Eckert Road, Boise River Bridge
Bridge Key No. 12811
Boise, Idaho
Geotechnical Engineering Report

July 14, 2026 | Terracon Project No. 62235109B

Prepared for:

Local Highway Technical Assistance Council (LTHAC)
3330 W. Grace Street
Boise, Idaho 83703

Ada County Highway District (ACHD)
5800 N Meeker Avenue
Boise, Idaho 83713

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July 14, 2026

Local Highway Technical Assistance Council (LTHAC)
3330 W. Grace Street
Boise, Idaho 83703

Attn: Scott Wood, P.E.
P: (208) 530-7466
E: swood@lthac.org

Re: Geotechnical Engineering Report
Eckert Road, Boise River Bridge
Bridge Key No. 12811
Boise, Idaho
Terracon Project No. 62235109B

Dear Mr. Wood:

In accordance with our agreement dated November 19, 2025, and our scope of work dated October 16, 2025 we have completed this Geotechnical Engineering Report for the Eckert Road, Boise River Bridge (Bridge Key No. 12811). The accompanying report presents the findings of the subsurface exploration and recommendations concerning the design of the project and was prepared in general accordance with Idaho Transportation Department (ITD) *Materials Manual* guidelines for a Geotechnical Engineering Report. Please provide this report to ACHD for their review.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

PROFESSIONAL ENGINEER
LICENSED
18343
7-14-2026
STATE OF IDAHO
LUCAS J. MARSH

Lucas J. Marsh, P.E.
Geotechnical Services Manager

Maren J. Tanberg, P.E., P.G.
Senior Staff Engineer

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Geotechnical Engineering Report

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Eckert Road, Boise River Bridge
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230.01 Introduction

The proposed project is replacing and realigning the Eckert Road bridges over the Ridenbaugh Canal (Bridge Key No. 12805) and the Boise River (Bridge Key No. 12810) between Boise Avenue and Millbrook Way in Boise, Idaho. The intersection of Boise Avenue and Eckert Road will be redesigned as a roundabout as part of a companion project (ACHD Project No. 325043). This project includes improvements to the intersection of Eckert Road and the ingress/egress to Barber Park, an undercrossing for the Greenbelt northeast of the Boise River and retaining walls to support the new alignment of Eckert Road.

The purpose of this report is to provide geotechnical engineering recommendations for the replacement of the Boise River Bridge (Bridge Key No. 12810), the undercrossing for the Greenbelt northeast of the Boise River, and the retaining walls associated with the abutments and approach embankments for the Boise River Bridge. A Site Location Map showing the location of the structure is provided in Appendix A. Not included in this report are recommendations regarding the pavements, intersection improvements, the replacement of the Ridenbaugh Canal Bridge (Bridge Key No. 12805), the retaining walls associated with the abutments and approach embankments for the Ridenbaugh Canal Bridge, and the retaining wall southwest of the Ridenbaugh Canal on the northwest side of Eckert Road.

The existing Eckert Road Bridge crosses over the Boise River via a nine-span bridge structure founded on timber piles and was constructed in 1954 and widened in 1998. The widening was for a multimodal path and is founded on H-piles. The existing structure has an out-to-out width and length of approximately 315 and 40 feet, respectively.

Based on the *Concept Plan* dated August 2025 prepared by HDR Engineering (HDR) and discussions with HDR between contract authorization and the issuance of this report, the preferred alternative is to replace the existing structure in full with a new three-span bridge structure. The bridge structure will have an out-to-out width and length of about 60 and 368 feet, respectively. The southwestern abutment (Abutment 1) will shift to the northwest from the existing alignment roughly 45 feet. The new bridge will be supported by deep foundations at the abutments by drilled shafts and in the river with piers also supported on drilled shafts.

New embankments associated with the planned realignment of Eckert Road will be placed at each abutment and will have a maximum height of about 25 feet. MSE walls (panel and welded wire) varying in height with a maximum height of 27 feet (including embedment) will be used to retain the embankments behind each abutment. The welded wire MSE walls will be placed directly behind the abutments. We understand the embankments, and slopes in front of and behind the walls will have a slope of 2(horizontal):1(vertical) or flatter. The road profile at the center line of Eckert Road will be raised to finish grade elevation of approximately 2771 feet at Abutment 1 and 2769 feet at Abutment 2. Embankment heights will range between about 25 feet above existing grade to meeting existing grade at the project's ends.

The recommendations in this report are based the following publications:

- AASHTO *LRFD Bridge Design Specifications*, 10th Edition, 2024
- ITD *Materials Manual,* 2020.
- ITD *Roadway Design Manual*, 2013
- ITD *Standard Specifications for Highway Construction, 2023,* and the *2026 Supplemental Specifications*.

230.02 Field Exploration and Laboratory Testing

230.02.01 Borings

Terracon drilled 7 borings to depths of about 30.4 to 91.5 feet below the existing ground surface (bgs) to provide subsurface information for the recommendations presented in this report. The borings were drilled February 18 through 28, 2025; November 26, 2025; and December 1, 2025. The quantity, location, and depth of the explorations are summarized in the following table.

Table 1: Exploration Boring Descriptions

Boring Name	Latitude / Longitude (Decimal Degrees)	Top of Boring Elevation (feet)	Depth (feet)	Location
B-2	43.5654, -116.1328	2771.33	91.5	Between Ridenbaugh Canal and Boise River

Boring Name	Latitude/ Longitude (Decimal Degrees)	Top of Boring Elevation (feet)	Depth (feet)	Location
B-3	43.5656, -116.1324	2750.12	91.5	Within the Boise River for Piers
B-4	43.5657, -116.1322	2750.07	90.9	
B-5	43.5658, -116.1321	2749.76	91.4	
B-6	43.5659, -116.1317	2764.98	91.5	Near existing Abutment 2 for the Boise River Bridge
RW-15	43.5662, -116.1311	2762.15	31.5	Between the Boise River and Millbrook way
RW-16	43.5665, -116.1307	2759.4	46.5	

The boring locations are shown on the Exploration Plan and the Foundation Investigation Plat in Appendix A. The borings were drilled using a truck-mounted drill rig equipped with hollow-stem augers. A Terracon field geologist/engineer recorded logs of the borings during the drilling operations.

The boring locations were selected by Terracon based on site access, utility, and safety considerations. Latitude and longitude provided in the table above were obtained with a recreational grade GPS unit. After drilling, the project team interpolated boring elevations from the survey data collected for this project. Boring locations and elevations are provided on the boring logs in Appendix A. Elevations shown on the boring logs and the Foundation Investigation Plat are based on the North American Vertical Datum of 1988 (NAVD 88).

230.02.02 Field Tests

Disturbed samples were collected from the borings using a 2-inch-outside diameter split-spoon sampler following Standard Penetration Test (SPT) methods in general accordance with ASTM D1586. Encountered soils were visually classified at the time of drilling per ASTM D2488. At select depths, Terracon used a 3-inch-outside-diameter split-spoon sampler (ring sampler) to obtain a larger sample quantity of the native granular soils. In our engineering evaluation, the blow counts required to drive the larger 3-inch-outside-diameter split-spoon sampler were corrected using the Lacroix-Horn equation (ASTM STP-523, 1973) to account for the larger sampler size and represent standard SPT N-values. The boring logs show the uncorrected blow counts that were recorded in the field. In addition to SPT samples, relatively undisturbed samples were occasionally obtained by pushing a thin-walled, seamless steel tube with a sharp cutting edge hydraulically into the soil. Quantities, locations, and depths are presented on the boring logs in Appendix A.

The SPT N-value provides a reasonable estimate of the relative in-place density of non-cemented sandy type materials. However, the N-value only provides an indication of the relative stiffness of cohesive materials since the penetration resistance of these soils may be affected by the moisture content. Considerable care must be exercised in interpreting the N-value in gravelly soils, particularly where the size of the gravel particles exceeds the inside diameter of the sampling spoon.

An automatic SPT hammer was used to advance the split-spoon sampler in the borings performed for this project. Greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the cathead and rope method. The higher efficiency of the automatic hammer affects the standard penetration resistance blow count (N-value) by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

230.02.03 Geophysical Exploration

Geophysical studies were not conducted at this site.

230.02.04 Laboratory Tests

Soil samples collected in the field were taken to the laboratory where soils were visually classified using the Unified Soil Classification System and in general accordance with ASTM D2488, or ASTM D2487 where laboratory data was available. The Unified Soil Classification System is described in Appendix C. Representative samples were selected for testing to determine the engineering and physical properties of the soil. The following table lists the tests performed and provides a brief description of the purpose of each.

Table 2. Laboratory Testing

Tests Conducted	To Determine
Moisture Content (ASTM D2216)	Moisture content of the soil sample.
Sieve Analysis (ASTM D6913)	Particle distribution of the soil sample
Percent Passing the No. 200 Sieve (ASTM D1140)	Percent of clay/silt sized particles in the sample.
Atterberg Limits (ASTM D4318)	Plasticity Index, Liquid Limit, and Plastic Limit of the soil sample.
pH (ASTM D4972) and Minimum Resistivity (ASTM G187)	Corrosion potential of metals in contact with soil.

Note: Laboratory tests were conducted in general accordance with their respective ASTM standards.

Results of the field and laboratory tests are generally summarized on the boring logs. Graphical results of the Atterberg limits and gradation analyses are included in Appendix B. The laboratory test data, along with the field information, were used to prepare the boring logs included in Appendix A.

230.03 Surface Conditions

The Boise River crosses beneath Eckert Road adjacent to ingress/egress to Barber Park in Boise, Idaho and flows northwest. The proposed new bridge structure will be constructed in the same general location, though the west abutment will shift roughly 45 feet north. The area surrounding the project primarily consists of undeveloped land at the east abutment and a park, laydown yard, and residences on the west abutment. The Nampa-Meridian Irrigation District headworks structure is located just upriver (southeast) of the existing bridge structure and is currently being reconstructed at the issuance of this report. At the project location, Eckert Road is paved with hot mix asphalt surfacing, including across the concrete bridge deck. Overhead power and telephone lines run along the southeast side of Eckert Road.

The natural topography at the project site slopes down to the Boise River. In the overall project area, the ground surface slopes down to the Boise River and down upriver (to the northwest). In general, Eckert Road near the Boise River is built on embankments that range between 15 to 23 feet higher than the surrounding land. Trees, shrubs and grasses are growing along the riverbanks. Water flows in the river year-round and was flowing at the time of our exploration. An aerial photograph showing the area near the existing bridge is shown on the Exploration Plan in Appendix A.

Table 3. Summary of Scour Elevations

Scour Event	Abutments [1]	Piers [1]	Greenbelt Undercrossing
50-year storm event, feet	Abutment 1 – 2748.98 Abutment 2 – 2749.18	2741.13	Not Anticipated
100-year storm event, feet	Abutment 1 – 2747.72 Abutment 2 – 2746.43	2739.16	Not Anticipated
500-year storm event, feet	Abutment 1 – 2743.56 Abutment 2 – 2739.61	2733.37	Not Anticipated

1. Values were provided by HDR on February 20, 2026 via email.

The bottom of the river at our exploration locations is about 2750 feet in elevation.

230.04 Subsurface Conditions

Subsurface conditions encountered at the boring locations are indicated on the boring logs included in Appendix A. Stratification boundaries shown on the boring logs represent the approximate locations of changes in the soil. In-situ, the transition between materials may be gradual.

Between Ridenbaugh Canal through the Northeast Abutment of the Boise River Bridge (B-2 through B-6): Borings B-2 and B-6 were drilled in the roadway and encountered asphalt, roughly 2¼ to 2½ inches thick, and underlying the asphalt were fill materials including poorly graded gravel with silt and sand, silty gravel with sand, and poorly graded gravel with sand to depths of about 16½ feet (2754.8 ft elevation) and 13 ft (2751.5 ft elevation) below the existing ground surface (bgs), respectively. Underlying the fill materials and at the surface of borings B-3, B-4, and B-5 which were drilled in the Boise River, were medium dense to very dense sands and gravels with varying amounts of silt cobbles and boulders to depths of about 25 feet to 49 feet (about 2725.1 elevation feet to 2715.1 elevation feet). In boring B-2 and thin layer (about ½-foot) of sandy silt was encountered beneath the fill materials. Underlying the sands and gravels were dense to very dense silty sand, sand with silt, sand, and sand with gravel extending to the bottom of our explorations about 91 to 91½ feet bgs (about 2679.8 feet elevation to 2658.3 feet elevation) except in B-6 where it extended to about 83 feet bgs (about 2682 feet elevation). Intermittent clay layers were also encountered within these sand soils. In boring B-6, hard lean clay was encountered below the sand layer and extended to the depth of the exploration, about 91½ feet bgs (about 2673.5 feet elevation).

Behind the Northeast Abutment of the Boise River Bridge to the planned Greenbelt Undercrossing (RW-15 and RW-16): Asphalt was encountered in RW-15, approximately 3½ inches. Underlying the asphalt and at ground surface in RW-16, were fill materials. The fill materials were sands and gravels with varying silt and clay content to depths of about 5 to 7½ feet bgs (about 2757.2 4 feet elevation to 2753.4 feet elevation). Below the fills were native medium dense to very dense sands and gravels with varying silt and cobbles content to depths of about 25 feet bgs (about 2737.2 feet elevation to 2734.4 feet elevation). A thin layer of silt with varying amounts of sand beneath these sands and gravel to depths of about 29 feet to 30 feet bgs (about 2732.2 feet elevation to 2730.4 ft elevation). Underlying the silt layer, dense to very dense sands with varying gravel and silt content were encountered to the bottom of our explorations, depths of about 31½ feet to 46½ feet bgs (about 2730.7 feet elevation to 2712.9 feet elevation).

The borings were monitored for the presence of groundwater. Groundwater was encountered in all borings at the time of exploration. Water was measured from the surface (0 feet bgs) to about 22 feet bgs (about 2752.1 feet elevation to 2749.3 feet elevation). Water was flowing in the river at the time of our exploration and groundwater was encountered at the time of drilling. Fluctuations of the groundwater level may occur due to variations in the amount of precipitation, out flow from upriver reservoirs, flood control measures, runoff, irrigation, and other factors not evident at the time of exploration. The evaluation of these factors was beyond the scope of this report.

We anticipate frost depths of 24 inches, according to local regulations. According to the NRCS Web Soils Survey, the potential for frost action of the near surface soils in the project area is low to moderate and the potential for corrosion of concrete is low to moderate and steel is low to high.

230.05 Conclusions and Recommendations

230.05.01 General

Based on conversations with HDR, we recommend that spread foundations used to support the Greenbelt Undercrossing and the moment slabs.

For the Boise River Bridge, different foundation options were discussed with HDR. Shallow foundations and driven piles were eliminated due to the amount of potential scour. Therefore, drilled shafts are the recommended foundation to support the Boise River Bridge.

230.05.02 Foundations

230.05.02.01 Shallow Foundations

Greenbelt Undercrossing

Spread foundations used to support the underpass extend to a minimum depth of 36 inches below the finished grade. A very loose sand layer was encountered directly and should be removed. As a result, we recommend placing and compacting a minimum of 24 inches of Granular Subbase or Aggregate for Untreated Base (Type B) below the spread foundations to remove the unsuitable material and provide a leveling course. The Granular Subbase or Aggregate for Untreated Base (Type B) should extend to undisturbed medium dense to very dense native granular soils and be compacted per Class A compaction. Granular Subbase should be used as structural backfill.

Table 4. Greenbelt Undercrossing – Shallow Foundations

Description	Criteria
Foundation type	Conventional spread footings.

Description	Criteria
Bearing material	Minimum of 24 inches of Granular Subbase or Aggregate for Untreated Base (Type B) supported on undisturbed medium dense to very dense native granular soils.
Minimum embedment depth	36 inches
Minimum footing width	36 inches [3]
Scour Depth	Not applicable for this structure
Nominal (ultimate) net bearing capacity	See chart below.
Recommended resistance factor to be used with the nominal bearing capacity for strength limit state design [1]	0.45
Presumptive bearing pressure for settlement less than 1 inch	See chart below.
Recommended resistance factor to be used with the nominal bearing capacity for service limit state design [1]	1.0
Ultimate coefficient of friction to resist sliding [2]	Pre-cast footings: 0.54 Cast-in-place footings: 0.65
Recommended resistance factors when designing resistance to sliding [1]	Pre-cast footings: 0.90 Cast-in-place footings: 0.80

1. Recommended resistance factors are based on *LRFD Bridge Design Specifications*.
2. Ultimate friction coefficient for sliding is C multiplied by tanΦ_f as defined in Section 10.6.3.4 of the *LRFD Bridge Design Specifications*.
3. Minimum footing width based on Article 12.11 of the ITD *Bridge Design LRFD Manual*.

Standard penetration test results from our borings were used to evaluate the strength of the foundation soil for bearing capacity. The ultimate bearing capacity is shown as a function of effective footing width in the chart below. The resistance factor shown above should be applied to the bearing values presented.

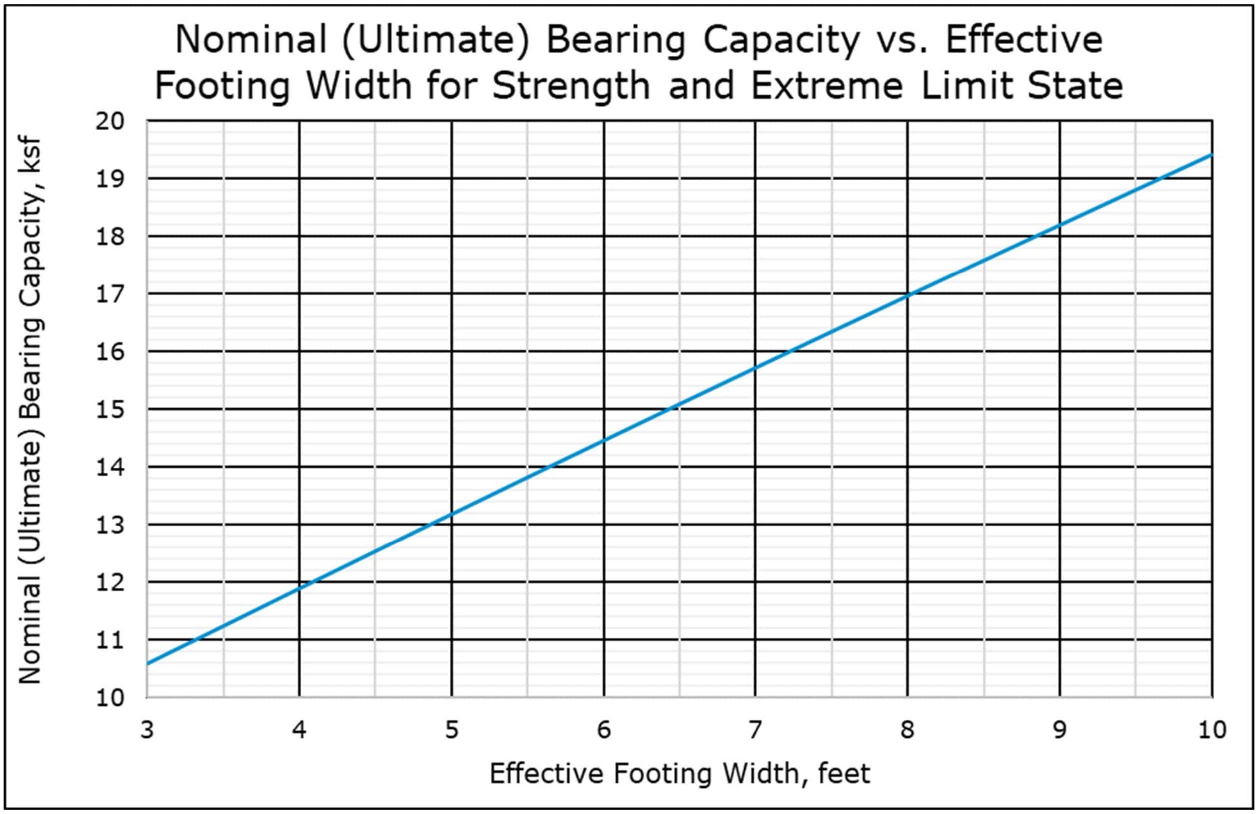


Figure 1: Greenbelt - Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

The graph below shows the service limit state bearing resistance as a function of effective footing width. The graph was developed based on an estimated settlement of 1-inch due to the structural loads.

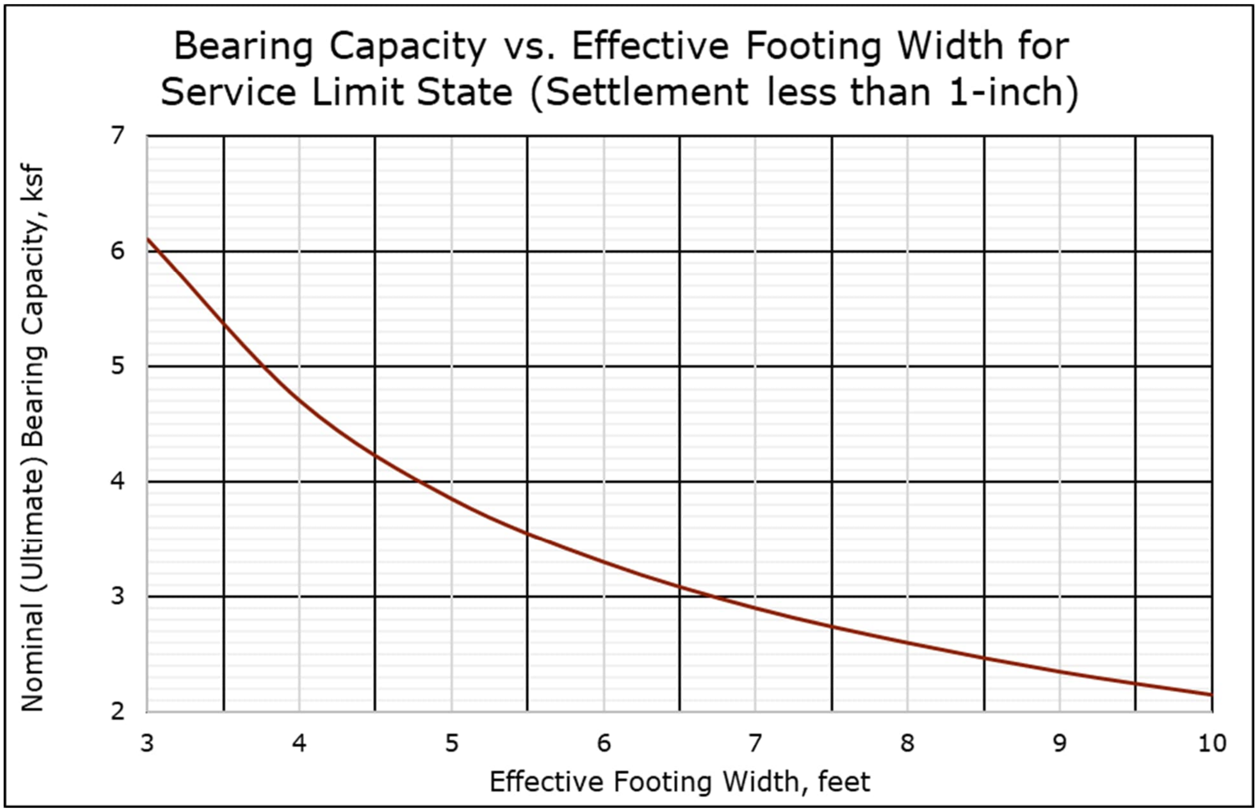


Figure 2: Greenbelt Undercrossing – Bearing Capacity vs. Effective Footing Width

Moment Slabs

Spread foundations used to support the moment slabs extend to a minimum depth of 24 inches below the finished grade. Outside of the MSE wall reinforced zones, Granular Subbase should be used as structural backfill.

Table 5. Moment Slabs – Shallow Foundations

Description	Criteria
Foundation type	Conventional spread footings.
Bearing material	Moment slab will bear on at least 36 inches of new embankment fill materials consisting of Granular Subbase, Aggregate for Untreated Base (Type B), and/or MSE wall reinforced zones extending to undisturbed native soils.
Minimum embedment depth	24 inches

Description	Criteria
Minimum footing width	24 inches
Scour Depth	Not applicable for this structure
Nominal (ultimate) net bearing capacity	See chart below.
Recommended resistance factor to be used with the nominal bearing capacity for strength limit state design [1]	0.45
Presumptive bearing pressure for settlement less than 1 inch	See chart below.
Recommended resistance factor to be used with the nominal bearing capacity for service limit state design [1]	1.0
Ultimate coefficient of friction to resist sliding [2]	Cast-in-place footings: 0.65 Precast footings: 0.50
Recommended resistance factors when designing resistance to sliding [1]	Cast-in-place footings: 0.80 Precast footings: 0.90

1. Recommended resistance factors are based on *LRFD Bridge Design Specifications*.
2. Ultimate friction coefficient for sliding is C multiplied by $\tan\Phi_f$ as defined in Section 10.6.3.4 of the *LRFD Bridge Design Specifications*.

Standard penetration test results from our borings were used to evaluate the strength of the foundation soil for bearing capacity. The ultimate bearing capacity is shown as a function of effective footing width in the chart below. The resistance factor shown above should be applied to the bearing values presented.

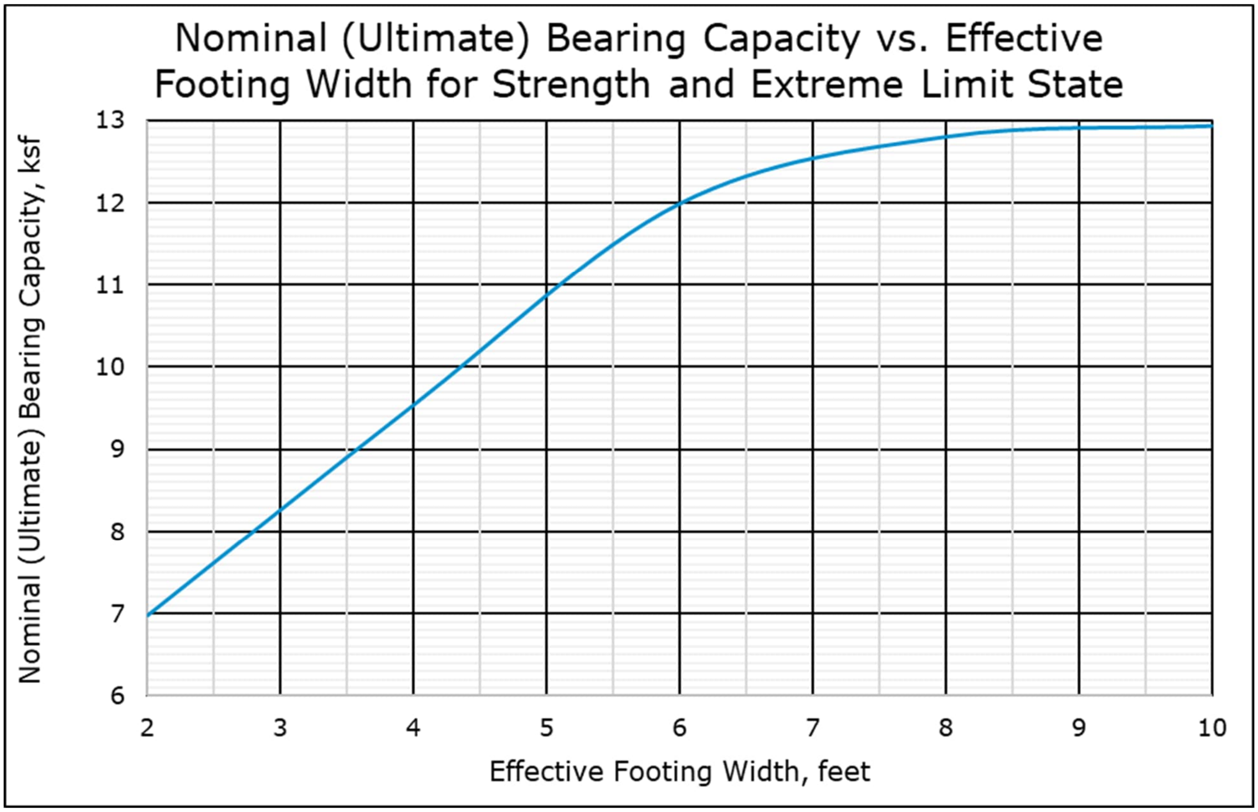


Figure 3: Moment Slabs - Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

The graph below shows the service limit state bearing resistance as a function of effective footing width. The graph was developed based on an estimated settlement of 1-inch due to the structural loads.

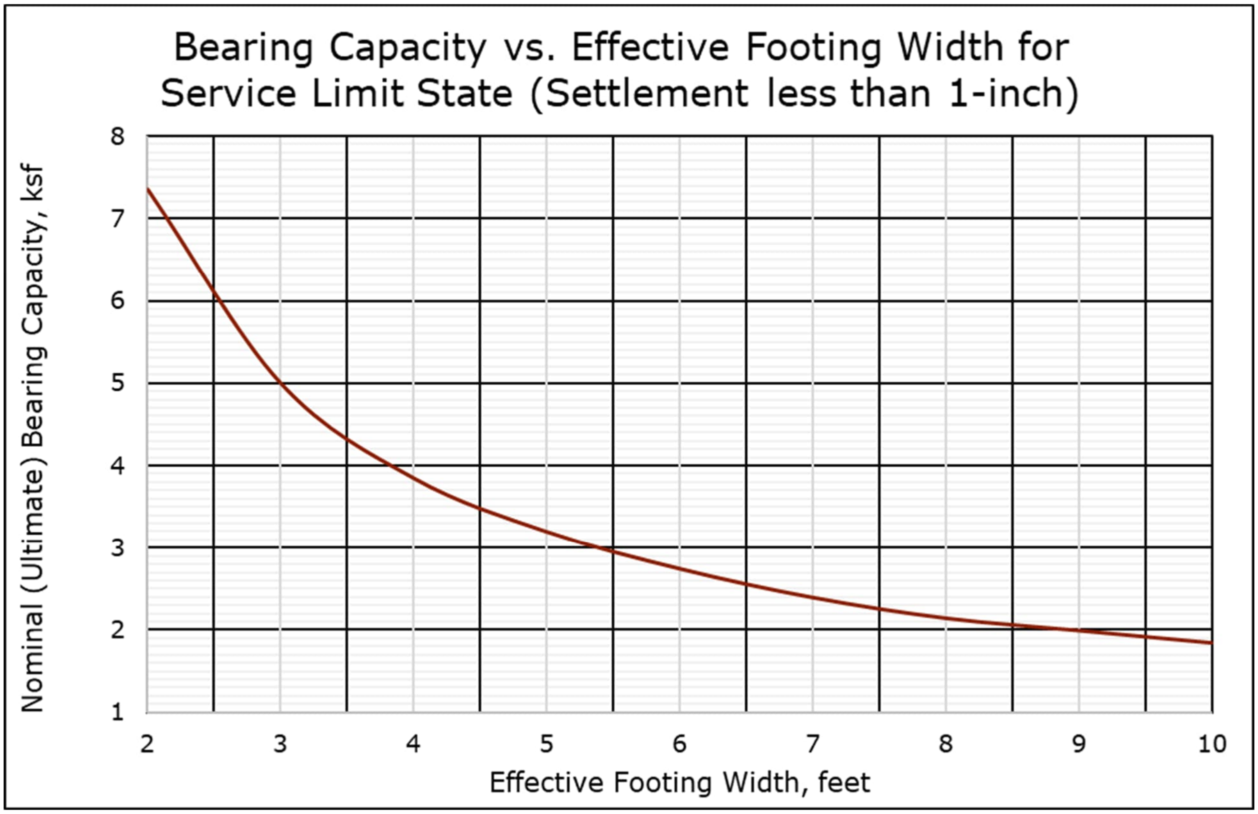


Figure 4: Moment Slabs - Bearing Capacity vs. Effective Footing Width

230.05.02.02 Deep Foundations

We understand that reinforced, cast-in-place drilled shaft foundations will be used to support the proposed bridge piers and at the abutments. In the following table, the assumptions used in the analysis are noted.

Table 6: Design Parameters for Drilled Shafts

Shaft Feature	Abutments	Pier
Number of Shafts [1]	4	3
Top of Shaft, feet elevation [1]	Abutment 1 – 2753 Abutment 2 – 2751.2	Pier 1 – 2748 Pier 2 – 2747.4
Diameter, feet [1]	4	6
Service Load (Per Shaft), kips [1, 2]	730	1450
Strength Load (Per Shaft), kips [1, 2]	1000	2030
Extreme Event Load (Per Shaft), kips [1, 2]	1010	1270

Shaft Feature	Abutments	Pier
50% of the 100-year storm event, feet [1]	Abutment 1 – 2748.5 Abutment 2 – 2751.2	2744.3
100-year storm event, feet [1]	Abutment 1 – 2747.7 Abutment 2 – 2746.4	2739.2
500-year storm event, feet [1]	Abutment 1 – 2743.6 Abutment 2 – 2739.6	2733.4

1. Values were provided by HDR.
2. Loads do not include the weight of the shaft.

The shaft lengths and reinforcement will be designed by the Structural Engineer. Design parameters are provided below for use in designing the shafts using LRFD design methods. The shafts should be designed considering both vertical and lateral resistance.

Vertical Resistance

The nominal (ultimate) vertical resistance of an individual drilled shaft may be determined by combining the tip resistance and the side resistance. Details about each are provided below. Figures presenting the combined resistance are included in the subsection Drilled Shaft – Combined Vertical Resistance.

Drilled Shaft – Tip Resistance

The nominal (ultimate) tip resistance of a drilled shaft may be calculated by multiplying the cross-sectional area of the base of the shaft by 12 kips per square foot (ksf). Enlarged bases (i.e., belled shafts) should not be used. Drilled shafts should not end within 2 shaft diameters above or 1 shaft diameter below the clay layers for the tip resistance above to be applicable. If drilled shafts end in within 2 shaft diameters above or 1 shaft diameter below the clay layers, they should be designed using only skin friction. The recommended resistance factor is shown in the Table 11 below.

Drilled Shaft – Side Resistance

The following tables should be used to determine the nominal (ultimate) side resistance of the drilled shafts. Permanent casing extends below the 100-year scour event at the pier. 100-year scour event elevation is 2739.2 feet elevation and the permanent casing elevation is 2735.1 feet elevation. Side resistance has been neglected to the elevation of the bottom of the permanent casing.

The vertical resistance of the portion of each shaft within the design scour depth should be neglected. The nominal side resistance of the drilled shaft below the maximum scour depth may be determined by multiplying the unit resistance value in the table below by the surface area of the shaft within the depth interval. The recommended resistance factor is shown in the Table 11 below.

Table 7: Nominal Side Resistance of 4 feet Diameter Drilled Shafts, Abutment 1

Elevation (Depth Below Top of Drilled Shaft), feet	Nominal Unit Shaft Resistance (psf)	
	Strength & Extreme Limit State [1]	1" Settlement – Service Limit State [2]
2748.5 - 2743.3 (22.8 - 28)	2,100	2,100
2743.3 - 2738.3 (28 - 33)	2,200	2,200
2738.3 - 2733.3 (33 - 38)	2,300	2,300
2733.3 - 2730.3 (38 - 41)	2,400	2,300
2730.3 - 2728.3 (41 - 43)	2,400	2,400
2728.3 - 2722.3 (43 - 49)	2,500	2,400
2722.3 - 2718.3 (49 - 53)	2,000	2,000
2718.3 - 2713.3 (53 - 58)	2,000	2,000
2713.3 - 2709.3 (58 - 62)	3,000	3,000
2709.3 - 2703.3 (62 - 68)	3,100	3,100
2703.3 - 2698.3 (68 - 73)	3,100	3,100
2698.3 - 2693.3 (73 - 78)	3,200	3,200
2693.3 - 2688.3 (78 - 83)	3,200	3,200
2688.3 - 2683.3 (83 - 88)	3,300	3,200
2683.3 - 2679.8 (88 - 91.5)	3,300	3,300

1. Values shown are for 50% of the 100-year scour event.
2. Values shown are for the 100-year scour event.

Table 8: Nominal Side Resistance of 4 feet Diameter Drilled Shafts, Abutment 2

Elevation (Depth Below Top of Drilled Shaft), feet	Nominal Unit Shaft Resistance (psf)	
	Strength & Extreme Limit State [1]	1" Settlement – Service Limit State [2]
2751.2 - 2750 (0 - 1.2)	2,200	0
2750 - 2747.8 (1.2 - 3.4)	800	0
2747.8 - 2746.4 (3.4 - 4.8)	900	0
2746.4 - 2745 (4.8 - 6.2)	900	900
2745 - 2742 (6.2 - 9.2)	1,200	1,100
2742 - 2739.6 (9.2 - 11.6)	2,000	2,000

Elevation (Depth Below Top of Drilled Shaft), feet	Nominal Unit Shaft Resistance (psf)	
	Strength & Extreme Limit State [1]	1" Settlement – Service Limit State [2]
2739.6 - 2737 (11.6 - 14.2)	2,100	2,000
2737 - 2732.5 (14.2 - 18.7)	1,600	1,500
2732.5 - 2727 (18.7 - 24.2)	2,200	2,200
2727 - 2720 (24.2 - 31.2)	2,300	2,300
2720 - 2717 (31.2 - 34.2)	2,800	2,800
2717 - 2712 (34.2 - 39.2)	2,800	2,800
2712 - 2707 (39.2 - 44.2)	2,900	2,900
2707 - 2702 (44.2 - 49.2)	3,000	2,900
2702 - 2697.5 (49.2 - 53.7)	3,000	3,000
2697.5 - 2692 (53.7 - 59.2)	3,100	3,000
2692 - 2687 (59.2 - 64.2)	3,100	3,100
2687 - 2685 (64.2 - 66.2)	3,100	3,100
2685 - 2682 (66.2 - 69.2)	3,200	3,100
2682 - 2677 (69.2 - 74.2)	2,000	2,000
2677 - 2673.5 (74.2 - 77.7)	2,000	2,000

1. Values shown are for 50% of the 100-year scour event.
2. Values shown are for the 100-year scour event.

Table 9: Nominal Side Resistance of 6 feet Diameter Drilled Shafts, Piers

Elevation (Depth Below Top of Drilled Shaft [1]), feet	Nominal Unit Shaft Resistance (psf)	
	Strength & Extreme Limit State [2]	1" Settlement – Service Limit State [3]
2744.3 – 2735.1 (3.7 – 12.9)	0	0
2735.11 - 2733.4 (12.9 - 14.6)	1,700	1,700
2733.4 - 2726.8 (14.6 - 21.2)	1,800	1,800
2726.8 - 2721.8 (21.2 - 26.2)	2,000	1,900

Elevation (Depth Below Top of Drilled Shaft [1]), feet	Nominal Unit Shaft Resistance (psf)	
	Strength & Extreme Limit State [2]	1" Settlement – Service Limit State [3]
2721.8 - 2714.8 (26.2 - 33.2)	2,100	2,100
2714.8 - 2711.8 (33.2 - 36.2)	2,500	2,500
2711.8 - 2706.8 (36.2 - 41.2)	2,300	2,300
2706.8 - 2701.8 (41.2 - 46.2)	2,700	2,600
2701.8 - 2696.8 (46.2 - 51.2)	2,700	2,700
2696.8 - 2693.8 (51.2 - 54.2)	2,800	2,800
2693.8 - 2686.8 (54.2 - 61.2)	2,800	2,800
2686.8 - 2681.8 (61.2 - 66.2)	2,900	2,900
2681.8 - 2676.8 (66.2 - 71.2)	2,000	2,000
2676.8 - 2670.8 (71.2 - 77.2)	3,000	3,000
2670.8 - 2666.8 (77.2 - 81.2)	3,100	3,000
2666.8 - 2661.8 (81.2 - 86.2)	3,100	3,100
2661.8 - 2658.3 (86.2 - 89.7)	3,200	3,100

1. Depth Below Top of Drilled Shaft is for Pier 1. The elevation of the top of drilled shaft for Pier 2 is 2747.4 feet. Therefore, for Pier 2, 0.6 feet should be subtracted from the values presented.
2. Values shown are for 50% of the 100-year scour event. Permanent casing elevation is 2735.1 feet elevation and side resistance has been neglected to this elevation.
3. Values shown are for the 100-year scour event.

Depending on the spacing, a group reduction factor should be applied that will reduce the capacity of each drilled shaft within a group. The reduction factor is a function of the center-to-center spacing of the shafts. The recommended resistance factors are shown in the Table 10 below.

Table 10: Group Reduction Factors of Drilled Shafts

Drilled Shafts – Reduction Factors	
Minimum Spacing (center to center)	3x shaft diameter
Reduction Factor for a Spacing of 4x the Shaft Diameter	1.0
Reduction Factor for a Spacing of 3x the Shaft Diameter	0.9

Drilled Shaft - Combined Vertical Resistance

Figures illustrating the combined tip and side resistance for the abutments and piers are presented in Appendix C. If the design scour changes or permanent casing extends below the scour zone, the values within the zone that is permanently cased will need to be reduced and the figures will need to be revised. The resistance factors presented in Table 11 below should be applied to the figures in Appendix C.

Downdrag

Downdrag is not anticipated on the drilled shafts.

Resistance Factors

Based on Table 10.5.5.2.4-1 and in Section 10.5.5.3 of *AASHTO LRFD*, the following table presents the recommended resistance factors.

Table 11: Resistance Factors

Drilled Shafts – Resistance Factors	
Tip Resistance Factor – Strength Limit State	0.50
Side Resistance Factor – Strength Limit State	0.55
Uplift Resistance Factor – Strength Limit State	0.45
Tip and Side Resistance Factor – Service & Extreme Limit State	1.0

Drilled Shaft Settlement

Based on the axial resistance presented above and in Appendix C for Service State Limit, the settlement of an individual drilled shaft is estimated to be about 1 inch or less. Based on the relatively minimal estimated settlement, settlement monitoring or mitigation is not recommended.

Lateral Resistance

Results of the lateral analysis of a 4-foot-diameter shaft at each abutment and 6-foot-diameter shaft at the pier, with scour, pinned and fixed head conditions, are presented in Appendix C. The lateral analysis was performed using the 500-year storm event scour conditions with an estimated applied service limit axial load of 625 kips and 1,167 kips for the abutments and pier, respectively. The lateral loads required to deflect the top of the pile a specified distance were evaluated along with the corresponding shear and moment within the pile. We analyzed deflections of 0.25 to 2 inches at 0.25-inch increments.

The drilled shaft geometry was provided to us by HDR. For the abutments fixed-head condition, the load point was modeled below the cap. For the abutments the free-head condition, the load point was modeled 5 feet above the top of the cap. For the piers fixed-head condition, the load point was modeled as the top of the column and below the column cap, above the drilled shaft. For the piers the free-head condition, the load point was modeled 5 feet above the top of the column at the top of the column cap. One percent reinforcement and 4,000 psi unconfined compressive strength of concrete was provided by HDR and used in the models. The dimensions and reinforcement used in the model can be found in the output files included in Appendix C. The following tables provides the soil parameters from the LPILE analysis.

Table 12: LPILE Parameters for Drilled Shafts, Abutment 1

Depth[1] (Elevation) Interval (ft.)	P-Y Curve Soil	Effective Unit Weight (pcf)	Effective Internal Friction Angle (°)	Undrained Cohesion, c (psf)	Lateral Subgrade Modulus k [2] (pci)	Strain Factor, ε_{50} [2]
0 - 3.7 (2753 - 2749.3)	API Sand	125	38	0	Use Default Values	
3.7 - 30.7 (2749.3 - 2722.3)	API Sand	62	38	0	Use Default Values	
30.7 - 34.7 (2722.3 - 2718.3)	API Sand	52	38	0	Use Default Values	
34.7 - 39.7 (2718.3 - 2713.3)	Stiff Clay W/ Free Water	52	0	4000	Use Default Values	
39.7 - 73.2 (2713.3 - 2679.8)	API Sand	52	38	0	Use Default Values	

1. Depths from top of shaft.
2. Recent versions of LPILE provide estimated default values of k and E50 based on soil strength (where applicable), and these default values are recommended for the project.

Table 13: LPILE Parameters for Drilled Shafts, Abutment 2

Depth[1] (Elevation) Interval (ft.)	P-Y Curve Soil	Effective Unit Weight (pcf)	Effective Internal Friction Angle (°)	Undrained Cohesion, c (psf)	Lateral Subgrade Modulus k [2] (pci)	Strain Factor, ε_{50} [2]
0 - 18.7 (2751.2 - 2732.5)	API Sand	62	34	0	Use Default Values	
18.7 - 31.2 (2732.5 - 2720)	API Sand	72	38	0	Use Default Values	
31.2 - 69.2 (2720 - 2682)	API Sand	52	38	0	Use Default Values	
69.2 - 77.7 (2682 - 2673.5)	Stiff Clay W/ Free Water	47	0	4000	Use Default Values	

1. Depths from top of shaft.
2. Recent versions of LPILE provide estimated default values of k and E50 based on soil strength (where applicable), and these default values are recommended for the project.

Table 14: LPILE Parameters for Drilled Shafts, Piers

Depth[1] (Elevation) Interval (ft.)	P-Y Curve Soil	Effective Unit Weight (pcf)	Effective Internal Friction Angle (°)	Undrained Cohesion, c (psf)	Lateral Subgrade Modulus k [2] (pci)	Strain Factor, ε_{50} [2]
0 - 14.6 (2747.4 - 2732.8)	API Sand	72	34	0	Use Default Values	
14.6 - 23.1 (2732.8 - 2724.3)	API Sand	72	38	0	Use Default Values	
23.1 - 65.6 (2724.3 - 2681.8)	API Sand	52	38	0	Use Default Values	
65.6 - 70.6 (2681.8 - 2676.8)	Stiff Clay W/ Free Water	47	0	4000	Use Default Values	
70.6 - 89.1 (2676.8 - 2658.3)	API Sand	52	38	0	Use Default Values	

1. Depths from top of shaft.
2. Recent versions of LPILE provide estimated default values of k and E50 based on soil strength (where applicable), and these default values are recommended for the project.

A reduction in lateral resistance should be applied if a group of shafts has a center-to-center spacings of 5B or less, where B is the shaft diameter. The Structural Engineer should apply the appropriate P-multipliers presented in AASHTO LRFD Table 10.7.2.4-1 to account for the group effects that considers the shaft spacing, group size, and load direction.

Summary of Estimated Drilled Shaft Elevations

The following table shows the estimated drilled shaft design elevations and lengths for each abutment and pier. The values in this table are reported to the nearest whole integer. These elevations may change as design of the structure progresses. The project Structural Engineer should adjust each elevation, as appropriate, once the top of drilled shaft geometries have been finalized.

Table 15: Drilled Shaft Lengths (feet)

Location	Estimated Shaft Length	Top of Shaft Elevation [1]	Estimated Bottom of Shaft Elevation [2]	Estimated Minimum Bottom of Shaft for Lateral Resistance [3]
Abutment 1	67	2753.0	2686.0	2700
Abutment 2	67	2751.2	2684.2	2695
Pier 1	90	2748.0	2670	2677
Pier 2	90	2747.4	2657.4	2677

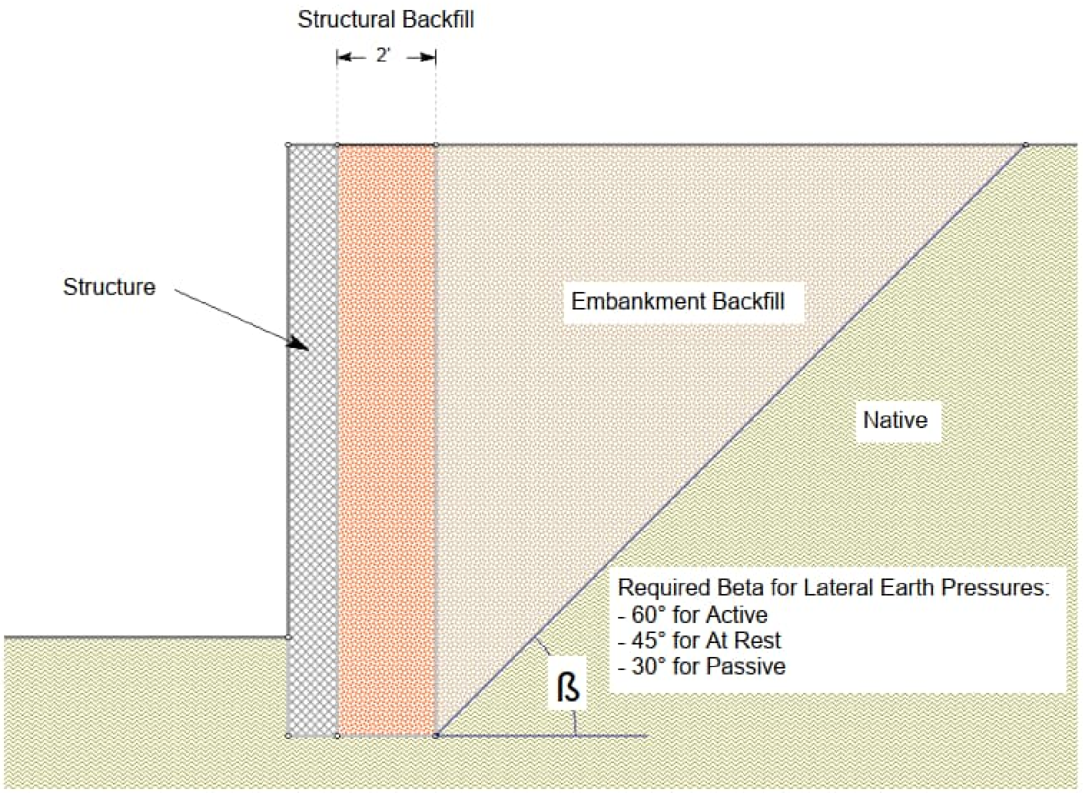
1. Values provides by HDR
2. Values estimated based on ultimate, unfactored axial loads provided by HDR.
3. Values based on lateral capacity analysis.

Note: All values are reported to the whole foot.

230.05.03 Lateral Pressures and Backfill

Unfactored lateral earth pressures are presented in Table 16 for compacted Granular Subbase or ¾-Inch Type A or B Aggregate for Untreated Base backfill. As indicated in the generalized diagram below, the zone of backfill should extend out horizontally at least two feet from the base of the foundation and upwards at an angle of 60 degrees from horizontal or flatter for the active values to apply, upwards at an angle 45 degrees from horizontal or flatter for the at-rest values to apply, and upwards at an angle of 30 degrees from horizontal or flatter for the passive values to apply. Unless temporary shoring is used, flatter slopes than those listed above may be required during construction for excavation safety. We understand the embankment in front of the walls will have a slope of 2(H):1(V) or flatter and consisting of Granular Subbase or ¾-Inch Type A or B Aggregate for Untreated Base. Granular Subbase should be used as structural backfill except where ¾-Inch Type A or B Aggregate for Untreated Base backfill specified.

Conceptual Limits for Wall Backfill
(Not For Construction)



Required Beta for Lateral Earth Pressures:
- 60° for Active
- 45° for At Rest
- 30° for Passive

- Structural Backfill - Excavation and backfill in accordance with Section 210 of ITD Standard Specifications
- Embankment Backfill - Excavation and backfill in accordance with Section 205 of ITD Standard Specifications
- Measurement of each item to be in accordance with ITD Standard Specifications
- The actual excavation backslope to be determined by the contractor, if necessary for safety

Figure 5: Conceptual Limits for Wall Backfill

Table 16: Lateral Earth Pressures

Parameter	Fully Drained Condition Above Groundwater[1]	Soil Below Groundwater Condition
Total Unit Weight, pcf	125	130
Friction Angle, Degrees	34	34

Parameter	Slope Above/Below Wall[2]	Pressure Coefficient	Equivalent Fluid Density (pcf)	
			Fully Drained Condition Above Groundwater[1, 3]	Soil Below Groundwater Condition[3, 4]
	Horizontal	0.28	35	81

Parameter	Slope Above/Below Wall [2]	Pressure Coefficient	Equivalent Fluid Density (pcf)	
			Fully Drained Condition Above Groundwater [1, 3]	Soil Below Groundwater Condition [3, 4]
Active Earth Pressure Condition	6.0(H):1(V)	0.29	36	82
	4.0(H):1(V)	0.31	39	83
	2.0(H):1(V)	0.41	51	90
At-Rest Earth Pressure Condition	Horizontal	0.44	55	92
	6.0(H):1(V)	0.51	64	97
	4.0(H):1(V)	0.55	69	100
	2.0(H):1(V)	0.64	80	106
Passive Earth Pressure Condition	Horizontal	3.54	442	302
	6.0(H):1(V)	3.29	412	285
	4.0(H):1(V)	3.07	384	270
	2.0(H):1(V)	1.92	240	192

1. To achieve and design on Fully Drained conditions, the recommendations in Section 230.05.05 should be followed.
2. Slopes reported in the table are above the wall for active and at-rest lateral earth condition, and below the wall for passive lateral earth condition.
3. These are ultimate values that assume compacted granular backfill with an estimated moist unit weight and an angle of internal friction as shown above.
4. For the active and at-rest earth pressures, the values presented for the soil-below-groundwater condition include water pressure. The passive earth pressure for the soil-below-groundwater condition does not include water pressure.

Lateral earth pressures on the abutment walls due to seismic shaking for active conditions (i.e., for yielding walls allowed to rotate) were estimated based on the Mononobe-Okabe method. Lateral earth pressures on the abutment walls due to seismic shaking for at-rest conditions (i.e., for non-yielding abutment walls restrained from rotation) were estimated based on the Wood (1973) method. If abutments will generally behave as non-yielding walls (i.e., at-rest conditions), a seismic equivalent fluid pressure of 10.8 pcf for backfill should be applied. For retaining walls that are free to rotate (i.e., active conditions), a seismic equivalent fluid pressure of 5.1 pcf for backfill should be applied. These values are based on horizontal backfill above the abutment walls. For active conditions, the seismic pressure resultant load should be applied ½H above the base of the wall and at 0.6H above the base of the wall for at-rest conditions. The seismic pressure resultants are in addition to the lateral earth pressures for static conditions in Table 16.

We anticipate the proposed walls may be constructed with backfill that is either horizontal or upward sloping. Permanent backfill slopes should be constructed no steeper than 2(horizontal):1(vertical). The unfactored lateral earth pressure values presented above only apply to the specified slope inclination.

Active earth pressures are applicable for an abutment wall that is free to rotate. The amount of movement relative to the wall height to develop active earth pressures is presented in the *LRFD Bridge Design Specifications* Table C3.11.1-1. At-rest earth pressures are appropriate for an abutment wall that is restrained at the top. We anticipate that the abutment walls will be rigid structures so the at-rest earth pressure condition will apply. We expect that wing walls will be structurally attached to the abutments so the at-rest earth pressure condition will also apply. However, we anticipate the cantilevered canal walls where not restrained from rotation by the bridge deck will be subject to active earth pressure conditions.

Some movement of the abutment wall would be required to mobilize the full passive pressure. Relative movements to develop passive resistance are provided in Table 3.11.1-1 of the *LRFD Bridge Design Specifications*. In accordance with Table 10.5.5.2.2-1 of the *LRFD Bridge Design Specifications*, the resistance factor for the passive earth pressure component of sliding resistance should be 0.50. As described in Section C10.6.3.4 of the *LRFD Bridge Design Specifications*, this resistance factor is based on the lateral foundation movement being less than what is needed to mobilize the full passive pressure. Passive pressures should not be used to resist the sliding of walls towards the canal or other downward slopes. The passive resistance should be neglected in the upper 2 feet of the backfill.

Lateral earth pressures should be adjusted for hydrostatic pressures, surcharge loads, sloping fill, live loads near the walls (including compaction equipment and traffic), and/or seismic loads as appropriate. The live load surcharge for vehicular loads is often modeled as an equivalent soil depth as presented in Tables 3.11.6.4.1-1 and 3.11.6.4.1-2 of the *LRFD Bridge Design Specifications*. The unit weight for the modeled equivalent soil depth should be at least 125 pcf.

Fill, debris, and loose soil should be removed before placing backfill behind abutment walls. ITD Class A compaction is recommended for backfill. Near the wall, wall backfill material should be compacted in accordance with Section 210.03.A of the *Standard Specifications for Highway Construction*.

230.05.04 Anchors

We do not anticipate that anchors will be used.

230.05.05 Drainage

Surface water runoff should be prevented from discharging or infiltrating behind or over the face of the structure, walls, or slopes. Surface water from the roadway should be collected and discharged to a safe location away from the structure and walls. Discharge areas should be protected with riprap underlain by a Riprap/Erosion Control Geotextile per Section 718.06 of the *Standard Specifications for Highway Construction*. For a discussion regarding erosion control, see Section 230.05.07 of this report.

As MSE walls will be constructed for the bridge approaches, surface drainage features should be incorporated into design to prevent salt-laden water from soaking into the MSE wall reinforced zones and/or sheet draining over the MSE wall faces. Such features could include paving the entire top surface up to all MSE wall faces, where applicable; and providing raised curbs and drain inlets to collect surface runoff and direct it away from MSE walls.

Northeast of the Abutment 2, a portion of the multi-use path will drain into or behind the reinforced zone of the MSE wall. We understand that the multi-use path will not be salted during winter weather conditions. However, Eckert Road will be treated for traction during winter weather conditions, and salting may be one of those treatments. Eckert Road will be sloped to drain away from this drainage area. Even with these measures, salt-laden water may drain into or behind the reinforced zone of the MSE wall. The wall designer for this MSE wall should select a corrosion resistance reinforcement and account for sacrificial thickness of the reinforcement, as needed.

The abutments should be designed to resist hydrostatic pressures. Walls should either be designed to resist hydrostatic pressures or should include a drainage layer extending to appropriate outlet locations to reduce the potential for hydrostatic pressure on the walls. The drainage layer should consist of drain rock composed of Drain Rock as defined in Section 711.01 Drain Rock of the *2025 Supplemental Specifications to the 2023 ITD Standard Specifications for Highway Construction*. The Drain Rock layer should be a minimum of 30 inches thick and should be separated from other soils with a Drainage Geotextile. The Drain Rock layer should extend vertically from the base of the structure to within 3 feet of the ground surface. Weep holes in the walls may also be used in conjunction with the drainage layer to reduce the potential for hydrostatic pressures. As an alternative to Drain Rock, manufactured drainage panels installed in accordance with the manufacturer’s recommendations may be used.

230.05.06 Embankments

New embankments fill associated with the project vary in height across the length of the structure. Embankment heights will range between about 25 feet above existing grade to meet existing grade at the project’s ends. Embankments should be constructed with granular borrow, Granular Subbase, or ¾-Inch Type A or B Aggregate for Untreated Base and have 2(horizontal):1(vertical) or flatter side slopes. Some sloughing and raveling of the soil slope faces may occur if soils are exposed to surface precipitation or runoff. To help reduce the potential for sloughing, erosion control measures, such as vegetation, mulching, or riprap described in Section 230.05.07 of this report, should be utilized. Class A compaction is recommended for construction of approach embankments. Prior to fill placement, existing undocumented fill soils, and disturbed soils should be removed from areas that will receive fill so that embankments are placed on undisturbed native. Embankment fill placed on slopes steeper than 3(horizontal):1(vertical) must be keyed in per Section 205.03.F in the *Standard Specifications for Highway Construction*. For estimating purposes, the depth of stripping is assumed to be 6 inches. The depth of topsoil stripping is likely deeper where trees or other mature vegetation exists. Settlement of the east and west approach embankments is estimated to be 3 inches or less. Due to the soil types encountered and based on test data from a nearby project, the majority of settlements (95 percent primary consolidation) are estimated to occur during or within approximately 1 month after construction.

Differential settlement may occur between the bridge and the approach fill, resulting in an abrupt grade transition felt by the traveling public. Use of approach slabs will help with this transition and potentially improve the ride quality.

MSE Walls

As previously described, Contractor-designed MSE (panel and welded wire basket) retaining walls will be constructed as part of this project. Backfill behind the reinforced zone of MSE walls should consist of Granular Subbase. Material within the reinforced zone of MSE walls should consist of sand and gravel meeting the requirements of the MSE wall special provisions. The Contractor designing the MSE walls should determine the specific lengths and spacing of the reinforcing elements and any special requirements for MSE wall materials. Class A compaction is recommended for wall backfill.

The base of the MSE walls should be founded in accordance with the recommendations presented in Section 11.10.2.2 of the LRFD Bridge Design Specifications, but no less than 2 feet below the adjacent grade (or scour where applicable). If any portion of these MSE walls is founded above a slope, a minimum 4-foot-wide bench should be established in front of the MSE wall in accordance with LRFD Bridge Design Specifications.

The following table presents design parameters for the walls.

Table 17: MSE Design Parameters

Material	Moist Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Nominal Bearing Capacity (psf)
Reinforced Backfill	*	*	*	N/A
Retained Soil	130	0	34	N/A

Material	Moist Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Nominal Bearing Capacity (psf)
Foundation Soil 1 – Undisturbed Medium Dense to Very Dense Native Granular Soils	125	0	34	See charts for Foundation Soil 1 below
Foundation Soil 2 – Existing Fill, Fine Grained Soils and Very Loose to Loose Granular Soils	115	0	28	See charts for Foundation Soil 2 below

* To be determined by the wall designer.

In accordance with Table 11.5.7-1 of the *LRFD Bridge Design Specifications*, a bearing resistance factors of 0.65 (strength limit state), 1.0 (service limit state) and 0.9 (extreme event limit state) should be used for MSE walls .

For walls founded on level ground and on Foundation Soil 1, the nominal bearing capacity (as a function of effective footing width) is shown in the figure below.

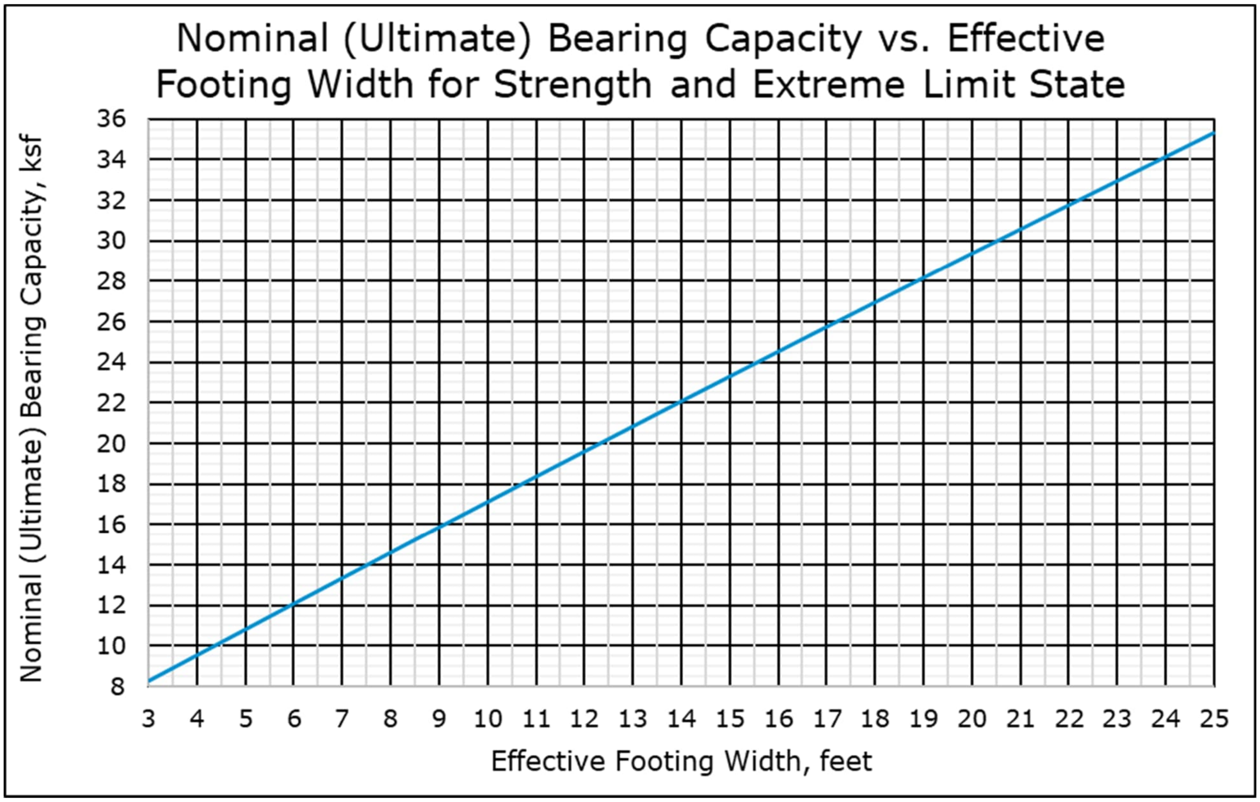


Figure 6: MSE Wall on Foundation Soil 1 on Level Ground - Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

For MSE walls founded on sloping ground up to 2(horizontal):1(vertical) and Foundation Soil 1, the nominal bearing capacity (as a function of effective footing width) is shown in the figure below.

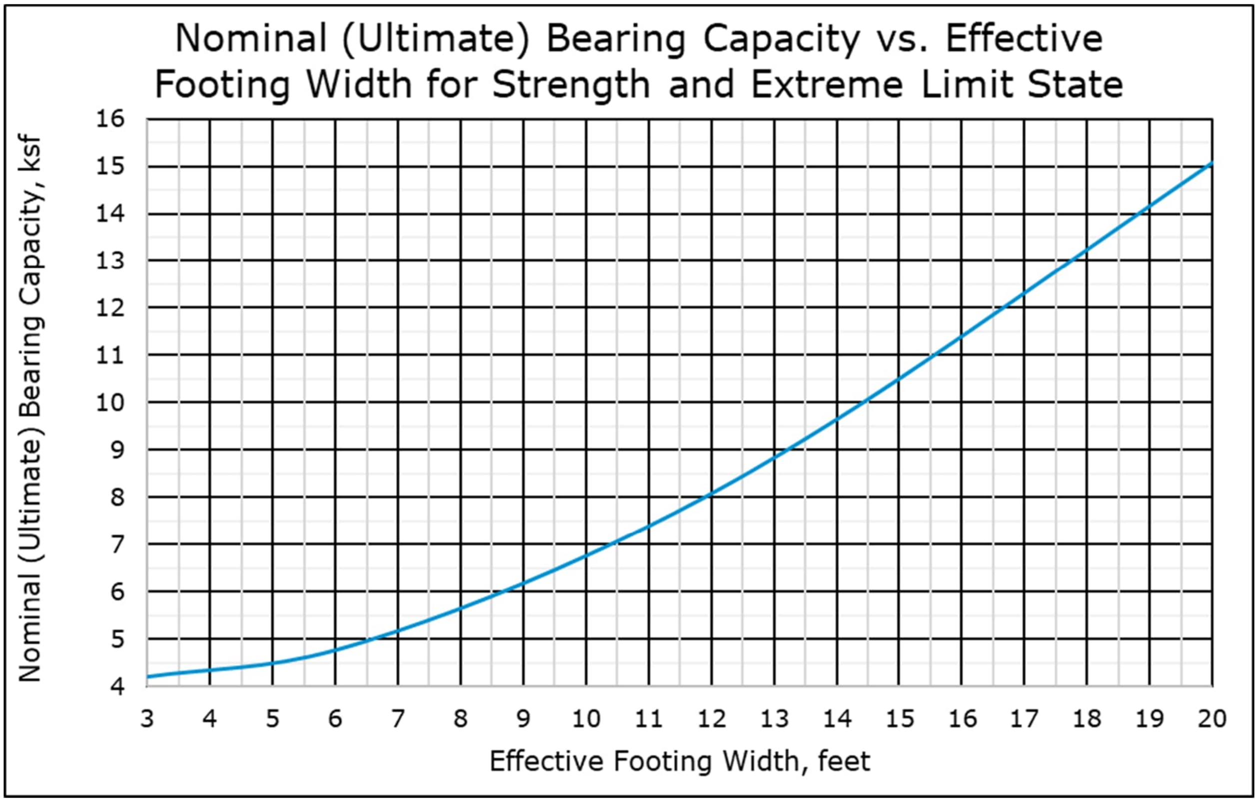


Figure 7: MSE Wall on Foundation Soil 1 on Sloping Ground up to 2:1- Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

For walls founded on level ground and Foundation Soil 2, the nominal bearing capacity (as a function of effective footing width) is shown in the figure below.

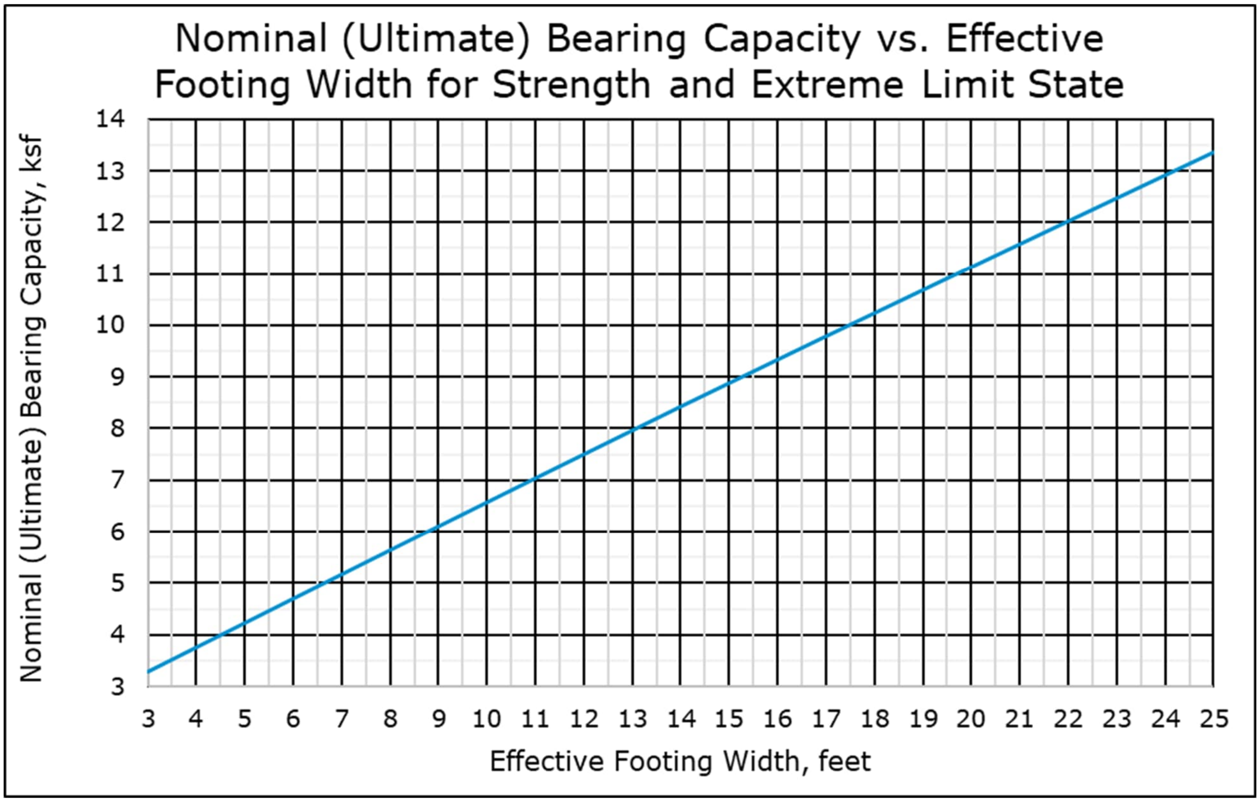


Figure 8: MSE Wall on Foundation Soil 2 on Level Ground - Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

For MSE walls founded on sloping ground up to 2(horizontal):1(vertical) and Foundation Soil 2, the nominal bearing capacity (as a function of effective footing width) is shown in the figure below.

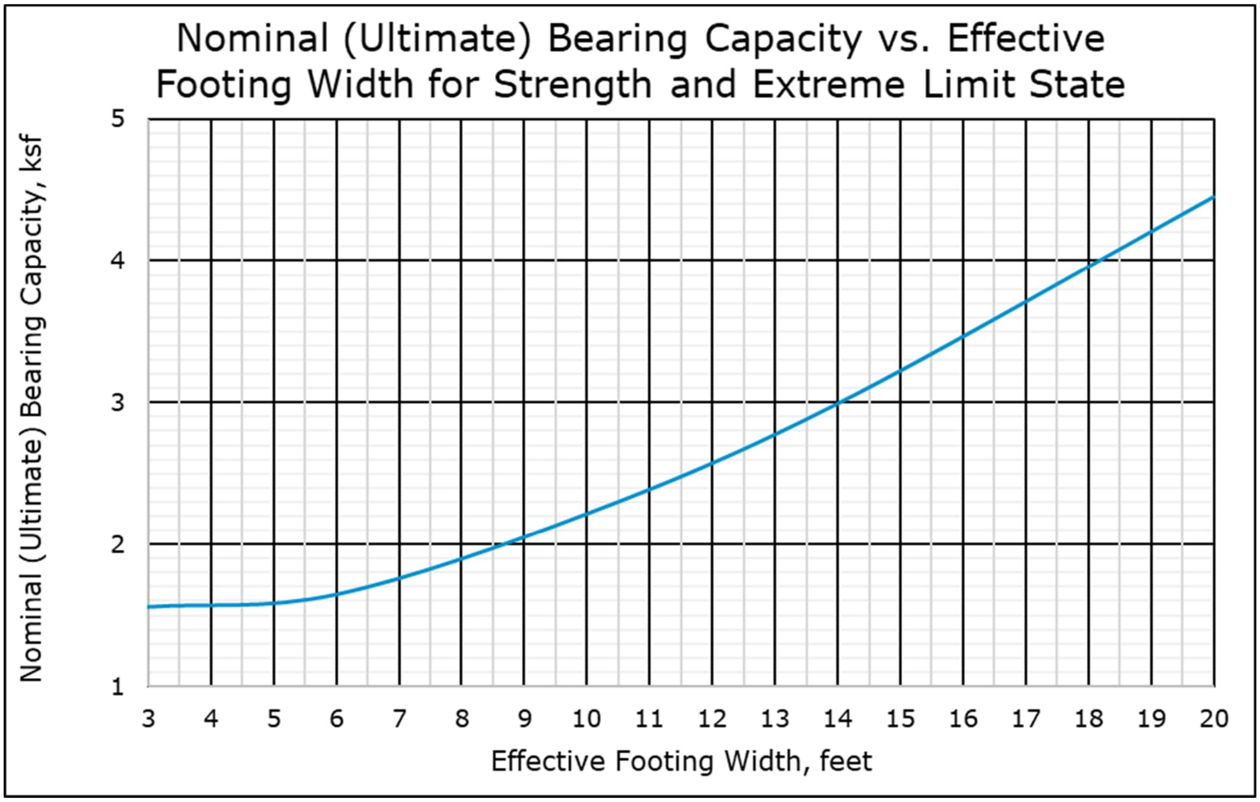


Figure 9: MSE Wall on Foundation Soil 2 on Sloping Ground up to 2:1 - Nominal (Ultimate, Unfactored) Bearing Capacity vs. Effective Footing Width

Based on the anticipated height of new fill required to construct and maximum MSE wall height up to about 27 feet included embedment, total settlement is expected to be approximately 3 inches or less. Due to the typically granular nature of the soils encountered in the borings, we estimate this settlement will occur quickly, as the embankments are constructed. As the height of some of the MSE walls will vary across the MSE wall’s length, the settlement will be differential across the lengths of these MSE walls. Settlement monitoring is not recommended for the MSE walls.

Analyses were performed to evaluate the global stability of the proposed walls. Our analyses are based on the assumption that the critical failure surfaces from slope stability analyses do not extend through the reinforced zones of an MSE wall. The wall designer should check this assumption as part of the design by modeling the actual wall design in the stability analysis, including the specific spacing, lengths, and strengths of the MSE reinforcement.

The results of our global stability analysis (static and pseudo-static) are attached. The walls were modeled with 24 inches of embedment and horizontal fill behind the walls. Based on our analysis, the reinforcement for the Abutment 1 MSE walls (about station 410+29 to 410+59) should have a minimum length equal to 1.0 times the wall height (including the embedment depth) or eight feet, whichever is greater. For the Abutment 2 MSE Walls and Moment Slab MSE walls (about station 414+25 to 417+50), the reinforcement should have a minimum length equal to 0.8 times the wall height (including the embedment depth) or eight feet, whichever is greater. The actual lengths of the reinforcement should be determined by the Contractor’s wall designer. Based on our global stability analyses, we estimate the proposed walls will have factors of safety of 1.5 or greater for static conditions and 1.3 or greater for the pseudo-static condition. If the walls are constructed with slopes behind the walls, we should be notified to revise these recommendations.

230.05.07 Erosion Control

Erosion protection should be provided, as needed, to protect the embankments and structure foundations from erosion. Design of erosion protection and scour, including riprap, will be completed by HDR. Riprap should be sized for the appropriate hydraulic conditions, per the approved hydraulics report. Any ground surface disturbed during construction of the bridge and its foundation should be restored and erosion protection provided. As previously described, potential significant erosion may occur and is expected to vary across the project site. Roadway runoff should be collected and discharged away from bridges and embankment slopes to reduce the potential of erosion of the fill slopes. We understand that runoff from a portion of the multi-use path northeast of Abutment 2 will drain into an embankment supported by an MSE wall. Erosion control measures, such as vegetation or mulching, should be taken in accordance with the ITD Best Management Practices (BMP) Manual to protect the slopes and drainage areas from the effects of precipitation and surface flows. Discharge areas and slopes within the canal should be protected with riprap underlain by a Riprap/Erosion Control Geotextile per Section 718.06 of the *Standard Specifications for Highway Construction.*

230.05.08 Seismic Design

Seismic ground motion parameters were developed for the project based on Section 630 of the *Materials Manual*. The seismic parameters were obtained from the USGS Seismic Design Web Services for the 2009 AASHTO Guide Specification. These values are presented in the following table and are for an earthquake having a probability of exceedance of 7 percent in 75 years (approximately 1000-year return period).

Table 18: Seismic Ground Motion Parameters

Ground Motion Parameter	Value
Site Soil Classification [1]	D
PGA, Peak Ground Acceleration Coefficient on Rock (Site Class B)	0.086 g
S_s, Horizontal Response Spectral Acceleration Coefficient at 0.2-sec Period on Rock (Site Class B)	0.203 g
S_1, Horizontal Response Spectral Acceleration Coefficient at 1.0-sec Period on Rock (Site Class B)	0.07 g
F_{PGA}, Site Factor for PGA,	1.6
F_A, Site Factor for S_s	1.6
F_V, Site Factor for S_1	2.4
A_S, Modified PGA for Project Site (Site Class D)	0.138 g
S_{DS}, Modified Ss for Project Site (Site Class D)	0.325 g
S_{D1}, Modified S1 for Project Site (Site Class D)	0.168 g
Seismic Performance Zone [2]	2

1. The current version of the Materials Manual is based on the 9th Edition of the LRFD Bridge Design Specifications. Therefore, the Site Soil Classification is based on the 9th Edition of the LRFD Bridge Design Specifications.
2. Based on Table 3.10.6-1 of the LRFD Bridge Design Specifications and the S_{D1} presented above.

Seismic design of the proposed bridge structure should be based on Site Class D. Based on Figure 630.05.01.1 of the *Materials Manual*, the nearest active fault to the site is mapped approximately 20 miles to the north-northeast. Therefore, the risk of fault rupture at the site is low.

A liquefaction analysis was performed using Youd and Idriss (2001). The analysis was based on the subsurface conditions encountered at the site, a site-modified peak ground acceleration (A_s) of 0.121g, and an earthquake moment magnitude (M_w) of 6.24. The earthquake moment magnitude was based on a United States Geological Survey deaggregation analysis for an earthquake with a return period of approximately 1,000 years. The analysis indicates liquefaction triggering is not likely at the site and the risk of liquefaction is low. Lateral spread is not considered to be a hazard at this site due to the low potential for liquefaction.

230.05.09 Construction

We recommend that construction of the proposed Boise River Bridge, Greenbelt Undercrossing, and associated improvements occur when the flow in the river is lowest, generally during the fall to winter, after the irrigation season. Depending on the time of year that construction occurs, the depth of excavations, and the proximity of these excavations to the river, groundwater may be encountered during construction. If construction occurs soon after water level in the river decreases, elevated groundwater levels may be encountered due to bank storage and a seasonally elevated perched groundwater level. The Contractor for expect to encounter groundwater in excavations. Where groundwater is encountered during construction, a positive means of construction dewatering will be required to complete the excavations and placement of the bridge structures and walls and backfill in the dry. Fill and concrete should not be placed in standing water.

Soils are likely to be wet. The Contractor should anticipate soft and/or wet soils, particularly within the excavations for the proposed structures. Wet soils will be prone to rutting or pumping under construction machinery. Soils that rut, pump, or are too wet to be compacted are not suitable for support of the proposed structure or the wing walls and should be repaired or excavated and replaced in accordance with Section 205.03.E of the *Standard Specifications for Highway Construction*. The success in drying the wet soils will depend on the weather, and in the late fall or winter months when this construction is most likely to occur, weather conditions can be wet.

The Contractor is responsible to maintain stable excavations for construction of the drilled shafts. This includes the side walls and drilled shaft bottoms. Permanent casing should be used to facilitate construction in the river. Measures should be taken to ensure shaft stability, possibly including temporary casing and synthetic slurry during excavation. Special care will be required during construction using these methods to ensure high quality shafts. The bottom of the shaft excavations should be cleaned of loose materials so that the concrete is placed on undisturbed soils.

We recommend cross hole sonic logging (CSL) and thermal integrity profiling (TIP) be performed on the drilled shafts during construction to evaluate the integrity of the shaft concrete and identify if any anomalies are present in the shaft. Since the shaft is designed for both end bearing and side resistance, a shaft inspection device (SID) should be used to inspect the shaft bottom during construction.

The contractor should anticipate encountering cobbles and potentially boulders in layers of dense to very dense gravels. Temporary shoring, drilled shafts, excavation, and other construction activities will likely be impacted by these materials. When considering concrete quantities for the drilled shafts, over-widening of the drill holes should be expected during excavation, particularly in soils containing gravel, cobbles and boulders. The contractor should anticipate the silty sand, sandy silts, and sands to adhere to temporary casing should the casing be left in the excavation for extended periods of time. Experience in the Treasure Valley has shown that temporary casing may become stuck if left in for extended periods of time.

Overhead power lines are located on the south side of the existing structure. These will need to be moved by arrangement with Idaho Power to construction portions of the project. Conflicts with buried utilities should be determined so relocation can be coordinated with the utility owners and carried out, as necessary.

Construction site safety is solely the responsibility of the Contractor who selects and directs the means, methods, and sequencing of the construction operations. It is the responsibility of the Contractor to provide safe working conditions related to project excavations. The Contractor must be familiar with, and comply with all applicable federal, state, and local regulations, including OSHA regulations for excavation. The Contractor is responsible for designing and constructing stable, temporary excavations as required to maintain stability of the excavation sides and bottom, and for protecting existing facilities/utilities. Contractor designed temporary shoring/retaining structures must be designed by a professional engineer licensed in the State of Idaho.

230.06 Appendices

The appendices contain a site location map, exploration plan, boring logs, laboratory test data, results of axial and lateral pile analyses, and other supporting information.

230.07 Foundation Investigation Plat

HDR will prepare the Foundation Investigation Plat with geotechnical information provided by Terracon.

230.08 Current Specifications and Minimum Testing Requirements

This Geotechnical Engineering Report is based on the following ITD documents:

- 2023 *Standard Specifications for Highway Construction*
- 2026 *Supplemental Specifications for the 2023 Idaho Standard Specifications for Highway Construction*
- 2019 *Quality Assurance Manual*
- 2020 *Materials Manual*

230.09 Special Provision Items

The following new specifications and notes to contractor should be incorporated into the project specifications.

SPECIAL PROVISIONS

S501-17A MSE RETAINING WALL

S501-30A SP BRIDGE, DRILLED SHAFT (Revised by Design Team)

Just prior to PS&E, obtain the Special Provision for Mechanically Stabilized Earth (MSE) Retaining Walls from the State Geotechnical Engineer at ITD Headquarters Anthony Beauchamp, phone number 208-334-8554 or email anthony.beauchamp@itd.idaho.gov or Tyler Coy phone number 208-334-8436 or email tyler.coy@itd.idaho.gov.

NOTES TO CONTRACTOR

The following Note to Contractor should be included in the project specifications:

> SOFT SUBGRADE SOILS. Anticipate soft, moisture-sensitive subgrade soils during construction. These soils may rut or pump under construction equipment, particularly if they become wetter than their optimum moisture content during construction.
>
> Protect these soils during all construction activities. Determine and implement the methods necessary to meet this requirement. No separate measurement or payment will be made for any excavation or replacement of excavated material below subgrade elevation made necessary due to construction activities.

230.10 References

American Association of State Highway and Transportation Officials, *AASHTO LRFD Bridge Design Specifications*, 10th Edition, 2024.

Idaho Transportation Department, *Bridge Design LRFD Manual*, December 2024.

Idaho Transportation Department, *Materials Manual*, October 2020.

Idaho Transportation Department, *Standard Specifications for Highway Construction*, 2023.

Idaho Transportation Department, *2026 Supplemental Specifications for the 2023 Idaho Standard Specifications for Highway Construction*, 2025.

LaCroix, Y. and Horn, H., *Direct Determination and Indirect Evaluation of Relative Density and Its Use on Earthwork Construction Projects*, In Evaluation of Relative Density and Its Role in Geotechnical Projects Involving Cohesionless Soils, ASTM Special Technical Publication 523, pp. 251-280, 1973.

Wood, J.H., *Earthquake-Induced Soil Pressures on Structures*, Report No. EERL 73-05. Earthquake Engineering Research Lab, California Institute of Technology, Pasadena, CA, 1973.

Youd, T.L., and Idriss, I.M., *Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on the Evaluation of Liquefaction Resistance of Soils,* Journal of Geotechnical and Geoenvironmental Engineering, Vol. 127, No. 4., 2001

General Comments

The analysis and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between the exploration locations, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. If changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

Contents:

- Site Location Map
- Exploration Plan
- Foundation Investigation Plat
- Boring Logs
- Photography Log

Site Location Map

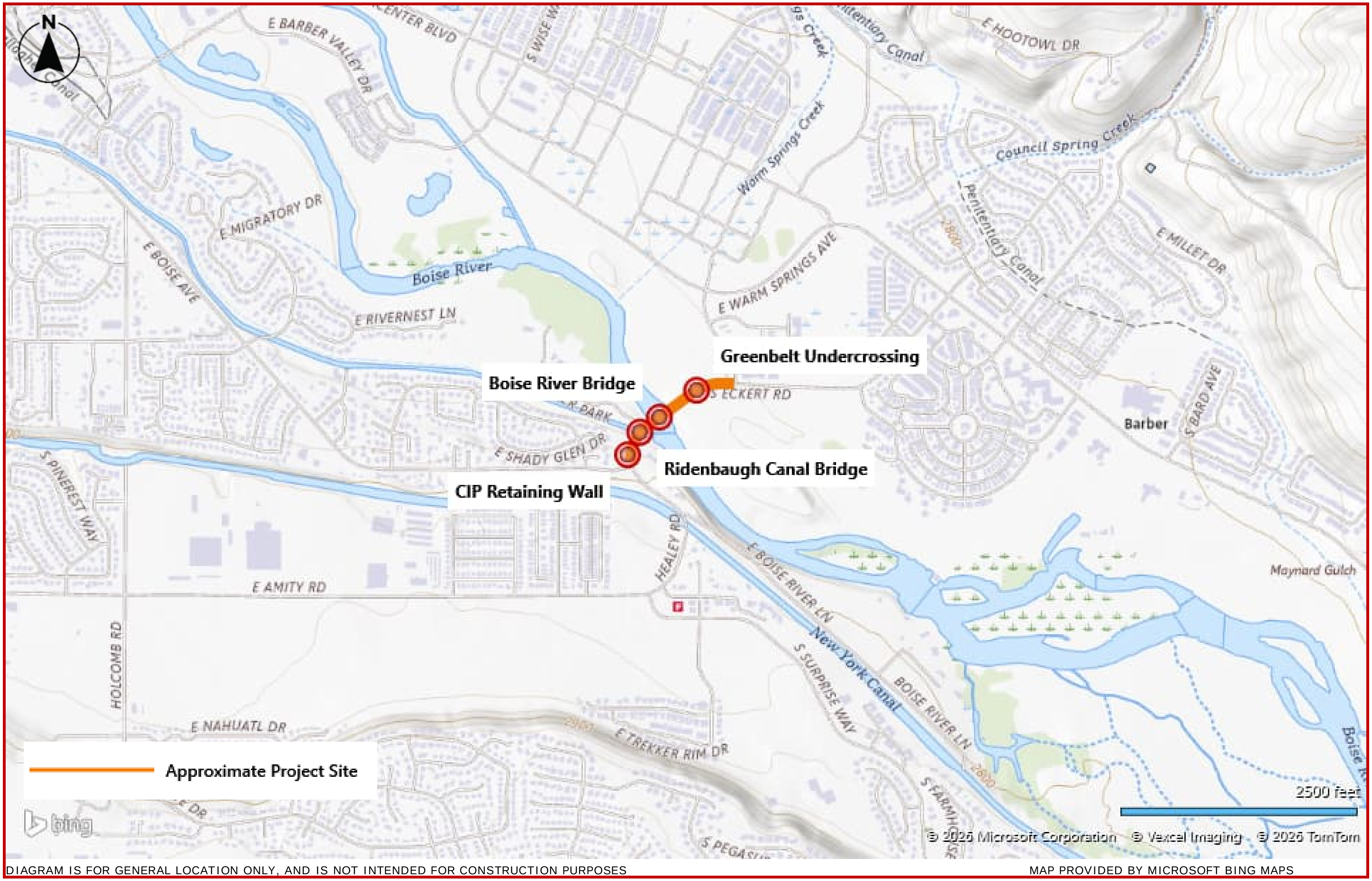


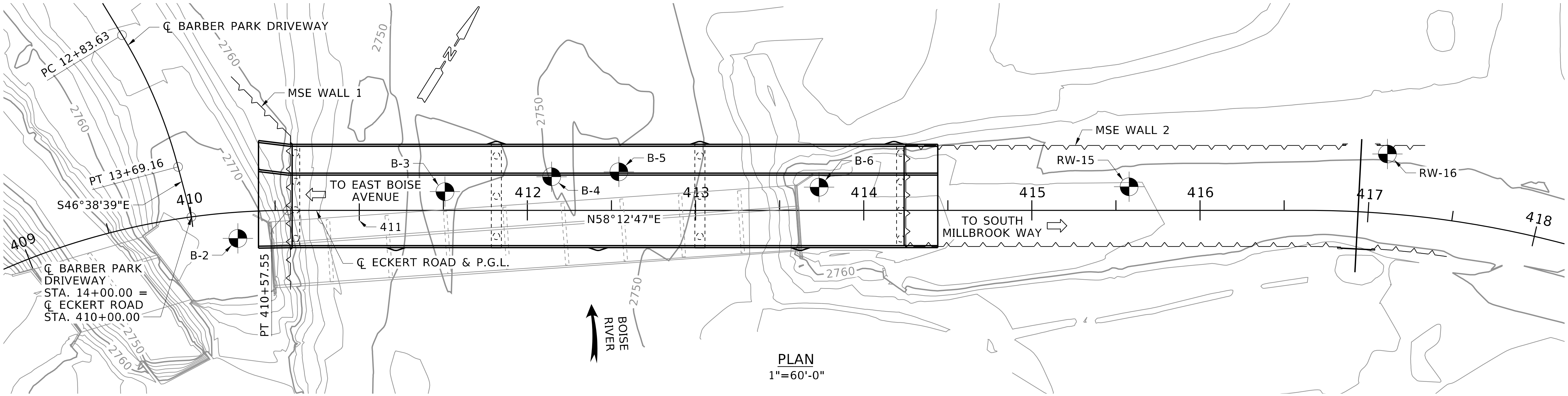
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

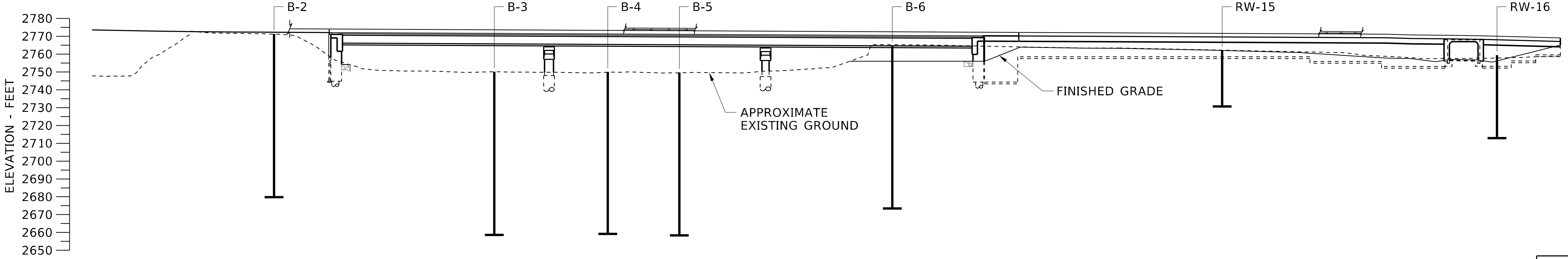
Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS



PLAN
1"=60'-0"



ELEVATION
1"=60'-0"

ORIGINAL STORED AT: ITD BRIDGE SECTION - Boise, Idaho

REVISIONS			
NO.	DATE	BY	DESCRIPTION
△			
△			
△			
△			
△			

DESIGNED

DESIGN CHECKED

DETAILED
S. WALIMAA

DWG. CHECKED
L. MARSH

CORRECTIONS

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME
DX\prjXXXXX\ProjDev\Bridge\Plans
12811 brFI 001.dgn

DRAWING DATE:
JUNE 2026

ENGLISH

FOUNDATION INVESTIGATION - SHEET 1

364' PRESTRESSED CONCRETE GIRDER BRIDGE
ECKERT ROAD OVER BOISE RIVER
ECKERT ROAD STA. 412+42.06

BRIDGE PLANS

BRIDGE KEY NO.
12811

COUNTY
ADA

ACHD NO.
2147

BRIDGE DWG. NO.
18582

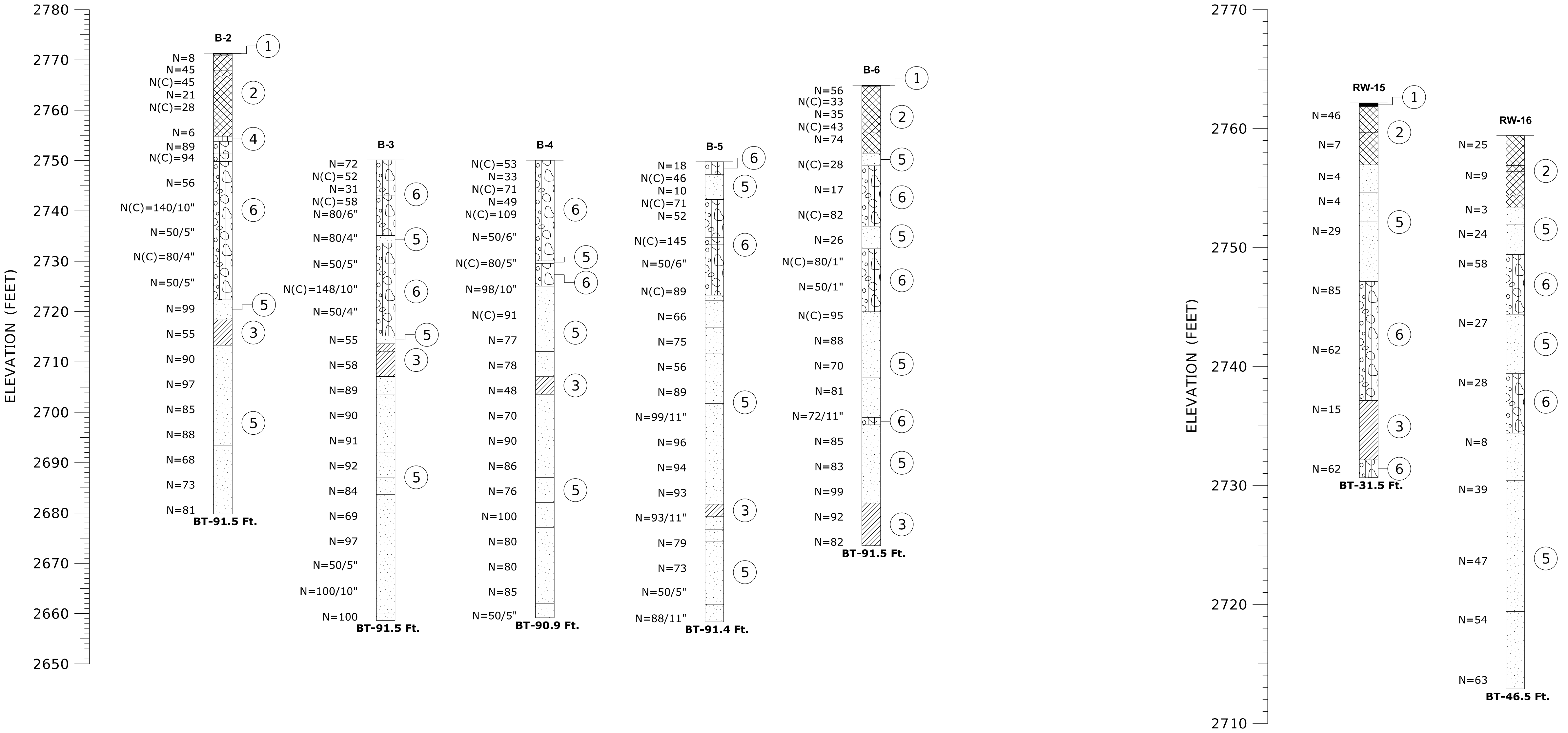
SHEET
5 OF 62

ORIGINAL SIGNED BY:

PRELIMINARY
NOT APPROVED FOR CONSTRUCTION

18343
LUCAS JASON MARSH

DATE SIGNED: DATE



BORING LOGS

LEGEND

①	■	ASPHALT
②	▩	FILL CONSISTING OF SILT, SILT WITH GRAVEL, GRAVEL WITH SILT AND SAND, SILTY GRAVEL WITH SAND, GRAVEL WITH SAND, SILTY SAND, CLAYEY SAND, CLAYEY SAND WITH GRAVEL
③	▨	SANDY FAT CLAY, SANDY LEAN CLAY, LEAN CLAY, LEAN CLAY WITH SAND, SANDY SILTY CLAY
④	▥	SANDY SILT
⑤	□	SILTY SAND, SAND WITH SILT, SAND, SAND WITH SILT AND GRAVEL, CLAYEY SAND, SAND WITH GRAVEL, CLAYEY SAND WITH GRAVEL
⑥	▦	GRAVEL WITH SILT AND SAND, GRAVEL WITH SAND, SILTY GRAVEL WITH SAND. COBBLES AND BOULDERS WERE ENCOUNTERED IN PORTIONS OF THIS LAYER.

NOTES

1. N - BLOWS OF A 140 LB. HAMMER FALLING 30" TO DRIVE A 2" O.D. STANDARD SPLIT SPOON PENETROMETER A DISTANCE OF 1.0' OR THE DISTANCE SHOWN.
2. N(C) - BLOWS OF A 140 LB. HAMMER FALLING 30" TO A DRIVE A 3" O.D. SPLIT BARREL "CALIFORNIA" SAMPLER A DISTANCE OF 1.0' OR THE DISTANCE SHOWN.
3. STRATIFICATION BOUNDARIES REPRESENT THE APPROXIMATE DEPTHS OF CHANGES IN SOIL TYPES. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL. CLASSIFICATION OF INTERVALS BETWEEN SAMPLES WAS INFERRED BASED ON OBSERVATIONS OF THE DRILL RIG AND SOIL CUTTINGS.
4. GROUNDWATER LEVELS SHOULD BE EXPECTED TO FLUCTUATE WITH TIME.
5. THE GEOTECHNICAL ENGINEERING REPORT AND OTHER INFORMATION RELATED TO THE FOUNDATION INVESTIGATION FOR THIS PROJECT ARE AVAILABLE WITH ACHD.

I, LUCAS J. MARSH HAVE REVIEWED THE GEOTECHNICAL INFORMATION ON THIS DRAWING AND FIND IT TO BE IN ACCORDANCE WITH THE GEOTECHNICAL ENGINEERING REPORT PREPARED FOR THE PROJECT BY TERRACON CONSULTANTS, INC.

ORIGINAL SIGNED BY:

18343
LUCAS JASON MARSH

PRELIMINARY
NOT APPROVED FOR CONSTRUCTION

DATE SIGNED: DATE

ORIGINAL STORED AT: ITD BRIDGE SECTION - Boise, Idaho

REVISIONS			
NO.	DATE	BY	DESCRIPTION
△			
△			
△			
△			
△			

DESIGNED
DESIGN CHECKED
DETAILED
S. WALIMAA
DWG. CHECKED
L. MARSH
CORRECTIONS

SCALES SHOWN ARE FOR 11" X 17" PRINTS ONLY

CADD FILE NAME
DX\prjXXXXX\ProjDev\Bridge\Plans
12811 brFI 002.dgn

DRAWING DATE:
JUNE 2026

ACHD
Terracon

ENGLISH

FOUNDATION INVESTIGATION - SHEET 2

364' PRESTRESSED CONCRETE GIRDER BRIDGE
ECKERT ROAD OVER BOISE RIVER
ECKERT ROAD STA. 412+42.06

BRIDGE PLANS
BRIDGE KEY NO.
12811
COUNTY
ADA
ACHD NO.
2147
BRIDGE DWG. NO.
18582
SHEET
5A OF 62

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 43.5654° Longitude: -116.1328°

Depth (Ft.) Elevation: 2771.3 (Ft.)

Depth (Ft.)	Description	Elevation
0.2	**ASPHALT**, approximately 2-1/2" thick	2771.1
0.5	**FILL - POORLY GRADED GRAVEL WITH SILT AND SAND**, brown	2770.8
3.5	**FILL - SILTY GRAVEL WITH SAND**, brown and gray	2767.8
4.5	**FILL - POORLY GRADED GRAVEL WITH SILT AND SAND**, brown and gray	2766.8
16.5	**FILL - SILTY GRAVEL WITH SAND**, with cobbles, grayish brown and gray	2754.8
17.5	**SANDY SILT (ML)**, brown	2753.8
20.0	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, light tan and gray, very dense	2751.3
21.5	**WELL GRADED GRAVEL WITH SAND (GW)**, brown and gray, very dense	2749.8
49.0	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles and boulders, with clay lenses, light tan and gray, very dense	2722.3
53.0	**SILTY SAND (SM)**, with gravel lenses, light orangish brown and tan, very dense, interbedded with layers of sandy silt	2718.3
	SANDY FAT CLAY (CH), brown, hard	

Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
0.9	4-5-3 N=8			
0.9	6-10-35 N=45			
1.2	11-20-25			
1	8-8-13 N=21			
1.1	11-17-19			
0.8	7-3-3 N=6	6.5		14.8
1.3				
1.2	18-39-50 N=89			
0.9	23-31-63	2.8		3.6
1.1	13-26-30 N=56			
1	32-60-80/4"	6.9		3.2
0.9	28-50/5"			
0.8	29-80/4"			
0.5	50/5"			
1.4	23-49-50 N=99			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.
Elevation Reference: Elevations interpreted from survey data.

Notes

Water Level Observations

▽ 22 feet 5 minutes after completion of drilling
▼ 21.9 feet 10 minutes after completion of drilling

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite
Surface Capped with Asphalt

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Logged by
JL

Boring Started
02-18-2025

Boring Completed
02-19-2025

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 43.5654° Longitude: -116.1328°

Elevation: 2771.3 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
			SANDY FAT CLAY (CH), brown, hard *(continued)*				☒	1.5	19-26-29 N=55	26.3	50-22-28	68.1
		58.0		2713.3								
			POORLY GRADED SAND WITH SILT (SP-SM), light brown to tan, very dense, interbedded with layers of silty sand		60		☒	1.5	25-40-50 N=90			
					65		☒	1.4	25-47-50 N=97			
					70		☒	1.2	20-38-47 N=85			
					75		☒	1.3	21-39-49 N=88			
		78.0		2693.3								
			POORLY GRADED SAND (SP), light brown, very dense		80		☒	1.2	33-34-34 N=68			
					85		☒	1.3	15-36-37 N=73			
					90		☒	1.2	26-39-42 N=81			
		91.5		2679.8								
			Boring Terminated at 91.5 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations

▽ 22 feet 5 minutes after completion of drilling

▼ 21.9 feet 10 minutes after completion of drilling

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

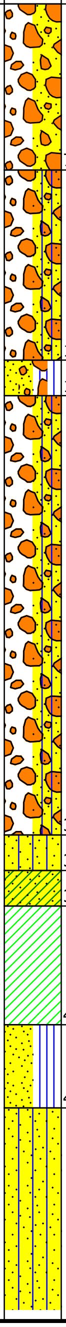
Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite
Surface Capped with Asphalt

Logged by
JL

Boring Started
02-18-2025

Boring Completed
02-19-2025

Boring Log No. B-3



Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 43.5656° Longitude: -116.1324° Depth (Ft.) Elevation: 2750.1 (Ft.)	Depth (Ft.)	Water Level Observations ▽	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		POORLY GRADED GRAVEL WITH SAND (GP), with cobbles and boulders, brown and gray, medium dense to very dense, boulders at surface in vicinity of boring				0.9	9-22-50 N=72			
						1.3	13-27-25			
			5			0.9	23-17-14 N=31			
		7.0 2743.1 **POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, with cobbles and boulders, brown and gray, dense to very dense, lenses of clay				0.9	14-30-28	12.3		9.9
			10			1.1	30-48-32 N=80			
		15.0 2735.1 **POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles and boulders, brown, very dense	15			1	30-80/6"	10.6		5.7
		16.5 2733.6 **POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, with cobbles and boulders, brown and gray, very dense								
			20			0.5	50/5"			
			25			1.3	37-68-80/4"			
			30			0.3	50/4"			
		35.0 2715.1 **SILTY SAND (SM)**, brown, very dense	35			1.5	9-18-37 N=55	29.3	41-29-12	31.9
		36.5 2713.6 **SANDY LEAN CLAY (CL)**, brown, interbedded with layers of silty sand, trace gravel								
		38.0 2712.1 **LEAN CLAY (CL)**, brown, hard	40			1.5	17-25-33 N=58			
		43.0 2707.1 **POORLY GRADED SAND WITH SILT (SP-SM)**, tan, very dense	45			1.5	27-44-45 N=89			
		46.5 2703.6 **SILTY SAND (SM)**, tan, very dense	50			1.5	27-40-50 N=90			
		zones of induration	55							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ Boring completed in the Boise River

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Logged by
JL

Boring Started
02-27-2025

Boring Completed
02-28-2025

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 43.5656° Longitude: -116.1324°

Depth (Ft.) Elevation: 2750.1 (Ft.)

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		SILTY SAND (SM), tan, very dense *(continued)*			☒	1.5	28-41-50 N=91			
		58.0 — 2692.1								
		POORLY GRADED SAND WITH SILT (SP-SM), light brown, very dense	60		☒	1.3	27-47-45 N=92			
		63.0 — 2687.1								
		CLAYEY SAND (SC), with clay lenses, tan, very dense	65		☒	1	27-34-50 N=84	15.9		23.6
		66.5 — 2683.6								
		POORLY GRADED SAND WITH SILT (SP-SM), tan to light brown, very dense	70		☒	1.2	25-34-35 N=69			
			75		☒	1.2	31-47-50 N=97			
			80		☒	1	40-50/5"			
			85		☒	1.1	42-50-50/4"			
		90.0 — 2660.1								
		SILTY SAND (SM), light brown, very dense	90		☒	1.2	36-50-50 N=100			
		91.5 — 2658.6								
		Boring Terminated at 91.5 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ Boring completed in the Boise River

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Logged by
JL

Boring Started
02-27-2025

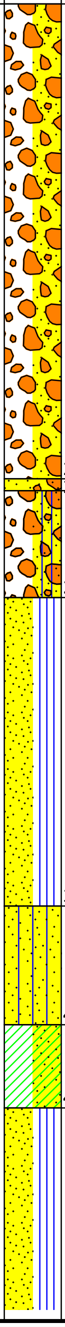
Boring Completed
02-28-2025

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 43.5657° Longitude: -116.1322°

Elevation: 2750.1 (Ft.)



Depth (Ft.)	Material Description	Elevation (Ft.)
	POORLY GRADED GRAVEL WITH SAND (GP), with cobbles, brown and gray, medium dense to very dense, boulders at surface in vicinity of boring	
20.0	**POORLY GRADED SAND WITH GRAVEL (SP)**, light brown and gray, very dense	2730.1
20.5	**POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, with cobbles, light brown and gray, very dense	2729.6
25.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, light brown, dense to very dense	2725.1
38.0	**SILTY SAND (SM)**, brown, very dense	2712.1
43.0	**LEAN CLAY WITH SAND (CL)**, tan, hard	2707.1
46.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, with lenses of clayey sand, light brown, very dense	2703.6

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
			1	8-31-22			
			1.3	2-8-25 N=33			
5			1	66-48-23			
			1.2	16-22-27 N=49			
10			1.1	32-78-31	8.2		4.1
15			0.5	50/6"	10.3		
20			1	52-80/5"			
25			1.3	26-48-50/4"	14.2		6.5
30			1.5	24-40-51			
35			1.5	24-37-40 N=77			
40			1.4	19-32-46 N=78			
45			1.5	15-21-27 N=48	28.1	42-25-17	71.8
50			1.5	26-37-33 N=70			
55							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ Boring completed in the Boise River

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Logged by
JL

Boring Started
02-25-2025

Boring Completed
02-26-2025

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 43.5657° Longitude: -116.1322°

Model Layer	Graphic Log	Depth (Ft.) / Description / Elevation: 2750.1 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		POORLY GRADED SAND WITH SILT (SP-SM), with lenses of clayey sand, light brown, very dense *(continued)*			☒	1.5	28-40-50 N=90			
			60		☒	1	30-42-44 N=86			
		63.0 2687.1								
		SILTY SAND (SM), brown, very dense	65		☒	1.5	26-31-45 N=76	25.4		19.6
		68.0 2682.1								
		CLAYEY SAND (SC), tan, very dense, trace gravel	70		☒	1.4	31-50-50 N=100			
		73.0 2677.1								
		POORLY GRADED SAND (SP), light tan, very dense	75		☒	1.2	26-40-40 N=80			
			80		☒	1.2	27-37-43 N=80			
		trace gravel, light orange and tan	85		☒	1.3	38-35-50 N=85			
		88.0 2662.1								
		POORLY GRADED SAND WITH GRAVEL (SP), light orange and light grayish tan								
		90.9 2659.2	90		☒	0.9	48-50/5"			
		Boring Terminated at 90.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Notes

Water Level Observations
▽ Boring completed in the Boise River

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Logged by
JL

Boring Started
02-25-2025

Boring Completed
02-26-2025

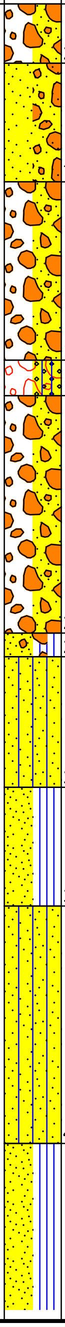
Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. B-5

Location: See Exploration Plan

Latitude: 43.5658° Longitude: -116.1321°

Elevation: 2749.8 (Ft.)



Depth (Ft.)	Description	Elevation (Ft.)
2.5	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, brown and gray, medium dense, boulders at surface in vicinity of boring	2747.3
7.5	**POORLY GRADED SAND WITH GRAVEL (SP)**, with cobbles, brown and gray, medium dense	2742.3
15.0	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, brown and gray, dense to very dense	2734.8
16.5	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**, brown and gray, very dense	2733.3
26.5	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, brown and gray, very dense	2723.3
27.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, brown	2722.3
33.0	**SILTY SAND (SM)**, light brown, dense	2716.8
38.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, tan, very dense	2711.8
48.0	**SILTY SAND (SM)**, with silt lenses, tan, very dense	2701.8
	POORLY GRADED SAND WITH SILT (SP-SM), light brown, very dense	

Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	7-11-7 N=18			
0.8	19-19-27	16.0		1.7
0.9	8-4-6 N=10			
1.1	18-23-48			
1.2	20-26-26 N=52			
1.3	42-65-80	7.3		5.6
0.5	50/6"			
1.5	37-41-48			
1.4	17-24-42 N=66			
1.4	23-33-42 N=75	20.9		10.3
1.5	15-23-33 N=56			
1.5	19-43-46 N=89	26.9	NP	48.1
1.4	28-49-50/5"			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ Boring completed in the Boise River

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Logged by
JL

Boring Started
02-20-2025

Boring Completed
02-21-2025

Boring Log No. B-5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 43.5658° Longitude: -116.1321° Depth (Ft.) Elevation: 2749.8 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		POORLY GRADED SAND WITH SILT (SP-SM), light brown, very dense *(continued)*			☒	1.5	28-50-46 N=96	23.9		10.9
			60		☒	1.5	27-44-50 N=94			
			65		☒	1.4	30-43-50 N=93			
		68.0 2681.8								
		LEAN CLAY (CL), tan	70		☒	1.3	23-27-50/5"			
		70.5 2679.3								
		CLAYEY SAND (SC), trace gravel, tan, very dense								
		73.0 2676.8								
		SILTY SAND (SM), tan	75		☒	1.3	27-39-40 N=79			
		75.5 2674.3								
		POORLY GRADED SAND WITH SILT (SP-SM), tan, very dense	80		☒	1.3	25-35-38 N=73			
		trace gravel	85		☒	0.9	34-50/5"			
		88.0 2661.8								
		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), light orangish brown, very dense	90		☒	1.4	36-38-50/5"			
		91.4 2658.4								
		Boring Terminated at 91.4 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ Boring completed in the Boise River

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

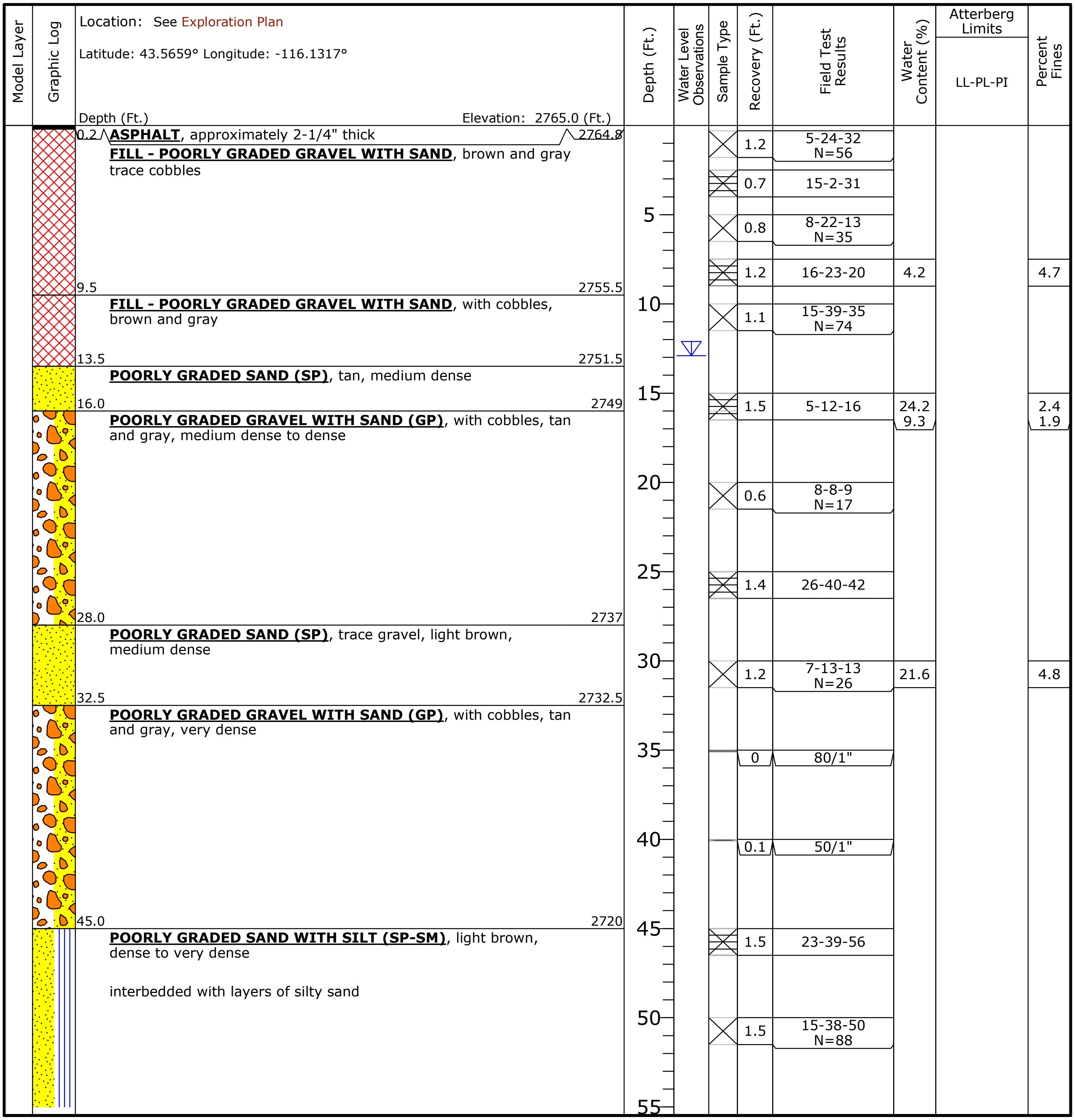
Logged by
JL

Boring Started
02-20-2025

Boring Completed
02-21-2025

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. B-6



Location: See Exploration Plan

Latitude: 43.5659° Longitude: -116.1317°

Depth (Ft.) Elevation: 2765.0 (Ft.)

Depth (Ft.)	Description	Elevation (Ft.)
0.2	**ASPHALT**, approximately 2-1/4" thick	2764.8
9.5	**FILL - POORLY GRADED GRAVEL WITH SAND**, brown and gray trace cobbles	2755.5
13.5	**FILL - POORLY GRADED GRAVEL WITH SAND**, with cobbles, brown and gray	2751.5
16.0	**POORLY GRADED SAND (SP)**, tan, medium dense	2749
28.0	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, tan and gray, medium dense to dense	2737
32.5	**POORLY GRADED SAND (SP)**, trace gravel, light brown, medium dense	2732.5
45.0	**POORLY GRADED GRAVEL WITH SAND (GP)**, with cobbles, tan and gray, very dense	2720
	POORLY GRADED SAND WITH SILT (SP-SM), light brown, dense to very dense interbedded with layers of silty sand	

Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1.2	5-24-32 N=56			
0.7	15-2-31			
0.8	8-22-13 N=35			
1.2	16-23-20	4.2		4.7
1.1	15-39-35 N=74			
1.5	5-12-16	24.2 9.3		2.4 1.9
0.6	8-8-9 N=17			
1.4	26-40-42			
1.2	7-13-13 N=26	21.6		4.8
0	80/1"			
0.1	50/1"			
1.5	23-39-56			
1.5	15-38-50 N=88			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations

▽ 12.9 feet 10 minutes after completion of drilling

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite
Surface Capped with Asphalt

Logged by
JL

Boring Started
02-24-2025

Boring Completed
02-25-2025

Boring Log No. B-6

Location: See Exploration Plan

Latitude: 43.5659° Longitude: -116.1317°

Elevation: 2765.0 (Ft.)

Depth (Ft.)	Description	Elevation (Ft.)
	POORLY GRADED SAND WITH SILT (SP-SM), light brown, dense to very dense *(continued)*	
58.0		2707
	SILTY SAND (SM), brown, very dense	
66.0		2699
	POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), brown, very dense	
67.5		2697.5
	SILTY SAND (SM), with sand and gravel lenses, light brown to tan, very dense	
83.0		2682
	LEAN CLAY (CL), tan and browinsh orange, hard, interbedded with layers of poorly graded sand with silt	
91.5		2673.5
	Boring Terminated at 91.5 Feet	

Depth (Ft.)	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.4	26-35-35 N=70			
60	1.5	22-39-42 N=81	28.1	NP	34.8
65	1.4	14-22-50/5"			
70	1.5	34-35-50 N=85	22.8		21.0
75	1.5	32-38-45 N=83			
80	1.5	31-49-50 N=99			
85	1.5	22-42-50 N=92			
90	1.5	20-34-48 N=82			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations

▽ 12.9 feet 10 minutes after completion of drilling

Drill Rig
CME-75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-stem auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite
Surface Capped with Asphalt

Logged by
JL

Boring Started
02-24-2025

Boring Completed
02-25-2025

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. RW-15

Location: See Exploration Plan

Latitude: 43.5662° Longitude: -116.1311°

Elevation: 2762.2 (Ft.)

Depth (Ft.)	Description	Elevation (Ft.)	Water Level Observations	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
0.3	**ASPHALT**, Approximately 3 1/2" thick	2761.9						
2.5	**FILL - POORLY GRADED GRAVEL WITH SILT AND SAND**, with cobbles, brown	2759.7		1.33	12-21-25 N=46			
5.0	**FILL - SILTY SAND WITH GRAVEL**, with cobbles, dark brown	2757.2		0.41	6-4-3 N=7			
7.5	**CLAYEY SAND WITH GRAVEL (SC)**, dark brown	2754.7		0.33	3-2-2 N=4			
10.0	**SILTY SAND (SM)**, with trace gravel, brown, loose	2752.2		1.25	2-2-2 N=4	17.3		23.4
15.0	**SILTY SAND WITH GRAVEL (SM)**, with cobbles, brown, dense	2747.2	▽	0.91	2-3-26 N=29			
25.0	**POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, with cobbles, brown and gray, very dense	2737.2		1 0.83	50-36-49 N=85 20-29-33 N=62			
30.0	**SILT (ML)**, brown, stiff to very stiff	2732.2		1.5	2-4-11 N=15	24.7	NP	64.1
31.5	**POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, with cobbles, brown and gray, very dense	2730.7		1.16	22-26-36 N=62			

Boring Terminated at 31.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.
Elevation Reference: Elevations interpreted from survey data.

Notes

Water Level Observations
▽ While drilling

Advancement Method
Hollow-Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite
Surface Capped with Asphalt

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Logged by
KU

Boring Started
12-01-2025

Boring Completed
12-01-2025

Eckert Bridge - Concept Design
Eckert Road Bridge over the Boise River | Boise, Idaho
Terracon Project No. 62235109

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. RW-16

Location: See Exploration Plan

Latitude: 43.5665° Longitude: -116.1307°

Elevation: 2759.4 (Ft.)

Model Layer	Graphic Log	Description	Depth (Ft.)	Elevation (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		FILL - POORLY GRADED GRAVEL WITH SILT AND SAND, with cobbles, brown and gray	2.5	2756.9		☒	0.75	4-11-14 N=25			
		FILL - SILTY SAND, dark brown	3.0	2756.4		☒	1.08	5-5-4 N=9			
		FILL - CLAYEY SAND WITH GRAVEL, brown	5.0	2754.4							
		FILL - CLAYEY SAND, dark brown	6.0	2753.4		☒	1.16	0-0-3 N=3			
		SILTY SAND (SM), brown, very loose, clayey sand lenses	7.5	2751.9							
		SILTY SAND WITH GRAVEL (SM), dark brown, medium dense	10.0	2749.4	▽	☒	0.75	1-5-19 N=24			
		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), with cobbles, brown and gray, very dense	15.0	2744.4		☒	1.08	17-25-33 N=58			
		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), brown and gray, medium dense	20.0	2739.4		☒	0.83	4-9-18 N=27			
		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), with cobbles, brown and gray, medium dense	25.0	2734.4		☒	0.58	9-13-15 N=28			
		SANDY SILT (ML), brown and orange, medium stiff to stiff	29.0	2730.4		☒	1	2-4-4 N=8	30.7	26-25-1	62.9
		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), brown, dense to very dense, sand lenses				☒ ☒	1.5 1.5	4-16-23 N=39 8-20-27			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ While drilling

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Logged by
KU

Boring Started
12-01-2025

Boring Completed
12-01-2025

Terracon
11849 W Executive Dr Ste G
Boise, ID

Boring Log No. RW-16

Location: See Exploration Plan

Latitude: 43.5665° Longitude: -116.1307°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 2759.4 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (Ft.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), brown, dense to very dense, sand lenses *(continued)* 40.0 2719.4			☒		N=47			
		SILTY SAND (SM), brown, very dense	40		☒	1.5	10-22-32 N=54			
		46.5 2712.9	45		☒	1.41	14-26-37 N=63	22.4		17.5

Boring Terminated at 46.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.
Elevation Reference: Elevations interpreted from survey data.

Water Level Observations
▽ While drilling

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Haz-Tech Drilling, Inc.

Notes

Advancement Method
Hollow-Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and Bentonite

Logged by
KU

Boring Started
12-01-2025

Boring Completed
12-01-2025

Photography Log

Looking northeast towards B-2

B-2, after completion of drilling operations

Looking northeast towards B-3, B-4, B-5

Looking northwest towards B-3

Looking northwest towards B-4

B-3, prior to completion of drilling operations

B-3, prior to completion of drilling operations

Looking northwest towards B-5

B-5, prior to completion of drilling activities

B-5, prior to completion of drilling activities

B-5, prior to completion of drilling activities

B-5, prior to completion of drilling activities

B-5, prior to completion of drilling activities

B-5, prior to completion of drilling activities

B-6, prior to completion of drilling activities

B-6, after completion of drilling operations

RW-15, prior to completion of drilling activities

RW-16, prior to completion of drilling activities

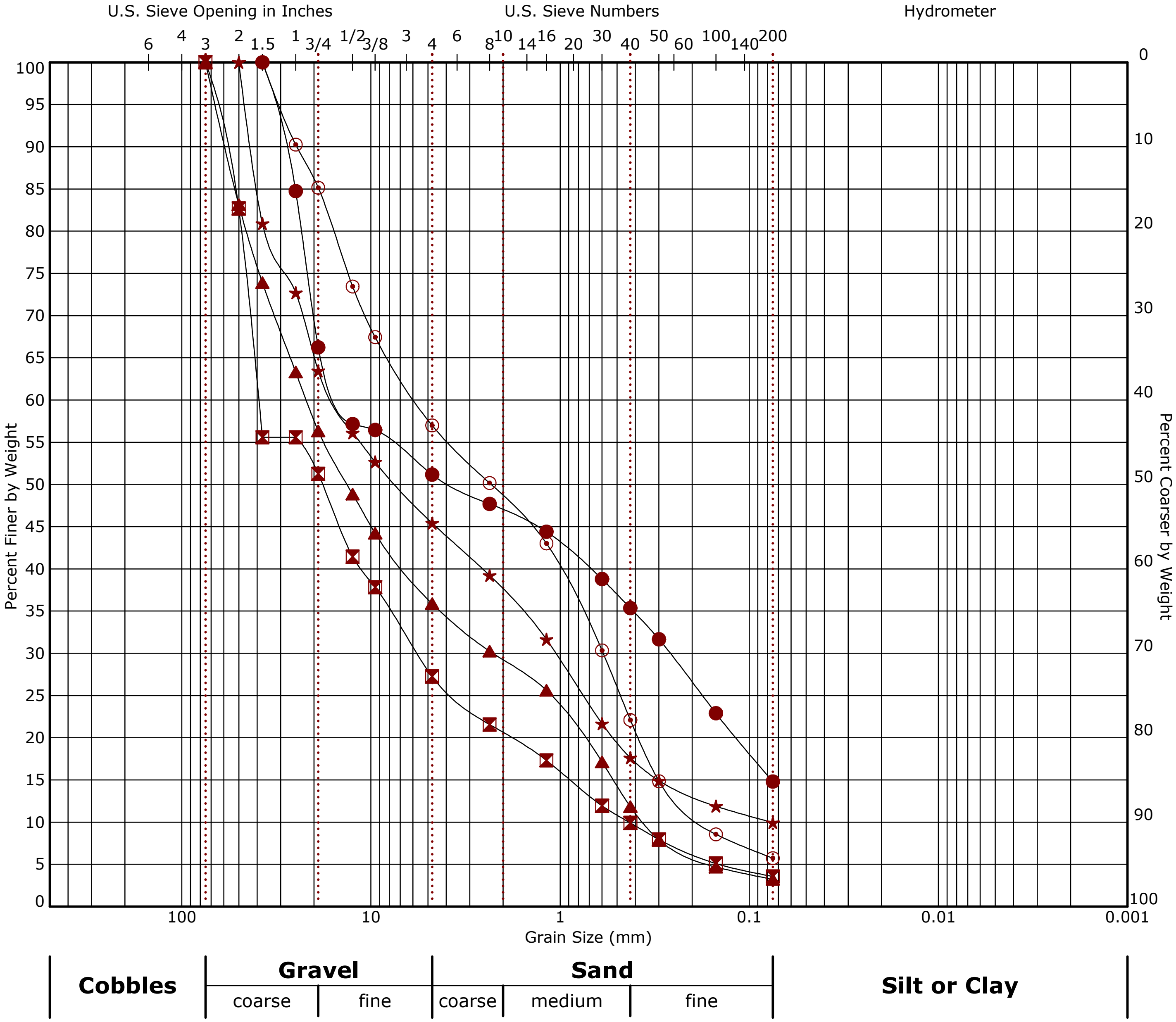
APPENDIX B

Contents:

- Grain Size Distribution Graph
- Atterberg Limits Graph
- Corrosion Test Results

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27

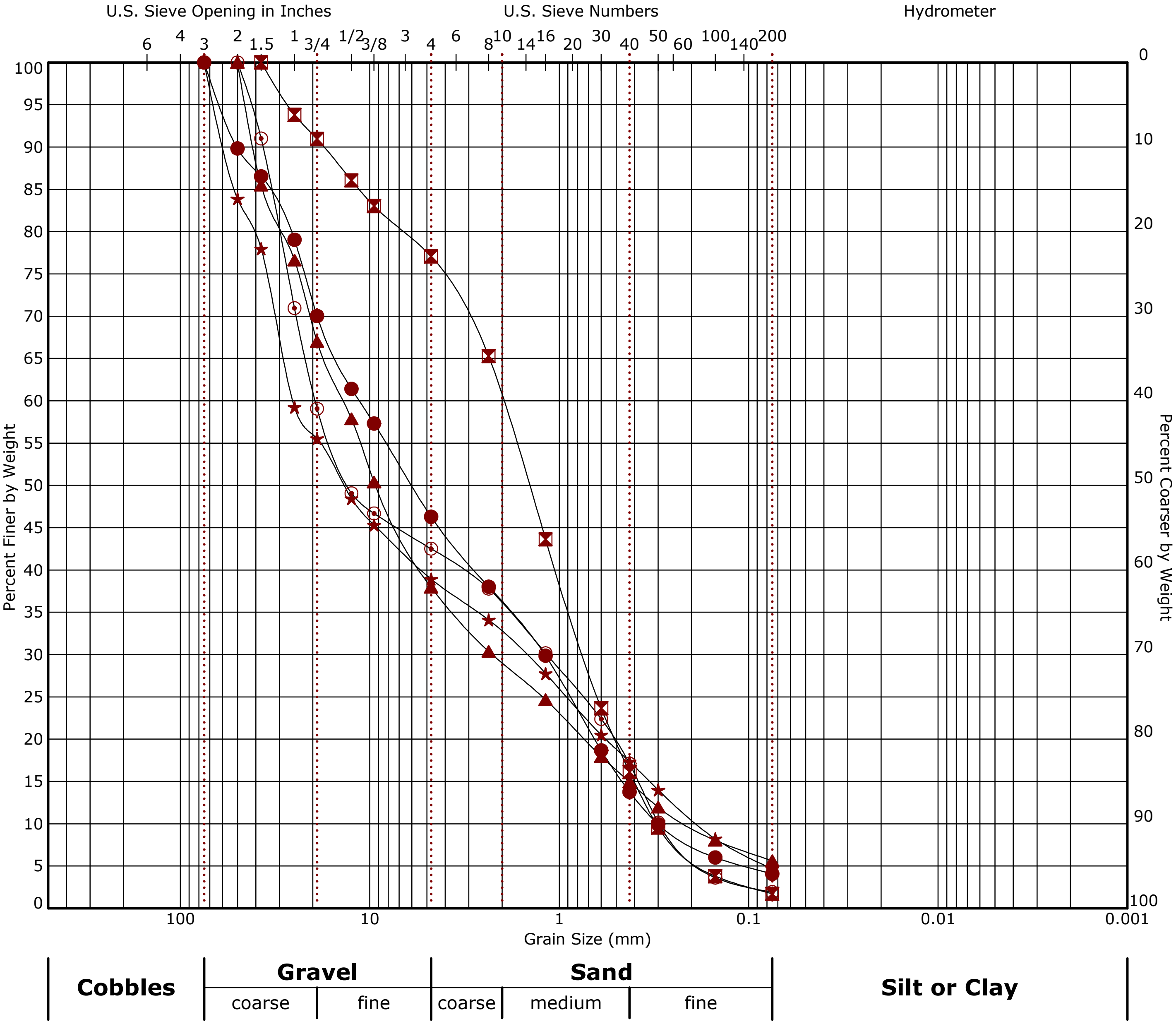


Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-2	15 - 16.5	SILTY GRAVEL with SAND	GM					
⊠	B-2	20 - 21.5	WELL-GRADED GRAVEL with SAND	GW				1.91	91.03
▲	B-2	30 - 31.3	POORLY GRADED GRAVEL with SAND	GP				0.65	60.73
★	B-3	7.5 - 9	POORLY GRADED GRAVEL with SILT and SAND	GP-GM				0.93	204.17
⊙	B-3	15 - 16	POORLY GRADED SAND with SILT and GRAVEL	SP-SM				0.34	32.97

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-2	15 - 16.5	37.5	14.255	3.757	0.263		0.0	48.8	36.4	14.8		
⊠	B-2	20 - 21.5	75	39.302	18.004	5.688	0.432	0.0	72.7	23.7	3.6		
▲	B-2	30 - 31.3	75	21.947	13.336	2.274	0.361	0.0	64.1	32.7	3.2		
★	B-3	7.5 - 9	50	15.607	7.364	1.056	0.076	0.0	54.6	35.5	9.9		
⊙	B-3	15 - 16	37.5	5.8	2.321	0.592	0.176	0.0	43.0	51.3	5.7		

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27

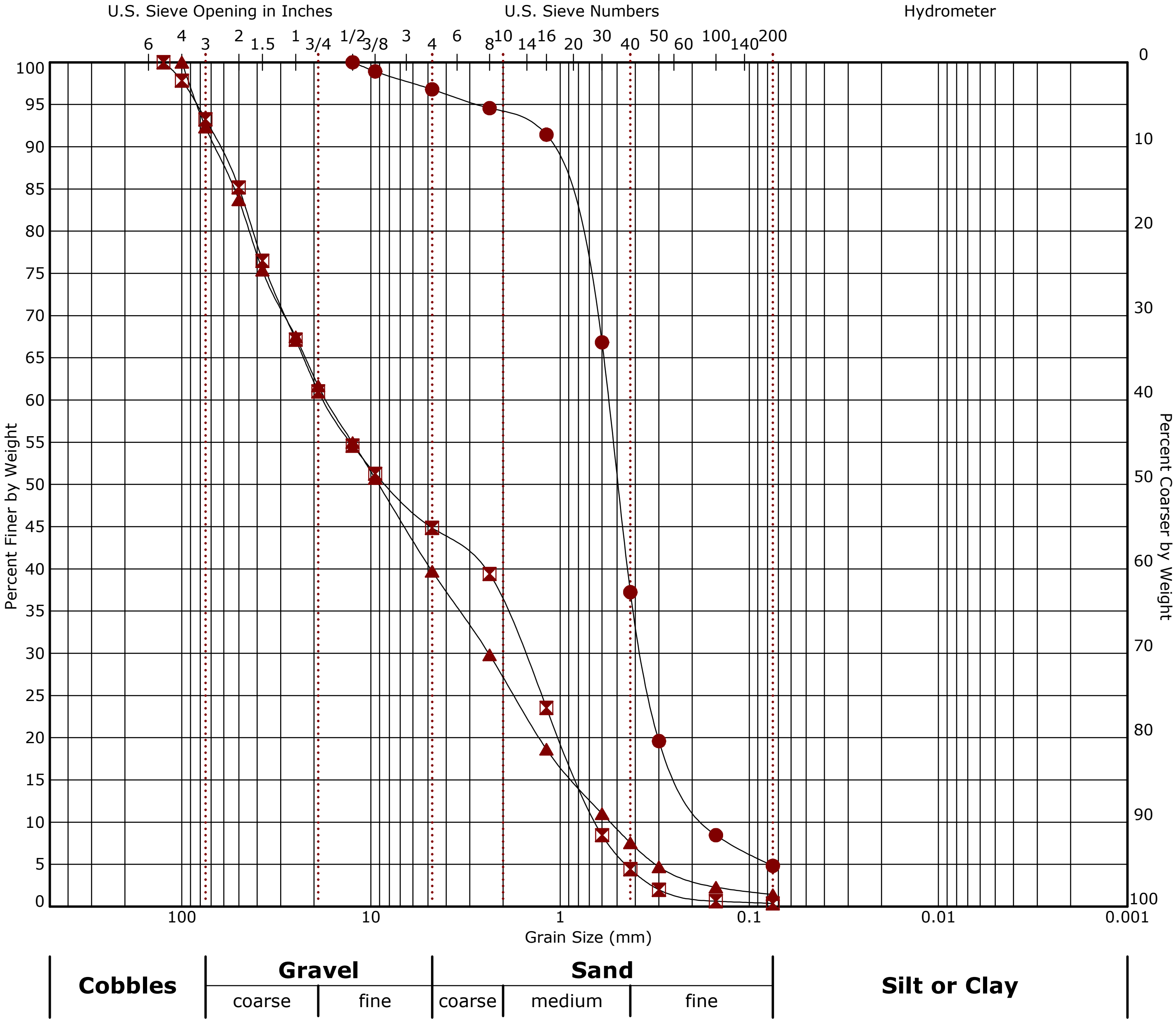


Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-4	10 - 11.5	POORLY GRADED GRAVEL with SAND	GP				0.42	37.67
☒	B-5	2.5 - 4	POORLY GRADED SAND with GRAVEL	SP				0.90	6.49
▲	B-5	15 - 16.5	WELL-GRADED GRAVEL withSILT and SAND	GW-GM				1.74	64.93
★	B-6	7.5 - 9	POORLY GRADED GRAVEL with SAND	GP				0.48	136.82
⊙	B-6	16 - 16.5	POORLY GRADED GRAVEL with SAND	GP				0.24	65.73

Boring ID		Depth (Ft)	D$_{100}$	D$_{60}$	D$_{50}$	D$_{30}$	D$_{10}$	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-4	10 - 11.5	75	11.375	5.997	1.194	0.302	0.0	53.7	42.2	4.1		
☒	B-5	2.5 - 4	37.5	1.993	1.447	0.744	0.307	0.0	22.9	75.4	1.7		
▲	B-5	15 - 16.5	50	13.788	9.293	2.254	0.212	0.0	62.1	32.3	5.6		
★	B-6	7.5 - 9	75	25.41	13.698	1.508	0.186	0.0	61.1	34.3	4.7		
⊙	B-6	16 - 16.5	50	19.412	12.997	1.163	0.295	0.0	57.5	40.6	1.9		

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27

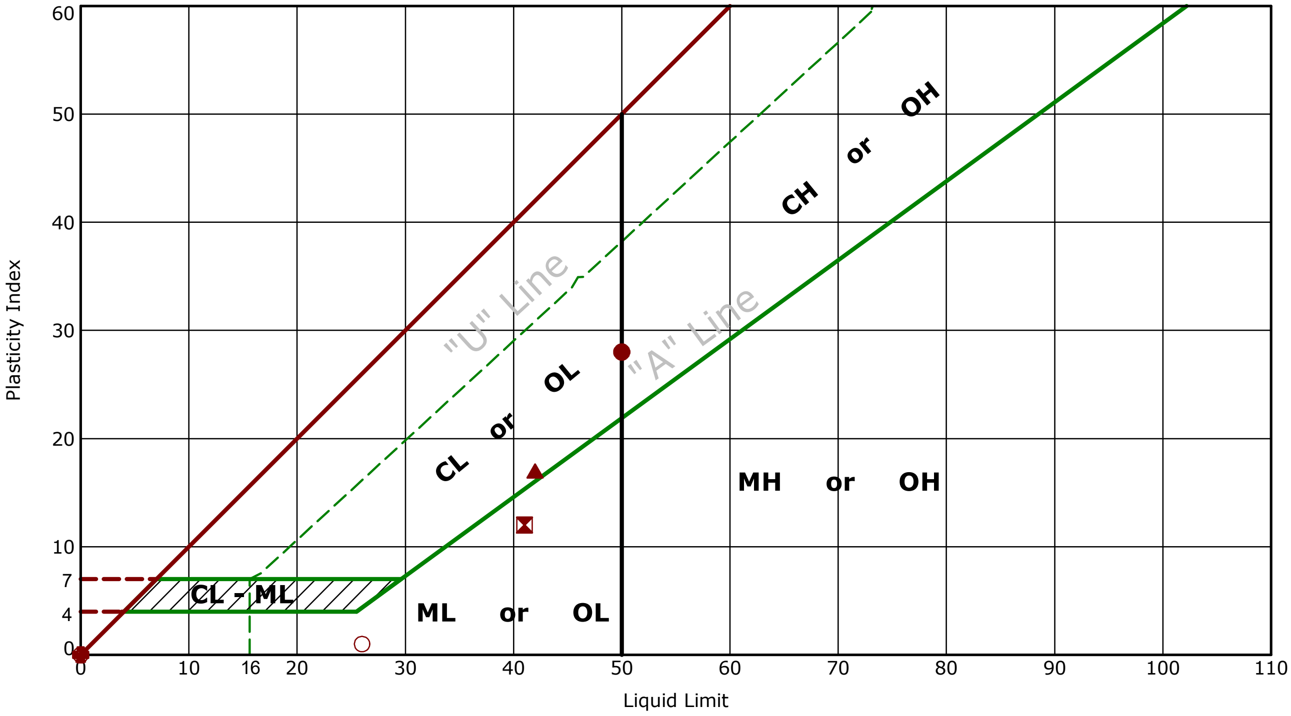


Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-6	30 - 31.5	POORLY GRADED SAND	SP				1.48	3.35
☒	Scour Sample 1	0 - 0.5	POORLY GRADED GRAVEL with SAND	GP				0.21	27.65
▲	Scour Sample 2	0 - 0.5	POORLY GRADED GRAVEL with SAND	GP				0.61	31.56

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-6	30 - 31.5	12.5	0.554	0.493	0.368	0.165	0.0	3.2	92.0	4.8		
☒	Scour Sample 1	0 - 0.5	125	17.784	8.287	1.566	0.643	6.8	48.4	44.5	0.4		
▲	Scour Sample 2	0 - 0.5	100	17.139	9.095	2.39	0.543	7.7	52.6	38.3	1.4		

Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-2	55 - 56.5	50	22	28	68.1	CH	SANDY FAT CLAY
☒	B-3	35 - 36.5	41	29	12	31.9	SM	SILTY SAND
▲	B-4	45 - 46.5	42	25	17	71.8	CL	LEAN CLAY with SAND
★	B-5	45 - 46.5	NP	NP	NP	48.1	SM	SILTY SAND
⊙	B-6	60 - 61.5	NP	NP	NP	34.8	SM	SILTY SAND
✤	RW-15	25 - 26.5	NP	NP	NP	64.1	ML	SANDY SILT
○	RW-16	25 - 26.5	26	25	1	62.9	ML	SANDY SILT

Corrosion Test Results

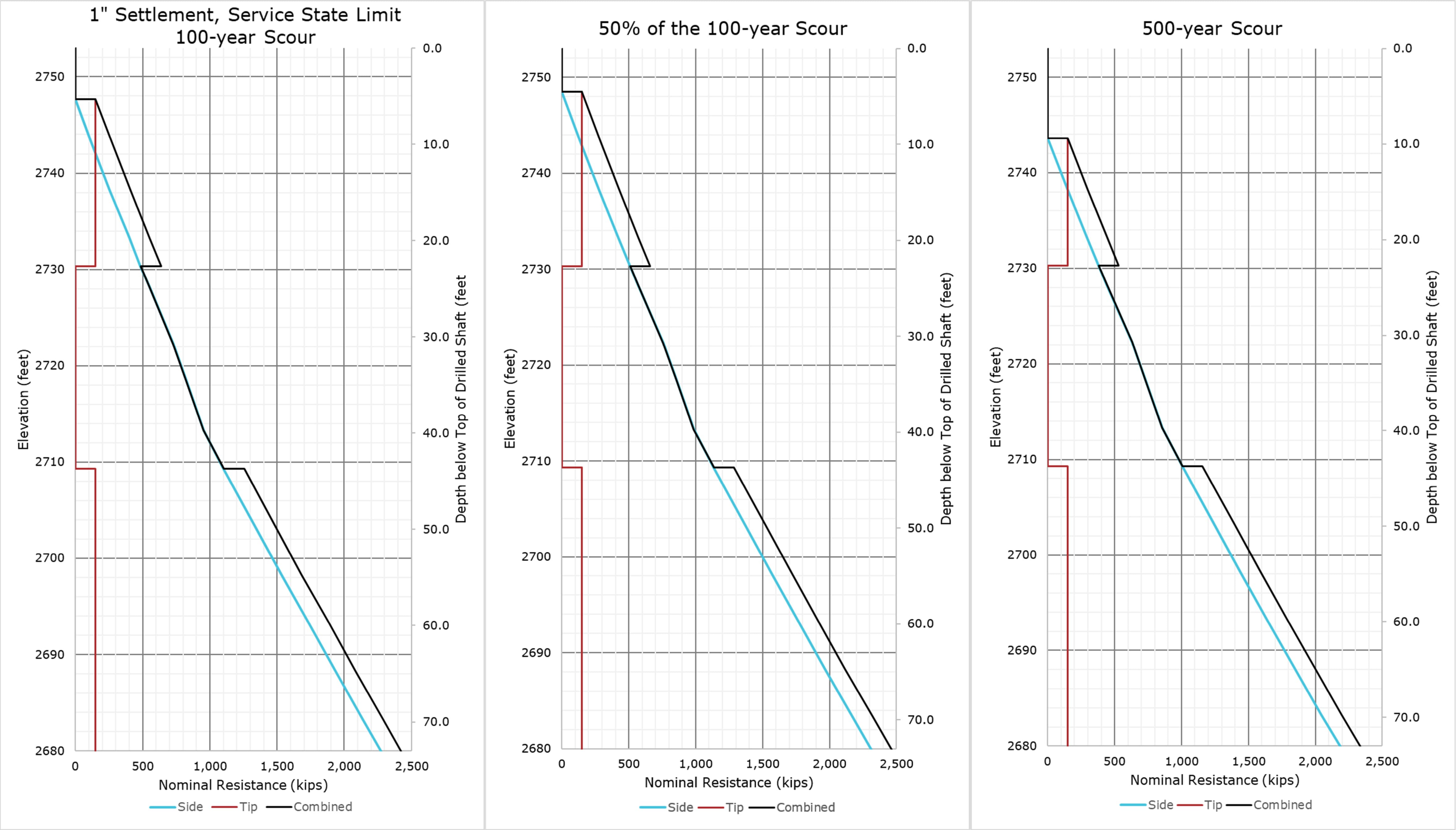
Boring ID	Depth (feet)	pH	Resistivity (ohm-cm)
B-2	16.3 – 17.8	7.85	2,800
B-2	25 – 26.5	7.44	7,200
B-3	40 – 41.5	7.22	1,600
B-4	40 – 41.5	7.56	4,000
B-5	50 – 51.4	7.95	8,100
B-6	65 – 66	7.64	1,900

APPENDIX C

Contents:

- Vertical Resistance Results
- LPILE Drilled Shaft Analysis Results
- Global Stability Analysis Results

Abutment 1 - Vertical Resistance Graphs

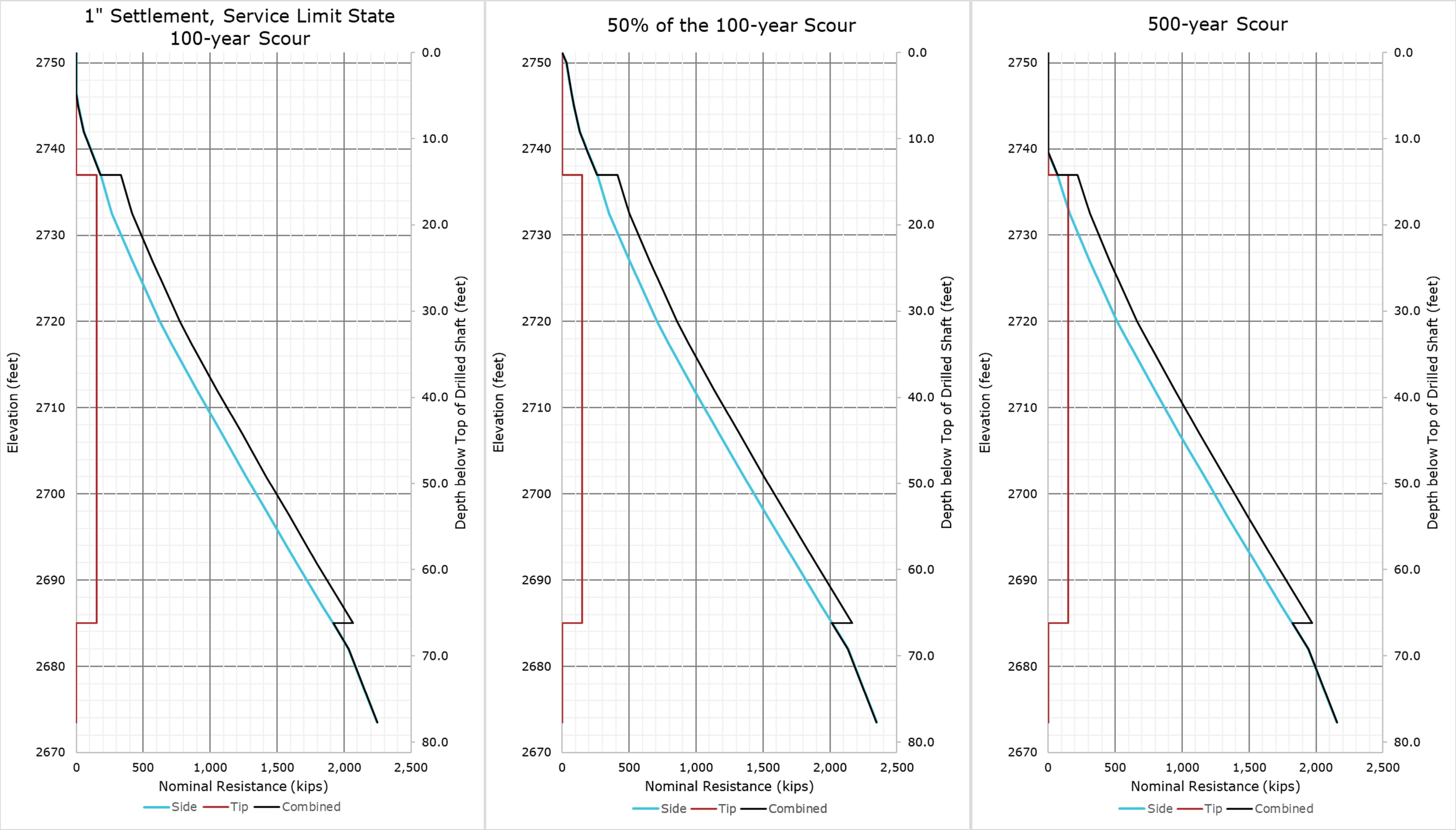


1" Settlement, Service State Limit 100-year Scour

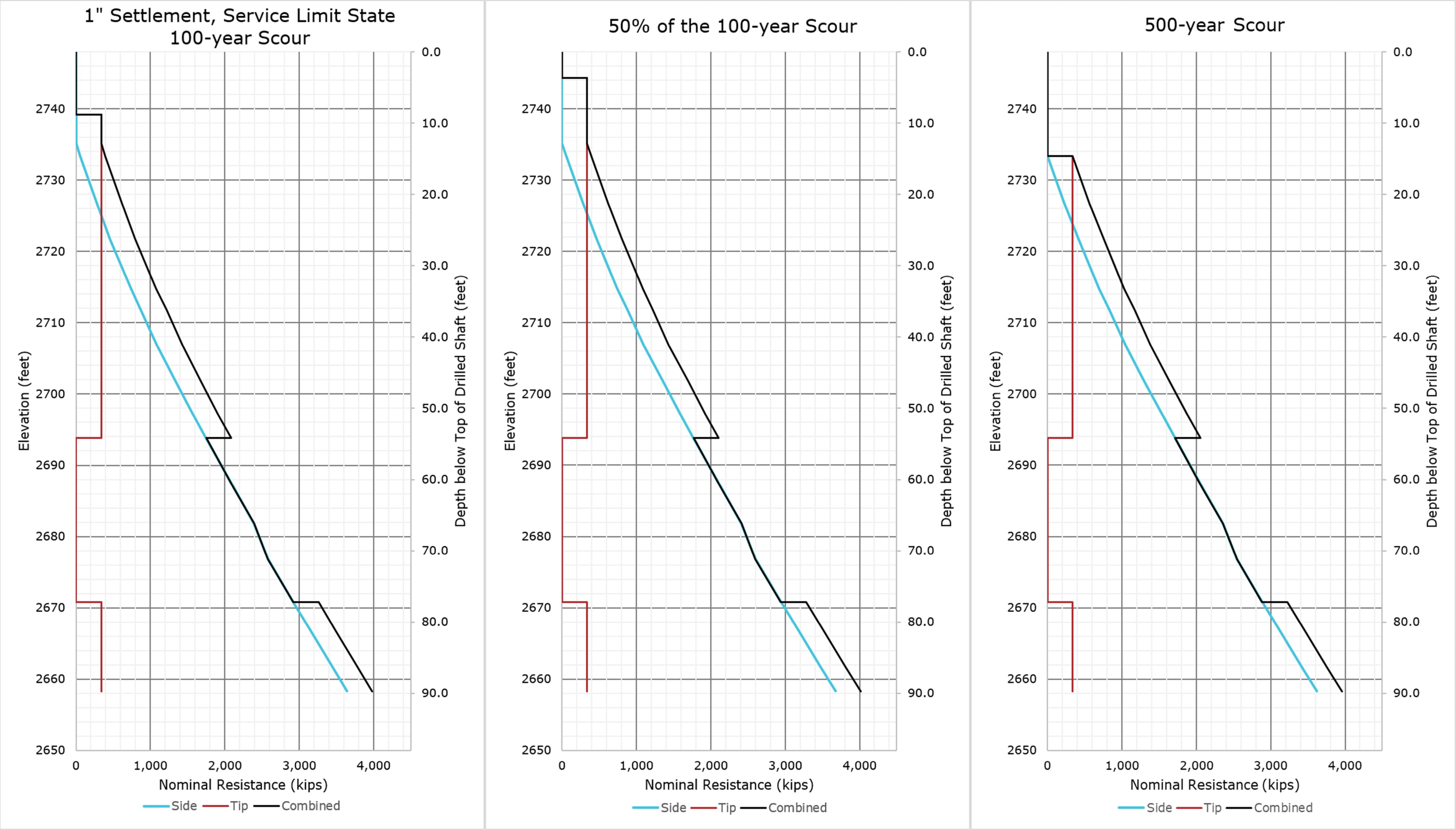
50% of the 100-year Scour

500-year Scour

Abutment 2 - Vertical Resistance Graphs

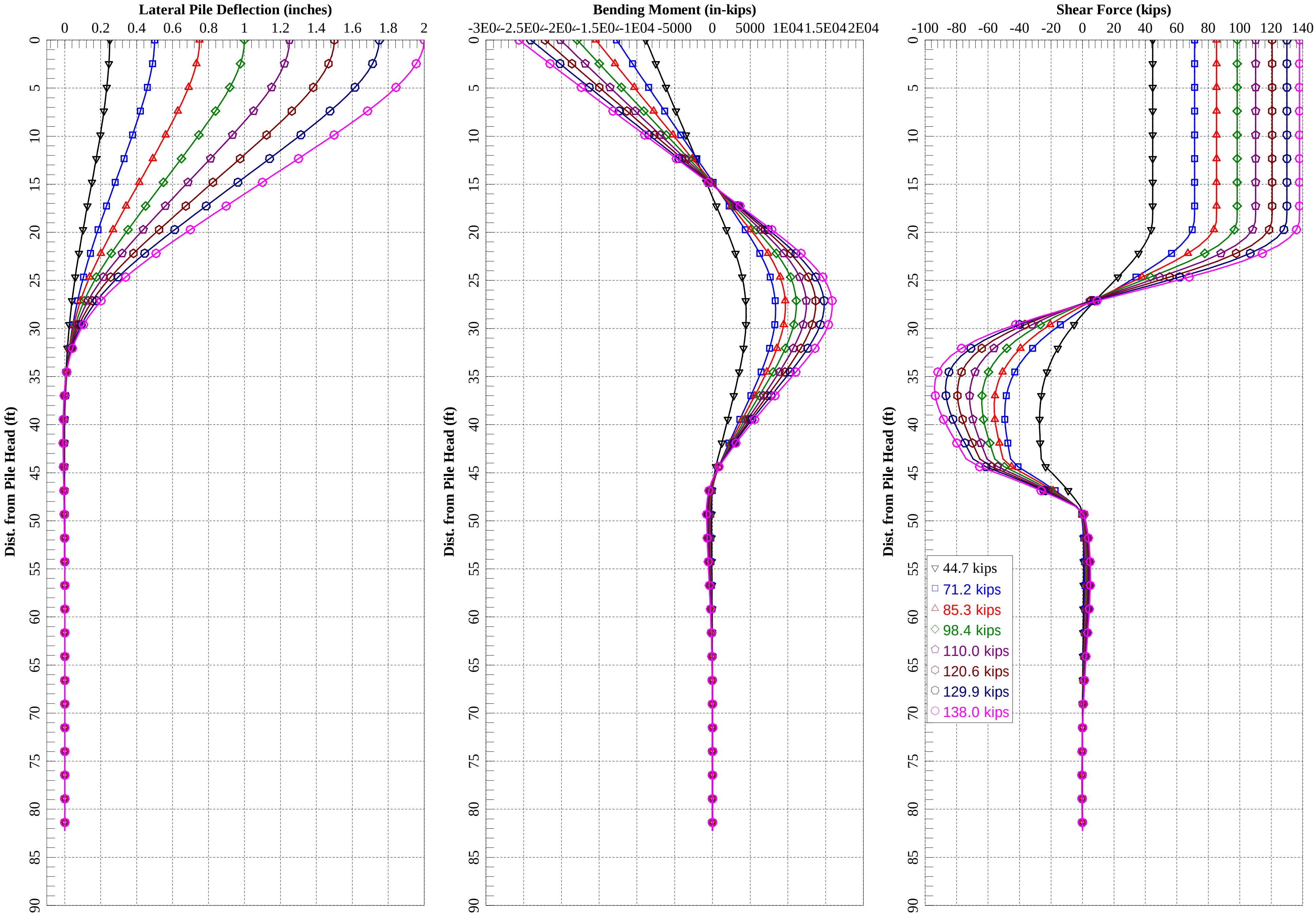


Piers - Vertical Resistance Graphs



Notes:

1. Depth Below Top of Drilled Shaft is for Pier 1. The elevation of the top of drilled shaft for Pier 2 is 2747.4 feet. Therefore, for Pier 2, 0.6 feet should be subtracted from the values presented.
2. Permanent casing extends to an elevation of 2735.11. Side resistance should be neglected from the top of shaft to the bottom of the permanent casing.



Abutment 1: 4-ft Diameter Shaft, Fixed with Scour

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                    License Type : (Enterprise Cloud License)

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


This model was prepared by:
Maren Tanberg




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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-2 Abutment 1 Fixed Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-2 Abutment 1 Fixed Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-2 Abutment 1 Fixed Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-2 Abutment 1 Fixed Model with Scour 1.05 steel.lp12r

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

```
               Date:  March 20, 2026              Time:   9:43:48


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

Project Name: Eckert Road Bridge over Boise River



Job Number: 62235109B



Client: LHTAC



Engineer: M.J. Tanberg



Description: Abutment 1, B-2, Fixed model with scour





--------------------------------------------------------------------------------
                          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

 - Use of p-y modification factors for p-y curves not selected
```

```
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - 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.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using narrow report formats
   (Note: Some output information is omitted from the narrow report formats)




--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            2
Total length of pile                                   =       82.200 ft
Depth of ground surface below top of pile              =      18.7000 ft

Pile diameters used for p-y curve computations are defined using 4 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.

            Depth Below          Pile
Point        Pile Head         Diameter
 No.            feet            inches
-----      -------------     -------------
  1             0.000          48.0000
  2             9.000          48.0000
  3             9.000          48.0000
  4            82.200          48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =     9.000000 ft
```

```
   Shaft Diameter                                       =    48.000000 in

Pile Section No. 2:

   Section 2 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                    =    73.200000 ft
   Shaft Diameter                                       =    48.000000 in



--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer            =    18.700000 ft
   Distance from top of pile to bottom of layer         =    39.700000 ft
   Effective unit weight at top of layer                =    62.000000 pcf
   Effective unit weight at bottom of layer             =    62.000000 pcf
   Friction angle at top of layer                       =    38.000000 deg.
   Friction angle at bottom of layer                    =    38.000000 deg.
   Subgrade k at top of layer                           =       0.0000 pci
   Subgrade k at bottom of layer                        =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer            =    39.700000 ft
   Distance from top of pile to bottom of layer         =    43.700000 ft
   Effective unit weight at top of layer                =    52.000000 pcf
   Effective unit weight at bottom of layer             =    52.000000 pcf
   Friction angle at top of layer                       =    38.000000 deg.
   Friction angle at bottom of layer                    =    38.000000 deg.
   Subgrade k at top of layer                           =       0.0000 pci
   Subgrade k at bottom of layer                        =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer            =    43.700000 ft
   Distance from top of pile to bottom of layer         =    48.700000 ft
   Effective unit weight at top of layer                =    52.000000 pcf
   Effective unit weight at bottom of layer             =    52.000000 pcf
   Undrained cohesion at top of layer                   =        4000. psf
   Undrained cohesion at bottom of layer                =        4000. psf
```

```
   Epsilon-50 at top of layer                          =       0.0000
   Epsilon-50 at bottom of layer                       =       0.0000
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for Epsilon-50 will be computed for this layer.

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 4 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    48.700000 ft
   Distance from top of pile to bottom of layer        =    82.200000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

 (Depth of the lowest soil layer extends 0.000 ft below the pile tip)



--------------------------------------------------------------------------------
                               Static Loading Type
--------------------------------------------------------------------------------

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



--------------------------------------------------------------------------------
                Pile-head Loading and Pile-head Fixity Conditions
--------------------------------------------------------------------------------

Number of loads specified = 8

Load    Load         Condition               Condition           Axial Thrust
 No.    Type             1                       2                 Force, lbs
-----   ----   --------------------   -----------------------   ----------------
   1     5     y =     0.250000 in    S =       0.0000 in/in            625000.
   2     5     y =     0.500000 in    S =       0.0000 in/in            625000.
   3     5     y =     0.750000 in    S =       0.0000 in/in            625000.
   4     5     y =     1.000000 in    S =       0.0000 in/in            625000.
   5     5     y =     1.250000 in    S =       0.0000 in/in            625000.
   6     5     y =     1.500000 in    S =       0.0000 in/in            625000.
   7     5     y =     1.750000 in    S =       0.0000 in/in            625000.
```

```
   8     5     y =     2.000000 in    S =       0.0000 in/in            625000.

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 = 2

Pile Section No. 1:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =     9.000000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           24 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     6.571329 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         8.76
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------
```

```
Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7225.631 kips
Tensile Load for Cracking of Concrete                  =     -808.162 kips
Nominal Axial Tensile Capacity                         =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar         Bar Diam.      Bar Area         X              Y
    Number        inches         sq. in.       inches         inches
  ----------    ----------    ----------    ----------    ----------
       1          1.000000      0.790000     16.492425      -0.49992
       2          1.000000      0.790000     16.492425      0.499923
       3          1.000000      0.790000     14.532821      7.813266
       4          1.000000      0.790000     14.032897      8.679159
       5          1.000000      0.790000      8.679159     14.032897
       6          1.000000      0.790000      7.813266     14.532821
       7          1.000000      0.790000      0.499923     16.492425
       8          1.000000      0.790000      -0.49992     16.492425
       9          1.000000      0.790000      -7.81327     14.532821
      10          1.000000      0.790000      -8.67916     14.032897
      11          1.000000      0.790000     -14.03290      8.679159
      12          1.000000      0.790000     -14.53282      7.813266
      13          1.000000      0.790000     -16.49242      0.499923
      14          1.000000      0.790000     -16.49242      -0.49992
      15          1.000000      0.790000     -14.53282      -7.81327
      16          1.000000      0.790000     -14.03290      -8.67916
      17          1.000000      0.790000      -8.67916     -14.03290
      18          1.000000      0.790000      -7.81327     -14.53282
      19          1.000000      0.790000      -0.49992     -16.49242
      20          1.000000      0.790000      0.499923     -16.49242
      21          1.000000      0.790000      7.813266     -14.53282
      22          1.000000      0.790000      8.679159     -14.03290
      23          1.000000      0.790000     14.032897      -8.67916
      24          1.000000      0.790000     14.532821      -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
```

```
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1              625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                 in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1               625.000             28274.447           0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
```

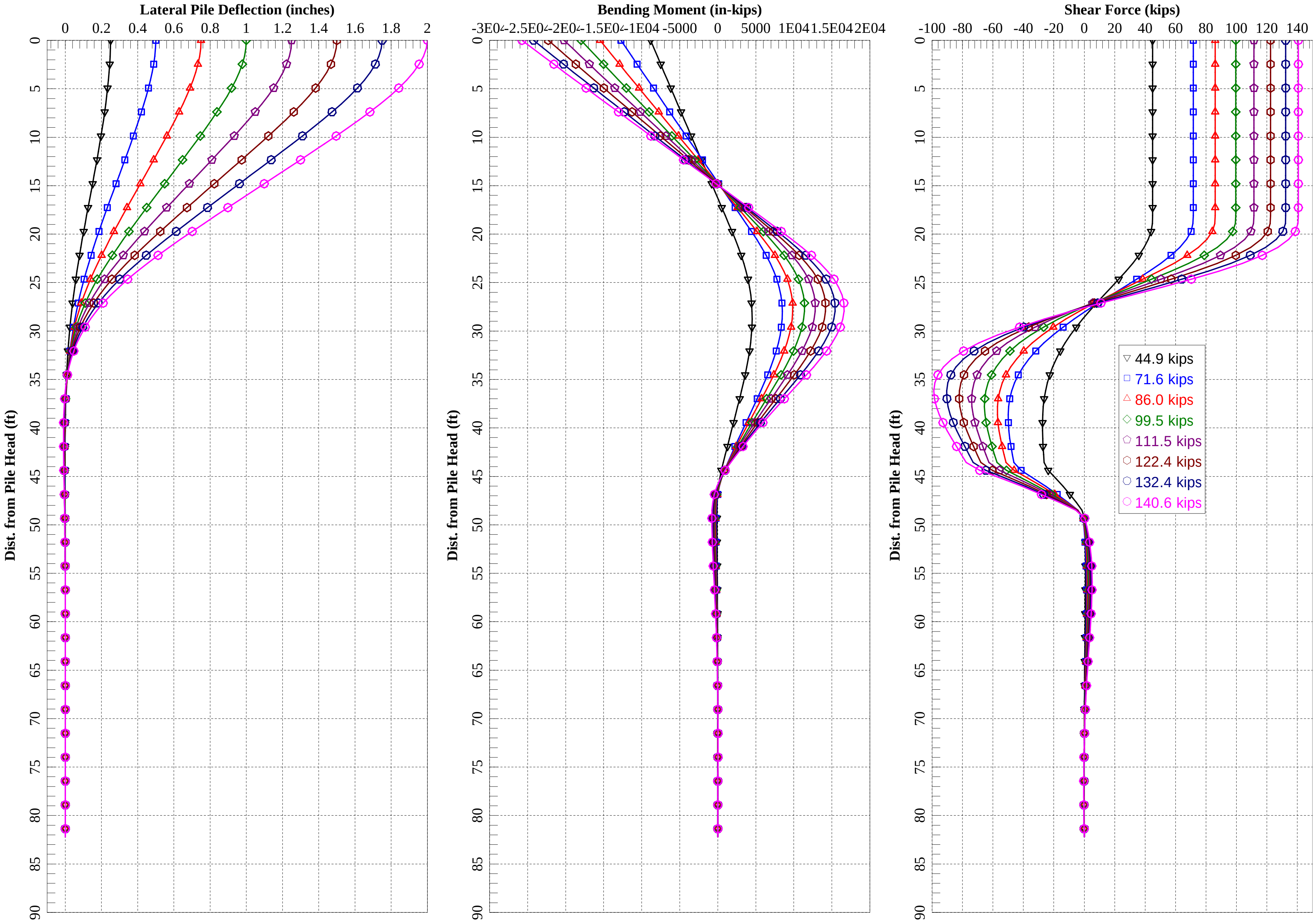
```
------------
   1       0.65         625.000000        28274.    406.250000        18378.
317082032.

   1       0.75         625.000000        28274.    468.750000        21206.
288182048.

   1       0.90         625.000000        28274.    562.500000        25447.
233661944.


Pile Section No. 2:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =    73.200000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           24 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     6.571329 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         8.76
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7225.631 kips
Tensile Load for Cracking of Concrete                  =     -808.162 kips
Nominal Axial Tensile Capacity                         =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area         X              Y
    Number         inches         sq. in.      inches         inches
  ----------     ----------     ----------     ----------     ----------
```

```
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      14.532821       7.813266
      4            1.000000       0.790000      14.032897       8.679159
      5            1.000000       0.790000       8.679159      14.032897
      6            1.000000       0.790000       7.813266      14.532821
      7            1.000000       0.790000       0.499923      16.492425
      8            1.000000       0.790000       -0.49992      16.492425
      9            1.000000       0.790000       -7.81327      14.532821
     10            1.000000       0.790000       -8.67916      14.032897
     11            1.000000       0.790000      -14.03290       8.679159
     12            1.000000       0.790000      -14.53282       7.813266
     13            1.000000       0.790000      -16.49242       0.499923
     14            1.000000       0.790000      -16.49242       -0.49992
     15            1.000000       0.790000      -14.53282       -7.81327
     16            1.000000       0.790000      -14.03290       -8.67916
     17            1.000000       0.790000       -8.67916      -14.03290
     18            1.000000       0.790000       -7.81327      -14.53282
     19            1.000000       0.790000       -0.49992      -16.49242
     20            1.000000       0.790000       0.499923      -16.49242
     21            1.000000       0.790000       7.813266      -14.53282
     22            1.000000       0.790000       8.679159      -14.03290
     23            1.000000       0.790000      14.032897       -8.67916
     24            1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
```

```
      1              625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 2
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                  in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1              625.000             28274.447           0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
------------
   1      0.65         625.000000        28274.    406.250000        18378.
317082032.

   1      0.75         625.000000        28274.    468.750000        21206.
288182048.

   1      0.90         625.000000        28274.    562.500000        25447.
233661944.
```

```
--------------------------------------------------------------------------------
           Layering Correction Equivalent Depths of Soil & Rock Layers
--------------------------------------------------------------------------------

         Top of    Equivalent
          Layer     Top Depth  Same Layer  Layer is        F0          F1
Layer     Below       Below      Type As    Rock or     Integral    Integral
 No.    Pile Head   Grnd Surf     Layer     is Below    for Layer   for Layer
           ft          ft         Above    Rock Layer      lbs         lbs
-----  ----------  ----------  ----------  ----------  ----------  ----------
  1       18.7000        0.00      N.A.        No            0.00     948431.
  2       39.7000     21.0000      Yes         No         948431.     531833.
  3       43.7000    373.8522      No          No        1480264.      77161.
  4       48.7000     25.9145      No          No        1557425.      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.



--------------------------------------------------------------------------------
            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            Pile-head      Pile-head      Max Shear     Max Moment
Case   Load    Deflection      Rotation        in Pile        in Pile
 No.   Type      inches         radians          lbs          in-lbs
----   ----   ------------   ------------   ------------   ------------
  1      5       0.250000         0.0000         44668.      -8815924.
  2      5       0.500000         0.0000         71238.     -12705374.
  3      5       0.750000         0.0000         85277.     -15444003.
  4      5       1.000000         0.0000         98391.     -17913141.
  5      5       1.250000         0.0000        110020.     -20138964.
  6      5       1.500000         0.0000        120551.     -22183366.
  7      5       1.750000         0.0000        129932.     -24065323.
  8      5       2.000000         0.0000        138006.     -25625403.
```

```
Maximum pile-head deflection = 2.0000000000 inches
Maximum pile-head rotation   = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.
```



Abutment 1: 4-ft Diameter Shaft, Pinned with Scour

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                    License Type : (Enterprise Cloud License)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
                           © 1985-2024 by Ensoft, Inc.
                               All Rights Reserved

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                                    Terracon


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


This model was prepared by:
Maren Tanberg




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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-2 Abutment 1 Pinned Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-2 Abutment 1 Pinned Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-2 Abutment 1 Pinned Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-2 Abutment 1 Pinned Model with Scour 1.05 steel.lp12r

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

```
               Date:  March 19, 2026              Time:  15:51:43


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

Project Name: Eckert Road Bridge over Boise River



Job Number: 62235109B



Client: LHTAC



Engineer: M.J. Tanberg



Description: Abutment 1, B-2, Fixed model with scour





--------------------------------------------------------------------------------
                          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

 - Use of p-y modification factors for p-y curves not selected
```

```
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - 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.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using narrow report formats
   (Note: Some output information is omitted from the narrow report formats)




--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                       =            2
Total length of pile                                  =       82.200 ft
Depth of ground surface below top of pile             =      18.7000 ft

Pile diameters used for p-y curve computations are defined using 4 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.

            Depth Below          Pile
Point        Pile Head         Diameter
 No.            feet            inches
-----      -------------     -------------
  1             0.000          48.0000
  2             9.000          48.0000
  3             9.000          48.0000
  4            82.200          48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                  =     9.000000 ft
```

```
   Shaft Diameter                                      =    48.000000 in

Pile Section No. 2:

   Section 2 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =    73.200000 ft
   Shaft Diameter                                      =    48.000000 in



--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    18.700000 ft
   Distance from top of pile to bottom of layer        =    39.700000 ft
   Effective unit weight at top of layer               =    62.000000 pcf
   Effective unit weight at bottom of layer            =    62.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    39.700000 ft
   Distance from top of pile to bottom of layer        =    43.700000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer           =    43.700000 ft
   Distance from top of pile to bottom of layer        =    48.700000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Undrained cohesion at top of layer                  =        4000. psf
   Undrained cohesion at bottom of layer               =        4000. psf
```

```
   Epsilon-50 at top of layer                          =       0.0000
   Epsilon-50 at bottom of layer                       =       0.0000
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for Epsilon-50 will be computed for this layer.

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 4 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    48.700000 ft
   Distance from top of pile to bottom of layer        =    82.200000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

 (Depth of the lowest soil layer extends 0.000 ft below the pile tip)



--------------------------------------------------------------------------------
                               Static Loading Type
--------------------------------------------------------------------------------

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



--------------------------------------------------------------------------------
                Pile-head Loading and Pile-head Fixity Conditions
--------------------------------------------------------------------------------

Number of loads specified = 8

Load    Load        Condition                Condition             Axial Thrust
 No.    Type            1                        2                  Force, lbs
-----   ----   --------------------   -----------------------   ----------------
   1     5     y =     0.250000 in    S =       0.0000 in/in            625000.
   2     5     y =     0.500000 in    S =       0.0000 in/in            625000.
   3     5     y =     0.750000 in    S =       0.0000 in/in            625000.
   4     5     y =     1.000000 in    S =       0.0000 in/in            625000.
   5     5     y =     1.250000 in    S =       0.0000 in/in            625000.
   6     5     y =     1.500000 in    S =       0.0000 in/in            625000.
   7     5     y =     1.750000 in    S =       0.0000 in/in            625000.
```

```
   8     5     y =     2.000000 in    S =       0.0000 in/in            625000.

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 = 2

Pile Section No. 1:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =     9.000000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           24 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     6.571329 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         8.76
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------
```

```
Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7225.631 kips
Tensile Load for Cracking of Concrete                  =     -808.162 kips
Nominal Axial Tensile Capacity                         =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area          X              Y
    Number         inches         sq. in.        inches         inches
  ----------     ----------     ----------     ----------     ----------
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      14.532821       7.813266
      4            1.000000       0.790000      14.032897       8.679159
      5            1.000000       0.790000       8.679159      14.032897
      6            1.000000       0.790000       7.813266      14.532821
      7            1.000000       0.790000       0.499923      16.492425
      8            1.000000       0.790000       -0.49992      16.492425
      9            1.000000       0.790000       -7.81327      14.532821
     10            1.000000       0.790000       -8.67916      14.032897
     11            1.000000       0.790000      -14.03290       8.679159
     12            1.000000       0.790000      -14.53282       7.813266
     13            1.000000       0.790000      -16.49242       0.499923
     14            1.000000       0.790000      -16.49242       -0.49992
     15            1.000000       0.790000      -14.53282       -7.81327
     16            1.000000       0.790000      -14.03290       -8.67916
     17            1.000000       0.790000       -8.67916      -14.03290
     18            1.000000       0.790000       -7.81327      -14.53282
     19            1.000000       0.790000       -0.49992      -16.49242
     20            1.000000       0.790000       0.499923      -16.49242
     21            1.000000       0.790000       7.813266      -14.53282
     22            1.000000       0.790000       8.679159      -14.03290
     23            1.000000       0.790000      14.032897       -8.67916
     24            1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
```

```
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                 in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1              625.000            28274.447          0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal       Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
```

```
------------
   1       0.65         625.000000        28274.    406.250000        18378.
317082032.

   1       0.75         625.000000        28274.    468.750000        21206.
288182048.

   1       0.90         625.000000        28274.    562.500000        25447.
233661944.


Pile Section No. 2:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =    73.200000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           30 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    23.700000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.31 percent
Edge-to-Edge Bar Spacing                               =     4.879938 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         6.51
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7493.915 kips
Tensile Load for Cracking of Concrete                  =     -822.049 kips
Nominal Axial Tensile Capacity                         =    -1422.000 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area          X              Y
    Number         inches         sq. in.        inches         inches
  ----------     ----------     ----------     ----------     ----------
```

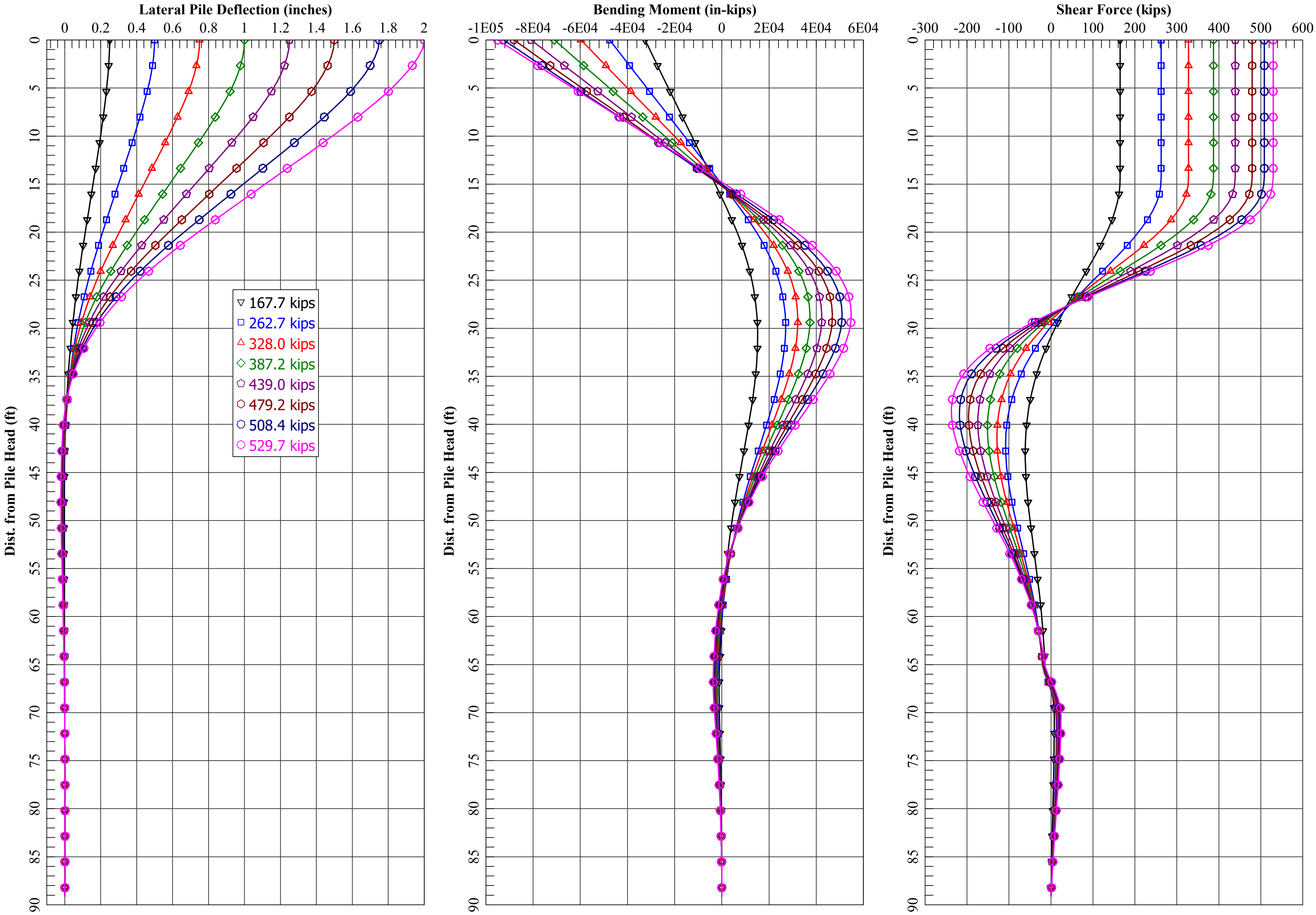
```
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      15.269917       6.251371
      4            1.000000       0.790000      14.863243       7.164776
      5            1.000000       0.790000      11.407102      11.921746
      6            1.000000       0.790000      10.664071      12.590774
      7            1.000000       0.790000       5.571895      15.530743
      8            1.000000       0.790000       4.620984      15.839713
      9            1.000000       0.790000       -1.22674      16.454334
     10            1.000000       0.790000       -2.22111      16.349821
     11            1.000000       0.790000       -7.81327      14.532821
     12            1.000000       0.790000       -8.67916      14.032897
     13            1.000000       0.790000      -13.04880      10.098451
     14            1.000000       0.790000      -13.63650       9.289557
     15            1.000000       0.790000      -16.02809       3.917967
     16            1.000000       0.790000      -16.23597       2.939969
     17            1.000000       0.790000      -16.23597       -2.93997
     18            1.000000       0.790000      -16.02809       -3.91797
     19            1.000000       0.790000      -13.63650       -9.28956
     20            1.000000       0.790000      -13.04880      -10.09845
     21            1.000000       0.790000       -8.67916      -14.03290
     22            1.000000       0.790000       -7.81327      -14.53282
     23            1.000000       0.790000       -2.22111      -16.34982
     24            1.000000       0.790000       -1.22674      -16.45433
     25            1.000000       0.790000       4.620984      -15.83971
     26            1.000000       0.790000       5.571895      -15.53074
     27            1.000000       0.790000      10.664071      -12.59077
     28            1.000000       0.790000      11.407102      -11.92175
     29            1.000000       0.790000      14.863243       -7.16478
     30            1.000000       0.790000      15.269917       -6.25137


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  4.880 inches
between bars 26 and 27.

Ratio of bar spacing to maximum aggregate size = 6.51


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =         4000. psi
Modulus of Elasticity of Concrete                      =      3604997. psi
Modulus of Rupture of Concrete                         =    -474.34165 psi
Compression Strain at Peak Stress                      =      0.001886
Tensile Strain at Fracture of Concrete                 =    -0.0001154
Maximum Coarse Aggregate Size                          =      0.750000 in
```

```
Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 2
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max. 
Tens.
  No.              kips                 in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1               625.000            31653.953           0.00300000
-0.00706375

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend. 
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at 
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
------------
   1      0.65         625.000000        31654.    406.250000        20575.
338901917.
```

```
   1       0.75         625.000000        31654.    468.750000        23740.
313562898.

   1       0.90         625.000000        31654.    562.500000        28489.
261677048.



--------------------------------------------------------------------------------
           Layering Correction Equivalent Depths of Soil & Rock Layers
--------------------------------------------------------------------------------

         Top of    Equivalent
          Layer     Top Depth  Same Layer  Layer is        F0          F1
Layer     Below       Below      Type As    Rock or     Integral    Integral
 No.    Pile Head   Grnd Surf     Layer    is Below    for Layer   for Layer
           ft          ft         Above    Rock Layer      lbs         lbs
-----  ----------  ----------  ----------  ----------  ----------  ----------
  1       18.7000        0.00      N.A.        No            0.00     948431.
  2       39.7000     21.0000      Yes         No         948431.     531833.
  3       43.7000    373.8522      No          No        1480264.      77161.
  4       48.7000     25.9145      No          No        1557425.      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.



--------------------------------------------------------------------------------
            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            Pile-head      Pile-head      Max Shear     Max Moment
Case   Load    Deflection      Rotation        in Pile        in Pile
 No.   Type      inches         radians          lbs           in-lbs
----   ----   ------------   ------------   ------------   ------------
  1      5       0.250000        0.0000        44853.      -8834521.
  2      5       0.500000        0.0000        71649.     -12727180.
```

```
   3      5      0.750000        0.0000        85970.     -15478440.
   4      5      1.000000        0.0000        99481.     -17966544.
   5      5      1.250000        0.0000       111468.     -20206720.
   6      5      1.500000        0.0000       122431.     -22296092.
   7      5      1.750000        0.0000       132383.     -24230790.
   8      5      2.000000        0.0000       140624.     -25745545.


 Maximum pile-head deflection = 2.0000000000 inches
 Maximum pile-head rotation   = 0.0000000000 radians = 0.000000 deg.

 The analysis ended normally.
```

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                     License Type : (Enterprise Cloud License)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
                           © 1985-2024 by Ensoft, Inc.
                               All Rights Reserved

                This software is licensed for exclusive use by:
                                    Terracon


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


This model was prepared by:
Maren Tanberg




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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-5 Pier Fixed Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-5 Pier Fixed Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-5 Pier Fixed Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-5 Pier Fixed Model with Scour 1.05 steel.lp12r

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



Piers: 6-ft Diameter Shaft, Pinned with Scour and Permanent Casing

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                    License Type : (Enterprise Cloud License)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
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                This software is licensed for exclusive use by:
                                    Terracon


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


This model was prepared by:
Maren Tanberg




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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-5 Pier Pinned Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-5 Pier Pinned Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-5 Pier Pinned Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-5 Pier Pinned Model with Scour 1.05 steel.lp12r

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

```
               Date:  July 14, 2026               Time:  10:52:46


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

Project Name: Eckert Road Bridge over Boise River



Job Number: 62235109A



Client: LHTAC



Engineer: M.J. Tanberg



Description: Piers - B-5, Pinned model with scour





--------------------------------------------------------------------------------
                          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

 - Use of p-y modification factors for p-y curves not selected
```

```
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - 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.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using narrow report formats
   (Note: Some output information is omitted from the narrow report formats)




--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            1
Total length of pile                                   =       89.100 ft
Depth of ground surface below top of pile              =      14.6000 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.

            Depth Below           Pile
Point        Pile Head          Diameter
 No.            feet             inches
-----      -------------     -------------
  1             0.000           72.0000
  2            89.100           72.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =    89.100000 ft
   Shaft Diameter                                      =    72.000000 in
```

```
--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    14.600000 ft
   Distance from top of pile to bottom of layer        =    23.100000 ft
   Effective unit weight at top of layer               =    72.000000 pcf
   Effective unit weight at bottom of layer            =    72.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    23.100000 ft
   Distance from top of pile to bottom of layer        =    65.600000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer           =    65.600000 ft
   Distance from top of pile to bottom of layer        =    70.600000 ft
   Effective unit weight at top of layer               =    47.000000 pcf
   Effective unit weight at bottom of layer            =    47.000000 pcf
   Undrained cohesion at top of layer                  =        4000. psf
   Undrained cohesion at bottom of layer               =        4000. psf
   Epsilon-50 at top of layer                          =       0.0000
   Epsilon-50 at bottom of layer                       =       0.0000
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for Epsilon-50 will be computed for this layer.

   NOTE: Default values for subgrade k will be computed for this layer.
```

```
Layer 4 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    70.600000 ft
   Distance from top of pile to bottom of layer        =    89.100000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

 (Depth of the lowest soil layer extends 0.000 ft below the pile tip)



--------------------------------------------------------------------------------
                               Static Loading Type
--------------------------------------------------------------------------------

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



--------------------------------------------------------------------------------
                Pile-head Loading and Pile-head Fixity Conditions
--------------------------------------------------------------------------------

Number of loads specified = 8

Load    Load       Condition              Condition            Axial Thrust
 No.    Type           1                       2                 Force, lbs
-----   ----   --------------------   -----------------------   ----------------
   1     4     y =     0.250000 in    M =       0.0000 in-lbs         1167000.
   2     4     y =     0.500000 in    M =       0.0000 in-lbs         1167000.
   3     4     y =     0.750000 in    M =       0.0000 in-lbs         1167000.
   4     4     y =     1.000000 in    M =       0.0000 in-lbs         1167000.
   5     4     y =     1.250000 in    M =       0.0000 in-lbs         1167000.
   6     4     y =     1.500000 in    M =       0.0000 in-lbs         1167000.
   7     4     y =     1.750000 in    M =       0.0000 in-lbs         1167000.
   8     4     y =     2.000000 in    M =       0.0000 in-lbs         1167000.

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
```

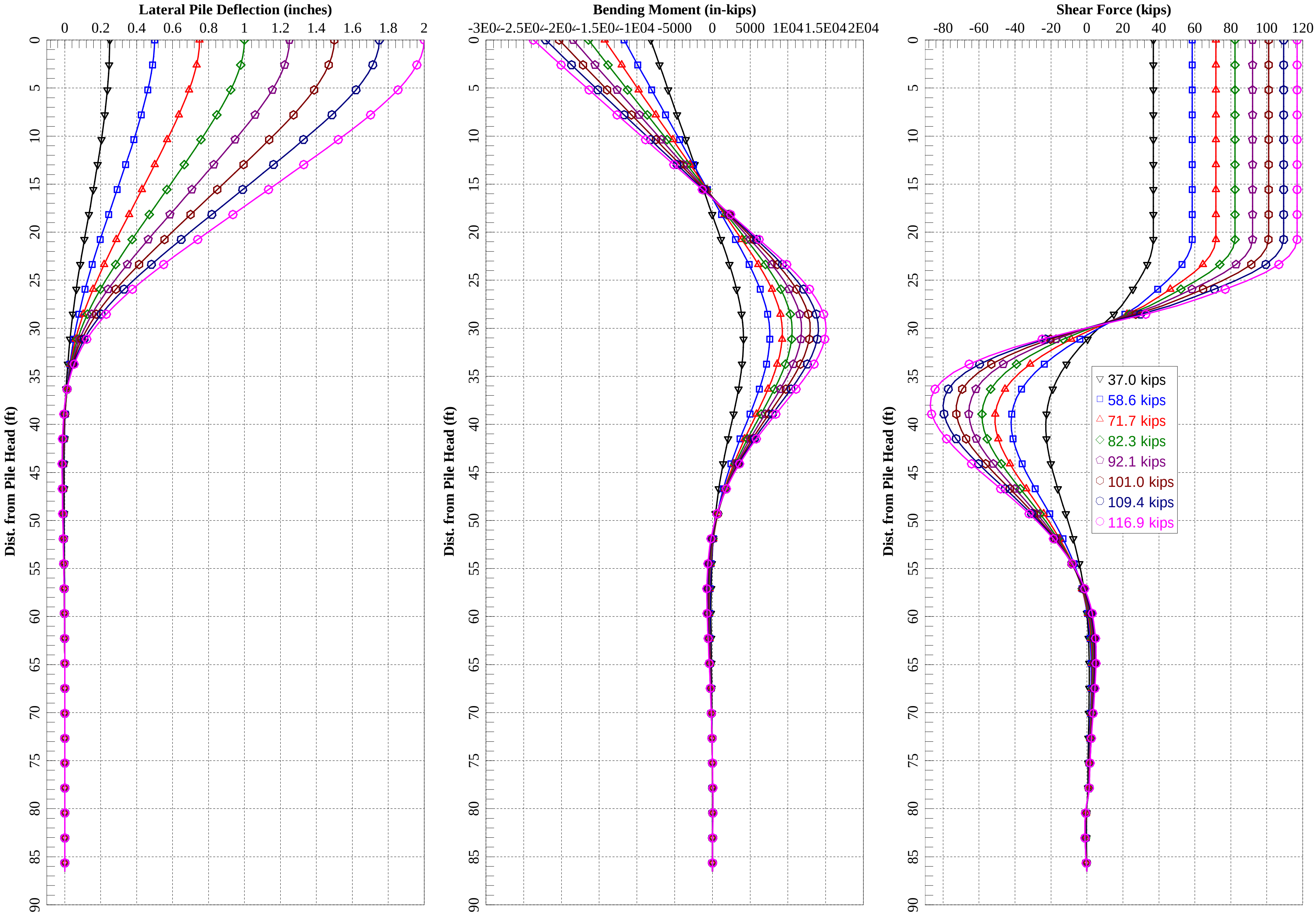
```
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.



--------------------------------------------------------------------------------
     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:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =    89.100000 ft
Shaft Diameter                                         =    72.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           54 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        4072. sq. in.
Total Area of Reinforcing Steel                        =    42.660000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     4.623090 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         6.16
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =    16257.670 kips
Tensile Load for Cracking of Concrete                  =    -1818.364 kips
Nominal Axial Tensile Capacity                         =    -2559.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area          X              Y
```

```
  Number         inches         sq. in.        inches         inches
----------     ----------     ----------     ----------     ----------
    1            1.000000       0.790000      28.495614       -0.49997
    2            1.000000       0.790000      28.495614       0.499974
    3            1.000000       0.790000      27.842813       6.085043
    4            1.000000       0.790000      27.612209       7.058038
    5            1.000000       0.790000      25.688999      12.342015
    6            1.000000       0.790000      25.240223      13.235602
    7            1.000000       0.790000      22.150284      17.933625
    8            1.000000       0.790000      21.507530      18.699630
    9            1.000000       0.790000      17.417442      22.558429
   10            1.000000       0.790000      16.615360      23.155557
   11            1.000000       0.790000      11.745621      25.967102
   12            1.000000       0.790000      10.827452      26.363162
   13            1.000000       0.790000       5.440590      27.975882
   14            1.000000       0.790000       4.455833      28.149521
   15            1.000000       0.790000       -1.15774      28.476475
   16            1.000000       0.790000       -2.15600      28.418333
   17            1.000000       0.790000       -7.69366      27.441894
   18            1.000000       0.790000       -8.65160      27.155105
   19            1.000000       0.790000      -13.81482      24.927913
   20            1.000000       0.790000      -14.68080      24.427939
   21            1.000000       0.790000      -19.19121      21.070062
   22            1.000000       0.790000      -19.91855      20.383855
   23            1.000000       0.790000      -23.53300      16.076318
   24            1.000000       0.790000      -24.08248      15.240873
   25            1.000000       0.790000      -26.60612      10.215896
   26            1.000000       0.790000      -26.94812       9.276252
   27            1.000000       0.790000      -28.24489       3.804733
   28            1.000000       0.790000      -28.36098       2.811545
   29            1.000000       0.790000      -28.36098       -2.81155
   30            1.000000       0.790000      -28.24489       -3.80473
   31            1.000000       0.790000      -26.94812       -9.27625
   32            1.000000       0.790000      -26.60612      -10.21590
   33            1.000000       0.790000      -24.08248      -15.24087
   34            1.000000       0.790000      -23.53300      -16.07632
   35            1.000000       0.790000      -19.91855      -20.38386
   36            1.000000       0.790000      -19.19121      -21.07006
   37            1.000000       0.790000      -14.68080      -24.42794
   38            1.000000       0.790000      -13.81482      -24.92791
   39            1.000000       0.790000       -8.65160      -27.15511
   40            1.000000       0.790000       -7.69366      -27.44189
   41            1.000000       0.790000       -2.15600      -28.41833
   42            1.000000       0.790000       -1.15774      -28.47648
   43            1.000000       0.790000       4.455833      -28.14952
   44            1.000000       0.790000       5.440590      -27.97588
   45            1.000000       0.790000      10.827452      -26.36316
   46            1.000000       0.790000      11.745621      -25.96710
   47            1.000000       0.790000      16.615360      -23.15556
   48            1.000000       0.790000      17.417442      -22.55843
```

```
     49            1.000000       0.790000      21.507530      -18.69963
     50            1.000000       0.790000      22.150284      -17.93363
     51            1.000000       0.790000      25.240223      -13.23560
     52            1.000000       0.790000      25.688999      -12.34201
     53            1.000000       0.790000      27.612209       -7.05804
     54            1.000000       0.790000      27.842813       -6.08504


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  4.623 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 6.16


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             1167.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                  in-kip              Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1            1167.000            95280.837          0.00300000
-0.00860590
```

```
Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                     kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
------------
   1      0.65             1167.        95281.    758.550000        61933.
1.6443E+09

   1      0.75             1167.        95281.    875.250000        71461.
1.5286E+09

   1      0.90             1167.        95281.         1050.        85753.
1.1972E+09



--------------------------------------------------------------------------------
           Layering Correction Equivalent Depths of Soil & Rock Layers
--------------------------------------------------------------------------------

         Top of    Equivalent
          Layer     Top Depth  Same Layer  Layer is        F0          F1
Layer    Below       Below      Type As    Rock or     Integral    Integral
 No.   Pile Head   Grnd Surf    Layer     is Below    for Layer   for Layer
           ft          ft         Above    Rock Layer      lbs         lbs
-----  ----------  ----------  ----------  ----------  ----------  ----------
  1       14.6000        0.00      N.A.        No            0.00    261558.
  2       23.1000      8.5000      Yes         No         261558.   1.05E+07
  3       65.6000    860.6052      No          No        1.07E+07    115742.
  4       70.6000     52.1444      No          No        1.08E+07      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.



--------------------------------------------------------------------------------
            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                Pile-head      Pile-head      Max Shear     Max Moment
Case   Load       Deflection      Rotation        in Pile        in Pile
 No.   Type         inches         radians          lbs          in-lbs
----   ----   ------------   ------------   ------------   ------------
  1      4       0.250000     -0.0008414         54977.      13963097.
  2      4       0.500000       -0.00168        104941.      26694546.
  3      4       0.750000       -0.00257        122812.      30830597.
  4      4       1.000000       -0.00347        142360.      35644930.
  5      4       1.250000       -0.00436        160325.      40143312.
  6      4       1.500000       -0.00527        176779.      44382098.
  7      4       1.750000       -0.00618       -194392.      48466584.
  8      4       2.000000       -0.00709       -214096.      52378350.


Maximum pile-head deflection = 2.0000000000 inches
Maximum pile-head rotation   = -0.0070856104 radians = -0.405976 deg.

The analysis ended normally.
```



Abutment 2: 4-ft Diameter Shaft, Fixed with Scour

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                    License Type : (Enterprise Cloud License)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
                           © 1985-2024 by Ensoft, Inc.
                               All Rights Reserved

                This software is licensed for exclusive use by:
                                    Terracon


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


This model was prepared by:
Maren Tanberg





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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-6 Abutment 2 Fixed Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-6 Abutment 2 Fixed Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-6 Abutment 2 Fixed Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-6 Abutment 2 Fixed Model with Scour 1.05 steel.lp12r

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

```
               Date:  March 20, 2026            Time:  11:05:57


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

Project Name: Eckert Road Bridge over Boise River



Job Number: 62235109B



Client: LHTAC



Engineer: M.J. Tanberg



Description: Abutment 1, B-2, Fixed model with scour





--------------------------------------------------------------------------------
                          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

 - Use of p-y modification factors for p-y curves not selected
```

```
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - 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.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using narrow report formats
   (Note: Some output information is omitted from the narrow report formats)




--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            2
Total length of pile                                   =       86.500 ft
Depth of ground surface below top of pile              =      20.7000 ft

Pile diameters used for p-y curve computations are defined using 4 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.

            Depth Below           Pile
Point        Pile Head          Diameter
 No.            feet             inches
-----      -------------     -------------
  1             0.000           48.0000
  2             9.000           48.0000
  3             9.000           48.0000
  4            86.500           48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =     9.000000 ft
```

```
   Shaft Diameter                                      =    48.000000 in

Pile Section No. 2:

   Section 2 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =    77.500000 ft
   Shaft Diameter                                      =    48.000000 in



--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    20.700000 ft
   Distance from top of pile to bottom of layer        =    27.700000 ft
   Effective unit weight at top of layer               =    62.000000 pcf
   Effective unit weight at bottom of layer            =    62.000000 pcf
   Friction angle at top of layer                      =    34.000000 deg.
   Friction angle at bottom of layer                   =    34.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    27.700000 ft
   Distance from top of pile to bottom of layer        =    40.200000 ft
   Effective unit weight at top of layer               =    72.000000 pcf
   Effective unit weight at bottom of layer            =    72.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    40.200000 ft
   Distance from top of pile to bottom of layer        =    78.200000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
```

```
   Subgrade k at top of layer                            =      0.0000 pci
   Subgrade k at bottom of layer                         =      0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 4 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer             =   78.200000 ft
   Distance from top of pile to bottom of layer          =   86.700000 ft
   Effective unit weight at top of layer                 =   47.000000 pcf
   Effective unit weight at bottom of layer              =   47.000000 pcf
   Undrained cohesion at top of layer                    =       4000. psf
   Undrained cohesion at bottom of layer                 =       4000. psf
   Epsilon-50 at top of layer                            =      0.0000
   Epsilon-50 at bottom of layer                         =      0.0000
   Subgrade k at top of layer                            =      0.0000 pci
   Subgrade k at bottom of layer                         =      0.0000 pci

   NOTE: Default values for Epsilon-50 will be computed for this layer.

   NOTE: Default values for subgrade k will be computed for this layer.

 (Depth of the lowest soil layer extends 0.200 ft below the pile tip)



--------------------------------------------------------------------------------
                               Static Loading Type
--------------------------------------------------------------------------------

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



--------------------------------------------------------------------------------
                Pile-head Loading and Pile-head Fixity Conditions
--------------------------------------------------------------------------------

Number of loads specified = 8

Load    Load        Condition              Condition            Axial Thrust
 No.    Type            1                      2                 Force, lbs
-----   ----   --------------------   ----------------------   ----------------
   1     5     y =     0.250000 in    S =       0.0000 in/in            625000.
   2     5     y =     0.500000 in    S =       0.0000 in/in            625000.
   3     5     y =     0.750000 in    S =       0.0000 in/in            625000.
   4     5     y =     1.000000 in    S =       0.0000 in/in            625000.
   5     5     y =     1.250000 in    S =       0.0000 in/in            625000.
   6     5     y =     1.500000 in    S =       0.0000 in/in            625000.
   7     5     y =     1.750000 in    S =       0.0000 in/in            625000.
```

```
   8     5     y =     2.000000 in    S =      0.0000 in/in            625000.

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 = 2

Pile Section No. 1:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =     9.000000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           24 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     6.571329 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         8.76
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------
```

```
Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7225.631 kips
Tensile Load for Cracking of Concrete                  =     -808.162 kips
Nominal Axial Tensile Capacity                         =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area          X              Y
    Number         inches         sq. in.        inches         inches
  ----------     ----------     ----------     ----------     ----------
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      14.532821       7.813266
      4            1.000000       0.790000      14.032897       8.679159
      5            1.000000       0.790000       8.679159      14.032897
      6            1.000000       0.790000       7.813266      14.532821
      7            1.000000       0.790000       0.499923      16.492425
      8            1.000000       0.790000       -0.49992      16.492425
      9            1.000000       0.790000       -7.81327      14.532821
     10            1.000000       0.790000       -8.67916      14.032897
     11            1.000000       0.790000      -14.03290       8.679159
     12            1.000000       0.790000      -14.53282       7.813266
     13            1.000000       0.790000      -16.49242       0.499923
     14            1.000000       0.790000      -16.49242       -0.49992
     15            1.000000       0.790000      -14.53282       -7.81327
     16            1.000000       0.790000      -14.03290       -8.67916
     17            1.000000       0.790000       -8.67916      -14.03290
     18            1.000000       0.790000       -7.81327      -14.53282
     19            1.000000       0.790000       -0.49992      -16.49242
     20            1.000000       0.790000       0.499923      -16.49242
     21            1.000000       0.790000       7.813266      -14.53282
     22            1.000000       0.790000       8.679159      -14.03290
     23            1.000000       0.790000      14.032897       -8.67916
     24            1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
```

```
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                 in-kip              Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1              625.000            28274.447          0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
```

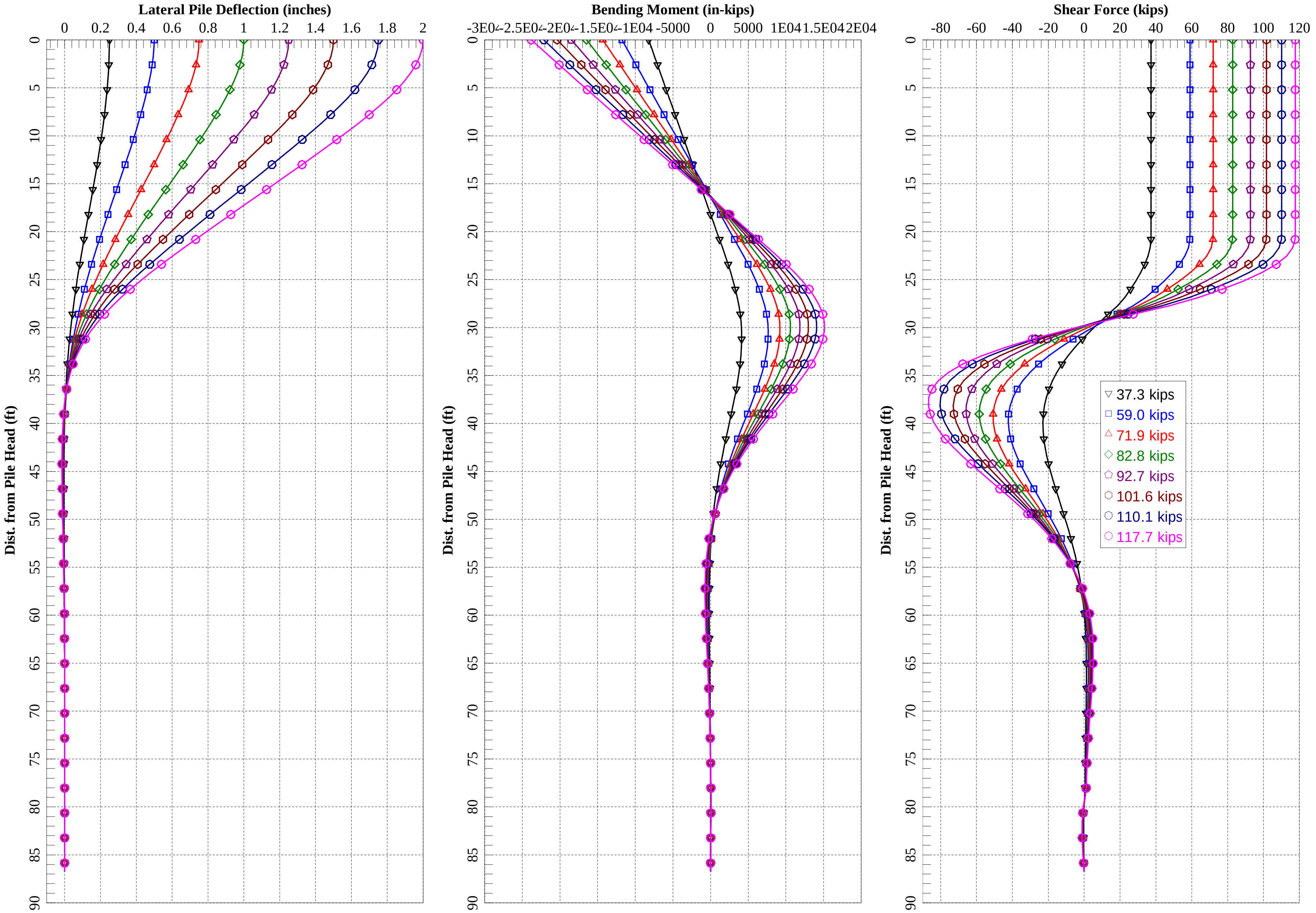
```
------------
   1      0.65        625.000000       28274.    406.250000       18378.
317082032.

   1      0.75        625.000000       28274.    468.750000       21206.
288182048.

   1      0.90        625.000000       28274.    562.500000       25447.
233661944.


Pile Section No. 2:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                          =   77.500000 ft
Shaft Diameter                                             =   48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)       =    6.000000 in
Number of Reinforcing Bars                                 =          24 bars
Yield Stress of Reinforcing Bars                           =      60000. psi
Modulus of Elasticity of Reinforcing Bars                  =   29000000. psi
Gross Area of Shaft                                        =       1810. sq. in.
Total Area of Reinforcing Steel                            =   18.960000 sq. in.
Area Ratio of Steel Reinforcement                          =        1.05 percent
Edge-to-Edge Bar Spacing                                   =    6.571329 in
Maximum Concrete Aggregate Size                            =    0.750000 in
Ratio of Bar Spacing to Aggregate Size                     =        8.76
Offset of Center of Rebar Cage from Center of Pile        =      0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)                  =           1
Spacing of Transverse Reinf.                               =    7.000000 in
Yield Stress of Transverse Reinf.                          =      60000. psi
Diameter of Transverse Reinf.                              =    1.000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As       =    7225.631 kips
Tensile Load for Cracking of Concrete                      =    -808.162 kips
Nominal Axial Tensile Capacity                             =   -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar         Bar Diam.      Bar Area         X             Y
    Number        inches         sq. in.       inches        inches
  ----------    ----------    ----------    ----------    ----------
```

```
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      14.532821       7.813266
      4            1.000000       0.790000      14.032897       8.679159
      5            1.000000       0.790000       8.679159      14.032897
      6            1.000000       0.790000       7.813266      14.532821
      7            1.000000       0.790000       0.499923      16.492425
      8            1.000000       0.790000       -0.49992      16.492425
      9            1.000000       0.790000       -7.81327      14.532821
     10            1.000000       0.790000       -8.67916      14.032897
     11            1.000000       0.790000      -14.03290       8.679159
     12            1.000000       0.790000      -14.53282       7.813266
     13            1.000000       0.790000      -16.49242       0.499923
     14            1.000000       0.790000      -16.49242       -0.49992
     15            1.000000       0.790000      -14.53282       -7.81327
     16            1.000000       0.790000      -14.03290       -8.67916
     17            1.000000       0.790000       -8.67916      -14.03290
     18            1.000000       0.790000       -7.81327      -14.53282
     19            1.000000       0.790000       -0.49992      -16.49242
     20            1.000000       0.790000       0.499923      -16.49242
     21            1.000000       0.790000       7.813266      -14.53282
     22            1.000000       0.790000       8.679159      -14.03290
     23            1.000000       0.790000      14.032897       -8.67916
     24            1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                       =        4000. psi
Modulus of Elasticity of Concrete                      =     3604997. psi
Modulus of Rupture of Concrete                         =   -474.34165 psi
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
```

```
      1              625.000


-------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 2
-------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                  in-kip                Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1              625.000             28274.447           0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
------------
   1      0.65         625.000000        28274.    406.250000        18378.
317082032.

   1      0.75         625.000000        28274.    468.750000        21206.
288182048.

   1      0.90         625.000000        28274.    562.500000        25447.
233661944.
```

```
--------------------------------------------------------------------------------
           Layering Correction Equivalent Depths of Soil & Rock Layers
--------------------------------------------------------------------------------

         Top of    Equivalent
          Layer     Top Depth  Same Layer  Layer is        F0          F1
Layer     Below       Below      Type As    Rock or     Integral    Integral
 No.    Pile Head   Grnd Surf     Layer     is Below    for Layer   for Layer
           ft          ft         Above    Rock Layer      lbs         lbs
-----  ----------  ----------  ----------  ----------  ----------  ----------
  1       20.7000        0.00      N.A.        No            0.00      78551.
  2       27.7000      6.1256      Yes         No          78551.     658218.
  3       40.2000     18.2066      Yes         No         736768.    1.31E+07
  4       78.2000       1279.      No          No        1.38E+07      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.



--------------------------------------------------------------------------------
            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            Pile-head      Pile-head      Max Shear     Max Moment
Case   Load    Deflection      Rotation        in Pile        in Pile
 No.   Type      inches         radians          lbs          in-lbs
----   ----   ------------   ------------   ------------   ------------
  1      5       0.250000         0.0000         36958.      -8162964.
  2      5       0.500000         0.0000         58556.     -11716462.
  3      5       0.750000         0.0000         71746.     -14276020.
  4      5       1.000000         0.0000         82331.     -16420249.
  5      5       1.250000         0.0000         92149.     -18430632.
  6      5       1.500000         0.0000        101036.     -20295759.
  7      5       1.750000         0.0000        109399.     -22088841.
  8      5       2.000000         0.0000        116908.     -23720589.
```

```
Maximum pile-head deflection = 2.0000000000 inches
Maximum pile-head rotation   = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.
```



Abutment 2: 4-ft Diameter Shaft, Pinned with Scour

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

                            LPile Version 2022-12.013

                             License ID : 5831629170
                    License Type : (Enterprise Cloud License)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
                           © 1985-2024 by Ensoft, Inc.
                               All Rights Reserved

                This software is licensed for exclusive use by:
                                    Terracon


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


This model was prepared by:
Maren Tanberg




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

Path to file locations on this computer:
\Users\mjtanberg\OneDrive - Terracon Consultants Inc\62235109B Bridge Key 12810;
 Eckert Road over Boise River - General\07 Working Files\02 Calculations\Boise R
iver Bridge\UPDATED CALCS 26.02.20\

Name of the input data file:
B-6 Abutment 2 Pinned Model with Scour 1.05 steel.lp12d

Name of the output report file:
B-6 Abutment 2 Pinned Model with Scour 1.05 steel.lp12o

Name of the plot output file:
B-6 Abutment 2 Pinned Model with Scour 1.05 steel.lp12p

Name of the runtime message file:
B-6 Abutment 2 Pinned Model with Scour 1.05 steel.lp12r

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

```
               Date:  March 20, 2026              Time:  11:33:58


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

Project Name: Eckert Road Bridge over Boise River



Job Number: 62235109B



Client: LHTAC



Engineer: M.J. Tanberg



Description: Abutment 1, B-2, Fixed model with scour





--------------------------------------------------------------------------------
                          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

 - Use of p-y modification factors for p-y curves not selected
```

```
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - 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.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using narrow report formats
   (Note: Some output information is omitted from the narrow report formats)




--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            2
Total length of pile                                   =       86.700 ft
Depth of ground surface below top of pile              =      20.7000 ft

Pile diameters used for p-y curve computations are defined using 4 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.

            Depth Below          Pile
Point        Pile Head         Diameter
 No.            feet            inches
-----      -------------     -------------
  1             0.000          48.0000
  2             9.000          48.0000
  3             9.000          48.0000
  4            86.700          48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =     9.000000 ft
```

```
   Shaft Diameter                                      =    48.000000 in

Pile Section No. 2:

   Section 2 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =    77.700000 ft
   Shaft Diameter                                      =    48.000000 in



--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    20.700000 ft
   Distance from top of pile to bottom of layer        =    27.700000 ft
   Effective unit weight at top of layer               =    62.000000 pcf
   Effective unit weight at bottom of layer            =    62.000000 pcf
   Friction angle at top of layer                      =    34.000000 deg.
   Friction angle at bottom of layer                   =    34.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    27.700000 ft
   Distance from top of pile to bottom of layer        =    40.200000 ft
   Effective unit weight at top of layer               =    72.000000 pcf
   Effective unit weight at bottom of layer            =    72.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is sand, p-y criteria by API RP-2A, 1987

   Distance from top of pile to top of layer           =    40.200000 ft
   Distance from top of pile to bottom of layer        =    78.200000 ft
   Effective unit weight at top of layer               =    52.000000 pcf
   Effective unit weight at bottom of layer            =    52.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
```

```
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for subgrade k will be computed for this layer.

Layer 4 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer           =    78.200000 ft
   Distance from top of pile to bottom of layer        =    86.700000 ft
   Effective unit weight at top of layer               =    47.000000 pcf
   Effective unit weight at bottom of layer            =    47.000000 pcf
   Undrained cohesion at top of layer                  =        4000. psf
   Undrained cohesion at bottom of layer               =        4000. psf
   Epsilon-50 at top of layer                          =       0.0000
   Epsilon-50 at bottom of layer                       =       0.0000
   Subgrade k at top of layer                          =       0.0000 pci
   Subgrade k at bottom of layer                       =       0.0000 pci

   NOTE: Default values for Epsilon-50 will be computed for this layer.

   NOTE: Default values for subgrade k will be computed for this layer.

 (Depth of the lowest soil layer extends 0.000 ft below the pile tip)



--------------------------------------------------------------------------------
                               Static Loading Type
--------------------------------------------------------------------------------

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



--------------------------------------------------------------------------------
                Pile-head Loading and Pile-head Fixity Conditions
--------------------------------------------------------------------------------

Number of loads specified = 8

Load    Load         Condition               Condition            Axial Thrust
 No.    Type             1                       2                 Force, lbs
-----   ----   --------------------   -----------------------   ----------------
   1     5     y =     0.250000 in    S =       0.0000 in/in            625000.
   2     5     y =     0.500000 in    S =       0.0000 in/in            625000.
   3     5     y =     0.750000 in    S =       0.0000 in/in            625000.
   4     5     y =     1.000000 in    S =       0.0000 in/in            625000.
   5     5     y =     1.250000 in    S =       0.0000 in/in            625000.
   6     5     y =     1.500000 in    S =       0.0000 in/in            625000.
   7     5     y =     1.750000 in    S =       0.0000 in/in            625000.
```

```
   8     5     y =     2.000000 in    S =       0.0000 in/in            625000.

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 = 2

Pile Section No. 1:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                      =     9.000000 ft
Shaft Diameter                                         =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)    =     6.000000 in
Number of Reinforcing Bars                             =           24 bars
Yield Stress of Reinforcing Bars                       =       60000. psi
Modulus of Elasticity of Reinforcing Bars              =    29000000. psi
Gross Area of Shaft                                    =        1810. sq. in.
Total Area of Reinforcing Steel                        =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                      =         1.05 percent
Edge-to-Edge Bar Spacing                               =     6.571329 in
Maximum Concrete Aggregate Size                        =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                 =         8.76
Offset of Center of Rebar Cage from Center of Pile     =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)              =            1
Spacing of Transverse Reinf.                           =     7.000000 in
Yield Stress of Transverse Reinf.                      =       60000. psi
Diameter of Transverse Reinf.                          =     1.000000 in

Axial Structural Capacities:
----------------------------
```

```
Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =     7225.631 kips
Tensile Load for Cracking of Concrete                   =     -808.162 kips
Nominal Axial Tensile Capacity                          =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area          X              Y
    Number         inches         sq. in.        inches         inches
  ----------     ----------     ----------     ----------     ----------
      1            1.000000       0.790000      16.492425       -0.49992
      2            1.000000       0.790000      16.492425       0.499923
      3            1.000000       0.790000      14.532821       7.813266
      4            1.000000       0.790000      14.032897       8.679159
      5            1.000000       0.790000       8.679159      14.032897
      6            1.000000       0.790000       7.813266      14.532821
      7            1.000000       0.790000       0.499923      16.492425
      8            1.000000       0.790000       -0.49992      16.492425
      9            1.000000       0.790000       -7.81327      14.532821
     10            1.000000       0.790000       -8.67916      14.032897
     11            1.000000       0.790000      -14.03290       8.679159
     12            1.000000       0.790000      -14.53282       7.813266
     13            1.000000       0.790000      -16.49242       0.499923
     14            1.000000       0.790000      -16.49242       -0.49992
     15            1.000000       0.790000      -14.53282       -7.81327
     16            1.000000       0.790000      -14.03290       -8.67916
     17            1.000000       0.790000       -8.67916      -14.03290
     18            1.000000       0.790000       -7.81327      -14.53282
     19            1.000000       0.790000       -0.49992      -16.49242
     20            1.000000       0.790000       0.499923      -16.49242
     21            1.000000       0.790000       7.813266      -14.53282
     22            1.000000       0.790000       8.679159      -14.03290
     23            1.000000       0.790000      14.032897       -8.67916
     24            1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                        =        4000. psi
Modulus of Elasticity of Concrete                       =     3604997. psi
Modulus of Rupture of Concrete                          =   -474.34165 psi
```

```
Compression Strain at Peak Stress                      =     0.001886
Tensile Strain at Fracture of Concrete                 =   -0.0001154
Maximum Coarse Aggregate Size                          =     0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.               kips                 in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1               625.000             28274.447           0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
```

```
------------
   1       0.65         625.000000        28274.    406.250000        18378.
317082032.

   1       0.75         625.000000        28274.    468.750000        21206.
288182048.

   1       0.90         625.000000        28274.    562.500000        25447.
233661944.


Pile Section No. 2:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                       =    77.700000 ft
Shaft Diameter                                          =    48.000000 in
Concrete Cover Thickness (to edge of trans. reinf.)     =     6.000000 in
Number of Reinforcing Bars                              =           24 bars
Yield Stress of Reinforcing Bars                        =       60000. psi
Modulus of Elasticity of Reinforcing Bars               =    29000000. psi
Gross Area of Shaft                                     =        1810. sq. in.
Total Area of Reinforcing Steel                         =    18.960000 sq. in.
Area Ratio of Steel Reinforcement                       =         1.05 percent
Edge-to-Edge Bar Spacing                                =     6.571329 in
Maximum Concrete Aggregate Size                         =     0.750000 in
Ratio of Bar Spacing to Aggregate Size                  =         8.76
Offset of Center of Rebar Cage from Center of Pile      =       0.0000 in
Transverse Reinforcement
Type: Hoop
Number of Transverse Reinf. (per spacing)               =            1
Spacing of Transverse Reinf.                            =     7.000000 in
Yield Stress of Transverse Reinf.                       =       60000. psi
Diameter of Transverse Reinf.                           =     1.000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As     =     7225.631 kips
Tensile Load for Cracking of Concrete                   =     -808.162 kips
Nominal Axial Tensile Capacity                          =    -1137.600 kips


Reinforcing Bar Dimensions and Positions Used in Computations:

     Bar          Bar Diam.      Bar Area         X              Y
    Number         inches         sq. in.      inches         inches
  ----------     ----------     ----------     ----------     ----------
```

```
        1          1.000000       0.790000      16.492425       -0.49992
        2          1.000000       0.790000      16.492425       0.499923
        3          1.000000       0.790000      14.532821       7.813266
        4          1.000000       0.790000      14.032897       8.679159
        5          1.000000       0.790000       8.679159      14.032897
        6          1.000000       0.790000       7.813266      14.532821
        7          1.000000       0.790000       0.499923      16.492425
        8          1.000000       0.790000       -0.49992      16.492425
        9          1.000000       0.790000       -7.81327      14.532821
       10          1.000000       0.790000       -8.67916      14.032897
       11          1.000000       0.790000      -14.03290       8.679159
       12          1.000000       0.790000      -14.53282       7.813266
       13          1.000000       0.790000      -16.49242       0.499923
       14          1.000000       0.790000      -16.49242       -0.49992
       15          1.000000       0.790000      -14.53282       -7.81327
       16          1.000000       0.790000      -14.03290       -8.67916
       17          1.000000       0.790000       -8.67916      -14.03290
       18          1.000000       0.790000       -7.81327      -14.53282
       19          1.000000       0.790000       -0.49992      -16.49242
       20          1.000000       0.790000       0.499923      -16.49242
       21          1.000000       0.790000       7.813266      -14.53282
       22          1.000000       0.790000       8.679159      -14.03290
       23          1.000000       0.790000      14.032897       -8.67916
       24          1.000000       0.790000      14.532821       -7.81327


NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero =  6.571 inches
between bars 18 and 19.

Ratio of bar spacing to maximum aggregate size = 8.76


Concrete Properties:
--------------------

Compressive Strength of Concrete                          =       4000. psi
Modulus of Elasticity of Concrete                         =    3604997. psi
Modulus of Rupture of Concrete                            =  -474.34165 psi
Compression Strain at Peak Stress                         =    0.001886
Tensile Strain at Fracture of Concrete                    =  -0.0001154
Maximum Coarse Aggregate Size                             =    0.750000 in


Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

   Number     Axial Thrust Force
                   kips
   ------     ------------------
```

```
      1              625.000


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 2
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.      Max.
Tens.
  No.              kips                 in-kip               Strain
Strain
 ----         ----------------     ------------------     ------------
------------
   1              625.000             28274.447          0.00300000
-0.00759260

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kips         in-kips        kips         in-kips
kip-in^2
-----  ------------   ------------  ------------  ------------  ------------
------------
   1       0.65         625.000000        28274.    406.250000        18378.
317082032.

   1       0.75         625.000000        28274.    468.750000        21206.
288182048.

   1       0.90         625.000000        28274.    562.500000        25447.
233661944.
```

```
--------------------------------------------------------------------------------
           Layering Correction Equivalent Depths of Soil & Rock Layers
--------------------------------------------------------------------------------

         Top of    Equivalent
          Layer     Top Depth  Same Layer  Layer is        F0          F1
Layer     Below       Below     Type As    Rock or     Integral    Integral
 No.    Pile Head   Grnd Surf     Layer     is Below    for Layer   for Layer
           ft          ft         Above    Rock Layer      lbs         lbs
-----  ----------  ----------  ----------  ----------  ----------  ----------
  1       20.7000        0.00      N.A.        No            0.00      78551.
  2       27.7000      6.1256      Yes         No          78551.     658218.
  3       40.2000     18.2066      Yes         No         736768.    1.31E+07
  4       78.2000       1279.      No          No        1.38E+07      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.


--------------------------------------------------------------------------------
            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            Pile-head      Pile-head      Max Shear     Max Moment
Case   Load    Deflection      Rotation        in Pile        in Pile
 No.   Type      inches         radians          lbs          in-lbs
----   ----   ------------   ------------   ------------   ------------
  1      5       0.250000         0.0000         37324.      -8217700.
  2      5       0.500000         0.0000         59013.     -11758371.
  3      5       0.750000         0.0000         71933.     -14313285.
  4      5       1.000000         0.0000         82828.     -16469036.
  5      5       1.250000         0.0000         92737.     -18489920.
  6      5       1.500000         0.0000        101644.     -20358993.
  7      5       1.750000         0.0000        110059.     -22157038.
  8      5       2.000000         0.0000        117666.     -23801816.
```

```
Maximum pile-head deflection = 2.0000000000 inches
Maximum pile-head rotation   = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.
```

APPENDIX D

Contents:

- Supporting Information for Borings
- Unified Soil Classification System

11849 W Executive Dr Ste G
Boise, ID

Supporting Information for Borings

Sampling

- ↕ Auger Cuttings
- ▯ Core
- ⊠ Ring Sampler
- ■ Shelby Tube
- ☒ Standard Penetration Test

Water Level

- ▽ Water Initially Encountered
- ▽ Water Level After a Specified Period of Time
- ▼ Water Level After a Specified Period of Time
- ▨ Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength, Qu (psf)**	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**
Very Loose	0 - 3	0 - 7	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	8 - 21	Soft	500 to 1,000	2 - 4	4 - 9
Medium Dense	10 - 29	22 - 66	Medium Stiff	1,000 to 2,000	4 - 8	9 - 18
Dense	30 - 50	67 - 113	Stiff	2,000 to 4,000	8 - 15	18 - 33
Very Dense	> 50	≥ 114	Very Stiff	4,000 to 8,000	15 - 30	34 - 68
			Hard	> 8,000	> 30	> 69

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots above “A” line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N] Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line	CH	Fat clay [K, L, M]
			PI plots below “A” line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P] Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.