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 73°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(40°)				896
40	fracture(45°)				895
41			Run: 6 40.8 - 45.8 Recovery: 5.3 ft. Recovery: 106.0% RQD = 104.0% No. of Pieces: 2 Pressure: 20 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 7m	1.4	894
42		Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, moderately weathered, frequently totally healed stylolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints			893
43					892
44					891
45	fracture(0°) Highly fractured fracture(0°)				890
46			Run: 7 45.8 - 50.8 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 3 Pressure: 20 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 7m		889
47		Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, moderately weathered, frequently totally healed stylolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints			888
48					887
49		End of boring recovery a			886
50					885
51				1.4	884
52					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29268.14
 Easting: 57781.86
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/7/2016
 Time Started: 3:50 PM Completed: 12:10 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-09

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
0		Gray gravel			935
1					934
2					933
3					932
4					931
5					930
6					929
7					928
8					927
9					926
10					925
11			Hollow-Stem Auger to refusal, no sample collected. Brown sandy silt and brown silty clay		924
12					923
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29233.02
 Easting: 57800.42
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

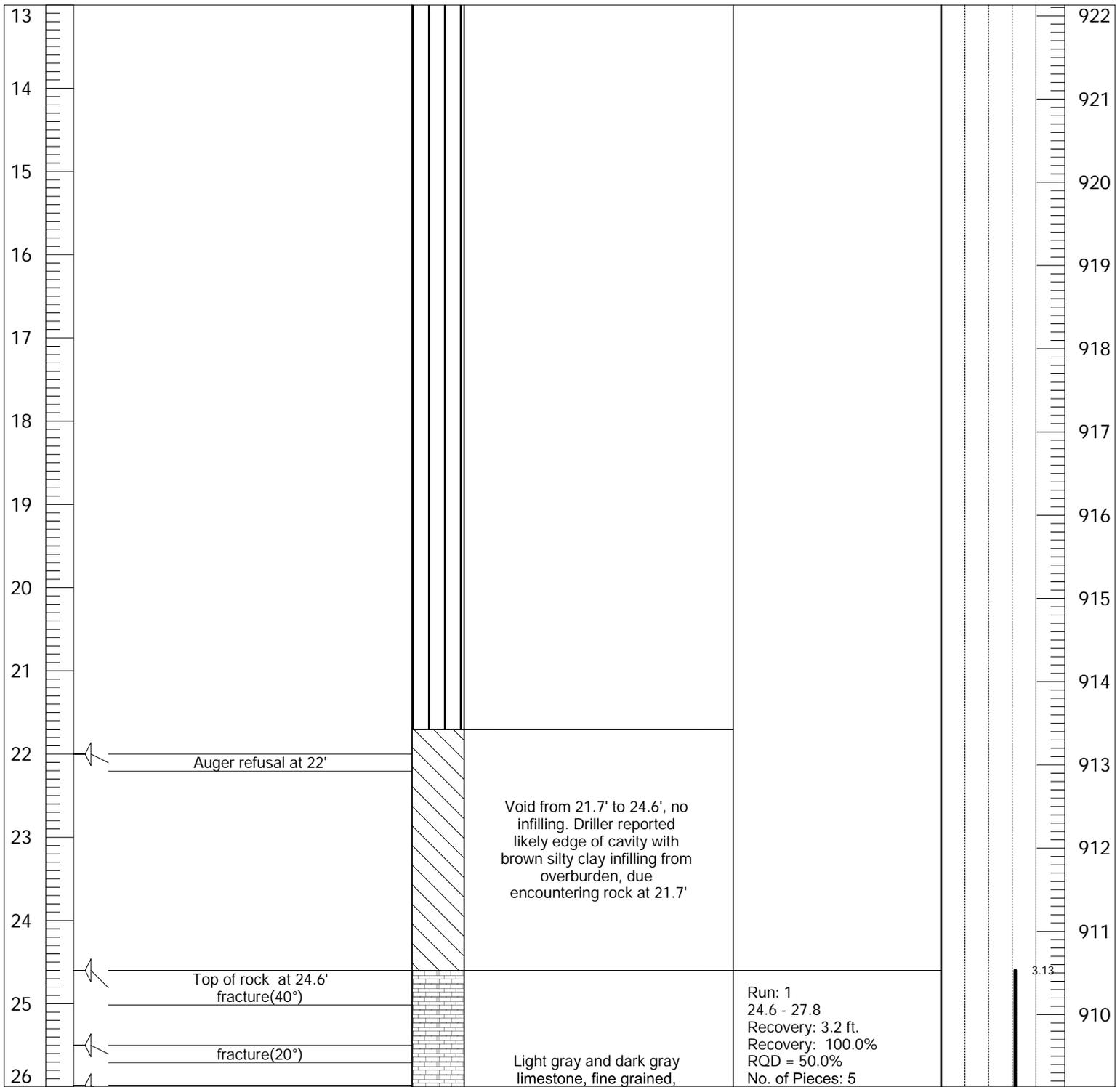


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/7/2016
 Time Started: 3:50 PM Completed: 12:10 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-09

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29233.02
 Easting: 57800.42
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/7/2016
 Time Started: 3:50 PM Completed: 12:10 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-09

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(0°)	hard, moderately fractured, slightly weathered, trace calcite and/or dolomite in joints, totally healed veins	Pressure: 15 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 10m	2	909
27	fracture(45°) Intensely fractured fracture(21°)				908
28	fracture(30°)	Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, slightly weathered, trace calcite and/or dolomite in joints, totally healed veins	Run: 2 27.8 - 32.8 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 5 Pressure: 75 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 16m:12s	3.24	907
29	fracture(15°)				906
30	fracture(15°)				905
31	fracture(15°) Open joint				904
32	Slightly fractured fracture(0°)				903
33		Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, slightly weathered, trace calcite and/or dolomite in joints, occasional moderately healed veins, totally healed veins	Run: 3 32.8 - 37.8 Recovery: 5 ft. Recovery: 100.0% RQD = 78.0% No. of Pieces: 5 Pressure: 25 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 11m:37s	3.32	902
34					901
35		void from 36.2' to 37.3', some intensely fractured rock, no infilling. Driller reported mud seam			900
36	fracture(25°) Brown silty clay infilling				899
37					898
38					897
39			Run: 4 37.8 - 42.8 Recovery: 4.29 ft. Recovery: 85.8% RQD = 78.0%	2.2	897

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29233.02
 Easting: 57800.42
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method
 Page 3 of 5

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/7/2016
 Time Started: 3:50 PM Completed: 12:10 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-09

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(65°) brown and reddish brown silty clay infilling at open joint	Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown and reddish brown silty clay, and calcite and/or dolomite in joints, occasional moderately healed veins	No. of Pieces: 7 Pressure: 50 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m:01s +	2	896
40					895
41	fracture(75°) brown and reddish brown, silty clay infilling, slightly weathered, highly fractured	Light gray and dark gray limestone, fine grained, hard, moderately to slightly fractured, slightly weathered, trace brown and reddish brown silty clay, and calcite and/or dolomite in joints, totally healed veins	Run: 5 42.8 - 47.8 Recovery: 2.95 ft. Recovery: 59.0% ROD = 58.0% No. of Pieces: 2 Pressure: 45 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:15s +	4	894
42	fracture(15°) Open joint Highly fractured fracture(0°)				893
43	fracture(45°)				892
44	fracture(0°) Moderately weathered	void from 45.7' to 47', no infilling. Driller reported void from 45.7' to 46.2', and 46.6' to 47.2', likely lost core piece	Run: 6 47.8 - 52.8 Recovery: 3.85 ft. Recovery: 77.0% ROD = 74.0% No. of Pieces: 3 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:54s +	1.45	891
45					890
46		void from 47' to 49', no infilling. Driller reported void from 47.2' to 48.7'		1.78	889
47					888
48	fracture(30°)	Light gray and dark gray limestone, fine grained, hard, slightly to highly fractured, slightly weathered, trace brown silty clay, brown sand, and calcite and/or dolomite in joints, totally healed veins Core coated in gray silty clay			887
49					886
50					885
51					884
52	fracture(37°)				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29233.02
 Easting: 57800.42
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/7/2016
 Time Started: 3:50 PM Completed: 12:10 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-09

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 70°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace brown silty clay, brown sand, and calcite and/or dolomite in joints, totally healed veins	Run: 7 52.8 - 57.8 Recovery: 5 ft. Recovery: 100.0% RQD = 52.0% No. of Pieces: 6 Pressure: 45 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:18s +	2	883
53	fracture(0°)				882
54	fracture(50°)				881
55	fracture(20°)				880
56	fracture(37°) Driller reported lost circulation/blocked at 55.8', recovered core fracture(0°) fracture(0°)	void from 55.9' to 57.4', no infilling		4	879
57	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, highly fractured, slightly weathered, trace brown silty clay, brown sand, calcite and/or dolomite in joints, totally healed veins End of boring recovery at 60.1'	Run: 8 57.8 - 60.2 Recovery: 2.3 ft. Recovery: 95.8% RQD = 82.0% No. of Pieces: 2 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 25m	4	878
58	Intensely fractured fracture(55°) fracture(20°) Open joint				877
59					876
60					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29233.02
 Easting: 57800.42
 Ground Elevation: 935.13

Notes:
 Backfilled with grout using tremie method
 Page 5 of 5

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/5/2016
 Time Started: 8:00 AM Completed: 2:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-10

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
0		Gray gravel			935
1					934
2					933
3					932
4					931
5					930
6					929
7					928
8					927
9			Hollow-Stem Auger to refusal, no sample collected. Brown sandy silt and brown silty clay		926
10					925
11					924
12					923
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29244.02
 Easting: 57820.75
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

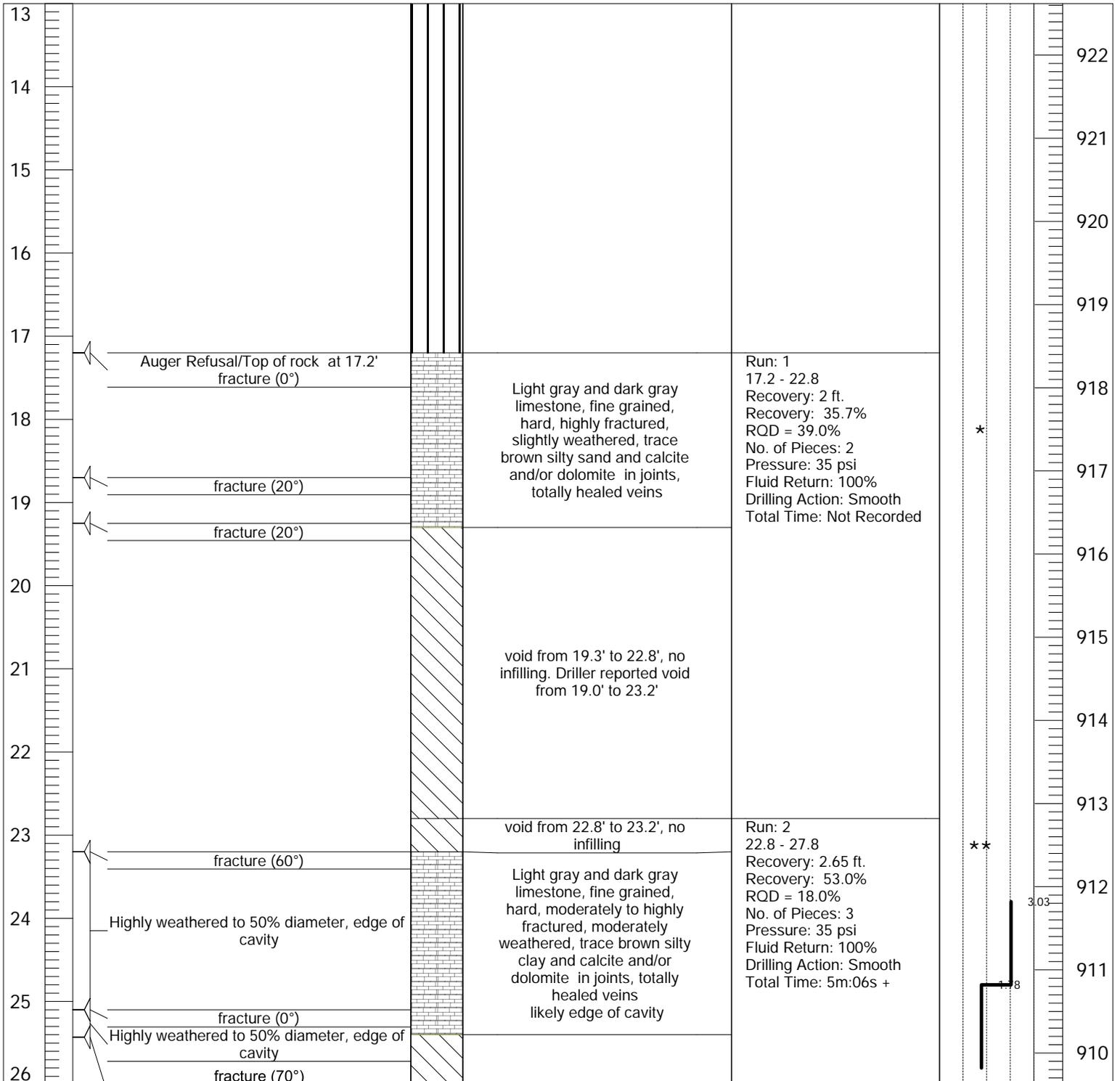


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/5/2016
 Time Started: 8:00 AM Completed: 2:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-10

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29244.02
 Easting: 57820.75
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

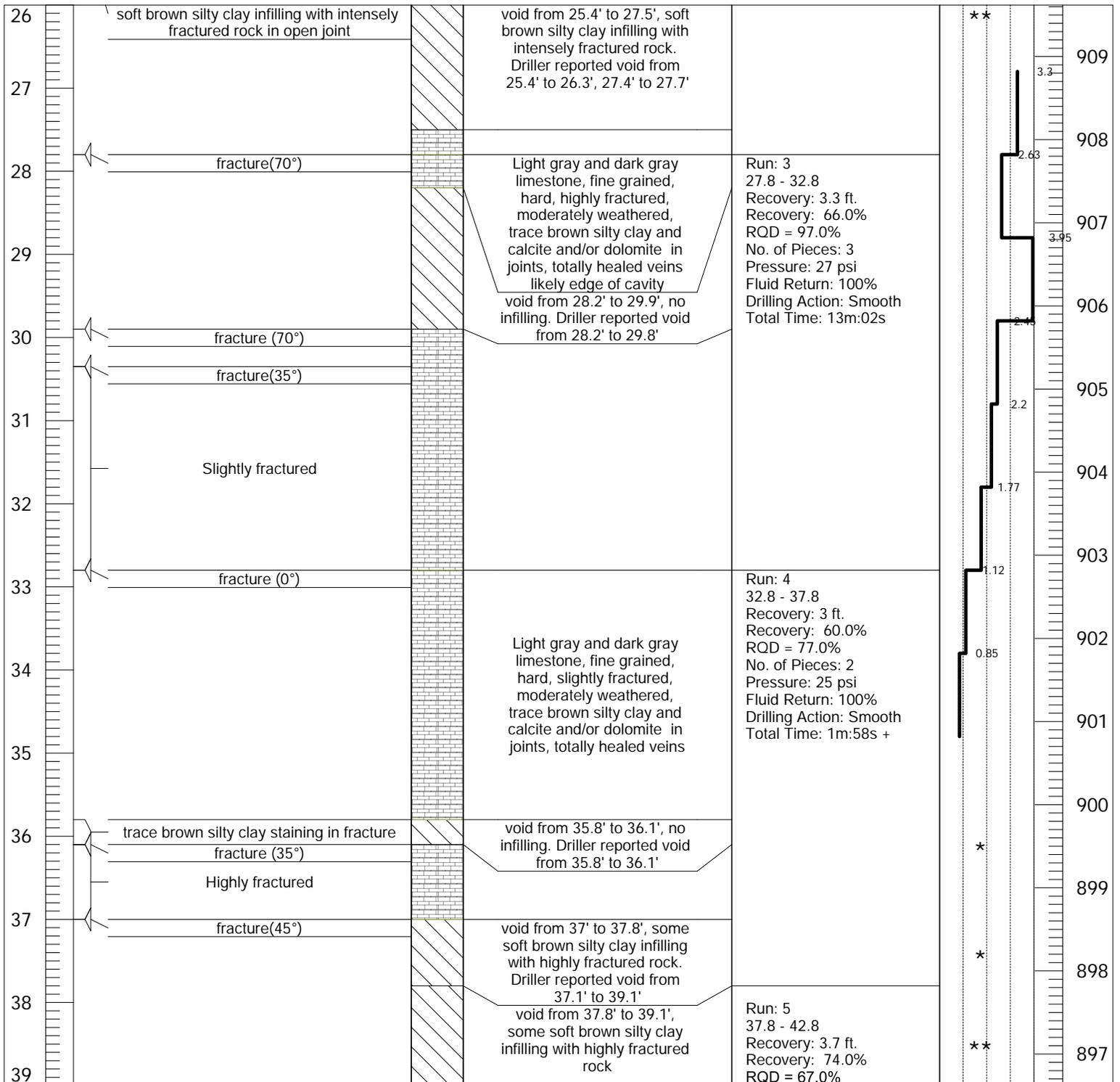


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/5/2016
 Time Started: 8:00 AM Completed: 2:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-10

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29244.02
 Easting: 57820.75
 Ground Elevation: 935.62

Notes:

Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/5/2016
 Time Started: 8:00 AM Completed: 2:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-10

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

39	fracture(45°) soft brown silty clay infilling with highly fractured rock at open joint	Light gray and dark gray limestone, fine grained, hard, slightly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins	No. of Pieces: 4 Pressure: 25 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 4m:06s +	1.4	896
40					895
41				1.37	894
42				1.3	893
43	fracture (0°)	Light gray and dark gray limestone, fine grained, hard, moderately to slightly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins	Run: 6 42.8 - 47.8 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 2 Pressure: 25 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 6m:36s +	1.75	892
44	fracture (30°) trace brown silt in fracture				891
45					890
46				1.57	889
47					888
48		Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins	Run: 7 47.8 - 52.8 Recovery: 5 ft. Recovery: 100.0% RQD = 87.0% No. of Pieces: 7 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:36s +	1.67	887
49	Driller reported fluid loss at 48.7' at highly weathered section from 48.7' to 48.8' fracture(35°)				886
50	fracture(40°) fracture(40°)				885
51					884
52				1.22	

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29244.02
 Easting: 57820.75
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/5/2016 Completed: 11/5/2016
 Time Started: 8:00 AM Completed: 2:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-10

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins	Run: 8 52.8 - 55.8 Recovery: 3 ft. Recovery: 100.0% RQD = 72.0% No. of Pieces: 10+ Pressure: 25 psi Fluid Return: 50% Drilling Action: Smooth Total Time: Not Recorded	2	883
53	Moderately weathered rock with trace brown silt at open joint fracture(0°)				
54					882
55	fracture(45°) Highly fractured rock	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace gray clay and calcite and/or dolomite in joints, totally healed veins	Run: 9 55.8 - 57.8 Recovery: 1.5 ft. Recovery: 75.0% RQD = 75.0% No. of Pieces: 2 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: Not Recorded	*	881
56	fracture (55°) Driller reported lost circulation/blocked at 55.8', recovered core				
57	fracture (45°)	Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace gray clay and calcite and/or dolomite in joints, totally healed veins	Run: 10 57.8 - 60 Recovery: 2.1 ft. Recovery: 95.5% RQD = 96.0% No. of Pieces: 8 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: Not Recorded	*	880
58	fracture (55°)				
59	fracture (45°) Intensely fractured rock with gray clay infilling	void from 58.45' to 58.55', some gray clay infilling with intensely fractured rock End of boring recovery at 60'		*	879
	fracture (45°)				
	fracture (40°)				
60	fracture (45°) Open joint fracture (0°)				878
					877
					876

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29244.02
 Easting: 57820.75
 Ground Elevation: 935.62

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void

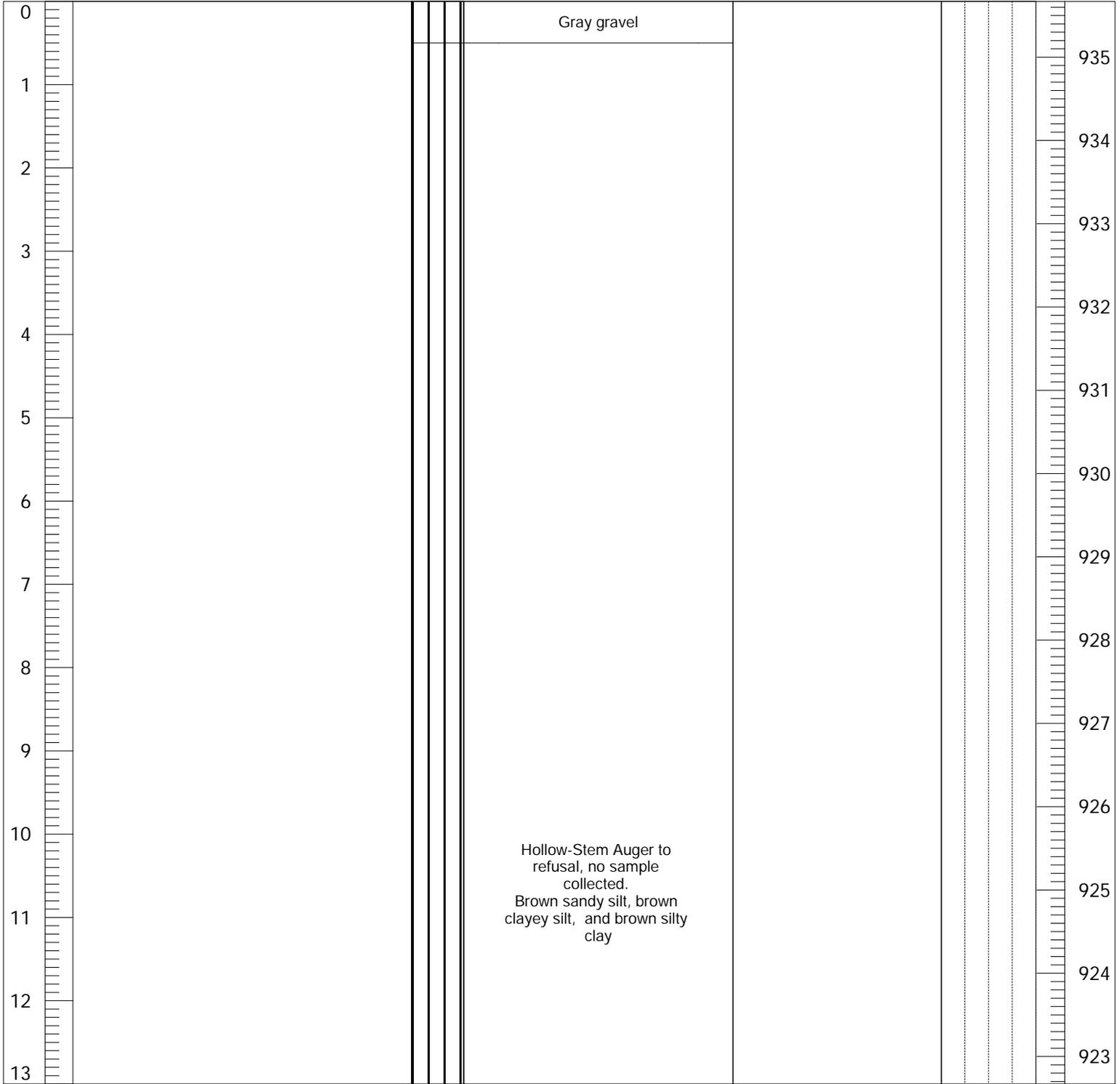


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/4/2016 Completed: 11/4/2016
 Time Started: 10:55 AM Completed: 4:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-11

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 64°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29253.27
 Easting: 57837.22
 Ground Elevation: 935.67

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

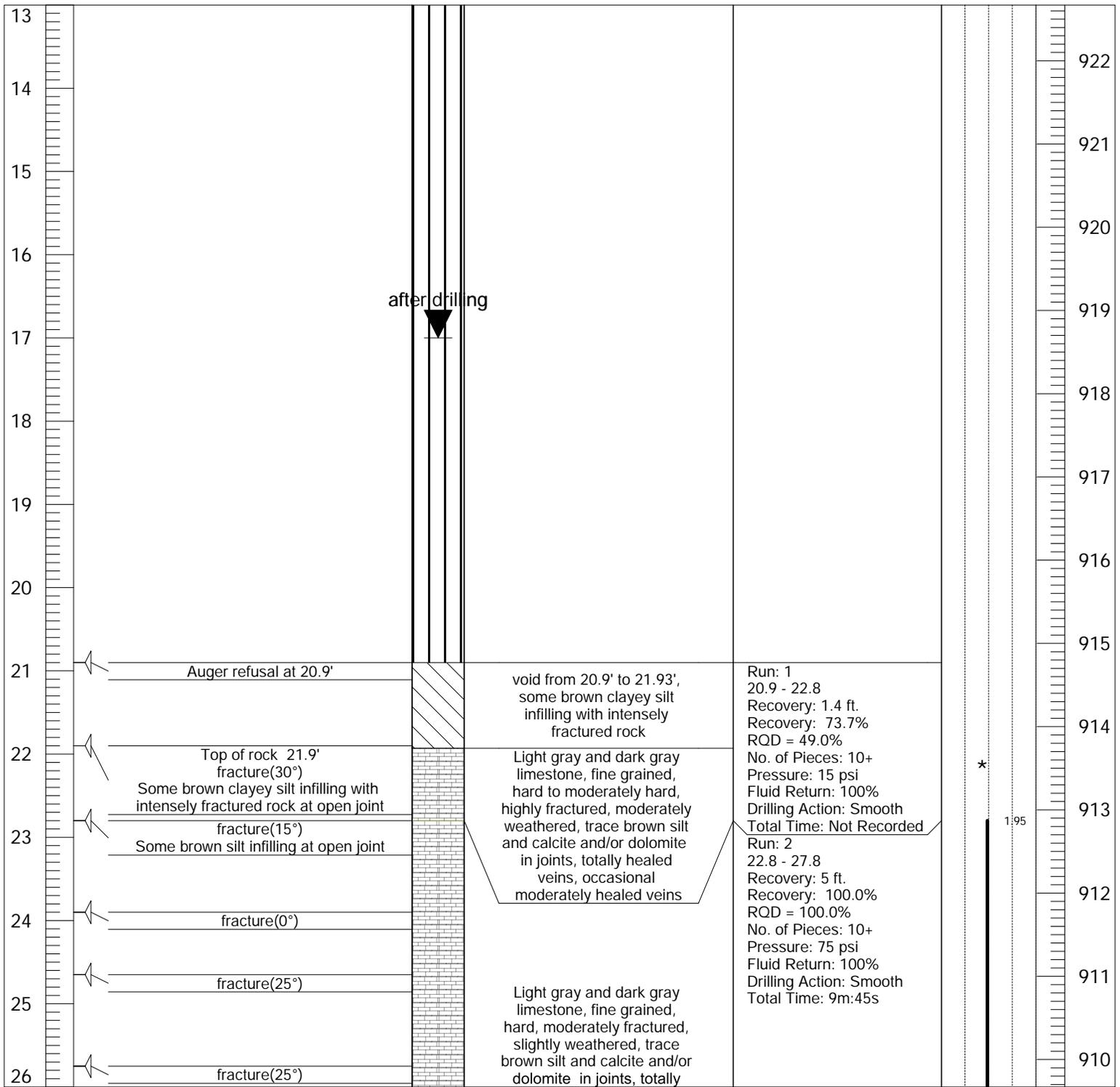


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/4/2016 Completed: 11/4/2016
 Time Started: 10:55 AM Completed: 4:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-11

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 64°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29253.27
 Easting: 57837.22
 Ground Elevation: 935.67

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolomite
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/4/2016 Completed: 11/4/2016
 Time Started: 10:55 AM Completed: 4:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-11

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 64°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26		healed veins			909
27					908
28	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins	Run: 3 27.8 - 32.8 Recovery: 5 ft. Recovery: 100.0% RQD = 87.0% No. of Pieces: 5 Pressure: 65 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 10m:7s	2.02	907
29	fracture(35°)				906
30	fracture(0°)				905
31					904
32					903
33	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins	Run: 4 32.8 - 37.8 Recovery: 5 ft. Recovery: 100.0% RQD = 96.0% No. of Pieces: 5 Pressure: 50 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 5m:28s	1.09	902
34	fracture(45°)				901
35	fracture(30°)				900
36					899
37	fracture(0°)	Moderately weathered rock with some calcite and/or dolomite and trace brown silt at open joint	Run: 5 37.8 - 42.8 Recovery: 5 ft. Recovery: 100.0% RQD = 87.0%	1.12	898
38	fracture(70°)				897
39	Moderately weathered rock with trace calcite and/or dolomite and brown silt at open joint				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29253.27
 Easting: 57837.22
 Ground Elevation: 935.67

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/4/2016 Completed: 11/4/2016
 Time Started: 10:55 AM Completed: 4:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-11

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 64°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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39	fracture(70°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins, occasional partly healed veins	No. of Pieces: 7 Pressure: 25 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 5m:33s	2	896	
40	fracture(20°)					895
41	fracture(0°)					894
42		Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins	Run: 6 42.8 - 47.8 Recovery: 5 ft. Recovery: 100.0% RQD = 85.0% No. of Pieces: 10+ Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: Not Recorded	*	893	
43	fracture(30°)					892
44	fracture(40°)					891
45	fracture(75°) fracture(0°) fracture(45°) Open joint					890
46	fracture(45°)	Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins	Run: 7 47.8 - 52.8 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 3 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:45s	1.15	889	
47	fracture(25°)					888
48	fracture(20°)					887
49		Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins			886	
50						885
51	fracture(40°)					884
52						

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29253.27
 Easting: 57837.22
 Ground Elevation: 935.67

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/4/2016 Completed: 11/4/2016
 Time Started: 10:55 AM Completed: 4:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-11

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 64°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(30°)	Light gray and dark gray limestone, fine grained, hard, slightly to highly fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins	Run: 8 52.8 - 57.8 Recovery: 5 ft. Recovery: 100.0% RQD = 93.0% No. of Pieces: 4 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 4m:49s	0.963	883
53	fracture(0°)				882
54					881
55					880
56	fracture(55°) Some brown sand infilling				879
57	fracture(45°) Slightly fractured				878
58	fracture(0°) fracture(0°)				877
59	fracture(30°) Open joint				876
60	fracture(0°)				
					Light gray and dark gray limestone, fine grained, hard, highly to moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins End of boring recovery at 60.3'

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29253.27
 Easting: 57837.22
 Ground Elevation: 935.67

Notes:
 Backfilled with grout using tremie method
 Page 5 of 5

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/19/2016 Completed: 11/19/2016
 Time Started: 10:30 AM Completed: 3:00 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-12

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
0		Gray gravel			935
1					934
2					933
3					932
4					931
5					930
6					929
7					928
8					927
9					926
10					925
11					924
12					923
13		Hollow-Stem Auger to			

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29211.79
 Easting: 57854.71
 Ground Elevation: 935.7

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/19/2016 Completed: 11/19/2016
 Time Started: 10:30 AM Completed: 3:00 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-12

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

13		refusal, no sample collected. Brown sandy silt, brown clayey silt, and brown silty clay			922
14					921
15					920
16					919
17					918
18					917
19					916
20					915
21					914
22					913
23					912
24					911
25					910
26					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29211.79
 Easting: 57854.71
 Ground Elevation: 935.7

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/19/2016 Completed: 11/19/2016
 Time Started: 10:30 AM Completed: 3:00 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-12

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Cloudy 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	Top of rock 26.3' fracture(45°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, some calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins	Run: 1 26.3 - 28.3 Recovery: 2 ft. Recovery: 100.0% ROD = 90.0% No. of Pieces: 3 Pressure: 60 psi Fluid Return: 80% Drilling Action: Smooth Total Time: 9m	2	909
27	driller reported fluid loss at 26.3' fracture(0°) Auger refusal at 27' fracture(0°)				
28	fracture(35°) Driller reported lost circulation/blocked at 28.3', recovered core	Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins	Run: 2 28.3 - 30.7 Recovery: 2.3 ft. Recovery: 95.8% ROD = 100.0% No. of Pieces: 3 Pressure: 20 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 7m	4	907
29	fracture(30°)				
30	fracture(25°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins	Run: 3 30.7 - 35.7 Recovery: 4.6 ft. Recovery: 92.0% ROD = 65.8% No. of Pieces: 7 Pressure: 40 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m	2.92	905
31	fracture(0°) Highly fractured, highly weathered fracture(45°)				
32	fracture(0°)	void from 33.8' to 34.6', no infilling. Driller reported void from 34.3' to 34.5'			903
33	fracture(15°) Highly fractured driller reported fluid loss at 33.8'				
34	fracture(45°) Highly fractured	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins	Run: 4 35.7 - 40.7 Recovery: 5.2 ft. Recovery: 104.0% ROD = 100.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m	2.2	901
35	fracture(0°) fracture(0°) fracture(70°) Highly fractured fracture(0°)				
36	fracture(0°)				900
37	fracture(0°)				
38	fracture(0°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins			899
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29211.79
 Easting: 57854.71
 Ground Elevation: 935.7

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/19/2016 Completed: 11/19/2016
 Time Started: 10:30 AM Completed: 3:00 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-12

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39		healed veins			896
40	fracture(20°) Highly fractured				895
41	fracture(30°)		Run: 5 40.7 - 45.7 Recovery: 5 ft. Recovery: 100.0% RQD = 94.0% No. of Pieces: 5 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:52s	2.2	894
42	fracture(40°)	Light gray and dark gray limestone, fine grained, hard, moderately fractured, highly weathered, frequent moderately healed veins with brown silty clay, occasional totally healed calcite and/or dolomite veins, totally healed veins			893
43					892
44	fracture(0°)				891
45					890
46	fracture(30°) Highly fractured, highly weathered fracture(0°)		Run: 6 45.7 - 50.7 Recovery: 5 ft. Recovery: 100.0% RQD = 92.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m	1.57	889
47	highly weathered from 1" to 2.87" diameter, edge of cavity	Light gray and dark gray limestone, fine grained, hard, moderately fractured, highly weathered, trace brown silty clay in joints, some calcite and/or dolomite in joints			888
48	fracture(35°) fracture(60°)				887
49					886
50	fracture(30°)				885
51	fracture(0°) Highly fractured fracture(40°)		Run: 7 50.7 - 55.7 Recovery: 5 ft. Recovery: 100.0% RQD = 85.0% No. of Pieces: 9	1.4	884
52					884

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29211.79
 Easting: 57854.71
 Ground Elevation: 935.7

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/19/2016 Completed: 11/19/2016
 Time Started: 10:30 AM Completed: 3:00 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-12

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)				
52	fracture(30°)	Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, highly weathered, frequent totally healed calcite and/or dolomite veins, trace brown silty clay in joints, some calcite and/or dolomite in joints	Pressure: 20 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m	2	883				
53	fracture(30°)								
	fracture(20°)								
	fracture(30°)								
54	fracture(40°)								
55	fracture(25°)								
	fracture(40°)								
56	fracture(0°)					Light gray and dark gray limestone, fine grained, hard, moderately fractured, highly weathered, frequent totally healed calcite and/or dolomite veins, trace brown silty clay in joints, some calcite and/or dolomite in joints End of boring recovery at 60.7'	Run: 8 55.7 - 60.7 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 5 Pressure: 20 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m	1.4	880
	fracture(25°)								
57	fracture(15°)								
58									
59	fracture(30°)								
60	fracture(35°)				876				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29211.79
 Easting: 57854.71
 Ground Elevation: 935.7

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/21/2016 Completed: 11/21/2016
 Time Started: 8:50 AM Completed: 2:25 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-14

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Partly Cloudy 30°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft) 2 4	Elevation (ft)
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Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft) 2 4	Elevation (ft)
0		Gray gravel			935
1					934
2					933
3					932
4					931
5					930
6					929
7					928
8					927
9					926
10					925
11					924
12					923
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29209.32
 Easting: 57926.26
 Ground Elevation: 935.75

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

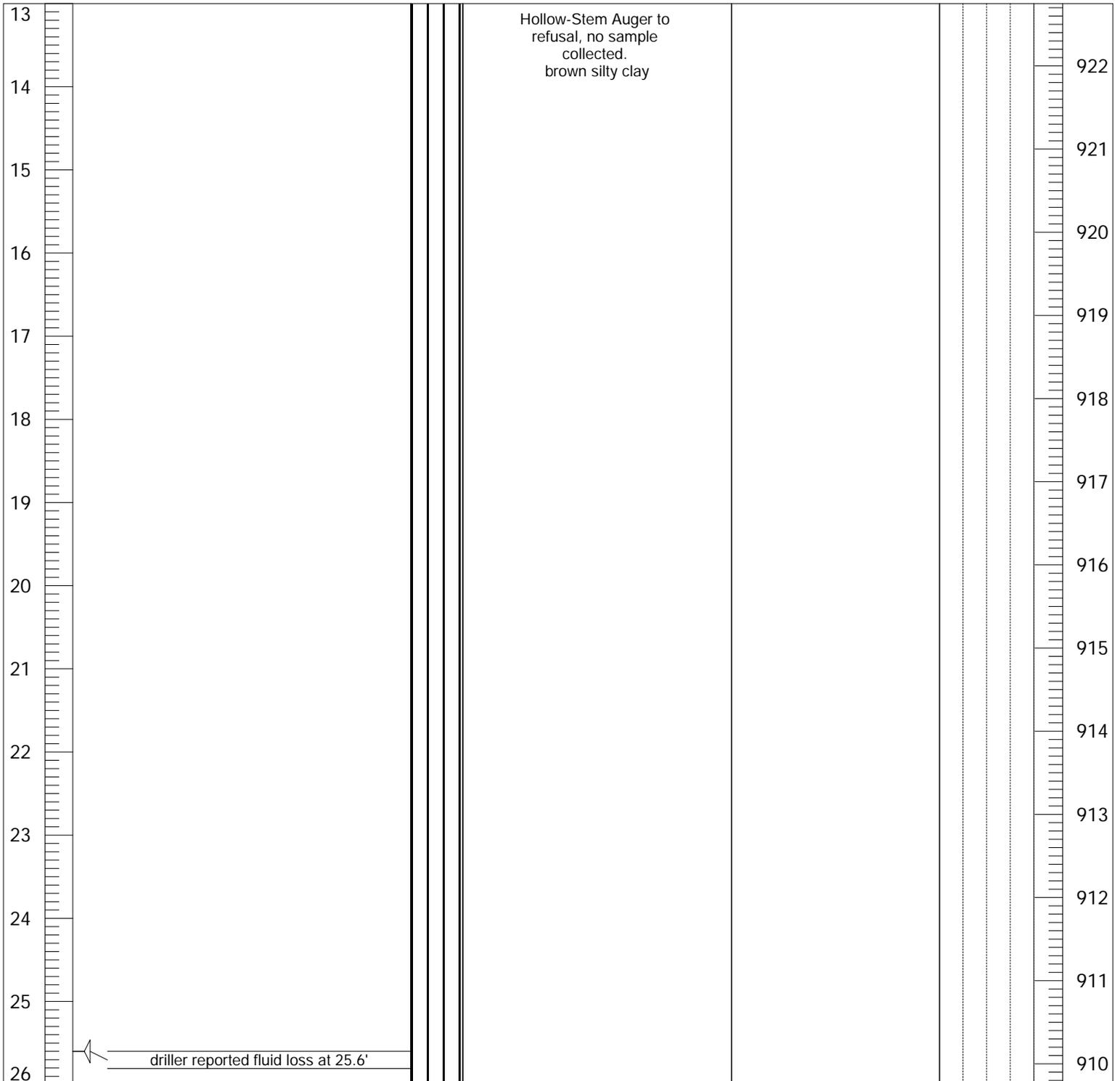


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/21/2016 Completed: 11/21/2016
 Time Started: 8:50 AM Completed: 2:25 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-14

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Partly Cloudy 30°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29209.32
 Easting: 57926.26
 Ground Elevation: 935.75

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

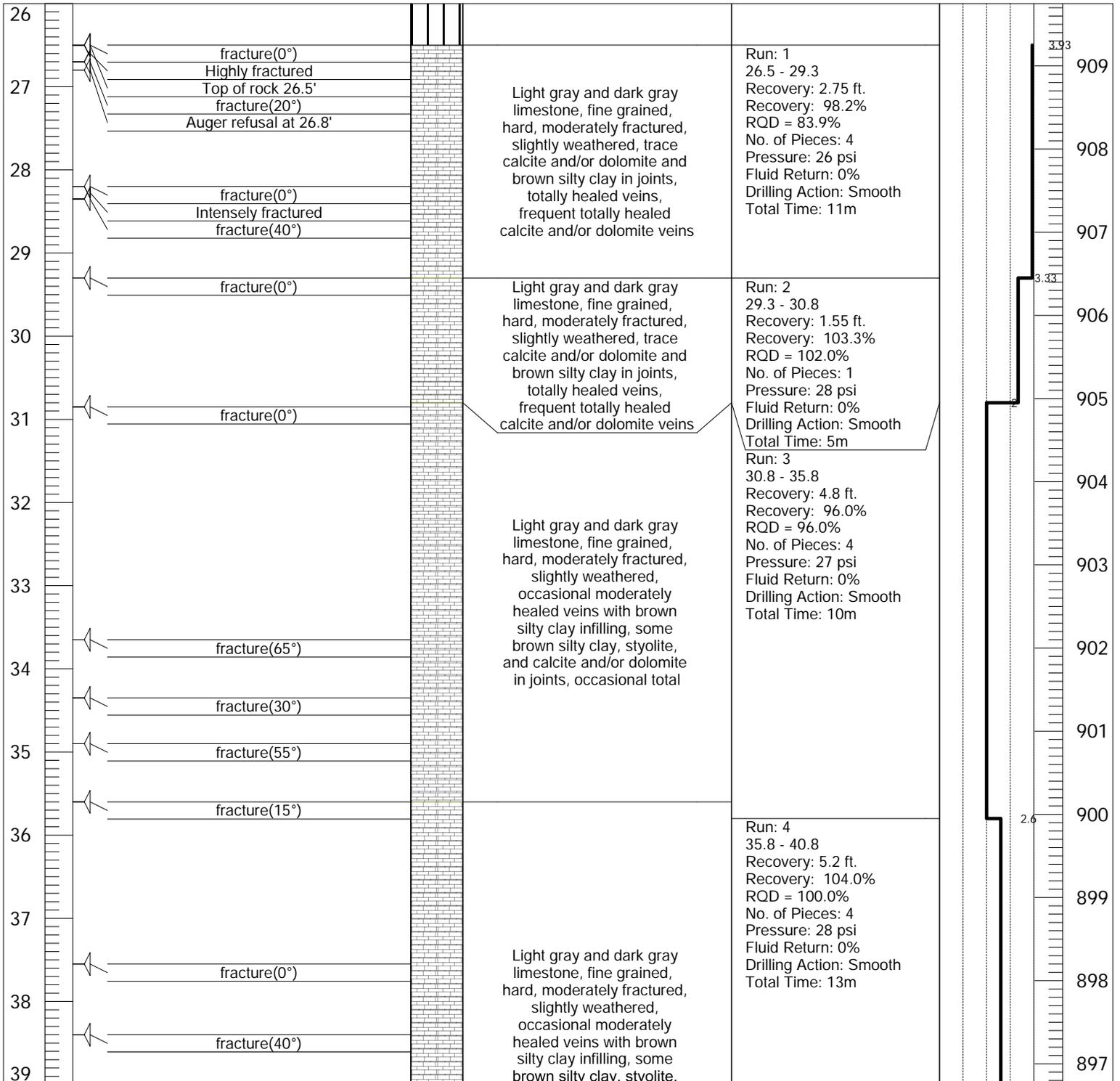


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/21/2016 Completed: 11/21/2016
 Time Started: 8:50 AM Completed: 2:25 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-14

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Partly Cloudy 30°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29209.32
 Easting: 57926.26
 Ground Elevation: 935.75

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

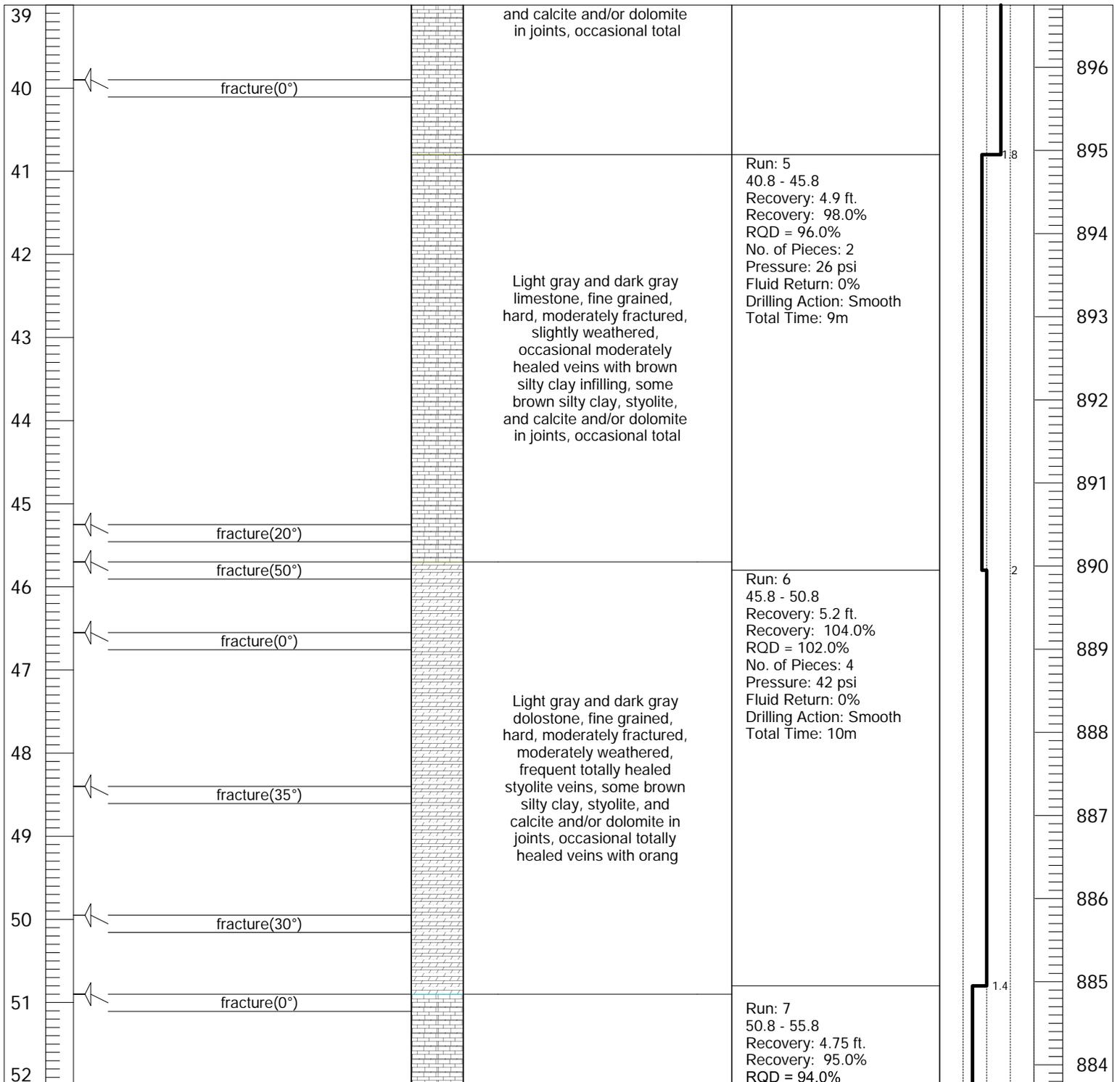


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/21/2016 Completed: 11/21/2016
 Time Started: 8:50 AM Completed: 2:25 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-14

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Partly Cloudy 30°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29209.32
 Easting: 57926.26
 Ground Elevation: 935.75

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

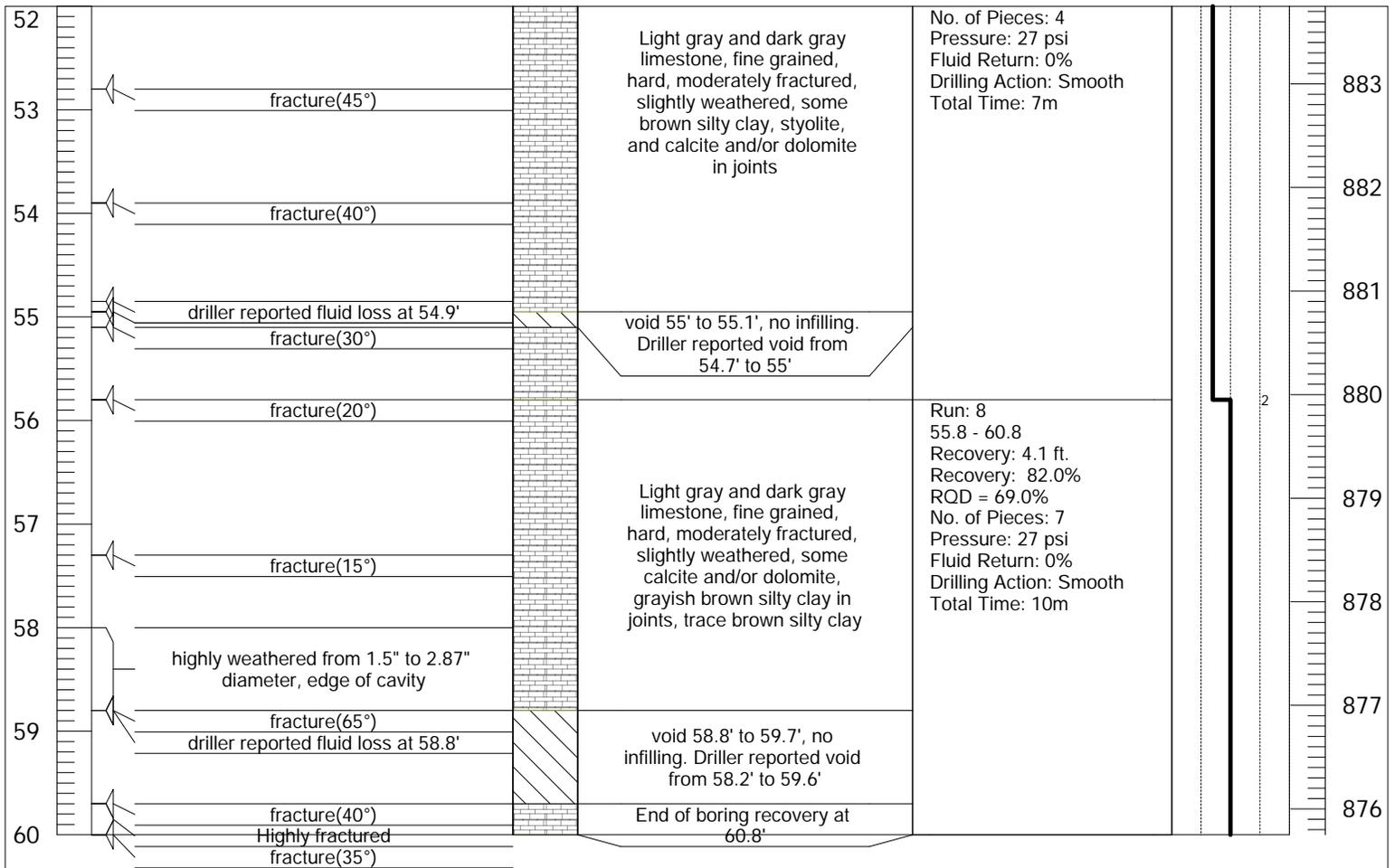


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/21/2016 Completed: 11/21/2016
 Time Started: 8:50 AM Completed: 2:25 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-14

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Partly Cloudy 30°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29209.32
 Easting: 57926.26
 Ground Elevation: 935.75

Notes:
 Backfilled with grout using tremie method
 Page 5 of 5

Legend

	soil		dolostone		limestone
	void				

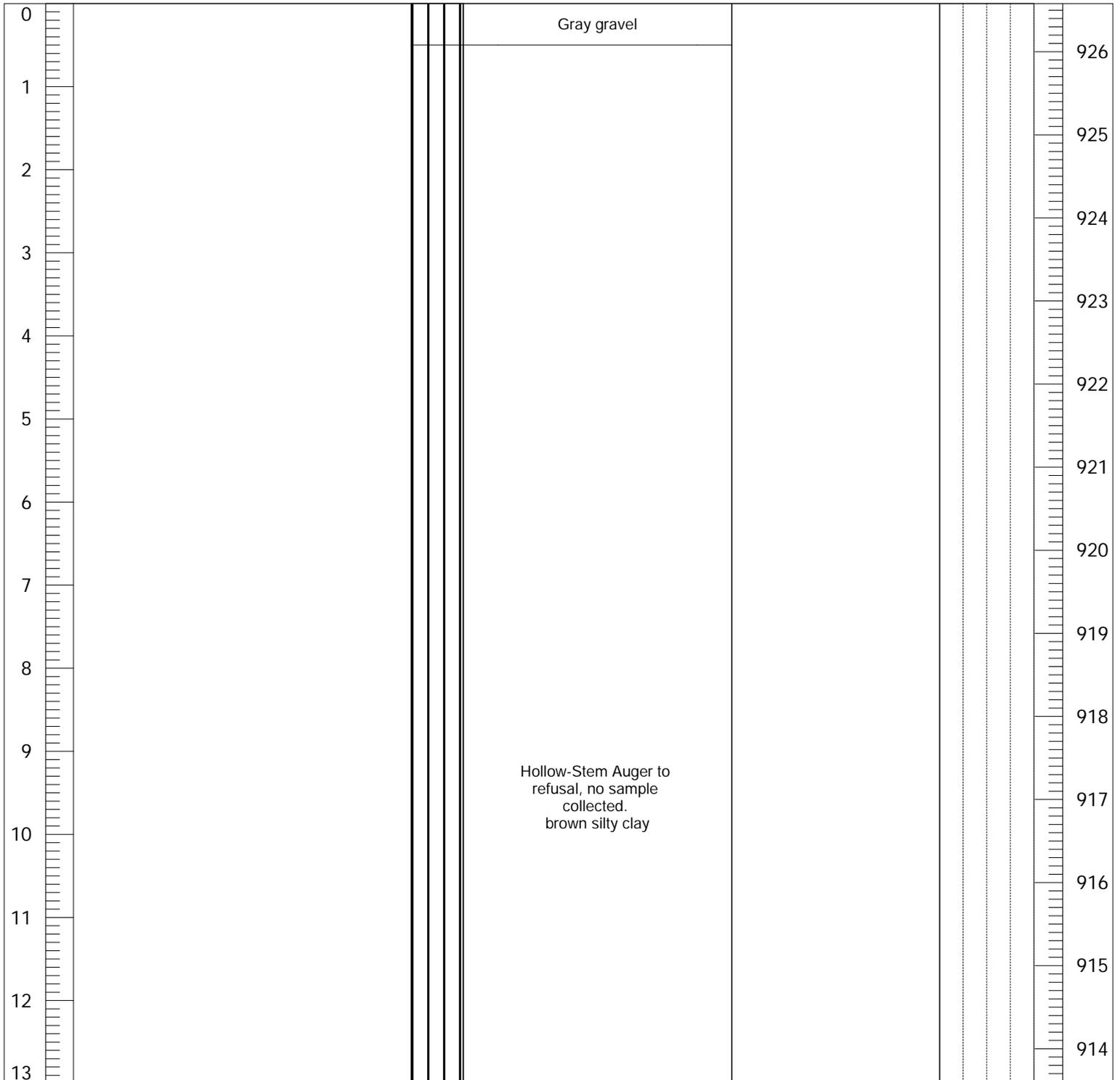


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/18/2016
 Time Started: 7:00 AM Completed: 10:50 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-15

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 43°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

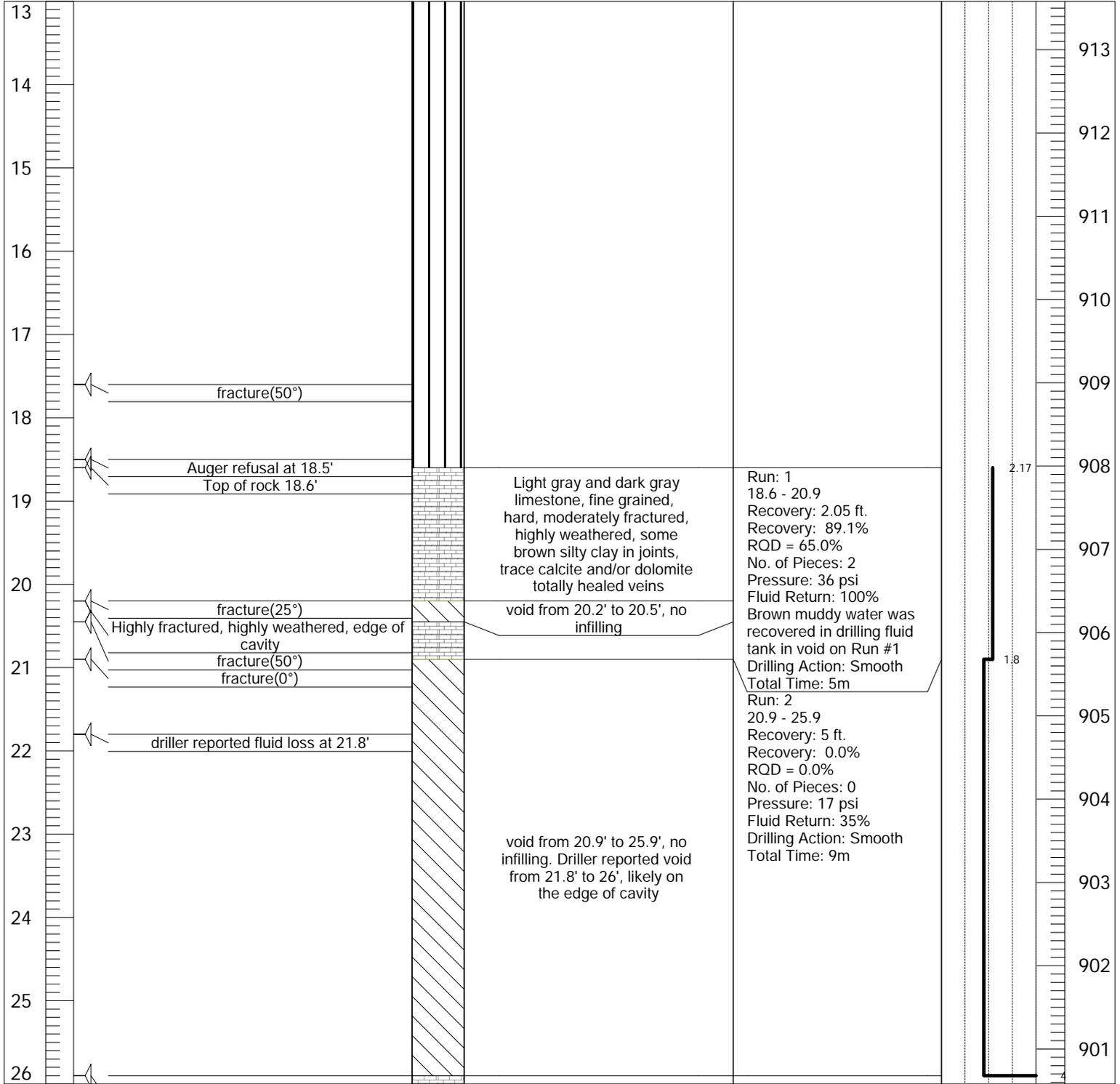


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/18/2016
 Time Started: 7:00 AM Completed: 10:50 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-15

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 43°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/18/2016
 Time Started: 7:00 AM Completed: 10:50 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-15

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 43°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(45°) intensely fractured rock at open joint	Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, occasional totally healed calcite and/or dolomite veins	Run: 2 25.9 - 30.9 Recovery: 5 ft. Recovery: 100.0% RQD = 94.0% No. of Pieces: 7 Pressure: 19 psi Fluid Return: 20% Drilling Action: Smooth Total Time: 24m	2	900
27					899
28					898
29	fracture(40°)				897
30	fracture(50°) Intensely fractured fracture(0°)				896
31	fracture(0°) driller reported fluid loss at 31' fracture(0°) Intensely fractured	void from 30.8' to 30.9'; some intensely fractured rock, no infilling. Driller reported void from 31' to 32.2'	Run: 3 30.9 - 35.9 Recovery: 2.55 ft. Recovery: 51.0% RQD = 33.0% No. of Pieces: 8 Pressure: 22 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 14m		895
32	fracture(60°)	Light gray and dark gray limestone, fine grained, hard, highly fractured, slightly weathered, occasional totally healed calcite and/or dolomite veins			894
33	fracture(15°)				893
34	fracture(60°) Intensely fractured fracture(40°)				892
35	fracture(50°) Intensely fractured driller reported fluid loss at 34.4'				void from 34.4' to 35.9'; no infilling. Driller reported void from 34.4' to 47.1'
36			Run: 4 35.9 - 49.5 Recovery: 1.9 ft. Recovery: 14.0% RQD = 7.0% No. of Pieces: 5 Pressure: 20 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 33m		890
37					889
38					888
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:

Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

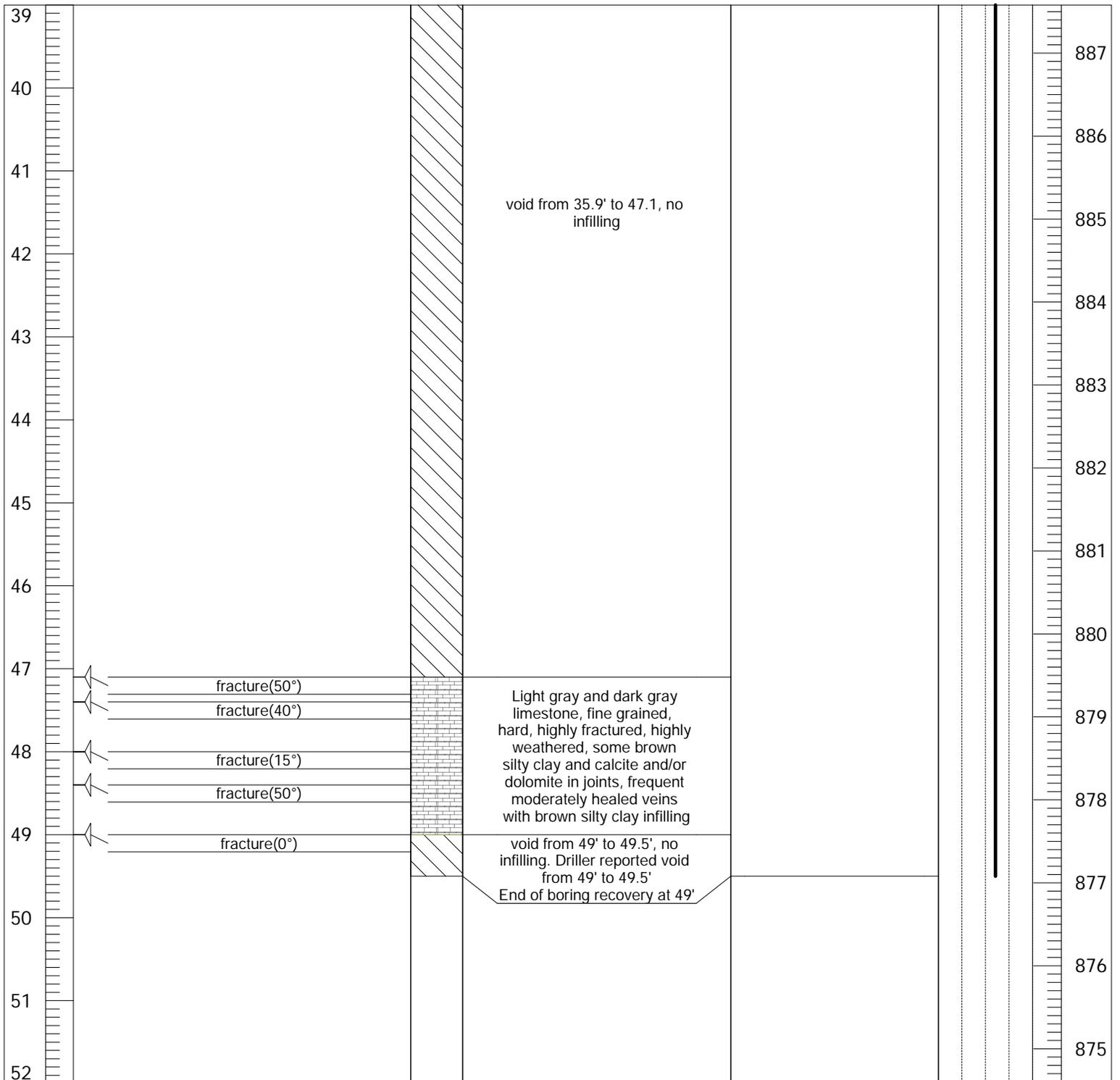


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/18/2016 Completed: 11/18/2016
 Time Started: 7:00 AM Completed: 10:50 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-15

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 43°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 12:45 PM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-16

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 72°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

0		Pavement cored Asphalt and concrete			926
1					925
2					924
3					923
4					922
5					921
6					920
7					919
8					918
9		Hollow-Stem Auger to refusal, no sample collected. Brown clayey silt			917
10					916
11					915
12					914
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

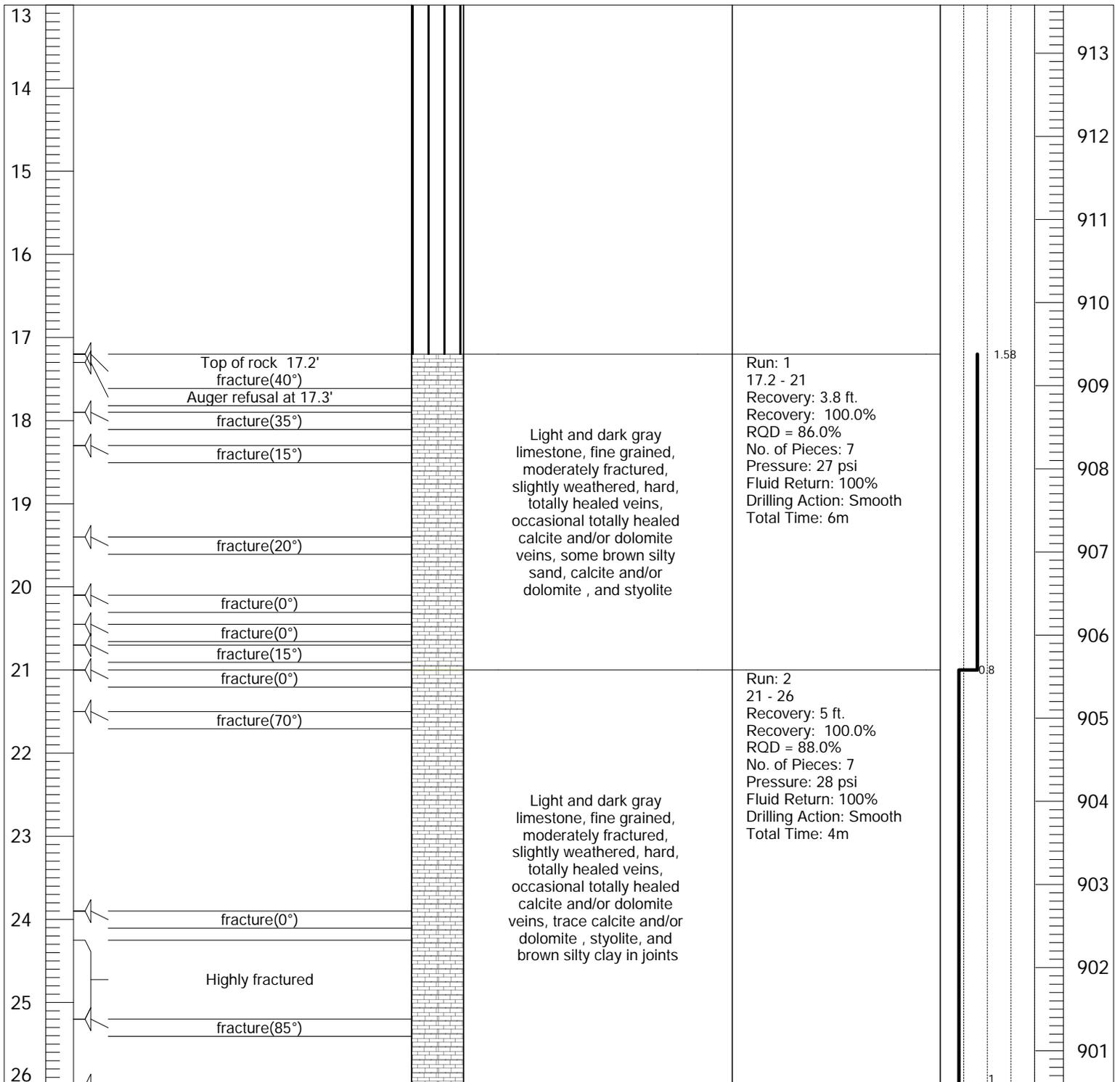


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 12:45 PM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-16

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 72°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 12:45 PM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-16

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 72°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(0°)	Light and dark gray limestone, fine grained, slightly to moderately fractured, moderately weathered, hard, totally healed veins, occasional totally healed calcite and/or dolomite veins, trace calcite and/or dolomite, stylolite and brown silty clay in join	Run: 3 26 - 31 Recovery: 4.35 ft. Recovery: 87.0% ROD = 87.0% No. of Pieces: 2 Pressure: 27 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m	2	900
27					
28					
29	fracture(80°)				
30	driller reported fluid loss at 30.2'	void from 30.4' to 31', no infilling. Driller reported void from 30.2' to 30.8'		4	896
30	fracture(40°)				
31	fracture(40°)	Light and dark gray limestone, fine grained, moderately fractured, moderately weathered, hard, frequent moderately healed veins with brown silty clay infilling, trace calcite and/or dolomite, stylolite, and brown silty clay in joints	Run: 4 31 - 36 Recovery: 5.1 ft. Recovery: 102.0% ROD = 88.0% No. of Pieces: 8 Pressure: 28 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m	1	895
32					
33	fracture(75°) Intensely to highly fractured				
33	fracture(70°)				
34	highly fractured				
34	fracture(65°)				
35	fracture(40°)				
35	fracture(0°)				
36	fracture(0°)	Light and dark gray limestone, fine grained, slightly to moderately fractured, moderately weathered, hard, totally healed veins, trace calcite and/or dolomite, stylolite,	Run: 5 36 - 41 Recovery: 4.45 ft. Recovery: 89.0% ROD = 89.0% No. of Pieces: 3 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m	1	890
37					
38					
39					888

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

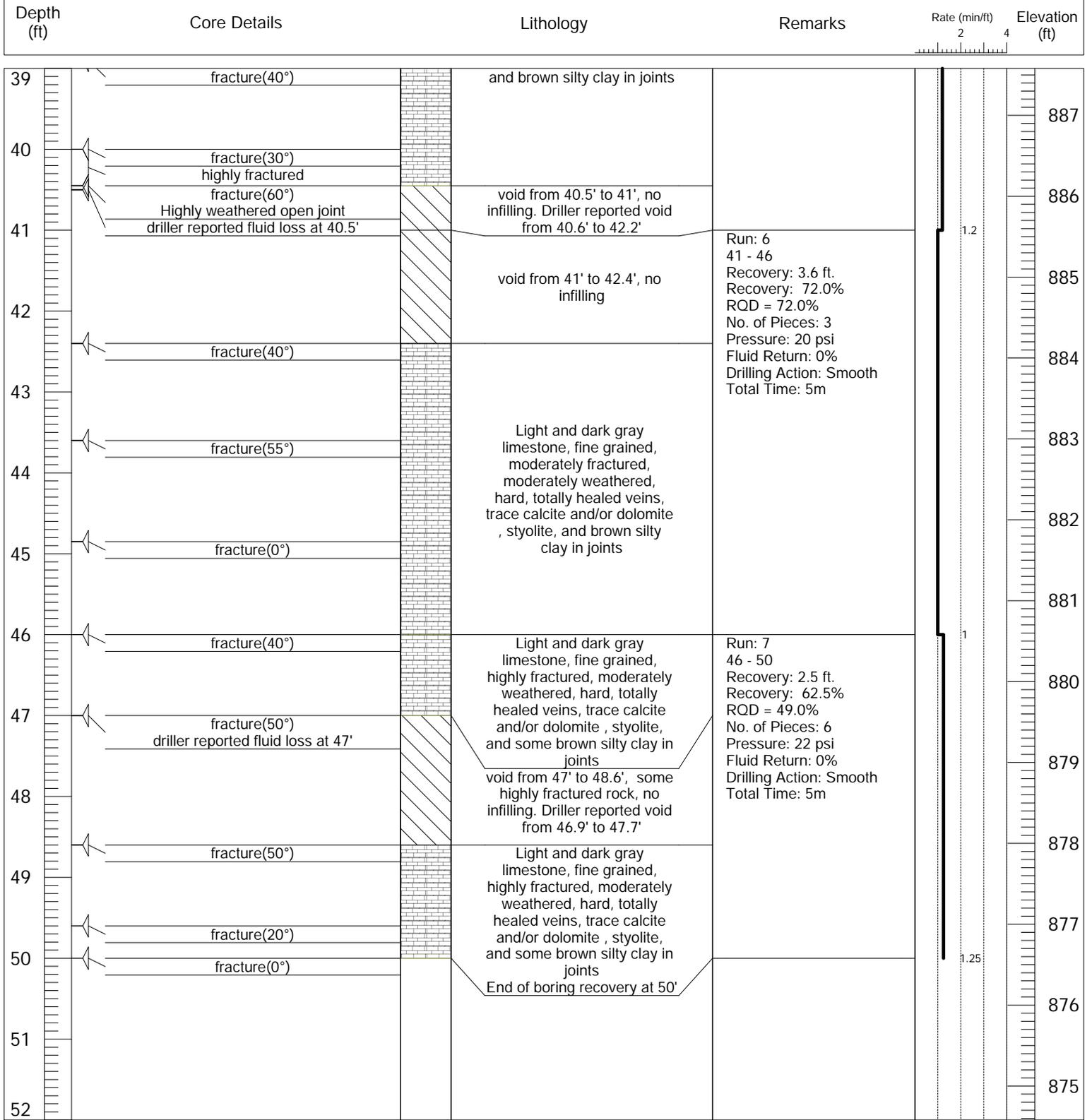
soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 12:45 PM Completed: 3:45 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-16

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 72°F



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28993.82
 Easting: 61431.31
 Ground Elevation: 926.58

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 8:03 AM Completed: 10:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-17

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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0		Pavement cored Asphalt and concrete			926
1					925
2					924
3					923
4					922
5					921
6					920
7					919
8		Hollow-Stem Auger to refusal, no sample collected. Brown clayey silt			918
9					917
10					916
11					915
12					914
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29014.23
 Easting: 61461.93
 Ground Elevation: 926.39

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

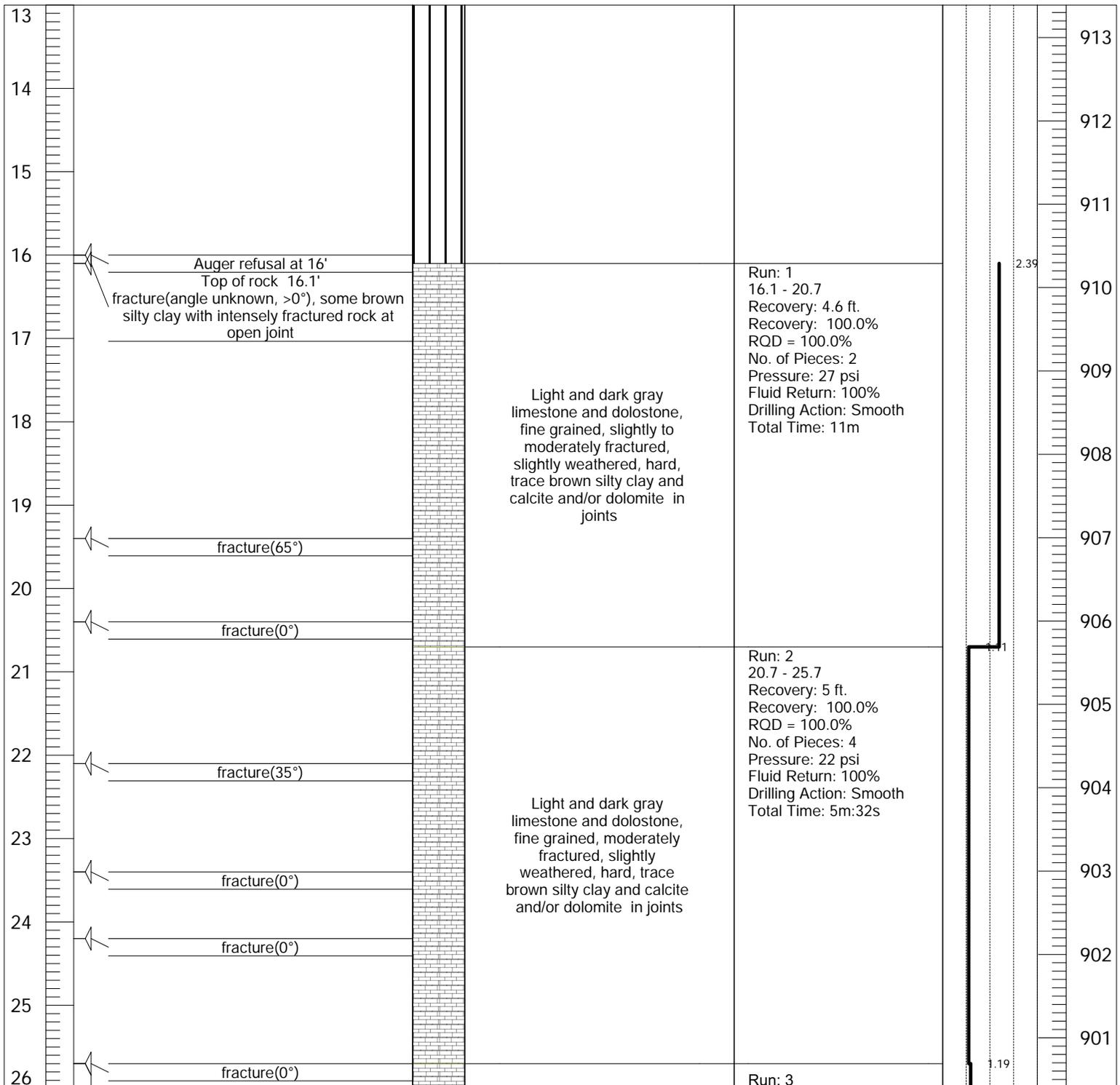


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 8:03 AM Completed: 10:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-17

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29014.23
 Easting: 61461.93
 Ground Elevation: 926.39

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 8:03 AM Completed: 10:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-17

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	moderately fractured	Light and dark gray limestone and dolostone, fine grained, highly fractured, slightly weathered, hard, some calcite and/or dolomite trace stylolite and trace brown silty clay	25.7 - 30.7 Recovery: 4.8 ft. Recovery: 96.0% RQD = 95.0% No. of Pieces: 10 Pressure: 62 psi Fluid Return: 95% Drilling Action: Smooth Total Time: 5m:57s	1.28	900
27	fracture(0°)				899
	fracture(15°)				
28	moderately fractured				898
29	fracture(0°)				897
	fracture(30°)				
30	fracture(15°)				896
	driller reported fluid loss at 30'				
	fracture(50°)				
	Intensely fractured				
31	fracture(35°)	Light and dark gray limestone and dolostone, fine grained, moderately fractured, highly weathered, hard, some calcite and/or dolomite trace stylolite and trace brown silty clay	Run: 4 30.7 - 35.7 Recovery: 1.9 ft. Recovery: 38.0% RQD = 100.0% No. of Pieces: 4 Pressure: 25 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 6m:25s	1.28	895
32	fracture(45°)				894
33		void from 32.3' to 35', intensely fractured rock, no infilling. Driller reported void from 32.3' to 35' with possible brown silty sand		1.4	893
34					892
35	fracture(30°)				891
	Highly fractured	void from 35.4' to 35.7, no infilling. Driller reported void from 35.5' to 36.2' with possible brown silty clay infilling	Run: 5 35.7 - 40.7 Recovery: 4.4 ft. Recovery: 88.0% RQD = 90.0% No. of Pieces: 3 Pressure: 55 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 7m	1.4	890
	fracture(65°)				889
	driller reported fluid loss at 35.5'	void from 35.7' to 36.3, no infilling			888
36	fracture(65°)	Light and dark gray limestone and dolostone, fine grained, moderately fractured, moderately weathered clay, hard, some calcite and/or dolomite			889
	Highly fractured				888
	fracture(0°)				
37					
38	fracture(0°)				
39	Open joint				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29014.23
 Easting: 61461.93
 Ground Elevation: 926.39

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/17/2016 Completed: 11/17/2016
 Time Started: 8:03 AM Completed: 10:45 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-17

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 45°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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39	fracture(25°) Open joint		trace stylolite and trace brown silty clay		887
40					886
41	fracture(15°)			Run: 6 40.7 - 45.7 Recovery: 5 ft. Recovery: 100.0% RQD = 90.0% No. of Pieces: 4 Pressure: 67 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 6m:56s	885
42					884
43	fracture(30°) fracture(0°)		Light and dark gray limestone and dolostone, fine grained, slightly fractured, slightly weathered clay, hard, some calcite and/or dolomite trace stylolite and trace brown silty clay		883
44	fracture(20°)				882
45					881
46	fracture(40°) Highly fractured fracture(20°)			Run: 7 45.7 - 50.7 Recovery: 3.55 ft. Recovery: 71.0% RQD = 90.0% No. of Pieces: 4 Pressure: 23 psi Fluid Return: 90% Drilling Action: Smooth Total Time: 4m:19s	880
47			Light and dark gray limestone and dolostone, fine grained, moderately fractured, moderately weathered, hard, some brown silty clay in joints, trace calcite and/or dolomite, and some brown silty clay in joints		879
48	fracture(30°) Intensely fractured fracture(30°)				878
49	fracture(55°) driller reported fluid loss at 49.3'				877
50			void from 49.3' to 50.7', no infilling. Driller reported void from 48.8' to 50.6' with possible brown silty clay infilling End of boring recovery at 49.3'		876
51					875
52					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29014.23
 Easting: 61461.93
 Ground Elevation: 926.39

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

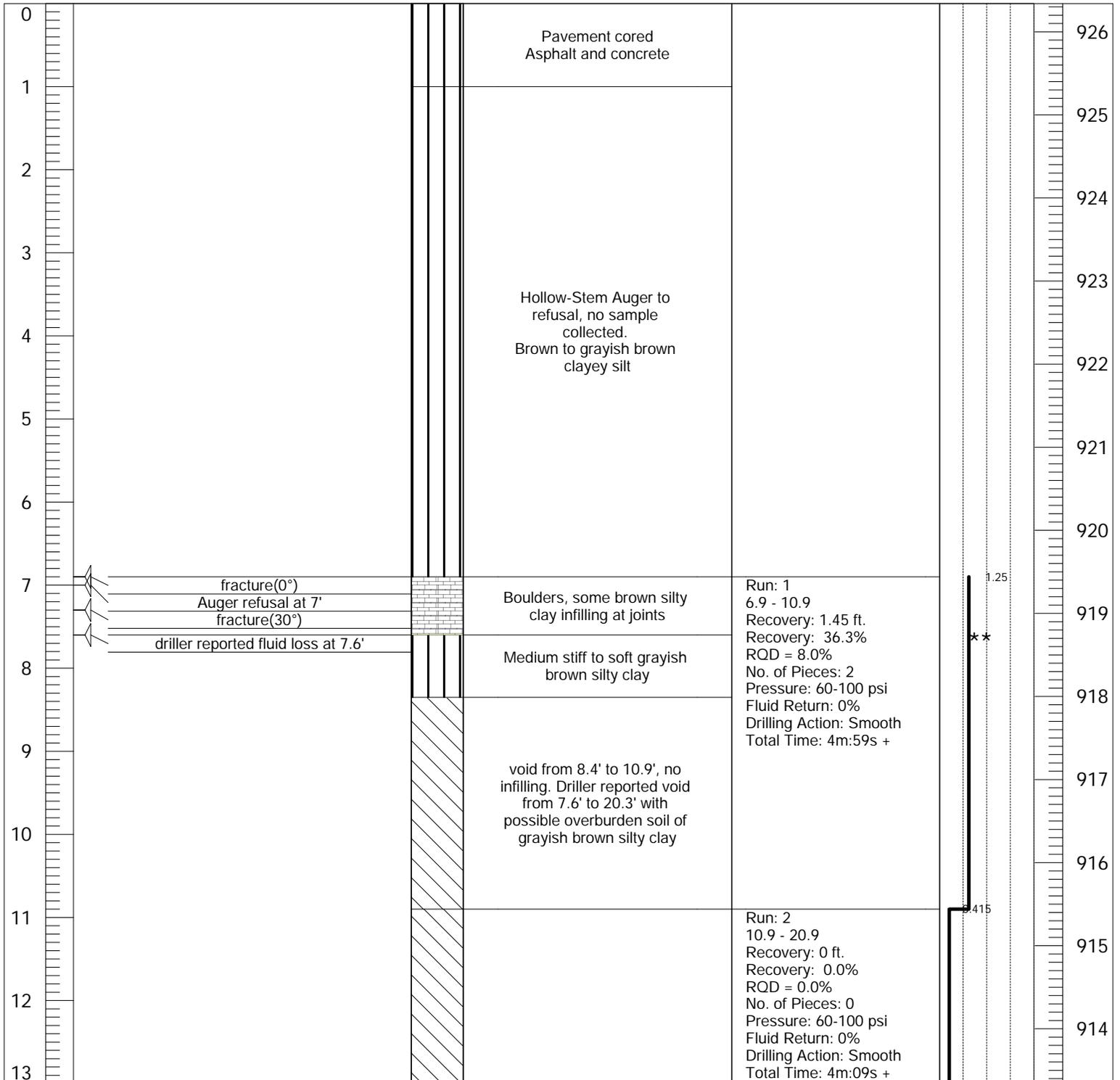


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/16/2016 Completed: 11/16/2016
 Time Started: 1:00 PM Completed: 4:54 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-18

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 66°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28974.77
 Easting: 61465.8
 Ground Elevation: 926.34

Notes:
 Backfilled with grout using tremie method
 Page 1 of 5

Legend

- soil
- dolostone
- limestone
- void

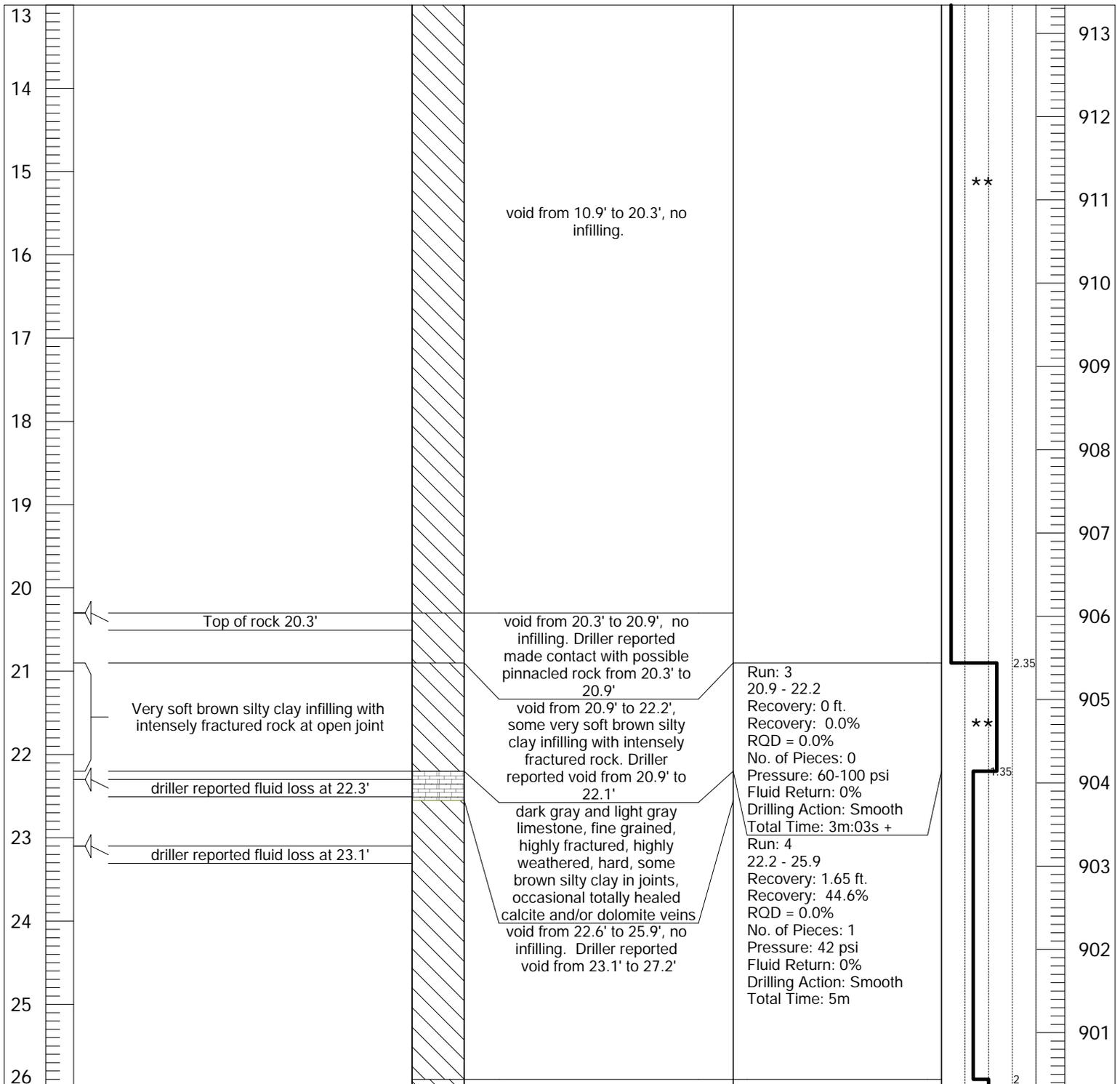


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/16/2016 Completed: 11/16/2016
 Time Started: 1:00 PM Completed: 4:54 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-18

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 66°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28974.77
 Easting: 61465.8
 Ground Elevation: 926.34

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/16/2016 Completed: 11/16/2016
 Time Started: 1:00 PM Completed: 4:54 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-18

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 66°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26			Run: 5 25.9 - 30.9 Recovery: 4 ft. Recovery: 80.0% ROD = 59.0% No. of Pieces: 6 Pressure: 42 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 10m		900
27	fracture(30°)				899
	fracture(60°)				
28	fracture(30°)				898
	driller reported fluid loss at 28'				
29	fracture(25°)				897
	fracture(0°)				
30					896
31	fracture(0°)				895
	fracture(60°)				
	Open joint				
	fracture(0°)				
	Open joint				
32	Intensely fractured				894
	fracture(35°)				
	Moderately fractured, highly weathered to 50% diameter from 32.9' to 33.2'				
33	fracture(40°)				893
	Open joint				
34	fracture(0°)				892
	fracture(40°)				
	Open joint				
	fracture(0°)				
	driller reported fluid loss at 34.4'				
35					891
36	fracture(0°)				890
37					889
38	fracture(20°)				888
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28974.77
 Easting: 61465.8
 Ground Elevation: 926.34

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/16/2016 Completed: 11/16/2016
 Time Started: 1:00 PM Completed: 4:54 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-18

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 66°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(20°)	and calcite and/or dolomite in joints		2	887
40	fracture(0°)				886
41	fracture(0°)	dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, some calcite and/or dolomite in joints, trace stylolite and brown silty clay	Run: 8 40.9 - 45.9 Recovery: 5 ft. Recovery: 100.0% ROD = 95.0% No. of Pieces: 6 Pressure: 23 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 4m +	0.8	885
42	fracture(25°)				884
43	fracture(30°)				883
44	fracture(50°)				882
45	fracture(0°)	dark gray and light gray limestone, fine grained, slightly to moderately fractured, highly weathered, hard, trace calcite and/or dolomite, stylolite, and brown silty clay in joints End of boring recovery at 50.8'	Run: 9 45.9 - 50.9 Recovery: 4.9 ft. Recovery: % ROD = 96.0% No. of Pieces: 5 Pressure: 22 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m	1.4	881
46	fracture(55°)				880
47	fracture(0°)				879
48	Intensely fractured				878
49	fracture(50°)				877
50	fracture(0°)				876
51	fracture(0°)				875
52					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28974.77
 Easting: 61465.8
 Ground Elevation: 926.34

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/15/2016
 Time Started: 9:20 AM Completed: 1:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-19

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 41°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

0		Pavement cored Asphalt and concrete			926
1					925
2					924
3					923
4					922
5					921
6					920
7					919
8					918
9					917
10		Hollow-Stem Auger to refusal, no sample collected. Gray gravelly clay			916
11					915
12					914
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29007.91
 Easting: 61555.54
 Ground Elevation: 926.37

Notes:
 Backfilled with grout using tremie method
 Page 1 of 5

Legend

- soil
- dolostone
- limestone
- void

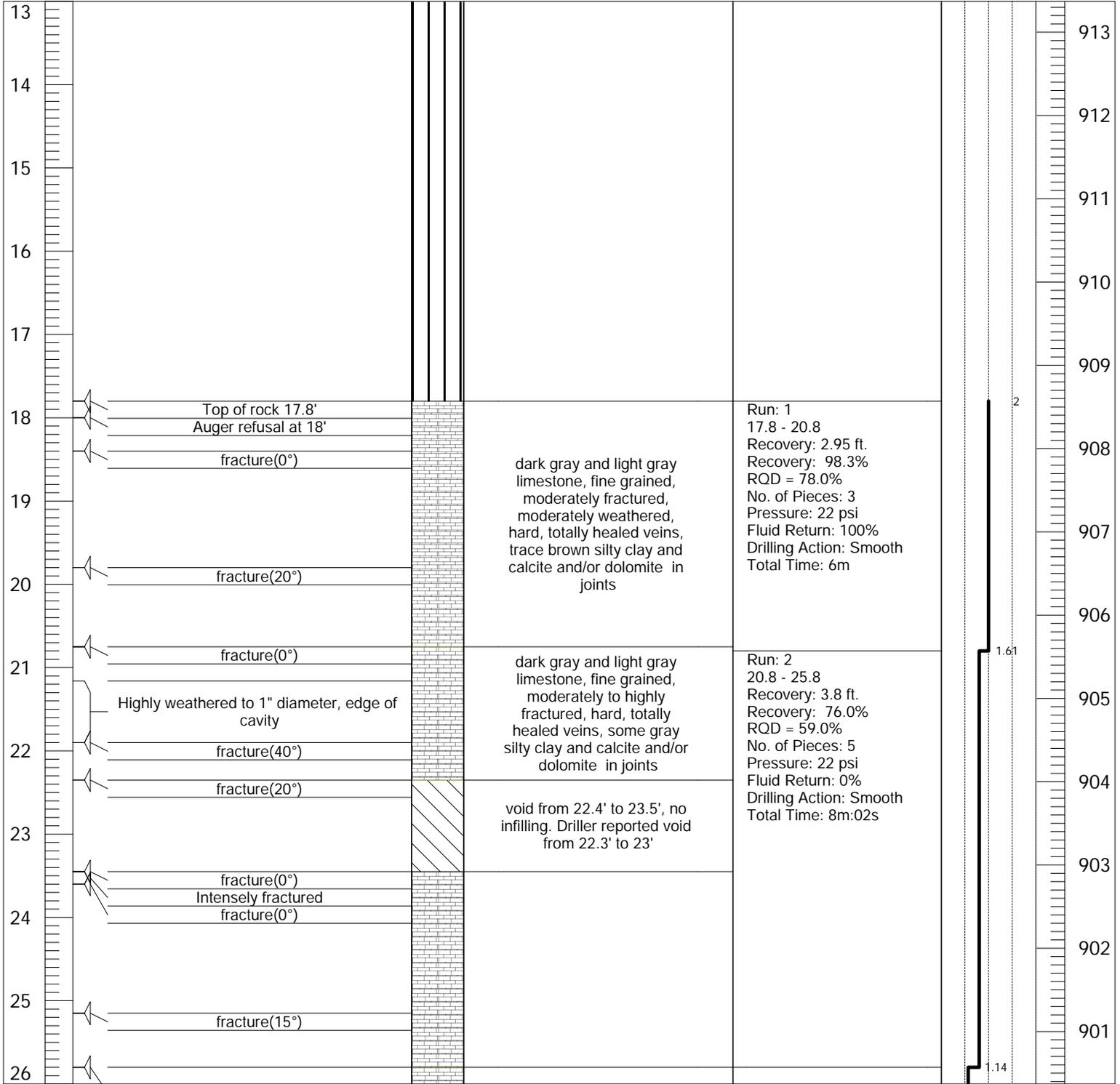


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/15/2016
 Time Started: 9:20 AM Completed: 1:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-19

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 41°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
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* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29007.91
 Easting: 61555.54
 Ground Elevation: 926.37

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/15/2016
 Time Started: 9:20 AM Completed: 1:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-19

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 41°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(0°)	dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, trace brown silty clay and calcite and/or dolomite in joints	Run: 3 25.8 - 30.8 Recovery: 2.3 ft. Recovery: 46.0% RQD = 44.0% No. of Pieces: 5 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:43s	2	900
27	fracture(35°)				899
28	fracture(45°) Intensely fractured rock at open joint				898
29		void from 28' to 30.8', some intensely fractured rock, no infilling. Driller reported void from 28' to 30.4'			897
30					896
31	fracture(0°)	dark gray and light gray limestone, fine grained, moderately to highly fractured, moderately weathered, hard, totally healed veins, frequent calcite and/or dolomite totally healed veins, occasional moderately healed veins, coated in brown silty clay	Run: 4 30.8 - 35.8 Recovery: 5.3 ft. Recovery: 106.0% RQD = 90.0% No. of Pieces: 7 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m	1.2	895
32	fracture(45°)				894
33	fracture(40°)				893
34	fracture(50°)				892
35	Highly weathered to 2" diameter, edge of cavity				891
36	fracture(60°)		Run: 5 35.8 - 40.8 Recovery: 5.15 ft. Recovery: 103.0% RQD = 97.0% No. of Pieces: 3 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:43s	1.34	890
37					889
38		dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, some calcite and/or			888
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29007.91
 Easting: 61555.54
 Ground Elevation: 926.37

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/15/2016
 Time Started: 9:20 AM Completed: 1:40 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-19

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Cloudy 41°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(60°)	dolomite in joints, trace silty clay in joints			887
40					886
41	fracture(20°) Highly fractured fracture(20°)	void from 41.1' to 41.3'; some highly fractured rock, no infilling. Driller reported void from 41.1' to 41.3'	Run: 5 40.8 - 45.8 Recovery: 3.4 ft. Recovery: 68.0% ROD = 48.0% No. of Pieces: 3 Pressure: 25 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:02s	1.61	885
42	fracture(65°) Intensely fractured rock at open joint	dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, some calcite and/or dolomite in joints, trace silty clay in joints			884
43					883
44	fracture(50°)				882
45					881
46					880
47		void from 44.3' to 51.2'; some highly fractured rock, no infilling. Driller reported void from 44.3' to 51.2' and likely reached pinnacle at 51.2'			879
48		End of boring recovery at 44.3'			878
49					877
50					876
51					875
52					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 29007.91
 Easting: 61555.54
 Ground Elevation: 926.37

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/16/2016
 Time Started: 4:25 PM Completed: 10:22 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-20A

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 31°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

13					913
14					912
15					911
16					910
17				1.58	909
18					908
19					907
20					906
21					905
22	Top of rock 21.6' fracture(25°)				904
23	fracture(0°) fracture(30°) Moderately fractured				903
24	fracture(20°) fracture(0°)				902
25	fracture(30°)				901
26					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28928.64
 Easting: 61531.31
 Ground Elevation: 926.04

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/16/2016
 Time Started: 4:25 PM Completed: 10:22 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-20A

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 31°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

26	driller reported fluid loss at 25.85'	void from 25.9' to 26.6', no infilling. Driller reported void from 25.5' to 26.9'			900
27	Soft grayish brown infilling at open joint fracture(25°)	void from 26.6' to 26.9', soft grayish brown silty clay infilling	Run: 7 26.6 - 31.6 Recovery: 3.6 ft. Recovery: 72.0% RQD = 66.0% No. of Pieces: 1 Pressure: 27 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 10m:50s	2.17	899
28		light gray dolostone, fine grained, moderately hard, slightly fractured, slightly weathered, occasional calcite and/or dolomite veins, some grayish brown silty clay at joints			898
29					897
30	fracture(60°) Soft grayish brown infilling at open joint	void from 30.2' to 31.6', no infilling. Driller reported void from 30.1' to 30.5'			896
31					895
32	fracture(35°)	light gray and dark gray, limestone, moderately to highly fractured, moderately weathered, trace brown silty clay is calcite and/or dolomite in joints	Run: 8 31.6 - 36.6 Recovery: 2.85 ft. Recovery: 57.0% RQD = 47.0% No. of Pieces: 8 Pressure: 32 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:52s	19	894
33	fracture(0°) fracture(15°) fracture(15°)				893
34	fracture(0°)				892
35	fracture(30°) driller reported fluid loss at 34.5'	void from 34.5' to 36.6', no infilling. Driller reported void from 33.1' to 39.3'			891
36					890
37			Run: 9 36.6 - 41.6 Recovery: 2 ft. Recovery: 40.0% RQD = 27.0% No. of Pieces: 1 Pressure: 33 psi Fluid Return: 0% Drilling Action: Smooth Total Time: N/A		889
38		void from 36.6' to 40.3', no infilling		*	888
39					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28928.64
 Easting: 61531.31
 Ground Elevation: 926.04

Notes:
 Backfilled with grout using tremie method
 Page 3 of 5

Legend

soil
 dolostone
 limestone
 void

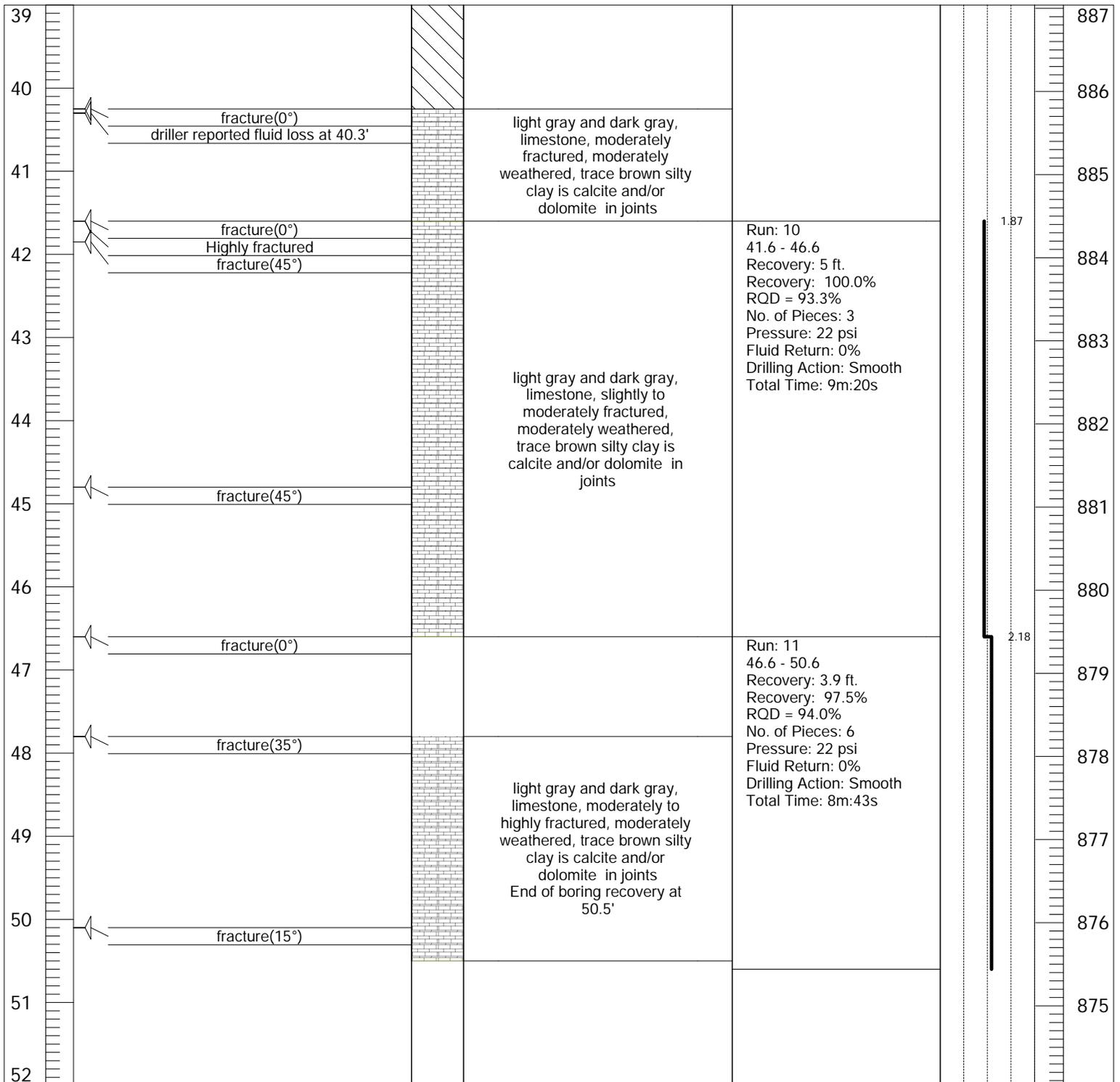


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/15/2016 Completed: 11/16/2016
 Time Started: 4:25 PM Completed: 10:22 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-20A

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 31°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28928.64
 Easting: 61531.31
 Ground Elevation: 926.04

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/14/2016 Completed: 11/14/2016
 Time Started: 1:15 PM Completed: 4:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-21

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 63°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

0		Pavement cored Asphalt and concrete			926
1					925
2					924
3					923
4					922
5					921
6					920
7					919
8					918
9		Hollow-Stem Auger to refusal, no sample collected. Brown sand, gray gravel, and brown silty clay			917
10					916
11					915
12					914
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28960.98
 Easting: 61385.12
 Ground Elevation: 926.43

Notes:
 Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

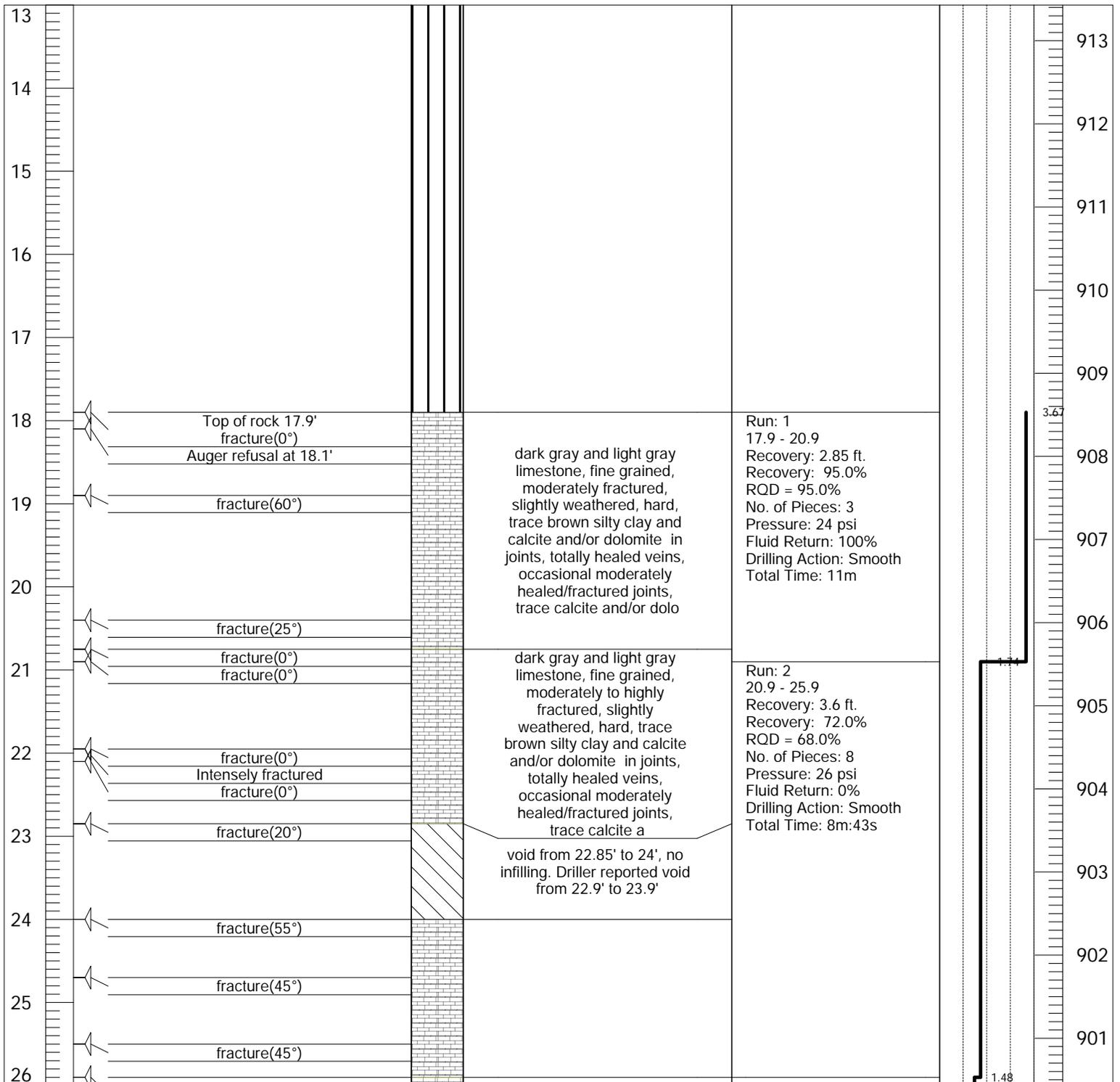


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/14/2016 Completed: 11/14/2016
 Time Started: 1:15 PM Completed: 4:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-21

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 63°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28960.98
 Easting: 61385.12
 Ground Elevation: 926.43

Notes:
 Backfilled with grout using tremie method
 Page 2 of 5

Legend

- soil
- dolomite
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/14/2016 Completed: 11/14/2016
 Time Started: 1:15 PM Completed: 4:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-21

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 63°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(0°)	dark gray and light gray limestone, fine grained, highly fractured, slightly weathered, hard, some calcite and/or dolomite in joints, trace grayish brown clay in joints	Run: 3 25.9 - 30.9 Recovery: 3.9 ft. Recovery: 78.0% RQD = 64.0% No. of Pieces: 8 Pressure: 24 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:25s	2	900
27	fracture(50°)				
28	highly weathered to 0.75" diameter, edge of cavity	void from 28.4' to 29.4', no infilling. Driller reported void from 28.5' to 29.2'			899
28	fracture(55°)				
29	fracture(70°)				898
30	Intensely fractured				897
30	Moderately fractured				
31	fracture(55°)	dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, some calcite and/or dolomite in joints, some calcite and/or dolomite in joints	Run: 4 30.9 - 35.9 Recovery: 5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 4 Pressure: 24 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:53s	1.18	896
32	fracture(50°)				
33	fracture(55°)				895
34	fracture(40°)				
35	fracture(0°)	dark gray and light gray limestone, fine grained, moderately to highly fractured, slightly weathered, hard, some calcite and/or dolomite in	Run: 5 35.9 - 40.9 Recovery: 5 ft. Recovery: 100.0% RQD = 94.0% No. of Pieces: 5 Pressure: 24 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m	1.2	894
36	fracture(0°)				
37					893
38	fracture(0°)				892
38	fracture(30°)				891
39					890
					889
					888

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28960.98
 Easting: 61385.12
 Ground Elevation: 926.43

Notes:
 Backfilled with grout using tremie method
 Page 3 of 5

Legend

- soil
- dolostone
- limestone
- void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/14/2016 Completed: 11/14/2016
 Time Started: 1:15 PM Completed: 4:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-21

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 63°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
39	fracture(35°)	joints, some calcite and/or dolomite in joints			887
40	fracture(45°)				886
41	fracture(0°)		Run: 6 40.9 - 45.9 Recovery: 5 ft. Recovery: 100.0% ROD = 100.0% No. of Pieces: 4 Pressure: 24 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:32s	1.31	885
42	fracture(0°)	dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, some stylolite in joints, trace calcite and/or dolomite and brown silty clay in joints			884
43	fracture(25°)				883
44					882
45	fracture(30°)				881
46	fracture(55°)		Run: 7 45.9 - 50.9 Recovery: 5 ft. Recovery: 100.0% ROD = 71.0% No. of Pieces: 8 Pressure: 56 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:13s	1.24	880
47	fracture(65°)	dark gray and light gray limestone, fine grained, moderately to highly fractured, slightly weathered, hard, trace stylolite, calcite and/or dolomite and brown silty clay in joints			879
48	fracture(50°)				878
49	fracture(35°)				877
49	fracture(30°)				877
49	fracture(25°)				877
50					876
51	fracture(0°)		Run: 8 50.9 - 55.9 Recovery: 4.9 ft. Recovery: 98.0% ROD = 100.0%	1.13	875
52					875

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28960.98
 Easting: 61385.12
 Ground Elevation: 926.43

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/14/2016 Completed: 11/14/2016
 Time Started: 1:15 PM Completed: 4:30 PM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-21

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Mostly Sunny 63°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52	fracture(20°)	dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, trace stylolite, calcite and/or dolomite and brown silty clay in joints, occasional joints with some stylolite, calcite and/or dolomite and brown silty clay	No. of Pieces: 5 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:40s	2	874
	fracture(55°)				873
53					872
54	fracture(0°)				871
55	fracture(0°)				870
56	fracture(0°)				869
	fracture(40°)				868
57	fracture(40°)				867
	fracture(30°)				
	fracture(50°)				
58	fracture(25°)	dark gray and light gray limestone, fine grained, highly fractured, highly weathered, hard, trace stylolite, calcite and/or dolomite and brown silty clay in joints, occasional joints with some stylolite, calcite and/or dolomite and brown silty clay	Run: 9 55.9 - 60.9 Recovery: 4.9 ft. Recovery: 98.0% ROD = 82.0% No. of Pieces: 9 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 9m	1.8	867
	fracture(0°)	End			
59					
60					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28960.98
 Easting: 61385.12
 Ground Elevation: 926.43

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolomite
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/12/2016 Completed: 11/14/2016
 Time Started: 8:30 AM Completed: 10:52 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-22

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

0		Pavement cored Asphalt and concrete	Industrial hygienist detected trichloroethylene (TCE) above acceptable levels in soil, halted operations and continued on the next workday. No detection the next day		926
1					925
2					924
3					923
4					922
5					921
6					920
7					919
8					918
9		Hollow-Stem Auger to refusal, no sample collected. Brown sand, gray gravel, and brown silty clay			917
10					916
11					915
12					914
13					

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28931.23
 Easting: 61414.39
 Ground Elevation: 926.14

Notes:
 Backfilled with grout using tremie method
 Page 1 of 5

Legend

- soil
- dolostone
- limestone
- void

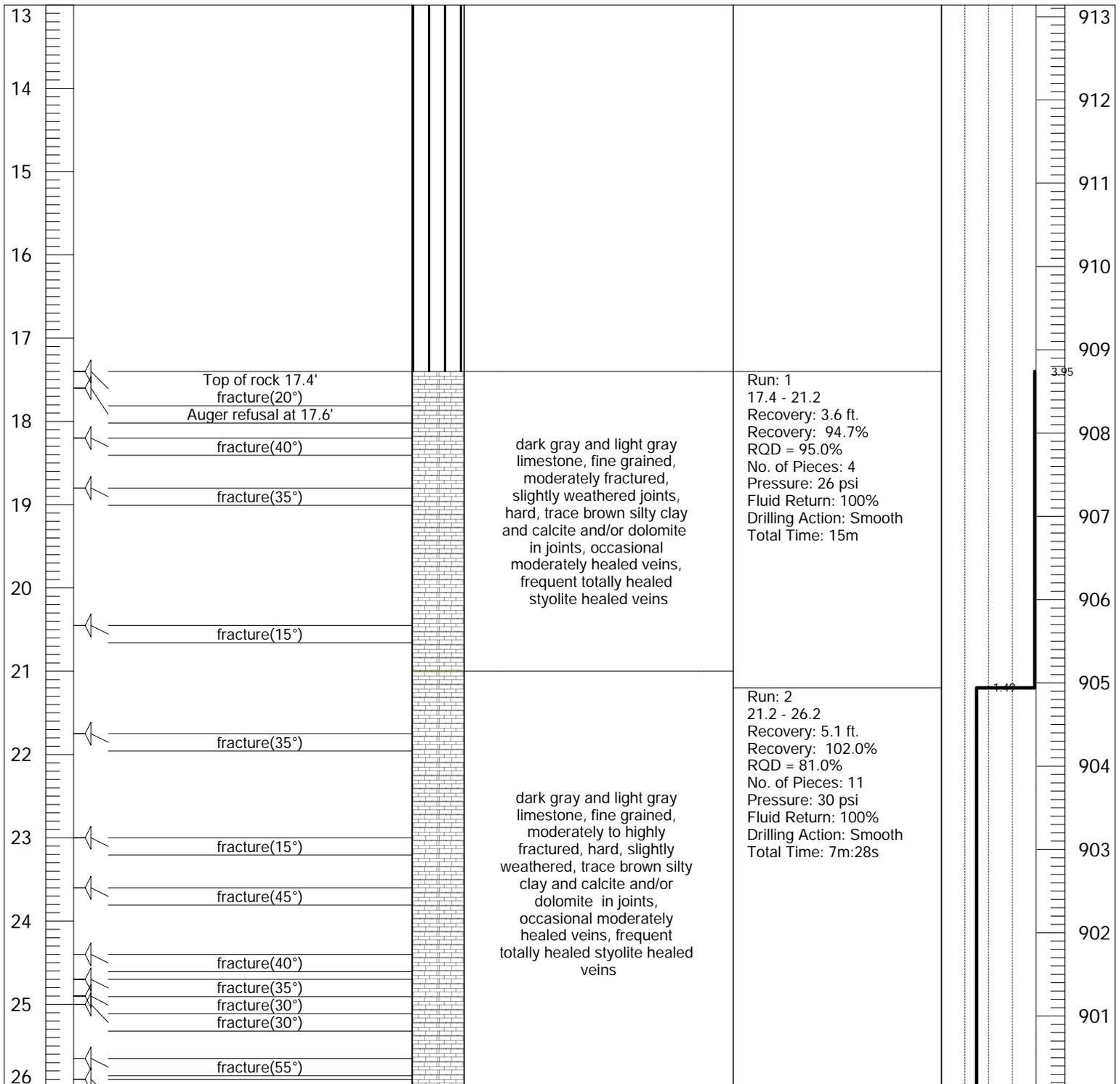


Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/12/2016 Completed: 11/14/2016
 Time Started: 8:30 AM Completed: 10:52 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-22

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------



* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28931.23
 Easting: 61414.39
 Ground Elevation: 926.14

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/12/2016 Completed: 11/14/2016
 Time Started: 8:30 AM Completed: 10:52 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-22

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 - 7/8"
 Weather: Sunny 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
26	fracture(30°) fracture(60°)	dark gray and light gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, frequent totally healed stylolite healed veins	Run: 3 26.2 - 31.2 Recovery: 5 ft. Recovery: 100.0% RQD = 87.0% No. of Pieces: 9 Pressure: 26 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 7m:08s	1.43	900
27	fracture(40°) fracture(45°)				899
28	fracture(20°)	dark gray and light gray limestone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, frequent totally healed stylolite healed veins	Run: 4 31.2 - 36.2 Recovery: 2.7 ft. Recovery: 54.0% RQD = 51.0% No. of Pieces: 2 Pressure: 26 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 7m:05s	1.42	898
29	fracture(0°)				897
30	fracture(30°) fracture(25°)	void from 33.0' to 35.3', no infilling. Driller reported void from 33.2' to 34.2', likely edge of rock because drillers did not experience casing drop	Run: 5 36.2 - 41.2 Recovery: 5.2 ft. Recovery: 104.0% RQD = 94.0% No. of Pieces: 4 Pressure: 27 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:22s	1.47	896
31	fracture(55°) fracture(18°)				895
32		light gray dolostone, moderately fractured			894
33	fracture(50°)	light gray dolostone, moderately fractured, slightly weathered, occasional totally healed			893
34					892
35	fracture(35°)				891
36	fracture(55°) some grayish brown silty clay with trace sand at open joint				890
37					889
38	fracture(30°)				888
39	fracture(60°)				

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28931.23
 Easting: 61414.39
 Ground Elevation: 926.14

Notes:
 Backfilled with grout using tremie method

Legend

soil
 dolostone
 limestone
 void



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/12/2016 Completed: 11/14/2016
 Time Started: 8:30 AM Completed: 10:52 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-22

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
------------	--------------	-----------	---------	---------------	----------------

39		veins with brown silty clay infilling			887
40	fracture(15°)				886
41	fracture(0°)				885
42			Run: 6 41.2 - 46.2 Recovery: 5 ft. Recovery: 100.0% ROD = 98.0% No. of Pieces: 5 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:48s	1.16	884
43	fracture(20°)	dark gray and light gray limestone and dolostone, fine grained, slightly fractured to moderately, slightly weathered, hard, some brown silty clay at top, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, fr			883
44	fracture(50°)				882
45	fracture(20°)				881
45	fracture(20°)				881
46	fracture(0°)				880
47			Run: 7 46.2 - 51.2 Recovery: 5 ft. Recovery: 100.0% ROD = 98.0% No. of Pieces: 5 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 7m:37s	1.52	879
48	fracture(45°)	dark gray and light gray limestone and dolostone, fine grained, moderately to slightly fractured, slightly weathered, hard, some calcite and/or dolomite in joints			878
49	fracture(35°)				877
50	fracture(50°)				876
51					875
52			Run: 8 51.2 - 56.2 Recovery: 5.05 ft.	1.12	875

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28931.23
 Easting: 61414.39
 Ground Elevation: 926.14

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				



Project Number: 1168070004
 Project Name: Y-12 Outfall 200
 Project Location: Oak Ridge, TN
 Client Name: Strata-G
 Date Started: 11/12/2016 Completed: 11/14/2016
 Time Started: 8:30 AM Completed: 10:52 AM
 Logged By: A. Spears Checked By: K. Foye

Borehole ID: B-22

Drilling Subcontractor: Tri-State Drilling, Inc.,
 Chattanooga, TN
 Drilling Method: Hollow-Stem Auger / Rock Coring
 Drill Rig Model: CME 55
 Core Size: HQ 2 -7/8"
 Weather: Sunny 39°F

Depth (ft)	Core Details	Lithology	Remarks	Rate (min/ft)	Elevation (ft)
52			Recovery: 101.0% RQD = 60.0% No. of Pieces: 4 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 5m:36s		874
53	fracture(55°)	dark gray and light gray limestone and dolostone, fine grained, moderately fractured, slightly weathered, hard, occasional totally healed stylolite veins, trace calcite and/or dolomite, stylolite and brown silty clay in joints			873
54	fracture(0°)				
55	fracture(40°)				
56	fracture(45°)	dark gray and light gray limestone and dolostone, fine grained, moderately fractured, slightly weathered, hard, occasional totally healed stylolite veins, trace calcite and/or dolomite, stylolite and brown silty clay in joints End of boring recovery at 60.2	Run: 9 56.2 - 60.2 Recovery: 4.1 ft. Recovery: 102.5% RQD = 100.0% No. of Pieces: 4 Pressure: 26 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 6m:44s	1.68	870
57	fracture(50°)				
58	fracture(45°)				
59	fracture(30°)				
60					867

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval
 + Some of total time not recorded

Northing: 28931.23
 Easting: 61414.39
 Ground Elevation: 926.14

Notes:
 Backfilled with grout using tremie method

Legend

	soil		dolostone		limestone
	void				

**GEOTECHNICAL REPORT FOR DATA GAP
CHARACTERIZATION AT THE PROPOSED OUTFALL 200
MERCURY TREATMENT FACILITY SITES**
January 2017

Appendix B – Geophysical Logging Report

Geophysical Logging Report

Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22

Outfall 200 Mercury Treatment Facility Sites

Y-12, Oak Ridge, Tennessee

Performed for:

Strata-G

November 29, 2016

Geophysical Logging Report
Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22
Outfall 200 Mercury Treatment Facility Sites
Y-12, Oak Ridge, Tennessee

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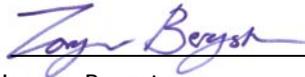
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Signature Page

This report, entitled "Geophysical Logging Report, Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22, Outfall 200 Mercury Treatment Facility Sites, Y-12, Oak Ridge, Tennessee" has been prepared for Strata-G located in Knoxville, Tennessee. It has been prepared under the supervision of Mr. Jorgen Bergstrom at the request of and the exclusive use of Strata-G. This report has been prepared in accordance with accepted quality control practices and has been reviewed by the undersigned.

GEL Geophysics, LLC

A Member of the GEL Group, Inc.



Jorgen Bergstrom
Senior Geophysicist



Matthew J. Wolf
Chief Technology Officer

November 29, 2016

Date

Geophysical Logging Report
Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22
Outfall 200 Mercury Treatment Facility Sites
Y-12, Oak Ridge, Tennessee

EXECUTIVE SUMMARY

GEL Geophysics performed geophysical borehole logging services in nine borings at the Outfall 200 Mercury treatment facility sites at Y-12, Oak Ridge, Tennessee on November 15-16, 2016. The geophysical logs consisted of mechanical 3-arm caliper and natural gamma. For this investigation, GEL Geophysics used a Mount Sopris logging system for collecting the data and WellCAD v. 5.1 for analyzing the data. WellCAD is manufactured by Advanced Logic Technology.

Several boreholes could not be logged to the total depth due to cave-ins. In a couple of boreholes, the holes caved in during logging causing differences in the total depth logged with each tool.

The logging data was analyzed to determine the location and aperture of borehole openings presumably caused by voids or fractures, and assess if the voids or fractures appear to be open or clay-filled. Overall, increases in caliper readings with no corresponding increase in natural gamma reading were interpreted as possibly open void or fracture. Increases in caliper readings with a corresponding increase in natural gamma reading were interpreted as possible clay-filled void or fracture.

Geophysical Logging Report
Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22
Outfall 200 Mercury Treatment Facility Sites
Y-12, Oak Ridge, Tennessee

1.0 INTRODUCTION

GEL Geophysics performed geophysical borehole logging services in nine borings, at the Outfall 200 Mercury treatment facility sites at Y-12, Oak Ridge, Tennessee. The geophysical logs consisted of mechanical 3-arm caliper and natural gamma. The field investigations were performed on November 15-16, 2016. The logging data was analyzed to determine the location and aperture of borehole openings presumably caused by voids or fractures, and assess if the voids or fractures appear to be open or clay-filled.

2.0 EQUIPMENT AND METHODOLOGY

The information below is an overview of the geophysical methodologies used for this investigation. The intent of this overview is to give the reader a better understanding of each method, and background information as to what is actually measured, the resolution of the method, and the limitations imposed by site-specific subsurface conditions.

2.1 Mechanical 3-arm caliper

Caliper logging is used to generate a profile of the borehole diameter with depth. The tool measures the borehole diameter using three spring-loaded arms. Narrow enlargements in the borehole diameter can, in most cases, be attributed to fractures. Caliper logging can be conducted above and below the water surface.

2.2 Natural Gamma

Natural gamma tools measure the gamma radiation from the formation. These logs can be used to discriminate between different formations by utilizing variations in the concentration of naturally occurring radioactive isotopes such as potassium, uranium and thorium. These logs are particularly popular for correlating logs and locating clay and shale formations since radioactive elements tend to concentrate in these materials. Natural gamma logging can be conducted in cased and uncased boreholes, water-filled and dry.

3.0 FIELD PROCEDURES

For this investigation, GEL Geophysics used a Mount Sopris logging system for collecting the data and WellCAD v. 5.1 for analyzing the data. WellCAD is manufactured by Advanced Logic Technology. The following equipment was used onsite:

Data Acquisition System: Matrix data logger

Logging Winch: MX system with 1,500 feet of cable

Mechanical 3-arm caliper: QL40-CAL

Natural Gamma: 2PGA

Several boreholes could not be logged to the total depth due to cave-ins before or between logging runs. In a couple of boreholes, the holes caved in during or after logging with one tool causing differences in the total depth logged with subsequent tools.

A summary of the borehole configurations is provided below. All depth measurements are referenced from ground surface. All borings were surface cased to the overburden and bedrock/competent rock interface with an approximately 4-inch casing and open uncased hole below the casing.

Logging Configuration Summary

Well ID	Borehole diameter (in)* (open hole)	Casing Depth (ft)*	Total depth logged (ft)	Reported total depth (ft)
B-2	3.5	7.6	58.8	60.0
B-4	3.5	Appr. 4.6	38.3	60.0
B-6	3.5	6.9	34.3	60.0
B-7	3.8 to 46' 3.5 below 46'	17.5	58.5 (caliper) 40.4 (gamma)	60.0
B-9	3.8	21.6	51.9	60.0
B-10	3.8	17.6	50.9 (gamma) 25.6 (caliper)	60.0
B-11	3.5	20.7	54.3	60.0
B-21	3.8 to 30' 3.5 below 30'	18.1	42.7	60.0
B-22	3.5	17.1	59.7	60.0

*Based on caliper logging

4.0 DATA PROCESSING AND RESULTS

Increases in caliper readings with no corresponding increase in natural gamma reading were interpreted as possibly open void or fracture. Increases in caliper readings with a corresponding increase in natural gamma reading were interpreted as possible clay-filled void or fracture. There was one void or fracture detected in boring B-7 at a depth where only caliper data was collected (45.5 feet below ground surface). Without the natural gamma data, it could not be assessed if this void or fracture was open or clay-filled. Also, there was one section with increased natural gamma readings detected in boring B-10 at a depth where only natural gamma data was collected (38.2 feet below ground surface). This section was interpreted as possible clay-filled void or fracture. One reason for this interpretation is that the natural gamma response looks very similar to the response at 46.7 feet and 48.5 feet in the adjacent boring B-9 (where both logs were available). A summary of the detected voids and fractures are provided below.

B-2

Depth (ft)	Aperture (mm)	Comment
8.1	150	Possibly clay-filled
9.9	105	Possibly clay-filled
11.9	80	Possibly clay-filled

B-4

Depth (ft)	Aperture (mm)	Comment
10.9	250	Possibly clay-filled
12.0	130	Possibly clay-filled
14.8	1120	Possibly clay-filled

B-6

Depth (ft)	Aperture (mm)	Comment
7.5	190	Possibly clay-filled
11.9	990	Possibly clay-filled
14.2	140	Possibly clay-filled

B-7

Depth (ft)	Aperture (mm)	Comment
17.9	150	Possibly clay-filled
33.7	550	Possibly open

36.8	620	Possibly clay-filled
39.1	250	Possibly clay-filled
45.5	230	Open or clay-filled (caliper only)

B-9

Depth (ft)	Aperture (mm)	Comment
23.4	820	Possibly open
36.6	370	Possibly open
46.7	560	Possibly clay-filled
48.5	70	Possibly clay-filled

B-10

Depth (ft)	Aperture (mm)	Comment
20.2	90	Possibly clay-filled
21.4	300	Possibly clay-filled
23.3	470	Possibly clay-filled
25.2	90	Possibly open
38.2	830	Possible clay-filled (gamma only)

B-11

Depth (ft)	Aperture (mm)	Comment
21.7	500	Possibly clay-filled

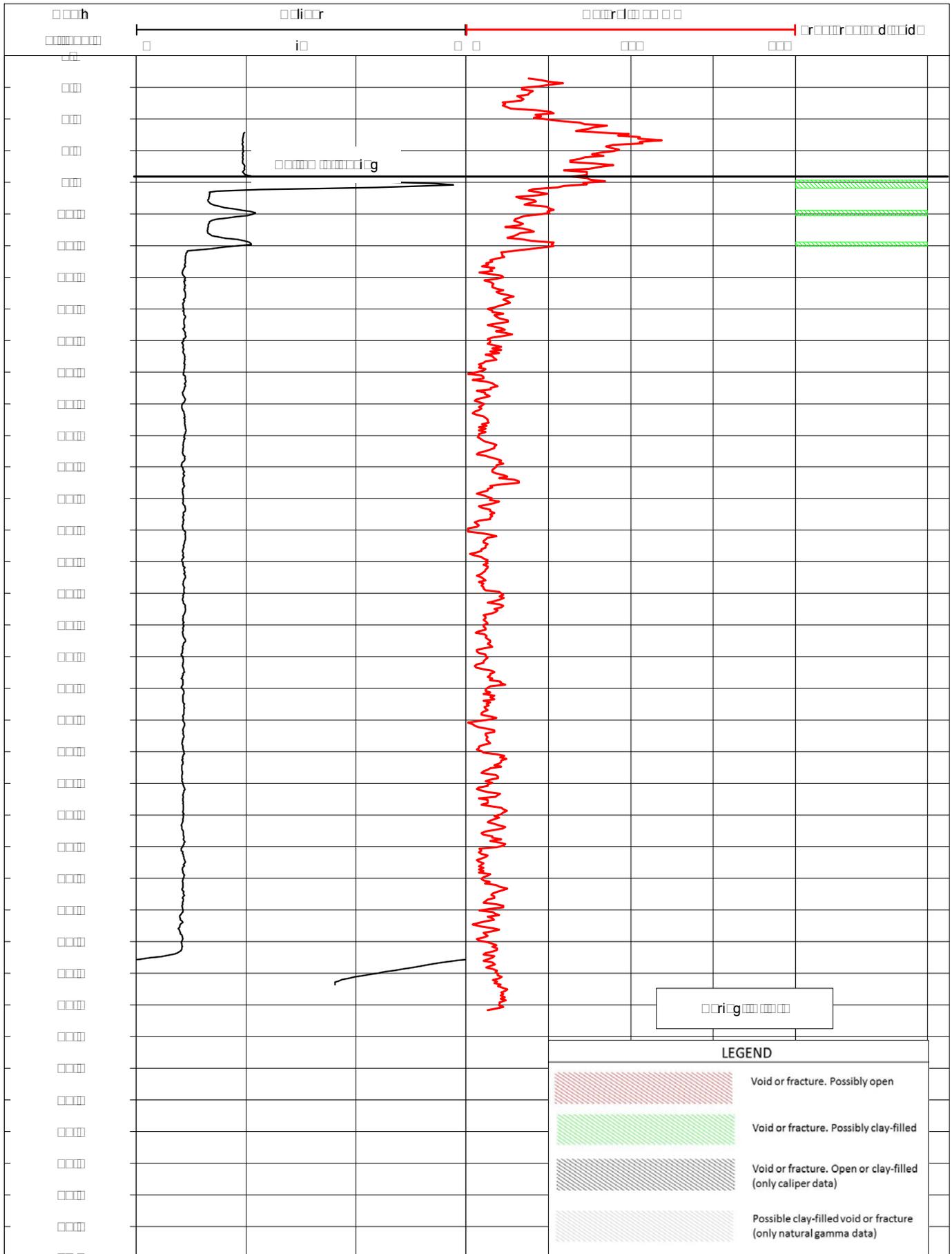
B-21

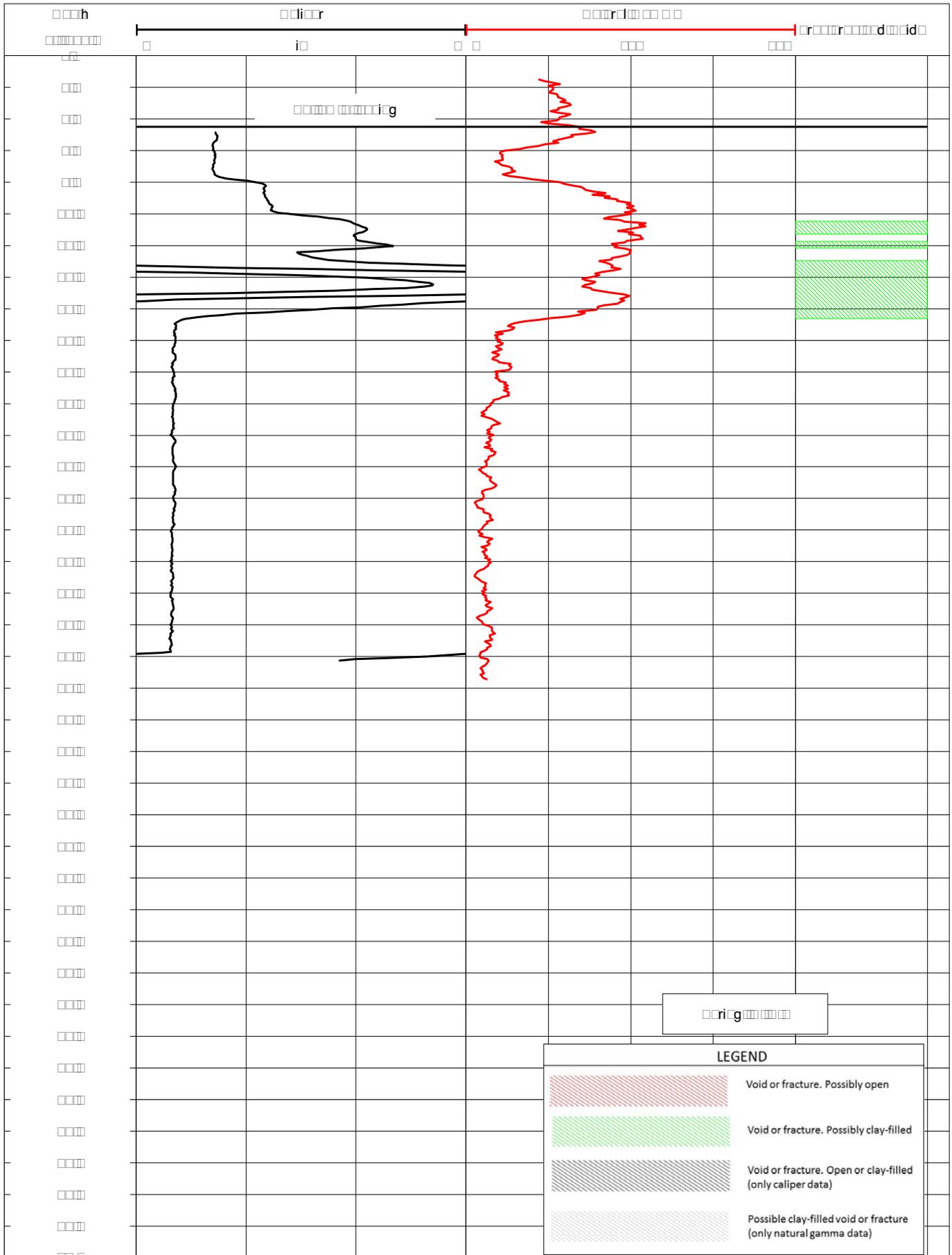
Depth (ft)	Aperture (mm)	Comment
22.4	60	Possibly open
24.0	250	Possibly clay-filled
28.3	310	Possibly open
29.8	120	Possibly open

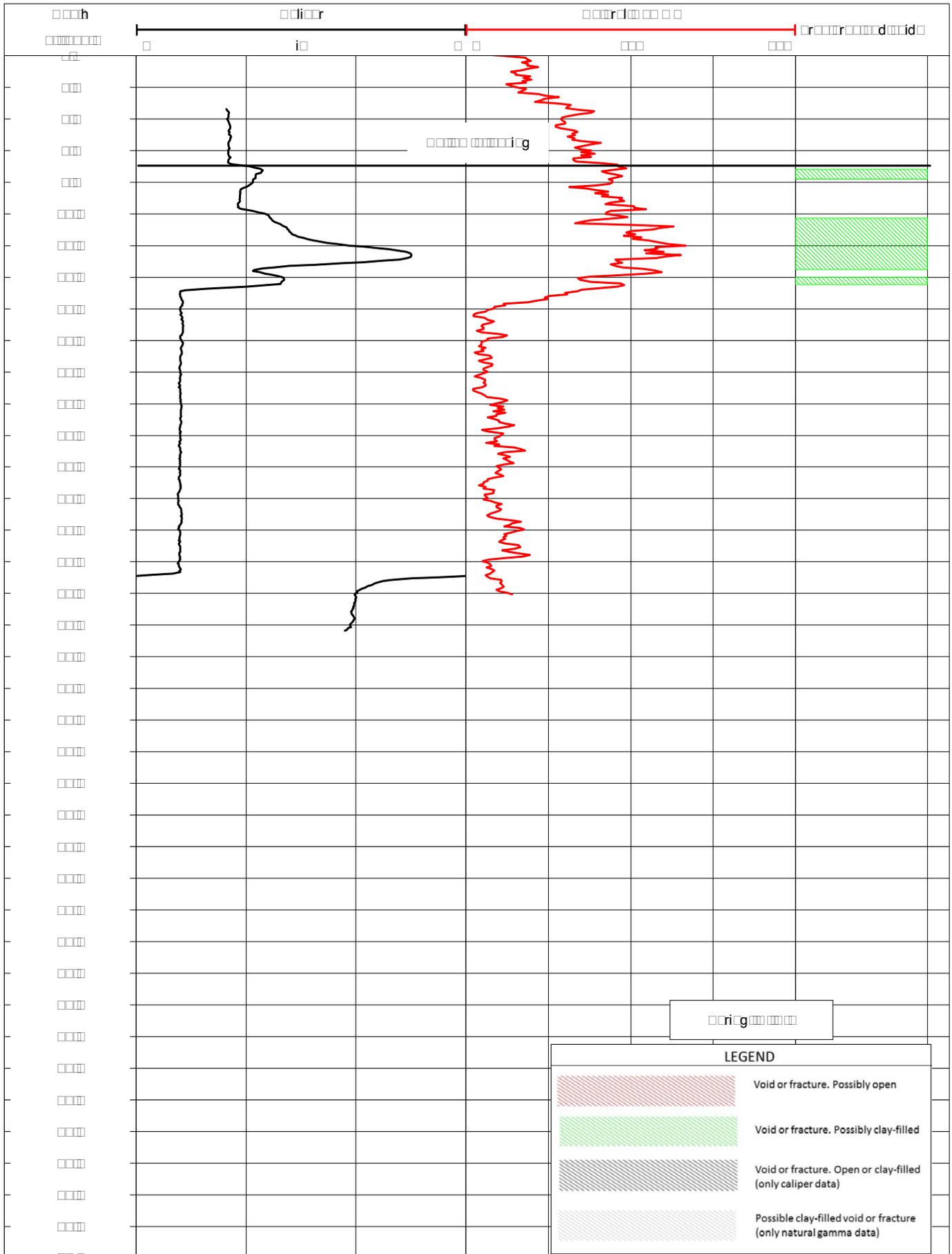
B-22

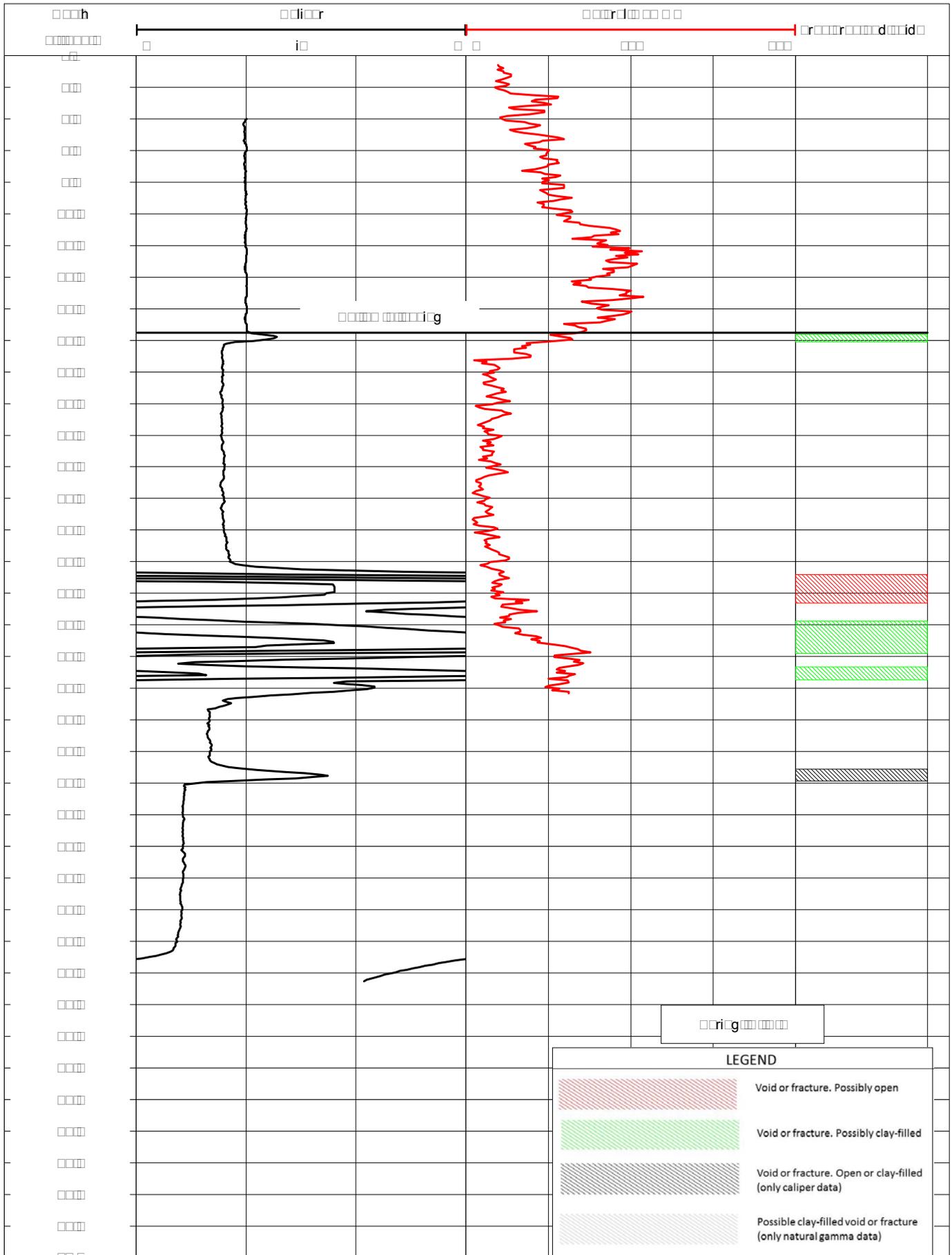
Depth (ft)	Aperture (mm)	Comment
34.2	650	Possibly open

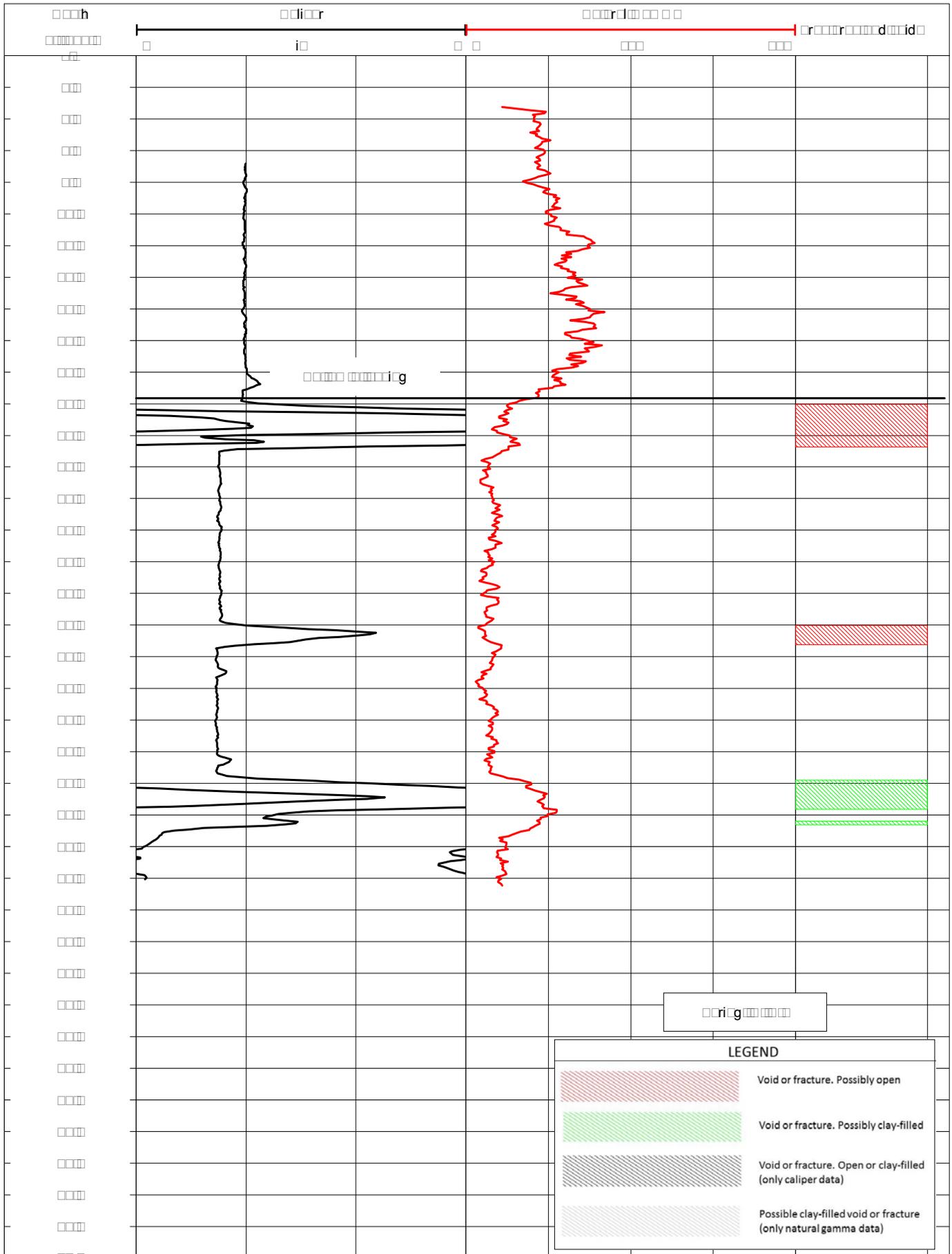
APPENDIX 1

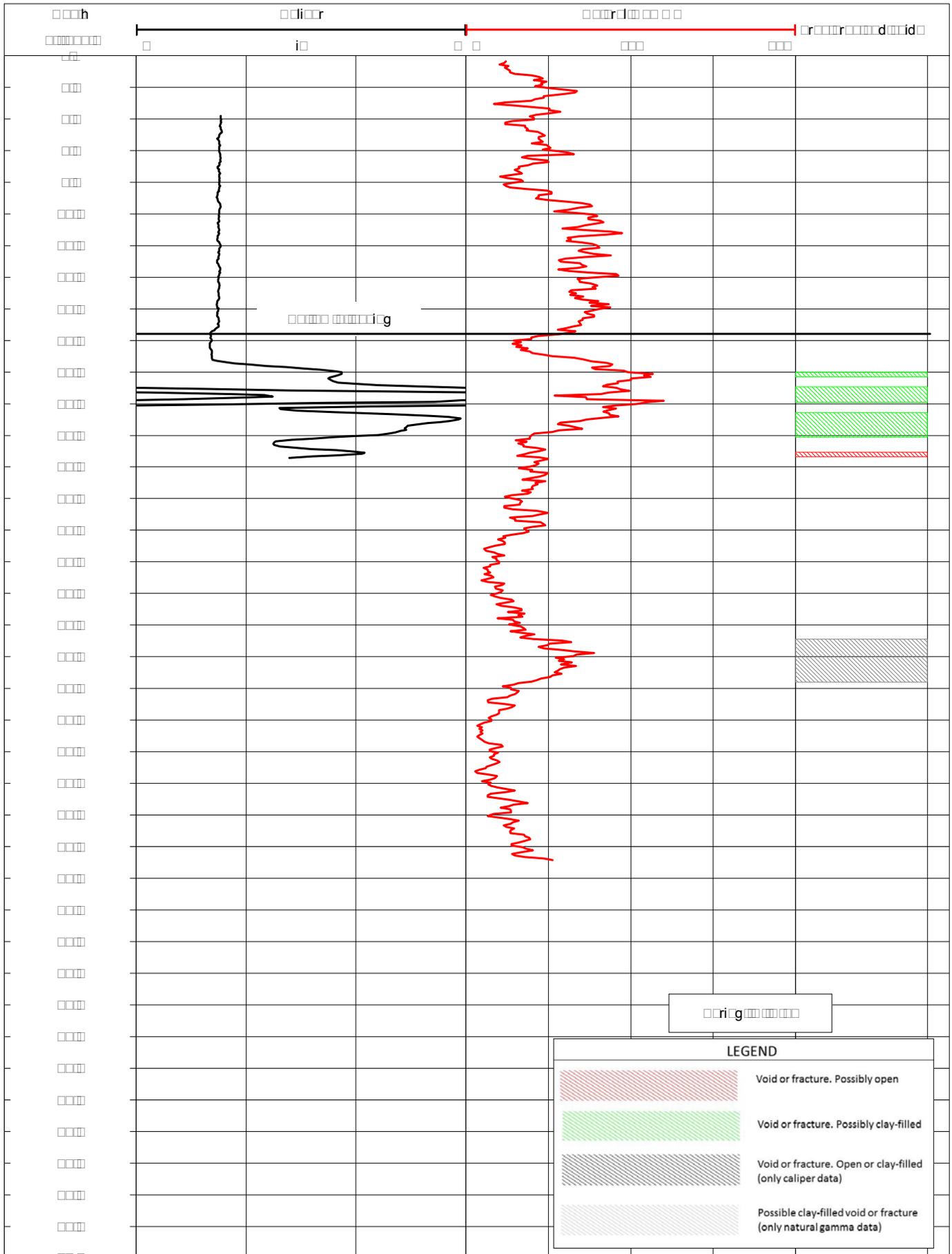


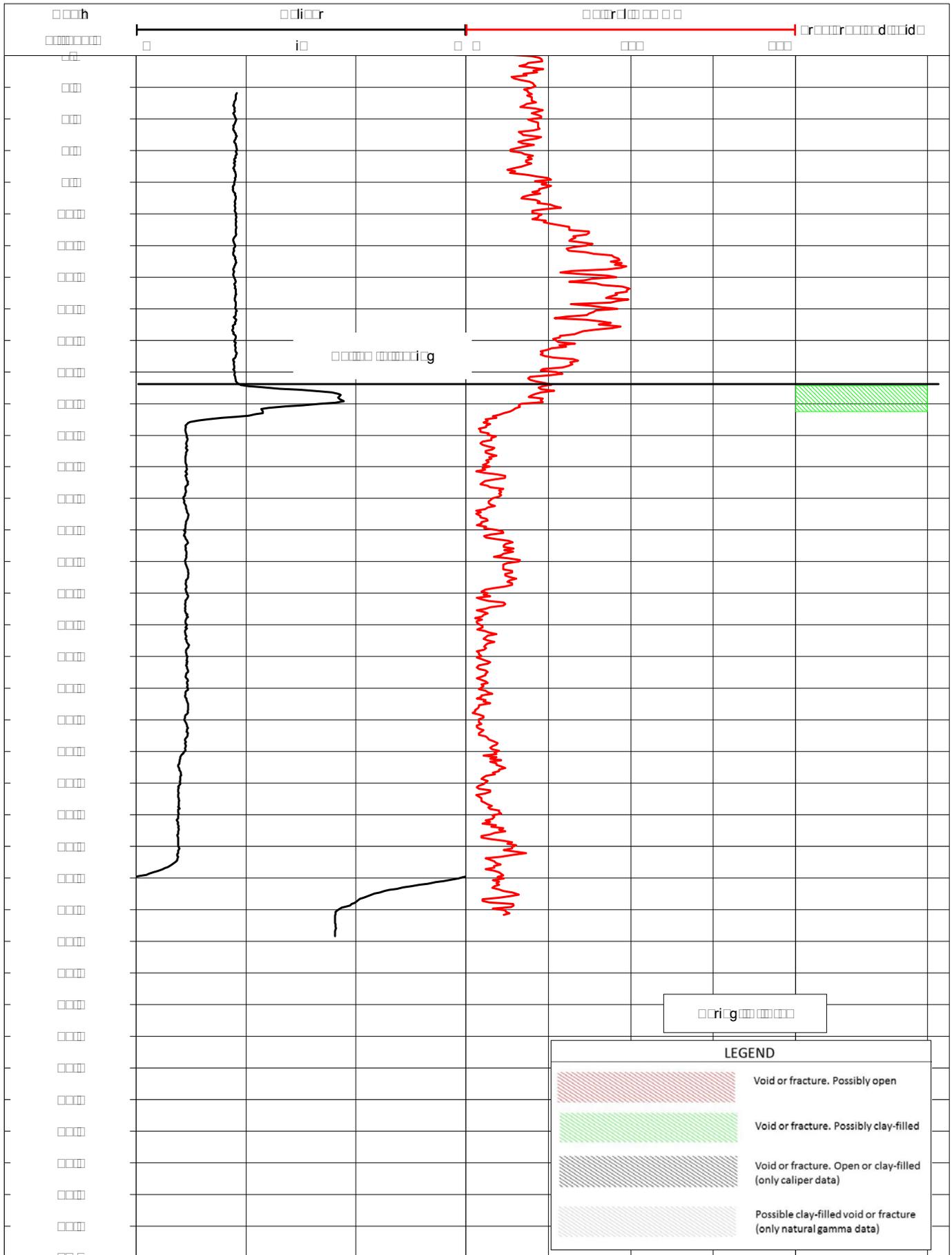


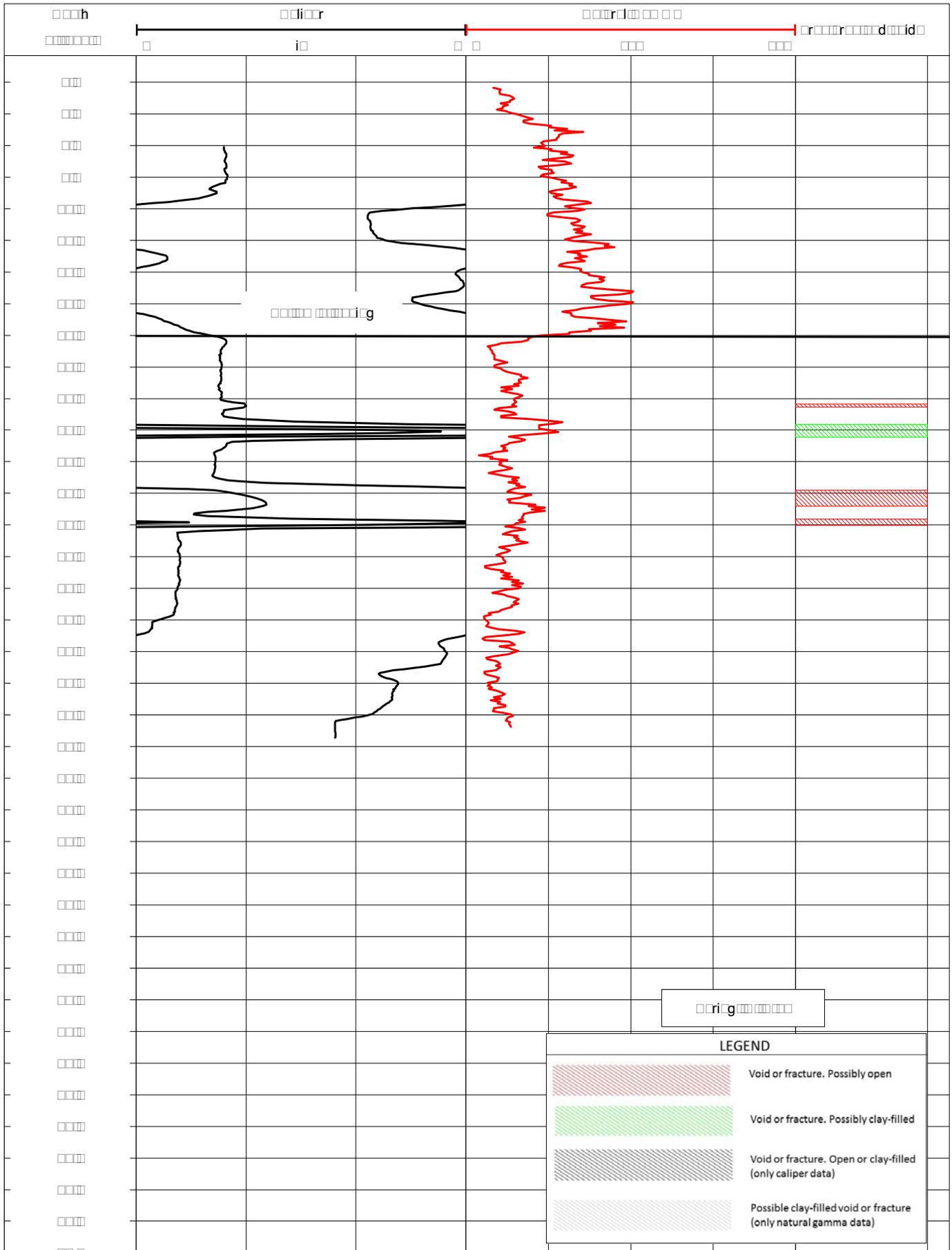


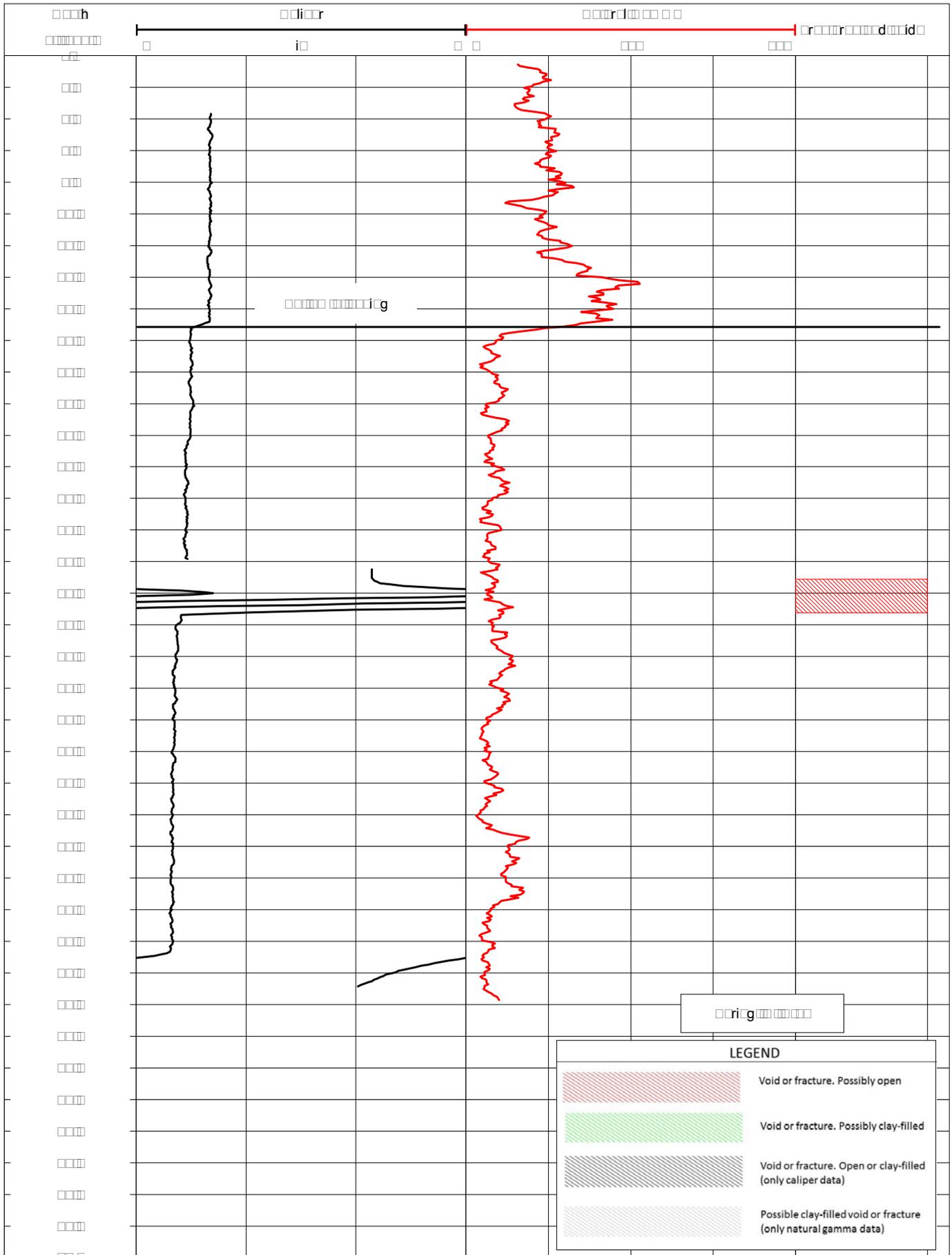












**GEOTECHNICAL REPORT FOR DATA GAP
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Appendix C – Boring Location Plan

**AS-BUILT SURVEY GEOTECHNICAL SOIL BORINGS
Y12 OUTFALL 200 MERCURY TREATMENT FACILITY**

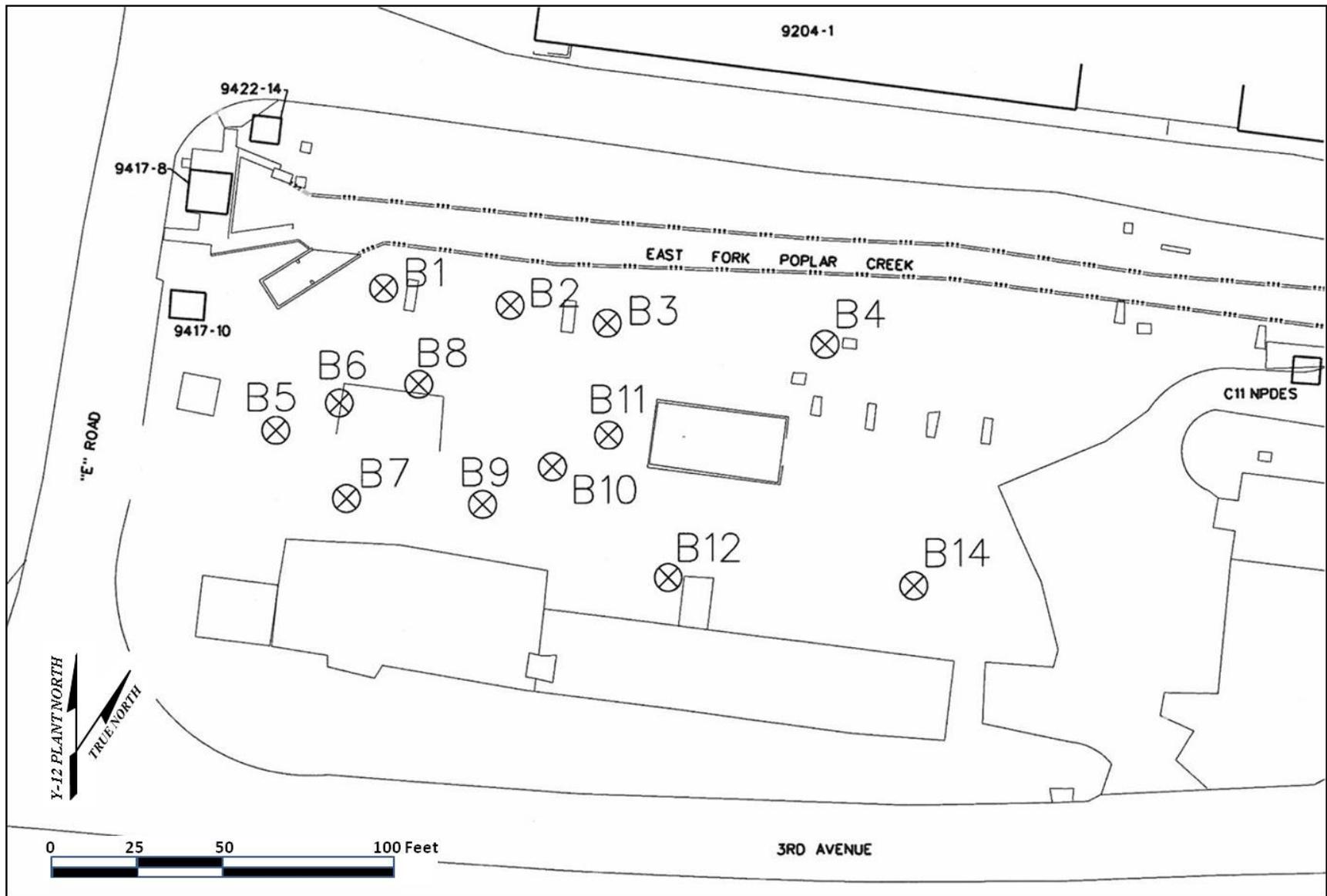
12/1/2016

Borehole ID	Y-12 Grid Easting (ft)	Y-12 Grid Northing (ft)	Elevation (ft amsl)
B-1	57771.7	29296.3	935.55
B-2	57808.5	29291.3	935.18
B-3	57836.8	29286.1	935.69
B-4	57900.5	29279.8	935.63
B-5	57740.1	29254.6	937.38
B-6	57758.7	29262.7	935.62
B-7	57760.8	29234.8	936.00
B-8	57781.9	29268.1	935.13
B-9	57800.4	29233.0	935.62
B-10	57820.8	29244.0	935.67
B-11	57837.2	29253.3	935.46
B-12	57854.7	29211.8	935.70
B-14	57926.3	29209.3	935.75
B-15	61392.9	29008.9	926.38
B-16	61431.3	28993.8	926.58
B-17	61461.9	29014.2	926.39
B-18	61465.8	28974.8	926.34
B-19	61555.5	29007.9	926.37
B-20	61531.3	28928.6	926.04
B-21	61385.1	28961.0	926.43
B-22	61414.4	28931.2	926.14

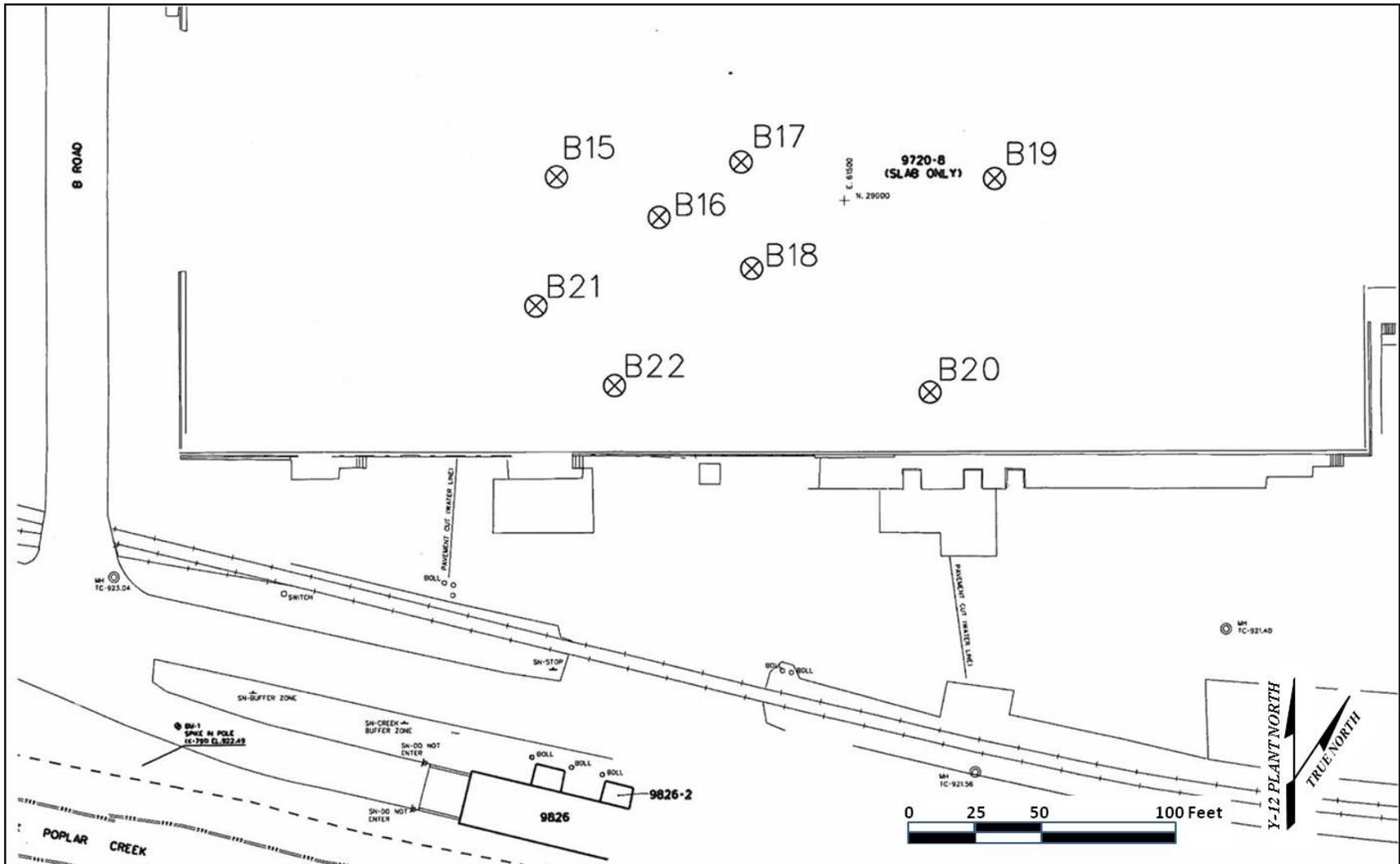
ft = feet

amsl = above mean sea level

Final, completed boring locations were surveyed to the nearest 0.05-ft. amsl as-built elevation and 0.1-ft. horizontally using Y-12 coordinates. Y-12 control point 176 was used for vertical control (NAVD29 datum). Survey performed by Barge Waggoner Sumner & Cannon, Knoxville, Tennessee on December 1, 2016



Borehole locations at the Headworks Area.



Borehole locations at the Outfall 200 Mercury Treatment Facility Area.

**GEOTECHNICAL REPORT FOR DATA GAP
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Appendix D – General Notes for Soil/Rock Classification



GENERAL NOTES FOR SOIL/ROCK CLASSIFICATION

Protecting, Enhancing, and Restoring Our Environment

GROUNDWATER: Observations, if any, are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations thereof), the classification is primarily based upon plasticity. For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor soil constituents are reported as “trace” (0-5%), “some” (5-12%) and “with” (15-29%). Where the minor constituents are in excess of 29%, an adjective is used preceding the major constituent name (i.e. for sands containing 35% silt, the soil is classified as silty sand). In some cases, consistency terms such as very soft, soft, medium stiff, stiff, very stiff, or hard may be used to describe cohesive soils (silt and clay), terms such as very loose, loose, medium dense, dense, or very dense may be used to describe cohesionless soils (sand). For the purposes of describing infilling, these consistency terms are relative, and not based on Standard Penetration Resistances (N) or unconfined compressive strength tests.

PARTICLE SIZE DISTRIBUTION

Boulders	Greater than 12 inches average diameter
Cobbles	3 inches to 12 inches
Gravel	No. 4 (4.75mm) to 3 inches
Sand	No. 200 (0.075mm) to No. 4 (4.75mm)
Silt	0.005mm to 0.075mm
Clay	size is less than 0.005mm

ROCK CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. However, information about local geologic formations can also be used to confirm classifications. Sedimentary, igneous, and metamorphic rock are determined by their color, texture, structure, particle shape and size, mineral composition, cement/matrix, and properties during inspection and/or testing. The occurrence of cementing veins is reported as “occasional” for one or less per foot of depth and “frequent” for more than one per foot of depth.

ROCK CORE EVALUATION

Fracture Density

Unfractured	0 fractures per run
Slightly fractured	spacing \geq 2 ft
Moderately fractured	8 in \leq spacing \leq 2 ft
Highly fractured	2 in \leq spacing \leq 8 in
Intensely fractured	spacing \leq 2 in

Rock Hardness

Very Soft	Deformed by hand, scratched with a fingernail
Soft	Scratched with a fingernail, crumbles with geologic pick
Moderately Hard	Scratched easily with a knife or steel nail
Hard	Broken with one hammer blow, difficulty scratching with knife
Very Hard	Broken with several hammer blows, cannot be scratched with knife or steel nail

Rock Quality (RQD)

Very Poor	RQD $<$ 25%
Poor	25% \leq RQD \leq 50%
Fair	50% \leq RQD \leq 75%
Good	75% \leq RQD \leq 90%
Excellent	90% \leq RQD \leq 100%

Degree of Weathering

Unweathered	No evidence of any chemical or mechanical alteration
Slightly Weathered	Slight discoloration on surface, slight alteration at fractures, less than 10 percent of rock volume altered
Moderately Weathered	Moderate discoloring, 10 percent to 50 percent of rock volume altered
Highly Weathered	Highly discolored, more than 50 percent of rock volume altered

Fracture Healing

Totally Healed Veins	Fracture re-cemented
Moderately Healed Veins	Greater than 50% of fracture material re-cemented
Partly Healed Veins	Less than 50% of fracture material re-cemented
Open Joint	Fracture without cementation, rock does not fit together with adjacent core pieces without open spaces