FINAL REPORT
SUBSURFACE INVESTIGATION
CAMARGO CANYON PUMP STATION ELIMINATION PROJECT
METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI
PID#: 10270026

For:

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Submitted by:

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1. INTRODUCTION

This report presents the results of the subsurface investigation for the Camargo Canyon Pump Station Elimination Project in Columbia Township, east of Cincinnati. The investigation was conducted in general accordance with the Barr & Prevost proposal to Ribway Engineering Group dated April 12, 2012 (revised May 23, 2012). The Metropolitan Sewer District of Greater Cincinnati (MSDGC) will own the proposed sewer, and the investigation has been conducted in accordance with its guidance.

The purpose of the investigation is to characterize the subsurface conditions along the proposed ~900-foot (ft) alignment, perform geotechnical analyses, and provide recommendations for the use of selected geotechnical parameters necessary for the design and installation of the sewer.

2. LOCATION AND SITE CONDITIONS

The overall project consists of approximately 928 ft of sanitary sewer, through Camargo Canyon [located east of Camargo Canyon Drive (Dr)] to Camargo Road (Rd). The alignment runs west to east down the canyon, turns south along an abandoned street alignment[1] paralleling a railroad line for about 300 ft before turning east again to cross beneath the railroad line and continue across the valley of Little Duck Creek to Camargo Rd where it terminates. The project area is shown on Exhibit 1.

The ground surface along the alignment drops from elevation ~740 ft behind Camargo Canyon Dr to ~690 ft at Camargo Rd. The proposed sewer will vary in depth from less than 10 ft to more than 30 ft. The valleys of Little Duck Creek and it tributary are steep sided with slopes extending up to a highly dissected plateau at about elevation 850-900 feet.

2.1. Geology

Physiographically, the site of the proposed sewer is in the Illinoian Till Plain of the Interior Lowland Plateaus Province, part of the Interior Plains region of Ohio (Brockman, 1998). This is characterized as a

[1] USDI, 1961.

rolling ground moraine of older till. The area is underlain by Ordovician- and Silurian-age carbonate rocks and calcareous shales capped with silt-loam, high-lime, Illinoian-age till with loess cap. The erosion of deep, steeply sided valleys by glacial melt water has repeatedly altered the drainage pattern in the area and subsequent infilling of these valleys with glacial outwash and, more recently, with flood plain alluvium creates a landscape that masks the historical features, but which strongly influences soil conditions in the area. Bedrock on the higher ground tends to be mantled with a relatively thin soil cover consisting of glacial till or, on slopes, colluvium.

Bedrock in the vicinity of the sewer alignment is mapped as Grant Lake and Miamitown Shale and Fairview formations (Osborne et.al., 1996). The contact between the Grant Lake formation and underlying Miamitown Shale and Fairview Formation generally occurs at about elevation 800 ft; so with the proposed pipe invert elevation ranging from about 730-675 ft, it is likely that only the Miamitown formation will be encountered. The Miamitown Shale is comprised of interbedded shale and limestone.

The Web Soil Survey (USDA, Natural Resources Conservation Service, 2012) maps the soils in the area as Eden silty clay loam (25 to 40 percent), which is rated as very limited in its capacity to support shallow excavations due to being too steep, depth to soft bedrock, slippage and too clayey.

Earthquake hazard analysis in this part of the country is dominated by proximity to the New Madrid Fault Zone (NMFZ) approximately 330 miles to the southwest. Possible future movements along this fault could generate earthquakes of magnitude 7.0-8.0 with a recurrence period of 500-1,500 years (USGS, 2008). The resulting ground motion would be experienced over a wide area, with Cincinnati located within the likely zone of influence. A cluster of earthquake epicenters of lesser magnitude (<~ magnitude 5) about 150 miles north of Cincinnati indicates another potential earthquake source area that is contributory to seismic risk (ODNR, 2012).

2.2. Hydrogeology

Based on the US Geological Survey topographic map of the area, an intermittent stream parallels the sewer line descending Camargo Canyon before discharging into Little Duck Creek, also an intermittent stream, paralleling Camargo Rd (US Department of the Interior, 1961). Little Duck Creek eventually discharges into Duck Creek, a perennial stream, approximately 3 miles to the south, which ultimately discharges into the Little Miami River. Duck Creek is at approximately elevation 500 ft and may indicate the elevation of the regional water table.

As shown on Federal Emergency Management Agency (FEMA) flood mapping (US Department of Homeland Security, 2010), the area immediately adjacent to Little Duck Creek along Camargo Rd is located in within the 100-year flood plain.

3. PROPOSED CONSTRUCTION

The sewer pipe will be 8 inches in diameter and laid at a depth of up to about 34 ft. Two alternate alignments are under consideration that will require construction of either three or four new manholes (MH) (see Exhibit 1).

The primary alignment (Alternative 1) involves pipe installation by horizontal directional drilling (HDD) from the existing manhole at the head of the line (50116001) to proposed MH 4, followed by trench burial to MH 3 and MH 2. The pipe will be jacked between MH 1 and MH 2 (beneath an active railroad), and placed by trenching from MH 1 to the tie-in on Camargo Road (50109013).

The second alternative alignment (Alternative 2) eliminates MH 3 by directional drilling directly from MH 4 to MH 2. This segment has been designed such that the invert is below the top of bedrock (a necessity for HDD). The depth of downstream segments is increased accordingly.

4. FIELD INVESTIGATION PROGRAM

Five borings were drilled along the proposed sewer alignment at approximate locations shown on Exhibit 1 and as presented in Table 1. They were drilled by Barr & Prevost, Inc. (BPI) between April 9-13, 2013. Boring depths were selected with the intention that the exploration extend at least 3 ft below the invert of the sewer. At least 5 ft of bedrock core was obtained from each boring when rock was encountered. Bedrock was encountered at depths indicated in Table 1.

Table 1: Boring Summary

Boring Number	Invert Elevation (ft)	Ground Elevation (ft)	Location (Ohio State Plane)	Depth to Bedrock (ft)	Boring Depth (ft)
B-001-0-13	730	773.99	N 434098.01 E 1436210.11	3.5	45.0
B-002-0-13	721	728.66	N 434025.02 E 1436483.83	9.0	13.5
B-003-0-13	710	715.98	N 433891.44 E 1436482.18	8.0	12.5
B-004-0-13	688	704.30	N 433736.84 E 1436423.72	15.0	25.0
B-005-0-13	682	694.45	N 433666.55 E 1436588.60	>21.5	21.5

The borings were drilled using an off-road vehicle (ORV) mounted B-57 rig with 3.25-inch diameter hollow stem augers and NQ2 coring equipment. Soil samples were recovered at intervals of 2.5 ft using a split spoon sampler (ASTM method D 1586 – Test Method for Penetration Test and Split Barrel Sampling of Soils) and placed in sealed jars. The standard penetration test (SPT) was conducted using a

CME auto hammer that has been calibrated as being 95.1% efficient and which results in N values that must be converted to N_{60} for use in analysis or for correlation purposes. Cores were taken from bedrock using NQ2 coring equipment with water as the drilling fluid. Cores were placed in core boxes for shipment.

Field boring logs were prepared by BPI's field personnel, including lithological description, and standard penetration test results recorded as blows per 6-inch increment of penetration. Groundwater related observations were included. Boring logs were prepared by BPI based on the information obtained from the field logs and a review of the samples and cores in the laboratory by a geologist. Final classification of the soil strata took place once the laboratory test results became available. The logs of the borings are presented in Appendix A.

Each boring was sealed with bentonite chips and grout upon completion. Samples will be retained at the laboratory for 60 days following report submittal, after which time they will be discarded. Rock cores will be made available to MSDGC upon request.

5. LABORATORY TESTING

Selected soil samples were subjected to a laboratory-testing program to develop information regarding the physical properties of the materials encountered. All split-spoon soil samples were tested for natural moisture content, and soil classification related testing (Atterberg limits, and particle size analysis) was conducted on about 50% of the samples, the results shown on the boring logs (Appendix A).

5.1. Unconfined Compression Testing

Two samples of the limestone bedrock were tested in unconfined compression. The results are shown in Table 2 and the material is characterized as slightly to moderately strong; the results are provided in Appendix B.

Table 2: Unconfined Compression Testing Results

Boring Number	Depth (ft)	Material	Unconfined Compressive Strength (psi)	Strain (%)	Moisture Content (%)
B-001-0-13	26	limestone	6,470	1.7	0.2
B-001-0-13	41	limestone	3,243	0.9	1.5

6. SUBSURFACE CONDITIONS

The general stratigraphy is consistent with the geological model described above. From the tie-in manhole on Camargo Rd to proposed manhole MH 2 the sewer will cross the flood plain of Little Duck Creek. Both of these manholes are close to or at the bedrock valley wall. Between them, overburden soils include a significant body of fill extending from just beyond the Camargo Rd right-of-way to near the rail road right-of-way placed in connection with construction of a 10 x 20 ft culvert that conveys the flow of Little Duck Creek from north to south (transverse to the proposed sewer). From MH 4 to the existing manhole at the head of the proposed sewer (50116001) the alignment traverses the valley wall of a steeply incised tributary to Little Duck Creek, terminating at the creek bed.

6.1. Overburden

Overburden soils in the project area may exist as four distinct types - man-made fill, flood plain deposits, glacial tills, and residual soil/colluvium. Man made fill in the form of stiff to very stiff lean clay was encountered in B-005-0-13 to a depth of 18.5 ft underlain by medium dense silt.

Boring B-004-0-13 was drilled at the likely location of a receiving pit for the planned thrust bore beneath the railroad. The overburden soils at this location consist of very stiff to hard clays interpreted to be glacial till. The clays contain traces of sand and gravel and vary from high (upper 4 ft) to low plasticity. B-003-0-13 and B-002-0-13 encountered 9 and 8 ft of overburden, respectively, generally consisting of very stiff high plasticity clay.

Overburden soil along the steep valley wall between MH 4 and MH 50116001 was sampled in B-001-0-13 where it was a 3.5 ft thickness of low plasticity glacial till. No colluvium or residual soils were encountered in the borings.

Exploration by others (Thelen, 2002) provides some additional information on the shallow geological profile. Two auger borings drilled near the proposed alignment between MH 4 and MH 50116001 encountered a layer of stiff clay (8.5 to 9.5 ft thick) below which highly weathered bedrock in the form of stiff silty clay with some bedding structure and limestone 'floaters' occurred. These borings terminated at a depth of 13 - 15.5 ft when either auger or sample refusal occurred.

The combined findings of the earlier exploration and the current one suggest that the concept of 'top of rock' is extremely fluid. The upper bedrock appears to have weathered differentially to a depth of at least 15 ft resulting in a stratigraphy where thin intact limestone beds are interspersed with soil-like weathered shale. Such conditions should be expected throughout the project area upstream from MH 2.

6.2. Bedrock

Bedrock is interpreted to be the Miamitown Shale formation comprised of interbedded shale and limestone. Shale/limestone fractions for the recovered cores are presented on the logs of borings. The limestone appears as discrete strata on the order of 4"-8" in thickness. Miamitown Shale is reported to contain up to 90% shale.

The rock quality designation (RQD) for the recovered core is generally low (0-49%) suggesting a high degree of fracturing in both the shale and limestone. The shale is not expected to exceed a compressive strength of 1,200 psi and may be considerably lower at shallow depth. Limestone compressive strengths on the order of 3,000-6,000 psi were measured in the laboratory.

6.3. Groundwater

Free groundwater was not encountered in any of the borings.

7. ANALYSIS AND RECOMMENDATIONS

Three pipe installation technologies are expected to be applied to the installation of the sewer as shown in Table 3. These are considered separately below. A previous alternative for open trench construction from MH4 to 50116001 is no longer under consideration and is not discussed further.

Table 3: Pipe Installation Technologies

Sewer Segment	Technology	Notes
MH 50109013 to MH 1	Open trench construction	maximum invert depth ~ 18 ft
MH 1 - MH 2	Jack and bore	depth to invert may increase for Alt 2
MH 2 - MH 3 - MH 4 (Alt 1)	Open trench construction	
MH 2 - MH 4 (Alt 2)	Horizontal directional drilling	assume drill from MH 4 to MH 2
MH 4 - MH 50116001	Horizontal directional drilling	assume drill from 50116001 to MH 4

7.1. Existing MH 50109013 (Camargo Rd) to MH 1

The first 124-ft segment will be installed in an open trench excavated to a depth of 10-15 ft through (primarily) clayey man-made fill. A temporary retaining system will be required to support the vertical walls of pits and trenches excavated in the course of the sewer and manhole installation above bedrock.

The design of such a system for support of soil should consider a trapezoidal earth pressure distribution as shown in Exhibit 2. Allowance should be made for surcharge loads (such as traffic, excavated spoil, or construction equipment) that might be imposed near the retaining system. Surcharge loads should not impact trench stability if they are maintained a distance at least the supported trench depth away from its edge.

7.2. MH 1 to MH 2 (Jack and Bore)

The sewer will pass beneath the active railroad in a 24-inch steel casing at a depth of 5-7 ft below the track (Alt 1) or 10-13 ft (Alt 2) installed by the jack and bore method. The nominal live load applied by the railroad (Cooper E-72 loading) is estimated to be 3,360 pounds per linear foot (plf) on the crown of the casing.

Bedrock should be encountered at a depth of about 15 ft in the receiving pit, but is not expected in the thrust pit. Shoring of the pits may be designed using the following shear strength values.

Thrust pit:	1,000 psf	
Receiving pit:	0-5 ft	1,000 psf
	5-15 ft	2,000 psf
	>15 ft	weathered bedrock

7.3. MH 2 to MH 3 to MH 4 (Alt 1)

These two segments are similar in that they parallel the valley wall along the abandoned road alignment and geotechnical conditions are expected to be relatively constant throughout with 8-10 ft of overburden soils overlying bedrock in the MH 3 - MH 4 segment and about 15 ft at MH 2. The material at MH 2 appears to be hard glacial till.

Shoring will be required for excavations created in this material although the natural cross slope of about 2.3H:1V will not dictate the need for tight sheet shoring. Shoring may be designed using the soil strength profile given in Section 7.2 for the receiving pit at MH 4.

7.4. MH 2 to MH 4 (Alt 2)

Alternate 2 employs HDD to extend the pipe on a direct alignment from MH 2 to MH 4, so avoiding the need for MH 3. Ribway has proposed to deepen the invert by about 5 ft at MH 4 in order to ensure that the HDD operation will be entirely in rock. Five feet should provide an adequate rock buffer above the

drill to reduce the likelihood of caving, although it should be mentioned that the deep soil in the vicinity of MH 2 appears to be a hard glacial till that is expected to stable. The proposed direct alignment is up to 25 ft horizontally and 10 ft vertically above the Alt 1 alignment. Subsurface conditions beneath this alignment are expected to be similar to those observed elsewhere with a soil and weathered rock mantle of similar dimensions.

It is expected that the HDD operation will take place by drilling the pilot down from MH 4 to MH 2 and that bentonite drilling fluid will be used to remove cuttings from the hole. The hole will be reamed back from MH 2 to MH 4 as the pipe is pulled through the enlarged pilot. The HDD drill will set up a few feet east of MH 2 and angle drill down to the invert level of MH 2 before establishing the sewer grade for the remainder of the advance. Maintaining a constant grade will require great care and skill by the driller as the frequently occurring horizontally oriented limestone layers will try to deflect the drill along their surface. Once penetrated, there may be a tendency for the drill to plunge into the soft intervening shale layers.

The actual entry pit for the HDD operation is likely to be shallow and require only nominal shoring or sloping walls. The excavations for MH 2 and MH 4 should be shored as discussed in Section 7.1.

7.5. MH 4 to MH 50116001

It is proposed to install this ~ 380 ft segment by HDD in order to avoid the need for the more than 30 ft of rock excavation that would otherwise be required. The site access and room for operations is very limited in the vicinity of MH 50116001, which was constructed in bedrock in the streambed between, steeply sloping valley walls of the narrow tributary to Little Duck Creek. It is assumed that the manhole surround will be excavated to expose the inflow pipe and that the HDD drill will be positioned a few feet upstream in the creek bed. The entry pit will be shallow and formed in rock, and require no special stabilizing requirements.

The excavation for MH 4 will be created and serve as the target pit for the drill which, after passing through the pit it will daylight a few feet to the south where the terrain drops away. The area around MH 4 can be used to stage the pipe and reaming equipment.

7.6. Pipe Design Related Recommendations

The following table provides an estimate of the vertical earth load on 8-inch diameter pipes installed using the open cut method and using a trench shield with near-vertical trench walls. Granular (sandy) backfill is assumed. The values are based on the Marston equation (NCPI, 2006).

Table 4: Vertical Earth Load on Pipe

Location	MH 50109013	MH 1	MH 2	MH 3	MH 4
Pipe Diameter (in)	8	8	8	8	8
Pipe Crown Depth (ft)	15	8	18	7	10
Trench Width (inches)	24	24	24	24	24
Vertical Earth Load (plf)	1,110	888	1,149	847	979
Trench Width (inches)	18	18	18	18	18
Vertical Earth Load (plf)	656	564	668	535	606

Vertical pressures are influenced strongly by the width of the trench for open cut construction. Note that it is the trench width in the zone above the pipe crown that is considered when computing the load on pipes installed in trenches with sloping walls. The use of excavated material as backfill material will result in an increase of 40-50% over the values presented in Table 4.

8. CONSTRUCTION CONSIDERATIONS

Following are general construction related recommendations for open cut construction of the sewer.

8.1. Excavation

Excavations should be performed in compliance with local, state and federal regulations. The potential effect of ground movements on nearby structures, roadways and utilities should be considered when planning the construction program. If sloped excavations in the overburden are considered for the open cut method of installation, the walls should be sloped not steeper than 2 horizontal to 1 vertical (2:1).

8.2. Dewatering

Significant inflow of groundwater into open excavations terminated above the elevation of the tributary to Little Duck Creek is not anticipated, although the possibility of perched groundwater at the soil/bedrock interface cannot be ruled out. Below the creek flow line elevation, it is possible that significant groundwater flow could occur if open fractures in the bedrock are present.

Surface water should be directed away from open excavations and the bottom of those excavations should be sloped where possible to promote the drainage of unwanted water to points from which it can be pumped. The tributary to Little Duck Creek is intermittent, but drilling operations will require careful planning to allow time to move off-site in the event that significant rainfall is forecast.

8.3. Backfill

All backfill material should be as specified, and pre-approved by the site engineer. It should be free of organic materials and debris. For backfill against structures such as manholes, porous granular material is recommended. Backfill under roads should also consist of granular material to facilitate compaction and minimize future settlement.

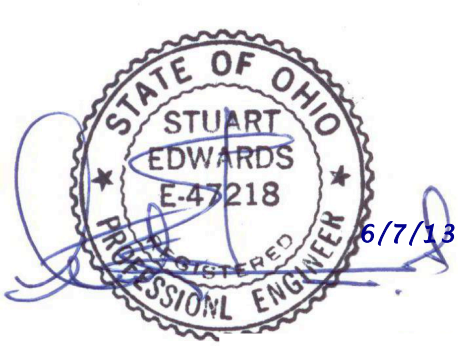
9. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of determining sewer design related recommendations only. Verification of the subsurface conditions for purposes of determining contamination, or the effect of excavation on existing structures, is beyond the scope of this study. The analyses and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on Exhibit 1, and presented on the Boring Logs (Appendix A). This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the proposed sewer are made, the conclusions and recommendations contained in this report should not be considered valid until the changes are reviewed, and the conclusions and recommendations in this report have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Ribway Engineering Group and the Metropolitan Sewer District of Greater Cincinnati on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Barr & Prevost



Enoch Chipukaizer
Principal

Stuart Edwards, P.E.
Geotechnical Engineer

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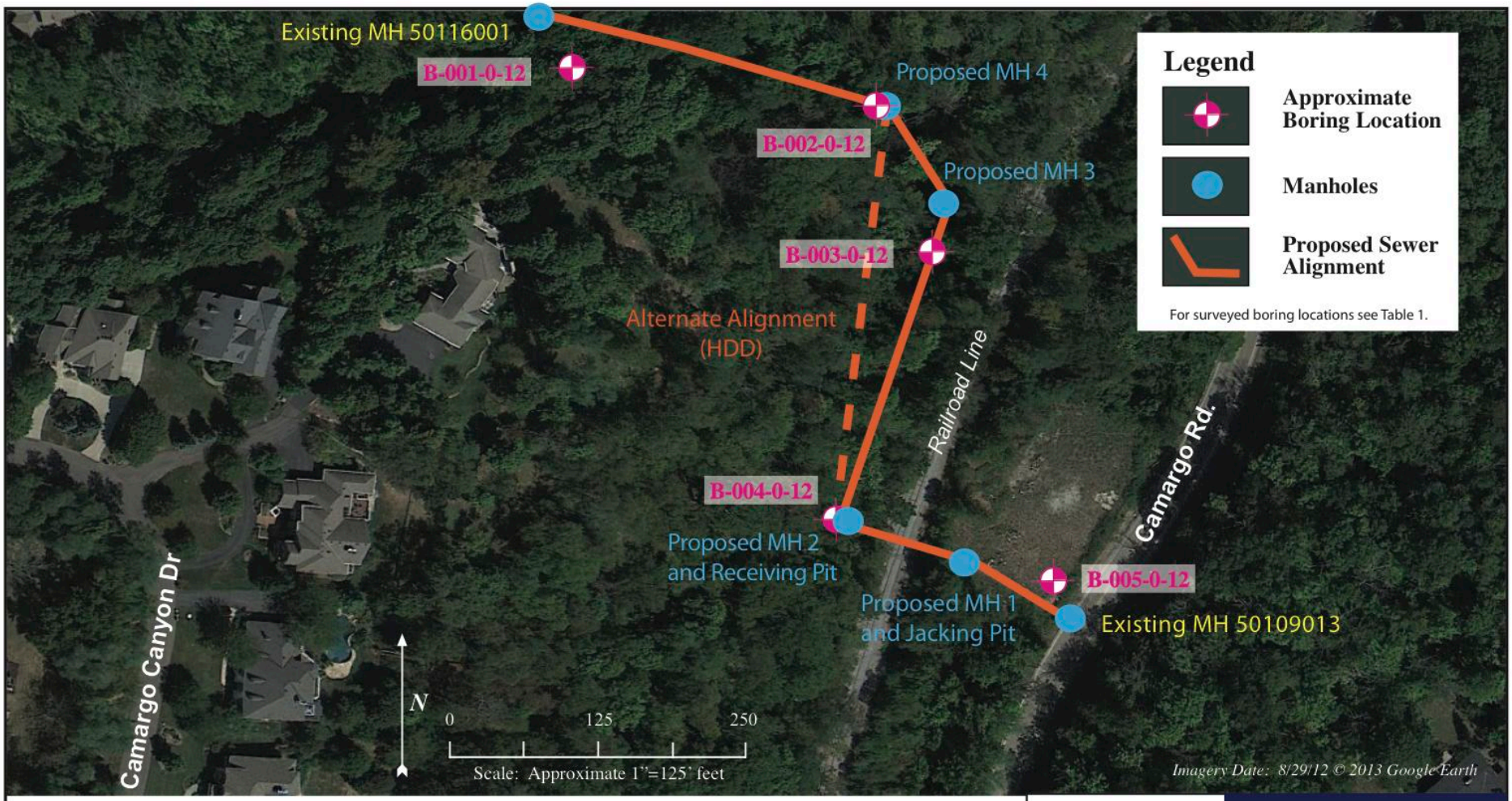

Area of Detail



Exhibit 1

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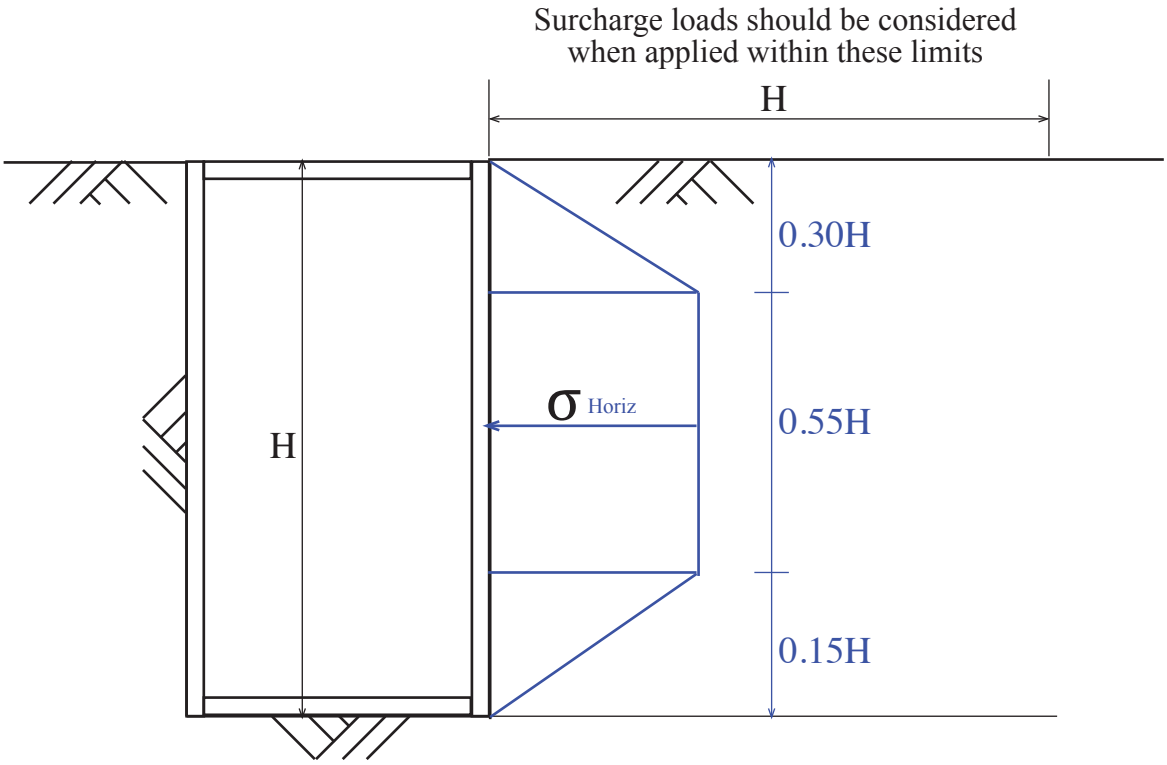
Boring Locations

MSD - Camargo Canyon Pump Station Elimination Project



$$\sigma_{Horiz} = 36 \times H(ft)\ psf\ ^{(1)}$$

(1) Source: Terzaghi and Peck, 1967.

Exhibit 2

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Lateral Earth Pressure for Braced Excavation Design in Stiff Clay

MSD - Camargo Canyon Pump Station Elimination Project

APPENDIX A

LOGS OF BORINGS AND ROCK CORE PHOTOGRAPHS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G

PROJECT: CARMARGO CANYON	DRILLING FIRM / OPERATOR: B&P / P. WEBB	DRILL RIG: MOBILE B57 ORV	STATION / OFFSET:	EXPLORATION ID B-001-0-13
TYPE: PUMP STATION ELIMINATION	SAMPLING FIRM / LOGGER: B&P / R.BLASKO	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:	
PID: Client: MSDGC/RIBWAY	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 6/30/11	ELEVATION: 734.0 (MSL) EOB: 45.0 ft.	PAGE 1 OF 2
START: 4/10/13 END: 4/10/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 95.1	COORD: 434098.010 N, 1436210.110 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 734.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
STIFF TO VERY STIFF, BROWN MOTTLED WITH ORANGE-BROWN, **LEAN CLAY**, TRACE SAND, MOIST		1	1 2 2	6	61	SS-1	1.5 - 3.1	0	0	4	2	44	52	47	24	23	28	CL	
	730.5	TR 3																	
INTERBEDDED SHALE (70%) AND LIMESTONE (30%), RQD 13.1%, REC. 48.7%; **SHALE**, GRAY, MODERATELY WEATHERED, VERY WEAK, LAMINATED, CONTAINS BROWN CLAY LAYERS BETWEEN LIMESTONE BEDS, JOINT DISCONTINUITIES, HIGHLY FRACTURED, OPEN, SLIGHTLY ROUGH; **LIMESTONE**, GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED, FOSSILIFEROUS.		4	0		33	NQ-1												CORE	
		8	11		28	NQ-2													CORE
		13	18		29	NQ-3													CORE
		18	9		62	NQ-4													CORE
		23	32		73	NQ-5													CORE
@26.8'; SHALE BECOMES WEAK.		28																	

PID:	BR ID:	PROJECT: CARMARGO CANYON	STATION / OFFSET:	START: 4/10/13	END: 4/10/13	PG 2 OF 2	B-001-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
INTERBEDDED SHALE (70%) AND LIMESTONE (30%), RQD 13.1%, REC. 48.7%; **SHALE**, GRAY, MODERATELY WEATHERED, VERY WEAK, LAMINATED, CONTAINS BROWN CLAY LAYERS BETWEEN LIMESTONE BEDS, JOINT DISCONTINUITIES, HIGHLY FRACTURED, OPEN, SLIGHTLY ROUGH; **LIMESTONE**, GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED, FOSSILIFEROUS. *(continued)*	704.0	31	0		26	NQ-6													CORE	
	699.0	35																	
INTERBEDDED LIMESTONE (57%) AND SHALE (43%), RQD 40.2%, REC. 90.8%; **LIMESTONE**, GRAY TO LIGHT GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, THIN BEDDED, FOSSILIFEROUS, BEDDING DISCONTINUITIES, FRACTURED, NARROW, SLIGHTLY ROUGH; **SHALE**, DARK GRAY, SLIGHTLY WEATHERED, WEAK TO SLIGHTLY STRONG, LAMINATED.		40	49		93	NQ-7													CORE	
	689.0	EOB 45	31		89	NQ-8													CORE	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. CAVE DEPTH 8.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED .5 BAG BENTONITE CHIPS; PUMPED 33 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G



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Rock Core B-001-0-13
Runs 1-4

MSD - Camargo Canyon Pump Station
Elimination Project



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Rock Core B-001-0-13
Runs 5-7

MSD - Camargo Canyon Pump Station Elimination Project

PROJECT: CARMARGO CANYON	DRILLING FIRM / OPERATOR: B&P / P. WEBB	DRILL RIG: MOBILE B57 ORV	STATION / OFFSET:
TYPE: PUMP STATION ELIMINATION	SAMPLING FIRM / LOGGER: B&P / R.BLASKO	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:
PID: Client: MSDGC/RIBWAY	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 6/30/11	ELEVATION: 728.7 (MSL) EOB: 13.5 ft.
START: 4/9/13 END: 4/9/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 95.1	COORD: 434025.020 N, 1436483.830 E

EXPLORATION ID: B-002-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 728.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
MEDIUM STIFF, BROWN MOTTLED WITH ORANGE-BROWN, **LEAN CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	725.7	1 2 3	2 2 3	8	44	SS-1	0.8 - 1.7	-	-	-	-	-	-	-	-	-	27	CL (V)	
STIFF TO VERY STIFF, BROWN MOTTLED WITH ORANGE-BROWN, **FAT CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	719.7	4 5 6 7 8	3 3 5	13	67	SS-2	2.4 - 3.5	0	0	2	1	38	60	52	22	30	25	CH	
			6 11 50/2"	-	71	SS-3	1.6 - 3.9	-	-	-	-	-	-	-	-	-	23	CH (V)	
INTERBEDDED SHALE (70%) AND LIMESTONE (30%), RQD 0%, REC. 19%; **SHALE**, GRAY, SLIGHTLY WEATHERED, VERY WEAK, LAMINATED, CONTAINS CLAY LAYERS BETWEEN LIMESTONE BEDS, JOINT AND BEDDING DISCONTINUITIES, HIGHLY FRACTURED, OPEN, SLIGHTLY ROUGH; **LIMESTONE**, GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED.	715.2 TR EOB	9 10 11 12 13	0		27	NQ-1												CORE	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. CAVE DEPTH 5.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED .5 BAG BENTONITE CHIPS; PUMPED 5 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G

PROJECT: CARMARGO CANYON	DRILLING FIRM / OPERATOR: B&P / P. WEBB	DRILL RIG: MOBILE B57 ORV	STATION / OFFSET:
TYPE: PUMP STATION ELIMINATION	SAMPLING FIRM / LOGGER: B&P / R.BLASKO	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:
PID: Client: MSDGC/RIBWAY	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 6/30/11	ELEVATION: 716.0 (MSL) EOB: 12.5 ft.
START: 4/9/13 END: 4/9/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 95.1	COORD: 433891.440 N, 1436482.180 E

EXPLORATION ID B-003-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
VERY STIFF, BROWN MOTTLED WITH ORANGE-BROWN, **FAT CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	716.0	1	7 4 3	11	56	SS-1	2.7 - 2.9	-	-	-	-	-	-	-	-	-	28	CH (V)	
		2																	
		3																	
		4	2 10 17	43	50	SS-2	2.7 - 3.4	-	-	-	-	-	-	-	-	-	26	CH (V)	
		5																	
		6	11 7 11	29	39	SS-3	3.1 - 3.5	-	-	-	-	-	-	-	-	-	24	CH (V)	
	708.0	TR 7																	
INTERBEDDED SHALE (70%) AND LIMESTONE (30%), RQD 0%, REC. 24.1%; **SHALE**, GRAY, MODERATELY WEATHERED, VERY WEAK, LAMINATED, CONTAINS CLAY LAYERS BETWEEN LIMESTONE BEDS, JOINT AND BEDDING DISCONTINUITIES, HIGHLY FRACTURED, OPEN, SLIGHTLY ROUGH; **LIMESTONE**, GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED.		8	0		32	NQ-1													CORE	
	703.5	EOB 9																	
		10																	
		11																	
		12																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. CAVE DEPTH 7.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED .5 BAG BENTONITE CHIPS; PUMPED 12 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G





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Rock Cores B-002-0-13 and B-003-013 Run 1

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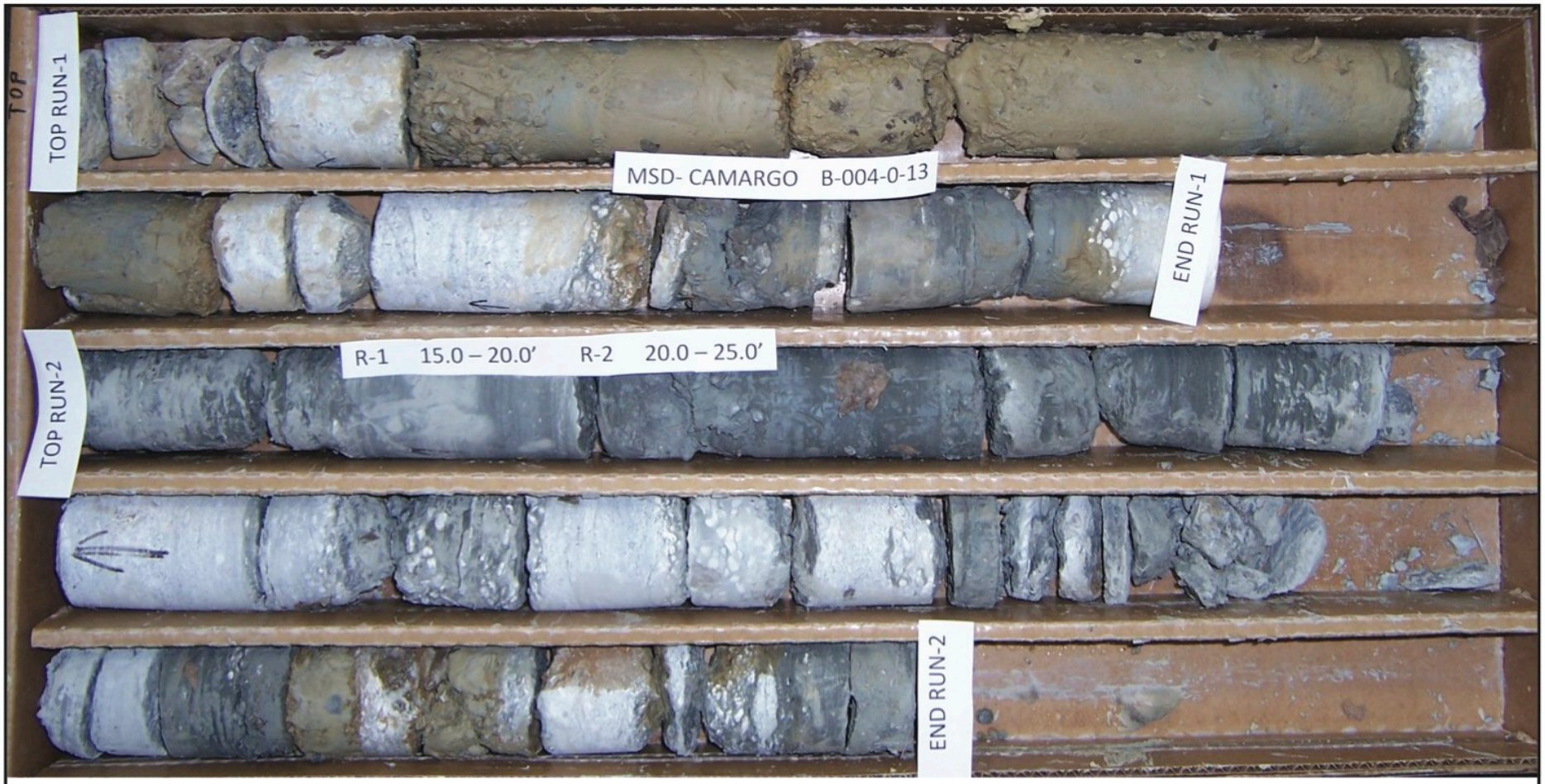
STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G

PROJECT: CARMARGO CANYON	DRILLING FIRM / OPERATOR: B&P / P. WEBB	DRILL RIG: MOBILE B57 ORV	STATION / OFFSET:	EXPLORATION ID B-004-0-13
TYPE: PUMP STATION ELIMINATION	SAMPLING FIRM / LOGGER: B&P / R.BLASKO	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:	
PID: Client: MSDGC/RIBWAY	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 6/30/11	ELEVATION: 704.3 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 4/9/13 END: 4/9/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 95.1	COORD: 433666.550 N, 1436588.600 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 704.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
VERY STIFF, BROWN MOTTLED WITH ORANGE-BROWN, **FAT CLAY**, TRACE SAND, TRACE GRAVEL, MOIST			5 3 3	10	61	SS-1	2.8 - 3.0	-	-	-	-	-	-	-	-	-	24	CH (V)	
	700.8																		
BROWN, **GRAVELLY, LEAN CLAY**, TRACE SAND, MOIST			3 6 34	63	44	SS-2	3.5 - 4.5	29	6	6	4	25	30	38	17	21	20	CL	
@10.0'; VERY STIFF TO HARD, CHANGES TO BROWN MOTTLED WITH GRAY, **LEAN CLAY**, TRACE SAND, TRACE GRAVEL, DAMP			6 16 29	71	89	SS-3	4.5+	-	-	-	-	-	-	-	-	-	15	CL (V)	
	689.3	TR																	
INTERBEDDED SHALE (70%) AND LIMESTONE (30%), RQD 54.3%, REC. 100%; **SHALE**, GRAY, MODERATELY WEATHERED, VERY WEAK, LAMINATED, BEDDING AND JOINT DISCONTINUITIES, FRACTURED, OPEN-NARROW, SLIGHTLY ROUGH; **LIMESTONE**, GRAY TO LIGHT GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED, FOSSILIFEROUS.	686.5		30		70	NQ-1												CORE	
SHALE, DARK GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG, LAMINATED, BEDDING DISCONTINUITIES, MODERATELY FRACTURED, NARROW, SLIGHTLY ROUGH; RQD 22.9%, REC 69.2%.	682.5																		
INTERBEDDED LIMESTONE (85%) AND SHALE (15%), RQD 0%, REC. 80.7%; **LIMESTONE**, GRAY TO LIGHT GRAY, UNWEATHERED, MODERATELY STRONG, THIN BEDDED, FOSSILIFEROUS, BEDDING DISCONTINUITIES, FRACTURED, NARRROW, SLIGHTLY ROUGH; **SHALE**, DARK GRAY, SLIGHTLY WEATHERED, WEAK TO SLIGHTLY STRONG.	679.3	EOB	18		93	NQ-2												CORE	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. CAVE DEPTH 11.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED .5 BAG BENTONITE CHIPS; PUMPED 20 GAL. BENTONITE GROUT



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Rock Core B-004-0-13
Runs 1-2

MSD - Camargo Canyon Pump Station Elimination Project

PROJECT: CARMARGO CANYON	DRILLING FIRM / OPERATOR: B&P / ISON	DRILL RIG: MOBILE B57 ORV	STATION / OFFSET:
TYPE: PUMP STATION ELIMINATION	SAMPLING FIRM / LOGGER: B&P / R.BLASKO	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:
PID: Client: MSDGC/RIBWAY	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 6/30/11	ELEVATION: 694.5 (MSL) EOB: 21.5 ft.
START: 4/11/13 END: 4/11/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 95.1	COORD: 433666.550 N, 1436588.600 E

EXPLORATION ID: B-005-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 694.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	MS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	USCS CLASS	HOLE SEALED
VERY STIFF TO HARD, BROWN, DARK BROWN AND GRAY, **LEAN CLAY WITH SAND**, LITTLE GRAVEL, CONTAINS ASPHALT AND BRICK FRAGMENTS, DAMP TO MOIST **(FILL)**		1	3 5 8	21	56	SS-1	3.4 - 4.2	-	-	-	-	-	-	-	-	-	14	CL (V)	
		2																	
		3																	
		4																	
		5																	
		6	3 4 3	11	56	SS-2	2.4 - 2.6	8	4	7	9	40	32	41	22	19	22	CL	
		7																	
		8																	
		9																	
		10																	
		11	2 4 3	11	50	SS-3	2.1 - 2.5	-	-	-	-	-	-	-	-	-	20	CL (V)	
		12																	
		13																	
		14																	
@15.0'; ALSO CONTAINS LIMESTONE FRAGMENTS		15																	
		16	3 3 3	10	67	SS-4	1.5 - 1.8	7	3	5	6	38	41	40	19	21	21	CL	
		17																	
		18																	
	676.0	19																	
MEDIUM DENSE, BROWN, **SILT**, LITTLE SAND, TRACE GRAVEL, MOIST		20																	
	673.0	21 EOB	3 6 7	21	72	SS-5	-	-	-	-	-	-	-	-	-	-	15	ML (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. CAVE DEPTH 10.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED .5 BAG BENTONITE CHIPS; PUMPED 10 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/6/13 13:24 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CAMARGO SEWER EXTENSION\CARMARGO SEWER EXTENSION.G

APPENDIX B

LABORATORY TEST RESULTS

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5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength Test

(Project:Camargo Sewer Extension, Boring Location: B-001-0-13, R-5, Depth: 26.1- 26.5 ft)

Tested Date: 4/30/2013

Specimen Properties

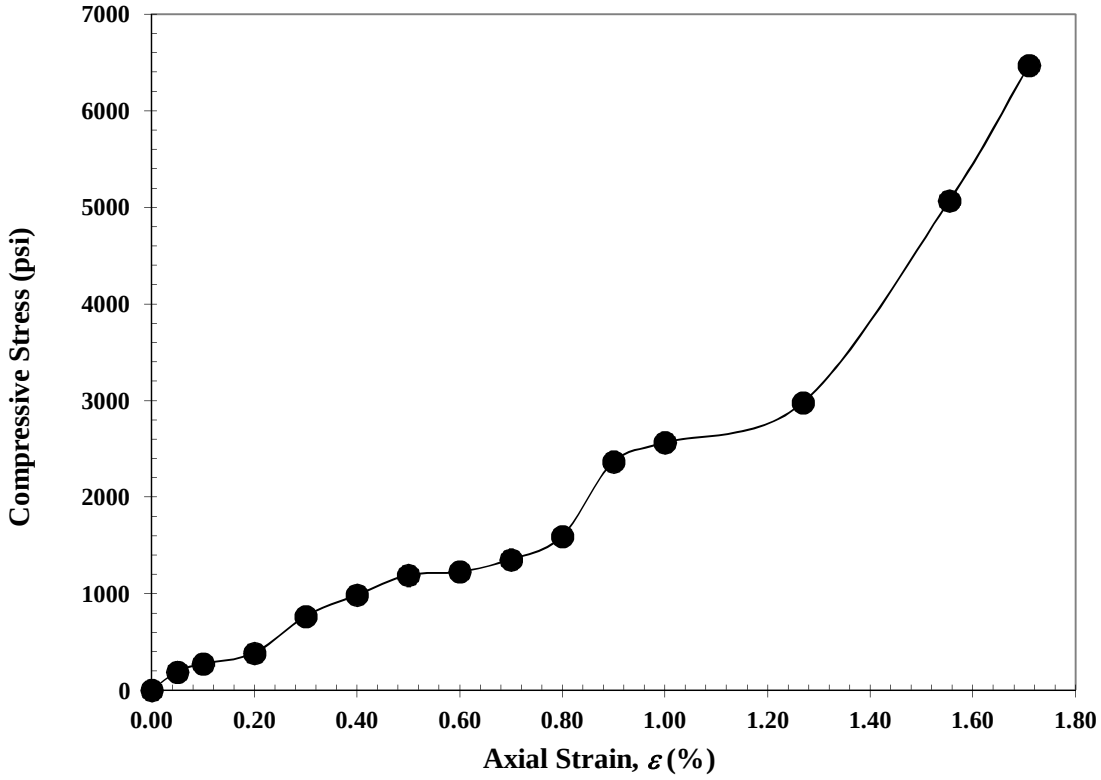
Average Dia., D_{avg} (in):	1.97
Average Height, H_{avg} (in):	3.86
Area, A (in^2):	3.05
Volume, V (in^3):	11.77
Wet Mass of Specimen (lb):	1.1
Moisture Content (%):	0.2
Dry Mass of Specimen (lb):	1.1
Wet Unit Weight, γ (lb/ft^3):	166.5
Dry Unit Weight, γ_d (lb/ft^3):	166.1

Final Specimen Figure



Results

Unconfined Compressive Strength (psi):	**6469.8**
Strain (%):	**1.7**



NOTES: Gray, LIMESTONE, moderately strong.

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5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength Test

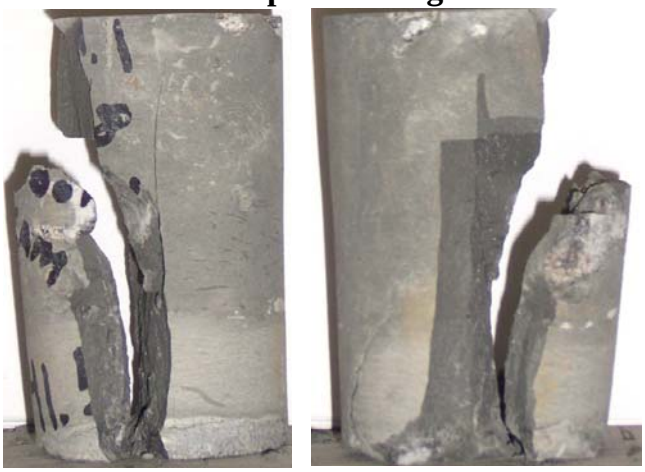
(Project:Camargo Sewer Extension, Boring Location: B-001-0-13, R-8, Depth: 41.1- 41.5 ft)

Tested Date: 4/30/2013

Specimen Properties

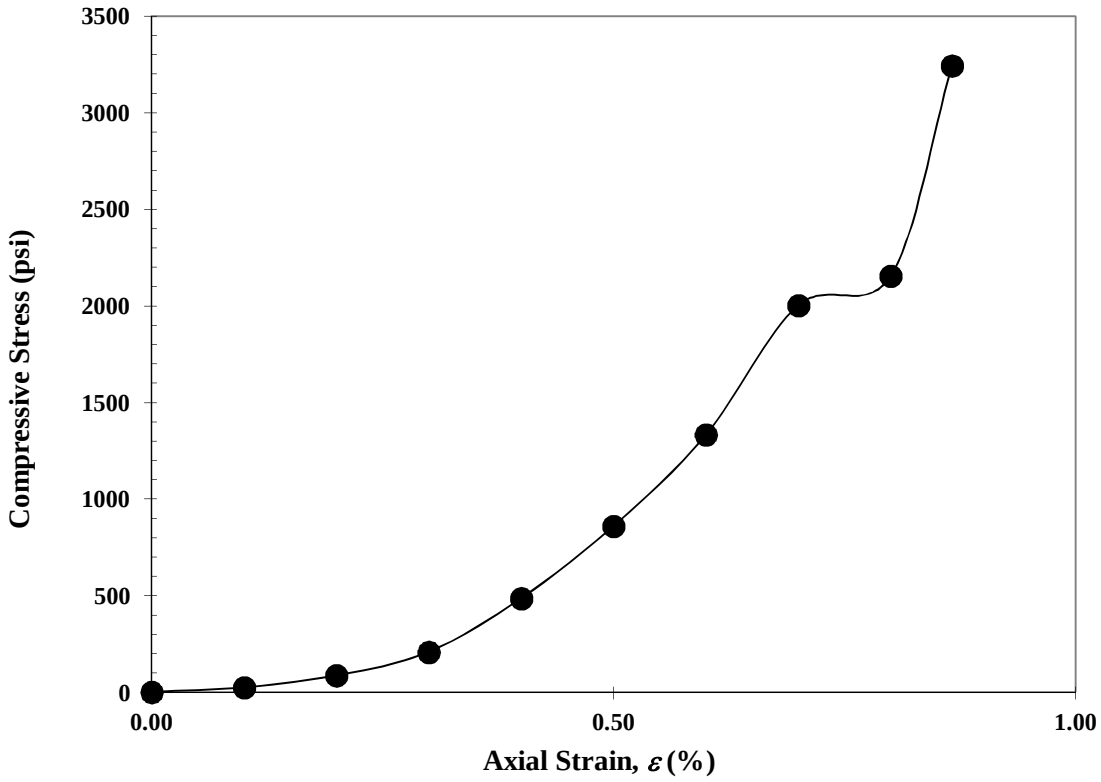
Average Dia., D_{avg} (in):	1.97
Average Height, H_{avg} (in):	3.81
Area, A (in^2):	3.06
Volume, V (in^3):	11.64
Wet Mass of Specimen (lb):	1.1
Moisture Content (%):	1.5
Dry Mass of Specimen (lb):	1.1
Wet Unit Weight, γ (lb/ft^3):	159.4
Dry Unit Weight, γ_d (lb/ft^3):	157.0

Final Specimen Figure



Results

Unconfined Compressive Strength (psi):	**3243.2**
Strain (%):	**0.9**



NOTES: Gray, LIMESTONE, slightly strong.