CTL Engineering, Inc.
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March 10, 2023
Revised June 9, 2023

IBI Group
23 Triangle Park Drive
Cincinnati, Ohio 45246

Attention: Mr. Steven Butler, P.E.
Associate – Manager, Transportation Engineering

Reference: Geohazard Exploration Report - Final
PIK-772-14.10 Slide Repair
PID: 115993
Pike County, Ohio
CTL Project No. 23050003COL

Dear Mr. Butler:

CTL Engineering, Inc. has completed the Geohazard Exploration for the above referenced project. Enclosed is the digital (pdf) copy of the Final report.

Thank you for the opportunity to work with you on this project. If you have any questions or need further information, please feel free to contact our office.

Respectfully Submitted

CTL ENGINEERING, INC.

Joe Grani, P.E.
Project Engineer

GEOTECHNICAL SUBSURFACE EXPLORATION - FINAL

PIK-772-14.10 SLIDE REPAIR
PID: 115993
PIKE COUNTY, OHIO
CTL PROJECT NO. 23050003COL

PREPARED FOR:

IBI GROUP
23 TRIANGLE PARK DRIVE
CINCINNATI, OHIO 45246

PREPARED BY:

CTL ENGINEERING, INC.
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March 10, 2023
Revised June 9, 2023

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The project involves the exploration of a landslide near mile marker 14.10 of State Route 772 (SR 772) in Pike County, Ohio. Within the project limits, the SR 772 southwest/westbound lanes and guardrail are experiencing instability consisting of rotational/translational movement with a head scarp developed within the roadway pavement (near the centerline of the road) and into the slope below the roadway.

A total of four (4) test borings were performed for this project. Three (3) borings were performed within the southwest/westbound lane of SR 772, and one (1) boring was performed within the northeast/eastbound lane. All four borings were extended into the underlying bedrock. The top of bedrock was encountered at depths ranging from 8.5 to 17.4 feet below existing grade. The top of bedrock elevations range from 818.9 to 837.2 feet.

Slope stability and drilled shaft analyses were performed at the critical section (Station 1406+75) along SR 772. Based on the results of the analyses, the following drilled shaft retaining wall with plug piles is recommended:

- 3.0-foot diameter reinforced shafts installed at a 5.5-foot center to center spacing with W24x131 steel piles.
- 3.0 feet diameter plug (unreinforced) shafts installed between the structural shafts at an offset along the proposed centerline of the reinforced drilled shafts.
- Minimum bedrock embedment length of reinforced shafts of 15.0 feet.
- Constructed at a 23.0-foot offset (left) from the centerline of SR 772.

II. INTRODUCTION

The project involves the exploration of a landslide near mile marker 14.10 of SR 772 in Pike County, Ohio. The length of the project is approximately 386 feet.

The purpose of this report is to provide findings from the subsurface exploration performed by ODOT and to provide recommendations for the repair of the landslide. This is a Final Report.

III. GEOLOGY AND OBSERVATIONS OF THE PROJECT

According to the Ohio Department of Natural Resources, Physiographic Regions of Ohio Map, the site is located within the Shawnee-Mississippian Plateau, which is an unglaciated portion of the Alleghney Plateau. Bedrock below the site generally consists of Mississippian-age shale, siltstone and sandstone.

According to web based mapping from *United States Department of Agriculture, Natural Resources Conservation Service,* the project area contains one primary soil:

1. Trappist-Shelocta Association, Steep *(TsF)*: Weathered bedrock residuum, 25 to 40 percent slopes, well-drained, very low to moderately high hydraulic conductivity (0.0 to 0.2 in/hr).

According to the Ohio Department of Natural Resources (ODNR) Ohio Karst Areas map, no karst features have been mapped near the project site.

According to mapping from the ODNR Website, No underground mines have been mapped in the project area.

A site visit was performed by ODOT and CTL Engineering personnel on December 1, 2022. SR 772 is a rural minor collector road with a design and posted speed limit of 55 mph and approximately 9-foot wide travel lanes with little to no existing paved shoulders. A major portion of the distresses appeared to be in the southwest/westbound lane of SR 772. Tension cracks were noted within the pavement extending to near the centerline of the road. An existing pile wall was observed near the northern side of the existing guardrail within the project limits. Shale bedrock was exposed on the uphill side of SR 772. An existing culvert was located within the project limits.

IV. EXPLORATION

A. Test Borings

A total of four (4) test borings were performed for this project by ODOT between September 12 and October 2, 2018. Three (3) borings were performed within the southwest/westbound lane of SR 772, and one (1) boring was performed within the northeast/eastbound lane. The test boring records were provided to CTL to be utilized for this report.

The test borings were performed with a truck mounted drill rig, utilizing 3.25-inch hollow stem augers (HSA), between September 12 and October 2, 2018. Rock coring was performed in all four borings, using an NQ-size core barrel. The hammer system used was calibrated on April 2, 2018. The hammer system had a drill rod energy ratio of 87.0 percent.

Split spoon soil samples were collected at 2.5-foot intervals until split spoon refusal was encountered. Representative soil samples were subjected to laboratory testing including moisture content, hand penetrometer, grain size distribution and Atterberg limits.

Rock from the coring operation was visually classified. The Rock Quality Designation (RQD) and percent core loss values were determined. Representative samples of the recovered rock were subjected to compressive strength testing.

Latitude and Longitude coordinates and ground surface elevations of the test boring locations were included on the test boring records when provided to CTL.

B. Geophysical Testing

In addition to the test borings performed by ODOT, geophysical testing was also performed by ODOT for this project within the area of the landslide. The results of this testing were provided to CTL. The geophysical test results are located in Appendix C of this report.

V. FINDINGS

A. Test Borings

The borings were drilled through the existing pavement of SR 772. The borings exhibited pavement compositions consisting of 12 to 42 inches of asphalt.

Beneath the existing pavement borings B-011-0-18 and B-013-0-18 encountered gravel and/or stone fragments with sand (A-1-b) to depths of 6.0 and 3.5 feet respectively. These materials exhibited N_{60} values ranging from 6 to 12 blows per foot (bpf), with natural moisture content values ranging from 3 to 11 percent.

Below the stone fragments in borings B-011-0-18 and B-013-0-18, and below the pavement in B-010-0-18 and B-012-0-18, the borings exhibited layers of sandy silt (A-4a) and silt and clay (A-6a). A layer of stone fragments with sand and silt (A-2-4) with cobbles and boulders was encountered in boring B-11-0-18 between depths of 11.0 and 17.0 feet. These soils exhibited N_{60} values ranging from 4 blows per foot (bpf) to 60 blows for 6 inches of penetration, and natural moisture content values ranging from 9 to 24 percent.

Below the soils in borings B-010-0-18 and B-012-0-18, augerable shale bedrock was encountered at depths ranging from 8.5 to 11.0 feet. These depths correspond to elevations ranging from 837.2 to 818.9 feet. The augerable bedrock exhibited N_{60} values ranging from 77 bpf to 48 blows for 6 inches of penetration.

Below the soil overburden or below the augerable bedrock, the borings exhibited coreable bedrock. The recovered bedrock from the coring operations was described as shale or interbedded shale and sandstone. The bedrock recovered from the coring operations exhibited Rock Quality Designation (RQD) values ranging from 0 to 50 percent, and core recovery values ranging from 35 to 100 percent.

No groundwater was encountered during drilling and sampling of the test borings.

VI. ANALYSES AND RECOMMENDATIONS

A. Global Stability Analyses

A global stability analysis was performed to estimate the shape and depth of the failure surface for the existing site conditions. The stability of the existing slope was evaluated using the *Rocscience Slide* computer program, and the analysis was based on the Morgenstern-Price method. The slope on the northern side of SR 772 was used in the analysis.

Cross sections within the area of the slip were prepared by IBI Group, and were provided to CTL Engineering. The stability analysis was performed using the most critical cross section (Station 1406+75).

The stability of the slope was evaluated from laboratory test results, parameters provided in ODOT's Geotechnical Design Manual (GDM) and engineering judgment. Soil and rock strength parameters used in the analysis are summarized in Table 1.

Table 1 – Soil and Rock Parameters

Material No.	γ_T (pcf)	Effective Stress Parameters		Material Types
		C (psf)	∅ (deg)	
1	145	50*	0	Pavement
2	122	50*	32	A-1-b
3	118	150	22	A-6a
4	130	275	28	A-4a
5	140	0	20	Soft Rock
6	140	2000	40	Firm Rock

* A low value for cohesion was used so that the analysis would not exhibit shallow sloughing in these layers.

Results of the global stability analysis are provided in Appendix D. During the site reconnaissance visit, cracking from the head scarp extended to near the centerline of SR 772. Therefore, the shear surface was estimated to intercept the ground surface at the observed head scarp for the global stability model. The failure surface is also assumed to travel along top of rock and exit near the toe of slope.

B. Initial Slope Repair Alternatives

Based upon the conditions encountered in our exploration, the existing grades and results of the slope stability analysis, it is CTL's opinion that the slope repair could be performed by installing a retaining wall system on the northern downslope side of SR 772. The retaining wall should be extended into the underlying competent bedrock. The following retaining wall is being considered for this project:

Drilled Shaft Retaining Wall with Plug Piles– Under this retaining wall type, the roadway can be supported by installing row of structural drilled shafts at an offset location from the edge of roadway. The structural drilled shafts should be reinforced with steel pile sections, and then filled to their full length with structural concrete. The structural shafts should be socketed into competent bedrock. The plug piles (non-reinforced shafts), should be installed between the structural shafts and should extend down to the top of rock, and serve the purpose of lagging between the structural (reinforced) shafts.

C. Drilled Shaft Analysis

Drilled shaft analyses were also performed at the critical section of the proposed wall alignment, which was estimated to be at Station 1406+75.

The analyses were performed to determine the steel size that will be required for the project. The following assumptions were used in the analyses:

- 3.0-foot diameter reinforced shafts will be installed at a 5.5-foot center to center spacing.
- 3.0 feet diameter plug (unreinforced) shafts will be installed between the structural shafts at an offset along the proposed centerline of the reinforced drilled shafts.
- The retaining wall is assumed to be constructed at a 23.0-foot offset from the centerline of SR 772.

UA SLOPE Analysis

The shear plane surface obtained from the *SLIDE* analysis was input into the *UA Slope Program Version 2.3* software. The model was initially checked to verify the FS of existing conditions closely resembled the results from the *SLIDE* analysis, which was at 1.0. The output of this initial run is provided in Appendix E.

The analysis then involves modeling drilled shafts at a 23.0-foot offset (left) from the centerline of SR 772. The output of the *UA Slope Program* showing the force per shaft value at this assumed drilled shaft location is attached to this report in Appendix E.

L-Pile Analysis

The force per shaft value obtained from the *UA Slope Program* was then entered into the L-pile program to estimate the deflection, shear, and moments within the shafts. Procedures outlined in the ODOT GDM along with AASHTO and LRFD manuals were followed while performing the L-pile analyses.

Design checks per the ODOT GDM were performed for each case**.** Based on the analyses, the steel section that satisfied the necessary design checks is provided in Table 2.

Table 2- Steel Section

Description	Wall Location	Force per Shaft (lbs)	Diameter of Shaft (feet)	Center to Center Spacing (feet)	Recommended Steel Section
Plug Pile Retaining Wall	23.0-foot offset from the centerline of SR 772	76,196	3.0	5.5	W24x131

Results of the L-pile analyses are provided in Appendix E. The bedrock encountered at the project site consisted of shale or interbedded shale and sandstone. The upper several feet of bedrock was either augerable or exhibited a relatively low RQD value. Therefore, the upper several feet of bedrock may not be relied upon for bedrock resistance even though it was identified as bedrock on the test boring records. Although the LPILE analysis indicated that a 10-foot rock socket would be adequate for the design, CTL recommends utilizing a deeper rock socket depth of 15.0 feet to ensure adequate rock socket is achieved.

The failure plane at the shaft location along Station 1406+75 is estimated to extend approximately 24.3 feet below the top of proposed wall, which is near the estimated top of bedrock at the proposed wall location. Therefore, it is our recommendation that non-reinforced shafts (plugs) should extend to the top of bedrock.

Based on the analyses, it is CTL's opinion that the steel section provided in Table 2 can be used for the entire length of the project (Station 1404+86.12 to 1408+72.14) provided that the recommended drilled shaft retaining wall configuration is selected for this project.

Table 3 below shows the estimated top of rock elevations at the location of the proposed wall.

Table 3- Estimated Top of Bedrock Elevations at Proposed Wall Location

Station	Boring	Estimated Top of Bedrock Elevation at Proposed Wall Location (23-foot Offset)
1405+10.28	B-010-0-18	812.6
1406+68.10	B-011-0-18	815.6
1407+42.02	B-012-0-18	825.2
1407+93.65	B-013-0-18	829.2

The top of rock elevations at the proposed wall location were estimated assuming a 22 degree slope rate of the bedrock and the top of bedrock elevations encountered at the test boring locations for borings B-010-0-18 through B-013-0-18.

Additional L-Pile analyses were performed at the critical section (Station 1406+75) assuming a maximum depth of bedrock at the proposed wall location of 30.0 feet below the top of proposed wall. This was done to verify that the proposed retaining wall would properly function if bedrock is encountered deeper than (up to 30 feet below the top of the wall) what is shown on the plans.

D. Culvert Replacement

It is understood a new 18-inch CPP culvert is to be constructed within the project site crossing SR 772. Based on preliminary information provided by IBI Group, it is understood the wall configuration at the location where the culvert will cross through the wall will consist of two consecutive 3.0-foot diameter plug piles below the culvert, and two consecutive 3.0-foot diameter reinforced shafts on both ends, creating a 3'-8" opening in the wall. The proposed configuration at this location along the wall is acceptable using W24x131 piles in the reinforced shafts.

VII. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL Engineering should be notified so that our recommendations can modified, if required.

VIII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL Engineering work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL Engineering is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report.

IX. CLOSING

This report has been prepared for the exclusive use by the client for use only on this project. Our services have been performed in accordance with generally accepted Geotechnical Engineering principles and practices. No warranty is either expressed or implied.

CTL Engineering's assignment does not include, nor does this geotechnical report address the environmental aspects of this particular site.

Specific design and construction recommendations have been provided in this report. Therefore, the report should be used in its entirety.

Respectfully Submitted,

CTL ENGINEERING, INC.

Evan Holcombe, P.E.
Senior Geotechnical Engineer

Joe Grani, P.E.
Project Engineer

APPENDIX A
GEOTECHNICAL PLAN AND PROFILE SHEETS

PROJECT DESCRIPTION

EXPLORATION OF SLOPE INSTABILITY ALONG SR 772 IN PIKE COUNTY NEAR MILE MARKER 14.10. THE SLOPE INSTABILITY EXTENDS FOR APPROXIMATELY 390 FEET. A NEW RETAINING WALL IS PLANNED TO BE CONSTRUCTED ALONG THE AFFECTED ALIGNMENT.

HISTORIC RECORDS

NO HISTORIC BORINGS WERE FOUND FOR THIS PROJECT.

GEOLOGY

ACCORDING TO PHYSIOGRAPHIC MAPS (ODNR, 1998), THE PROJECT SITE LIES WITHIN THE SHAWNEE-MISSISSIPPIAN PLATEAU, WHICH IS AN UNGLACIATED PORTION OF THE ALLEGHENY PLATEAU. ACCORDING TO BEDROCK GEOLOGIC MAP OF OHIO (2006), THE BEDROCK UNDERLYING THE SITE CONSISTS OF SHALE, SANDSTONE AND SILTSTONE OF THE MISSISSIPPIAN-AGE FORMATION.

RECONNAISSANCE

A FIELD RECONNAISSANCE WAS PERFORMED ON JANUARY 5, 2023. THE LANDSLIDE IS OCCURING WITHIN THE SOUTHWEST- BOUND LANE OF TRAFFIC. TENSION CRACKS AND SETTLEMENT WERE OBSERVED WITHIN THE PAVEMENT OF SR 772. AN EXISTING PILE WALL WAS OBSERVED ALONG THE NORTHERN EDGE OF THE EXISTING GUARDRAIL WITHIN THE PROJECT LIMITS. SHALE BEDROCK WAS EXPOSED ON THE UPHILL SIDE OF THE ROAD. AN EXISTING CULVERT WAS LOCATED WITHIN THE PROJECT LIMITS. THE SURROUNDING LAND WAS RURAL.

SUBSURFACE EXPLORATION

FOUR BORINGS WERE ADVANCE ALONG THE AFFECTED ALIGNMENT FOR THIS PROJECT LABELED B-010-0-18 THROUGH B-013-0-18. THE BORINGS WERE DRILLED USING A TRUCK MOUNTED ROTARY DRILL RIG AND 3.25-INCH I.D. HOLLOW STEM AUGERS TO ADVANCE THE BORINGS THROUGH THE SOIL. THE HAMMER SYSTEM USED WAS LAST CALIBRATED ON APRIL 2, 2018, AND THE AVERAGE DRILL ROD RATIO (ER) WAS 87 PERCENT. DISTURBED SAMPLES WERE COLLECTED IN ACCORDANCE WITH THE STANDARD PENETRATION TEST (AASHTO T206) AT 2.5-FOOT INTERVALS FOR THE SOIL DEPTH OF THE BORINGS. THE BORINGS WERE ADVANCE INTO BEDROCK AND SAMPLED (AASHTO T225) USING AN NQ WIRELINE CORE BARREL.

EXPLORATION FINDINGS

THE FOUR BORINGS DRILLED WITHIN THE LIMITS OF THIS PROJECT WERE DRILLED IN THE PAVEMENT AND ENCOUTNERED APPROXIMATELY 12 TO 42 INCHES OF ASPHALT PAVEMENT. BORINGS B-011-0-18 AND B-013-0-18 ENCOUNTERED A LAYER OF GRANULAR MATERIAL (A-1-b) DIRECTLY BENEATH THE ASPHALT PAVEMENT TO DEPTHS OF 3.5 TO 6.0 FEET BELOW GRADE. PRIMARILY COHESIVE SOILS (A- 4a, A- 6a) WHICH WERE MEDIUM STIFF TO HARD WERE OBSERVED UNDERLYING THESE SURFACE MATERIALS. SHALE AND INTERBEDDED SHALE AND SANDSTONE BEDROCK WAS ENCOUNTERED AT DEPTHS RANGING FROM 8.5 TO 17.4 FEET BELOW GRADE. THE SHALE WAS DESCRIBED AS BROWN TO GRAY, SEVERELY TO MODERATELY WEATHERED AND VERY WEAK TO WEAK AND THE SANDSTONE WAS DESCRIBED AS MODERATELY TO HIGHLY WEATHERED AND SLIGHTLY TO VERY STRONG.

THE BORINGS DID NOT ENCOUNTERED GROUNDWATER DURING DRILLING.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JANUARY 2023.

AVAILABLE INFORMATION

THE SOIL, BEDROCK, AND GROUNDWATER INFORMATION COLLECTED FOR THIS SUBSURFACE EXPLORATION THAT CAN BE CONVENIENTLY DISPLAYED ON THE SOIL PROFILE SHEETS HAS BEEN PRESENTED. GEOTECHNICAL REPORTS, IF PREPARED, ARE AVAILABLE FOR REVIEW ON THE OFFICE OF CONTRACT SALES WEBSITE.

LEGEND

	DESCRIPTION	ODOT CLASS	CLASSIFIED MECH./VISUAL	
	GRAVEL AND/OR STONE FRAGMENTS WITH SAND	A-1-b (0)	1	1
	GRAVEL AND/OR STONE FRAGMENTS W/SAND AND SILT	A-2-4	0	1
	SANDY SILT	A-4a (2)	4	5
	SILT AND CLAY	A-6a (2)	3	1
		TOTAL	8	8
	BOULDERS	VISUAL		
	SANDSTONE	VISUAL		
	SHALE	VISUAL		
	PAVEMENT OR BASE = X = APPROXIMATE THICKNESS	VISUAL		

EXPLORATION LOCATION - PLAN VIEW

DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.

WC — INDICATES WATER CONTENT IN PERCENT.

N_{60} — INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.

W — INDICATES FREE WATER ELEVATION.

X/Y/D" — NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT): X= NUMBER OF BLOWS FOR 6 INCHES (UNCORRECTED).

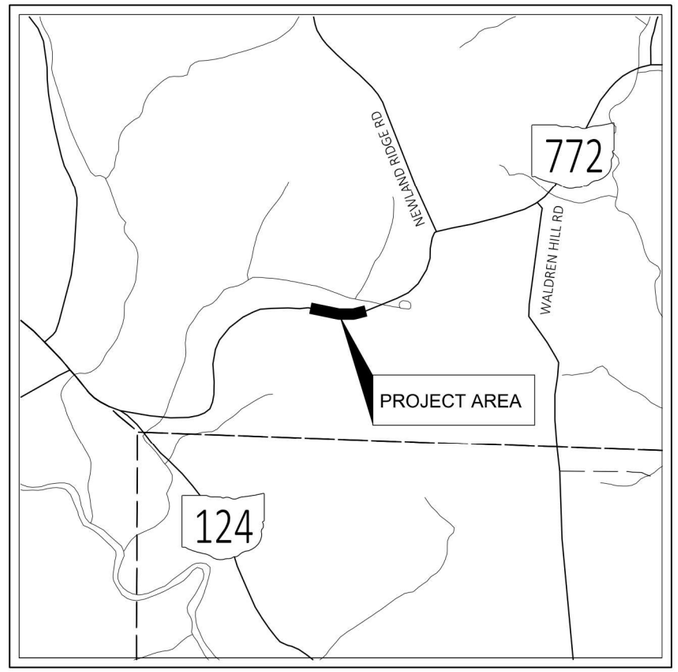
SS — INDICATES A SPLIT-SPOON SAMPLE.

TR — INDICATES TOP OF ROCK.

NP — INDICATES A NON-PLASTIC SAMPLE.

BED ROCK TEST SUMMARY

BORING ID	SAMPLE ELEVATION	SAMPLE DEPTH	QU (PSI)	LITHOLOGY
B-010-0-18	806.3' - 805.8'	23.6' - 24.1'	38	SHALE
B-010-0-18	800.9' - 800.3'	29.0' - 29.6'	273	SHALE
B-012-0-18	836.1' - 835.7'	9.6' - 10.0'	17,479	SANDSTONE
B-012-0-18	832.3' - 831.9'	13.4' - 13.8'	20,328	SANDSTONE
B-012-0-18	827.4' - 827.0'	18.3' - 18.7'	27,884	SANDSTONE
B-013-0-18	835.2' - 834.8'	14.0' - 14.4'	15,391	SANDSTONE
B-013-0-18	827.5' - 827.2'	21.7' - 22.0'	4,273	SANDSTONE



LOCATION MAP

SCALE IN MILES

0 1 2 3 4

N

PARTICLE SIZE DEFINITIONS

12"	3"	2.0 mm	0.42 mm	0.074 mm	0.005 mm
BOULDERS	COBBLES	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY
		No. 10 SIEVE	No. 40 SIEVE	No. 200 SIEVE		

RECON. - SM 01/05/2023
DRILLING - ODOT 09/12/18 TO 10/02/18
DRAWN - SACHINA 03/06/23
REVIEWED - JG 03/07/23

GEOTECHNICAL PROFILE - LANDSLIDE

PIK-772-14.10

PIK-772-13.77

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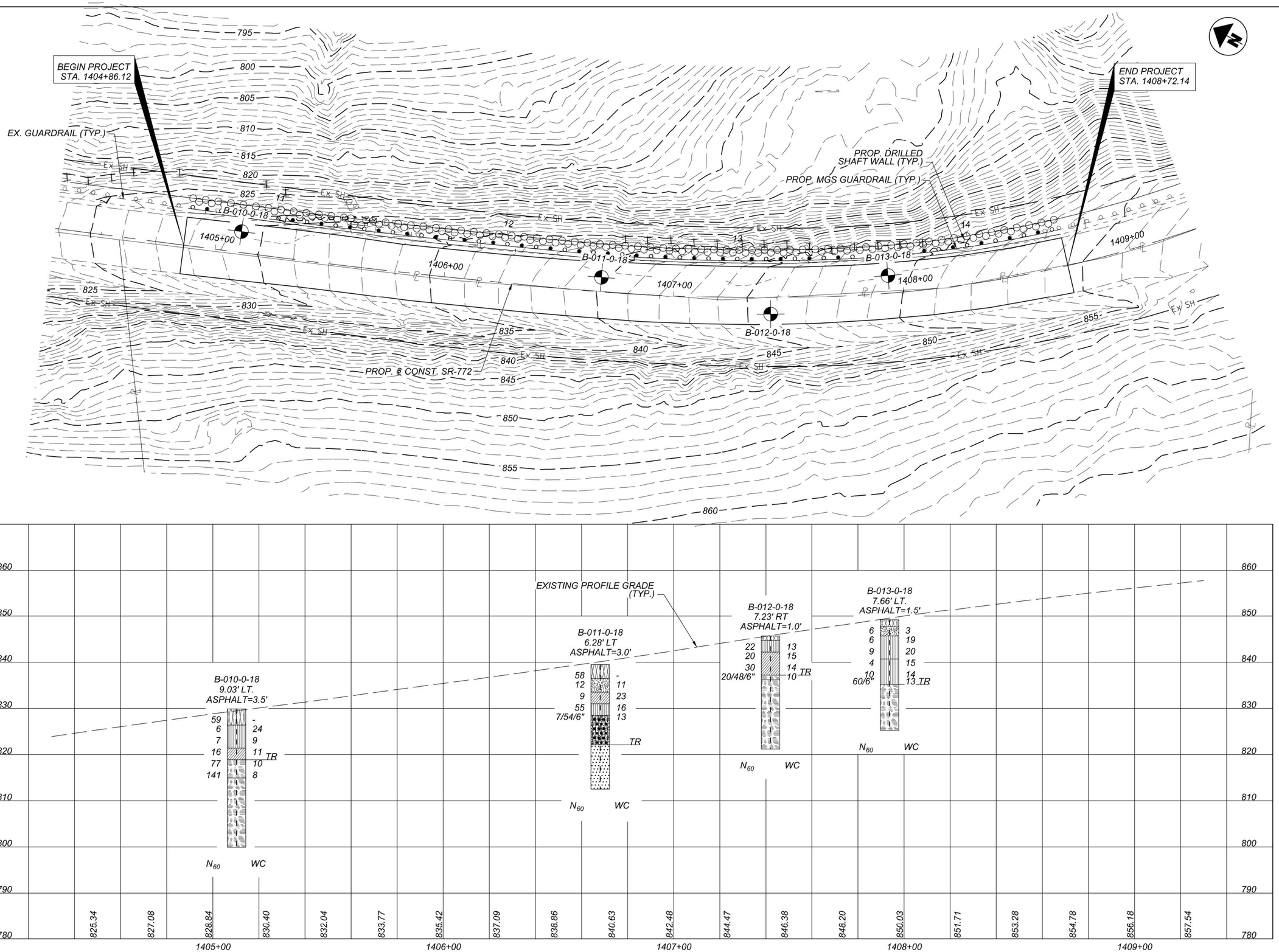
DESIGNER N.K.S

REVIEWER JG 03-07-23

PROJECT ID 115993

SUBSET 1 | TOTAL 11

SHEET - | TOTAL -



HORIZONTAL SCALE IN FEET
0 10 20 40

GEOTECHNICAL PROFILE - LANDSLIDE
STA. 1404+86.12+00.00 TO STA. 1408+72.14

PIK-772-13.77

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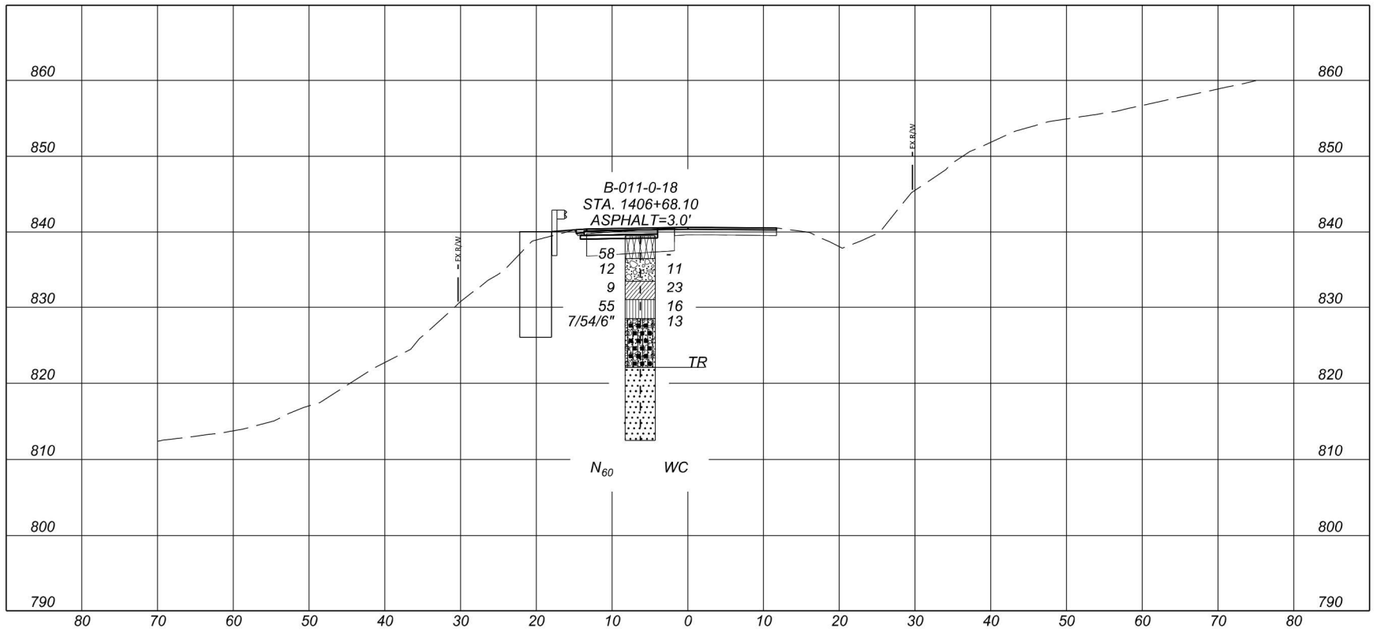
REVIEWER	JG 03-07-23
PROJECT ID	115993
SUBSET	TOTAL 2 | 11
SHEET	TOTAL - | -

STA. 1406+75.00



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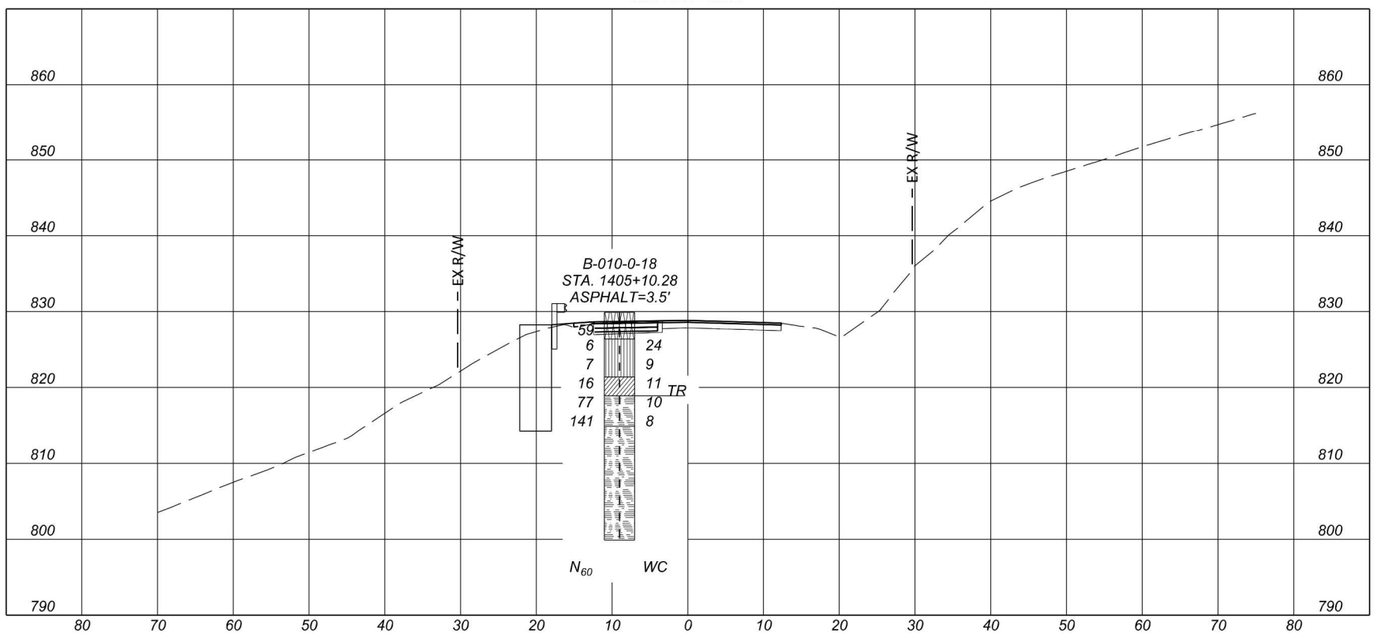

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - LANDSLIDE
CROSS SECTION STA. 1405+00.00 AND STA. 1406+75.00

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REVIEWER: JG 03-07-23
PROJECT ID: 115993
SUBSET: 3 TOTAL: 11
SHEET: P.0 TOTAL: 0

PIK-772-13.77

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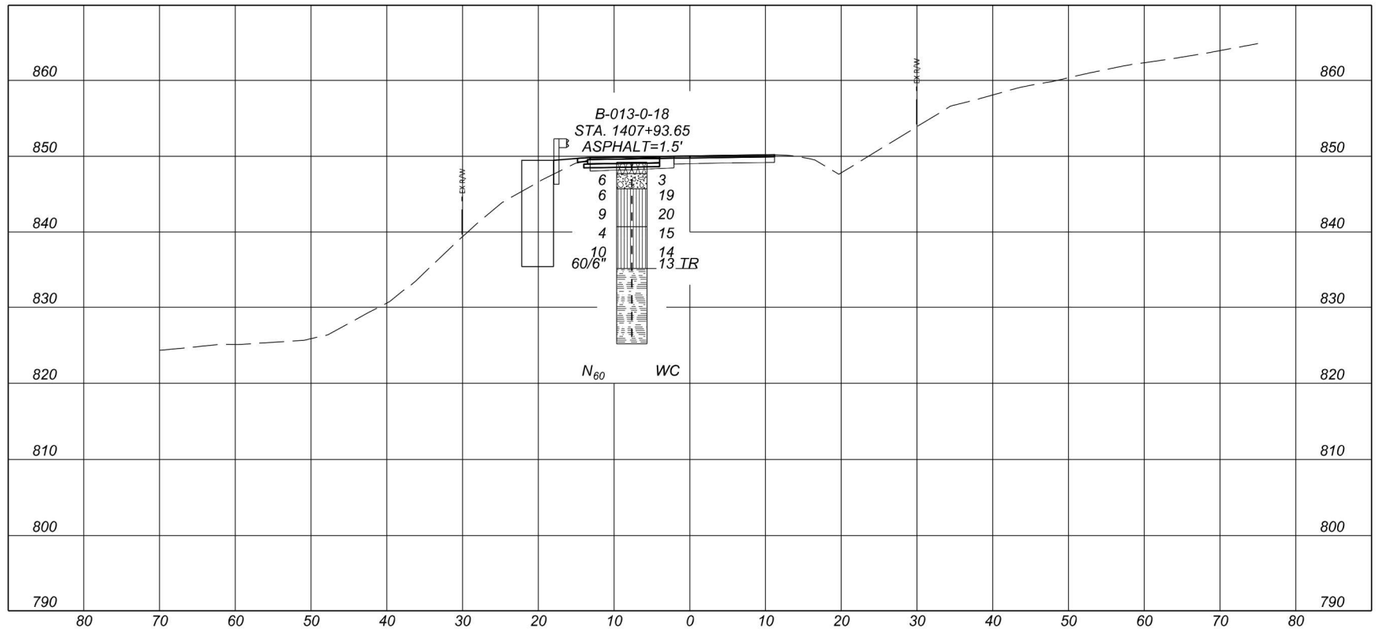
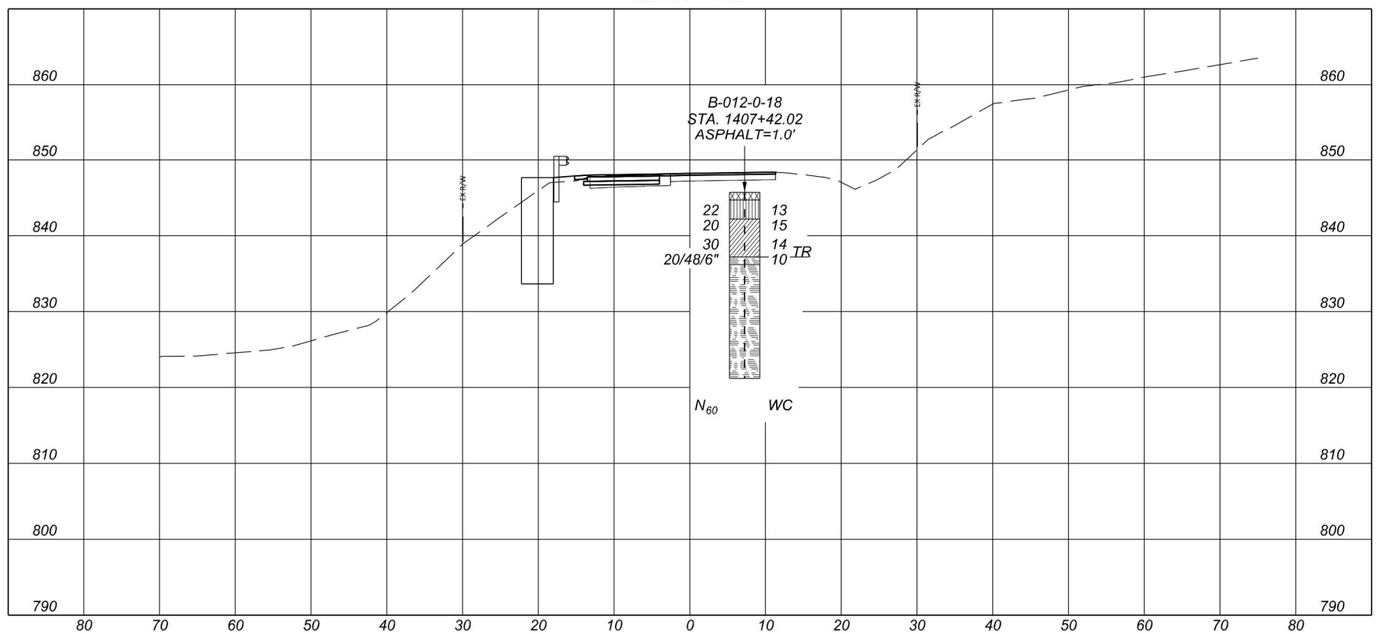
STA. 1408+00.00



STA. 1407+75.00



HORIZONTAL SCALE IN FEET
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GEOTECHNICAL PROFILE - LANDSLIDE
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PIK-772-13.77

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FAX: (614)276-6377

DESIGNER	N.K.S
REVIEWER	JG 03-07-23
PROJECT ID	115993
SUBSET / TOTAL	4 / 11
SHEET / TOTAL	P.0 / 0

PIK-772-13.77

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 08-06-2023 TIME: 13:00:54 USER: hp
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PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1405+10, 9' RT.	EXPLORATION ID B-010-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4-2-18	ELEVATION: 829.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 9-12-18 END: 9-18-18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090208, -83.128718	

MATERIAL DESCRIPTION AND NOTES	ELEV. 829.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
ASPHALT (42")	825.8																		
MEDIUM STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE STONE FRAGMENTS, NOT ENOUGH MATERIAL TO TEST, MOIST TO WET @6.0'; ENCOUNTERED SANDSTONE FRAGMENTS	820.8		23 29 12	59	100	SS-1	-	-	-	-	-	-	-	-	-	-		-	
			2 1 3	6	11	SS-2	0.50	-	-	-	-	-	-	-	-	24	A-4a (V)	-	
			3 2 3	7	11	SS-3	-	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
VERY STIFF, YELLOWISH BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	818.3		3 4 7	16	67	SS-4	2.00	47	8	4	21	20	31	18	13	11	A-6a (2)	-	
SHALE, BROWN WITH GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED.	814.3	TR	18 25 28	77	100	SS-5	-	-	-	-	-	-	-	-	-	10	Rock (V)	-	
			30 44 53	141	100	SS-6	-	-	-	-	-	-	-	-	-	8	Rock (V)	-	
SHALE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED, SLIGHTLY CALCAREOUS, BLOCKY, FAIR; RQD 37%, REC 100%. @15.4' - 17.8'; CONTAINS CLAY SEAM WITH LOSS			0		35	NQ-1											CORE		
			0		50	NQ-2											CORE		
			0		40	NQ-3											CORE		
@ 23.6' - 24.1'; γ = 149 pcf; Qu = 38 psi			50		100	NQ-4											CORE		
@ 29.0' - 29.6'; γ = 164 pcf; Qu = 273 psi	799.3	EOB	12		100	NQ-5											CORE		

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 8-6-23 10:10 - G:\2023\JUNE\08\23050003COL\600555.GPJ

SHEET -	SUBSET 5	PROJECT ID 115993	REVIEWER JG 06-08-23	DESIGNER N.K.S	DESIGN AGENCY ENGINEERING LLC 2740 FAIRMONT BLVD COLUMBUS, OHIO 43204 PHONE: (614)276-8123 FAX: (614)276-8377	GEOTECHNICAL PROFILE - LANDSLIDE	BORING LOG AND ROCK CORE PHOTO FOR B-010-0-18	
TOTAL -	TOTAL 11							

GEOTECHNICAL PROFILE - LANDSLIDE

ROCK CORE PHOTO FOR B-010-0-18 (CONTINUED)

DESIGN AGENCY
GTL ENGINEERING
2240 FISKE ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S

REVIEWER JG 06-08-23

PROJECT ID 115993

SUBSET 6 TOTAL 11

SHEET - TOTAL -

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1406+68, 6' LT.	EXPLORATION ID B-011-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4-2-18	ELEVATION: 839.9 (MSL) EOB: 27.0 ft.	PAGE 1 OF 1
START: 9-18-18 END: 9-27-18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090127, -83.128173	

MATERIAL DESCRIPTION AND NOTES	ELEV. 839.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
ASPHALT (36")	836.9	0–3	40-28-12	58	100	SS-1	-	-	-	-	-	-	-	-	-	-		-	
MEDIUM DENSE, BROWN AND REDDISH BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP	833.9	3–6	5-3-5	12	22	SS-2	-	54	12	11	17	6	NP	NP	NP	11	A-1-b (0)	-	
STIFF, BROWN AND DARK BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, MOIST	831.4	6–8.5	2-2-4	9	44	SS-3	2.00	40	10	6	24	20	32	21	11	23	A-6a (2)	-	
VERY DENSE, REDDISH BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST	828.9	8.5–11	4-31-7	55	56	SS-4	-	43	7	8	31	11	NP	NP	NP	16	A-4a (1)	-	
VERY DENSE, REDDISH BROWN, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP TO MOIST @11.5' - 17.4'; ENCOUNTERED BOULDERS/COBBLES		11–12	7-54	-	50	SS-5	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	-	
	822.5	12–17 (TR)	0		40	NQ-1											CORE		
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), RQD 4%, REC. 98%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 1.5 INCHES; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO THIN VERY BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 0.5 INCHES.		17–22	8		100	NQ-2											CORE		
		22–23	0		100	NQ-3											CORE		
	812.9	23–27 (EOB)	0		96	NQ-4											CORE		

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 8-6-23 10:10 - G:\2023\JUNE\08\23050003COL\600555.GPJ

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 08-06-2023 TIME: 13:10:11 USER: hp
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GEOTECHNICAL PROFILE - LANDSLIDE

ROCK CORE PHOTO FOR B-011-0-18 (CONTINUED)

DESIGN AGENCY
GTL ENGINEERING
2240 FISKE ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER	N.K.S
REVIEWER	JG 06-08-23
PROJECT ID	115993
SUBSET	8
TOTAL	11
SHEET	-
TOTAL	-

PIK-772-13.77

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 08-06-2023 TIME: 13:12:49 USER: hp
D:\Drop Box\CTL 2023\June\Dept 05\COL\Evan\23050003COL_ODOT\MOD_08.06.23\115993ZL005.dgn

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1407+42, 7' RT.	EXPLORATION ID B-012-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4-2-18	ELEVATION: 845.8 (MSL) EOB: 24.5 ft.	PAGE 1 OF 1
START: 10-1-18 END: 10-2-18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090071, -83.127918	

MATERIAL DESCRIPTION AND NOTES	ELEV. 845.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
ASPHALT (12")	844.8																		
MEDIUM DENSE, BROWN, **SANDY SILT**, "AND" GRAVEL AND STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST	842.3		8 8 7	22	56	SS-1	-	39	8	13	29	11	NP	NP	NP	13	A-4a (1)	-	
VERY STIFF TO HARD, BROWN WITH GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	837.3		8 7 7	20	56	SS-2	2.50	39	5	7	30	19	27	16	11	15	A-6a (3)	-	
			7 10 11	30	83	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
SHALE, BROWN, SEVERELY WEATHERED, VERY WEAK, LAMINATED.	836.3	TR	20 48	-	117	SS-4	-	-	-	-	-	-	-	-	-	10	Rock (V)	-	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 2 INCHES, RQD 21%, REC. 87%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 35 INCHES. @9.6' - 10.2'; SANDSTONE LAYER, VERY STRONG @ 9.6' - 10.0'; γ = 163 pcf; Qu = 17,479 psi @12.1' - 15.0'; SANDSTONE LAYER, VERY STRONG @13.4' - 13.8'; γ = 161 pcf; Qu = 20,328 psi @17.5' - 18.8'; SANDSTONE LAYER, VERY STRONG @ 18.3' - 18.7'; γ = 164 pcf; Qu = 27,884 psi			24		82	NQ-1										CORE		
@23.1' - 23.5'; SANDSTONE LAYER	821.3	EOB	0		100	NQ-2											CORE		

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 8-6-23 10:10 - G:\2023\JUNE\08\23050003COL\600555.GPJ

DESIGNER N.K.S	REVIEWER JG 06-08-23	SUBSET 9 TOTAL 11	SHEET - TOTAL -
PROJECT ID 115993			

DESIGN AGENCY
GTL ENGINEERING
2740 AIRFIELD RD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

GEOTECHNICAL PROFILE - LANDSLIDE

BORING LOG AND ROCK CORE PHOTO FOR B-012-0-18

PIK-772-13.77

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 08-06-2023 TIME: 13:15:37 USER: hp
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GEOTECHNICAL PROFILE - LANDSLIDE

ROCK CORE PHOTO FOR B-012-0-18 (CONTINUED)

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S
REVIEWER JG 06-08-23
PROJECT ID 115993
SUBSET 10 TOTAL 11
SHEET - TOTAL -

PIK-772-13.77

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 08-06-2023 TIME: 13:18:32 USER: hp
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PROJECT: PIK-772-13.77
TYPE: RETAINING WALL
PID: 104155 SFN:
START: 10-2-18 END: 10-2-18

DRILLING FIRM / OPERATOR: ODOT / CAREY
SAMPLING FIRM / LOGGER: ODOT / MCINTOSH
DRILLING METHOD: 3.25" HSA / NQ
SAMPLING METHOD: SPT

DRILL RIG: CME 55 TRUCK
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 4-2-18
ENERGY RATIO (%): 87

STATION / OFFSET: 1407+94, 8' LT.
ALIGNMENT: SR 772
ELEVATION: 849.3 (MSL) EOB: 24.0 ft.
LAT / LONG: 39.090109, -83.127735

EXPLORATION ID B-013-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 849.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
ASPHALT (18")	847.8	1																	
LOOSE, BLACK, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, ASPHALT GRINDINGS, DAMP	845.8	2–3	9 3 1	6	44	SS-1	-	-	-	-	-	-	-	-	-	3	A-1-b (V)	-	
STIFF, BROWN WITH GRAY, **SANDY SILT**, SOME CLAY, SOME STONE FRAGEMENTS, MOIST		4–5	3 1 3	6	44	SS-2	1.50	25	5	5	39	26	27	17	10	19	A-4a (6)	-	
	840.8	6–8	2 3 3	9	44	SS-3	2.00	-	-	-	-	-	-	-	-	20	A-4a (V)	-	
STIFF, BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP		9–10	2 2 1	4	44	SS-4	1.50	45	8	6	25	16	24	17	7	15	A-4a (1)	-	
		11–13	4 5 2	10	56	SS-5	2.00	-	-	-	-	-	-	-	-	14	A-4a (V)	-	
@13.5'; VERY STIFF TO HARD	835.3	TR 14	60	-	100	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-4a (V)	-	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 1 INCH, RQD 22%, REC. 86%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED; **SANDSTONE**, GRAY AND BROWNISH GRAY, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY TO MODERATELY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 17 INCHES. @14.0' - 14.6'; SANDSTONE LAYER, VERY STRONG, CALCAREOUS @ 14.0' - 14.4'; γ = 169 pcf; Qu = 15,391 psi @16.6' - 18.0; SANDSTONE LAYER, MODERATELY STRONG TO STRONG @21.6' - 22.9'; SANDSTONE LAYER, MODERATELY STRONG TO STRONG, SLIGHTLY CALCAREOUS @ 21.7' - 22.0'; γ = 164 pcf; Qu = 4,273 psi	825.3	15–23, EOB 24	22		86	NQ2-1											CORE		

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 8-6-23 10:10 - G:\2023\JUNE\08\23050003COL\600555.GPJ

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

DESIGN AGENCY
CTL ENGINEERING INC.
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S
REVIEWER JG 06-08-23
PROJECT ID 115993
SUBSET 11 TOTAL 11
SHEET - TOTAL -

GEOTECHNICAL PROFILE - LANDSLIDE

BORING LOG AND ROCK CORE PHOTO FOR B-013-0-18

APPENDIX B
TEST BORING RECORDS

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1405+10, 9' RT.	EXPLORATION ID B-010-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 829.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 9/12/18 END: 9/18/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090208, -83.128718	

MATERIAL DESCRIPTION AND NOTES	ELEV. 829.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (42")	825.8	1																
MEDIUM STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE STONE FRAGMENTS, NOT ENOUGH MATERIAL TO TEST, MOIST TO WET @6.0'; ENCOUNTERED SANDSTONE FRAGMENTS	820.8	2 3 4 5 6 7 8	23 29 12	59	100	SS-1	-	-	-	-	-	-	-	-	-	-		
			2 1 3	6	11	SS-2	0.50	-	-	-	-	-	-	-	-	24	A-4a (V)	
			3 2 3	7	11	SS-3	-	-	-	-	-	-	-	-	-	9	A-4a (V)	
VERY STIFF, YELLOWISH BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	818.3	9 10	3 4 7	16	67	SS-4	2.00	47	8	4	21	20	31	18	13	11	A-6a (2)	
SHALE, BROWN WITH GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED.	814.3	TR 11 12 13 14	18 25 28	77	100	SS-5	-	-	-	-	-	-	-	-	-	10	Rock (V)	
			30 44 53	141	100	SS-6	-	-	-	-	-	-	-	-	-	8	Rock (V)	
SHALE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED, SLIGHTLY CALCAREOUS, BLOCKY, FAIR; RQD 37%, REC 100%. @15.4' - 17.8'; CONTAINS CLAY SEAM WITH LOSS		15 16 17 18 19	0		35	NQ-1											CORE	
			0		50	NQ-2											CORE	
			0		40	NQ-3											CORE	
@ 23.6' - 24.1'; γ = 149 pcf; Qu = 38 psi		20 21 22 23 24	50		100	NQ-4											CORE	
@ 29.0' - 29.6'; γ = 164 pcf; Qu = 273 psi	799.3	25 26 27 28 29 EOB	12		100	NQ-5											CORE	

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/30/23 14:35 - O:\PROJECT\2023\COL-05\23050003COL\DESIGN\PIK-772-14.10\600555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1406+68, 6' LT.	EXPLORATION ID B-011-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 839.9 (MSL) EOB: 27.0 ft.	PAGE 1 OF 1
START: 9/18/18 END: 9/27/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090127, -83.128173	

MATERIAL DESCRIPTION AND NOTES	ELEV. 839.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (36")	836.9	1																
		2	40 28 12	58	100	SS-1	-	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, BROWN AND REDDISH BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP	833.9	3																
		4	5 3 5	12	22	SS-2	-	54	12	11	17	6	NP	NP	NP	11	A-1-b (0)	
STIFF, BROWN AND DARK BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, MOIST	831.4	5																
		6	2 2 4	9	44	SS-3	2.00	40	10	6	24	20	32	21	11	23	A-6a (2)	
VERY DENSE, REDDISH BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST	828.9	7																
		8	4 31 7	55	56	SS-4	-	43	7	8	31	11	NP	NP	NP	16	A-4a (1)	
VERY DENSE, REDDISH BROWN, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP TO MOIST @11.5' - 17.4'; ENCOUNTERED BOULDERS/COBBLES	822.5	9																
		10																
		11	7 54	-	50	SS-5	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	
		12																
		13																
		14	0		40	NQ-1											CORE	
		15																
		16																
		17																
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), RQD 4%, REC. 98%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 1.5 INCHES; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO THIN VERY BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 0.5 INCHES.	TR	18																
		19	8		100	NQ-2											CORE	
		20																
		21																
		22																
		23	0		100	NQ-3											CORE	
		24																
		25																
		26	0		96	NQ-4											CORE	
	812.9	27																
	EOB																	

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/30/23 14:35 - O:\PROJECT\2023\COL-05\23050003COL\DESIGN\PIK-772-14.10\600555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1407+42, 7' RT.	EXPLORATION ID B-012-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 845.8 (MSL) EOB: 24.5 ft.	PAGE 1 OF 1
START: 10/1/18 END: 10/2/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090071, -83.127918	

MATERIAL DESCRIPTION AND NOTES	ELEV. 845.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (12")	844.8																	
MEDIUM DENSE, BROWN, **SANDY SILT**, "AND" GRAVEL AND STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST	842.3		8 8 7	22	56	SS-1	-	39	8	13	29	11	NP	NP	NP	13	A-4a (1)	
VERY STIFF TO HARD, BROWN WITH GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	837.3		8 7 7	20	56	SS-2	2.50	39	5	7	30	19	27	16	11	15	A-6a (3)	
			7 10 11	30	83	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
SHALE, BROWN, SEVERELY WEATHERED, VERY WEAK, LAMINATED.	836.3	TR	20 48	-	117	SS-4	-	-	-	-	-	-	-	-	-	10	Rock (V)	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 2 INCHES, RQD 21%, REC. 87%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 35 INCHES. @9.6' - 10.2'; SANDSTONE LAYER, VERY STRONG @ 9.6' - 10.0'; γ = 163 pcf; Qu = 17,479 psi @12.1' - 15.0'; SANDSTONE LAYER, VERY STRONG @13.4' - 13.8'; γ = 161 pcf; Qu = 20,328 psi @17.5' - 18.8'; SANDSTONE LAYER, VERY STRONG @ 18.3' - 18.7'; γ = 164 pcf; Qu = 27,884 psi			24		82	NQ-1											CORE	
@23.1' - 23.5'; SANDSTONE LAYER	821.3	EOB	0		100	NQ-2											CORE	

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/30/23 14:35 - O:\PROJECT\2023\COL-05\23050003COL\DESIGN\PIK-772-14.10\6005555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 1407+94, 8' LT.	EXPLORATION ID B-013-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 849.3 (MSL) EOB: 24.0 ft.	PAGE 1 OF 1
START: 10/2/18 END: 10/2/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090109, -83.127735	

MATERIAL DESCRIPTION AND NOTES	ELEV. 849.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (18")	847.8																	
LOOSE, BLACK, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, ASPHALT GRINDINGS, DAMP	845.8		9 3 1	6	44	SS-1	-	-	-	-	-	-	-	-	-	3	A-1-b (V)	
STIFF, BROWN WITH GRAY, **SANDY SILT**, SOME CLAY, SOME STONE FRAGEMENTS, MOIST	840.8		3 1 3	6	44	SS-2	1.50	25	5	5	39	26	27	17	10	19	A-4a (6)	
			2 3 3	9	44	SS-3	2.00	-	-	-	-	-	-	-	-	20	A-4a (V)	
STIFF, BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP			2 2 1	4	44	SS-4	1.50	45	8	6	25	16	24	17	7	15	A-4a (1)	
			4 5 2	10	56	SS-5	2.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
@13.5'; VERY STIFF TO HARD	835.3	TR	60	-	100	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-4a (V)	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 1 INCH, RQD 22%, REC. 86%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED; **SANDSTONE**, GRAY AND BROWNISH GRAY, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY TO MODERATELY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 17 INCHES. @14.0' - 14.6'; SANDSTONE LAYER, VERY STRONG, CALCAREOUS @ 14.0' - 14.4'; γ = 169 pcf; Qu = 15,391 psi @16.6' - 18.0; SANDSTONE LAYER, MODERATELY STRONG TO STRONG @21.6' - 22.9'; SANDSTONE LAYER, MODERATELY STRONG TO STRONG, SLIGHTLY CALCAREOUS @ 21.7' - 22.0'; γ = 164 pcf; Qu = 4,273 psi	825.3	EOB	22		86	NQ2-1											CORE	

NOTES: HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/30/23 14:35 - O:\PROJECT\2023\COL-05\23050003COL\DESIGN\PIK-772-14.10\6005555.GPJ

APPENDIX C
GEOPHYSICAL TEST RESULTS

INTEROFFICE COMMUNICATION

To: Justin Gardner P.E., District Geotechnical Engineer, District 9

FROM: Andrew Jalbrzikowski, Office of Geotechnical Engineering

P. Paul Painter, Office of Geotechnical Engineering

DATE: July 8, 2022

SUBJECT: PIK-772-14.10 PID 115993 Geophysical Exploration Summary

Pursuant to your request, the Office of Geotechnical Engineering (OGE) has completed two geophysical surveys to characterize the subsurface conditions to aid in the determination of the top of rock elevation in the project area.

A previous geotechnical exploration, PIK-772-13.77, was completed with borings advanced within the southbound/westbound lane to evaluate areas of instability. Road construction appears to be through side hill construction methods. Several sections of piling have been installed previously. These piles are typically heavily corroded and partially or fully buried. Borings B-010-0-18 through B-013-0-18 were completed by OGE within the current project area from September 12 to October 2, 2018. Highly variable pavement thickness was noted between 12 and 42-inches underlain by predominately non-cohesive soils appearing to be an aggregate base course. The soils encountered in the borings were a mix of cohesive and non-cohesive appearing to be either residual or side hill fill and included Sandy Silt (A-4a), Silt and Clay (A-6a), Stone Fragments with sand (A-1-b), and Stone Fragments with sand and silt (A-2-4), on top of bedrock comprised of either shale or interbedded shale and sandstone. Bedrock was encountered at elevations ranging from 818.9 in B-010-0-18 to 835.2 in B-013-0-18 or between a depth of 8.5 to 17.4 feet. The bedrock was generally described as highly to moderately weathered and ranged from very weak to slightly strong.

It is understood that construction of a lo drill wall was attempted here by District forces in the summer of 2021, with the depth of rock anticipated at less than 20 feet. The first lo drill shaft did not encounter rock and the construction was halted.

To supplement the boring information and to define the top of rock along the north side of SR 772, two geophysical methods; refraction microtremor (ReMi) and electric resistivity (ER) were utilized. The latitude, longitude, and elevation values used to create the seismic and resistivity profiles are from a Trimble Geo7x GPS. The geophysical field work was completed on May 11, 2022.

The ReMi survey line was completed along the westbound lane guardrail. The geophones were planted into the soil along the east side of the roadway. The ReMi data was collected with a SeismicSource DAQlink III 24 channel seismograph along one survey line using 24 geophones spaced approximately 10 feet apart. The ReMi data consisted of ten 30 second records using a 2-millisecond sampling interval. Data was recorded with a laptop computer using SeismicSource Vibrascope software. The data was processed, and surface elevation corrected by SubTerraSeis using Vibrascope, Geogiga Seismic Pro, and Golden Surfer software packages.

The ReMi 2D profile indicates the top of rock is at an approximate shear wave velocity of 2,000 feet per second as indicated by the yellow to red transition on the figure. The top of rock at the east end of the profile is close to the elevation encountered at B-011-0-18 but it sharply drops to the west, extending as deep as elevation 790. This is nearly 30 feet deeper than what was encountered in B-010-0-18.

The ER data was collected with an Advanced Geosciences Inc. (AGI) SuperSting R8 control unit. For the ER Survey, 56 electrodes were spaced approximately 10 feet apart north of and along the guardrail. The electrodes were used to measure the potential field with Dipole-Dipole and Strong Gradient Arrays. The data was processed, and surface elevation corrected using AGI's EarthImager 2D software.

The ER survey collected extremely noisy data on the east end of the survey line, and various errors, throughout. This is most likely due to high contact resistance along the length of the survey. There is a contrast indicating a dip in the top of rock elevation from 240 feet to 400 feet along the length of the ER profile. The contrast is indicated by the green to yellow/red transition on the figure.

It is recommended that additional geophysical surveys be completed here, including a refraction survey. Down slope surveys perpendicular to the road could help further define the top of rock. Two additional borings are also recommended west of B-010-0-18. The additional borings should be completed on or behind the guardrail line if possible.

Attached are a site plan, overview map, ReMi profile, resistivity profile, boring log and point load testing results.

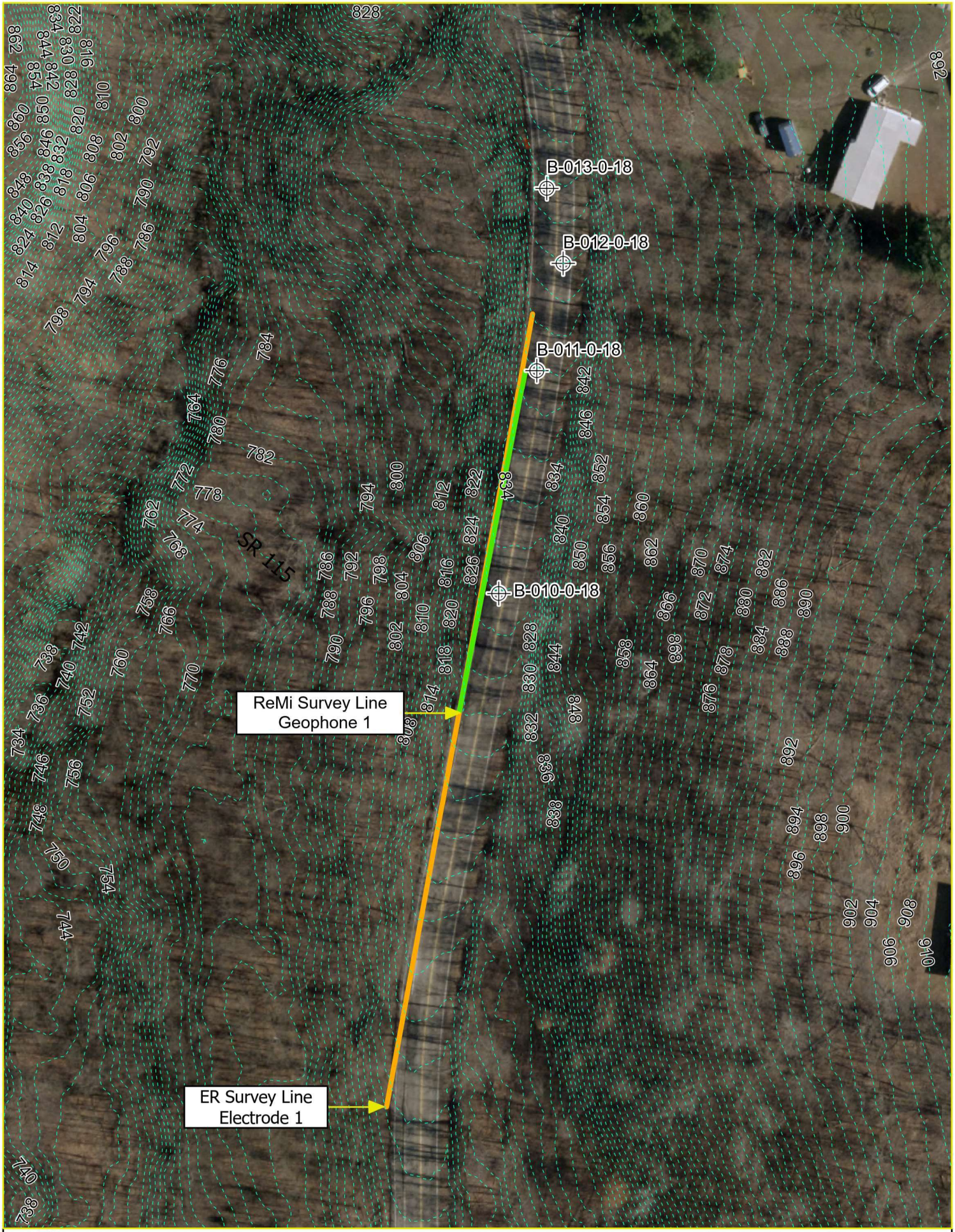
If you have any questions, please feel free to contact me at 614-275-1305.

Thank you,

AMJ/PPP

PC: Reading File, File

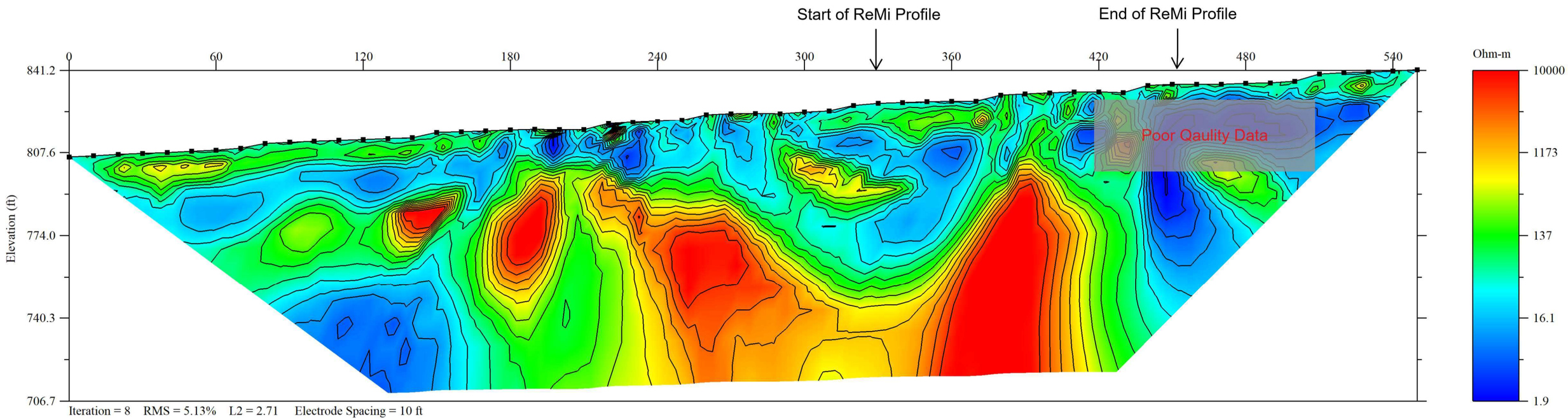
Attachments: Site plan, geophysical exploration results, boring logs.



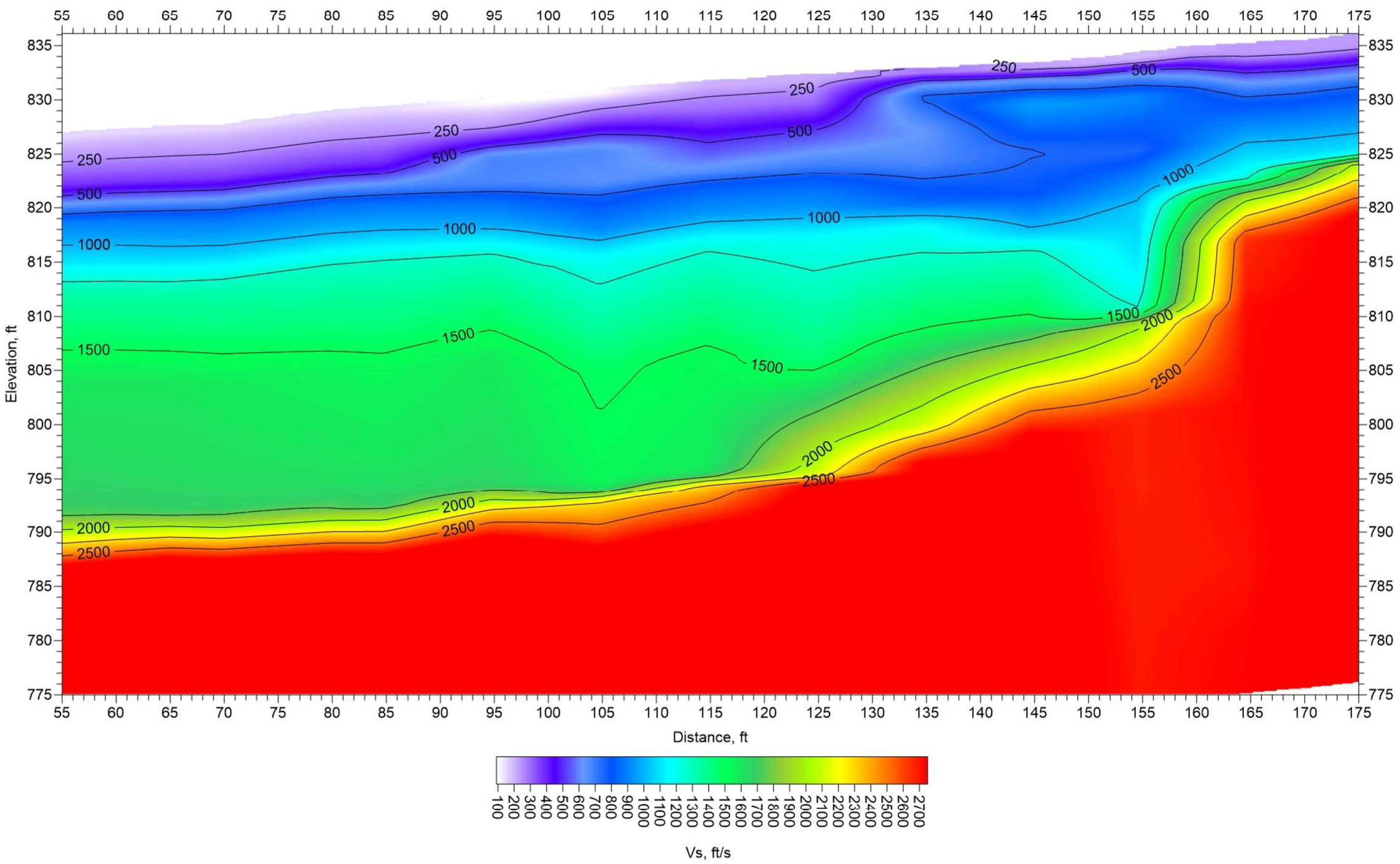
PIK-772-14.10
Exploration Plan

0 5 10 20
Feet

PIK-772-14.10 Inverted Resistivity Profile



PIK-772-14.10 ReMi Profile



PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-010-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 829.9 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 9/12/18 END: 9/18/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090108, -83.129233	

MATERIAL DESCRIPTION AND NOTES	ELEV. 829.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (42")	826.4																	
MEDIUM STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE STONE FRAGMENTS, NOT ENOUGH MATERIAL TO TEST, MOIST TO WET @6.0'; ENCOUNTERED SANDSTONE FRAGMENTS	821.4		23 29 12	59	100	SS-1	-	-	-	-	-	-	-	-	-	-		
VERY STIFF, YELLOWISH BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	818.9		2 1 3	6	11	SS-2	0.50	-	-	-	-	-	-	-	-	24	A-4a (V)	
			3 2 3	7	11	SS-3	-	-	-	-	-	-	-	-	-	9	A-4a (V)	
			3 4 7	16	67	SS-4	2.00	47	8	4	21	20	31	18	13	11	A-6a (2)	
SHALE, BROWN WITH GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED.	814.9	TR	18 25 28	77	100	SS-5	-	-	-	-	-	-	-	-	-	10	Rock (V)	
			30 44 53	141	100	SS-6	-	-	-	-	-	-	-	-	-	8	Rock (V)	
SHALE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY WEAK, LAMINATED TO VERY THIN BEDDED, SLIGHTLY CALCAREOUS, BLOCKY, FAIR; RQD 37%, REC 100%. @15.4' - 17.8'; CONTAINS CLAY SEAM WITH LOSS			0		35	NQ-1											CORE	
			0		50	NQ-2											CORE	
			0		40	NQ-3											CORE	
@ 23.6' - 24.1'; γ = 149 pcf; Qu = 38 psi			50		100	NQ-4											CORE	
@ 29.0' - 29.6'; γ = 164 pcf; Qu = 273 psi	799.9	EOB	12		100	NQ-5											CORE	

NOTES: LAT/LONG FROM OGE HANDHELD GPS UNIT. ELEV FROM OSIP DEM. HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 11/16/18 07:44 - X:\GINT\PROJECTS\600555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-011-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 839.5 (MSL) EOB: 27.0 ft.	PAGE 1 OF 1
START: 9/18/18 END: 9/27/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090039, -83.128698	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (36")	839.5																	
	836.5	1	40 28 12	58	100	SS-1	-	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, BROWN AND REDDISH BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP		2																
	833.5	3	5 3 5	12	22	SS-2	-	54	12	11	17	6	NP	NP	NP	11	A-1-b (0)	
STIFF, BROWN AND DARK BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, MOIST		4																
	831.0	5	2 2 4	9	44	SS-3	2.00	40	10	6	24	20	32	21	11	23	A-6a (2)	
VERY DENSE, REDDISH BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST		6																
	828.5	7	4 31 7	55	56	SS-4	-	43	7	8	31	11	NP	NP	NP	16	A-4a (1)	
VERY DENSE, REDDISH BROWN, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP TO MOIST @11.5' - 17.4'; ENCOUNTERED BOULDERS/COBBLES		8																
	822.1	9	7 54	-	50	SS-5	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	
		10	0		40	NQ-1											CORE	
		11																
		12																
		13																
		14																
		15																
		16																
		17																
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), RQD 4%, REC. 98%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 1.5 INCHES; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO THIN VERY BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 0.5 INCHES.		18																
		19	8		100	NQ-2											CORE	
		20																
		21																
		22	0		100	NQ-3											CORE	
		23																
		24																
		25	0		96	NQ-4											CORE	
	812.5	26																
	TR	27																
	EOB																	

NOTES: LAT/LONG FROM OGE HANDHELD GPS UNIT. ELEV FROM OSIP DEM. HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 11/16/18 07:44 - X:\GINT\PROJECTS\600555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-012-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 845.7 (MSL) EOB: 24.5 ft.	PAGE 1 OF 1
START: 10/1/18 END: 10/2/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.089992, -83.128442	

MATERIAL DESCRIPTION AND NOTES	ELEV. 845.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (12")	844.7																	
MEDIUM DENSE, BROWN, **SANDY SILT**, "AND" GRAVEL AND STONE FRAGMENTS, LITTLE CLAY, DAMP TO MOIST	842.2		8 8 7	22	56	SS-1	-	39	8	13	29	11	NP	NP	NP	13	A-4a (1)	
VERY STIFF TO HARD, BROWN WITH GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP	837.2		8 7 7	20	56	SS-2	2.50	39	5	7	30	19	27	16	11	15	A-6a (3)	
			7 10 11	30	83	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
SHALE, BROWN, SEVERELY WEATHERED, VERY WEAK, LAMINATED.	836.2	TR	20 48	-	117	SS-4	-	-	-	-	-	-	-	-	-	10	Rock (V)	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), RQD 21%, REC. 87%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED, BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 2 INCHES; **SANDSTONE**, LIGHT GRAY WITH BROWN, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, RANGES IN THICKNESS FROM 0.25 INCHES TO 35 INCHES. @9.6' - 10.2'; SANDSTONE LAYER, VERY STRONG @ 9.6' - 10.0'; γ = 163 pcf; Qu = 17,479 psi @12.1' - 15.0'; SANDSTONE LAYER, VERY STRONG @13.4' - 13.8'; γ = 161 pcf; Qu = 20,328 psi @17.5' - 18.8'; SANDSTONE LAYER, VERY STRONG @ 18.3' - 18.7'; γ = 164 pcf; Qu = 27,884 psi			24		82	NQ-1										CORE	
@23.1' - 23.5'; SANDSTONE LAYER	821.2	EOB	0		100	NQ-2										CORE	

NOTES: LAT/LONG FROM OGE HANDHELD GPS UNIT. ELEV FROM OSIP DEM. HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 11/16/18 07:44 - X:\GINT\PROJECTS\600555.GPJ

PROJECT: PIK-772-13.77	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-013-0-18
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: ODOT / MCINTOSH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 772	
PID: 104155 SFN:	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/2/18	ELEVATION: 849.2 (MSL) EOB: 24.0 ft.	PAGE 1 OF 1
START: 10/2/18 END: 10/2/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 39.090023, -83.128263	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (18")	849.2																	
	847.7																	
LOOSE, BLACK, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, ASPHALT GRINDINGS, DAMP			9 3 1	6	44	SS-1	-	-	-	-	-	-	-	-	-	3	A-1-b (V)	
	845.7																	
STIFF, BROWN WITH GRAY, **SANDY SILT**, SOME CLAY, SOME STONE FRAGEMENTS, MOIST			3 1 3	6	44	SS-2	1.50	25	5	5	39	26	27	17	10	19	A-4a (6)	
			2 3 3	9	44	SS-3	2.00	-	-	-	-	-	-	-	-	20	A-4a (V)	
	840.7																	
STIFF, BROWN, **SANDY SILT**, "AND" STONE FRAGMENTS, LITTLE CLAY, DAMP			2 2 1	4	44	SS-4	1.50	45	8	6	25	16	24	17	7	15	A-4a (1)	
			4 5 2	10	56	SS-5	2.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
@13.5'; VERY STIFF TO HARD	835.2	TR	60	-	100	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-4a (V)	
INTERBEDDED SHALE (60%) AND SANDSTONE (40%), RQD 22%, REC. 86%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, LAMINATED TO VERY THIN BEDDED, BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 1 INCH; **SANDSTONE**, GRAY AND BROWNISH GRAY, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY TO MODERATELY STRONG, VERY FINE GRAINED, LAMINATED TO VERY THIN BEDDED, BLOCKY, FAIR, RANGES IN THICKNESS FROM 0.25 INCHES TO 17 INCHES. @14.0' - 14.6'; SANDSTONE LAYER, VERY STRONG, CALCAREOUS @ 14.0' - 14.4'; γ = 169 pcf; Qu = 15,391 psi @16.6' - 18.0; SANDSTONE LAYER, MODERATELY STRONG TO STRONG @21.6' - 22.9'; SANDSTONE LAYER, MODERATELY STRONG TO STRONG, SLIGHTLY CALCAREOUS @ 21.7' - 22.0'; γ = 164 pcf; Qu = 4,273 psi	825.2	EOB	22		86	NQ2-1											CORE	

NOTES: LAT/LONG FROM OGE HANDHELD GPS UNIT. ELEV FROM OSIP DEM. HOLE DRY BEFORE CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG HOLE PLUG

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 11/16/18 08:02 - X:\GINT\PROJECTS\600555.GPJ

The Ohio Department of Transportation
Office of Geotechnical Engineering

PROJECT	PIK-772-13.77	DISTRICT No.:	9	PID No	104155	Tech:	PPP

Point Load Strength Calc Is = P / (D_e^2) $D_e^2 = 4A/\pi$ A = (WD) Stregnth = Is * K K= 12 Sample Preservation Method: AR Core Box

Boring #	Sample Depth (ft)	Material Type	Test Type	Moist Cont.	W (in)	W (mm)	D (in)	D (mm) Initial	D (mm) Final	D (mm) Avg	L/D	P: Failure Load (kN)	Is_{50} (MPa)	Is_{50} (psi)	Strength S_c (MPa)	Strength S_c (psi)
B-008-0-18	15.1-16.5	SH	a	ar	1.988	50.5	1.289	35.0	30.5	32.8	0.649	4.324	2.05	298	25	3573
					1.988	50.5	1.102	30.0	26.0	28.0	0.554	4.844	2.69	390	32	4682
					1.988	50.5	0.955	26.5	22.0	24.3	0.480	5.619	3.60	523	43	6270
					1.988	50.5	0.768	21.0	18.0	19.5	0.386	2.971	2.37	344	28	4123
					1.988	50.5	0.6	16.5	14.0	15.3	0.302	2.696	2.75	399	33	4784
					1.988	50.5	1.112	30.5	26.0	28.3	0.559	4.069	2.24	325	27	3898
					1.988	50.5	0.807	22.0	19.0	20.5	0.406	4.344	3.30	478	40	5734
					1.988	50.5	1.22	33.0	29.0	31.0	0.614	4.295	2.15	312	26	3749
					1.988	50.5	1.299	35.5	30.5	33.0	0.653	5.687	2.68	389	32	4664
					1.988	50.5	1.024	28.0	24.0	26.0	0.515	4.726	2.83	410	34	4919
					1.988	50.5	1.014	27.5	24.0	25.8	0.510	4.638	2.80	406	34	4874
					1.988	50.5	1.024	27.0	25.0	26.0	0.515	3.824	2.29	332	27	3980
					1.988	50.5	0.846	23.0	20.0	21.5	0.426	5.727	4.14	601	50	7208
														Avg. Strength (psi)		4612

Note: Avg. Strength calculated with the two highest and lowest values (red) excluded.

Comments: Test Type: a: axial, d: diametrical; b: block; i: irregular; ⊥: perpendicular; //: parallel

Rock Type: SS: Sandstone; SH: Shale; LS: Limestone; CLS: Claystone; BLDR: Boulder Moist. Cont.: s: saturated; ar: as received; ad: air dried; od: oven dried (%)


PIK 772-13.77
B-010-0-18
R1 15'-17' Rec 35% RQD 0%
R2 17'-19' Rec 50% RQD 0%
R3 19'-20' Rec 40% RQD 0%
R4 20'-25' Rec 100% RQD 50%
TOP 15.0
Lufkin
1F
2F
B10

PIK 772-13.77

B-010-0-18

R5 25.0'-30.0' Rec 100%. RQD 12%.


PIK 772-13.77
B-011-0-18
R1 12'-17' Rec 40% RQD 0
R2 17'-22' Rec 100% RQD 8%
TOP 12.0
Lufkin

PIK 772-13.77

B-011-0-18

R3 22'-23' Rec 100% RQD 0%.

R4 23'-27' Rec 96% RQD 0%.


PIK 772-13.77
BO12-0-15
R1 9.5'-19.5' Rec 82%. RQD 24%
Lufkin

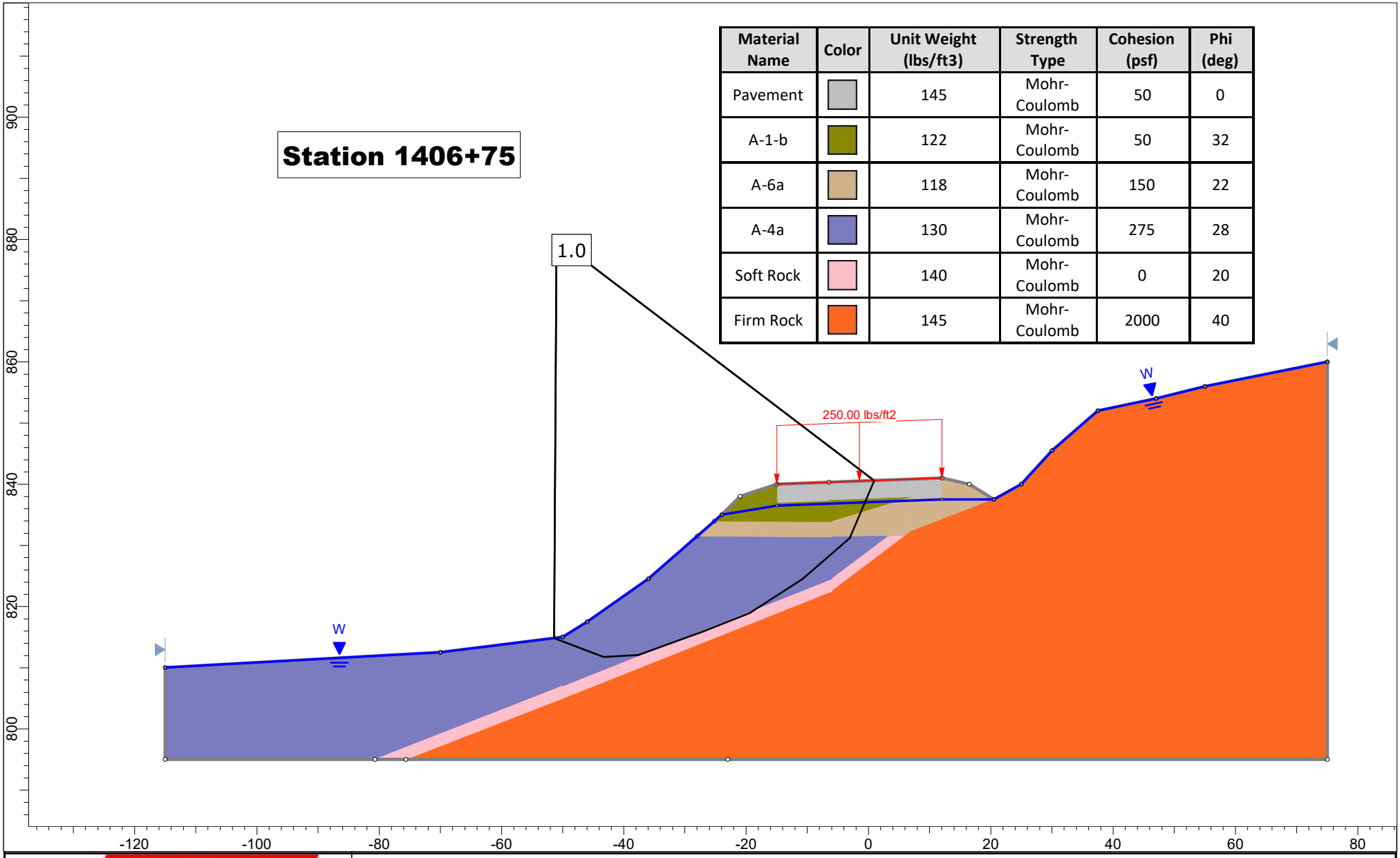

PIK 772-13.77
BO12-0-15
R2 19.5'-24.5' Rec 100%. RQD 61


PIK-772-13.77
B-013-0-18
14.0' to 24.0'
REC=86% RQD=22%

APPENDIX D
GLOBAL STABILITY ANALYSES

Station 1406+75

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Pavement		145	Mohr-Coulomb	50	0
A-1-b		122	Mohr-Coulomb	50	32
A-6a		118	Mohr-Coulomb	150	22
A-4a		130	Mohr-Coulomb	275	28
Soft Rock		140	Mohr-Coulomb	0	20
Firm Rock		145	Mohr-Coulomb	2000	40



CTL ENGINEERING INC.

PIK-772-14.10

Group	Group1	Scenario	Master Scenario
Drawn By	CTL Engineering, Inc.	Company	CTL Engineering Inc.
Date	6/7/2023 11:03:26 AM	File Name	Station 1406+75.slmd

SLIDEINTERPRET 9.0

APPENDIX E
DRILLED SHAFT ANALYSES

PIK-772-14.70 LANDSLIDE REPAIR STATION 1406+75 UASLOPE OUTPUT EXISTING CONDITIONS

File Run Options Help

Calculated Results

Factor of Safety: 1.00

Force per Shaft: 0.000 lb

Acting Point X: 98.000 ft Y: 0.000 ft

Analysis Unit System

(•) English ( ) Metric

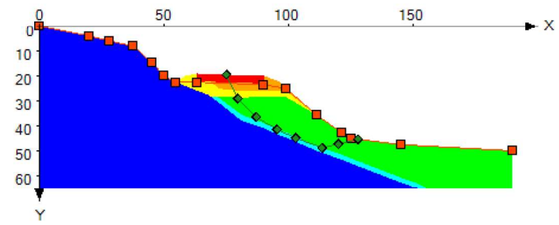
Number of Vertical Sections and Soil Layers

Vertical Section Num: 25 Soil Layer Num: 6

Analysis Method

( ) Total Stress (•) Effective Stress

Chart (Double-Click for More Options)



Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	50.0	0.0	145.0
Layer2	50.0	32.0	122.0
Layer3	150.0	22.0	118.0
Layer4	300.0	31.0	130.0
Layer5	0.0	20.0	140.0
Layer6	2000.0	40.0	145.0

Slope Profile Vertical Sections

	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13	Section 14	Section 15	Section 1
X (ft)	28.00	37.50	45.00	50.00	54.50	58.50	62.99	63.00	68.00	69.10	71.70	81.00	90.00	90.01
Y1 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	19.00	19.20	19.30	19.40	19.70	20.00	20.00
Y2 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	22.00	22.20	22.30	22.40	22.70	23.00	20.00
Y3 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	22.00	22.20	22.50	25.00	26.10	25.90	25.90
Y4 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	28.50	28.60	28.50	28.50
Y5 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	28.50	35.50	38.90	38.90
Y6 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	30.50	37.90	40.90	40.90
Y7 (ft)	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00

Coordinates of Crest X: 70.70 ft Y: 19.30 ft Coordinates of Toe X: 128.90 ft Y: 45.50 ft

Drilled Shaft Information

(•) Calculate without Drilled Shaft

( ) Automatic Load Transfer Factor

( ) Manually Defined Load Transfer Factor

[ ] Anchor (On/Off)

Anchor force: 0.00 lb

Anchor angle: 0.00

Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)

Xmin 0.00 Diameter: 3.00 ft

Xmax 0.00 CTC Spacing: 5.50 ft

XDelta 0.00 X Coordinate: 98.00 ft

[ ] Auto Save Data

▷ Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14	Point 15
X (ft)	0.00	20.00	28.00	37.50	45.00	50.00	54.50	63.00	90.00	99.00	111.00	121.00	125.00	145.00	190.00
Y (ft)	0.00	4.00	6.00	8.00	14.50	20.00	22.50	22.50	23.50	25.00	35.50	42.50	45.00	47.50	50.00

Slip Surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8
X (ft)	75.02	79.62	87.02	95.30	102.80	113.56	120.05	127.89
Y (ft)	19.44	29.12	36.48	41.42	44.88	48.80	47.25	45.36

PIK-772-14.70 LANDSLIDE REPAIR STATION 1406+75 UASLOPE OUTPUT WITH SHAFTS

File Run Options Help

Calculated Results

Factor of Safety: 1.76

Force per Shaft: 89050.619 lb

Acting Point X: 98.000 ft Y: 35.186 ft

Analysis Unit System

(•) English ( ) Metric

Number of Vertical Sections and Soil Layers

Vertical Section Num: 27 Soil Layer Num: 7

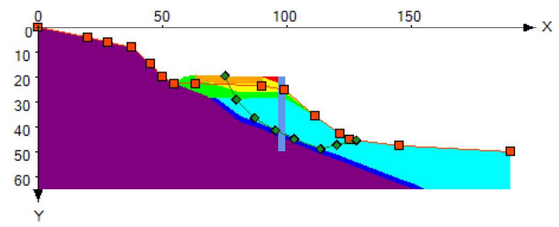
Analysis Method

( ) Total Stress (•) Effective Stress

Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	150.0	22.0	118.0
Layer2	50.0	0.0	145.0
Layer3	50.0	32.0	122.0
Layer4	150.0	22.0	118.0
Layer5	275.0	30.0	130.0
Layer6	0.0	20.0	140.0
Layer7	2000.0	40.0	145.0

Chart (Double-Click for More Options)



Slope Profile Vertical Sections

	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13	Section 14	Section 15	Section 1
X (ft)	28.00	37.50	45.00	50.00	54.50	58.50	62.99	63.00	68.00	69.10	71.70	81.00	90.00	90.01
Y1 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	19.00	19.20	19.30	19.40	19.70	20.00	20.00
Y2 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	19.00	19.20	19.30	19.40	19.70	20.00	20.00
Y3 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	22.00	22.20	22.30	22.40	22.70	22.70	20.00
Y4 (ft)	6.00	8.00	14.50	20.00	22.50	20.00	19.00	22.00	22.20	22.50	23.10	26.10	25.90	25.90
Y5 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	28.50	28.60	28.50	28.50
Y6 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	28.50	35.50	38.90	38.90
Y7 (ft)	6.00	8.00	14.50	20.00	22.50	24.00	25.80	25.80	27.70	28.50	30.50	37.90	40.90	40.90
Y8 (ft)	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00

Coordinates of Crest X: 75.02 ft Y: 19.44 ft Coordinates of Toe X: 127.89 ft Y: 45.36 ft

Drilled Shaft Information

( ) Calculate without Drilled Shaft

( ) Automatic Load Transfer Factor

(•) Manually Defined Load Transfer Factor

[ ] Anchor (On/Off)

Anchor force: 0.00 lb

Anchor angle: 0.00

Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)

Xmin 0.00 Diameter: 3.00 ft

Xmax 0.00 CTC Spacing: 5.50 ft

XDelta 0.00 X Coordinate: 98.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14	Point 15
X (ft)	0.00	20.00	28.00	37.50	45.00	50.00	54.50	63.00	90.00	99.00	111.00	121.00	125.00	145.00	190.00
Y (ft)	0.00	4.00	6.00	8.00	14.50	20.00	22.50	22.50	23.50	25.00	35.50	42.50	45.00	47.50	50.00

Slip Surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8
X (ft)	75.02	79.62	87.02	95.30	102.80	113.56	120.06	127.89
Y (ft)	19.44	29.12	36.48	41.42	44.88	48.80	47.25	45.36

Project: PIK-CR772-14.70
Project No: 23050003OL
June 7, 2023

L-PILE Soil Parameters (Station 1406+75)

Artificial Lowering of Ground Surface

The passive resistance from the downhill side soil mass should be ignored. In order to include this in the L-pile soil model, the ground level should be artificially lowered.

To do this, first determine the angle of steepness of the slope - downhill of the drilled shafts - from horizontal (β_{dh}), and then determine the depth to the shear surface at the location of the drilled shafts (d_τ). For slopes of steepness from β=0° to 45°, lower the ground surface by an amount equal to $d_\tau TAN(\beta_{dh})$.

For the current project, β_{dh} = 37 degrees (From cross section at Sta. 1406+75)

Proposed top of pile elevation = 840.0 (Assumed top of wall elevation)
Existing grade at pile location = 834.6 (From cross section at Sta. 1406+75)
Estimated shear surface elevation at pile location = 815.6
d_τ = 834.6 – 815.7 = 18.9 feet

Therefore, $d_\tau TAN(\beta_{dh})$ = 14.2 feet.

The first soil layer should start at elevation 834.6– 14.2 = 820.4

Which is at a depth of 840.0 – 820.4 = 19.6 feet along the shaft

From 19.6' to 24.3'
Use soil type – *Stiff Clay with Free Water (Reese)*
Effective Unit Weight (pcf) = 130 pcf – 62.4 pcf = 67.6 pcf
N_{60} = 25 bpf (Average blow count in cohesive soils, B-011-0-18 and B-012-0-18)
Undrained Cohesion (psf) = $N_{60}/8$ = 25/8 = 3,125 psf
Use Strain Factor K_{rm} = 0.005 (From L-pile Technical Manual Table 3-4, stiff clay)
Use Subgrade Modulus K_{static} = 1,000 pci (From L-pile Technical Manual Table 3-3)

Below 24.3'
Use soil type – *Weak Rock (Reese)*
Effective Unit Weight (pcf) = 145 pcf – 62.4 pcf = 82.6 pcf
Compressive strength (q_u) = 273 psi (B-010-0-18, NQ-2 Compressive Strength Test Result of Shale)
Initial Rock Modulus (E_r) = 24,388 psi (Per ODOT OGE, Very Weak to Weak)
RQD = 0% (Lowest RQD from Borings B-011-0-18 and B-012-0-18, Estimated Weakest Bedrock Profile)
Use Strain Factor K_{rm} = 0.0005 (From L-pile Technical Manual Equation 3-136)

Project: PIK-CR772-14.70
Project No: 23050003OL
June 7, 2023

P-y Modification Factors

If the drilled shafts are at a center-to-center spacing closer than about 3½ diameters, a reduction in the soil resistance p, for the p-y curve behavior of the soil, must be considered.

P- modification factor $\beta_a = 0.64(S/D)^{0.34}$

In which S= Center to Center Spacing between the Piles

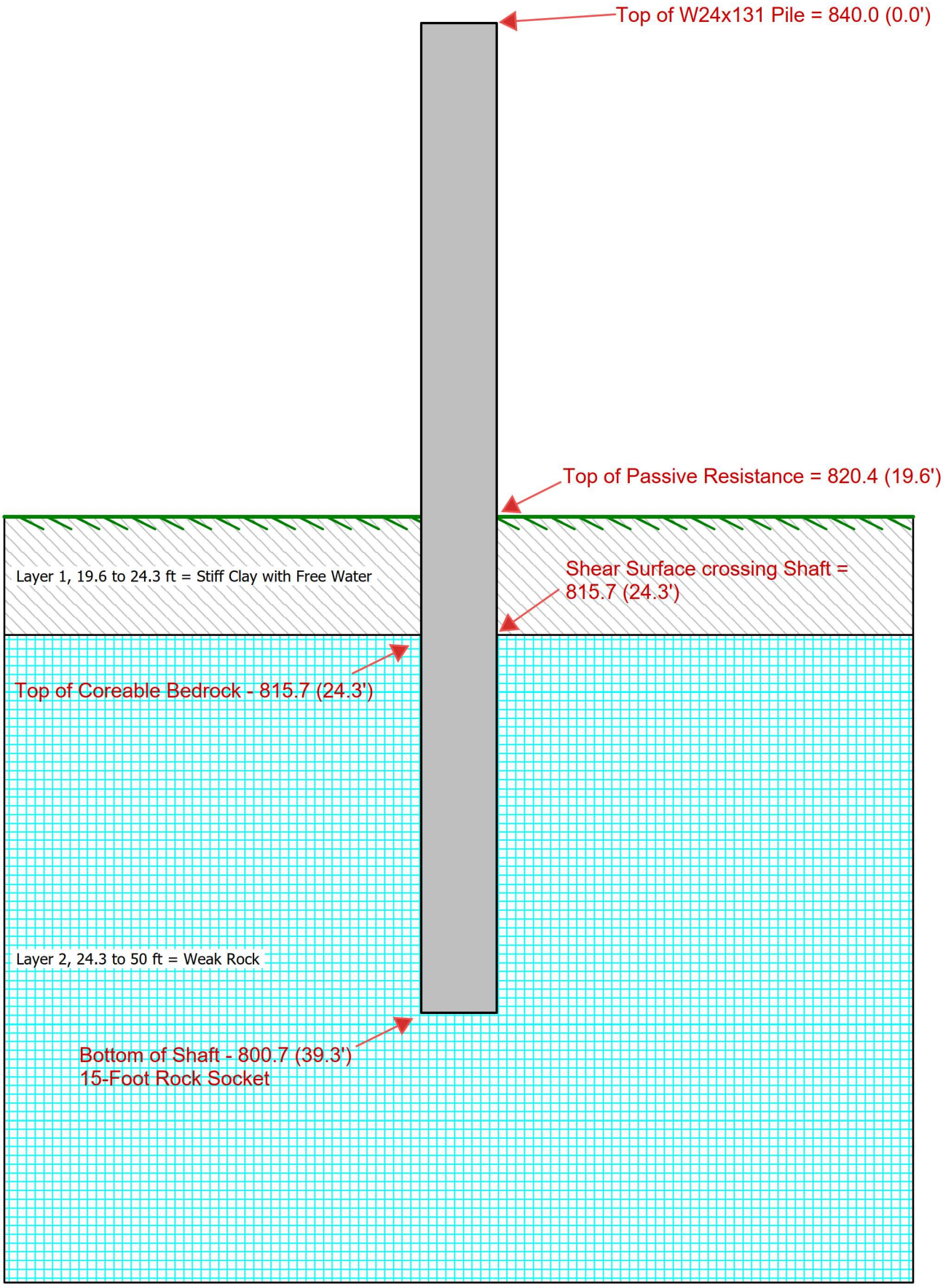
D= Diameter of the Shaft

For 36- inch shafts with reinforced shafts placed at 5.5 feet center to center

$\beta a = 0.64(5.5/3.0)^{0.34} = 0.79$

No P-Y modification factors are applied to the bedrock layers

STATION 1406+75



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================================================================================

                    LPile for Windows, Version 2022-12.007

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
                           © 1985-2022 by Ensoft, Inc.
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================================================================================

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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\PROJECT\2023\COL-05\23050003COL\Design\LPILE\Station 1406+75\

Name of input data file:
Station 1406+75.lp12d

Name of output report file:
Station 1406+75.lp12o

Name of plot output file:
Station 1406+75.lp12p

Name of runtime message file:
Station 1406+75.lp12r



--------------------------------------------------------------------------------
                          Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  June 7, 2023               Time:  10:35:33
```

Problem Title

Project Name: PIK-772-14.10

Job Number: 23050003COL

Client: OHIO DEPARTMENT OF TRANSPORTATION

Engineer: CTL ENGINEERING, INC.

Description: STATION 1406+75 DRILELD SHAFT WALL ANALYSIS

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - Analysis includes loading by multiple distributed lateral loads acting on pile
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1

- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 39.300 ft
Depth of ground surface below top of pile = 19.6000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	36.0000
2	39.300	36.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile
Cross-sectional Shape = Circular Pile
Length of section = 39.300000 ft
Width of top of section = 36.000000 in
Width of bottom of section = 36.000000 in
Top Area = 38.500000 sq. in
Bottom Area = 38.500000 sq. in
Moment of Inertia at Top = 4020. in^4
Moment of Inertia at Bottom = 4020. in^4
Elastic Modulus = 29000000. psi

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay with water-induced erosion

```
   Distance from top of pile to top of layer          =    19.600000 ft
   Distance from top of pile to bottom of layer       =    24.300000 ft
   Effective unit weight at top of layer              =    67.600000 pcf
   Effective unit weight at bottom of layer           =    67.600000 pcf
   Undrained cohesion at top of layer                 =        3125. psf
   Undrained cohesion at bottom of layer              =        3125. psf
   Epsilon-50 at top of layer                         =     0.005000
   Epsilon-50 at bottom of layer                      =     0.005000
   Subgrade k at top of layer                         =  1000.000000 pci
   Subgrade k at bottom of layer                      =  1000.000000 pci


Layer 2 is weak rock, p-y criteria by Reese, 1997

   Distance from top of pile to top of layer          =    24.300000 ft
   Distance from top of pile to bottom of layer       =    50.000000 ft
   Effective unit weight at top of layer              =    82.600000 pcf
   Effective unit weight at bottom of layer           =    82.600000 pcf
   Uniaxial compressive strength at top of layer      =   273.000000 psi
   Uniaxial compressive strength at bottom of layer   =   273.000000 psi
   Initial modulus of rock at top of layer            =       24388. psi
   Initial modulus of rock at bottom of layer         =       24388. psi
   RQD of rock at top of layer                        =       0.0000 %
   RQD of rock at bottom of layer                     =       0.0000 %
   k rm of rock at top of layer                       =    0.0005000
   k rm of rock at bottom of layer                    =    0.0005000


 (Depth of the lowest soil layer extends 10.700 ft below the pile tip)


--------------------------------------------------------------------------------
                      Summary of Input Soil Properties
--------------------------------------------------------------------------------

Layer         Soil Type          Layer      Effective    Cohesion     Uniaxial                  E50                  Rock Mass
 Num.          Name              Depth      Unit Wt.                    qu          RQD %        or          kpy       Modulus
          (p-y Curve Type)        ft          pcf          psf         psi                      krm          pci         psi
-----   -------------------   ----------   ----------   ----------   ----------   ----------   ----------   ----------   ----------
  1         Stiff Clay          19.6000      67.6000       3125.       --           --          0.00500    1000.0000       --
          with Free Water       24.3000      67.6000       3125.       --           --          0.00500    1000.0000       --
  2            Weak             24.3000      82.6000       --         273.0000        0.00     5.00E-04       --          24388.
               Rock             50.0000      82.6000       --         273.0000        0.00     5.00E-04       --          24388.


--------------------------------------------------------------------------------
                      Modification Factors for p-y Curves
--------------------------------------------------------------------------------

Distribution of p-y modifiers with depth defined using 3 points

Point      Depth X         p-mult         y-mult
```

No.	ft		
1	19.600	0.7900	1.0000
2	24.300	0.7900	1.0000
3	24.300	1.0000	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading for Individual Load Cases

Distributed lateral load intensity for Load Case 1 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	34.100
2	24.300	610.800

Distributed lateral load intensity for Load Case 2 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	59.600
2	24.300	865.100

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes
2	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	19.6000	0.00	N.A.	No	0.00	13066.
2	24.3000	4.7000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals
for Layer n. Layering correction equivalent depths are computed only
for soil types with both shallow-depth and deep-depth expressions for
peak lateral load transfer. These soil types are soft and stiff clays,
non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	2.2457	-1.86E-05	2.47E-07	-0.00884	8.34E-08	1.17E+11	0.00	0.00	36.4317
0.3930	2.2040	405.1326	188.3066	-0.00884	1.8140	1.17E+11	0.00	0.00	43.4269
0.7860	2.1623	1776.	415.1005	-0.00884	7.9527	1.17E+11	0.00	0.00	52.7538
1.1790	2.1206	4320.	685.8800	-0.00884	19.3449	1.17E+11	0.00	0.00	62.0806
1.5720	2.0790	8245.	1001.	-0.00884	36.9194	1.17E+11	0.00	0.00	71.4075
1.9650	2.0373	13758.	1359.	-0.00884	61.6050	1.17E+11	0.00	0.00	80.7344
2.3580	1.9956	21067.	1762.	-0.00883	94.3305	1.17E+11	0.00	0.00	90.0613
2.7510	1.9540	30379.	2209.	-0.00883	136.0248	1.17E+11	0.00	0.00	99.3881
3.1440	1.9123	41901.	2700.	-0.00883	187.6166	1.17E+11	0.00	0.00	108.7150
3.5370	1.8707	55841.	3234.	-0.00883	250.0349	1.17E+11	0.00	0.00	118.0419
3.9300	1.8290	72407.	3813.	-0.00883	324.2083	1.17E+11	0.00	0.00	127.3688
4.3230	1.7874	91805.	4436.	-0.00882	411.0658	1.17E+11	0.00	0.00	136.6956
4.7160	1.7458	114243.	5102.	-0.00882	511.5361	1.17E+11	0.00	0.00	146.0225
5.1090	1.7042	139929.	5813.	-0.00882	626.5481	1.17E+11	0.00	0.00	155.3494
5.5020	1.6626	169070.	6568.	-0.00881	757.0305	1.17E+11	0.00	0.00	164.6763
5.8950	1.6211	201874.	7366.	-0.00880	903.9123	1.17E+11	0.00	0.00	174.0031
6.2880	1.5796	238547.	8209.	-0.00879	1068.	1.17E+11	0.00	0.00	183.3300
6.6810	1.5382	279298.	9095.	-0.00878	1251.	1.17E+11	0.00	0.00	192.6569
7.0740	1.4968	324334.	10026.	-0.00877	1452.	1.17E+11	0.00	0.00	201.9838
7.4670	1.4555	373862.	11000.	-0.00876	1674.	1.17E+11	0.00	0.00	211.3107
7.8600	1.4142	428090.	12019.	-0.00874	1917.	1.17E+11	0.00	0.00	220.6375
8.2530	1.3730	487224.	13081.	-0.00872	2182.	1.17E+11	0.00	0.00	229.9644
8.6460	1.3319	551474.	14188.	-0.00870	2469.	1.17E+11	0.00	0.00	239.2913
9.0390	1.2910	621045.	15338.	-0.00868	2781.	1.17E+11	0.00	0.00	248.6182
9.4320	1.2501	696146.	16533.	-0.00865	3117.	1.17E+11	0.00	0.00	257.9450
9.8250	1.2094	776983.	17771.	-0.00862	3479.	1.17E+11	0.00	0.00	267.2719
10.2180	1.1688	863765.	19054.	-0.00859	3868.	1.17E+11	0.00	0.00	276.5988
10.6110	1.1284	956699.	20380.	-0.00855	4284.	1.17E+11	0.00	0.00	285.9257
11.0040	1.0882	1055992.	21751.	-0.00851	4728.	1.17E+11	0.00	0.00	295.2525
11.3970	1.0481	1161851.	23165.	-0.00846	5202.	1.17E+11	0.00	0.00	304.5794
11.7900	1.0083	1274485.	24623.	-0.00842	5707.	1.17E+11	0.00	0.00	313.9063
12.1830	0.9688	1394100.	26126.	-0.00836	6242.	1.17E+11	0.00	0.00	323.2332
12.5760	0.9295	1520904.	27672.	-0.00830	6810.	1.17E+11	0.00	0.00	332.5600
12.9690	0.8905	1655104.	29263.	-0.00824	7411.	1.17E+11	0.00	0.00	341.8869
13.3620	0.8518	1796908.	30897.	-0.00817	8046.	1.17E+11	0.00	0.00	351.2138
13.7550	0.8134	1946523.	32575.	-0.00809	8716.	1.17E+11	0.00	0.00	360.5407
14.1480	0.7754	2104157.	34297.	-0.00801	9422.	1.17E+11	0.00	0.00	369.8676
14.5410	0.7379	2270017.	36064.	-0.00792	10164.	1.17E+11	0.00	0.00	379.1944
14.9340	0.7007	2444311.	37874.	-0.00783	10945.	1.17E+11	0.00	0.00	388.5213
15.3270	0.6640	2627246.	39728.	-0.00772	11764.	1.17E+11	0.00	0.00	397.8482
15.7200	0.6279	2819028.	41627.	-0.00761	12623.	1.17E+11	0.00	0.00	407.1751
16.1130	0.5922	3019867.	43569.	-0.00750	13522.	1.17E+11	0.00	0.00	416.5019
16.5060	0.5572	3229969.	45555.	-0.00737	14463.	1.17E+11	0.00	0.00	425.8288

16.8990	0.5227	3449542.	47585.	-0.00723	15446.	1.17E+11	0.00	0.00	435.1557
17.2920	0.4889	3678793.	49659.	-0.00709	16472.	1.17E+11	0.00	0.00	444.4826
17.6850	0.4558	3917930.	51778.	-0.00694	17543.	1.17E+11	0.00	0.00	453.8094
18.0780	0.4235	4167159.	53940.	-0.00677	18659.	1.17E+11	0.00	0.00	463.1363
18.4710	0.3920	4426689.	56146.	-0.00660	19821.	1.17E+11	0.00	0.00	472.4632
18.8640	0.3613	4696727.	58396.	-0.00641	21030.	1.17E+11	0.00	0.00	481.7901
19.2570	0.3315	4977480.	60690.	-0.00622	22287.	1.17E+11	0.00	0.00	491.1170
19.6500	0.3026	5269156.	62690.	-0.00601	23593.	1.17E+11	-143.438	2235.	500.4438
20.0430	0.2748	5568772.	63832.	-0.00579	24935.	1.17E+11	-382.353	6563.	509.7707
20.4360	0.2480	5871222.	64008.	-0.00556	26289.	1.17E+11	-571.921	10877.	519.0976
20.8290	0.2223	6172497.	63395.	-0.00532	27638.	1.17E+11	-735.431	15601.	528.4245
21.2220	0.1978	6469168.	62113.	-0.00506	28966.	1.17E+11	-874.561	20849.	537.7513
21.6150	0.1746	6758348.	60274.	-0.00479	30261.	1.17E+11	-990.185	26750.	547.0782
22.0080	0.1526	7037673.	57988.	-0.00452	31512.	1.17E+11	-1083.	33457.	556.4051
22.4010	0.1320	7305295.	55365.	-0.00422	32710.	1.17E+11	-1152.	41157.	565.7320
22.7940	0.1128	7559881.	52517.	-0.00392	33850.	1.17E+11	-1197.	50067.	575.0588
23.1870	0.09497	7800633.	49561.	-0.00361	34928.	1.17E+11	-1216.	60387.	584.3857
23.5800	0.07867	8027335.	46661.	-0.00329	35943.	1.17E+11	-1192.	71428.	593.7126
23.9730	0.06391	8240741.	43977.	-0.00296	36899.	1.17E+11	-1144.	84398.	603.0395
24.3660	0.05071	8442123.	27704.	-0.00263	37801.	1.17E+11	-6563.	610292.	202.3087
24.7590	0.03913	8502047.	-4377.	-0.00228	38069.	1.17E+11	-7245.	873210.	0.00
25.1520	0.02917	8400838.	-39733.	-0.00194	37616.	1.17E+11	-7749.	1252897.	0.00
25.5450	0.02081	8127290.	-77000.	-0.00161	36391.	1.17E+11	-8056.	1825839.	0.00
25.9380	0.01400	7674573.	-115196.	-0.00129	34364.	1.17E+11	-8142.	2742959.	0.00
26.3310	0.00866	7040761.	-153191.	-9.91E-04	31526.	1.17E+11	-7971.	4343120.	0.00
26.7240	0.00465	6229676.	-189596.	-7.22E-04	27894.	1.17E+11	-7468.	7568003.	0.00
27.1170	0.00184	5252489.	-222376.	-4.90E-04	23519.	1.17E+11	-6433.	1.65E+07	0.00
27.5100	3.05E-05	4132227.	-237971.	-3.00E-04	18503.	1.17E+11	-180.609	2.79E+07	0.00
27.9030	-9.92E-04	3007948.	-223560.	-1.56E-04	13468.	1.17E+11	6292.	2.99E+07	0.00
28.2960	-0.00144	2023612.	-191069.	-5.42E-05	9061.	1.17E+11	7487.	2.45E+07	0.00
28.6890	-0.00150	1205790.	-154429.	1.12E-05	5399.	1.17E+11	8051.	2.53E+07	0.00
29.0820	-0.00134	567036.	-115903.	4.70E-05	2539.	1.17E+11	8287.	2.93E+07	0.00
29.4750	-0.00106	112597.	-76871.	6.08E-05	504.1640	1.17E+11	8265.	3.68E+07	0.00
29.8680	-7.62E-04	-158015.	-42154.	5.98E-05	707.5277	1.17E+11	6458.	4.00E+07	0.00
30.2610	-4.95E-04	-285000.	-16539.	5.09E-05	1276.	1.17E+11	4405.	4.20E+07	0.00
30.6540	-2.82E-04	-314015.	53.4613	3.88E-05	1406.	1.17E+11	2632.	4.40E+07	0.00
31.0470	-1.29E-04	-284496.	9234.	2.67E-05	1274.	1.17E+11	1262.	4.60E+07	0.00
31.4400	-3.08E-05	-226920.	12948.	1.63E-05	1016.	1.17E+11	313.4156	4.80E+07	0.00
31.8330	2.45E-05	-162374.	13074.	8.44E-06	727.0485	1.17E+11	-259.605	5.00E+07	0.00
32.2260	4.88E-05	-103602.	11194.	3.06E-06	463.8886	1.17E+11	-538.046	5.20E+07	0.00
32.6190	5.33E-05	-56796.	8485.	-1.87E-07	254.3099	1.17E+11	-610.765	5.40E+07	0.00
33.0120	4.70E-05	-23574.	5727.	-1.81E-06	105.5543	1.17E+11	-558.604	5.60E+07	0.00
33.4050	3.62E-05	-2775.	3369.	-2.35E-06	12.4273	1.17E+11	-441.601	5.75E+07	0.00
33.7980	2.49E-05	8201.	1612.	-2.24E-06	36.7228	1.17E+11	-303.466	5.75E+07	0.00
34.1910	1.51E-05	12429.	461.5998	-1.82E-06	55.6524	1.17E+11	-184.409	5.75E+07	0.00
34.5840	7.73E-06	12555.	-195.518	-1.31E-06	56.2175	1.17E+11	-94.267	5.75E+07	0.00
34.9770	2.73E-06	10585.	-496.394	-8.46E-07	47.3951	1.17E+11	-33.332	5.75E+07	0.00
35.3700	-2.44E-07	7873.	-567.965	-4.72E-07	35.2534	1.17E+11	2.9794	5.75E+07	0.00
35.7630	-1.72E-06	5228.	-511.481	-2.07E-07	23.4083	1.17E+11	20.9748	5.75E+07	0.00
36.1560	-2.20E-06	3049.	-398.808	-3.98E-08	13.6521	1.17E+11	26.8084	5.75E+07	0.00
36.5490	-2.10E-06	1466.	-275.349	5.16E-08	6.5655	1.17E+11	25.5492	5.75E+07	0.00
36.9420	-1.71E-06	451.8729	-165.871	9.04E-08	2.0233	1.17E+11	20.8790	5.75E+07	0.00
37.3350	-1.24E-06	-98.194	-80.897	9.75E-08	0.4397	1.17E+11	15.1575	5.75E+07	0.00

37.7280	-7.93E-07	-311.149	-22.367	8.92E-08	1.3932	1.17E+11	9.6644	5.75E+07	0.00
38.1210	-4.01E-07	-309.160	11.9645	7.67E-08	1.3843	1.17E+11	4.8952	5.75E+07	0.00
38.5140	-6.93E-08	-198.299	25.5004	6.64E-08	0.8879	1.17E+11	0.8452	5.75E+07	0.00
38.9070	2.25E-07	-68.641	21.0241	6.10E-08	0.3073	1.17E+11	-2.744	5.75E+07	0.00
39.3000	5.06E-07	0.00	0.00	5.96E-08	0.00	1.17E+11	-6.173	2.88E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

Pile-head deflection = 2.24565727 inches
Computed slope at pile head = -0.0088366 radians
Maximum bending moment = 8502047. inch-lbs
Maximum shear force = -237971. lbs
Depth of maximum bending moment = 24.75900000 feet below pile head
Depth of maximum shear force = 27.51000000 feet below pile head
Number of iterations = 20
Number of zero deflection points = 4
Pile deflection at ground = 0.30628301 inches

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs
Moment = 0. in-lbs
Axial Load = 0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	2.24565727	8502047.	-237971.
37.33500	2.29557953	8589262.	-242816.
35.37000	2.25583971	8524176.	-240428.
33.40500	2.25161271	8506195.	-236507.
31.44000	2.28148941	8571222.	-241678.
29.47500	2.41070655	8516366.	-268558.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	3.5911	-5.59E-05	0.00	-0.01389	2.50E-07	1.17E+11	0.00	0.00	62.8568
0.3930	3.5256	698.9884	319.4714	-0.01389	3.1298	1.17E+11	0.00	0.00	72.6272
0.7860	3.4601	3013.	692.6995	-0.01389	13.4922	1.17E+11	0.00	0.00	85.6544
1.1790	3.3946	7233.	1127.	-0.01389	32.3845	1.17E+11	0.00	0.00	98.6817
1.5720	3.3291	13647.	1623.	-0.01389	61.1040	1.17E+11	0.00	0.00	111.7089
1.9650	3.2636	22545.	2181.	-0.01389	100.9480	1.17E+11	0.00	0.00	124.7361
2.3580	3.1981	34218.	2800.	-0.01389	153.2139	1.17E+11	0.00	0.00	137.7633
2.7510	3.1326	48954.	3480.	-0.01389	219.1989	1.17E+11	0.00	0.00	150.7906
3.1440	3.0671	67045.	4222.	-0.01388	300.2004	1.17E+11	0.00	0.00	163.8178
3.5370	3.0017	88779.	5026.	-0.01388	397.5158	1.17E+11	0.00	0.00	176.8450
3.9300	2.9362	114445.	5890.	-0.01388	512.4422	1.17E+11	0.00	0.00	189.8722
4.3230	2.8708	144335.	6816.	-0.01387	646.2771	1.17E+11	0.00	0.00	202.8994
4.7160	2.8054	178738.	7804.	-0.01386	800.3177	1.17E+11	0.00	0.00	215.9267
5.1090	2.7400	217942.	8853.	-0.01386	975.8614	1.17E+11	0.00	0.00	228.9539
5.5020	2.6747	262239.	9963.	-0.01385	1174.	1.17E+11	0.00	0.00	241.9811
5.8950	2.6094	311918.	11135.	-0.01384	1397.	1.17E+11	0.00	0.00	255.0083
6.2880	2.5442	367268.	12369.	-0.01382	1644.	1.17E+11	0.00	0.00	268.0356
6.6810	2.4790	428580.	13663.	-0.01381	1919.	1.17E+11	0.00	0.00	281.0628
7.0740	2.4140	496142.	15020.	-0.01379	2222.	1.17E+11	0.00	0.00	294.0900
7.4670	2.3490	570245.	16437.	-0.01377	2553.	1.17E+11	0.00	0.00	307.1172
7.8600	2.2841	651179.	17916.	-0.01374	2916.	1.17E+11	0.00	0.00	320.1444
8.2530	2.2194	739233.	19457.	-0.01371	3310.	1.17E+11	0.00	0.00	333.1717
8.6460	2.1548	834697.	21059.	-0.01368	3737.	1.17E+11	0.00	0.00	346.1989
9.0390	2.0904	937861.	22722.	-0.01364	4199.	1.17E+11	0.00	0.00	359.2261
9.4320	2.0261	1049014.	24447.	-0.01360	4697.	1.17E+11	0.00	0.00	372.2533
9.8250	1.9620	1168446.	26233.	-0.01356	5232.	1.17E+11	0.00	0.00	385.2806
10.2180	1.8982	1296447.	28081.	-0.01351	5805.	1.17E+11	0.00	0.00	398.3078
10.6110	1.8346	1433307.	29990.	-0.01345	6418.	1.17E+11	0.00	0.00	411.3350
11.0040	1.7713	1579315.	31961.	-0.01339	7072.	1.17E+11	0.00	0.00	424.3622
11.3970	1.7083	1734761.	33993.	-0.01333	7768.	1.17E+11	0.00	0.00	437.3894
11.7900	1.6456	1899935.	36086.	-0.01325	8507.	1.17E+11	0.00	0.00	450.4167
12.1830	1.5833	2075127.	38241.	-0.01317	9292.	1.17E+11	0.00	0.00	463.4439
12.5760	1.5213	2260626.	40457.	-0.01309	10122.	1.17E+11	0.00	0.00	476.4711
12.9690	1.4599	2456721.	42735.	-0.01299	11000.	1.17E+11	0.00	0.00	489.4983
13.3620	1.3988	2663704.	45074.	-0.01289	11927.	1.17E+11	0.00	0.00	502.5256
13.7550	1.3383	2881863.	47475.	-0.01277	12904.	1.17E+11	0.00	0.00	515.5528
14.1480	1.2783	3111489.	49937.	-0.01265	13932.	1.17E+11	0.00	0.00	528.5800
14.5410	1.2190	3352870.	52461.	-0.01252	15013.	1.17E+11	0.00	0.00	541.6072
14.9340	1.1602	3606297.	55046.	-0.01238	16148.	1.17E+11	0.00	0.00	554.6344
15.3270	1.1022	3872060.	57692.	-0.01223	17338.	1.17E+11	0.00	0.00	567.6617
15.7200	1.0449	4150447.	60400.	-0.01207	18584.	1.17E+11	0.00	0.00	580.6889
16.1130	0.9884	4441750.	63169.	-0.01189	19888.	1.17E+11	0.00	0.00	593.7161
16.5060	0.9327	4746257.	66000.	-0.01171	21252.	1.17E+11	0.00	0.00	606.7433
16.8990	0.8779	5064259.	68892.	-0.01151	22676.	1.17E+11	0.00	0.00	619.7706
17.2920	0.8241	5396044.	71845.	-0.01130	24161.	1.17E+11	0.00	0.00	632.7978

17.6850	0.7714	5741904.	74860.	-0.01107	25710.	1.17E+11	0.00	0.00	645.8250
18.0780	0.7197	6102127.	77937.	-0.01083	27323.	1.17E+11	0.00	0.00	658.8522
18.4710	0.6692	6477003.	81075.	-0.01058	29002.	1.17E+11	0.00	0.00	671.8794
18.8640	0.6199	6866823.	84274.	-0.01031	30747.	1.17E+11	0.00	0.00	684.9067
19.2570	0.5719	7271875.	87535.	-0.01002	32561.	1.17E+11	0.00	0.00	697.9339
19.6500	0.5254	7692450.	90572.	-0.00972	34444.	1.17E+11	-120.878	1085.	710.9611
20.0430	0.4803	8126148.	93070.	-0.00940	36386.	1.17E+11	-254.606	2500.	723.9883
20.4360	0.4367	8570286.	94947.	-0.00906	38374.	1.17E+11	-410.538	4433.	737.0156
20.8290	0.3948	9021685.	96104.	-0.00871	40396.	1.17E+11	-585.621	6996.	750.0428
21.2220	0.3546	9476741.	96411.	-0.00833	42433.	1.17E+11	-797.583	10608.	763.0700
21.6150	0.3162	9931029.	95809.	-0.00794	44467.	1.17E+11	-996.672	14865.	776.0972
22.0080	0.2797	1.04E+07	94402.	-0.00753	46479.	1.17E+11	-1165.	19649.	789.1244
22.4010	0.2452	1.08E+07	92331.	-0.00710	48454.	1.17E+11	-1304.	25087.	802.1517
22.7940	0.2127	1.13E+07	89736.	-0.00665	50379.	1.17E+11	-1413.	31336.	815.1789
23.1870	0.1824	1.17E+07	86758.	-0.00619	52244.	1.17E+11	-1493.	38598.	828.2061
23.5800	0.1543	1.21E+07	83537.	-0.00571	54043.	1.17E+11	-1542.	47129.	841.2333
23.9730	0.1286	1.25E+07	80219.	-0.00521	55772.	1.17E+11	-1561.	57247.	854.2606
24.3660	0.1052	1.28E+07	60660.	-0.00470	57431.	1.17E+11	-7875.	353189.	286.5478
24.7590	0.08420	1.30E+07	22076.	-0.00418	58334.	1.17E+11	-8775.	491493.	0.00
25.1520	0.06573	1.30E+07	-21001.	-0.00365	58363.	1.17E+11	-9494.	681205.	0.00
25.5450	0.04974	1.28E+07	-67008.	-0.00313	57447.	1.17E+11	-10017.	949701.	0.00
25.9380	0.03621	1.24E+07	-114975.	-0.00262	55533.	1.17E+11	-10326.	1344965.	0.00
26.3310	0.02504	1.17E+07	-163834.	-0.00213	52591.	1.17E+11	-10395.	1958041.	0.00
26.7240	0.01611	1.09E+07	-212363.	-0.00167	48614.	1.17E+11	-10186.	2982447.	0.00
27.1170	0.00925	9742347.	-259089.	-0.00126	43622.	1.17E+11	-9630.	4910473.	0.00
27.5100	0.00425	8413395.	-301974.	-8.90E-04	37672.	1.17E+11	-8557.	9496681.	0.00
27.9030	8.55E-04	6894132.	-334942.	-5.80E-04	30869.	1.17E+11	-5424.	2.99E+07	0.00
28.2960	-0.00122	5254226.	-330783.	-3.35E-04	23526.	1.17E+11	7188.	2.77E+07	0.00
28.6890	-0.00230	3774183.	-292717.	-1.52E-04	16899.	1.17E+11	8956.	1.84E+07	0.00
29.0820	-0.00266	2493321.	-248390.	-2.52E-05	11164.	1.17E+11	9843.	1.75E+07	0.00
29.4750	-0.00254	1431373.	-200932.	5.42E-05	6409.	1.17E+11	10283.	1.91E+07	0.00
29.8680	-0.00215	598131.	-152184.	9.52E-05	2678.	1.17E+11	10390.	2.28E+07	0.00
30.2610	-0.00164	-4022.	-103609.	1.07E-04	18.0093	1.17E+11	10210.	2.94E+07	0.00
30.6540	-0.00113	-379105.	-56514.	9.95E-05	1697.	1.17E+11	9763.	4.06E+07	0.00
31.0470	-7.01E-04	-537058.	-17365.	8.10E-05	2405.	1.17E+11	6840.	4.60E+07	0.00
31.4400	-3.71E-04	-542888.	7661.	5.91E-05	2431.	1.17E+11	3773.	4.80E+07	0.00
31.8330	-1.44E-04	-464802.	20149.	3.88E-05	2081.	1.17E+11	1523.	5.00E+07	0.00
32.2260	-5.20E-06	-352845.	23875.	2.22E-05	1580.	1.17E+11	57.3584	5.20E+07	0.00
32.6190	6.59E-05	-239612.	22230.	1.02E-05	1073.	1.17E+11	-755.012	5.40E+07	0.00
33.0120	9.13E-05	-143171.	17892.	2.49E-06	641.0661	1.17E+11	-1085.	5.60E+07	0.00
33.4050	8.94E-05	-70858.	12764.	-1.84E-06	317.2726	1.17E+11	-1090.	5.75E+07	0.00
33.7980	7.39E-05	-22784.	8068.	-3.73E-06	102.0180	1.17E+11	-901.670	5.75E+07	0.00
34.1910	5.42E-05	5236.	4384.	-4.09E-06	23.4437	1.17E+11	-660.424	5.75E+07	0.00
34.5840	3.54E-05	18567.	1810.	-3.61E-06	83.1371	1.17E+11	-431.358	5.75E+07	0.00
34.9770	2.01E-05	22305.	213.7327	-2.78E-06	99.8737	1.17E+11	-245.486	5.75E+07	0.00
35.3700	9.14E-06	20583.	-628.045	-1.91E-06	92.1637	1.17E+11	-111.502	5.75E+07	0.00
35.7630	2.08E-06	16381.	-950.866	-1.17E-06	73.3496	1.17E+11	-25.402	5.75E+07	0.00
36.1560	-1.85E-06	11615.	-957.498	-6.00E-07	52.0059	1.17E+11	22.5896	5.75E+07	0.00
36.5490	-3.57E-06	7350.	-801.512	-2.16E-07	32.9118	1.17E+11	43.5620	5.75E+07	0.00
36.9420	-3.89E-06	4055.	-586.941	1.47E-08	18.1557	1.17E+11	47.4352	5.75E+07	0.00
37.3350	-3.43E-06	1814.	-376.346	1.33E-07	8.1236	1.17E+11	41.8757	5.75E+07	0.00
37.7280	-2.63E-06	505.0875	-201.922	1.80E-07	2.2616	1.17E+11	32.0956	5.75E+07	0.00
38.1210	-1.73E-06	-90.262	-76.391	1.89E-07	0.4042	1.17E+11	21.1405	5.75E+07	0.00

38.5140	-8.53E-07	-215.432	-2.029	1.82E-07	0.9646	1.17E+11	10.3954	5.75E+07	0.00
38.9070	-1.24E-08	-109.401	22.8406	1.76E-07	0.4899	1.17E+11	0.1515	5.75E+07	0.00
39.3000	8.07E-07	0.00	0.00	1.74E-07	0.00	1.17E+11	-9.838	2.88E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

Pile-head deflection = 3.59114861 inches
Computed slope at pile head = -0.0138906 radians
Maximum bending moment = 13034417. inch-lbs
Maximum shear force = -334942. lbs
Depth of maximum bending moment = 25.15200000 feet below pile head
Depth of maximum shear force = 27.90300000 feet below pile head
Number of iterations = 22
Number of zero deflection points = 4
Pile deflection at ground = 0.53130030 inches

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs
Moment = 0. in-lbs
Axial Load = 0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	3.59114861	13034417.	-334942.
37.33500	3.67562821	13245733.	-341994.
35.37000	3.61039112	13097833.	-338104.
33.40500	3.60671397	13088348.	-339387.
31.44000	3.65289839	13194380.	-337803.
29.47500	6.16406772	13662890.	-453415.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs

Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	2.2457	-0.00884	-237971.	8502047.
2	V, lb	0.00	M, in-lb	0.00	0.00	3.5911	-0.01389	-334942.	1.30E+07

Maximum pile-head deflection = 3.5911486075 inches
Maximum pile-head rotation = -0.0138905922 radians = -0.795872 deg.

The analysis ended normally.

```
================================================================================

                    LPile for Windows, Version 2022-12.007

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\PROJECT\2023\COL-05\23050003COL\Design\LPILE\Station 1406+75\

Name of input data file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12d

Name of output report file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12o

Name of plot output file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12p

Name of runtime message file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12r



--------------------------------------------------------------------------------
                            Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  June 7, 2023               Time:  10:26:50



--------------------------------------------------------------------------------
                                  Problem Title
--------------------------------------------------------------------------------

Project Name: PIK-772-14.10


Job Number: 23050003COL


Client: OHIO DEPARTMENT OF TRANSPORTATION
```

Engineer: CTL ENGINEERING, INC.

Description: STATION 1406+75 DRILELD SHAFT WALL ANALYSIS

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - Analysis includes loading by multiple distributed lateral loads acting on pile
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 39.300 ft
Depth of ground surface below top of pile = 19.6000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	36.0000
2	39.300	36.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile		
Cross-sectional Shape	=	Circular Pile
Length of section	=	39.300000 ft
Width of top of section	=	36.000000 in
Width of bottom of section	=	36.000000 in
Top Area	=	38.500000 sq. in
Bottom Area	=	38.500000 sq. in
Moment of Inertia at Top	=	4020. in^4
Moment of Inertia at Bottom	=	4020. in^4
Elastic Modulus	=	29000000. psi

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	19.600000 ft
Distance from top of pile to bottom of layer	=	30.000000 ft
Effective unit weight at top of layer	=	67.600000 pcf
Effective unit weight at bottom of layer	=	67.600000 pcf
Undrained cohesion at top of layer	=	3125. psf
Undrained cohesion at bottom of layer	=	3125. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000
Subgrade k at top of layer	=	1000.000000 pci
Subgrade k at bottom of layer	=	1000.000000 pci

Layer 2 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	30.000000 ft
Distance from top of pile to bottom of layer	=	50.000000 ft
Effective unit weight at top of layer	=	82.600000 pcf
Effective unit weight at bottom of layer	=	82.600000 pcf
Uniaxial compressive strength at top of layer	=	273.000000 psi
Uniaxial compressive strength at bottom of layer	=	273.000000 psi
Initial modulus of rock at top of layer	=	24388. psi
Initial modulus of rock at bottom of layer	=	24388. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.700 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Uniaxial qu psi	RQD %	E50 or krm	Rock Mass kpy Modulus pci psi
1	Stiff Clay with Water-Induced Erosion (Reese, 1997)	19.600000 to 30.000000	67.600000	3125.				
2	Weak Rock (Reese, 1997)	30.000000 to 50.000000	82.600000		273.000000	0.0000	0.0005000	24388.

```
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  1         Stiff Clay           19.6000      67.6000        3125.       --           --          0.00500
1000.0000       --
          with Free Water        30.0000      67.6000        3125.       --           --          0.00500
1000.0000       --
  2            Weak              30.0000      82.6000       --         273.0000         0.00     5.00E-04       --
       24388.
               Rock              50.0000      82.6000       --         273.0000         0.00     5.00E-04       --
       24388.
```

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 3 points

Point No.	Depth X ft	p-mult	y-mult
1	19.600	0.7900	1.0000
2	24.300	0.7900	1.0000
3	24.300	1.0000	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading for Individual Load Cases

Distributed lateral load intensity for Load Case 1 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	34.100
2	24.300	610.800

Distributed lateral load intensity for Load Case 2 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	59.600
2	24.300	865.100

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis

1	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes
2	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	19.6000	0.00	N.A.	No	0.00	57214.
2	30.0000	10.4000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals
for Layer n. Layering correction equivalent depths are computed only
for soil types with both shallow-depth and deep-depth expressions for
peak lateral load transfer. These soil types are soft and stiff clays,
non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	3.2104	-1.16E-04	0.00	-0.01160	5.21E-07	1.17E+11	0.00	0.00	36.4317
0.3930	3.1557	405.1326	188.3066	-0.01160	1.8140	1.17E+11	0.00	0.00	43.4269
0.7860	3.1009	1776.	415.1005	-0.01160	7.9527	1.17E+11	0.00	0.00	52.7538
1.1790	3.0462	4320.	685.8800	-0.01160	19.3449	1.17E+11	0.00	0.00	62.0806

1.5720	2.9915	8245.	1001.	-0.01160	36.9194	1.17E+11	0.00	0.00	71.4075
1.9650	2.9368	13758.	1359.	-0.01160	61.6050	1.17E+11	0.00	0.00	80.7344
2.3580	2.8821	21067.	1762.	-0.01160	94.3305	1.17E+11	0.00	0.00	90.0613
2.7510	2.8274	30379.	2209.	-0.01160	136.0248	1.17E+11	0.00	0.00	99.3881
3.1440	2.7727	41901.	2700.	-0.01160	187.6166	1.17E+11	0.00	0.00	108.7150
3.5370	2.7180	55841.	3234.	-0.01159	250.0349	1.17E+11	0.00	0.00	118.0419
3.9300	2.6634	72407.	3813.	-0.01159	324.2083	1.17E+11	0.00	0.00	127.3688
4.3230	2.6087	91805.	4436.	-0.01159	411.0658	1.17E+11	0.00	0.00	136.6956
4.7160	2.5541	114243.	5102.	-0.01158	511.5361	1.17E+11	0.00	0.00	146.0225
5.1090	2.4994	139929.	5813.	-0.01158	626.5481	1.17E+11	0.00	0.00	155.3494
5.5020	2.4448	169070.	6568.	-0.01157	757.0305	1.17E+11	0.00	0.00	164.6763
5.8950	2.3903	201874.	7366.	-0.01157	903.9123	1.17E+11	0.00	0.00	174.0031
6.2880	2.3358	238547.	8209.	-0.01156	1068.	1.17E+11	0.00	0.00	183.3300
6.6810	2.2813	279298.	9095.	-0.01155	1251.	1.17E+11	0.00	0.00	192.6569
7.0740	2.2269	324334.	10026.	-0.01153	1452.	1.17E+11	0.00	0.00	201.9838
7.4670	2.1725	373862.	11000.	-0.01152	1674.	1.17E+11	0.00	0.00	211.3107
7.8600	2.1182	428090.	12019.	-0.01150	1917.	1.17E+11	0.00	0.00	220.6375
8.2530	2.0640	487224.	13081.	-0.01149	2182.	1.17E+11	0.00	0.00	229.9644
8.6460	2.0099	551474.	14188.	-0.01146	2469.	1.17E+11	0.00	0.00	239.2913
9.0390	1.9559	621045.	15338.	-0.01144	2781.	1.17E+11	0.00	0.00	248.6182
9.4320	1.9020	696146.	16533.	-0.01141	3117.	1.17E+11	0.00	0.00	257.9450
9.8250	1.8482	776983.	17771.	-0.01138	3479.	1.17E+11	0.00	0.00	267.2719
10.2180	1.7946	863765.	19054.	-0.01135	3868.	1.17E+11	0.00	0.00	276.5988
10.6110	1.7411	956699.	20380.	-0.01131	4284.	1.17E+11	0.00	0.00	285.9257
11.0040	1.6879	1055992.	21751.	-0.01127	4728.	1.17E+11	0.00	0.00	295.2525
11.3970	1.6348	1161851.	23165.	-0.01123	5202.	1.17E+11	0.00	0.00	304.5794
11.7900	1.5820	1274485.	24623.	-0.01118	5707.	1.17E+11	0.00	0.00	313.9063
12.1830	1.5294	1394100.	26126.	-0.01113	6242.	1.17E+11	0.00	0.00	323.2332
12.5760	1.4770	1520904.	27672.	-0.01107	6810.	1.17E+11	0.00	0.00	332.5600
12.9690	1.4250	1655104.	29263.	-0.01100	7411.	1.17E+11	0.00	0.00	341.8869
13.3620	1.3733	1796908.	30897.	-0.01093	8046.	1.17E+11	0.00	0.00	351.2138
13.7550	1.3219	1946523.	32575.	-0.01086	8716.	1.17E+11	0.00	0.00	360.5407
14.1480	1.2709	2104157.	34297.	-0.01077	9422.	1.17E+11	0.00	0.00	369.8676
14.5410	1.2202	2270017.	36064.	-0.01069	10164.	1.17E+11	0.00	0.00	379.1944
14.9340	1.1701	2444311.	37874.	-0.01059	10945.	1.17E+11	0.00	0.00	388.5213
15.3270	1.1204	2627246.	39728.	-0.01049	11764.	1.17E+11	0.00	0.00	397.8482
15.7200	1.0711	2819028.	41627.	-0.01038	12623.	1.17E+11	0.00	0.00	407.1751
16.1130	1.0225	3019867.	43569.	-0.01026	13522.	1.17E+11	0.00	0.00	416.5019
16.5060	0.9744	3229969.	45555.	-0.01013	14463.	1.17E+11	0.00	0.00	425.8288
16.8990	0.9269	3449542.	47585.	-0.01000	15446.	1.17E+11	0.00	0.00	435.1557
17.2920	0.8801	3678793.	49659.	-0.00985	16472.	1.17E+11	0.00	0.00	444.4826
17.6850	0.8339	3917930.	51778.	-0.00970	17543.	1.17E+11	0.00	0.00	453.8094
18.0780	0.7886	4167159.	53940.	-0.00954	18659.	1.17E+11	0.00	0.00	463.1363
18.4710	0.7440	4426689.	56146.	-0.00936	19821.	1.17E+11	0.00	0.00	472.4632
18.8640	0.7003	4696727.	58396.	-0.00918	21030.	1.17E+11	0.00	0.00	481.7901
19.2570	0.6574	4977480.	60690.	-0.00898	22287.	1.17E+11	0.00	0.00	491.1170
19.6500	0.6155	5269156.	62837.	-0.00878	23593.	1.17E+11	-81.304	622.9229	500.4438
20.0430	0.5746	5570154.	64542.	-0.00856	24941.	1.17E+11	-205.507	1687.	509.7707
20.4360	0.5348	5877919.	65655.	-0.00832	26319.	1.17E+11	-351.522	3100.	519.0976
20.8290	0.4961	6189411.	66078.	-0.00808	27714.	1.17E+11	-516.430	4909.	528.4245
21.2220	0.4586	6501170.	65730.	-0.00782	29110.	1.17E+11	-697.654	7174.	537.7513
21.6150	0.4223	6809372.	64529.	-0.00755	30490.	1.17E+11	-896.381	10010.	547.0782
22.0080	0.3873	7109806.	62399.	-0.00727	31835.	1.17E+11	-1110.	13518.	556.4051
22.4010	0.3537	7397920.	59360.	-0.00698	33125.	1.17E+11	-1301.	17341.	565.7320
22.7940	0.3215	7669690.	55521.	-0.00668	34342.	1.17E+11	-1468.	21536.	575.0588
23.1870	0.2908	7921596.	50989.	-0.00636	35470.	1.17E+11	-1613.	26168.	584.3857
23.5800	0.2615	8150616.	45868.	-0.00603	36495.	1.17E+11	-1737.	31315.	593.7126
23.9730	0.2338	8354218.	40261.	-0.00570	37407.	1.17E+11	-1838.	37065.	603.0395
24.3660	0.2078	8530356.	32103.	-0.00536	38196.	1.17E+11	-2427.	55097.	202.3087
24.7590	0.1833	8657011.	20960.	-0.00501	38763.	1.17E+11	-2500.	64335.	0.00
25.1520	0.1605	8728054.	9060.	-0.00466	39081.	1.17E+11	-2546.	74821.	0.00
25.5450	0.1393	8742468.	-2989.	-0.00431	39145.	1.17E+11	-2564.	86768.	0.00
25.9380	0.1199	8699864.	-15051.	-0.00395	38955.	1.17E+11	-2552.	100393.	0.00
26.3310	0.1020	8600511.	-26959.	-0.00360	38510.	1.17E+11	-2499.	115471.	0.00
26.7240	0.08587	8445587.	-38497.	-0.00326	37816.	1.17E+11	-2394.	131498.	0.00
27.1170	0.07130	8237412.	-49507.	-0.00292	36884.	1.17E+11	-2275.	150471.	0.00
27.5100	0.05831	7978637.	-59922.	-0.00259	35725.	1.17E+11	-2142.	173213.	0.00
27.9030	0.04684	7672229.	-69676.	-0.00228	34353.	1.17E+11	-1995.	200872.	0.00
28.2960	0.03683	7321450.	-78710.	-0.00197	32783.	1.17E+11	-1836.	235104.	0.00

28.6890	0.02822	6929834.	-86968.	-0.00169	31029.	1.17E+11	-1666.	278391.	0.00
29.0820	0.02093	6501167.	-94351.	-0.00141	29110.	1.17E+11	-1465.	330136.	0.00
29.4750	0.01488	6039911.	-100720.	-0.00116	27044.	1.17E+11	-1236.	391519.	0.00
29.8680	0.00999	5551176.	-106020.	-9.26E-04	24856.	1.17E+11	-1012.	477963.	0.00
30.2610	0.00615	5039931.	-118344.	-7.12E-04	22567.	1.17E+11	-4214.	3232416.	0.00
30.6540	0.00327	4434955.	-138157.	-5.20E-04	19858.	1.17E+11	-4188.	6035331.	0.00
31.0470	0.00124	3736829.	-156876.	-3.55E-04	16732.	1.17E+11	-3750.	1.42E+07	0.00
31.4400	-7.43E-05	2955305.	-165017.	-2.19E-04	13233.	1.17E+11	297.0218	1.89E+07	0.00
31.8330	-8.27E-04	2180386.	-155682.	-1.16E-04	9763.	1.17E+11	3662.	2.09E+07	0.00
32.2260	-0.00116	1486916.	-135131.	-4.14E-05	6658.	1.17E+11	5053.	2.05E+07	0.00
32.6190	-0.00122	905827.	-110083.	6.96E-06	4056.	1.17E+11	5570.	2.16E+07	0.00
33.0120	-0.00110	448613.	-83093.	3.44E-05	2009.	1.17E+11	5876.	2.52E+07	0.00
33.4050	-8.94E-04	122091.	-56311.	4.59E-05	546.6772	1.17E+11	5482.	2.89E+07	0.00
33.7980	-6.66E-04	-82513.	-33087.	4.67E-05	369.4615	1.17E+11	4367.	3.09E+07	0.00
34.1910	-4.54E-04	-189983.	-15317.	4.12E-05	850.6702	1.17E+11	3169.	3.29E+07	0.00
34.5840	-2.78E-04	-226979.	-2993.	3.28E-05	1016.	1.17E+11	2058.	3.49E+07	0.00
34.9770	-1.45E-04	-218216.	4536.	2.37E-05	977.0852	1.17E+11	1135.	3.69E+07	0.00
35.3700	-5.38E-05	-184198.	8261.	1.56E-05	824.7670	1.17E+11	444.1719	3.90E+07	0.00
35.7630	2.26E-06	-140302.	9262.	9.04E-06	628.2160	1.17E+11	-19.614	4.10E+07	0.00
36.1560	3.15E-05	-96841.	8538.	4.25E-06	433.6181	1.17E+11	-287.263	4.30E+07	0.00
36.5490	4.23E-05	-59770.	6909.	1.08E-06	267.6274	1.17E+11	-403.647	4.50E+07	0.00
36.9420	4.17E-05	-31676.	4977.	-7.70E-07	141.8338	1.17E+11	-415.618	4.70E+07	0.00
37.3350	3.51E-05	-12826.	3138.	-1.67E-06	57.4296	1.17E+11	-364.289	4.90E+07	0.00
37.7280	2.60E-05	-2078.	1617.	-1.97E-06	9.3031	1.17E+11	-280.830	5.10E+07	0.00
38.1210	1.65E-05	2425.	518.0894	-1.96E-06	10.8569	1.17E+11	-185.164	5.30E+07	0.00
38.5140	7.44E-06	2809.	-123.218	-1.86E-06	12.5773	1.17E+11	-86.807	5.50E+07	0.00
38.9070	-1.06E-06	1263.	-297.808	-1.78E-06	5.6530	1.17E+11	12.7650	5.70E+07	0.00
39.3000	-9.31E-06	0.00	0.00	-1.75E-06	0.00	1.17E+11	113.5318	2.88E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     3.21036621 inches
Computed slope at pile head      =     -0.0116007 radians
Maximum bending moment           =       8742468. inch-lbs
Maximum shear force              =       -165017. lbs
Depth of maximum bending moment  =    25.54500000 feet below pile head
Depth of maximum shear force     =    31.44000000 feet below pile head
Number of iterations             =             23
Number of zero deflection points =              3
Pile deflection at ground        =     0.62086080 inches
```

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

```
Shear      =              0. lbs
Moment     =              0. in-lbs
Axial Load =              0. lbs
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	3.21036621	8742468.	-165017.
37.33500	3.23205922	8776651.	-166028.
35.37000	3.21308438	8757553.	-166006.
33.40500	3.28770218	8772933.	-180412.

Computed Values of Pile Loading and Deflection

for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	5.8444	8.85E-05	4.94E-07	-0.02023	3.96E-07	1.17E+11	0.00	0.00	62.8568
0.3930	5.7489	698.9882	319.4713	-0.02023	3.1298	1.17E+11	0.00	0.00	72.6272
0.7860	5.6535	3013.	692.6995	-0.02023	13.4922	1.17E+11	0.00	0.00	85.6544
1.1790	5.5581	7233.	1127.	-0.02023	32.3845	1.17E+11	0.00	0.00	98.6817
1.5720	5.4627	13647.	1623.	-0.02023	61.1040	1.17E+11	0.00	0.00	111.7089
1.9650	5.3673	22545.	2181.	-0.02023	100.9480	1.17E+11	0.00	0.00	124.7361
2.3580	5.2719	34218.	2800.	-0.02023	153.2139	1.17E+11	0.00	0.00	137.7633
2.7510	5.1765	48954.	3480.	-0.02023	219.1989	1.17E+11	0.00	0.00	150.7906
3.1440	5.0811	67045.	4222.	-0.02023	300.2004	1.17E+11	0.00	0.00	163.8178
3.5370	4.9857	88779.	5026.	-0.02022	397.5158	1.17E+11	0.00	0.00	176.8450
3.9300	4.8903	114445.	5890.	-0.02022	512.4422	1.17E+11	0.00	0.00	189.8722
4.3230	4.7950	144335.	6816.	-0.02021	646.2771	1.17E+11	0.00	0.00	202.8994
4.7160	4.6997	178738.	7804.	-0.02021	800.3177	1.17E+11	0.00	0.00	215.9267
5.1090	4.6044	217942.	8853.	-0.02020	975.8614	1.17E+11	0.00	0.00	228.9539
5.5020	4.5091	262239.	9963.	-0.02019	1174.	1.17E+11	0.00	0.00	241.9811
5.8950	4.4139	311918.	11135.	-0.02018	1397.	1.17E+11	0.00	0.00	255.0083
6.2880	4.3188	367268.	12369.	-0.02016	1644.	1.17E+11	0.00	0.00	268.0356
6.6810	4.2238	428580.	13663.	-0.02015	1919.	1.17E+11	0.00	0.00	281.0628
7.0740	4.1288	496142.	15020.	-0.02013	2222.	1.17E+11	0.00	0.00	294.0900
7.4670	4.0339	570245.	16437.	-0.02011	2553.	1.17E+11	0.00	0.00	307.1172
7.8600	3.9391	651179.	17916.	-0.02008	2916.	1.17E+11	0.00	0.00	320.1444
8.2530	3.8445	739233.	19457.	-0.02006	3310.	1.17E+11	0.00	0.00	333.1717
8.6460	3.7500	834697.	21059.	-0.02002	3737.	1.17E+11	0.00	0.00	346.1989
9.0390	3.6556	937861.	22722.	-0.01999	4199.	1.17E+11	0.00	0.00	359.2261
9.4320	3.5614	1049014.	24447.	-0.01995	4697.	1.17E+11	0.00	0.00	372.2533
9.8250	3.4675	1168446.	26233.	-0.01990	5232.	1.17E+11	0.00	0.00	385.2806
10.2180	3.3737	1296447.	28081.	-0.01985	5805.	1.17E+11	0.00	0.00	398.3078
10.6110	3.2802	1433307.	29990.	-0.01980	6418.	1.17E+11	0.00	0.00	411.3350
11.0040	3.1870	1579315.	31961.	-0.01974	7072.	1.17E+11	0.00	0.00	424.3622
11.3970	3.0941	1734761.	33993.	-0.01967	7768.	1.17E+11	0.00	0.00	437.3894
11.7900	3.0015	1899935.	36086.	-0.01960	8507.	1.17E+11	0.00	0.00	450.4167
12.1830	2.9092	2075127.	38241.	-0.01952	9292.	1.17E+11	0.00	0.00	463.4439
12.5760	2.8174	2260626.	40457.	-0.01943	10122.	1.17E+11	0.00	0.00	476.4711
12.9690	2.7260	2456721.	42735.	-0.01933	11000.	1.17E+11	0.00	0.00	489.4983
13.3620	2.6350	2663704.	45074.	-0.01923	11927.	1.17E+11	0.00	0.00	502.5256
13.7550	2.5446	2881863.	47475.	-0.01912	12904.	1.17E+11	0.00	0.00	515.5528
14.1480	2.4547	3111489.	49937.	-0.01900	13932.	1.17E+11	0.00	0.00	528.5800
14.5410	2.3654	3352870.	52461.	-0.01886	15013.	1.17E+11	0.00	0.00	541.6072
14.9340	2.2768	3606297.	55046.	-0.01872	16148.	1.17E+11	0.00	0.00	554.6344
15.3270	2.1888	3872060.	57692.	-0.01857	17338.	1.17E+11	0.00	0.00	567.6617
15.7200	2.1016	4150447.	60400.	-0.01841	18584.	1.17E+11	0.00	0.00	580.6889
16.1130	2.0152	4441750.	63169.	-0.01824	19888.	1.17E+11	0.00	0.00	593.7161
16.5060	1.9296	4746257.	66000.	-0.01805	21252.	1.17E+11	0.00	0.00	606.7433
16.8990	1.8449	5064259.	68892.	-0.01785	22676.	1.17E+11	0.00	0.00	619.7706
17.2920	1.7612	5396044.	71845.	-0.01764	24161.	1.17E+11	0.00	0.00	632.7978
17.6850	1.6786	5741904.	74860.	-0.01742	25710.	1.17E+11	0.00	0.00	645.8250
18.0780	1.5970	6102127.	77937.	-0.01718	27323.	1.17E+11	0.00	0.00	658.8522
18.4710	1.5165	6477003.	81075.	-0.01692	29002.	1.17E+11	0.00	0.00	671.8794
18.8640	1.4374	6866823.	84274.	-0.01665	30747.	1.17E+11	0.00	0.00	684.9067
19.2570	1.3595	7271875.	87535.	-0.01637	32561.	1.17E+11	0.00	0.00	697.9339
19.6500	1.2830	7692450.	90831.	-0.01606	34444.	1.17E+11	-11.004	40.4465	710.9611
20.0430	1.2080	8128592.	94098.	-0.01574	36397.	1.17E+11	-38.408	149.9449	723.9883
20.4360	1.1345	8579982.	97294.	-0.01541	38418.	1.17E+11	-67.137	279.0793	737.0156
20.8290	1.0627	9046270.	100337.	-0.01505	40506.	1.17E+11	-129.611	575.1924	750.0428
21.2220	0.9926	9526358.	102916.	-0.01467	42655.	1.17E+11	-289.688	1376.	763.0700
21.6150	0.9243	1.00E+07	104757.	-0.01428	44852.	1.17E+11	-468.566	2391.	776.0972

22.0080	0.8579	1.05E+07	105778.	-0.01386	47080.	1.17E+11	-663.953	3650.	789.1244
22.4010	0.7935	1.10E+07	105904.	-0.01343	49319.	1.17E+11	-873.714	5192.	802.1517
22.7940	0.7313	1.15E+07	105073.	-0.01297	51552.	1.17E+11	-1096.	7067.	815.1789
23.1870	0.6712	1.20E+07	103232.	-0.01250	53757.	1.17E+11	-1328.	9334.	828.2061
23.5800	0.6134	1.25E+07	100335.	-0.01200	55912.	1.17E+11	-1570.	12068.	841.2333
23.9730	0.5580	1.30E+07	96348.	-0.01149	57994.	1.17E+11	-1817.	15353.	854.2606
24.3660	0.5051	1.34E+07	88660.	-0.01095	59981.	1.17E+11	-2584.	24131.	286.5478
24.7590	0.4547	1.38E+07	76566.	-0.01040	61739.	1.17E+11	-2831.	29367.	0.00
25.1520	0.4070	1.41E+07	62719.	-0.00984	63215.	1.17E+11	-3041.	35238.	0.00
25.5450	0.3619	1.44E+07	47974.	-0.00926	64388.	1.17E+11	-3212.	41858.	0.00
25.9380	0.3196	1.46E+07	32510.	-0.00868	65241.	1.17E+11	-3346.	49368.	0.00
26.3310	0.2801	1.47E+07	16507.	-0.00808	65761.	1.17E+11	-3441.	57942.	0.00
26.7240	0.2434	1.47E+07	144.3790	-0.00749	65938.	1.17E+11	-3498.	67793.	0.00
27.1170	0.2094	1.47E+07	-16397.	-0.00689	65767.	1.17E+11	-3517.	79188.	0.00
27.5100	0.1783	1.46E+07	-32933.	-0.00630	65245.	1.17E+11	-3496.	92462.	0.00
27.9030	0.1500	1.44E+07	-49278.	-0.00572	64376.	1.17E+11	-3436.	108023.	0.00
28.2960	0.1244	1.41E+07	-65235.	-0.00514	63164.	1.17E+11	-3332.	126317.	0.00
28.6890	0.1015	1.38E+07	-80541.	-0.00458	61621.	1.17E+11	-3159.	146798.	0.00
29.0820	0.08122	1.33E+07	-94796.	-0.00403	59763.	1.17E+11	-2886.	167597.	0.00
29.4750	0.06349	1.29E+07	-107620.	-0.00350	57617.	1.17E+11	-2552.	189559.	0.00
29.8680	0.04821	1.23E+07	-118881.	-0.00299	55218.	1.17E+11	-2224.	217521.	0.00
30.2610	0.03529	1.17E+07	-139507.	-0.00250	52597.	1.17E+11	-6523.	871643.	0.00
30.6540	0.02461	1.10E+07	-171243.	-0.00204	49326.	1.17E+11	-6936.	1328912.	0.00
31.0470	0.01603	1.01E+07	-204355.	-0.00161	45364.	1.17E+11	-7107.	2090179.	0.00
31.4400	0.00939	9088629.	-237578.	-0.00123	40695.	1.17E+11	-6983.	3507396.	0.00
31.8330	0.00448	7890565.	-269226.	-8.82E-04	35331.	1.17E+11	-6439.	6783141.	0.00
32.2260	0.00107	6549294.	-296076.	-5.90E-04	29325.	1.17E+11	-4948.	2.18E+07	0.00
32.6190	-0.00109	5097980.	-294979.	-3.54E-04	22827.	1.17E+11	5413.	2.35E+07	0.00
33.0120	-0.00227	3767048.	-265603.	-1.75E-04	16867.	1.17E+11	7045.	1.46E+07	0.00
33.4050	-0.00274	2592814.	-230256.	-4.64E-05	11610.	1.17E+11	7945.	1.37E+07	0.00
33.7980	-0.00271	1595277.	-191513.	3.83E-05	7143.	1.17E+11	8485.	1.48E+07	0.00
34.1910	-0.00238	786461.	-150861.	8.65E-05	3521.	1.17E+11	8755.	1.74E+07	0.00
34.5840	-0.00189	172359.	-109503.	1.06E-04	771.7564	1.17E+11	8785.	2.19E+07	0.00
34.9770	-0.00138	-246367.	-68540.	1.04E-04	1103.	1.17E+11	8587.	2.94E+07	0.00
35.3700	-9.08E-04	-474114.	-30603.	8.98E-05	2123.	1.17E+11	7502.	3.90E+07	0.00
35.7630	-5.30E-04	-535014.	-2062.	6.94E-05	2396.	1.17E+11	4602.	4.10E+07	0.00
36.1560	-2.53E-04	-493568.	14233.	4.86E-05	2210.	1.17E+11	2309.	4.30E+07	0.00
36.5490	-7.12E-05	-400768.	21278.	3.05E-05	1794.	1.17E+11	678.8757	4.50E+07	0.00
36.9420	3.46E-05	-292870.	22066.	1.65E-05	1311.	1.17E+11	-344.754	4.70E+07	0.00
37.3350	8.45E-05	-192639.	19183.	6.69E-06	862.5632	1.17E+11	-878.031	4.90E+07	0.00
37.7280	9.77E-05	-111936.	14622.	5.26E-07	501.2076	1.17E+11	-1056.	5.10E+07	0.00
38.1210	8.95E-05	-54728.	9759.	-2.84E-06	245.0495	1.17E+11	-1006.	5.30E+07	0.00
38.5140	7.08E-05	-19890.	5438.	-4.35E-06	89.0584	1.17E+11	-826.534	5.50E+07	0.00
38.9070	4.84E-05	-3434.	2109.	-4.83E-06	15.3777	1.17E+11	-585.459	5.70E+07	0.00
39.3000	2.53E-05	0.00	0.00	-4.90E-06	0.00	1.17E+11	-308.837	2.88E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =     5.84436039 inches
Computed slope at pile head      =     -0.0202332 radians
Maximum bending moment           =      14726107. inch-lbs
Maximum shear force              =       -296076. lbs
Depth of maximum bending moment  =    26.72400000 feet below pile head
Depth of maximum shear force     =    32.22600000 feet below pile head
Number of iterations             =             33
Number of zero deflection points =              2
Pile deflection at ground        =     1.29273437 inches
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

```
Shear      =              0. lbs
Moment     =              0. in-lbs
Axial Load =              0. lbs
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	5.84436039	14726107.	-296076.
37.33500	5.88268972	14796501.	-299310.
35.37000	5.83751236	14726251.	-295458.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	3.2104	-0.01160	-165017.	8742468.
2	V, lb	0.00	M, in-lb	0.00	0.00	5.8444	-0.02023	-296076.	1.47E+07

Maximum pile-head deflection = 5.8443603866 inches
Maximum pile-head rotation   = -0.0202331845 radians = -1.159276 deg.

The analysis ended normally.

```
================================================================================

                    LPile for Windows, Version 2022-12.007

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\PROJECT\2023\COL-05\23050003COL\Design\LPILE\Station 1406+75\

Name of input data file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12d

Name of output report file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12o

Name of plot output file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12p

Name of runtime message file:
Station 1406+75 Weak Rock WITH UPDATED SRUVEY DATA.lp12r



--------------------------------------------------------------------------------
                            Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  June 7, 2023               Time:  10:23:34



--------------------------------------------------------------------------------
                                  Problem Title
--------------------------------------------------------------------------------

Project Name: PIK-772-14.10


Job Number: 23050003COL


Client: OHIO DEPARTMENT OF TRANSPORTATION
```

Engineer: CTL ENGINEERING, INC.

Description: STATION 1406+75 DRILELD SHAFT WALL ANALYSIS

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - Analysis includes loading by multiple distributed lateral loads acting on pile
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 39.300 ft
Depth of ground surface below top of pile = 19.6000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	36.0000
2	39.300	36.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile		
Cross-sectional Shape	=	Circular Pile
Length of section	=	39.300000 ft
Width of top of section	=	36.000000 in
Width of bottom of section	=	36.000000 in
Top Area	=	38.500000 sq. in
Bottom Area	=	38.500000 sq. in
Moment of Inertia at Top	=	4020. in^4
Moment of Inertia at Bottom	=	4020. in^4
Elastic Modulus	=	29000000. psi

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	19.600000 ft
Distance from top of pile to bottom of layer	=	30.000000 ft
Effective unit weight at top of layer	=	67.600000 pcf
Effective unit weight at bottom of layer	=	67.600000 pcf
Undrained cohesion at top of layer	=	3125. psf
Undrained cohesion at bottom of layer	=	3125. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000
Subgrade k at top of layer	=	1000.000000 pci
Subgrade k at bottom of layer	=	1000.000000 pci

Layer 2 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	30.000000 ft
Distance from top of pile to bottom of layer	=	50.000000 ft
Effective unit weight at top of layer	=	82.600000 pcf
Effective unit weight at bottom of layer	=	82.600000 pcf
Uniaxial compressive strength at top of layer	=	38.000000 psi
Uniaxial compressive strength at bottom of layer	=	38.000000 psi
Initial modulus of rock at top of layer	=	3420. psi
Initial modulus of rock at bottom of layer	=	3420. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.700 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Uniaxial qu psi	RQD %	E50 or krm	Rock Mass Modulus kpy pci
1	Stiff Clay with Water-Induced Erosion	19.600 to 30.000	67.600	3125.			0.005000	1000.
2	Weak Rock (Reese, 1997)	30.000 to 50.000	82.600		38.000	0.0000	0.0005000	3420.

```
----------   ----------
  1         Stiff Clay           19.6000      67.6000        3125.       --          --          0.00500
1000.0000       --
          with Free Water        30.0000      67.6000        3125.       --          --          0.00500
1000.0000       --
  2            Weak              30.0000      82.6000       --          38.0000         0.00     5.00E-04       --
        3420.
               Rock              50.0000      82.6000       --          38.0000         0.00     5.00E-04       --
        3420.
```

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 3 points

Point No.	Depth X ft	p-mult	y-mult
1	19.600	0.7900	1.0000
2	24.300	0.7900	1.0000
3	24.300	1.0000	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading for Individual Load Cases

Distributed lateral load intensity for Load Case 1 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	34.100
2	24.300	610.800

Distributed lateral load intensity for Load Case 2 defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	59.600
2	24.300	865.100

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis

1	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes
2	1	V =	0.0000 lbs	M =	0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	19.6000	0.00	N.A.	No	0.00	55516.
2	30.0000	10.4000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals
for Layer n. Layering correction equivalent depths are computed only
for soil types with both shallow-depth and deep-depth expressions for
peak lateral load transfer. These soil types are soft and stiff clays,
non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	3.2770	2.33E-05	0.00	-0.01180	1.04E-07	1.17E+11	0.00	0.00	36.4317
0.3930	3.2214	405.1327	188.3066	-0.01180	1.8140	1.17E+11	0.00	0.00	43.4269
0.7860	3.1657	1776.	415.1005	-0.01180	7.9527	1.17E+11	0.00	0.00	52.7538
1.1790	3.1101	4320.	685.8800	-0.01180	19.3449	1.17E+11	0.00	0.00	62.0806

1.5720	3.0545	8245.	1001.	-0.01180	36.9194	1.17E+11	0.00	0.00	71.4075
1.9650	2.9988	13758.	1359.	-0.01179	61.6050	1.17E+11	0.00	0.00	80.7344
2.3580	2.9432	21067.	1762.	-0.01179	94.3305	1.17E+11	0.00	0.00	90.0613
2.7510	2.8876	30379.	2209.	-0.01179	136.0248	1.17E+11	0.00	0.00	99.3881
3.1440	2.8320	41901.	2700.	-0.01179	187.6166	1.17E+11	0.00	0.00	108.7150
3.5370	2.7764	55841.	3234.	-0.01179	250.0349	1.17E+11	0.00	0.00	118.0419
3.9300	2.7208	72407.	3813.	-0.01179	324.2083	1.17E+11	0.00	0.00	127.3688
4.3230	2.6652	91805.	4436.	-0.01178	411.0658	1.17E+11	0.00	0.00	136.6956
4.7160	2.6096	114243.	5102.	-0.01178	511.5361	1.17E+11	0.00	0.00	146.0225
5.1090	2.5541	139929.	5813.	-0.01177	626.5481	1.17E+11	0.00	0.00	155.3494
5.5020	2.4986	169070.	6568.	-0.01177	757.0305	1.17E+11	0.00	0.00	164.6763
5.8950	2.4431	201874.	7366.	-0.01176	903.9123	1.17E+11	0.00	0.00	174.0031
6.2880	2.3877	238547.	8209.	-0.01175	1068.	1.17E+11	0.00	0.00	183.3300
6.6810	2.3323	279298.	9095.	-0.01174	1251.	1.17E+11	0.00	0.00	192.6569
7.0740	2.2769	324334.	10026.	-0.01173	1452.	1.17E+11	0.00	0.00	201.9838
7.4670	2.2216	373862.	11000.	-0.01172	1674.	1.17E+11	0.00	0.00	211.3107
7.8600	2.1664	428090.	12019.	-0.01170	1917.	1.17E+11	0.00	0.00	220.6375
8.2530	2.1113	487224.	13081.	-0.01168	2182.	1.17E+11	0.00	0.00	229.9644
8.6460	2.0563	551474.	14188.	-0.01166	2469.	1.17E+11	0.00	0.00	239.2913
9.0390	2.0013	621045.	15338.	-0.01164	2781.	1.17E+11	0.00	0.00	248.6182
9.4320	1.9465	696146.	16533.	-0.01161	3117.	1.17E+11	0.00	0.00	257.9450
9.8250	1.8918	776983.	17771.	-0.01158	3479.	1.17E+11	0.00	0.00	267.2719
10.2180	1.8373	863765.	19054.	-0.01155	3868.	1.17E+11	0.00	0.00	276.5988
10.6110	1.7829	956699.	20380.	-0.01151	4284.	1.17E+11	0.00	0.00	285.9257
11.0040	1.7287	1055992.	21751.	-0.01147	4728.	1.17E+11	0.00	0.00	295.2525
11.3970	1.6748	1161851.	23165.	-0.01142	5202.	1.17E+11	0.00	0.00	304.5794
11.7900	1.6210	1274485.	24623.	-0.01137	5707.	1.17E+11	0.00	0.00	313.9063
12.1830	1.5675	1394100.	26126.	-0.01132	6242.	1.17E+11	0.00	0.00	323.2332
12.5760	1.5142	1520904.	27672.	-0.01126	6810.	1.17E+11	0.00	0.00	332.5600
12.9690	1.4613	1655104.	29263.	-0.01120	7411.	1.17E+11	0.00	0.00	341.8869
13.3620	1.4086	1796908.	30897.	-0.01113	8046.	1.17E+11	0.00	0.00	351.2138
13.7550	1.3563	1946523.	32575.	-0.01105	8716.	1.17E+11	0.00	0.00	360.5407
14.1480	1.3044	2104157.	34297.	-0.01097	9422.	1.17E+11	0.00	0.00	369.8676
14.5410	1.2528	2270017.	36064.	-0.01088	10164.	1.17E+11	0.00	0.00	379.1944
14.9340	1.2017	2444311.	37874.	-0.01079	10945.	1.17E+11	0.00	0.00	388.5213
15.3270	1.1511	2627246.	39728.	-0.01068	11764.	1.17E+11	0.00	0.00	397.8482
15.7200	1.1010	2819028.	41627.	-0.01057	12623.	1.17E+11	0.00	0.00	407.1751
16.1130	1.0514	3019867.	43569.	-0.01045	13522.	1.17E+11	0.00	0.00	416.5019
16.5060	1.0024	3229969.	45555.	-0.01033	14463.	1.17E+11	0.00	0.00	425.8288
16.8990	0.9540	3449542.	47585.	-0.01019	15446.	1.17E+11	0.00	0.00	435.1557
17.2920	0.9062	3678793.	49659.	-0.01005	16472.	1.17E+11	0.00	0.00	444.4826
17.6850	0.8592	3917930.	51778.	-0.00990	17543.	1.17E+11	0.00	0.00	453.8094
18.0780	0.8129	4167159.	53940.	-0.00973	18659.	1.17E+11	0.00	0.00	463.1363
18.4710	0.7674	4426689.	56146.	-0.00956	19821.	1.17E+11	0.00	0.00	472.4632
18.8640	0.7227	4696727.	58396.	-0.00937	21030.	1.17E+11	0.00	0.00	481.7901
19.2570	0.6790	4977480.	60690.	-0.00918	22287.	1.17E+11	0.00	0.00	491.1170
19.6500	0.6362	5269156.	62858.	-0.00897	23593.	1.17E+11	-72.251	535.6155	500.4438
20.0430	0.5944	5570355.	64609.	-0.00875	24942.	1.17E+11	-195.257	1549.	509.7707
20.4360	0.5536	5878550.	65773.	-0.00852	26322.	1.17E+11	-340.224	2898.	519.0976
20.8290	0.5140	6190722.	66251.	-0.00828	27720.	1.17E+11	-504.234	4626.	528.4245
21.2220	0.4756	6503433.	65962.	-0.00802	29120.	1.17E+11	-684.709	6790.	537.7513
21.6150	0.4384	6812875.	64832.	-0.00775	30505.	1.17E+11	-879.326	9460.	547.0782
22.0080	0.4025	7114927.	62775.	-0.00747	31858.	1.17E+11	-1096.	12847.	556.4051
22.4010	0.3679	7404972.	59787.	-0.00717	33157.	1.17E+11	-1293.	16575.	565.7320
22.7940	0.3348	7678839.	55969.	-0.00687	34383.	1.17E+11	-1467.	20662.	575.0588
23.1870	0.3031	7932873.	51429.	-0.00655	35520.	1.17E+11	-1618.	25171.	584.3857
23.5800	0.2730	8163921.	46273.	-0.00623	36555.	1.17E+11	-1747.	30177.	593.7126
23.9730	0.2444	8369324.	40606.	-0.00589	37475.	1.17E+11	-1853.	35768.	603.0395
24.3660	0.2174	8546917.	32349.	-0.00555	38270.	1.17E+11	-2453.	53224.	202.3087
24.7590	0.1920	8674443.	21069.	-0.00520	38841.	1.17E+11	-2533.	62202.	0.00
25.1520	0.1683	8745640.	9004.	-0.00485	39160.	1.17E+11	-2584.	72399.	0.00
25.5450	0.1463	8759368.	-3235.	-0.00450	39221.	1.17E+11	-2607.	84037.	0.00
25.9380	0.1259	8715126.	-15510.	-0.00414	39023.	1.17E+11	-2599.	97359.	0.00
26.3310	0.1072	8613076.	-27669.	-0.00379	38566.	1.17E+11	-2557.	112498.	0.00
26.7240	0.09013	8454155.	-39483.	-0.00345	37854.	1.17E+11	-2453.	128353.	0.00
27.1170	0.07468	8240676.	-50757.	-0.00311	36899.	1.17E+11	-2328.	147034.	0.00
27.5100	0.06080	7975415.	-61404.	-0.00278	35711.	1.17E+11	-2187.	169634.	0.00
27.9030	0.04844	7661516.	-71345.	-0.00247	34305.	1.17E+11	-2029.	197527.	0.00
28.2960	0.03754	7302492.	-80500.	-0.00216	32698.	1.17E+11	-1854.	232868.	0.00

28.6890	0.02804	6902239.	-88787.	-0.00188	30906.	1.17E+11	-1661.	279291.	0.00
29.0820	0.01985	6465053.	-96068.	-0.00161	28948.	1.17E+11	-1427.	338991.	0.00
29.4750	0.01290	5996128.	-102145.	-0.00135	26848.	1.17E+11	-1150.	420549.	0.00
29.8680	0.00709	5501618.	-106869.	-0.00112	24634.	1.17E+11	-852.876	567264.	0.00
30.2610	0.00233	4988140.	-109966.	-9.08E-04	22335.	1.17E+11	-460.424	931665.	0.00
30.6540	-0.00148	4464422.	-109925.	-7.17E-04	19990.	1.17E+11	477.6427	1524473.	0.00
31.0470	-0.00443	3951327.	-107108.	-5.47E-04	17693.	1.17E+11	717.2248	762819.	0.00
31.4400	-0.00664	3454183.	-103315.	-3.97E-04	15466.	1.17E+11	891.0977	633197.	0.00
31.8330	-0.00818	2976859.	-98757.	-2.67E-04	13329.	1.17E+11	1042.	600666.	0.00
32.2260	-0.00916	2522707.	-93523.	-1.56E-04	11296.	1.17E+11	1178.	606555.	0.00
32.6190	-0.00965	2094747.	-87680.	-6.25E-05	9379.	1.17E+11	1301.	635547.	0.00
33.0120	-0.00975	1695714.	-81285.	1.42E-05	7593.	1.17E+11	1411.	682971.	0.00
33.4050	-0.00952	1328071.	-74396.	7.53E-05	5947.	1.17E+11	1510.	748243.	0.00
33.7980	-0.00904	994011.	-67072.	1.22E-04	4451.	1.17E+11	1596.	833094.	0.00
34.1910	-0.00836	695449.	-59372.	1.56E-04	3114.	1.17E+11	1669.	941177.	0.00
34.5840	-0.00756	434011.	-51361.	1.79E-04	1943.	1.17E+11	1728.	1078318.	0.00
34.9770	-0.00667	211015.	-43104.	1.92E-04	944.8448	1.17E+11	1773.	1253322.	0.00
35.3700	-0.00575	27458.	-34672.	1.97E-04	122.9448	1.17E+11	1802.	1479570.	0.00
35.7630	-0.00481	-116013.	-26143.	1.95E-04	519.4607	1.17E+11	1815.	1778163.	0.00
36.1560	-0.00390	-219127.	-17603.	1.89E-04	981.1638	1.17E+11	1807.	2184471.	0.00
36.5490	-0.00303	-282041.	-9149.	1.78E-04	1263.	1.17E+11	1778.	2763490.	0.00
36.9420	-0.00222	-305421.	-906.189	1.67E-04	1368.	1.17E+11	1718.	3652157.	0.00
37.3350	-0.00146	-290588.	6954.	1.55E-04	1301.	1.17E+11	1615.	5209215.	0.00
37.7280	-7.61E-04	-239836.	13483.	1.44E-04	1074.	1.17E+11	1154.	7152550.	0.00
38.1210	-1.06E-04	-163412.	16598.	1.36E-04	731.6976	1.17E+11	166.5799	7434265.	0.00
38.5140	5.19E-04	-83285.	14990.	1.31E-04	372.9160	1.17E+11	-848.338	7715980.	0.00
38.9070	0.00113	-22024.	8830.	1.29E-04	98.6161	1.17E+11	-1764.	7383602.	0.00
39.3000	0.00173	0.00	0.00	1.28E-04	0.00	1.17E+11	-1981.	2698125.	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     3.27698621 inches
Computed slope at pile head      =     -0.0117958 radians
Maximum bending moment           =       8759368. inch-lbs
Maximum shear force              =       -109966. lbs
Depth of maximum bending moment  =    25.54500000 feet below pile head
Depth of maximum shear force     =    30.26100000 feet below pile head
Number of iterations             =             25
Number of zero deflection points =              2
Pile deflection at ground        =     0.64160389 inches
```

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

```
Shear      =              0. lbs
Moment     =              0. in-lbs
Axial Load =              0. lbs
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	3.27698621	8759368.	-109966.
37.33500	3.30227040	8794195.	-108705.
35.37000	3.58934049	8868915.	-121692.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	6.3664	-3.63E-04	0.00	-0.02160	1.63E-06	1.17E+11	0.00	0.00	62.8568
0.3930	6.2645	698.9881	319.4714	-0.02160	3.1298	1.17E+11	0.00	0.00	72.6272
0.7860	6.1626	3013.	692.6995	-0.02160	13.4922	1.17E+11	0.00	0.00	85.6544
1.1790	6.0608	7233.	1127.	-0.02160	32.3845	1.17E+11	0.00	0.00	98.6817
1.5720	5.9589	13647.	1623.	-0.02160	61.1040	1.17E+11	0.00	0.00	111.7089
1.9650	5.8570	22545.	2181.	-0.02160	100.9480	1.17E+11	0.00	0.00	124.7361
2.3580	5.7552	34218.	2800.	-0.02160	153.2139	1.17E+11	0.00	0.00	137.7633
2.7510	5.6533	48954.	3480.	-0.02160	219.1989	1.17E+11	0.00	0.00	150.7906
3.1440	5.5514	67045.	4222.	-0.02160	300.2004	1.17E+11	0.00	0.00	163.8178
3.5370	5.4496	88779.	5026.	-0.02159	397.5158	1.17E+11	0.00	0.00	176.8450
3.9300	5.3478	114445.	5890.	-0.02159	512.4422	1.17E+11	0.00	0.00	189.8722
4.3230	5.2460	144335.	6816.	-0.02158	646.2771	1.17E+11	0.00	0.00	202.8994
4.7160	5.1442	178738.	7804.	-0.02158	800.3177	1.17E+11	0.00	0.00	215.9267
5.1090	5.0425	217942.	8853.	-0.02157	975.8614	1.17E+11	0.00	0.00	228.9539
5.5020	4.9408	262239.	9963.	-0.02156	1174.	1.17E+11	0.00	0.00	241.9811
5.8950	4.8392	311918.	11135.	-0.02155	1397.	1.17E+11	0.00	0.00	255.0083
6.2880	4.7376	367268.	12369.	-0.02153	1644.	1.17E+11	0.00	0.00	268.0356
6.6810	4.6361	428580.	13663.	-0.02152	1919.	1.17E+11	0.00	0.00	281.0628
7.0740	4.5346	496142.	15020.	-0.02150	2222.	1.17E+11	0.00	0.00	294.0900
7.4670	4.4333	570245.	16437.	-0.02148	2553.	1.17E+11	0.00	0.00	307.1172
7.8600	4.3321	651179.	17916.	-0.02145	2916.	1.17E+11	0.00	0.00	320.1444
8.2530	4.2309	739233.	19457.	-0.02142	3310.	1.17E+11	0.00	0.00	333.1717
8.6460	4.1300	834697.	21059.	-0.02139	3737.	1.17E+11	0.00	0.00	346.1989
9.0390	4.0292	937861.	22722.	-0.02136	4199.	1.17E+11	0.00	0.00	359.2261
9.4320	3.9286	1049014.	24447.	-0.02132	4697.	1.17E+11	0.00	0.00	372.2533
9.8250	3.8281	1168446.	26233.	-0.02127	5232.	1.17E+11	0.00	0.00	385.2806
10.2180	3.7279	1296447.	28081.	-0.02122	5805.	1.17E+11	0.00	0.00	398.3078
10.6110	3.6280	1433307.	29990.	-0.02117	6418.	1.17E+11	0.00	0.00	411.3350
11.0040	3.5283	1579315.	31961.	-0.02111	7072.	1.17E+11	0.00	0.00	424.3622
11.3970	3.4289	1734761.	33993.	-0.02104	7768.	1.17E+11	0.00	0.00	437.3894
11.7900	3.3299	1899935.	36086.	-0.02096	8507.	1.17E+11	0.00	0.00	450.4167
12.1830	3.2312	2075127.	38241.	-0.02088	9292.	1.17E+11	0.00	0.00	463.4439
12.5760	3.1329	2260626.	40457.	-0.02080	10122.	1.17E+11	0.00	0.00	476.4711
12.9690	3.0350	2456721.	42735.	-0.02070	11000.	1.17E+11	0.00	0.00	489.4983
13.3620	2.9376	2663704.	45074.	-0.02060	11927.	1.17E+11	0.00	0.00	502.5256
13.7550	2.8407	2881863.	47475.	-0.02049	12904.	1.17E+11	0.00	0.00	515.5528
14.1480	2.7444	3111489.	49937.	-0.02036	13932.	1.17E+11	0.00	0.00	528.5800
14.5410	2.6487	3352870.	52461.	-0.02023	15013.	1.17E+11	0.00	0.00	541.6072
14.9340	2.5536	3606297.	55046.	-0.02009	16148.	1.17E+11	0.00	0.00	554.6344
15.3270	2.4592	3872060.	57692.	-0.01994	17338.	1.17E+11	0.00	0.00	567.6617
15.7200	2.3655	4150447.	60400.	-0.01978	18584.	1.17E+11	0.00	0.00	580.6889
16.1130	2.2726	4441750.	63169.	-0.01961	19888.	1.17E+11	0.00	0.00	593.7161
16.5060	2.1806	4746257.	66000.	-0.01942	21252.	1.17E+11	0.00	0.00	606.7433
16.8990	2.0894	5064259.	68892.	-0.01922	22676.	1.17E+11	0.00	0.00	619.7706
17.2920	1.9993	5396044.	71845.	-0.01901	24161.	1.17E+11	0.00	0.00	632.7978
17.6850	1.9101	5741904.	74860.	-0.01878	25710.	1.17E+11	0.00	0.00	645.8250
18.0780	1.8221	6102127.	77937.	-0.01854	27323.	1.17E+11	0.00	0.00	658.8522
18.4710	1.7352	6477003.	81075.	-0.01829	29002.	1.17E+11	0.00	0.00	671.8794
18.8640	1.6496	6866823.	84274.	-0.01802	30747.	1.17E+11	0.00	0.00	684.9067
19.2570	1.5653	7271875.	87535.	-0.01773	32561.	1.17E+11	0.00	0.00	697.9339
19.6500	1.4823	7692450.	90831.	-0.01743	34444.	1.17E+11	-11.004	35.0079	710.9611
20.0430	1.4008	8128592.	94098.	-0.01711	36397.	1.17E+11	-38.408	129.3009	723.9883
20.4360	1.3209	8579982.	97294.	-0.01677	38418.	1.17E+11	-67.137	239.6952	737.0156
20.8290	1.2426	9046270.	100415.	-0.01642	40506.	1.17E+11	-96.418	365.9204	750.0428
21.2220	1.1661	9527096.	103385.	-0.01604	42659.	1.17E+11	-157.128	635.4772	763.0700
21.6150	1.0913	1.00E+07	105872.	-0.01565	44872.	1.17E+11	-327.361	1415.	776.0972
22.0080	1.0185	1.05E+07	107576.	-0.01523	47130.	1.17E+11	-515.151	2385.	789.1244

22.4010	0.9477	1.10E+07	108420.	-0.01479	49415.	1.17E+11	-718.362	3575.	802.1517
22.7940	0.8790	1.15E+07	108335.	-0.01434	51709.	1.17E+11	-934.983	5017.	815.1789
23.1870	0.8125	1.21E+07	107263.	-0.01386	53990.	1.17E+11	-1163.	6751.	828.2061
23.5800	0.7482	1.26E+07	105153.	-0.01336	56239.	1.17E+11	-1401.	8830.	841.2333
23.9730	0.6864	1.30E+07	101964.	-0.01284	58431.	1.17E+11	-1647.	11314.	854.2606
24.3660	0.6271	1.35E+07	95103.	-0.01231	60545.	1.17E+11	-2404.	18078.	286.5478
24.7590	0.5703	1.39E+07	83698.	-0.01175	62448.	1.17E+11	-2720.	22487.	0.00
25.1520	0.5163	1.43E+07	70228.	-0.01118	64080.	1.17E+11	-2993.	27340.	0.00
25.5450	0.4649	1.46E+07	55558.	-0.01059	65414.	1.17E+11	-3229.	32751.	0.00
25.9380	0.4163	1.48E+07	39864.	-0.01000	66426.	1.17E+11	-3427.	38817.	0.00
26.3310	0.3706	1.50E+07	23325.	-0.00940	67097.	1.17E+11	-3587.	45651.	0.00
26.7240	0.3277	1.51E+07	6118.	-0.00879	67411.	1.17E+11	-3710.	53392.	0.00
27.1170	0.2877	1.50E+07	-11580.	-0.00818	67356.	1.17E+11	-3795.	62210.	0.00
27.5100	0.2506	1.49E+07	-29588.	-0.00757	66922.	1.17E+11	-3842.	72316.	0.00
27.9030	0.2163	1.48E+07	-47729.	-0.00697	66106.	1.17E+11	-3851.	83971.	0.00
28.2960	0.1848	1.45E+07	-65818.	-0.00638	64907.	1.17E+11	-3821.	97505.	0.00
28.6890	0.1561	1.41E+07	-83669.	-0.00580	63326.	1.17E+11	-3750.	113284.	0.00
29.0820	0.1301	1.37E+07	-100971.	-0.00524	61373.	1.17E+11	-3588.	130069.	0.00
29.4750	0.1067	1.32E+07	-117232.	-0.00469	59062.	1.17E+11	-3308.	146225.	0.00
29.8680	0.08582	1.26E+07	-132029.	-0.00417	56422.	1.17E+11	-2967.	163043.	0.00
30.2610	0.06735	1.19E+07	-141541.	-0.00368	53486.	1.17E+11	-1067.	74731.	0.00
30.6540	0.05115	1.13E+07	-146791.	-0.00321	50444.	1.17E+11	-1159.	106868.	0.00
31.0470	0.03711	1.06E+07	-152401.	-0.00276	47287.	1.17E+11	-1220.	155060.	0.00
31.4400	0.02508	9828420.	-158208.	-0.00235	44008.	1.17E+11	-1243.	233663.	0.00
31.8330	0.01492	9068495.	-163993.	-0.00197	40605.	1.17E+11	-1211.	382711.	0.00
32.2260	0.00650	8281637.	-169398.	-0.00162	37082.	1.17E+11	-1081.	784540.	0.00
32.6190	-3.47E-04	7470737.	-171341.	-0.00130	33451.	1.17E+11	256.6907	3490255.	0.00
33.0120	-0.00577	6665546.	-167817.	-0.00101	29846.	1.17E+11	1238.	1012397.	0.00
33.4050	-0.00991	5887886.	-161301.	-7.60E-04	26364.	1.17E+11	1526.	725679.	0.00
33.7980	-0.01294	5144157.	-153586.	-5.37E-04	23034.	1.17E+11	1746.	636418.	0.00
34.1910	-0.01498	4439261.	-144915.	-3.43E-04	19877.	1.17E+11	1931.	607861.	0.00
34.5840	-0.01618	3777315.	-135432.	-1.77E-04	16913.	1.17E+11	2091.	609433.	0.00
34.9770	-0.01665	3161867.	-125246.	-3.69E-05	14158.	1.17E+11	2229.	631168.	0.00
35.3700	-0.01653	2595992.	-114455.	7.95E-05	11624.	1.17E+11	2347.	669857.	0.00
35.7630	-0.01590	2082326.	-103151.	1.74E-04	9324.	1.17E+11	2447.	725498.	0.00
36.1560	-0.01488	1623076.	-91425.	2.49E-04	7268.	1.17E+11	2526.	800378.	0.00
36.5490	-0.01355	1220007.	-79374.	3.07E-04	5463.	1.17E+11	2585.	899227.	0.00
36.9420	-0.01199	874419.	-67102.	3.49E-04	3915.	1.17E+11	2620.	1030305.	0.00
37.3350	-0.01026	587100.	-54725.	3.79E-04	2629.	1.17E+11	2629.	1208026.	0.00
37.7280	-0.00842	358250.	-42382.	3.98E-04	1604.	1.17E+11	2606.	1459229.	0.00
38.1210	-0.00651	187357.	-30245.	4.09E-04	838.9101	1.17E+11	2541.	1840074.	0.00
38.5140	-0.00457	72975.	-18561.	4.14E-04	326.7536	1.17E+11	2414.	2493060.	0.00
38.9070	-0.00261	12288.	-7737.	4.16E-04	55.0230	1.17E+11	2176.	3935358.	0.00
39.3000	-6.46E-04	0.00	0.00	4.16E-04	0.00	1.17E+11	1105.	4032180.	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

Pile-head deflection = 6.36638269 inches
Computed slope at pile head = -0.0216017 radians
Maximum bending moment = 15055182. inch-lbs
Maximum shear force = -171341. lbs
Depth of maximum bending moment = 26.72400000 feet below pile head
Depth of maximum shear force = 32.61900000 feet below pile head
Number of iterations = 44
Number of zero deflection points = 2
Pile deflection at ground = 1.49287444 inches

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs

Moment   =   0. in-lbs
Axial Load =   0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
39.30000	6.36638269	15055182.	-171341.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	3.2770	-0.01180	-109966.	8759368.
2	V, lb	0.00	M, in-lb	0.00	0.00	6.3664	-0.02160	-171341.	1.51E+07

Maximum pile-head deflection = 6.3663826902 inches
Maximum pile-head rotation   = -0.0216017315 radians = -1.237688 deg.

Summary of Warning Messages

The following warning was reported 2736 times

**** Warning ****

An unreasonable input value for compressive strength has been specified
for a soil defined using the weak rock criteria. The input value is less
than 100 psi. Please check your input data for correctness.

The analysis ended normally.

From AASHTO 3.11.5.3, Active Earth Pressure

$$K_a = \sin^2(\Theta+\phi'_f)/\Gamma[\sin^2(\Theta)*\sin(\Theta-\delta)]$$

in which $\Gamma = [1+\sqrt{\{(\sin(\phi'f+\delta)*\sin(\phi'f-\beta))/(\sin(\Theta-\delta)*\sin(\Theta+\beta))\}}]^2$

Where

Angle of back face of the wall to the horizontal (Degrees), Θ=	90	
Effective angle of internal friction (degrees), Ø'f=	30	(Assumed)
Friction angle between fill and wall (degrees), δ=	20	(2/3 Ø'f)
Angle of fill to the horizontal , β=	0	Assumed)

Calculation

$\sin(\Theta-\delta)$=	0.94
$\sin^2(\Theta)$=	1.00
$\sin(\Theta+\phi'_f)$=	0.87
$\sin^2(\Theta+\phi'_f)$=	0.75
$\sin(\phi'_f-\beta)$=	0.50
$\sin(\Theta+\beta)$=	1.00
$\sin(\phi'_f+\delta)$=	0.77
Γ=	2.68
K_a=	0.30

γ_{Ls}= 125 pcf (GB7, Section E.7)

Case 1

Diameter of Shaft=	36	inches
C/C Spacing (CC)=	5.5	feet

Therefore for a 36-inch Shaft placed at 5.5 feet center to center

Surcharge Load q_{LS}, 34.1 lb/in $\gamma_{LS}*2*K_a*CC/12$

PIK-772-14.10 SLIDE REPAIR

Conversion of force per Shaft to Distributed Load

The UA Slope 2.3 program calculates the unfactored earth pressure (EH), resultant load per shaft, however, for proper structural analysis of pile reaction, we need to convert this to a realistic load.

The triangular load distribution is a close enough approximation of the actual condition to develop a realistic calculation of distributed shear, moment and displacement in the drilled shaft

Case 1

Diameter of Shaft=	36	inches
C/C Spacing (CC)=	5.5	feet

For a 36-inch shaft at 5.5 feet center to center spacing

Load on Shaft (F_{SW})=	89,051	lbs
Depth of Shear plane at Shaft Location(D_S)=	24.3	feet
The Distibuted Load (F_D)=	576.7	lbs/in

PIK-CR37-05.03 Slide Repair

a) ***Following cases were evaluated:***

Case1

Diameter of Shaft =	36	inches
Center to Center Spacing =	5.5	feet

b) ***Unfactored Loads***

Case	Surchage Loads(lbs/in)	Distributed Load(lbs/in)	Total Unfactored Load (lbs/in)
1	34.1	576.7	610.8

c) ***Load Factor per AASHTO Table 3.4.1.1 and 3.4.1.2***

Load Factor for Surcharge Load (LS) = 1.75
Load Factor for Distributed Load (EH) = 1.5

d) ***Factored Distributed loads***

Case	Factored Surcharge Load (lbs/in)	Factored Distributed Loads(lbs/in)	Total Factored Load(lbs/in)
1	59.6	865.1	924.7

e) ***Limit State Checks***

1 Use Factored Loads for Strength Limit State and check Moment capacity and Nominal Shear per AASHTO 6.10.8 and 6.10.9
2 Use Unfactored Loads for Service Limit State for deflection

f) ***L-pile Analysis***

Note: It is assumed that 50 Ksi steel will be used.

Section Used= W24x131

Case1: 36 inch diameter Shafts with 5.5 feet center to center spacing

Checks:

Structural Strength Limit State Checks (W24x131 Section)

Calculated Factored Moment(in-lbs)	Factored Nominal Moment Resistance(in-lbs)	Acceptable Or Unacceptable
13,000,000	16,450,000	Acceptable

Calculated Factored Shear (Kips)	Factored Nominal Shear resistance (Kips)	Acceptable Or Unacceptable
334.9	395.8	Acceptable

and for nominal shear resistance calculation Per AASHTO 6.10.9

Service Limit State Checks (W24x131 Section)

Drilled Shaft Length above bedrock= 24.3 feet

For the unfactored Service Limit State analysis, the maximum Pilehead deflection must be limited to 1% or less of the drilled shaft length above bedrock (24.3').

Calculated Deflection(in)	Allowable Deflection(in) Per ODOT Recommendations	Acceptable Or Unacceptable
2.2	2.9	Acceptable

PIK-772-14.10 Slide Repair

W24x131

	Thickness of Flange (t_f) =	0.96	in
	Depth (d) =	24.48	in
	Yield Strength of Steel (F_y) =	50	Ksi
	$D = d-2t_f$ =	22.56	in
	thickness of Web (t_w) =	0.605	in
V_p =	$0.58\ F_y D t_w$ =	395.8	Kips
	Young's Modulus (E) =	29000	Ksi
Assume Unstiffened Web			
	Shear Buckling Coefficient (K) =	5.0	
	$Sqrt(EK/F_y)$ =	53.9	Equation 1
	$1.12*Sqrt(EK/F_y)$ =	60.3	Equation 2
	$1.4*Sqrt(EK/F_y)$ =	75.4	Equation 3
	D/t_w =	37.3	
	Since, $D/t_w \leq$ Equation1, C =	1.0	
Therefore,			
Nominal Shear Resistance (V_n) = CV_p		395.8	Kips
ϕ_v =		1.0	
Factored Shear Resistance (V_u) = $\phi_v V_n$		395.8	Kips

PIK-772-14.10 Slide Repair

W24x131

Per AASHTO, 6.10.8

For Continously Braced Flanges in Tension or Compression

$f_{bu} \leq \phi_f R_h F_{yf}$ Equation 1

Where f_{bu} = Factored Bending Moment Obtained in Strength Limit State

ϕ_f = Flexural Resistance Factor

R_h = Hybrid Factor

F_{yf} = $f_y * S_{x-x}$

f_y = Yield Strength of Steel

S_{x-x} = Section Modulus of Steel Section

ϕ_f =	1.0	Per AASHTO 6.5.4.2
R_h =	1.0	Per AASHTO 6.10.1.10.1
S_{x-x} =	329.0	In^3
f_y =	50.0	ksi
F_{yf} =	16,450,000	lb-in