GEOTECHNICAL DESIGN REPORT

19-1436

March 25, 2021

Explorations and Geotechnical Engineering Services

Alder Stream Bridge #3265 Replacement
Route 27 over Alder Stream
Jim Pond Township, Maine
WIN 023104.00

PREPARED FOR:
Erdman Anthony
Attention: Christopher Sichak, P.E.
145 Culver Road, Suite 200
Rochester, NY 14620

S.W.COLE ENGINEERING, INC.

- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
- *GeoEnvironmental Services*
- *Test Boring Explorations*

www.swcole.com

PREPARED BY:
S. W. Cole Engineering, Inc.
26 Coles Crossing Drive
Sidney, ME 04330
T: (207) 626-0600

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Dear Chris:

In accordance with our Phase 1 Proposal, dated October 8, 2019, Phase 1 Contract Addendum dated January 13, 2020 and Phase 2 Proposal, dated June 19, 2020, we have made subsurface explorations for the subject project. The purpose of our services was to obtain subsurface information in order to provide geotechnical parameters and recommendations for foundations and earthwork associated with the proposed construction. The services provided by S. W. Cole Engineering, Inc. (S.W.COLE) and the contents of this report are subject to the limitations in Appendix A.

1.0 INTRODUCTION

1.1 Site Conditions

The project is Alder Stream Bridge (MaineDOT Bridge #3265) carrying Route 27 over Alder Stream in Jim Pond Township, Maine. The site is located within the Alder Stream valley just upstream of its confluence with the Dead River. The site location is shown on the "Site Location Map" attached in Appendix B.

Based on the Historic Geotechnical Report and Bridge Plans provided by Maine Department of Transportation (MaineDOT), we understand the existing crossing was constructed in 1961. Based on the Historic Bridge Plans, we understand the existing structure is a three-span bridge with steel girders and concrete deck supported on concrete abutments and piers. We understand the existing structure is about 128 feet long (end-to-end) and 31 feet wide (out-to-out) with zero skew. Existing plans indicate the abutments are supported on cast-in-place concrete piles and interior piers are supported on untreated timber piles. Based on a 1961 Geotechnical Report, we understand historic borings were terminated on large boulders at depths of about 40 to 50 feet (estimated Elevation 1140 to 1150 feet), prior to placement of existing embankment fills. We understand the Alder Stream channel was diverted and straightened during the 1961 bridge construction. Historic bridge plans suggest the Alder Stream channel bottom was at or about elevation 1180 to 1183 feet at it deepest reach in the vicinity of the current 1961 bridge.

Additionally, we understand the stream meanders within the existing flood plain. A 2017 bridge inspection report indicates the stream has migrated northward and beginning to potentially erode the approach embankment on the northerly side of the bridge.

1.2 Proposed Construction

Based on the Preliminary Design Report (PDR) prepared by Erdman Anthony (EA) dated March 31, 2020, we understand the existing bridge will be replaced with a new 135 foot single-span, Integral Abutment Bridge (IAB) with 6 degree skew supported on a single row of steel H-piles at each abutment. We understand the superstructure will consist of, steel beam girders with a reinforced cast-in-place concrete deck and a 1 inch integral wearing surface. We understand the replacement structure will be constructed on the existing horizontal alignment and will generally match the existing vertical grade (less than 0.5 foot). We understand the proposed abutments will be constructed behind the existing abutments and that the existing abutments will be removed. We understand the bridge will be widened about 2.5 feet for a total out-to-out width of 33.5 feet. We understand the stub abutments and wing walls will consist of cast-in-place concrete walls. We anticipate 1.75H:1V, or flatter, riprap slopes will be placed in front of the new integral stub abutments and wing walls.

We understand during construction of the new bridge, alternating two-way traffic controlled by traffic signals will be maintained on a temporary bridge (special detour) located downstream (east) of the existing bridge.

2.0 EXPLORATIONS AND TESTING

2.1 Explorations

Three test borings (BB-JSMS-102, -102A and -102B) were made at the site between November 20 and December 13, 2019 by S. W. Cole Explorations, LLC (S.W.COLEX). Two test borings (BB-JSMS-101 and -101A) were made at the site between February 11 and 21, 2020 by New England Boring Contractors (NEBC) working under subcontract to S.W.COLE. The exploration locations were selected in consultation with Erdman Anthony and established in the field by S.W.COLE. The “as-drilled” exploration locations are shown on the “Boring Location Plan” attached in Appendix B. Logs of the test borings and a Key to Soil and Rock Descriptions and Terms used on the logs are attached as Appendix C.

2.2 Testing

The test borings were drilled using a combination of solid-stem auger and cased-wash boring drilling techniques. The soils were sampled at 5 foot intervals using a split-spoon sampler and Standard Penetration Testing (SPT) methods using a calibrated automatic hammer. Both the S.W.COLEX and NEBC drill rigs are equipped with automatic hammers to drive the split-spoon sampler. Both hammers were calibrated per ASTM D4633-10 "Standard Test Method for Energy Measurement for Dynamic Penetrometers." Corrected N-values discussed in this report were computed by applying the corresponding average energy transfer factors of 0.977 (for the S.W.COLEX hammer) and 0.904 (for the NEBC hammer) to the raw field N-values. The hammer efficiency factors (0.977 and 0.904), uncorrected SPT blow counts and the uncorrected and corrected SPT N-values are shown on the boring logs provided in Appendix C.

Soils samples recovered from the test borings were visually classified in our laboratory and transported to GeoTesting Express of Acton, Massachusetts, for laboratory testing. Laboratory testing was performed on disturbed SPT samples obtained during the explorations. Laboratory testing was performed in accordance with applicable American Association of State Highway and Transportation Officials (AASHTO) testing procedures. Laboratory testing included 12 natural water content tests, one organic content test, 12 grain size analyses (one with hydrometer and 11 without hydrometer) and one direct shear test. Laboratory testing results are provided in Appendix D.

3.0 SUBSURFACE CONDITIONS

3.1 Surficial and Bedrock Geology

According to the Maine Geological Survey's (MGS's) mapping of the Sherbrooke Quadrangle, Maine[1], surficial geologic units within the site vicinity consist of stream alluvium (sand, gravel and silt), glacial outwash (sand and gravel) and glacial till. The subsurface conditions encountered in the test borings were generally consistent with the mapped surficial geology; however, the explorations also encountered fill soils from previous site development.

Bedrock was not encountered at the test borings to the depths drilled; however, according to MGS[2], bedrock in the site vicinity is mapped as quartzwacke and pelite of the Jim Pond Formation.

3.2 Soil and Bedrock

The test borings encountered a soils profile generally consisting of a surface layer of pavement overlying granular fill overlying stream alluvium overlying glacial till. An "Interpretive Subsurface

[1] Caldwell, D. W. and Lowell, T. V., 1987, Surficial Geology of the Sherbrooke 1 x 2 degree Quadrangle, Maine, Maine Geological Survey, Open-File 87-11.

[2] Osberg, P. H., Hussey, A. M., and Boone, G. M., 1985, Bedrock Geologic Map of Maine, Maine Geological Survey.

Profile" is attached in Appendix B. The principal strata encountered in the explorations are summarized below; refer to the exploration logs in Appendix C for more detailed subsurface information at the exploration locations.

Fill: Below an approximate 3 to 6 inch layer of pavement, the borings encountered granular fill to depths of about 14 to 16.3 feet below ground surface (bgs) corresponding to Elevation (El.) 1187.6 to 1191.6 feet. The granular fill generally consisted of:

- Brown, damp, Gravelly SAND, little silt; and
- Brown, damp to moist, SAND, some gravel, little to trace silt.

The granular fill was generally dense to very dense with SPT N_{60} values ranging from 42 to 73 blows per foot (bpf).

Stream Alluvium: Below the granular fill, the borings encountered alluvial stream deposits to depths of about 20 to 22 feet bgs (El. 1181.6 to 1183.9 feet). The alluvial material generally consisted of:

- Dark brown, moist, SAND, some silt, trace to no gravel, with organics; and
- Brown-grey, wet, fine SAND, some silt, trace gravel, trace organics.

The stream alluvium was generally very loose to medium dense with SPT N_{60} values ranging from 3 to 14 bpf.

Glacial Outwash: Below the stream alluvium, the borings encountered glacial outwash to depths of about 48 to 61.5 feet bgs (El. 1142.4 to 1155.6 feet). The glacial outwash generally consisted of:

- Brown, wet, SAND, little gravel, trace silt;
- Brown, wet, Silty SAND, some gravel;
- Brown-grey, wet, Sandy GRAVEL, trace silt;
- Grey-brown, wet, SAND, some to little gravel, little to trace silt;
- Grey, wet, SAND, little to trace silt, little to trace gravel;
- Grey, wet, sandy GRAVEL, little silt with cobbles.

The glacial outwash was generally medium dense to dense with SPT N_{60} values ranging from 14 to 42 bpf.

Glacial Till: Below the glacial outwash, the borings encountered glacial till with cobbles and boulders. The borings were terminated on cobbles and boulders in the glacial till at depths of 83.2 to 85.1 feet bgs (El. 1118.5 to 1120.7 feet). Where sampled, the glacial till generally consisted of:

- Grey, wet, SAND, some to little silt, little gravel;
- Grey, moist, SILT, some to little sand, some to trace gravel;
- Cobbles; and
- Boulders.

The glacial till was generally very dense or hard with SPT N_{60} values ranging from greater than 100 bpf to greater than 50 blows for less than 6 inches (sampler refusal).

Bedrock: Bedrock was not encountered within the depths explored at the test borings.

3.3 Groundwater

Measured water levels made during drilling ranged from about 11 to 19.5 feet below ground surface. It should be noted that water was introduced during drilling; therefore, water levels indicated may not represent stabilized ground water conditions. Long term groundwater information is not available. It should be anticipated that groundwater levels will fluctuate seasonally, particularly in response to periods of snowmelt and precipitation, changes in site use and the water level of Alder Stream.

4.0 GEOTECHNICAL EVALUATION

S.W.COLE conducted geotechnical engineering evaluations in accordance with 2017 AASHTO LRFD Bridge Design Specifications, 8th Edition (AASHTO LRFD) and the MaineDOT Bridge Design Guide, 2003 Edition with revisions through June 2018 (MaineDOT BDG) and offers the following:

4.1 Foundation Alternatives and Discussion

The PDR identifies a single-span, steel and precast concrete superstructure with pile-supported integral abutments (Integral Abutment Bridge - IAB) as the preferred replacement structure. We understand the proposed structure will be replaced on the existing horizontal alignment. We understand the vertical profile will generally match the existing profile.

The following sections provide geotechnical design considerations and recommendations for H-pile supported IAB.

4.2 Integral Abutment H-Piles

Abutments No. 1 (South) and No. 2 (North) will be integral abutments founded on a single row of steel H-piles. The explorations were terminated within a cobble and boulder layer in the glacial till at about El. 1118 to 1120 feet; therefore, we anticipate the pile capacities will be limited to the drivability resistance within the glacial till before encountering bedrock. Based on discussions with EA and MaineDOT BDG Section 5.4.2.1, pile sections may include HP 14x89, 14x102 or 14x117. Additional pile sections may be considered depending on the factored design axial loads.

H-piles shall be 50 ksi, Grade A572 steel with cast driving points conforming to MaineDOT Standard Specification 711.10 to help reduce damage to the piles during driving and improve penetration.

Based on the depths to refusal of the cobble and boulder layer in the glacial till encountered in boring BB-JPTAS-102B for Abutment No. 2 and critical embedment (20 diameters) in the glacial till in boring BB=JPTAS-101A for Abutment No. 1, we estimate the following pile lengths:

Location / Boring	Approx. Bottom of Proposed Abutment	Anticipated Pile Tip Elevation	Estimated Pile Length[1] (feet)
	Elevation (feet)		
Abutment No. 1 BB-JPTAS-101A	1192.5	1130	65
Abutment No. 2 BB-JPTAS-102B	1192.0	1120	72

Note: 1. Estimated pile lengths rounded up to the nearest 5 feet.

The estimated pile lengths do not take into account locations where refusal may be deeper or shallower than that encountered in the test borings, damaged pile, the additional five (5) feet of pile required for dynamic testing instrumentation (per ASTM D4945), additional pile length needed to accommodate leads and driving equipment, or additional pile length needed for embedment in the abutment or pile cap.

Based on the presence of numerous cobbles and boulders, a minimum 10 feet of additional pile length per pile location should be specified on Contract Plans to reduce construction delays in the event that piles penetrate the cobble and boulder layer.

4.2.1 Strength Limit State Design

Design of pile foundations at the strength limit state shall consider;

- Compressive axial geotechnical resistance of individual piles;
- Drivability resistance of individual piles;
- Structural resistance of individual piles in axial compression, and;
- Structural resistance of individual piles in combined axial loading and flexure.

Pile groups should be designed to resist lateral earth loads, vehicular loads, dead and live loads, and lateral forces transferred through the abutments. The pile group resistance after scour due to the design flood shall provide adequate foundation resistance using the resistance factors given in this section.

Per LRFD Article 6.5.4.2, at the strength limit state, the axial resistance factor ϕ_c of 0.50, shall be applied to the structural compressive resistance of the pile. The H-piles will be subjected to lateral loading; therefore, the piles shall be evaluated for resistance against combined axial compression and flexure in accordance with LRFD Articles 6.9.2.2 and 6.15.2. Per LRFD Article

6.5.4.2, at the strength limit state, the axial resistance factor ϕ_c of 0.70 and the flexural resistance factor ϕ_f of 1.0 shall be applied to the combined axial and flexural resistance of the pile in the interaction equation (LRFD Eq. 6.9.2.2-1 or -2).

Abutment H-piles shall also be analyzed for determination of unbraced lengths and fixity using LPile® 2016 (LPile) software, or similar. The calculated unbraced lengths should be used to analyze the piles in combined axial compression and flexure resistance provided in LRFD Articles 6.9.2.2 and 6.15.2.

Structural Resistance: The nominal axial compressive structural resistance (P_n) for piles loaded in compression shall be as specified in LRFD Article 6.9.4.1. The nominal axial structural compressive resistance (P_n) subject to the combined axial compression and flexure shall be evaluated based on unbraced lengths (l) and effective length factors (K) as determined from LPile once structural loads are available. The nominal axial structural resistance should be evaluated based on combined axial compression and flexure.

Geotechnical Resistance: The nominal axial geotechnical resistance estimates at the strength limit state was evaluated using the guidance in LRFD Article 10.7.3.8.6 and utilizing the Nordlund/Thurman static pile resistance method (LRFD Article 10.7.3.8.6f) and SPT-Meyerhof method (LRFD Article 10.7.3.8.6g) limiting the side resistance below the pile's critical depth of 20 pile diameters for very dense glacial till. Dynamic testing shall be performed to establish driving criteria and measure the actual nominal pile resistance; therefore, the reliability of the nominal pile resistance is dependent upon the reliability of the dynamic testing and a resistance factor, ϕ_{dyn}, of 0.65 applies as recommended by LRFD Article C10.5.5.2.3.

Drivability Analyses: Drivability analyses were performed to determine the pile resistance that might be achieved considering available diesel hammers. The maximum driving stresses in the pile, assuming the use of 50 ksi steel, shall be less than 45 ksi. The drivability resistances shall be calculated using the resistance factor, ϕ_{dyn}, of 0.65, for a single pile in axial compression when a dynamic test is performed as specified in LRFD Table 10.5.5.2.3-1.

A summary of the calculated factored axial compressive structural, geotechnical, and drivability resistances of selected H-piles for the strength limit states are provided in the following table.

Abutment No. 1 Factored Axial Pile Resistances Strength Limit States (kips)				
Pile Section	**Structural Resistance ϕ_c = 0.5**	**Controlling Geotechnical Resistance ϕ_{dyn} = 0.65**	**Drivability Resistance ϕ_{dyn} = 0.65**	**Controlling Axial Pile Resistance**
HP 14x89	652	387	356	356
HP 14x102	750	418	361	361
HP 14x117	860	452	363 (631)	363 (452)

Notes: Drivability resistance based on Delmag D19-42. Drivability resistance based on Delmag D36-32 shown in parentheses.

Abutment No. 2 Factored Axial Pile Resistances Strength Limit States (kips)				
Pile Section	**Structural Resistance ϕ_c = 0.5**	**Controlling Geotechnical Resistance ϕ_{dyn} = 0.65**	**Drivability Resistance ϕ_{dyn} = 0.65**	**Controlling Axial Pile Resistance**
HP 14x89	652	403	356	356
HP 14x102	750	435	361	361
HP 14x117	860	471	363 (631)	363 (471)

Notes: Drivability resistance based on Delmag D19-42. Drivability resistance based on Delmag D36-32 shown in parentheses.

The estimated factored axial pile resistances from the drivability analyses for the H-piles driven to the tip elevation, at El 1130 feet at Abutment No. 1 and El 1120 feet at Abutment No. 2 with a Delmag D19-42 hammer, are less than the axial pile resistances from the geotechnical static pile resistance and the structural resistances with a resistance factor for severe driving conditions applied; therefore, the drivability resistance for the Delmag D19-42 hammer controls. For an HP14x117 pile driven to the specified tip elevations, the geotechnical static pile resistance controls.

The maximum applied factored axial pile load for the strength limit states should not exceed the controlling factored pile resistance shown in above table.

4.2.2 Service and Extreme Limit State Design

The design of H-piles at the service limit state shall consider tolerable transverse and longitudinal movement of piles and pile group movement considering changes in soil conditions due to scour based on the design flood (Q_{100}). For the service limit state, resistance factors, φ of 1.0 should be used in accordance with LRFD Article 10.5.5.1. The exception is the overall global stability of the foundation which should be investigated at the Service I load combination and a resistance factor, φ of 0.65.

Extreme limit state design shall include pile axial compressive resistance, overall global stability of the pile group, pile failure by uplift in tension and structural failure. The extreme event load combinations are those related to seismic forces, ice loads, debris loads, and hydraulic events. Extreme limit state design shall also check that the nominal pile foundation resistance remaining after scour due to the check flood (Q_{500}) can support the extreme limit state loads. Resistance factors for extreme limit states, per LRFD Article 10.5.5.3, shall be taken as φ = 1.0 with the exception of uplift of piles, for which the resistance factor, φ_{up}, shall be 0.80 or less per LRFD Article 10.5.5.3.2.

The nominal axial geotechnical pile resistance at the service and extreme limit state was calculated using the guidance in LRFD Article 10.7.3.8.6. A summary of the calculated factored axial structural, geotechnical, and drivability resistances of selected H-piles for the extreme and service limit states are provided in the following table.

Abutment No. 1 Factored Axial Pile Resistances Service and Extreme Limit States (kips)				
Pile Section	Structural Resistance $\phi_c = 1.0$	Controlling Geotechnical Resistance $\phi = 1.0$	Drivability Resistance $\phi = 1.0$	Controlling Axial Pile Resistance
HP 14x89	886	595	547	547
HP 14x102	1019	643	555	555
HP 14x117	1169	695	559 (970)	559 (695)

Notes: Drivability resistance based on Delmag D19-42. Drivability resistance based on Delmag D36-32 shown in parentheses.

Abutment No. 2 Factored Axial Pile Resistances Service and Extreme Limit States (kips)				
Pile Section	Structural Resistance $\phi_c = 1.0$	Controlling Geotechnical Resistance $\phi = 1.0$	Drivability Resistance $\phi = 1.0$	Controlling Axial Pile Resistance
HP 14x89	886	620	547	547
HP 14x102	1019	669	555	555
HP 14x117	1169	725	559 (970)	559 (725)

Notes: Drivability resistance based on Delmag D19-42. Drivability resistance based on Delmag D36-32 shown in parentheses.

The estimated factored axial pile resistances from the drivability analyses for the H-pile sections driven with a Delmag D19-42 hammer are less than the axial pile resistances from the geotechnical static pile and the structural resistances. Therefore, the drivability resistance for the Delmag D19-42 hammer controls. For an HP14x117 pile driven to the specified tip elevations, the geotechnical static pile resistance controls.

The maximum applied factored axial pile load for the extreme and service limit states should not exceed the controlling factored pile resistance shown in above table.

4.2.3 Lateral Pile Resistance/Behavior

In accordance with LRFD Article 6.15.1, the structural analysis of pile groups subjected to lateral loads shall include consideration of soil-structure interaction effects as specified in LRFD Article 10.7.3.9. Assumptions regarding a fixed or pinned condition at the pile tip should be also confirmed with soil-structure interaction analyses.

A series of lateral pile resistance analyses should be performed to evaluate pile behavior at both abutments using LPile® Plus 5.0 (LPile) or FB-MultiPier® software. S.W.COLE is available to perform lateral pile analyses using LPile software once provided with the anticipate pile head deflections, moments and axial loads.

Geotechnical parameters for generation of soil-resistance (p-y) curves in lateral pile analyses using LPile® software are shown in the following Table. In general, the program emulates the soil at the site by using the soil layers, appropriate pile material properties, section parameters, and pile-head boundary conditions for the pile section being analyzed.

Recommended LPILE® Soil Parameters							
Elevation Range[1,2] (Depth Range)		Soil Layer[2] (Soil Model)	K_{static} (pci)	Soil Parameters			
Top	Bottom			Effective Unit Wt. γ', (pcf)	Cohesion c, (psf)	e_{50}	Friction Angle ϕ', (deg)
Abutment 1 (Borings BB-JPTAS-101 & 101A)							
1192.5 (0)	1181.5 (11.0)	loose/med dense Fill/Alluvium (Sand-Reese)	20	59.6	-	-	30
1181.5 (11.0)	1163.5 (29.0)	med dense, Glacial Outwash (Sand-Reese)	60	65.6	-	-	32
1163.5 (29.0)	1155.5 (37.0)	dense, Glacial Outwash (Sand-Reese)	125	67.6	-	-	34
1155.5 (37.0)	1118.5 (74.0)	dense/very dense Glacial Till (Sand-Reese)	125	72.6	-	-	38
Abutment 2 (Borings BB-JPTAS-102, 102A & 102B)							
1192.0 (0)	1184.0 (8.0)	Loose/med dense Fill/Alluvium (Sand-Reese)	20	62.6	-	-	30
1184.0 (8.0)	1159.0 (33.0)	med dense, Glacial Outwash (Sand-Reese)	60	65.6	-	-	32
1159.0 (33.0)	1142.5 (49.5)	dense/med, Glacial Outwash (Sand-Reese)	60	67.6	-	-	34
1142.5 (49.5)	1120.5 (70.0)	dense/very dense Glacial Till (Sand-Reese)	125	72.6	-	-	38

Notes: 1. Abutment 1 bottom of pile cap at El 1192.5 feet. Abutment 2 bottom of pile cap at El 1192 feet.
2. Groundwater at El. 1196.35 feet corresponding to Q_{50}.

4.2.4 Driven Pile Resistance and Pile Quality Control

The contract documents shall require the contractor to perform four (4) wave equation analyses (two at each abutment) for the proposed pile-hammer system and conduct dynamic pile load tests with signal matching. The first pile driven at each abutment should be dynamically tested to confirm nominal pile resistance and verify the stop-driving criteria developed by the contractor in the wave equation analysis. Minimum 24-hour restrike tests will be required and should be noted on the plans because piles end bearing in glacial till may "relax."

We anticipate piles will refuse within the cobble and boulder layer encountered at about El. 1118 to 1120 feet. Additional dynamic tests shall be performed as part of the pile field quality control program if:

- Pile behavior vary radically between adjacent piles;
- Pile refusal on a boulder or in a cobble layer above minimum pile tip elevation; or
- Pile is out of tolerance.

Piles should be driven to an acceptable penetration resistance based on the results of a wave equation analysis provided by the contractor and as approved by the design team. Pile load testing shall be completed by PDA testing with signal matching for a minimum of two piles at each abutment. Driving stresses in the pile determined in the drivability analysis and confirmed by PDA testing shall be less than 45 ksi, in accordance with LRFD Article 10.7.8. The pile hammer should be selected such that the required pile resistance when the penetration resistance for the final 3 to 6 inches is between 3 to 15 blows per inch (bpi). If an abrupt increase in driving resistance is encountered, the driving may be terminated when the penetration is less than 0.5-inch in 10 consecutive blows. Termination criteria shall be confirmed and evaluated for the selected pile hammer.

4.3 Integral Abutment Design

Integral abutment sections shall be designed for all relevant strength, service, and extreme limit states and load combinations specified in LRFD Articles 3.4.1 and 11.5.5. Stub abutments shall be designed to resist all lateral earth loads, vehicular loads, dead and live loads, and lateral forces transferred through the integral superstructure. The design of the integral abutment at the strength limit state shall consider reinforced-concrete structural design. Strength limit state design shall also consider changes in foundation conditions and foundation resistance after scour due to the design (Q_{100}) flood.

A resistance factor (φ) of 1.0 shall be used to assess abutment design at the service limit state, including: settlement, excessive horizontal movement, and movement resulting after scour due to the design (Q_{100}) flood. The overall stability of the foundation should be investigated at the Service I Load Combination and a resistance factor, φ, of 0.65.

Extreme limit state design of integral abutment supported on H-piles shall include pile structural resistance, pile geotechnical resistance, pile resistance in combined axial and flexure, and overall stability. Resistance factors for extreme limit state shall be taken as 1.0. Extreme limit state design shall also check that the nominal foundation resistance remaining after scour due to the check (Q_{500}) flood can support the extreme limit state loads with a resistance factor of 1.0.

The designer may assume Soil Type 4 (MaineDOT Bridge Design Guide (BDG) Section 3.6.1) for abutment backfill material soil properties. The backfill properties are as follows:

- Angle of internal friction (ϕ) of 32 degrees;
- Total unit weight (γ) of 125 pcf; and
- Soil-concrete interface friction angle (δ) of 20 degrees.

Integral abutment sections shall be designed to withstand a lateral earth load equal to the passive pressure state. Calculation of passive earth pressures should assume a Coulomb passive earth pressure coefficient, K_p, of 6.73. Developing full passive pressure assumes that the ratio of lateral abutment movement to abutment height (y/H) exceeds 0.005. If the calculated displacements are significantly less than that required to develop full passive pressure the designer may consider using the Rankine passive earth pressure coefficient of 3.25.

Additional lateral earth pressure due to live load surcharge is required per Section 3.6.8 of the MaineDOT BDG for abutments if an approach slab is not specified. When a structural approach slab is specified reduction, not elimination, of the surcharge load is permitted per LRFD Article 3.11.6.5. The live load surcharge may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) based on LRFD Table 3.11.6.4-1.

The abutment design shall include a drainage system behind the abutment to mitigate excessive hydrostatic pressures. Drainage behind the structure shall be in accordance with MaineDOT BDG Section 5.4.2.13.

Backfill within 10 feet of the abutments and side slope fill shall conform to MaineDOT Specification 703.19 “Granular Borrow for Underwater Backfill.”

Slopes in front of the pile supported integral abutments should be constructed with riprap and erosion control geotextile. The riprap slopes should not exceed 1.75H:1V in accordance with MaineDOT Standard Detail 610(03).

4.4 Frost Considerations

According to MaineDOT BDG Section 5.2.1 and BDG Figure 5-2, pile supported integral abutments shall be embedded a minimum of 4.0 feet for frost protection. Foundations bearing on soil should be designed with an appropriate embedment for frost protection. Based on the Maine Design Freezing Index Map[3], the design freezing index for the Jim Pond Township, Maine area is approximately 2,275 freezing degree-days. Based on Section 5.2.1 of the MaineDOT BDG and subsurface soils encountered, the maximum seasonal frost penetration is estimated to be on the order of about 8.5 feet; consequently, we recommend foundations should have at least 8.5 feet of soil cover to provide frost protection. Riprap is not to be considered as contributing to the overall thickness of soils required for frost protection.

4.5 Seismic Design Considerations

Seismic site class was evaluated in accordance with AASHTO Section 3.10.3.1 Method B (average N-value method). Based on the subsurface information, the average N-value is between 15 and 50 bpf corresponding to an AASHTO Site Class D as defined in AASHTO Table 3.10.3.1-1.

The United States Geological Survey (USGS) Seismic Design Parameters program (Version 2.1) was used to obtain the seismic design parameters for the site. Based on the assigned site

[3] Maine Department of Transportation, Bridge Design Guide (BDG), August 2003, with Revisions through 2014, Figure 5-1.

class (AASHTO Site Class D) and site coordinates, the software provides the recommended AASHTO Response Spectrum for a 7 percent probability of exceedance in 75 years (1,000-year return period). The results for the project site are summarized below and program output are provided in Appendix E.

Recommended Seismic Design Parameters	
Site Class	D
PGA	0.069 g
S_s	0.157 g
S_1	0.051 g
F_{pga}	1.60
F_a	1.60
F_v	2.40
A_s	0.110 g
S_{DS}	0.252 g
S_{D1}	0.122 g
Seismic Zone (based on S_{D1})	Zone 1

NOTE: Site Coordinates: N45.254232, W-70.547002

4.6 Recommendations for Scour Evaluation

Laboratory grain size analyses were performed on soil samples taken near the approximate streambed elevation (±El. 1180 to 1183 feet) to generate parameters to be used in scour analyses. Results of the grain size analyses tests are included in Appendix D and summarized in the following table:

Boring No.	Sample No.	Depth (ft)	Elevation (ft)	Estimated D_{95} (mm)	Estimated D_{50} (mm)
BB-JPTAS-101A	4D	20	1183.6	0.31	0.13
BB-JPTAS-102B	4D	20	1183.9	4.02	1.06

Design at the strength limit state should consider loss of lateral and vertical support due to scour. Design at the extreme limit state should check that the nominal foundation resistance due to the check flood (Q_{500}) event is no less than the extreme limit state loads. At the service limit state, the design shall limit movements and ensure overall stability considering scour at the design load.

For scour protection of the pile-supported abutments, the bridge approach slopes and the abutment slopes will be armored with the existing granite blocks and riprap where the granite blocks are removed. In accordance with MaineDOT BDG Section 2.3.11.3, the top of the riprap shall be located at or above, the Q_{50} elevation.

Riprap shall conform to MaineDOT Standard Specification 703.26 “Plain and Hand Laid Riprap”. The riprap section shall be underlain by a Class 1 nonwoven erosion control geotextile per MaineDOT Standard Specification 722.03.

5.0 CLOSURE

We trust this information meets your present needs. Please contact us if you have any questions or need further assistance.

Sincerely,

S. W. Cole Engineering, Inc.

STATE OF MAINE
MICHAEL A.
ST. PIERRE
No. 12519
LICENSED
PROFESSIONAL ENGINEER

Michael A. St. Pierre, P.E.
Senior Geotechnical Engineer

Timothy J. Boyce, P.E.
Senior Geotechnical Engineer

MAS/tjb-rec

APPENDIX A
Limitations

This report has been prepared for the exclusive use of the Erdman Anthony for specific application to the Alder Stream Bridge #3265 Replacement carrying Route 27 over Alder Stream (MaineDOT WIN 023104.00) in Jim Pond Township, Maine. S. W. Cole Engineering, Inc. (S.W.COLE) has endeavored to conduct our services in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

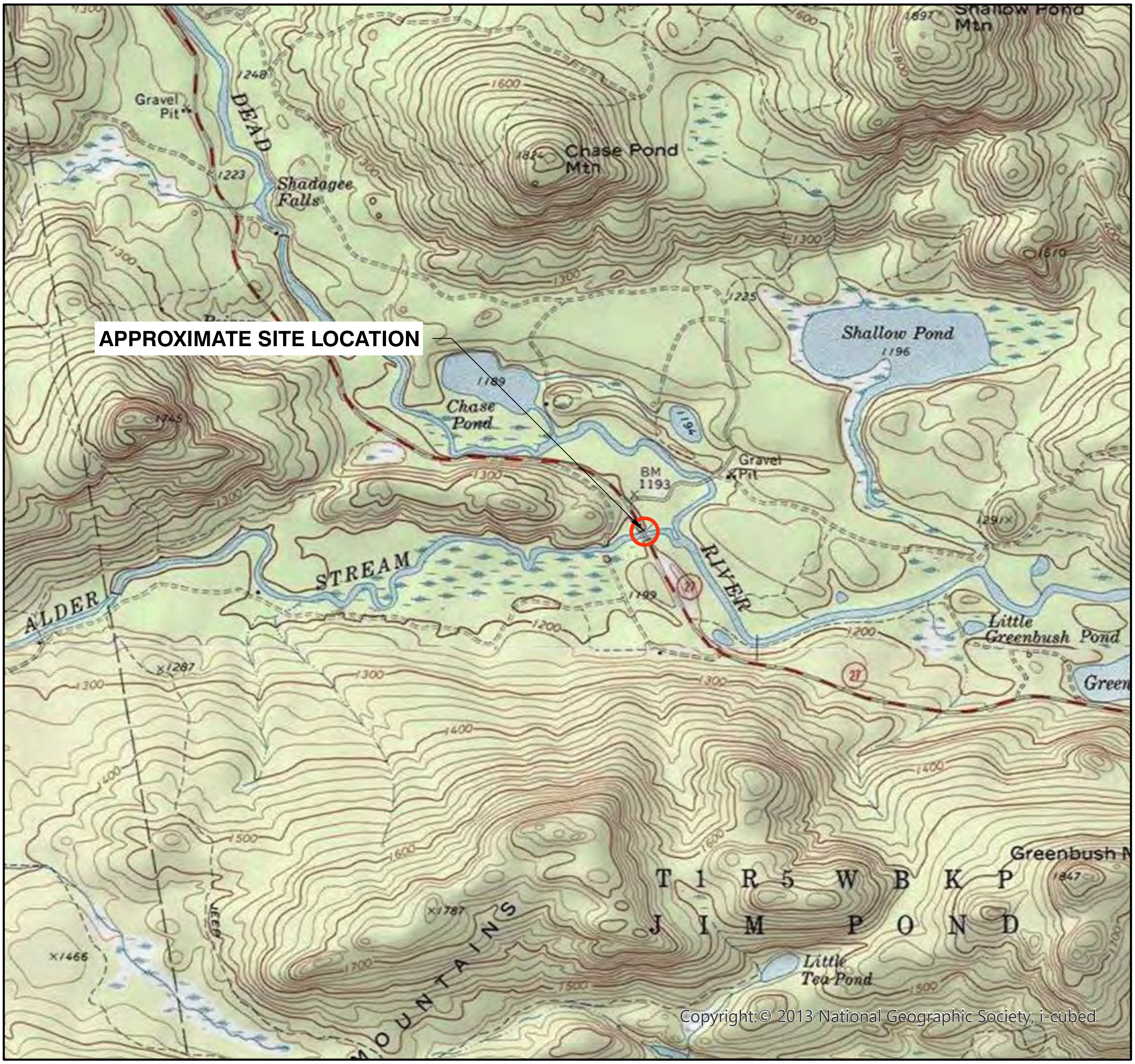
The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S.W.COLE should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S.W.COLE.

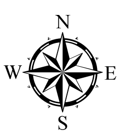
APPENDIX B

Figures



2,000 0 2,000 4,000

Scale in Feet



S.W.COLE ENGINEERING, INC.

ERDMAN ANTHONY

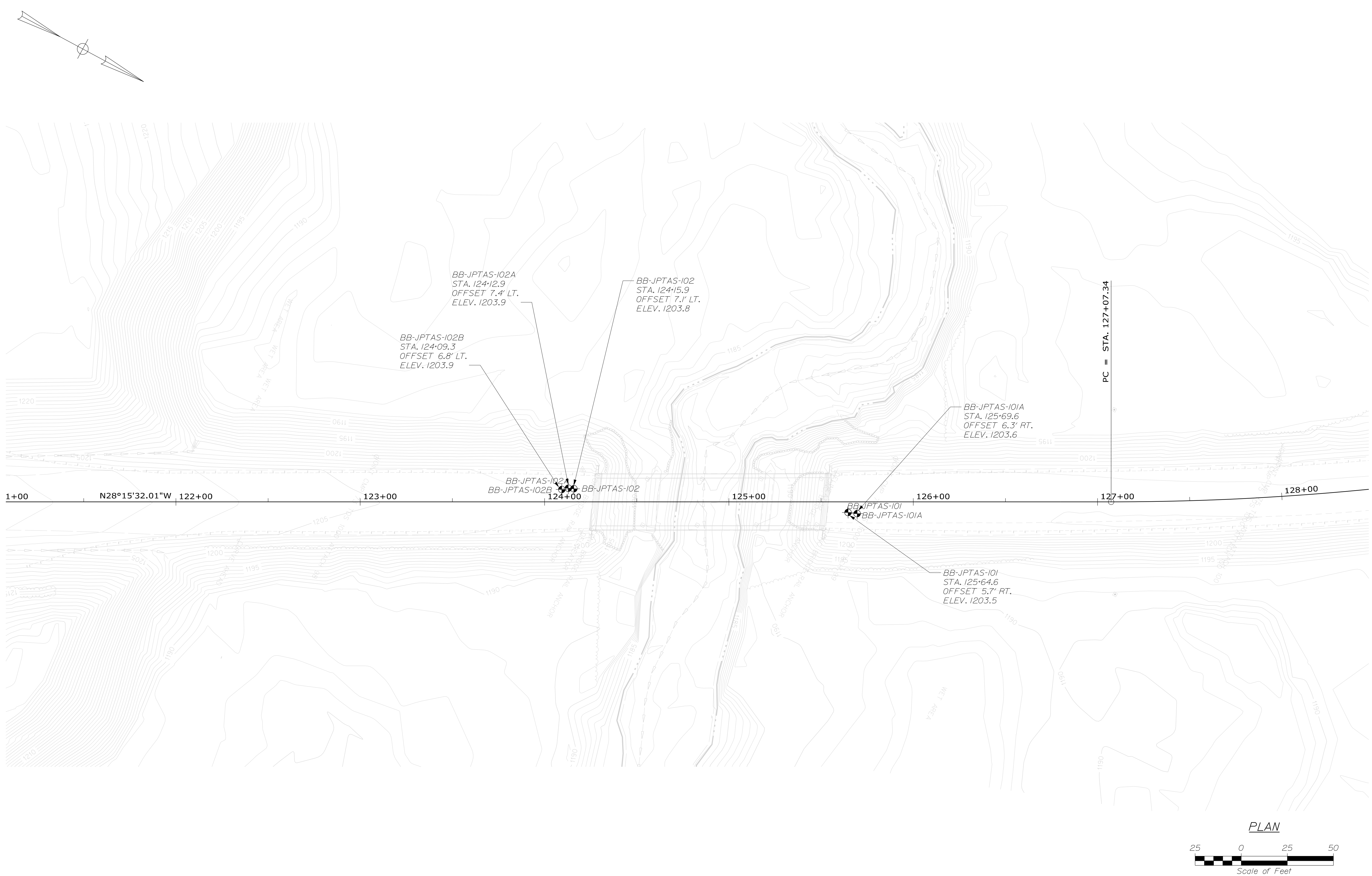
SITE LOCATION MAP

ALDER STREAM BRIDGE #3265 REPLACEMENT
ROUTE 27 OVER ALDER STREAM
JIM POND TOWNSHIP, MAINE
WIN 023104.00

Job No.	19-1436	Scale	1" = 2000'
Date:	3/10/2020	Sheet	1

NOTE:
SITE LOCATION MAP PREPARED FROM ESRI ArcGIS ONLINE AND DATA PARTNERS INCLUDING USGS AND © 2007 NATIONAL GEOGRAPHIC SOCIETY.

R:\2019\19-1436\GIS\Project\19-1436.aprx, 3/10/2020 2:24 PM, 1:24,000, Filename: ...\Bridge\MSTA\100_BLP&ISP1.dgn Division: BRIDGE Username: Date:4/3/2020



ERDMAN ANTHONY

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS
WIN 23104.00
BRIDGE NO. 3265

SIGNATURE
P.E. NUMBER
DATE

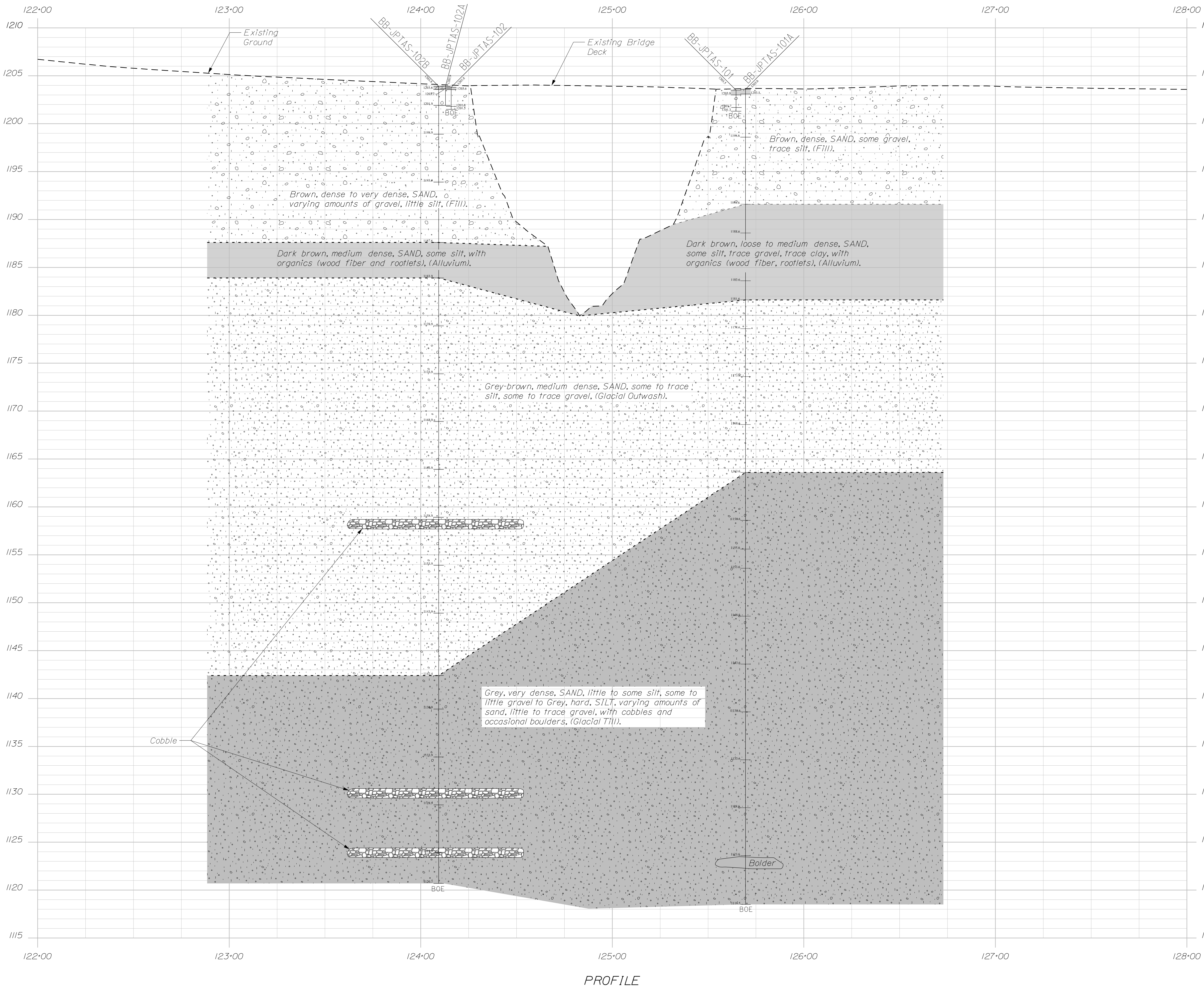
PROJ. MANAGER	DESIGN-DETAILED	CHECKED-REVIEWED	DESIGN2-DETAILED2	DESIGN3-DETAILED3	REVISIONS 1	REVISIONS 2	REVISIONS 3	REVISIONS 4	FIELD CHANGES
MICHAEL WIGHT									

BY DATE

ALDER STREAM BRIDGE
ALDER STREAM
JIM POND FRANKLIN COUNTY

BORING LOCATION PLAN

SHEET NUMBER
1
OF 2



Boring No. Offset, if shown
Strata Interface
Boring
RQD= Rock Quality Designation for Rock Core Sample
BOE= Bottom Of Exploration

Note:
This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

PROFILE

Horiz. 25 0 25 50

Vert. 5 0 5 10

Scale of Feet

ERDMAN ANTHONY

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN 23104.00

BRIDGE NO. 3265

	BY	DATE
PROJ. MANAGER	MICHAEL WIGHT	
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

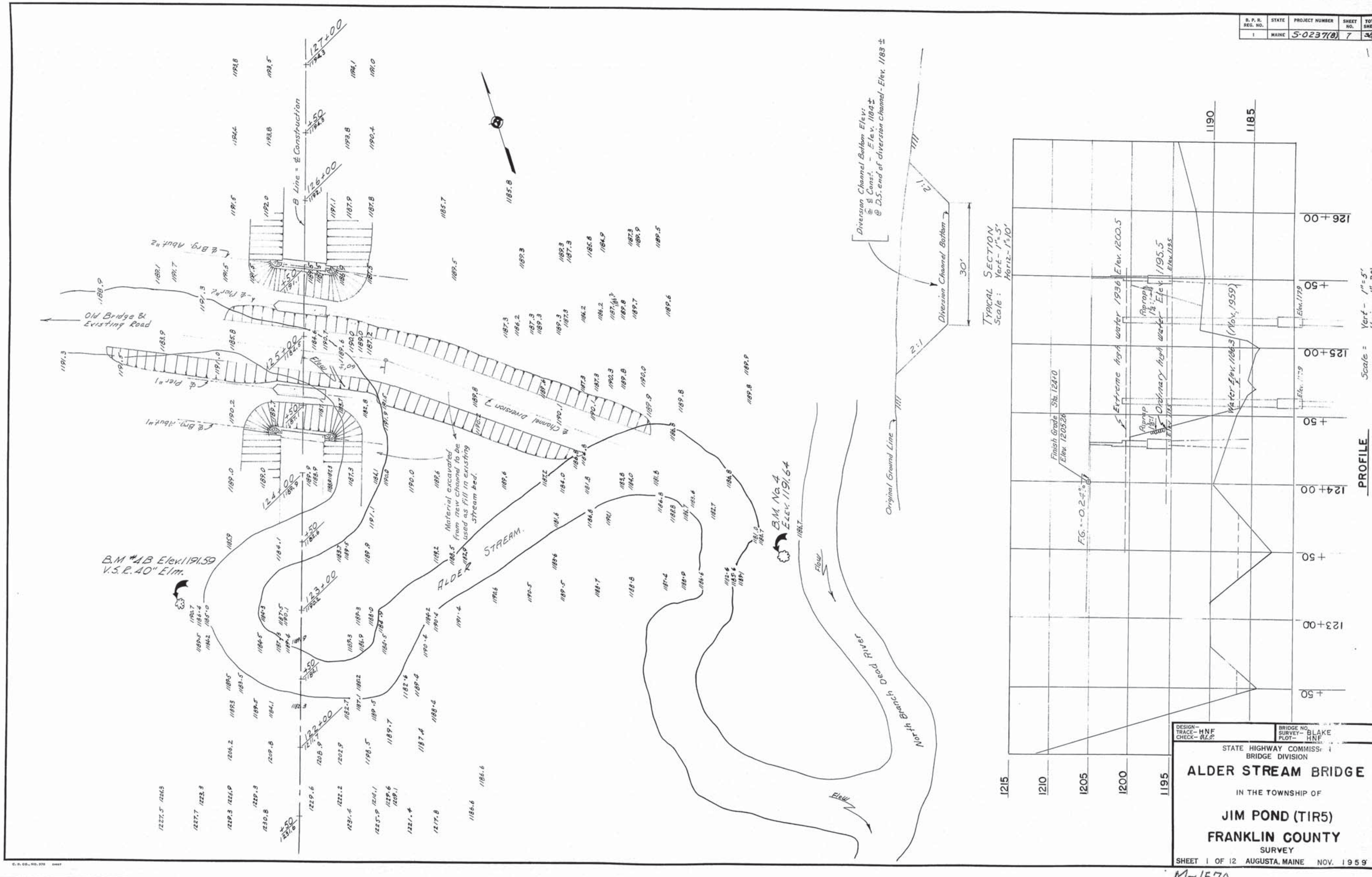
DATE

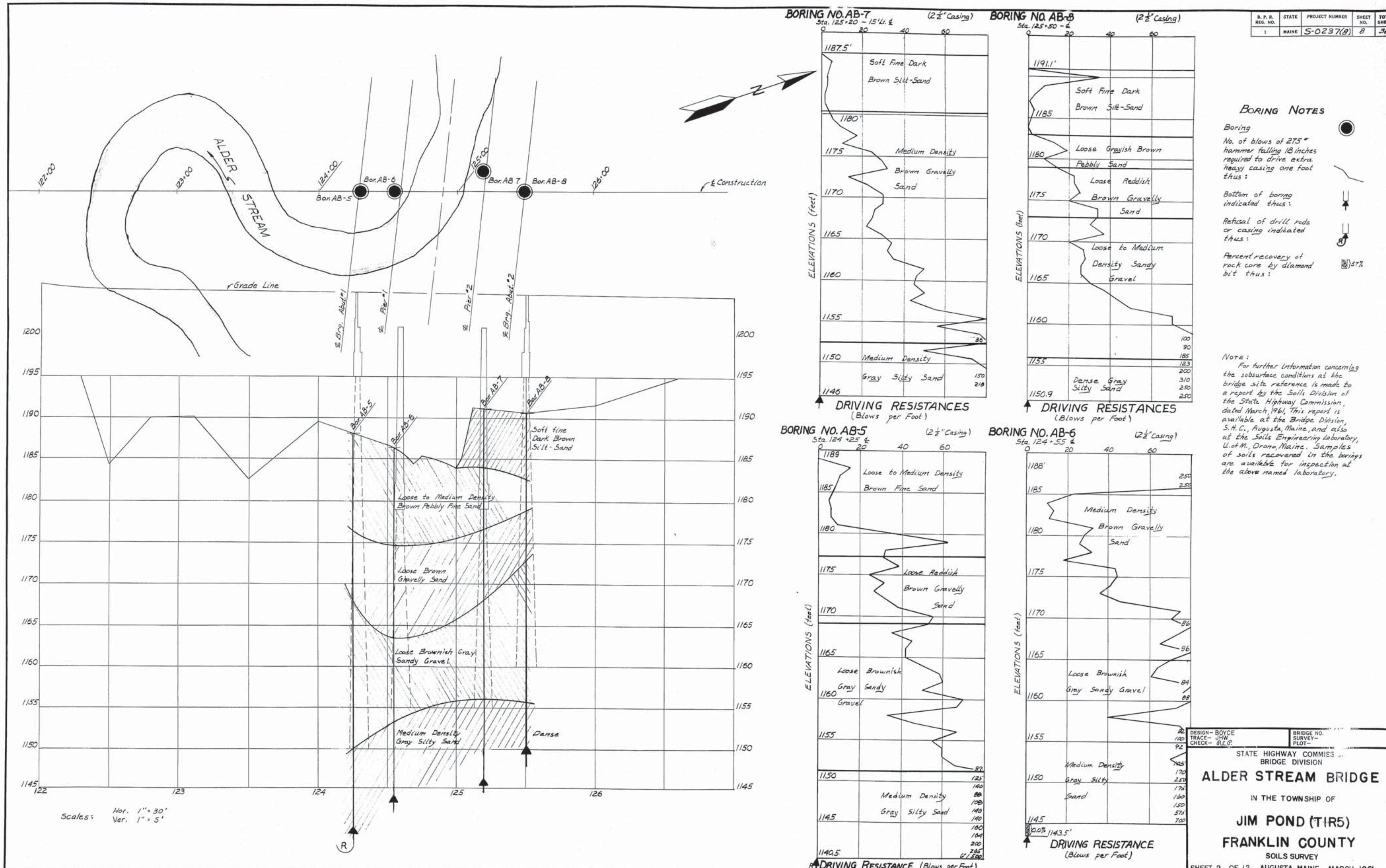
ALDER STREAM BRIDGE
ALDER STREAM
JIM POND FRANKLIN COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 2

Date:4/6/2020 Username: Division: BRIDGE Filename: ...\Bridge\MSTA\101_GeoProfile.dgn


B. P. R. REG. NO. 1
STATE MAINE
PROJECT NUMBER S-0237(8)
SHEET NO. 7
Old Bridge & Existing Road
B Line = ℄ Construction
℄ Brg. Abut. 2
℄ Pier 1
℄ Brg. Abut. 1
℄ Channel Diversion
Material excavated from new channel to be used as fill in existing stream bed.
ALDER STREAM
B.M. #4B Elev. 1191.59 V.S.R. 40" Elm.
B.M. No. 4 Elev. 1191.64
North Branch Dead River
Flow
Diversion Channel Bottom Elev.
@ ℄ Const. - Elev. 1184±
@ D.S. end of diversion channel - Elev. 1183±
Diversion Channel Bottom
Original Ground Line
TYPICAL SECTION
Scale: Vert. - 1" = 5' Horiz. - 1" = 10'
PROFILE
Scale = Vert. - 1" = 5' Horiz. - 1" = 30'
Finish Grade Sta. 124+0 Elev. 1205.26
F.G. -0.24%
Extreme high water 1936 Elev. 1200.5
Ordinary high water Elev. 1195.5
Water Elev. 1186.3 (Nov. 1959)
Riprap
DESIGN-
TRACE- HNF
CHECK-
BRIDGE NO.
SURVEY- BLAKE
PLOT- HNF
STATE HIGHWAY COMMISSION
BRIDGE DIVISION
ALDER STREAM BRIDGE
IN THE TOWNSHIP OF
JIM POND (T1R5)
FRANKLIN COUNTY
SURVEY
SHEET 1 OF 12 AUGUSTA, MAINE NOV. 1959
M-1570



B.P.R. REG. NO. 1
STATE MAINE
PROJECT NUMBER S-0237(8)
SHEET NO. 8
TOTAL SHEETS 38
ALDER STREAM
Bor. AB-5
Bor. AB-6
Bor. AB 7
Bor. AB-8
℄ Construction
Grade Line
℄ Brg. Abut. #1
℄ Pier #1
℄ Pier #2
℄ Brg. Abut. #2
Soft fine Dark Brown Silt-Sand
Loose to Medium Density Brown Pebbly Fine Sand
Loose Brown Gravelly Sand
Loose Brownish Gray Sandy Gravel
Medium Density Gray Silty Sand
Dense
Scales: Hor. 1" = 30' Ver. 1" = 5'
BORING NO. AB-7 (2½" Casing) Sta. 125+20 - 15' Lt. ℄
Soft Fine Dark Brown Silt-Sand
Medium Density Brown Gravelly Sand
Medium Density Gray Silty Sand
BORING NO. AB-8 (2½" Casing) Sta. 125+50 - ℄
Soft Fine Dark Brown Silt-Sand
Loose Grayish Brown Pebbly Sand
Loose Reddish Brown Gravelly Sand
Loose to Medium Density Sandy Gravel
Dense Gray Silty Sand
BORING NO. AB-5 (2½" Casing) Sta. 124+25 ℄
Loose to Medium Density Brown Fine Sand
Loose Reddish Brown Gravelly Sand
Loose Brownish Gray Sandy Gravel
Medium Density Gray Silty Sand
BORING NO. AB-6 (2½" Casing) Sta. 124+55 ℄
Medium Density Brown Gravelly Sand
Loose Brownish Gray Sandy Gravel
Medium Density Gray Silty Sand
ELEVATIONS (feet)
DRIVING RESISTANCES (Blows per Foot)
BORING NOTES
Boring
No. of blows of 275# hammer falling 18 inches required to drive extra heavy casing one foot thus:
Bottom of boring indicated thus:
Refusal of drill rods or casing indicated thus:
Percent recovery of rock core by diamond bit thus:
Note: For further information concerning the subsurface conditions at the bridge site reference is made to a report by the Soils Division of the State Highway Commission, dated March, 1961. This report is available at the Bridge Division, S.H.C., Augusta, Maine, and also at the Soils Engineering Laboratory, U. of M., Orono, Maine. Samples of soils recovered in the borings are available for inspection at the above named laboratory.
DESIGN- BOYCE
TRACE- JHW
CHECK-
BRIDGE NO.
SURVEY-
PLOT-
STATE HIGHWAY COMMISSION
BRIDGE DIVISION
ALDER STREAM BRIDGE
IN THE TOWNSHIP OF
JIM POND (T1R5)
FRANKLIN COUNTY
SOILS SURVEY
SHEET 2 OF 12 AUGUSTA, MAINE MARCH, 1961

M-1571

APPENDIX C
Boring Logs & Key to Soil and Rock Descriptions and Terms

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations (in this order, if applicable):
Color (Munsell color chart)
Moisture (dry, damp, moist, wet)
Density/Consistency (from above right hand side)
Texture (fine, medium, coarse, etc.)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc.,)
Cementation (weak, moderate, or strong)
Geologic Origin (till, marine clay, alluvium, etc.)
Groundwater level

MODIFIED BURMISTER SYSTEM

Descriptive Term	Portion of Total (%)
trace	0 - 10
little	11 - 20
some	21 - 35
adjective (e.g. sandy, clayey)	36 - 50

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Density is rated according to standard penetration resistance (N-value).

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to undrained shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value (blows per foot)	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

RQD (%) = sum of the lengths of intact pieces of core* > 4 inches / length of core advance

*Minimum NQ rock core (1.88 in. OD of core)

Correlation of RQD to Rock Mass Quality

Rock Mass Quality	RQD (%)
Very Poor	≤25
Poor	26 - 50
Fair	51 - 75
Good	76 - 90
Excellent	91 - 100

Desired Rock Observations (in this order, if applicable):
Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
- -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
- -tightness (tight, open, or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: ASTM D6032 and AASHTO Standard Specification for Highway Bridges, 17th Ed. Table 4.4.8.1.2A
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

Maine Department of Transportation
Geotechnical Section
Key to Soil and Rock Descriptions and Terms
Field Identification Information

Sample Container Labeling Requirements:

WIN	Blow Counts
Bridge Name / Town	Sample Recovery
Boring Number	Date
Sample Number	Personnel Initials
Sample Depth	

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-101
WIN: 023104

Driller:	New England Boring Contractors	**Elevation (ft.)**	1203.5	**Auger ID/OD:**	5" Solid-Stem
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. McElroy	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	02/11/2020	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	Sta. 125+64.6, 5.7 ft Rt	**Casing ID/OD:**	N/A	**Water Level*:**	None observed.
Hammer Efficiency Factor:	0.904	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks		Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	1203.0		6" of Pavement.	0.5	
								1201.7		Fill.	1.8	
								1201.3		Concrete.	2.2	
										Bottom of Exploration at 2.2 feet below ground surface. Auger refusal at 2.2 ft bgs while advancing through concrete.		
5												
10												
15												
20												
25												

Remarks:

Autohammer SN NEBCD-24 Calibrated 7/12/2019.
bgs = below ground surface.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-101A

WIN: 023104

Driller:	New England Boring Contractors	**Elevation (ft.)**	1203.6	**Auger ID/OD:**	5" Solid-Stem
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. McElroy	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	02/11/2020 - 02/24/2020	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	NQ2 2"
Boring Location:	Sta. 125+69.6, 6.3 ft Rt	**Casing ID/OD:**	PW 5"/5.5" / HW 4"/4.5"	**Water Level*:**	19.5 feet (during drilling)
Hammer Efficiency Factor: 0.904		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	1203.1		6" of Pavement. 0.5 Augered to 5 ft bgs. Soils similar to boring BB-JPTAS-101 from 0 to 2.2 ft bgs (Fill).	
5	1D	24/24	5.00 - 7.00	13/17/16/17	33	50	82			Brown, damp, dense, SAND, some gravel, trace silt, (Fill).	GTX #551287 A-1-b, SP WC=3.2%
							90				
							108				
							115				
							131				
10	2D	24/16	10.00 - 12.00	16/16/12/7	28	42	65			Similar to above, except moist.	
							55				
							44	1191.6		12.0	
							46				
							78				
15	3D	24/9	15.00 - 17.00	14/5/4/3	9	14	73			Dark brown, moist, medium dense, SAND, some silt, trace gravel, trace clay, with organcis (wood fiber and rootlets), (Stream Alluvium).	
							50				
							37				
							46				
							56				
20	4D	24/19	20.00 - 22.00	1/1/1/1	2	3	65			Brown-grey, wet, very loose, fine SAND, some silt, trace gravel, trace organics (wood fiber), (Stream Alluvium).	GTX #551292 A-2-4, SP WC=33.5%
							64				
							82	1181.6		22.0	
							100				
							79				
25											

Remarks:

Autohammer SN NEBCD-24 Calibrated 7/12/2019.
bgs = below ground surface.
Water level measured on 02-21-2020 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-101A
WIN: 023104

Driller:	New England Boring Contractors	**Elevation (ft.)**	1203.6	**Auger ID/OD:**	5" Solid-Stem
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. McElroy	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	02/11/2020 - 02/24/2020	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	NQ2 2"
Boring Location:	Sta. 125+69.6, 6.3 ft Rt	**Casing ID/OD:**	PW 5"/5.5" / HW 4"/4.5"	**Water Level*:**	19.5 feet (during drilling)
Hammer Efficiency Factor:	0.904	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
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RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	5D	24/9	25.00 - 27.00	8/8/9/10	17	26	40			Brown, wet, medium dense, SAND, little gravel, trace silt, (Glacial Outwash).	
							68				
							69				
							79				
							76				
30	6D	24/7	30.00 - 32.00	7/4/5/5	9	14	81			Similar to above.	GTX #551288 A-1-b, SP WC=15.4%
							68				
							71				
							78				
							101				
35	7D	24/5	35.00 - 37.00	9/8/8/7	16	24	75	1168.6		35.0 Brown, wet, medium dense, Silty SAND, some gravel, (Glacial Outwash).	
							62				
							65				
							72				
							93				
40	8D	24/10	40.00 - 42.00	7/7/15/17	22	33	80	1163.6		40.0 Brown-grey, wet, dense, SAND, some gravel, trace silt, (Glacial Outwash).	GTX #551989 A-1-b, SP WC=13.7%
							113				
							160				
							166				
							168				
45	9D	24/2	45.00 - 47.00	38/19/9/8	28	42	129			Grey, wet, dense, Sandy GRAVEL, trace silt, (Glacial Outwash).	
							141				
							160				
							213	1155.6		48.0	
50							394				

Remarks:

Autohammer SN NEBCD-24 Calibrated 7/12/2019.
bgs = below ground surface.
Water level measured on 02-21-2020 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-101A
WIN: 023104

Driller:	New England Boring Contractors	**Elevation (ft.)**	1203.6	**Auger ID/OD:**	5" Solid-Stem
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. McElroy	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	02/11/2020 - 02/24/2020	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	NQ2 2"
Boring Location:	Sta. 125+69.6, 6.3 ft Rt	**Casing ID/OD:**	PW 5"/5.5" / HW 4"/4.5"	**Water Level*:**	19.5 feet (during drilling)
Hammer Efficiency Factor:	0.904	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	10D	17/17	50.00 - 51.42	58/68/75-5"	- -		129			Grey, moist, very dense, SAND, some silt, some gravel, (Glacial Till). Advanced casing by drill then drive.	GTX #551290 A-2-4, SM WC=6.8%
							115				
							248				
							151				
							191				
55	11D	6/6	55.00 - 55.50	112-6"	- -		84			Similar to above.	
							110				
							125				
							159				
							197				
60	12D	6/6	60.00 - 60.50	129-6"	- -		130			Grey, moist, hard, SILT, little sand, trace gravel, (Glacial Till).	GTX #551291 A-4, ML WC=15.6%
							110				
							99				
							122				
							199				
65	13D	3/3	65.00 - 65.25	50-3"	- -		145			Grey, moist, hard, SILT, some sand, little gravel, (Glacial Till).	
							117				
							132				
							146				
							235				
70	14D	3/3	70.00 - 70.25	68-3"	- -		120			Similar to above, except wet.	
							132				
							145				
							273				
75							583				

Remarks:

Autohammer SN NEBCD-24 Calibrated 7/12/2019.
bgs = below ground surface.
Water level measured on 02-21-2020 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream Location: Jim Pond Township, Maine	Boring No.: BB-JPTAS-101A WIN: 023104

Driller:	New England Boring Contractors	**Elevation (ft.)**	1203.6	**Auger ID/OD:**	5" Solid-Stem
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. McElroy	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	02/11/2020 - 02/24/2020	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	NQ2 2"
Boring Location:	Sta. 125+69.6, 6.3 ft Rt	**Casing ID/OD:**	PW 5"/5.5" / HW 4"/4.5"	**Water Level*:**	19.5 feet (during drilling)
Hammer Efficiency Factor:	0.904	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75	15D	2/2	75.00 - 75.17	100-2"	- -		327 OPEN			Similar to above. PW casing refusal. Placed HW casing.	
80	MD R1	0/0 27/8	80.70 - 80.70 80.70 - 82.95	50-0"	- -		NQ2			Boulder.	
							OPEN				
85	MD	1/0	85.00 - 85.08	50-0"	- -			1118.5		HW casing refusal. Drive shoe broke. 85.1 **Bottom of Exploration at 85.1 feet below ground surface.** No Refusal.	
90											
95											
100											

Remarks:

Autohammer SN NEBCD-24 Calibrated 7/12/2019.
bgs = below ground surface.
Water level measured on 02-21-2020 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream Location: Jim Pond Township, Maine	Boring No.: BB-JPTAS-102 WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.8	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	Sta. 124+15.9, 7.1 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None observed.
Hammer Efficiency Factor:	0.977	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	16/16	0.30 - 1.63	64/49/50-4"	- -		SSA	1203.6		3" of Pavement. (0.3)	
										Brown, damp, very dense, Gravelly SAND, trace silt, (Fill).	
								1201.8		(2.0)	
								1201.5		Concrete. (2.3)	
										Bottom of Exploration at 2.3 feet below ground surface. Auger head broke at 2.3 ft bgs while advancing through concrete; auger recovered. No Refusal.	
5											
10											
15											
20											
25											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Boring No.: BB-JPTAS-102

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream Location: Jim Pond Township, Maine	Boring No.: BB-JPTAS-102A WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.9	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019	**Drilling Method:**	Cased Wash	**Core Barrel:**	N/A
Boring Location:	Sta. 124+12.9, 7.4 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None observed.
Hammer Efficiency Factor: 0.977		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	1203.7		3" of Pavement — 0.3	
								1201.9		Augered to 2 ft bgs. Soils similar to boring BB-JPTAS-102 from 0 to 2 ft bgs, (Fill). — 2.0	
										Bottom of Exploration at 2.0 feet below ground surface. Concrete encountered; offset boring. No Refusal.	
5											
10											
15											
20											
25											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.

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Boring No.: BB-JPTAS-102A

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-102B
WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.9	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom/J. Lee	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker/J. McElroy	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019/12-13-2019	**Drilling Method:**	Cased Wash	**Core Barrel:**	NQ2 (2")
Boring Location:	Sta. 124+09.3, 6.8 ft Lt.	**Casing ID/OD:**	HW 4.5"/4" NW 3.5"/3"	**Water Level*:**	10.9 feet (during drilling)
Hammer Efficiency Factor:	0.977	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	1203.6		4" of Pavement — 0.3	
										Augered to 5 ft bgs. Soils similar to boring BB-JPTAS-102 and BB-JPTAS-102A from 0 to 2 ft bgs, (Fill).	
								1201.9		— 2.0	
5	1D	24/18	5.00 - 7.00	17/23/22/21	45	73				Brown, damp, very dense, Gravelly SAND, little silt, (Fill).	GTX#534406 A-1-b, SW WC=2.9%
10	2D	24/19	10.00 - 12.00	12/15/11/20	26	42	68			Brown, damp, dense, SAND, some gravel, little silt, (Fill).	
							74				
							107				
							115				
							102				
15	3D	24/19	15.00 - 17.00	19/23/12/18	35	57	74			3D/A: Similar to above except moist.	
							97	1187.6		— 16.3 3D/B: Dark brown, moist, medium dense, SAND, some silt, with organics (wood fibers and rootlets), (Stream Alluvium).	GTX#534419 WC=22.0% Organic Content=4.5%
							131				
							89				
							66				
20	4D	24/12	20.00 - 22.00	5/5/5/4	10	16	42	1183.9		— 20.0 Grey-brown, wet, medium dense, SAND, little gravel, little silt, (Glacial Outwash).	GTX#534411 A-1-b, SM WC=13.3%
							49				
							50				
							55				
							76				
25											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.
0 to 70 ft bgs drilled 11-20-2019 to 11-21-2019.
Water level measured on 11-21-2019 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-102B
WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.9	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom/J. Lee	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker/J. McElroy	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019/12-13-2019	**Drilling Method:**	Cased Wash	**Core Barrel:**	NQ2 (2")
Boring Location:	Sta. 124+09.3, 6.8 ft Lt.	**Casing ID/OD:**	HW 4.5"/4" NW 3.5"/3"	**Water Level*:**	10.9 feet (during drilling)
Hammer Efficiency Factor:	0.977	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	5D	24/8	25.00 - 27.00	9/8/8/22	16	26	58			Grey, wet, medium dense, SAND, trace silt, trace fine gravel, (Glacial Outwash).	GTX#311078
							55				
							101				
							87				
							74			Drill action suggests gravel layer from 29 to 29.5 fet bgs.	
30	6D	24/3	30.00 - 32.00	6/6/6/7	12	20	70			Grey-brown, wet, medium dense, fine SAND, some silt, (Glacial Outwash).	GTX#311078
							95				
							119				
							120				
							104				
35	MD	24/0	35.00 - 37.00	6/6/6/7	12	20	79			No recovery.	
							83				
							105				
							121				
							96				
40	7D	24/3	40.00 - 42.00	5/5/7/8	12	20	89			Grey-brown, wet, medium dense, SAND, little silt, (Glacial Outwash).	GTX#311078
							116				
							115				
							143				
							128				
45	8D	24/4	45.00 - 47.00	8/12/10/8	22	36	127			Similar to above, except trace silt.	GTX#311078
							135				
							151				
							181				
							139				
50											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.
0 to 70 ft bgs drilled 11-20-2019 to 11-21-2019.
Water level measured on 11-21-2019 prior to start of drilling.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-102B
WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.9	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom/J. Lee	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker/J. McElroy	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019/12-13-2019	**Drilling Method:**	Cased Wash	**Core Barrel:**	NQ2 (2")
Boring Location:	Sta. 124+09.3, 6.8 ft Lt.	**Casing ID/OD:**	HW 4.5"/4" NW 3.5"/3"	**Water Level*:**	10.9 feet (during drilling)
Hammer Efficiency Factor:	0.977	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	9D	24/14	50.00 - 52.00	5/8/6/7	14	23	114			Grey, wet, medium dense, fine SAND, little silt, (Glacial Outwash).	
							163				
							170				
							174				
							187				
55	10D	24/20	55.00 - 57.00	6/8/7/8	15	24	181			10D/A Grey, wet, medium dense, fine SAND, little silt, layered with 10D/B grey, wet, very stiff, SILT, little fine sand, (Glacial Outwash).	GTX#534407 A-2-4, SM WC=21.0% GTX#534408 A-4, ML WC=19.7%
							161				
							146				
							291			Drill action suggests gravels or cobbles from 58 to 60 ft bgs.	
							322				
60	11D	20/10	60.00 - 61.67	5/5/16/50-2"	21	34	112			11D/A: Grey, wet, medium dense, fine to medium SAND, little silt, little gravel, (Glacial Outwash).	
							213	1142.4		61.5	
							409			11D/B: Grey, wet, very dense, SAND, some silt, little gravel, (Glacial Till). Boulder from 61.7 to 63 ft bgs.	
							144				
							159				
65	12D	9/9	65.00 - 65.75	48/50-3"	- -		OPEN			Grey, wet, very dense, SAND, little gravel, little silt, (Glacial Till). Frequent cobbles from 65.7 to 70 ft bgs.	GTX#534409 A-1-b, SW
70	13D	10/10	70.00 - 70.83	75/50-4"	- -					Grey, wet, hard, Sandy SILT, trace gravel, (Glacial Till).	
										Cobble.	
75											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.
0 to 70 ft bgs drilled 11-20-2019 to 11-21-2019.
Water level measured on 11-21-2019 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Alder Stream Bridge #3265 carries Route 27 over Alder Stream
Location: Jim Pond Township, Maine

Boring No.: BB-JPTAS-102B
WIN: 023104

Driller:	S. W. Cole Explorations, LLC	**Elevation (ft.)**	1203.9	**Auger ID/OD:**	5" Solid-Stem
Operator:	K. Hanscom/J. Lee	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	E. Walker/J. McElroy	**Rig Type:**	Diedrich D-50 Track Mounted	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	11-20-2019/12-13-2019	**Drilling Method:**	Cased Wash	**Core Barrel:**	NQ2 (2")
Boring Location:	Sta. 124+09.3, 6.8 ft Lt.	**Casing ID/OD:**	HW 4.5"/4" NW 3.5"/3"	**Water Level*:**	10.9 feet (during drilling)
Hammer Efficiency Factor:	0.977	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75	14D	17/14	75.00 - 76.42	30/45/50-5"	- -					Similar to above. Placed NW Casing. Advanced by drill then drive. Grey, wet, very dense, Silty SAND, little gravel, well bonded, (Till).	GTX#534410 A-4, ML WC=8.7%
80	MD	3/0	80.00 - 80.25	50-3"	- -					No recovery. Cobble.	
								1120.7		NW casing refusal. Drive shoe broke. 83.2	
										Bottom of Exploration at 83.2 feet below ground surface.	
85											
90											
95											
100											

Remarks:

Autohammer SN 367 Calibrated 7/29/2019.
bgs = below ground surface.
0 to 70 ft bgs drilled 11-20-2019 to 11-21-2019.
Water level measured on 11-21-2019 prior to start of drilling.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

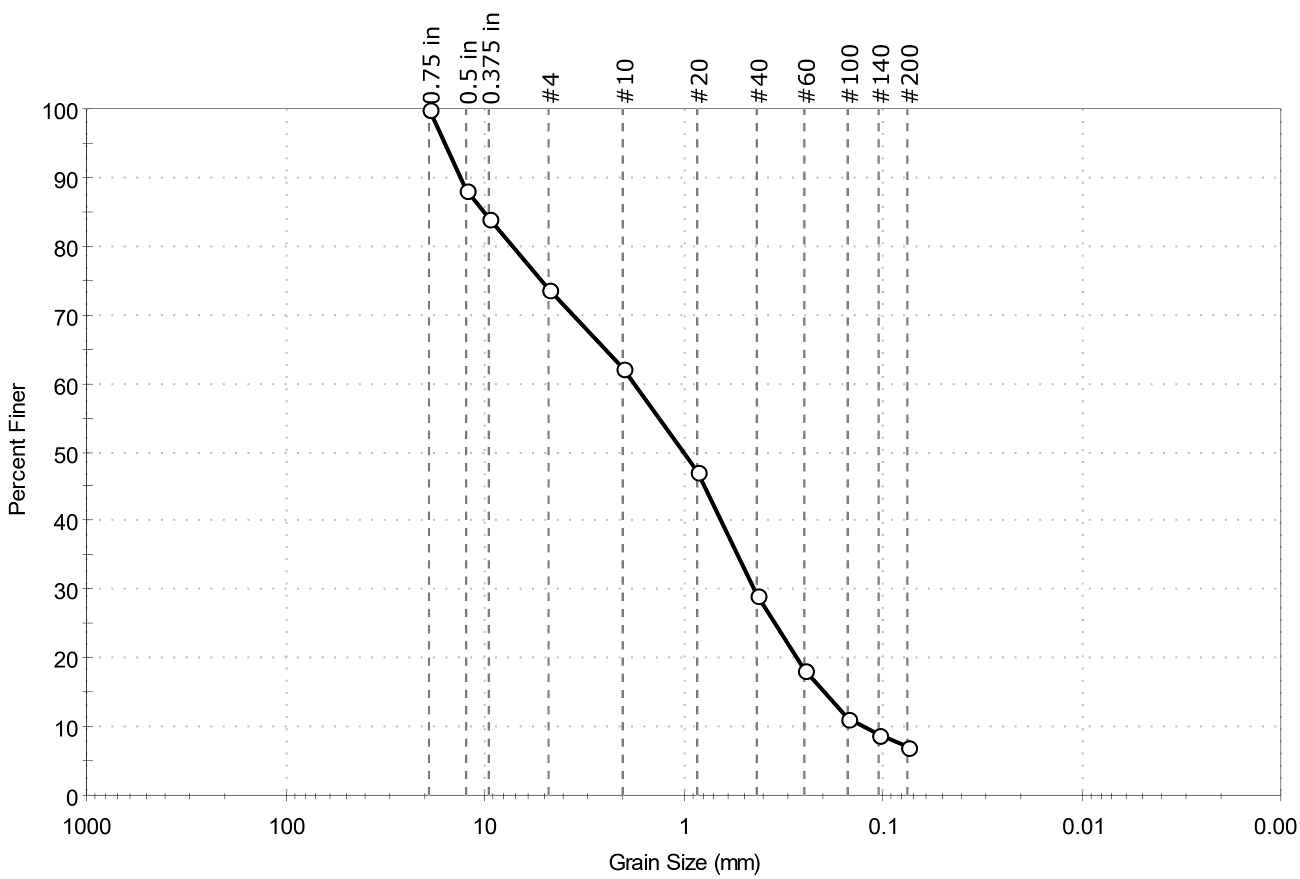
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Boring No.: BB-JPTAS-102B

APPENDIX D
Laboratory Test Results

Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-101A	Sample Type: bag	Tested By:	ckg
Sample ID: 1D	Test Date: 03/25/20	Checked By:	bfs
Depth : 5-7	Test Id: 551287		
Test Comment:	---		
Visual Description:	Moist, grayish brown sand with silt and gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	26.3	66.6	7.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	88		
0.375 in	9.50	84		
#4	4.75	74		
#10	2.00	62		
#20	0.85	47		
#40	0.42	29		
#60	0.25	18		
#100	0.15	11		
#140	0.11	9		
#200	0.075	7.1		

Coefficients

D_{85} =10.0372 mm D_{30} =0.4373 mm

D_{60} =1.7615 mm D_{15} =0.1972 mm

D_{50} =0.9906 mm D_{10} =0.1258 mm

C_u =14.002 C_c =0.863

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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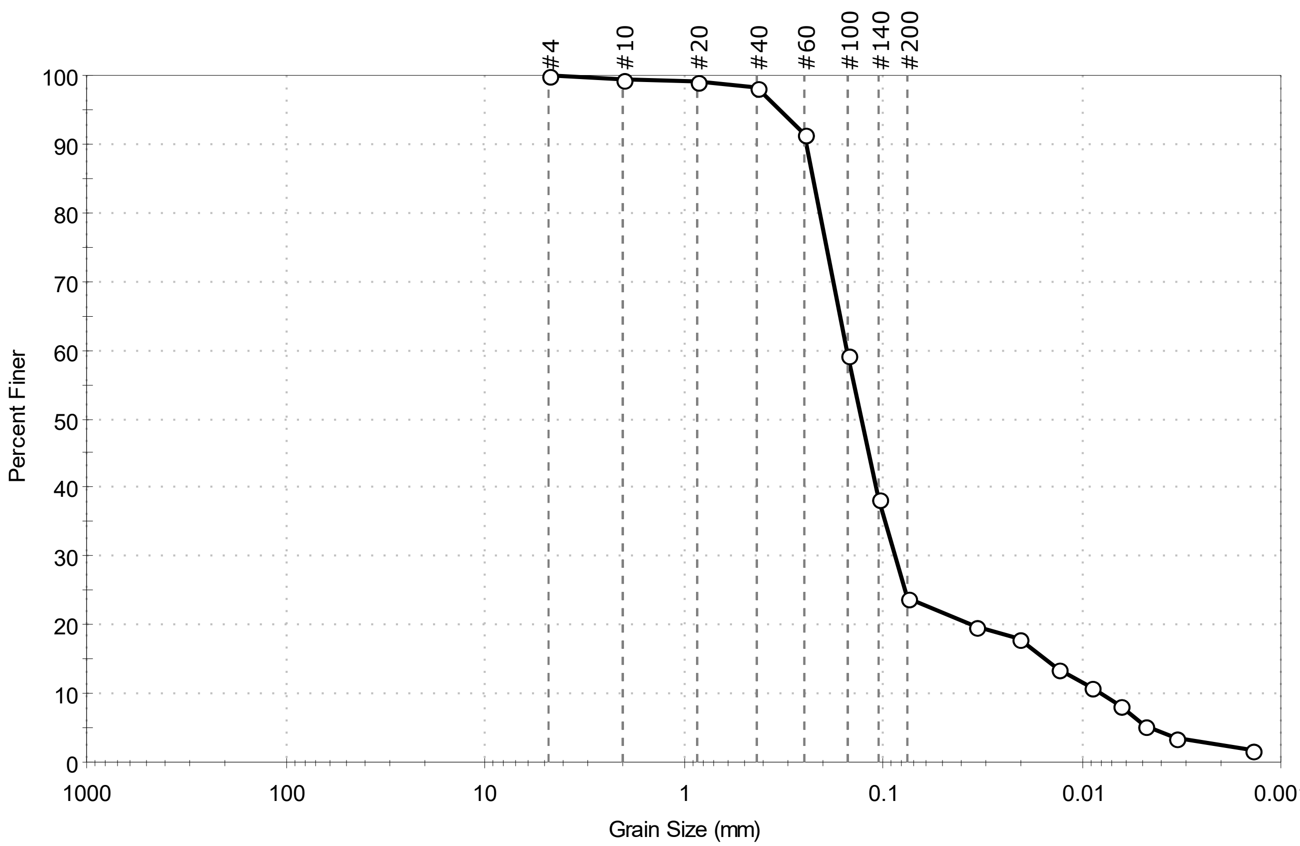
Client: S.W. Cole Engineering, Inc.			
Project: Alder Stream Bridge #3265 Replace.			
Location: Jim Pond Township, ME		Project No: GTX-311078	
Boring ID: BB-JPTAS-101A	Sample Type: bag	Tested By: ckg	
Sample ID: 4D	Test Date: 03/25/20	Checked By: bfs	
Depth : 20-22	Test Id: 551292		
Test Comment: ---			
Visual Description: Moist, dark gray silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	75.9	24.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	91		
#100	0.15	59		
#140	0.11	38		
#200	0.075	24		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0342	20		
---	0.0208	18		
---	0.0132	14		
---	0.0089	11		
---	0.0064	8		
---	0.0048	5		
---	0.0034	4		
---	0.0014	2		

Coefficients

D_{85} =0.2260 mm	D_{30} =0.0866 mm
D_{60} =0.1518 mm	D_{15} =0.0152 mm
D_{50} =0.1286 mm	D_{10} =0.0080 mm
C_u =18.975	C_c =6.176

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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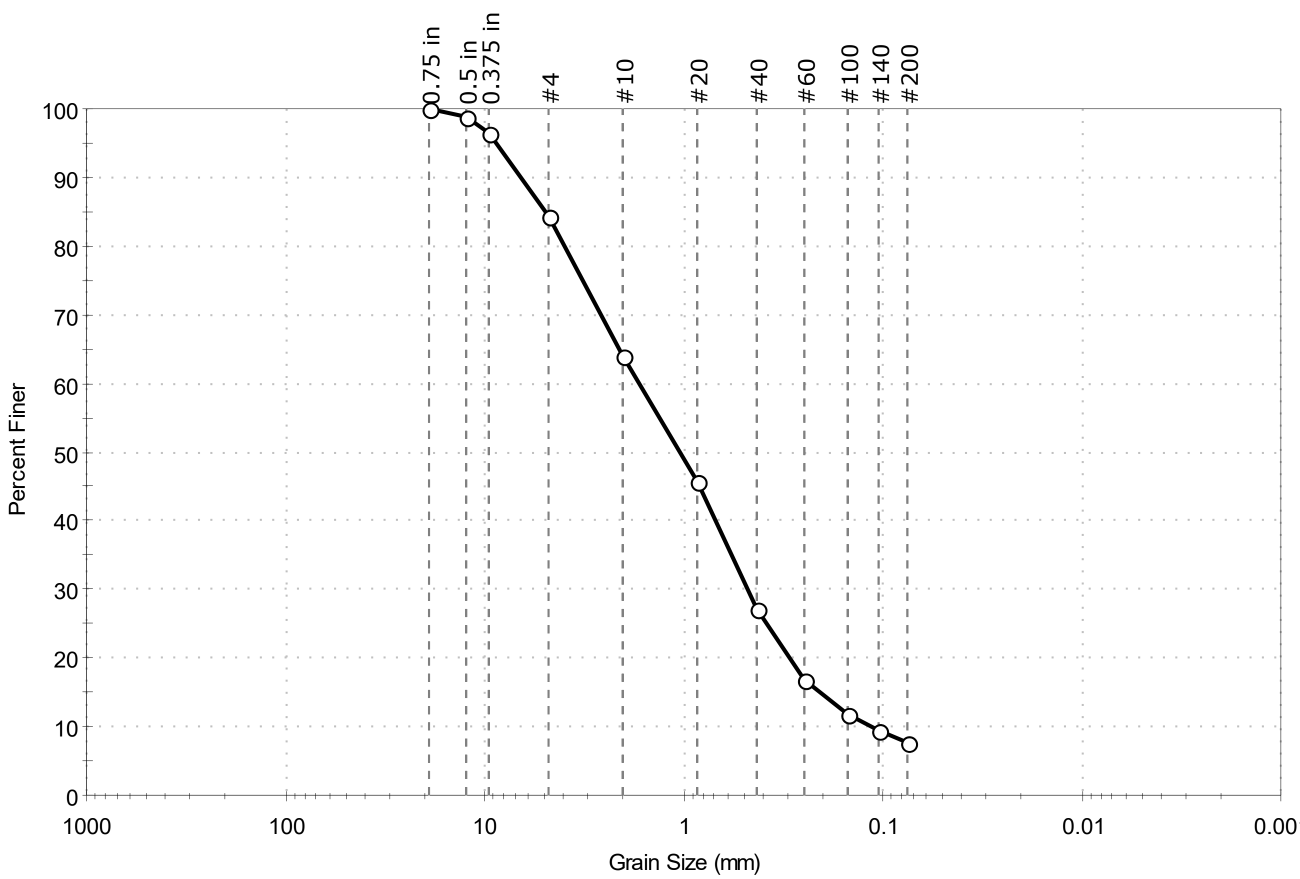
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-101A	Sample Type: bag	Tested By:	ckg
Sample ID: 6D	Test Date: 03/25/20	Checked By:	bfs
Depth : 30-32	Test Id: 551288		
Test Comment:	---		
Visual Description:	Moist, dark grayish brown sand with silt and gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.6	76.8	7.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	96		
#4	4.75	84		
#10	2.00	64		
#20	0.85	46		
#40	0.42	27		
#60	0.25	17		
#100	0.15	12		
#140	0.11	9		
#200	0.075	7.6		

Coefficients

D_{85} =4.9366 mm D_{30} =0.4726 mm
D_{60} =1.6524 mm D_{15} =0.2071 mm
D_{50} =1.0391 mm D_{10} =0.1154 mm
C_u =14.319 C_c =1.171

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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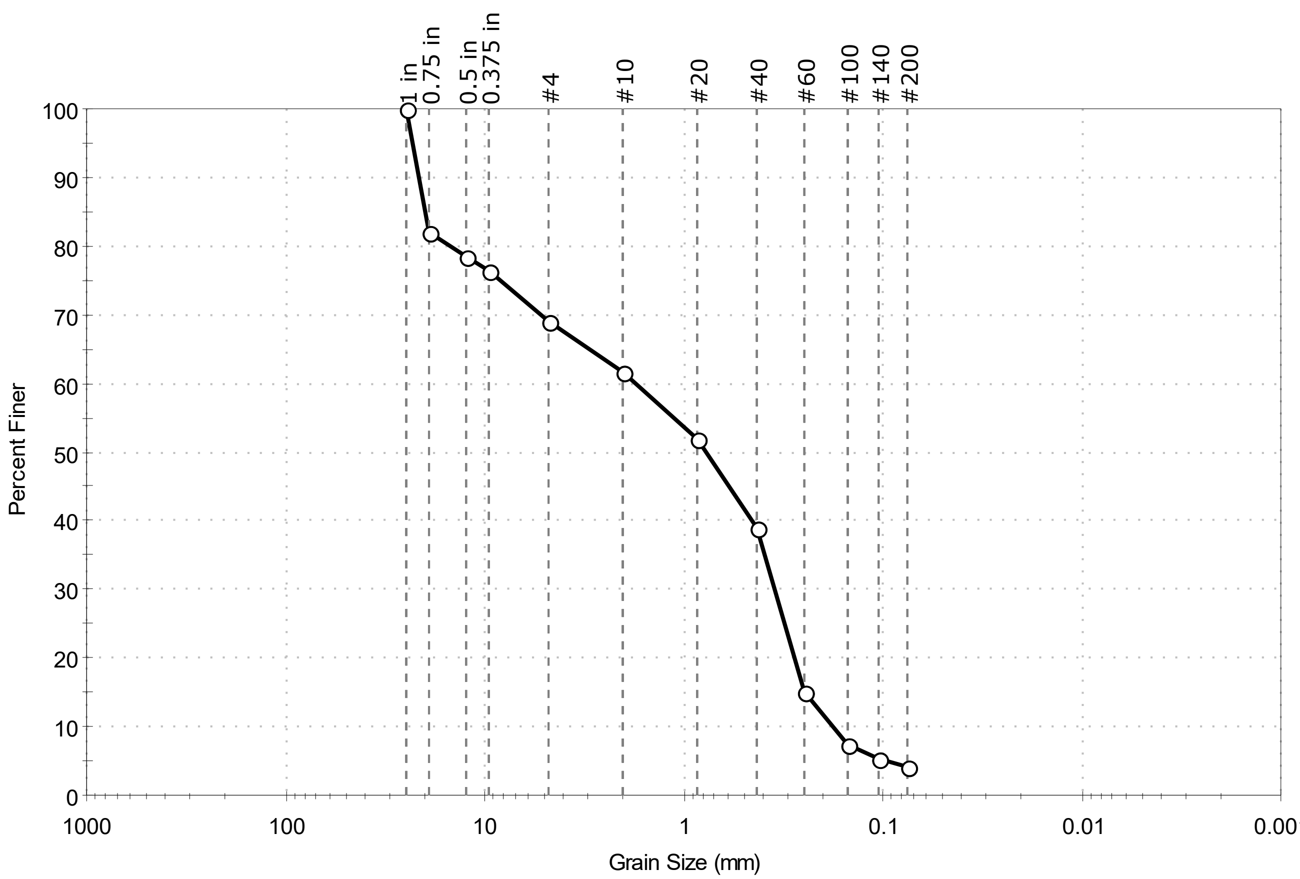
Client:	S.W. Cole Engineering, Inc.
Project:	Alder Stream Bridge #3265 Replace.
Location:	Jim Pond Township, ME
Project No:	GTX-311078
Boring ID:	BB-JPTAS-101A
Sample ID:	8D
Depth :	40-42
Sample Type:	bag
Test Date:	03/25/20
Test Id:	551289
Tested By:	ckg
Checked By:	bfs
Test Comment:	---
Visual Description:	Moist, dark gray sand with gravel
Sample Comment:	---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	30.9	64.9	4.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	82		
0.5 in	12.50	78		
0.375 in	9.50	76		
#4	4.75	69		
#10	2.00	62		
#20	0.85	52		
#40	0.42	39		
#60	0.25	15		
#100	0.15	7		
#140	0.11	5		
#200	0.075	4.2		

Coefficients

D_{85} =19.8868 mm
D_{30} =0.3474 mm
D_{60} =1.7402 mm
D_{15} =0.2471 mm
D_{50} =0.7619 mm
D_{10} =0.1786 mm
C_u =9.744
C_c =0.388

Classification

ASTM Poorly graded SAND with Gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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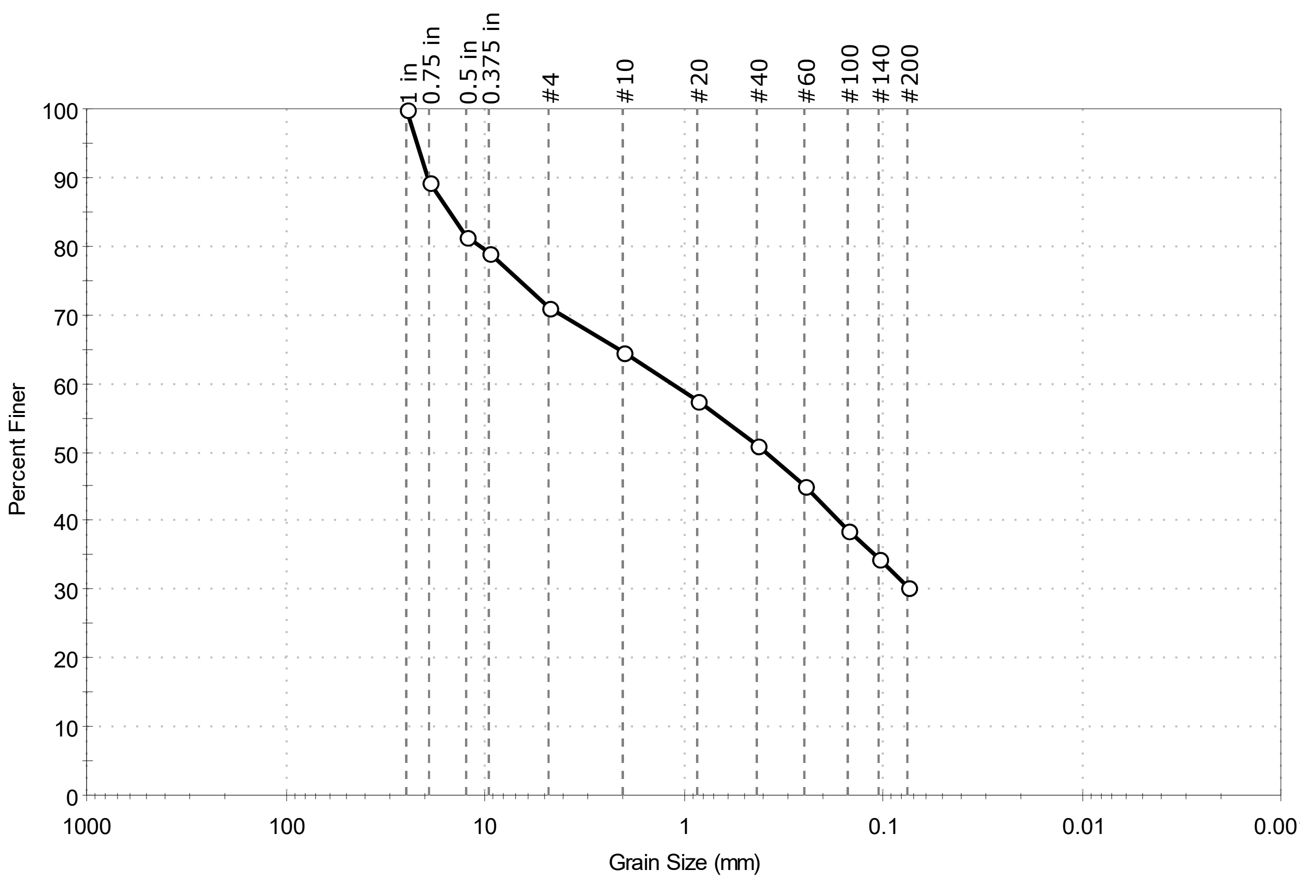
Client:	S.W. Cole Engineering, Inc.				
Project:	Alder Stream Bridge #3265 Replace.				
Location:	Jim Pond Township, ME			Project No:	GTX-311078
Boring ID:	BB-JPTAS-101A	Sample Type:	bag	Tested By:	ckg
Sample ID:	10D	Test Date:	03/25/20	Checked By:	bfs
Depth :	50-51.4	Test Id:	551290		
Test Comment:	---				
Visual Description:	Moist, gray silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	28.8	40.7	30.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	89		
0.5 in	12.50	81		
0.375 in	9.50	79		
#4	4.75	71		
#10	2.00	65		
#20	0.85	58		
#40	0.42	51		
#60	0.25	45		
#100	0.15	39		
#140	0.11	34		
#200	0.075	31		

Coefficients

D_{85} =15.0929 mm　D_{30} =N/A

D_{60} =1.1490 mm　D_{15} =N/A

D_{50} =0.3868 mm　D_{10} =N/A

C_u =N/A　C_c =N/A

Classification

ASTM　N/A

AASHTO　Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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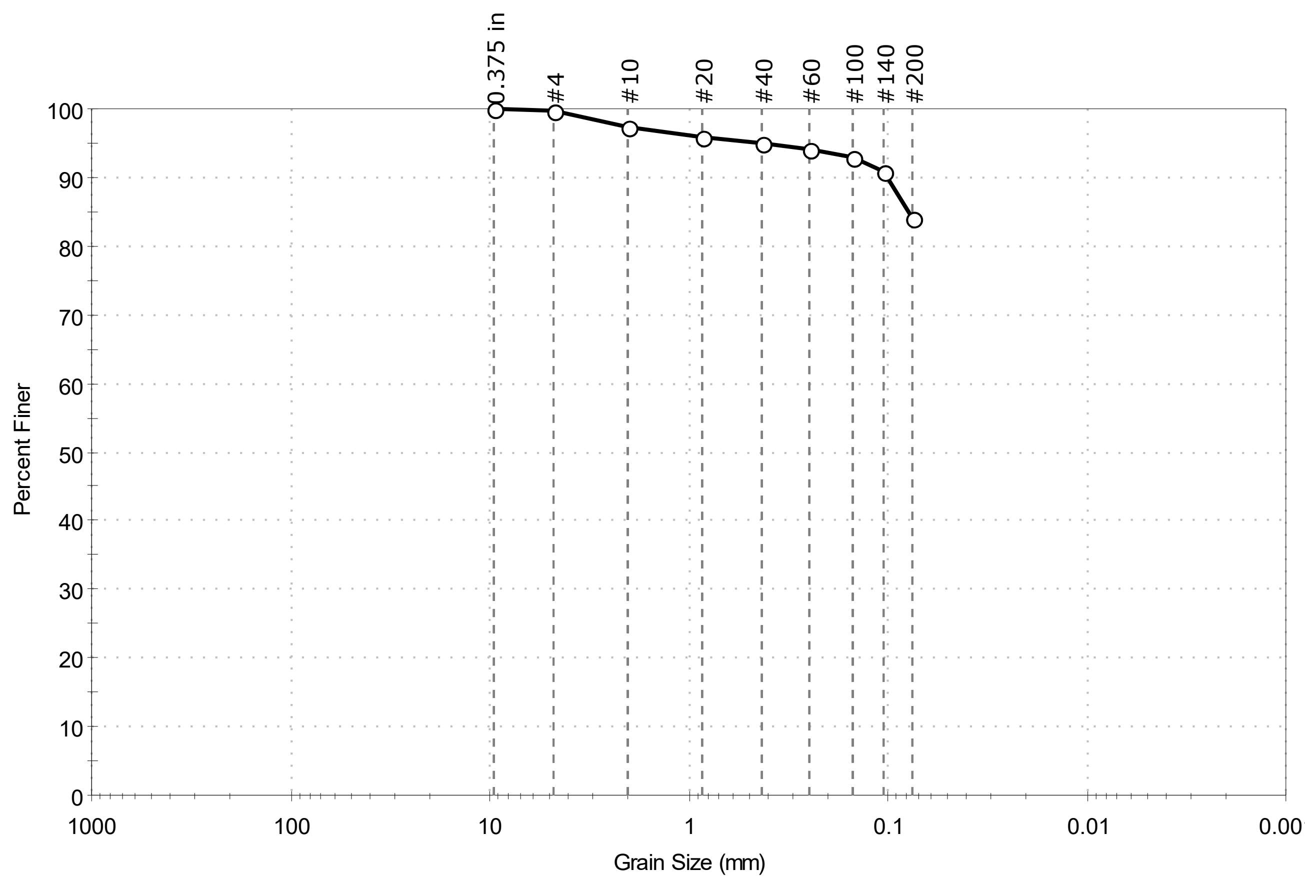
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-101A	Sample Type: bag	Tested By:	ckg
Sample ID: 12D	Test Date: 03/25/20	Checked By:	bfs
Depth : 60-60.5	Test Id: 551291		
Test Comment:	---		
Visual Description:	Moist, greenish gray silt with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.4	15.6	84.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	97		
#20	0.85	96		
#40	0.42	95		
#60	0.25	94		
#100	0.15	93		
#140	0.11	91		
#200	0.075	84		

Coefficients

D_{85} =0.0790 mm — D_{30} =N/A

D_{60} =N/A — D_{15} =N/A

D_{50} =N/A — D_{10} =N/A

C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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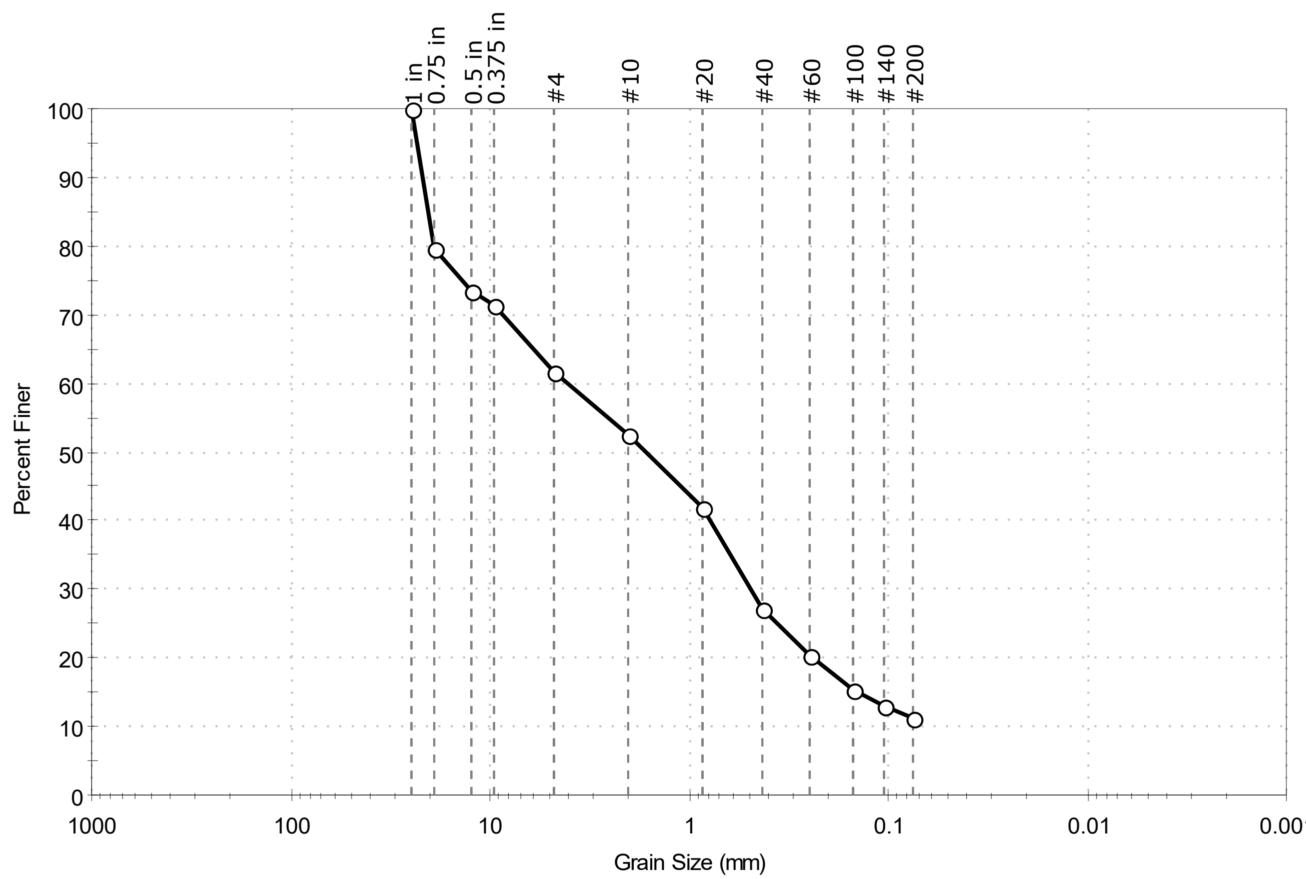
Client: S.W. Cole Engineering, Inc.			
Project: Alder Stream Bridge #3265 Replace.			
Location: Jim Pond Township, ME		Project No:	GTX-311078
Boring ID: BB-JPTAS-102B	Sample Type: jar	Tested By:	ckg
Sample ID: 1D	Test Date: 12/31/19	Checked By:	jsc
Depth : 5-7 ft	Test Id: 534406		
Test Comment: ---			
Visual Description: Moist, light yellowish brown sand with silt and gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	38.5	50.4	11.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	80		
0.5 in	12.50	73		
0.375 in	9.50	72		
#4	4.75	62		
#10	2.00	52		
#20	0.85	42		
#40	0.42	27		
#60	0.25	20		
#100	0.15	15		
#140	0.11	13		
#200	0.075	11		

Coefficients

D_{85} =20.4304 mm D_{30} =0.4837 mm
D_{60} =4.1079 mm D_{15} =0.1432 mm
D_{50} =1.6356 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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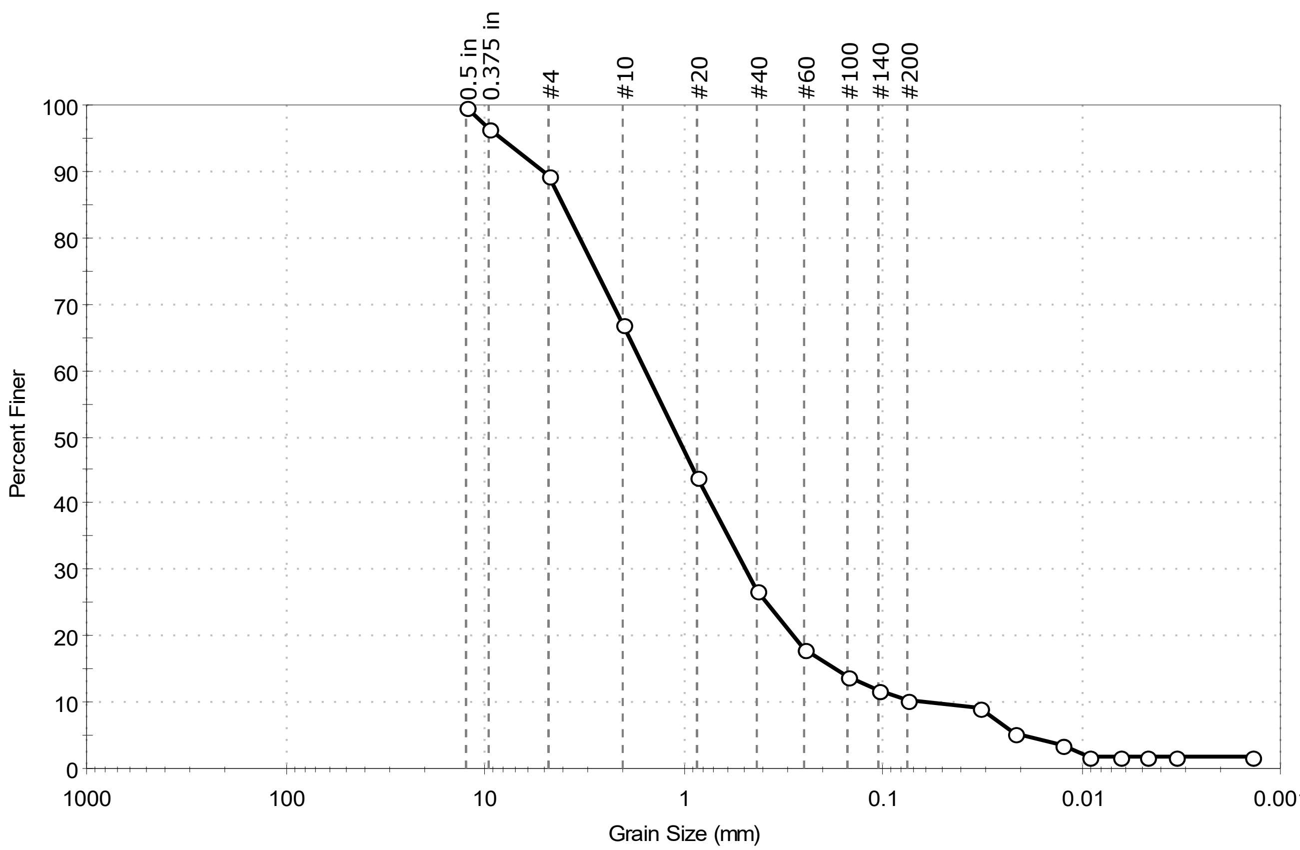
GeoTesting EXPRESS

Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-102B	Sample Type: jar	Tested By:	ckg
Sample ID: 4D	Test Date: 12/20/19	Checked By:	jsc
Depth : 20-22 ft	Test Id: 534411		
Test Comment:	---		
Visual Description:	Moist, olive sand with silt		
Sample Comment:	--		

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.7	79.0	10.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	96		
#4	4.75	89		
#10	2.00	67		
#20	0.85	44		
#40	0.42	27		
#60	0.25	18		
#100	0.15	14		
#140	0.11	12		
#200	0.075	10		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0323	9		
---	0.0215	5		
---	0.0125	4		
---	0.0092	2		
---	0.0065	2		
---	0.0047	2		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} =4.0204 mm D_{30} =0.4818 mm

D_{60} =1.5407 mm D_{15} =0.1741 mm

D_{50} =1.0607 mm D_{10} =0.0616 mm

C_u =25.011 C_c =2.446

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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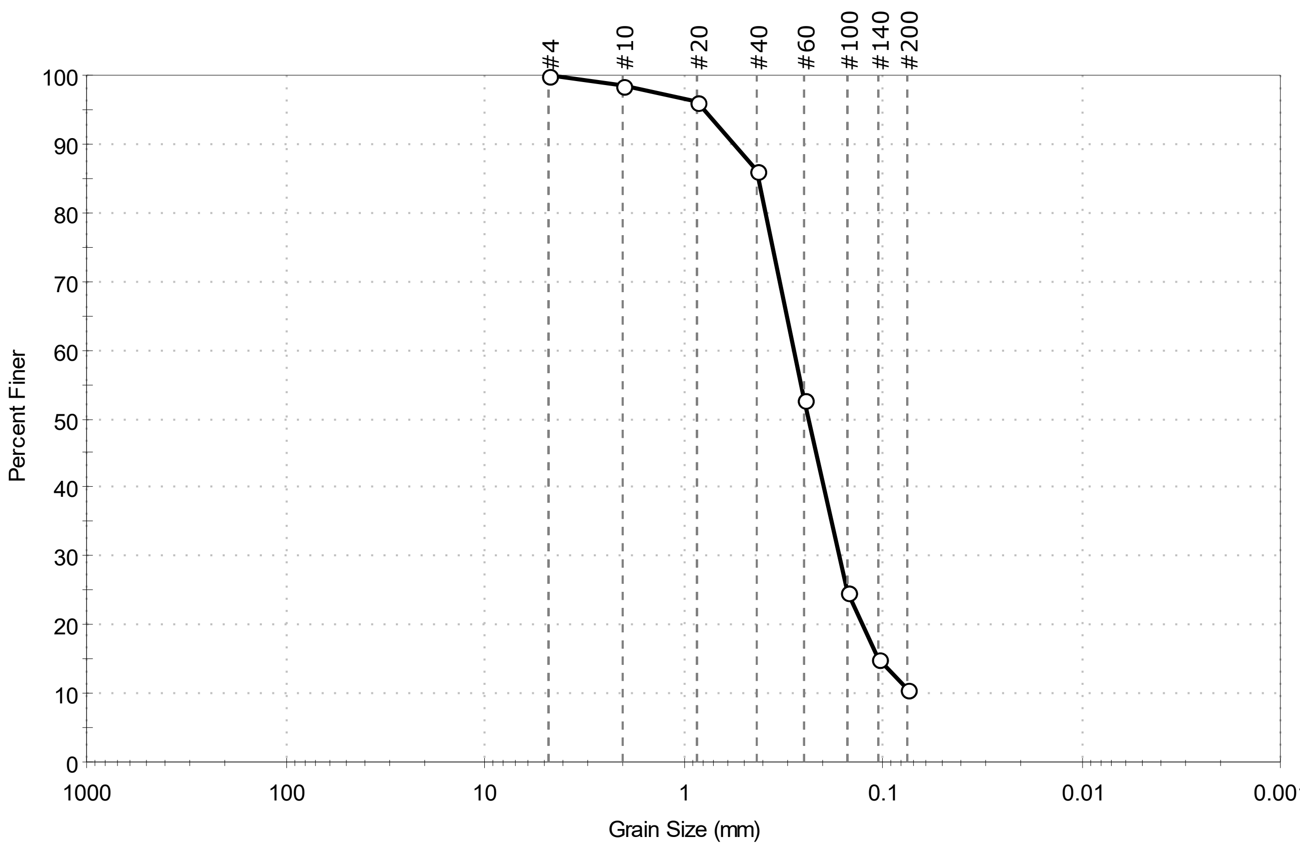
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-102B	Sample Type: jar	Tested By:	ckg
Sample ID: 10D/A	Test Date: 12/31/19	Checked By:	jsc
Depth : 55-56 ft	Test Id: 534407		
Test Comment:	---		
Visual Description:	Moist, gray sand with silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	89.4	10.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.85	96		
#40	0.42	86		
#60	0.25	53		
#100	0.15	25		
#140	0.11	15		
#200	0.075	11		

Coefficients

D_{85} =0.4182 mm D_{30} =0.1650 mm

D_{60} =0.2806 mm D_{15} =0.1062 mm

D_{50} =0.2377 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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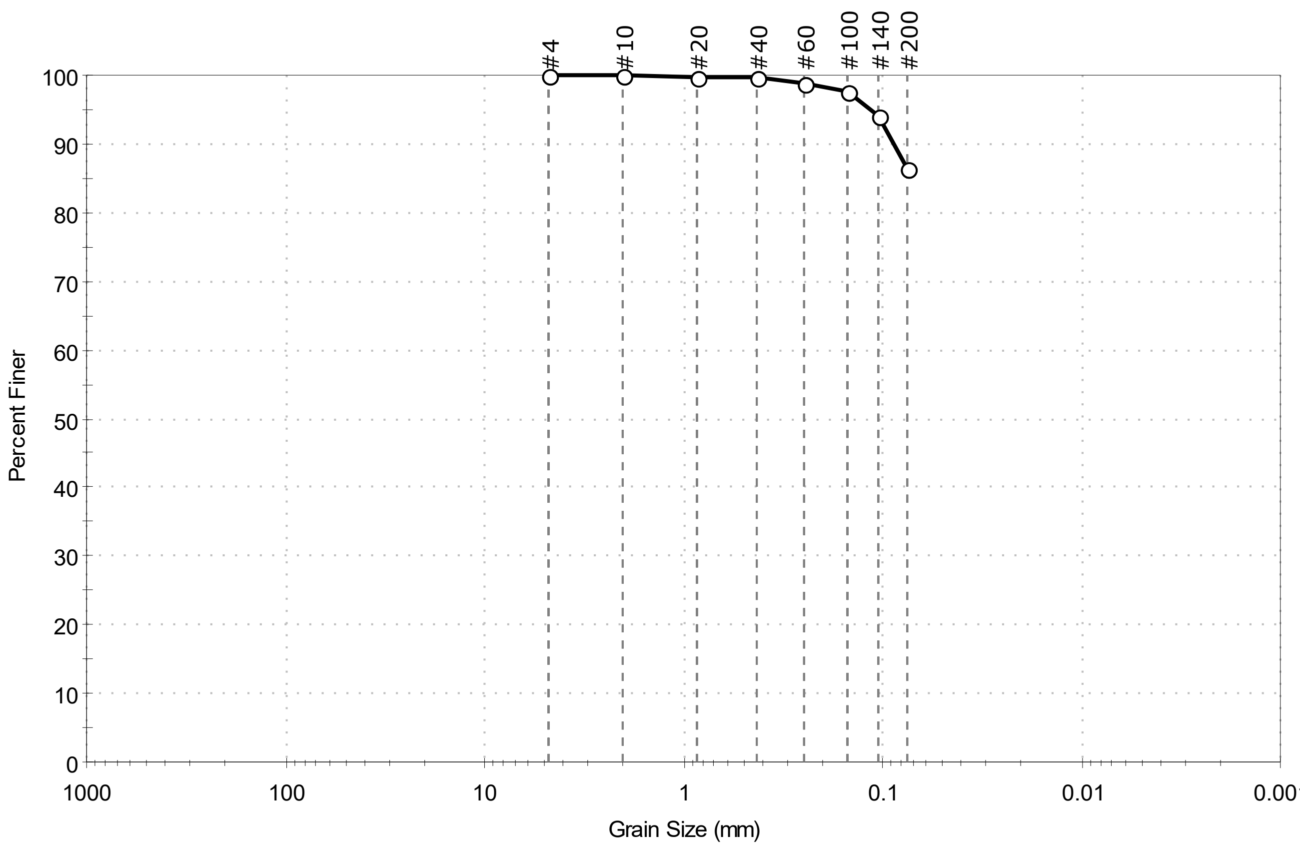
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID:	BB-JPTAS-102B	Sample Type: jar	Tested By: ckg
Sample ID:	10D/B	Test Date: 12/31/19	Checked By: jsc
Depth :	56-57 ft	Test Id: 534408	
Test Comment:	---		
Visual Description:	Moist, gray silt		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	13.7	86.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	98		
#140	0.11	94		
#200	0.075	86		

Coefficients

D_{85} =N/A
D_{30} =N/A
D_{60} =N/A
D_{15} =N/A
D_{50} =N/A
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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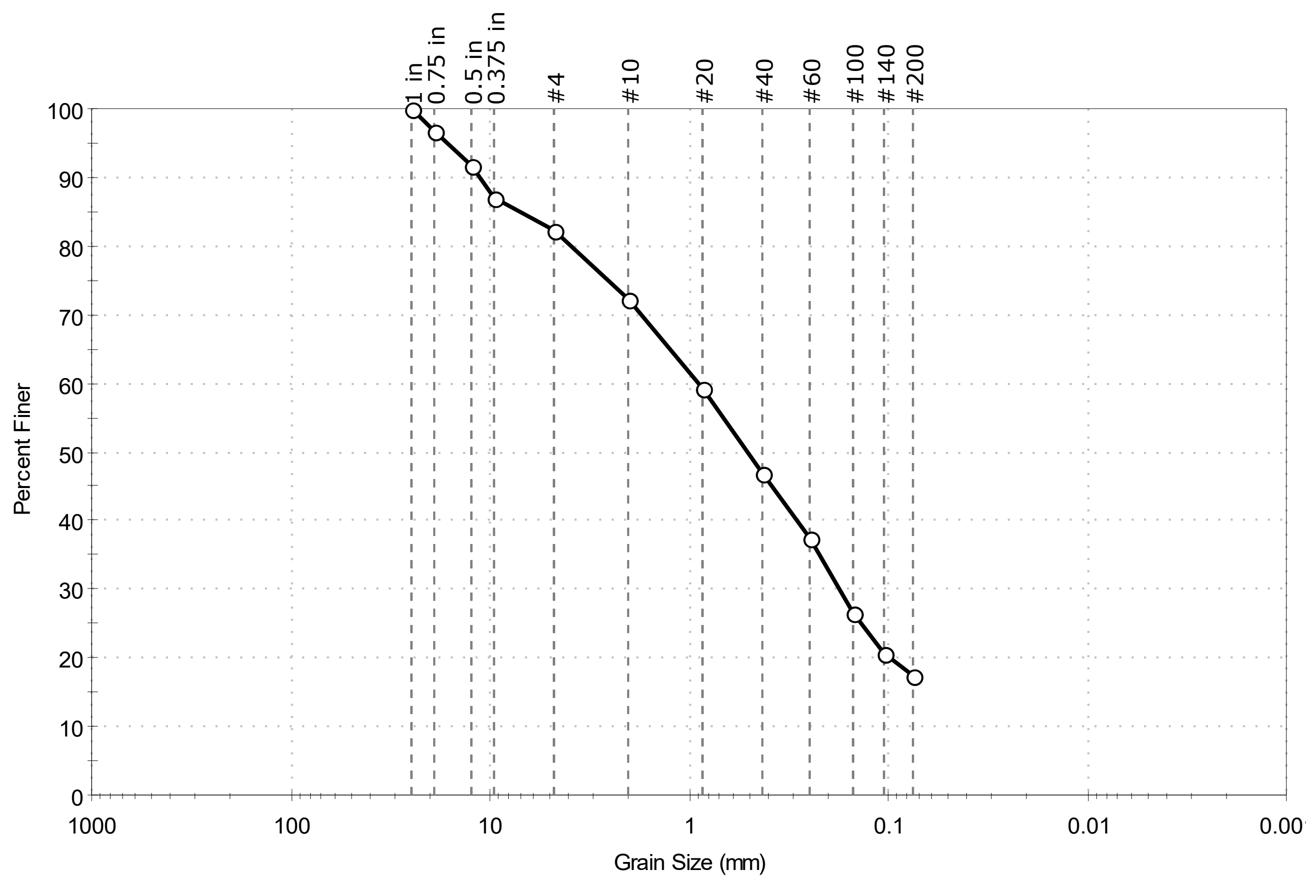
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-102B	Sample Type: jar	Tested By:	ckg
Sample ID: 12D	Test Date: 12/31/19	Checked By:	jsc
Depth : 65-65.8 ft	Test Id: 534409		
Test Comment:	---		
Visual Description:	Moist, gray silty sand with gravel		
Sample Comment:	Sample contains glass		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	17.8	64.8	17.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	92		
0.375 in	9.50	87		
#4	4.75	82		
#10	2.00	72		
#20	0.85	59		
#40	0.42	47		
#60	0.25	37		
#100	0.15	26		
#140	0.11	21		
#200	0.075	17		

Coefficients

D_{85} =7.0782 mm
D_{30} =0.1766 mm
D_{60} =0.8852 mm
D_{15} =N/A
D_{50} =0.5036 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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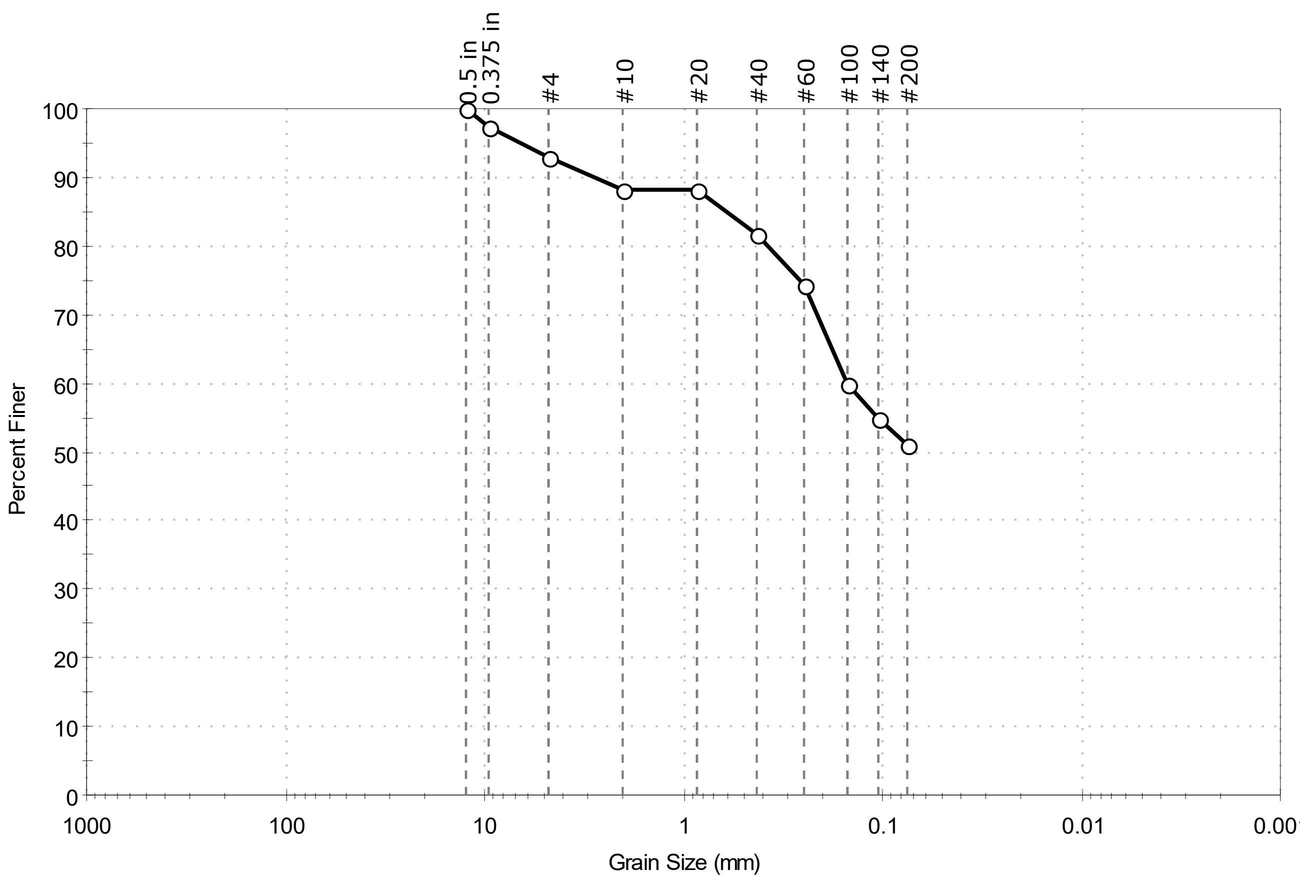
Client:	S.W. Cole Engineering, Inc.		
Project:	Alder Stream Bridge #3265 Replace.		
Location:	Jim Pond Township, ME	Project No:	GTX-311078
Boring ID: BB-JPTAS-102B	Sample Type: jar	Tested By:	ckg
Sample ID: 14D	Test Date: 12/31/19	Checked By:	jsc
Depth : 75-76.4 ft	Test Id: 534410		
Test Comment:	---		
Visual Description:	Moist, dark gray sandy clay		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	7.0	41.8	51.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	93		
#10	2.00	88		
#20	0.85	88		
#40	0.42	82		
#60	0.25	74		
#100	0.15	60		
#140	0.11	55		
#200	0.075	51		

Coefficients

D_{85} =0.6088 mm
D_{30} =N/A
D_{60} =0.1514 mm
D_{15} =N/A
D_{50} =N/A
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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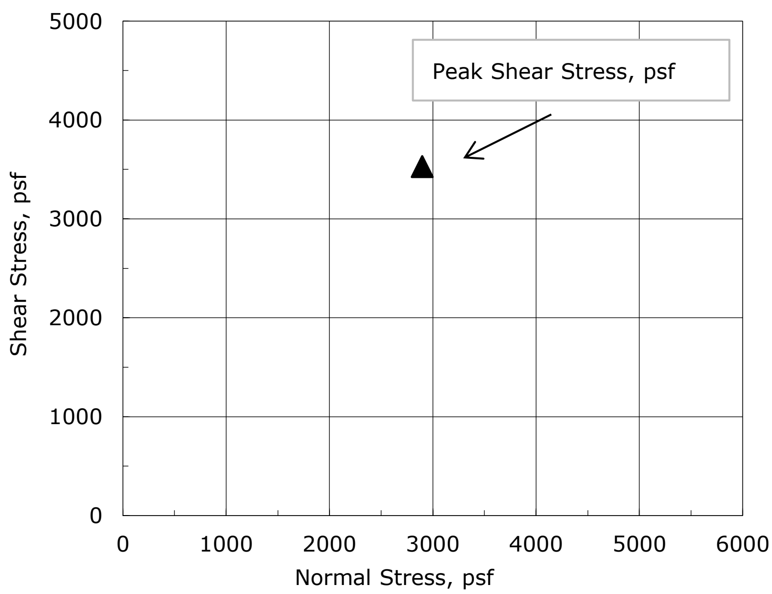
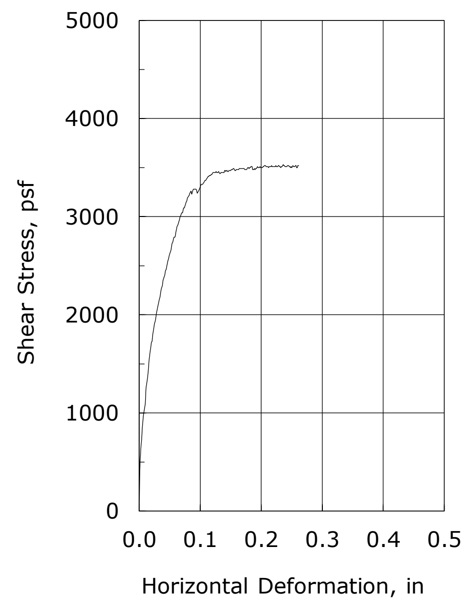
Client:	S.W. Cole Engineering, Inc.
Project Name:	Alder Stream Bridge #3265 Replacement
Project Location:	Jim Pond Township, ME
GTX #:	311078
Test Date:	12/27/2019
Tested By:	md
Checked By:	njh
Boring ID:	BB-JPTAS-102B
Sample ID:	5D,6D, 7D, 8D
Depth, ft:	25-32, 40-47
Visual Description:	Moist, gray sand

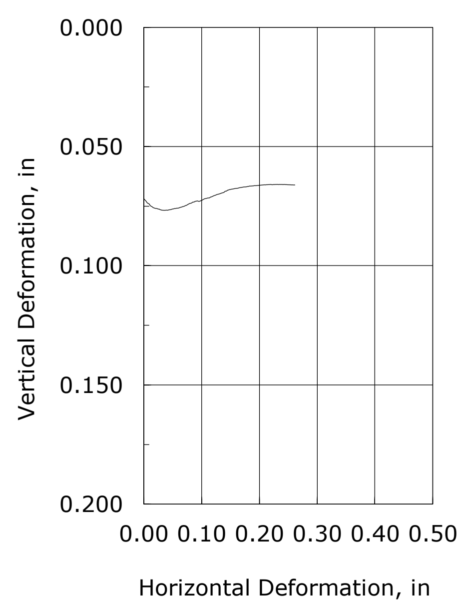
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-1		
Initial Diameter, in	2.50		
Initial Height, in	1.00		
Initial Mass, grams	150		
Initial Dry Density, pcf	99.2		
Initial Moisture Content, %	17.5		
Initial Bulk Density, pcf	116.5		
Initial Degree of Saturation	67.4		
Initial Void Ratio	0.70		
Final Dry Density, pcf	106.2		
Final Moisture Content, %	18.4		
Final Bulk Density, pcf	125.7		
Normal Stress, psf	2899		
Maximum Shear Stress, psf	3530		
Shear Rate, in/min	0.004		

Sample Type:	reconstituted
Estimated Specific Gravity:	2.65
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	---
Soil Classification:	---
Group Symbol:	---



Notes:
Material greater than #5 sieve screened out of sample prior to testing
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D2216
Target Compaction: 115- 118 pcf at saturated moisture content (values provided by client).
Values for cohesion and friction angle not presented because only one test point was requested. If zero cohesion is assumed, the approximate friction angle would be 50.6°.
"---" indicates testing required to determine these values was not requested.

APPENDIX E

Calculations

S.W.COLE ENGINEERING, INC.

SPT BLOW COUNT CONVERSION AND FRICTION ANGLE CORRELATION FOR GRANULAR SOILS

Project Name: Alder Stream Bridge #3265 Replacement
Project No.: 19-1436
Evaluated By/Date: MAS / March 2020
Reviewed By/Date: TJB / March 2020

90.4 Hammer Efficiency
u = 19.5 Depth to Water

		Boring	BB-JPTAS-101A				Correction Factors							
Soil Layer	Stratum	Sample No.	Top of Sample Depth (ft)	Field N-Value N_m	Total Stress at Sample Depth (psf)	Effective Stress at Sample Depth (psf)	Overburden Stress[1] C_N	Hammer Efficiency C_E	Borehole Diameter[2] C_B	Rod Length[2] C_R	Sampler[2] C_S	N_{60}	$(N1)_{60}$	Friction Angle[3] (degrees)
1	Fill	1D	5	33	625	625	1.39	1.51	1.1	0.75	1.0	50	70	41
1	Fill	2D	10	28	1250	1250	1.16	1.51	1.1	0.75	1.0	43	50	39
2	Alluvium	3D	15	9	1863	1863	1.03	1.51	1.1	0.85	1.0	14	15	31
2	Alluvium	4D	20	2	2473	2442	0.94	1.51	1.1	0.95	1.0	4	4	28
3	Glacial Outwash	5D	25	17	3115	2772	0.89	1.51	1.1	0.95	1.0	26	24	35
3	Glacial Outwash	6D	30	9	3765	3110	0.85	1.51	1.1	0.95	1.0	14	12	31
3	Glacial Outwash	7D	35	16	4415	3448	0.82	1.51	1.1	1.00	1.0	25	21	34
3	Glacial Outwash	8D	40	22	5065	3786	0.79	1.51	1.1	1.00	1.0	34	27	37
3	Glacial Outwash	9D	45	48	5715	4124	0.76	1.51	1.1	1.00	1.0	73	56	46
4	Glacial Till	10D	50	100	6380	4477	0.73	1.51	1.1	1.00	1.0	151	111	60
4	Glacial Till	11D	55	100	7055	4840	0.71	1.51	1.1	1.00	1.0	151	107	60
4	Glacial Till	12D	60	100	7730	5203	0.68	1.51	1.1	1.00	1.0	151	103	60
4	Glacial Till	13D	65	100	8405	5566	0.66	1.51	1.1	1.00	1.0	151	100	60
4	Glacial Till	14D	70	100	9080	5929	0.64	1.51	1.1	1.00	1.0	151	97	60
4	Glacial Till	15D	75	100	9755	6292	0.62	1.51	1.0	1.00	1.0	151	94	60
4	Glacial Till	MD	80	100	10430	6655	0.60	1.51	1.0	1.00	1.0	151	91	60
4	Glacial Till	MD	85	100	11105	7018	0.58	1.51	1.0	1.00	1.0	151	88	60

1. Determination of overburden stress correction factor (CN) based on Peck, Hanson and Thornburn (1974) and guidance from AASHTO LRFD Section 10.4.6.2.4 (AASHTO LRFD 8th Ed., 2017).
2. Determination of correction factors (CB, CR, CS) based on guidance from Seed et al. (1985) and Skempton (1986) as presented in Das (2014) Principles of Foundation Engineering, 8th Ed. Table 3.5.
3. Estimated friction angle based on guidance from Peck, Hanson and Thornburn (1974)
4. Refusal field N-values reported as N60 = 100 bpf.

S.W.COLE ENGINEERING, INC.

SPT BLOW COUNT CONVERSION AND FRICTION ANGLE CORRELATION FOR GRANULAR SOILS

Project Name: Alder Stream Bridge #3265 Replacement
Project No.: 19-1436
Evaluated By/Date: MAS / March 2020
Reviewed By/Date: TJB / March 2020

97.7 Hammer Efficiency
u = 10.9 Depth to Water

		Boring		BB-JPTAS-102B			Correction Factors							
Soil Layer	Stratum	Sample No.	Top of Sample Depth (ft)	Field N-Value N_m	Total Stress at Sample Depth (psf)	Effective Stress at Sample Depth (psf)	Overburden Stress[1] C_N	Hammer Efficiency C_E	Borehole Diameter[2] C_B	Rod Length[2] C_R	Sampler[2] C_S	N_{60}	$(N1)_{60}$	Friction Angle[3] (degrees)
1	Fill	1D	5	45	625	625	1.39	1.63	1.0	0.75	1.0	74	103	46
1	Fill	2D	10	26	1250	1250	1.16	1.63	1.0	0.75	1.0	43	50	39
1	Fill	3D	15	35	1875	1619	1.07	1.63	1.0	0.85	1.0	57	62	42
3	Glacial Outwash	4D	20	10	2496	1928	1.01	1.63	1.0	0.95	1.0	17	18	32
3	Glacial Outwash	5D	25	16	3146	2266	0.96	1.63	1.0	0.95	1.0	27	26	35
3	Glacial Outwash	6D	30	12	3796	2604	0.91	1.63	1.0	0.95	1.0	20	19	33
3	Glacial Outwash	MD	35	12	4446	2942	0.87	1.63	1.0	1.00	1.0	20	18	33
3	Glacial Outwash	7D	40	12	5096	3280	0.84	1.63	1.0	1.00	1.0	20	17	33
3	Glacial Outwash	8D	45	22	5746	3618	0.80	1.63	1.0	1.00	1.0	36	29	37
3	Glacial Outwash	9D	50	14	6396	3956	0.77	1.63	1.0	1.00	1.0	23	18	34
3	Glacial Outwash	10D	55	15	7046	4294	0.75	1.63	1.0	1.00	1.0	25	19	34
3	Glacial Outwash	11D	60	21	7696	4632	0.72	1.63	1.0	1.00	1.0	35	26	37
4	Glacial Till	12D	65	100	8366	4990	0.70	1.63	1.0	1.00	1.0	163	114	62
4	Glacial Till	13D	70	100	9041	5353	0.67	1.63	1.0	1.00	1.0	163	110	62
4	Glacial Till	14D	75	100	9716	5716	0.65	1.63	1.0	1.00	1.0	163	107	62
4	Glacial Till	MD	80	100	10391	6079	0.63	1.63	1.0	1.00	1.0	163	103	62

1. Determination of overburden stress correction factor (CN) based on Peck, Hanson and Thornburn (1974) and guidance from AASHTO LRFD Section 10.4.6.2.4 (AASHTO LRFD 8th Ed., 2017).
2. Determination of correction factors (CB, CR, CS) based on guidance from Seed et al. (1985) and Skempton (1986) as presented in Das (2014) Principles of Foundation Engineering, 8th Ed. Table 3.5.
3. Estimated friction angle based on guidance from Peck, Hanson and Thornburn (1974)
4. Refusal field N-values reported as N60 = 100 bpf.

S.W.COLE ENGINEERING, INC.

Design of Bearing H-Piles

Reference:

1. AASHTO LRFD Bridge Design Specifications, 8th Edition, 2017. (LRFD)
2. AASHTO Standard Specifications for Highway Bridges 17th Edition, 2002. (AASHTO)

Pile Properties:

HP14x89 **NOTE: ALL MATRICES SET UP IN THIS ORDER**
HP14x102
HP14x117

$f_y := 50\ ksi$

$A_s := \begin{bmatrix} 26.1 \\ 30.0 \\ 34.4 \end{bmatrix} \cdot in^2$ $d := \begin{bmatrix} 13.8 \\ 14.0 \\ 14.2 \end{bmatrix} \cdot in$ $b := \begin{bmatrix} 14.7 \\ 14.8 \\ 14.9 \end{bmatrix} \cdot in$

$A_p := \overrightarrow{(d \cdot b)} = \begin{bmatrix} 202.86 \\ 207.2 \\ 211.58 \end{bmatrix} in^2$ Area of Box Perimeter

$P_A := \overrightarrow{(d + d + b + b)} = \begin{bmatrix} 57 \\ 57.6 \\ 58.2 \end{bmatrix} in$ Box Perimeter

Nominal and Factored Structural Compressive Resistance

Find Nominal Axial Structural Resistance

$P_o := f_y \cdot A_s = \begin{bmatrix} 1305 \\ 1500 \\ 1720 \end{bmatrix} kip$

Structural Resistance of unbraced segment
Assume 4 foot unbraced section due to scour Lu=4
Determine elastic critical buckling resistance Pe

$E_s := 29000\ ksi$

$K_{eff} := 1.2$ effective length factor / LRFD Table C4.6.2.5-1

$l_{unbraced} := 5\ ft$ unbraced length top of pile

Calculated by / Date: MAS / March 2021
Checked by: TJB

$r_y := \begin{bmatrix} 3.53 \\ 3.56 \\ 3.59 \end{bmatrix} \cdot in$ radius of gyration, weak axis / LRFD Article C6.9.4.1.2

LRFD Eqn 6.9.4.1.2-1

$$P_e := \overrightarrow{\left(\frac{\pi^2 \cdot E_s}{\left(\frac{K_{eff} \cdot l_{unbraced}}{r_y} \right)^2} \cdot A_s \right)} = \begin{bmatrix} 17957 \\ 20992 \\ 24478 \end{bmatrix} kip$$

LRFD Article 6.9.4.1.1

$$\frac{P_e}{P_o} = \begin{bmatrix} 13.76 \\ 13.995 \\ 14.232 \end{bmatrix}$$

$$P_n := \begin{cases} \overrightarrow{0.658^{\left(\frac{P_o}{P_e}\right)} \cdot P_o} & \text{if } \frac{P_e}{P_o} \ge 0.44 \\ 0.877 \cdot P_e & \text{if } \frac{P_e}{P_o} < 0.44 \end{cases} = \begin{bmatrix} 1266 \\ 1456 \\ 1670 \end{bmatrix} kip$$

Find Factored Axial Structural Resistance at Strength Limit State

$\phi_{cu} := 0.7$ For combined axial and flexural resistance of H piles
LRFD Article 6.5.4.2

$P_r := \phi_{cu} \cdot P_n = \begin{bmatrix} 886 \\ 1019 \\ 1169 \end{bmatrix} kip$ LRFD Eqn 6.9.2.1-1

Find Factored Axial Structural Resistance at Strength Limit State

Structural Resistance of braced length

$l_{braced} := 0.1\ ft$

LRFD Eqn 6.9.4.1.2-1

$$P_e := \overrightarrow{\left(\frac{\pi^2 \cdot E_s}{\left(\frac{K_{eff} \cdot l_{braced}}{r_y}\right)^2} \cdot A_s\right)} = \begin{bmatrix} 44891351 \\ 52480022 \\ 61195586 \end{bmatrix} kip$$

LRFD Article 6.9.4.1.1

$$\frac{P_e}{P_o} = \begin{bmatrix} 34399.503 \\ 34986.681 \\ 35578.829 \end{bmatrix}$$ if Pe/Po >/= 0.44 then $$P_n := \overrightarrow{0.658^{\left(\frac{P_o}{P_e}\right)} \cdot P_o} = \begin{bmatrix} 1305 \\ 1500 \\ 1720 \end{bmatrix} kip$$

Find Factored Axial Structural Resistance at Strength Limit State

$\phi_c := 0.5$ LRFD Article 6.5.4.2

$$P_r := \phi_c \cdot P_n = \begin{bmatrix} 652 \\ 750 \\ 860 \end{bmatrix} kip$$ LRFD Eqn 6.9.2.1-1

Nominal and Factored Geotechnical Resistance

Evaluate the Static Analysis of piles driven to end bearing in the glacial till using Nordlund/Thurman static pile resistance method (LRFD Article 10.7.3.8.6f) and SPT-Meyerhof method (LRFD Article 10.7.3.8.6g) limiting the side resistance below the pile's critical depth of 20 pile diameters for very dense glacial till

Nominal Resistance from Axial Pile Worksheet(s)
Assume pile driven to Elevation (El.) 1130 ft at Abutment 1 and El. 1120 ft at Abutment 2

$$R_{A1} := \begin{bmatrix} 595 \\ 643 \\ 695 \end{bmatrix} kip$$ Abutment 1

$$R_{A2} := \begin{bmatrix} 620 \\ 669 \\ 725 \end{bmatrix} kip$$ Abutment 2

Find Factored Geotechnical Resistance at Strength, Service and Extreme Limit States

$\phi_{dyn} := 0.65$ LRFD Table 10.5.5.2.3-1 since dynamic testing will be performed

LRFD Eqn 10.7.3.8.6a-2

Abutment 1

$$R_{R1} := \phi_{dyn} \cdot R_{A1} = \begin{bmatrix} 387 \\ 418 \\ 452 \end{bmatrix} kip$$

Abutment 2

$$R_{R2} := \phi_{dyn} \cdot R_{A2} = \begin{bmatrix} 403 \\ 435 \\ 471 \end{bmatrix} kip$$

Drivability Analysis

From LRFD Article 10.7.8

For steel piles in compression or tension, limit driving stresses to 90% fy

$\phi_{da} := 1.0$ LRFD Table 10.5.5.2.3-1, Drivability Analysis, Steel Piles (See LRFD 6.5.4.2)

$\sigma_{da} := 0.9 \cdot f_y \cdot \phi_{da} = 45\ ksi$ LRFD Eqn 10.7.8.1

Per LRFD, limit driving stresses to 45 ksi or less or
Per BDG Section 501, limit blow counts to 5-15 blows to inch (bpi) with 6-10 bpi optimal

Find maximum resistance from drivability analysis:

$\phi_{dyn} := 0.65$ LRFD Table 10.5.5.2.3-1 Strength Limit State

$\phi_s := 1$ Service and Extreme Limit States

GRL WEAP Soil and Pile Model Assumptions

Estimated pile lengths: 60 to 70 ft (bottom of pile cap to 20D into glacial till or to cobble/boulder refusal layer from explorations)

Assume contractor drives **70 to 80 ft piles** (worst case) to account for additional pile length for testing (5 ft), pile cap embedment (3 ft) and cut off.

DELMAG D19-42 and D36-32 Hammers was chosen as typical pile hammers capable of driving the piles.

The following pile hammer and cushion parameters were used in the analysis:

DELMAG D19-42 Hammer

Hammer parameters

Efficiency	0.8				
Pressure	1600	psi	Fixed	100	%
Stroke	10.81	ft	Fixed		

DELMAG D36-32 Hammer
for 14x117 piles

Hammer parameters

Efficiency	0.8				
Pressure	1500	psi	Fixed	100	%
Stroke	11.42	ft	Fixed		

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

From GRL WEAP output:

$$R_{ndr} := \begin{bmatrix} 547 \\ 555 \\ 559 \\ 970 \end{bmatrix} kip$$

HP14x89
HP14x102
HP14x117
HP14x117 with Delmag D36-32

Strength Limit State

$$R_{fdr} := \overrightarrow{R_{ndr} \cdot \phi_{dyn}} = \begin{bmatrix} 356 \\ 361 \\ 363 \\ 631 \end{bmatrix} kip$$

Service and Extreme Limit States

$$R_{dr} := \overrightarrow{R_{ndr} \cdot \phi_{s}} = \begin{bmatrix} 547 \\ 555 \\ 559 \\ 970 \end{bmatrix} kip$$

AXIAL PILE RESISTANCE **Abutment No. 1**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-101, -101A

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

PILE DATA

Pile Size:	HP14x89	
Depth/Diameter:	1.15	ft
Web Thickness:	0.05	ft
Flange Width:	1.23	ft
Flange Thickness:	0.05	ft
Perimeter:	4.75	ft
Section Area:	0.18	ft^2
Cutting Shoe End Area:	0.36	ft^2
Plugged Section Area:	1.41	ft^2
Ground Surface El.:	1203.6	ft
Pile Head El.:	1194.0	ft
Pile Cap El.:	1192.0	ft
Q50 Water El.:	1196.5	ft

20D
23.0 ft

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance ϕ_{stat} = 0.45

Dynamic Resistance ϕ_{dyn} = 0.65

Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Factored Axial Res. kips	Nordlund Factored Axial Res. (kips)
0																								
1																								
1																								
1																								
1																								
1	Bottom of Pile Cap at Elevation ±1192 feet																							
1																								
1																								
1																								
1																								
1																								
1																								
2	1192	0	122	59.6	0.00		0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1191	1	122	59.6	0.06		0.85	0.95			0.10	0.02			0.5	0.1	0.0	0.0	0.5	0.1	0.1	0.0	0.3	0.1
2	1190	2	122	59.6	0.12		0.85	0.95			0.10	0.04			1.0	0.3	0.0	0.0	1.0	0.3	0.2	0.0	0.6	0.2
2	1189	3	122	59.6	0.18		0.85	0.95			0.10	0.06			1.4	0.5	0.0	0.0	1.4	0.5	0.3	0.0	0.9	0.3
2	1188	4	122	59.6	0.24		0.85	0.95			0.10	0.07			1.9	0.9	0.0	0.0	1.9	0.9	0.6	0.0	1.2	0.6
2	1187	5	122	59.6	0.30		0.85	0.95			0.10	0.09			2.4	1.3	0.0	0.0	2.4	1.3	0.9	0.0	1.5	0.9
2	1186	6	122	59.6	0.36		0.85	0.95			0.10	0.10			2.9	1.8	0.0	0.0	2.9	1.8	1.2	0.0	1.9	1.2
2	1185	7	122	59.6	0.42		0.85	0.95			0.10	0.10			3.3	2.3	0.0	0.0	3.3	2.3	1.5	0.0	2.2	1.5
2	1184	8	122	59.6	0.48		0.85	0.95			0.10	0.10			3.8	2.8	0.0	0.0	3.8	2.8	1.8	0.0	2.5	1.8
2	1183	9	122	59.6	0.54		0.85	0.95			0.10	0.10			4.3	3.2	0.0	0.0	4.3	3.2	2.1	0.0	2.8	2.1
3	1182	10	128	65.6	0.60		0.85	0.95			0.38	0.19			6.1	4.1	0.0	0.0	6.1	4.1	2.7	0.0	4.0	2.7
3	1181	11	128	65.6	0.67		0.85	0.95			0.38	0.21			7.9	5.1	0.0	0.0	7.9	5.1	3.3	0.0	5.1	3.3
3	1180	12	128	65.6	0.73		0.85	0.95			0.38	0.23			9.7	6.2	0.0	0.0	9.7	6.2	4.0	0.0	6.3	4.0
3	1179	13	128	65.6	0.80		0.85	0.95			0.38	0.25			11.5	7.4	0.0	0.0	11.5	7.4	4.8	0.0	7.5	4.8
3	1178	14	128	65.6	0.86		0.85	0.95			0.38	0.27			13.3	8.7	0.0	0.0	13.3	8.7	5.7	0.0	8.6	5.7
3	1177	15	128	65.6	0.93		0.85	0.95			0.38	0.29			15.1	10.1	0.0	0.0	15.1	10.1	6.6	0.0	9.8	6.6
3	1176	16	128	65.6	1.00		0.85	0.95			0.38	0.31			16.9	11.6	0.0	0.0	16.9	11.6	7.5	0.0	11.0	7.5
3	1175	17	128	65.6	1.06		0.85	0.95			0.38	0.33			18.7	13.2	0.0	0.0	18.7	13.2	8.6	0.0	12.2	8.6
3	1174	18	128	65.6	1.13		0.85	0.95			0.38	0.35			20.5	14.9	0.0	0.0	20.5	14.9	9.7	0.0	13.3	9.7
3	1173	19	128	65.6	1.19		0.85	0.95			0.38	0.37			22.3	16.6	0.0	0.0	22.3	16.6	10.8	0.0	14.5	10.8
3	1172	20	128	65.6	1.26		0.85	0.95			0.38	0.40			24.1	18.5	0.0	0.0	24.1	18.5	12.0	0.0	15.7	12.0
3	1171	21	128	65.6	1.32		0.85	0.95			0.38	0.42			25.9	20.5	0.0	0.0	25.9	20.5	13.3	0.0	16.9	13.3
3	1170	22	128	65.6	1.39		0.85	0.95			0.38	0.44			27.7	22.6	0.0	0.0	27.7	22.6	14.7	0.0	18.0	14.7
4	1169	23	130	67.6	1.46		1.15	0.93			0.80	0.61			31.5	25.4	0.0	0.0	31.5	25.4	16.5	0.0	20.5	16.5
4	1168	24	130	67.6	1.52		1.15	0.93			0.80	0.63			35.3	28.5	0.0	0.0	35.3	28.5	18.5	0.0	23.0	18.5
4	1167	25	130	67.6	1.59		1.15	0.93			0.80	0.66			39.1	31.6	0.0	0.0	39.1	31.6	20.5	0.0	25.4	20.5
4	1166	26	130	67.6	1.66		1.15	0.93			0.80	0.69			42.9	34.9	0.0	0.0	42.9	34.9	22.7	0.0	27.9	22.7
4	1165	27	130	67.6	1.73		1.15	0.93			0.80	0.72			46.7	38.3	0.0	0.0	46.7	38.3	24.9	0.0	30.4	24.9
4	1164	28	130	67.6	1.79		1.15	0.93			0.80	0.75			50.5	41.9	0.0	0.0	50.5	41.9	27.2	0.0	32.9	27.2
4	1163	29	130	67.6	1.86		1.15	0.93			0.80	0.78			54.3	45.5	0.0	0.0	54.3	45.5	29.6	0.0	35.3	29.6
4	1162	30	130	67.6	1.93		1.15	0.93			0.80	0.80			58.1	49.4	0.0	0.0	58.1	49.4	32.1	0.0	37.8	32.1
4	1161	31	130	67.6	2.00		1.15	0.93			0.80	0.83			61.9	53.3	0.0	0.0	61.9	53.3	34.7	0.0	40.3	34.7
4	1160	32	130	67.6	2.07		1.15	0.93			0.80	0.86			65.7	57.4	0.0	0.0	65.7	57.4	37.3	0.0	42.7	37.3
4	1159	33	130	67.6	2.13		1.15	0.93			0.80	0.89			69.5	61.6	0.0	0.0	69.5	61.6	40.1	0.0	45.2	40.1
4	1158	34	130	67.6	2.20		1.15	0.93			0.80	0.92			73.3	66.0	0.0	0.0	73.3	66.0	42.9	0.0	47.7	42.9
4	1157	35	130	67.6	2.27		1.15	0.93			0.80	0.94			77.1	70.5	0.0	0.0	77.1	70.5	45.8	0.0	50.1	45.8
5	1156	36	135	72.6	2.34	0.87	1.70	0.90	0.75	170.00	1.90	1.39	66.09	298.4	86.2	77.1	23.9	107.8	110.0	184.9	50.1	70.1	71.5	120.2
5	1155	37	135	72.6	2.41	1.74	1.70	0.90	0.75	170.00	1.90	1.44	132.17	307.7	95.2	83.9	47.8	111.2	142.9	195.1	54.5	72.3	92.9	126.8
5	1154	38	135	72.6	2.49	2.61	1.70	0.90	0.75	170.00	1.90	1.48	198.26	316.9	104.2	91.0	71.6	114.5	175.8	205.5	59.1	74.4	114.3	133.6
5	1153	39	135	72.6	2.56	3.48	1.70	0.90	0.75	170.00	1.90	1.52	264.35	326.2	113.2	98.2	95.5	117.9	208.8	216.1	63.8	76.6	135.7	140.4
5	1152	40	135	72.6	2.63	4.35	1.70	0.90	0.75	170.00	1.90	1.57	330.43	335.5	122.3	105.6	119.4	121.2	241.7	226.8	68.7	78.8	157.1	147.4
5	1151	41	135	72.6	2.70	5.22	1.70	0.90	0.75	170.00	1.90	1.61	396.52	344.7	131.3	113.3	143.3	124.5	274.6	237.8	73.6	81.0	178.5	154.6
5	1150	42	135	72.6	2.78	6.09	1.70	0.90	0.75	170.00	1.90	1.65	462.61	354.0	140.3	121.1	167.1	127.9	307.5	249.0	78.7	83.1	199.8	161.9
5	1149	43	135	72.6	2.85	6.96	1.70	0.90	0.75	170.00	1.90	1.70	528.70	363.2	149.3	129.2	191.0	131.2	340.4	260.4	84.0	85.3	221.2	169.3
5	1148	44	135	72.6	2.92	7.83	1.70	0.90	0.75	170.00	1.90	1.74	594.78	372.5	158.4	137.5	214.9	134.6	373.3	272.1	89.4	87.5	242.6	176.8
5	1147	45	135	72.6	2.99	8.70	1.70	0.90	0.75	170.00	1.90	1.78	660.87	381.7	167.4	146.0	238.8	137.9	406.2	283.9	94.9	89.7	264.0	184.5
5	1146	46	135	72.6	3.07	9.57	1.70	0.90	0.75	170.00	1.90	1.83	726.96	391.0	176.4	154.6	262.7	141.3	439.1	295.9	100.5	91.8	285.4	192.3
5	1145	47	135	72.6	3.14	10.43	1.70	0.90	0.75	170.00	1.90	1.87	760.00	400.2	185.4	163.5	274.6	144.6	460.0	308.1	106.3	94.0	299.0	200.3
5	1144	48	135	72.6	3.21	11.30	1.70	0.90	0.75	170.00	1.90	1.91	760.00	409.5	194.5	172.6	274.6	148.0	469.1	320.6	112.2	96.2	304.9	208.4

AXIAL PILE RESISTANCE **Abutment No. 1**

Evaluated By/Date:	MAS / March 2021
Reviewed By:	TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-101, -101A

PILE DATA

Pile Size:	HP14x89			
Depth/Diameter:	1.15	ft	**20D**	
Web Thickness:	0.05	ft	23.0	ft
Flange Width:	1.23	ft		
Flange Thickness:	0.05	ft		
Perimeter:	4.75	ft		
Section Area:	0.18	ft^2		
Cutting Shoe End Area:	0.36	ft^2		
Plugged Section Area:	1.41	ft^2		
Ground Surface El.:	1203.6	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors

Table 10.5.5.2.3-1

Static Side/End Resistance		Dynamic Resistance	
ϕ_{stat} =	0.45	ϕ_{dyn} =	0.65

Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Factored Axial Res. kips	Nordlund Factored Axial Res. (kips)
5	1143	49	135	72.6	3.28	12.17	1.70	0.90	0.75	170.00	1.90	1.96	760.00	418.8	203.5	181.9	274.6	151.3	478.1	333.2	118.2	98.3	310.8	216.6
5	1142	50	135	72.6	3.36	13.04	1.70	0.90	0.75	170.00	1.90	2.00	760.00	428.0	212.5	191.4	274.6	154.6	487.1	346.0	124.4	100.5	316.6	224.9
5	1141	51	135	72.6	3.43	13.91	1.70	0.90	0.75	170.00	1.90	2.04	760.00	437.3	221.5	201.1	274.6	158.0	496.1	359.1	130.7	102.7	322.5	233.4
5	1140	52	135	72.6	3.50	14.78	1.70	0.90	0.75	170.00	1.90	2.09	760.00	446.5	230.6	211.0	274.6	161.3	505.2	372.4	137.2	104.9	328.4	242.0
5	1139	53	135	72.6	3.57	15.65	1.70	0.90	0.75	170.00	1.90	2.13	760.00	455.8	239.6	221.1	274.6	164.7	514.2	385.8	143.7	107.0	334.2	250.8
5	1138	54	135	72.6	3.65	16.52	1.70	0.90	0.75	170.00	1.90	2.17	760.00	465.0	248.6	231.5	274.6	168.0	523.2	399.5	150.4	109.2	340.1	259.7
5	1137	55	135	72.6	3.72	17.39	1.70	0.90	0.75	170.00	1.90	2.22	760.00	474.3	257.6	242.0	274.6	171.4	532.2	413.4	157.3	111.4	346.0	268.7
5	1136	56	135	72.6	3.79	18.26	1.70	0.90	0.75	170.00	1.90	2.26	760.00	483.6	266.7	252.7	274.6	174.7	541.3	427.4	164.3	113.6	351.8	277.8
5	1135	57	135	72.6	3.87	19.13	1.70	0.90	0.75	170.00	1.90	2.30	760.00	492.8	275.7	263.7	274.6	178.1	550.3	441.7	171.4	115.7	357.7	287.1
5	1134	58	135	72.6	3.94	20.00	1.70	0.90	0.75	170.00	1.90	2.35	760.00	502.1	284.7	274.8	274.6	181.4	559.3	456.2	178.6	117.9	363.6	296.5
5	1133	59	135	72.6	4.01	20.87	1.70	0.90	0.75	170.00	1.90	2.39	760.00	511.3	293.7	286.2	274.6	184.7	568.3	470.9	186.0	120.1	369.4	306.1
5	1132	60	135	72.6	4.08	21.74	1.70	0.90	0.75	170.00	1.90	2.43	760.00	520.6	302.8	297.7	274.6	188.1	577.4	485.8	193.5	122.3	375.3	315.8
5	1131	61	135	72.6	4.16	22.61	1.70	0.90	0.75	170.00	1.90	2.48	760.00	529.8	311.8	309.5	274.6	191.4	586.4	500.9	201.2	124.4	381.2	325.6
5	1130	62	135	72.6	4.23	23.48	1.70	0.90	0.75	170.00	1.90	2.52	760.00	539.1	320.8	321.4	274.6	194.8	595.4	516.2	208.9	126.6	387.0	335.5
5	1129	63	135	72.6	4.30	24.35	1.70	0.90	0.75	170.00	1.90	2.56	760.00	548.4	329.8	333.6	274.6	198.1	604.4	531.7	216.8	128.8	392.9	345.6
5	1128	64	135	72.6	4.37	25.22	1.70	0.90	0.75	170.00	1.90	2.61	760.00	557.6	338.9	346.0	274.6	201.5	613.5	547.5	224.9	131.0	398.8	355.8
5	1127	65	135	72.6	4.45	26.09	1.70	0.90	0.75	170.00	1.90	2.65	760.00	566.9	347.9	358.6	274.6	204.8	622.5	563.4	233.1	133.1	404.6	366.2
5	1126	66	135	72.6	4.52	26.96	1.70	0.90	0.75	170.00	1.90	2.69	760.00	576.1	356.9	371.4	274.6	208.2	631.5	579.5	241.4	135.3	410.5	376.7
5	1125	67	135	72.6	4.59	27.83	1.70	0.90	0.75	170.00	1.90	2.74	760.00	585.4	365.9	384.3	274.6	211.5	640.5	595.9	249.8	137.5	416.3	387.3
5	1124	68	135	72.6	4.66	28.70	1.70	0.90	0.75	170.00	1.90	2.78	760.00	594.6	375.0	397.5	274.6	214.8	649.6	612.4	258.4	139.7	422.2	398.1
5	1123	69	135	72.6	4.74	29.57	1.70	0.90	0.75	170.00	1.90	2.82	760.00	603.9	384.0	411.0	274.6	218.2	658.6	629.1	267.1	141.8	428.1	408.9
5	1122	70	135	72.6	4.81	30.43	1.70	0.90	0.75	170.00	1.90	2.87	760.00	613.1	393.0	424.6	274.6	221.5	667.6	646.1	276.0	144.0	433.9	420.0
5	1121	71	135	72.6	4.88	31.30	1.70	0.90	0.75	170.00	1.90	2.91	760.00	622.4	402.0	438.4	274.6	224.9	676.6	663.3	284.9	146.2	439.8	431.1
5	1120	72	135	72.6	4.95	32.17	1.70	0.90	0.75	170.00	1.90	2.95	760.00	631.7	411.1	452.4	274.6	228.2	685.7	680.6	294.1	148.3	445.7	442.4

AXIAL PILE RESISTANCE **Abutment No. 1**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA
S.W. Cole Engineering, Inc.
Project: Alder Stream Bridge #3265
Project No.: 19-1436
Soil profile based on: BB-JPTAS-101, -101A

PILE DATA

Pile Size:	HP14x102	
Depth/Diameter:	1.17	ft
Web Thickness:	0.06	ft
Flange Width:	1.23	ft
Flange Thickness:	0.06	ft
Perimeter:	4.80	ft
Section Area:	0.21	ft^2
Cutting Shoe End Area:	0.42	ft^2
Plugged Section Area:	1.44	ft^2
Ground Surface El.:	1203.6	ft
Pile Head El.:	1194.0	ft
Pile Cap El.:	1192.0	ft
Q50 Water El.:	1196.5	ft

20D
23.3 ft

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	LRFD Method Factored End Resist (kips)	LRFD Method Meyerhoff Factored Axial Res. kips	LRFD Method Nordlund Factored Axial Res. (kips)
0																								
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1	Bottom of Pile Cap at Elevation ±1192 feet																							
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2	1192	0	122	59.6	0.00		0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1191	1	122	59.6	0.06		0.85	0.95			0.10	0.02			0.5	0.1	0.0	0.0	0.5	0.1	0.1	0.0	0.3	0.1
2	1190	2	122	59.6	0.12		0.85	0.95			0.10	0.04			1.0	0.3	0.0	0.0	1.0	0.3	0.2	0.0	0.6	0.2
2	1189	3	122	59.6	0.18		0.85	0.95			0.10	0.06			1.4	0.5	0.0	0.0	1.4	0.5	0.4	0.0	0.9	0.4
2	1188	4	122	59.6	0.24		0.85	0.95			0.10	0.07			1.9	0.9	0.0	0.0	1.9	0.9	0.6	0.0	1.2	0.6
2	1187	5	122	59.6	0.30		0.85	0.95			0.10	0.09			2.4	1.3	0.0	0.0	2.4	1.3	0.9	0.0	1.6	0.9
2	1186	6	122	59.6	0.36		0.85	0.95			0.10	0.10			2.9	1.8	0.0	0.0	2.9	1.8	1.2	0.0	1.9	1.2
2	1185	7	122	59.6	0.42		0.85	0.95			0.10	0.10			3.4	2.3	0.0	0.0	3.4	2.3	1.5	0.0	2.2	1.5
2	1184	8	122	59.6	0.48		0.85	0.95			0.10	0.10			3.8	2.8	0.0	0.0	3.8	2.8	1.8	0.0	2.5	1.8
2	1183	9	122	59.6	0.54		0.85	0.95			0.10	0.10			4.3	3.3	0.0	0.0	4.3	3.3	2.1	0.0	2.8	2.1
3	1182	10	128	65.6	0.60		0.85	0.95			0.38	0.19			6.1	4.2	0.0	0.0	6.1	4.2	2.7	0.0	4.0	2.7
3	1181	11	128	65.6	0.67		0.85	0.95			0.38	0.21			8.0	5.2	0.0	0.0	8.0	5.2	3.4	0.0	5.2	3.4
3	1180	12	128	65.6	0.73		0.85	0.95			0.38	0.23			9.8	6.3	0.0	0.0	9.8	6.3	4.1	0.0	6.4	4.1
3	1179	13	128	65.6	0.80		0.85	0.95			0.38	0.25			11.6	7.5	0.0	0.0	11.6	7.5	4.9	0.0	7.6	4.9
3	1178	14	128	65.6	0.86		0.85	0.95			0.38	0.27			13.4	8.8	0.0	0.0	13.4	8.8	5.7	0.0	8.7	5.7
3	1177	15	128	65.6	0.93		0.85	0.95			0.38	0.29			15.3	10.2	0.0	0.0	15.3	10.2	6.6	0.0	9.9	6.6
3	1176	16	128	65.6	1.00		0.85	0.95			0.38	0.31			17.1	11.7	0.0	0.0	17.1	11.7	7.6	0.0	11.1	7.6
3	1175	17	128	65.6	1.06		0.85	0.95			0.38	0.33			18.9	13.3	0.0	0.0	18.9	13.3	8.7	0.0	12.3	8.7
3	1174	18	128	65.6	1.13		0.85	0.95			0.38	0.35			20.7	15.0	0.0	0.0	20.7	15.0	9.8	0.0	13.5	9.8
3	1173	19	128	65.6	1.19		0.85	0.95			0.38	0.37			22.6	16.8	0.0	0.0	22.6	16.8	10.9	0.0	14.7	10.9
3	1172	20	128	65.6	1.26		0.85	0.95			0.38	0.40			24.4	18.7	0.0	0.0	24.4	18.7	12.2	0.0	15.8	12.2
3	1171	21	128	65.6	1.32		0.85	0.95			0.38	0.42			26.2	20.7	0.0	0.0	26.2	20.7	13.5	0.0	17.0	13.5
3	1170	22	128	65.6	1.39		0.85	0.95			0.38	0.44			28.0	22.8	0.0	0.0	28.0	22.8	14.8	0.0	18.2	14.8
4	1169	23	130	67.6	1.46		1.15	0.93			0.80	0.61			31.9	25.7	0.0	0.0	31.9	25.7	16.7	0.0	20.7	16.7
4	1168	24	130	67.6	1.52		1.15	0.93			0.80	0.63			35.7	28.8	0.0	0.0	35.7	28.8	18.7	0.0	23.2	18.7
4	1167	25	130	67.6	1.59		1.15	0.93			0.80	0.66			39.6	31.9	0.0	0.0	39.6	31.9	20.8	0.0	25.7	20.8
4	1166	26	130	67.6	1.66		1.15	0.93			0.80	0.69			43.4	35.3	0.0	0.0	43.4	35.3	22.9	0.0	28.2	22.9
4	1165	27	130	67.6	1.73		1.15	0.93			0.80	0.72			47.2	38.7	0.0	0.0	47.2	38.7	25.2	0.0	30.7	25.2
4	1164	28	130	67.6	1.79		1.15	0.93			0.80	0.75			51.1	42.3	0.0	0.0	51.1	42.3	27.5	0.0	33.2	27.5
4	1163	29	130	67.6	1.86		1.15	0.93			0.80	0.78			54.9	46.0	0.0	0.0	54.9	46.0	29.9	0.0	35.7	29.9
4	1162	30	130	67.6	1.93		1.15	0.93			0.80	0.80			58.8	49.9	0.0	0.0	58.8	49.9	32.4	0.0	38.2	32.4
4	1161	31	130	67.6	2.00		1.15	0.93			0.80	0.83			62.6	53.9	0.0	0.0	62.6	53.9	35.0	0.0	40.7	35.0
4	1160	32	130	67.6	2.07		1.15	0.93			0.80	0.86			66.4	58.0	0.0	0.0	66.4	58.0	37.7	0.0	43.2	37.7
4	1159	33	130	67.6	2.13		1.15	0.93			0.80	0.89			70.3	62.3	0.0	0.0	70.3	62.3	40.5	0.0	45.7	40.5
4	1158	34	130	67.6	2.20		1.15	0.93			0.80	0.92			74.1	66.7	0.0	0.0	74.1	66.7	43.3	0.0	48.2	43.3
4	1157	35	130	67.6	2.27		1.15	0.93			0.80	0.94			78.0	71.2	0.0	0.0	78.0	71.2	46.3	0.0	50.7	46.3
5	1156	36	135	72.6	2.34	0.86	1.70	0.90	0.75	170.00	1.90	1.39	65.14	298.4	87.1	77.9	27.3	125.1	114.4	203.0	50.6	81.3	74.3	131.9
5	1155	37	135	72.6	2.41	1.71	1.70	0.90	0.75	170.00	1.90	1.44	130.29	307.7	96.2	84.8	54.6	128.9	150.8	213.7	55.1	83.8	98.0	138.9
5	1154	38	135	72.6	2.49	2.57	1.70	0.90	0.75	170.00	1.90	1.48	195.43	316.9	105.3	91.9	81.9	132.8	187.2	224.7	59.7	86.3	121.7	146.1
5	1153	39	135	72.6	2.56	3.43	1.70	0.90	0.75	170.00	1.90	1.52	260.57	326.2	114.4	99.2	109.2	136.7	223.6	235.9	64.5	88.9	145.4	153.4
5	1152	40	135	72.6	2.63	4.29	1.70	0.90	0.75	170.00	1.90	1.57	325.71	335.5	123.6	106.8	136.5	140.6	260.1	247.3	69.4	91.4	169.0	160.8
5	1151	41	135	72.6	2.70	5.14	1.70	0.90	0.75	170.00	1.90	1.61	390.86	344.7	132.7	114.5	163.8	144.5	296.5	258.9	74.4	93.9	192.7	168.3
5	1150	42	135	72.6	2.78	6.00	1.70	0.90	0.75	170.00	1.90	1.65	456.00	354.0	141.8	122.4	191.1	148.3	332.9	270.8	79.6	96.4	216.4	176.0
5	1149	43	135	72.6	2.85	6.86	1.70	0.90	0.75	170.00	1.90	1.70	521.14	363.2	150.9	130.6	218.4	152.2	369.3	282.8	84.9	98.9	240.1	183.8
5	1148	44	135	72.6	2.92	7.71	1.70	0.90	0.75	170.00	1.90	1.74	586.29	372.5	160.0	138.9	245.7	156.1	405.7	295.0	90.3	101.5	263.7	191.8
5	1147	45	135	72.6	2.99	8.57	1.70	0.90	0.75	170.00	1.90	1.78	651.43	381.7	169.2	147.5	273.0	160.0	442.2	307.5	95.9	104.0	287.4	199.9
5	1146	46	135	72.6	3.07	9.43	1.70	0.90	0.75	170.00	1.90	1.83	716.57	391.0	178.3	156.3	300.3	163.9	478.6	320.1	101.6	106.5	311.1	208.1
5	1145	47	135	72.6	3.14	10.29	1.70	0.90	0.75	170.00	1.90	1.87	760.00	400.2	187.4	165.2	318.5	167.7	505.9	333.0	107.4	109.0	328.8	216.4
5	1144	48	135	72.6	3.21	11.14	1.70	0.90	0.75	170.00	1.90	1.91	760.00	409.5	196.5	174.4	318.5	171.6	515.0	346.0	113.4	111.6	334.8	224.9

AXIAL PILE RESISTANCE **Abutment No. 1**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-101, -101A

PILE DATA

Pile Size:	HP14x102	
Depth/Diameter:	1.17	ft
Web Thickness:	0.06	ft
Flange Width:	1.23	ft
Flange Thickness:	0.06	ft
Perimeter:	4.80	ft
Section Area:	0.21	ft^2
Cutting Shoe End Area:	0.42	ft^2
Plugged Section Area:	1.44	ft^2
Ground Surface El.:	1203.6	ft
Pile Head El.:	1194.0	ft
Pile Cap El.:	1192.0	ft
Q50 Water El.:	1196.5	ft

20D
23.3 ft

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance	Dynamic Resistance
ϕ_{stat} = 0.45	ϕ_{dyn} = 0.65

Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Factored Axial Res. kips	Nordlund Factored Axial Res. (kips)
5	1143	49	135	72.6	3.28	12.00	1.70	0.90	0.75	170.00	1.90	1.96	760.00	418.8	205.6	183.8	318.5	175.5	524.1	359.3	119.5	114.1	340.7	233.6
5	1142	50	135	72.6	3.36	12.86	1.70	0.90	0.75	170.00	1.90	2.00	760.00	428.0	214.8	193.4	318.5	179.4	533.3	372.8	125.7	116.6	346.6	242.3
5	1141	51	135	72.6	3.43	13.71	1.70	0.90	0.75	170.00	1.90	2.04	760.00	437.3	223.9	203.2	318.5	183.3	542.4	386.5	132.1	119.1	352.5	251.2
5	1140	52	135	72.6	3.50	14.57	1.70	0.90	0.75	170.00	1.90	2.09	760.00	446.5	233.0	213.2	318.5	187.1	551.5	400.4	138.6	121.6	358.5	260.2
5	1139	53	135	72.6	3.57	15.43	1.70	0.90	0.75	170.00	1.90	2.13	760.00	455.8	242.1	223.5	318.5	191.0	560.6	414.5	145.3	124.2	364.4	269.4
5	1138	54	135	72.6	3.65	16.29	1.70	0.90	0.75	170.00	1.90	2.17	760.00	465.0	251.2	233.9	318.5	194.9	569.7	428.8	152.0	126.7	370.3	278.7
5	1137	55	135	72.6	3.72	17.14	1.70	0.90	0.75	170.00	1.90	2.22	760.00	474.3	260.4	244.5	318.5	198.8	578.9	443.3	158.9	129.2	376.3	288.1
5	1136	56	135	72.6	3.79	18.00	1.70	0.90	0.75	170.00	1.90	2.26	760.00	483.6	269.5	255.4	318.5	202.7	588.0	458.0	166.0	131.7	382.2	297.7
5	1135	57	135	72.6	3.87	18.86	1.70	0.90	0.75	170.00	1.90	2.30	760.00	492.8	278.6	266.4	318.5	206.5	597.1	473.0	173.2	134.2	388.1	307.4
5	1134	58	135	72.6	3.94	19.71	1.70	0.90	0.75	170.00	1.90	2.35	760.00	502.1	287.7	277.7	318.5	210.4	606.2	488.1	180.5	136.8	394.0	317.3
5	1133	59	135	72.6	4.01	20.57	1.70	0.90	0.75	170.00	1.90	2.39	760.00	511.3	296.8	289.2	318.5	214.3	615.3	503.5	188.0	139.3	400.0	327.2
5	1132	60	135	72.6	4.08	21.43	1.70	0.90	0.75	170.00	1.90	2.43	760.00	520.6	306.0	300.8	318.5	218.2	624.5	519.0	195.5	141.8	405.9	337.4
5	1131	61	135	72.6	4.16	22.29	1.70	0.90	0.75	170.00	1.90	2.48	760.00	529.8	315.1	312.7	318.5	222.0	633.6	534.8	203.3	144.3	411.8	347.6
5	1130	62	135	72.6	4.23	23.14	1.70	0.90	0.75	170.00	1.90	2.52	760.00	539.1	324.2	324.8	318.5	225.9	642.7	550.7	211.1	146.9	417.8	358.0
5	1129	63	135	72.6	4.30	24.00	1.70	0.90	0.75	170.00	1.90	2.56	760.00	548.4	333.3	337.1	318.5	229.8	651.8	566.9	219.1	149.4	423.7	368.5
5	1128	64	135	72.6	4.37	24.86	1.70	0.90	0.75	170.00	1.90	2.61	760.00	557.6	342.4	349.6	318.5	233.7	660.9	583.3	227.3	151.9	429.6	379.2
5	1127	65	135	72.6	4.45	25.71	1.70	0.90	0.75	170.00	1.90	2.65	760.00	566.9	351.6	362.3	318.5	237.6	670.1	599.9	235.5	154.4	435.5	389.9
5	1126	66	135	72.6	4.52	26.57	1.70	0.90	0.75	170.00	1.90	2.69	760.00	576.1	360.7	375.3	318.5	241.4	679.2	616.7	243.9	156.9	441.5	400.9
5	1125	67	135	72.6	4.59	27.43	1.70	0.90	0.75	170.00	1.90	2.74	760.00	585.4	369.8	388.4	318.5	245.3	688.3	633.7	252.5	159.5	447.4	411.9
5	1124	68	135	72.6	4.66	28.29	1.70	0.90	0.75	170.00	1.90	2.78	760.00	594.6	378.9	401.7	318.5	249.2	697.4	650.9	261.1	162.0	453.3	423.1
5	1123	69	135	72.6	4.74	29.14	1.70	0.90	0.75	170.00	1.90	2.82	760.00	603.9	388.0	415.3	318.5	253.1	706.5	668.4	269.9	164.5	459.2	434.4
5	1122	70	135	72.6	4.81	30.00	1.70	0.90	0.75	170.00	1.90	2.87	760.00	613.1	397.2	429.0	318.5	257.0	715.7	686.0	278.9	167.0	465.2	445.9
5	1121	71	135	72.6	4.88	30.86	1.70	0.90	0.75	170.00	1.90	2.91	760.00	622.4	406.3	443.0	318.5	260.8	724.8	703.8	287.9	169.5	471.1	457.5
5	1120	72	135	72.6	4.95	31.71	1.70	0.90	0.75	170.00	1.90	2.95	760.00	631.7	415.4	457.2	318.5	264.7	733.9	721.9	297.2	172.1	477.0	469.2

AXIAL PILE RESISTANCE   Abutment No. 1

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-101, -101A

PILE DATA

Pile Size:	HP14x117			
Depth/Diameter:	1.18	ft	20D	
Web Thickness:	0.07	ft	23.7	ft
Flange Width:	1.24	ft		
Flange Thickness:	0.07	ft		
Perimeter:	4.85	ft		
Section Area:	0.24	ft^2		
Cutting Shoe End Area:	0.48	ft^2		
Plugged Section Area:	1.47	ft^2		
Ground Surface El.:	1203.6	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Factored Axial Res. kips	Nordlund Factored Axial Res. (kips)
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2	1192	0	122	59.6	0.00		0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1191	1	122	59.6	0.06		0.85	0.95			0.10	0.02			0.5	0.1	0.0	0.0	0.5	0.1	0.1	0.0	0.3	0.1
2	1190	2	122	59.6	0.12		0.85	0.95			0.10	0.04			1.0	0.3	0.0	0.0	1.0	0.3	0.2	0.0	0.6	0.2
2	1189	3	122	59.6	0.18		0.85	0.95			0.10	0.06			1.5	0.5	0.0	0.0	1.5	0.5	0.4	0.0	0.9	0.4
2	1188	4	122	59.6	0.24		0.85	0.95			0.10	0.07			1.9	0.9	0.0	0.0	1.9	0.9	0.6	0.0	1.3	0.6
2	1187	5	122	59.6	0.30		0.85	0.95			0.10	0.09			2.4	1.4	0.0	0.0	2.4	1.4	0.9	0.0	1.6	0.9
2	1186	6	122	59.6	0.36		0.85	0.95			0.10	0.10			2.9	1.8	0.0	0.0	2.9	1.8	1.2	0.0	1.9	1.2
2	1185	7	122	59.6	0.42		0.85	0.95			0.10	0.10			3.4	2.3	0.0	0.0	3.4	2.3	1.5	0.0	2.2	1.5
2	1184	8	122	59.6	0.48		0.85	0.95			0.10	0.10			3.9	2.8	0.0	0.0	3.9	2.8	1.8	0.0	2.5	1.8
2	1183	9	122	59.6	0.54		0.85	0.95			0.10	0.10			4.4	3.3	0.0	0.0	4.4	3.3	2.1	0.0	2.8	2.1
3	1182	10	128	65.6	0.60		0.85	0.95			0.38	0.19			6.2	4.2	0.0	0.0	6.2	4.2	2.7	0.0	4.0	2.7
3	1181	11	128	65.6	0.67		0.85	0.95			0.38	0.21			8.1	5.2	0.0	0.0	8.1	5.2	3.4	0.0	5.2	3.4
3	1180	12	128	65.6	0.73		0.85	0.95			0.38	0.23			9.9	6.4	0.0	0.0	9.9	6.4	4.1	0.0	6.4	4.1
3	1179	13	128	65.6	0.80		0.85	0.95			0.38	0.25			11.7	7.6	0.0	0.0	11.7	7.6	4.9	0.0	7.6	4.9
3	1178	14	128	65.6	0.86		0.85	0.95			0.38	0.27			13.6	8.9	0.0	0.0	13.6	8.9	5.8	0.0	8.8	5.8
3	1177	15	128	65.6	0.93		0.85	0.95			0.38	0.29			15.4	10.3	0.0	0.0	15.4	10.3	6.7	0.0	10.0	6.7
3	1176	16	128	65.6	1.00		0.85	0.95			0.38	0.31			17.3	11.8	0.0	0.0	17.3	11.8	7.7	0.0	11.2	7.7
3	1175	17	128	65.6	1.06		0.85	0.95			0.38	0.33			19.1	13.4	0.0	0.0	19.1	13.4	8.7	0.0	12.4	8.7
3	1174	18	128	65.6	1.13		0.85	0.95			0.38	0.35			21.0	15.2	0.0	0.0	21.0	15.2	9.9	0.0	13.6	9.9
3	1173	19	128	65.6	1.19		0.85	0.95			0.38	0.37			22.8	17.0	0.0	0.0	22.8	17.0	11.0	0.0	14.8	11.0
3	1172	20	128	65.6	1.26		0.85	0.95			0.38	0.40			24.6	18.9	0.0	0.0	24.6	18.9	12.3	0.0	16.0	12.3
3	1171	21	128	65.6	1.32		0.85	0.95			0.38	0.42			26.5	20.9	0.0	0.0	26.5	20.9	13.6	0.0	17.2	13.6
3	1170	22	128	65.6	1.39		0.85	0.95			0.38	0.44			28.3	23.0	0.0	0.0	28.3	23.0	15.0	0.0	18.4	15.0
4	1169	23	130	67.6	1.46		1.15	0.93			0.80	0.61			32.2	26.0	0.0	0.0	32.2	26.0	16.9	0.0	20.9	16.9
4	1168	24	130	67.6	1.52		1.15	0.93			0.80	0.63			36.1	29.1	0.0	0.0	36.1	29.1	18.9	0.0	23.5	18.9
4	1167	25	130	67.6	1.59		1.15	0.93			0.80	0.66			40.0	32.3	0.0	0.0	40.0	32.3	21.0	0.0	26.0	21.0
4	1166	26	130	67.6	1.66		1.15	0.93			0.80	0.69			43.8	35.6	0.0	0.0	43.8	35.6	23.2	0.0	28.5	23.2
4	1165	27	130	67.6	1.73		1.15	0.93			0.80	0.72			47.7	39.1	0.0	0.0	47.7	39.1	25.4	0.0	31.0	25.4
4	1164	28	130	67.6	1.79		1.15	0.93			0.80	0.75			51.6	42.7	0.0	0.0	51.6	42.7	27.8	0.0	33.5	27.8
4	1163	29	130	67.6	1.86		1.15	0.93			0.80	0.78			55.5	46.5	0.0	0.0	55.5	46.5	30.2	0.0	36.1	30.2
4	1162	30	130	67.6	1.93		1.15	0.93			0.80	0.80			59.4	50.4	0.0	0.0	59.4	50.4	32.8	0.0	38.6	32.8
4	1161	31	130	67.6	2.00		1.15	0.93			0.80	0.83			63.2	54.4	0.0	0.0	63.2	54.4	35.4	0.0	41.1	35.4
4	1160	32	130	67.6	2.07		1.15	0.93			0.80	0.86			67.1	58.6	0.0	0.0	67.1	58.6	38.1	0.0	43.6	38.1
4	1159	33	130	67.6	2.13		1.15	0.93			0.80	0.89			71.0	62.9	0.0	0.0	71.0	62.9	40.9	0.0	46.2	40.9
4	1158	34	130	67.6	2.20		1.15	0.93			0.80	0.92			74.9	67.4	0.0	0.0	74.9	67.4	43.8	0.0	48.7	43.8
4	1157	35	130	67.6	2.27		1.15	0.93			0.80	0.94			78.8	71.9	0.0	0.0	78.8	71.9	46.8	0.0	51.2	46.8
5	1156	36	135	72.6	2.34	0.85	1.70	0.90	0.75	170.00	1.90	1.39	64.23	298.4	88.0	78.7	31.1	144.5	119.1	223.2	51.2	93.9	77.4	145.1
5	1155	37	135	72.6	2.41	1.69	1.70	0.90	0.75	170.00	1.90	1.44	128.45	307.7	97.2	85.7	62.2	149.0	159.4	234.6	55.7	96.8	103.6	152.5
5	1154	38	135	72.6	2.49	2.54	1.70	0.90	0.75	170.00	1.90	1.48	192.68	316.9	106.4	92.9	93.3	153.4	199.7	246.3	60.4	99.7	129.8	160.1
5	1153	39	135	72.6	2.56	3.38	1.70	0.90	0.75	170.00	1.90	1.52	256.90	326.2	115.6	100.3	124.4	157.9	240.0	258.2	65.2	102.6	156.0	167.8
5	1152	40	135	72.6	2.63	4.23	1.70	0.90	0.75	170.00	1.90	1.57	321.13	335.5	124.8	107.9	155.5	162.4	280.3	270.3	70.1	105.6	182.2	175.7
5	1151	41	135	72.6	2.70	5.07	1.70	0.90	0.75	170.00	1.90	1.61	385.35	344.7	134.1	115.7	186.6	166.9	320.6	282.6	75.2	108.5	208.4	183.7
5	1150	42	135	72.6	2.78	5.92	1.70	0.90	0.75	170.00	1.90	1.65	449.58	354.0	143.3	123.7	217.6	171.4	360.9	295.1	80.4	111.4	234.6	191.8
5	1149	43	135	72.6	2.85	6.76	1.70	0.90	0.75	170.00	1.90	1.70	513.80	363.2	152.5	131.9	248.7	175.8	401.2	307.8	85.8	114.3	260.8	200.1
5	1148	44	135	72.6	2.92	7.61	1.70	0.90	0.75	170.00	1.90	1.74	578.03	372.5	161.7	140.4	279.8	180.3	441.5	320.7	91.2	117.2	287.0	208.5
5	1147	45	135	72.6	2.99	8.45	1.70	0.90	0.75	170.00	1.90	1.78	642.25	381.7	170.9	149.0	310.9	184.8	481.8	333.8	96.9	120.1	313.2	217.0
5	1146	46	135	72.6	3.07	9.30	1.70	0.90	0.75	170.00	1.90	1.83	706.48	391.0	180.1	157.9	342.0	189.3	522.1	347.2	102.6	123.0	339.4	225.7
5	1145	47	135	72.6	3.14	10.14	1.70	0.90	0.75	170.00	1.90	1.87	760.00	400.2	189.3	167.0	367.9	193.8	557.3	360.7	108.5	125.9	362.2	234.5
5	1144	48	135	72.6	3.21	10.99	1.70	0.90	0.75	170.00	1.90	1.91	760.00	409.5	198.6	176.2	367.9	198.2	566.5	374.5	114.6	128.9	368.2	243.4

AXIAL PILE RESISTANCE **Abutment No. 1**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA
S.W. Cole Engineering, Inc.
Project: Alder Stream Bridge #3265
Project No.: 19-1436
Soil profile based on: BB-JPTAS-101, -101A

PILE DATA

Pile Size:	HP14x117	
Depth/Diameter:	1.18	ft
Web Thickness:	0.07	ft
Flange Width:	1.24	ft
Flange Thickness:	0.07	ft
Perimeter:	4.85	ft
Section Area:	0.24	ft^2
Cutting Shoe End Area:	0.48	ft^2
Plugged Section Area:	1.47	ft^2
Ground Surface El.:	1203.6	ft
Pile Head El.:	1194.0	ft
Pile Cap El.:	1192.0	ft
Q50 Water El.:	1196.5	ft

20D
23.7 ft

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance ϕ_{stat} = 0.45
Dynamic Resistance ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	12	125	62.6	32	0	50	0.85	0.95			400
Alluvium	12	22	122	59.6	30	0	5	0.85	0.95			40
Glacial Outwash	22	35	128	65.6	32	0	19	0.85	0.95			152
Glacial Outwash	35	48	130	67.6	36	0	40	1.15	0.93			320
Glacial Till	48	85	135	72.6	40	0	95	1.70	0.9	0.75	170	760

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)	Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Factored Axial Res. kips	Nordlund Factored Axial Res. (kips)
5	1143	49	135	72.6	3.28	11.83	1.70	0.90	0.75	170.00	1.90	1.96	760.00	418.8	207.8	185.7	367.9	202.7	575.7	388.5	120.7	131.8	374.2	252.5
5	1142	50	135	72.6	3.36	12.68	1.70	0.90	0.75	170.00	1.90	2.00	760.00	428.0	217.0	195.4	367.9	207.2	584.9	402.6	127.0	134.7	380.2	261.7
5	1141	51	135	72.6	3.43	13.52	1.70	0.90	0.75	170.00	1.90	2.04	760.00	437.3	226.2	205.3	367.9	211.7	594.1	417.0	133.5	137.6	386.2	271.1
5	1140	52	135	72.6	3.50	14.37	1.70	0.90	0.75	170.00	1.90	2.09	760.00	446.5	235.4	215.5	367.9	216.2	603.3	431.6	140.0	140.5	392.2	280.6
5	1139	53	135	72.6	3.57	15.21	1.70	0.90	0.75	170.00	1.90	2.13	760.00	455.8	244.6	225.8	367.9	220.7	612.6	446.4	146.8	143.4	398.2	290.2
5	1138	54	135	72.6	3.65	16.06	1.70	0.90	0.75	170.00	1.90	2.17	760.00	465.0	253.8	236.3	367.9	225.1	621.8	461.5	153.6	146.3	404.2	300.0
5	1137	55	135	72.6	3.72	16.90	1.70	0.90	0.75	170.00	1.90	2.22	760.00	474.3	263.1	247.1	367.9	229.6	631.0	476.7	160.6	149.3	410.1	309.9
5	1136	56	135	72.6	3.79	17.75	1.70	0.90	0.75	170.00	1.90	2.26	760.00	483.6	272.3	258.0	367.9	234.1	640.2	492.1	167.7	152.2	416.1	319.9
5	1135	57	135	72.6	3.87	18.59	1.70	0.90	0.75	170.00	1.90	2.30	760.00	492.8	281.5	269.2	367.9	238.6	649.4	507.8	175.0	155.1	422.1	330.1
5	1134	58	135	72.6	3.94	19.44	1.70	0.90	0.75	170.00	1.90	2.35	760.00	502.1	290.7	280.6	367.9	243.1	658.6	523.6	182.4	158.0	428.1	340.4
5	1133	59	135	72.6	4.01	20.28	1.70	0.90	0.75	170.00	1.90	2.39	760.00	511.3	299.9	292.2	367.9	247.5	667.9	539.7	189.9	160.9	434.1	350.8
5	1132	60	135	72.6	4.08	21.13	1.70	0.90	0.75	170.00	1.90	2.43	760.00	520.6	309.1	304.0	367.9	252.0	677.1	556.0	197.6	163.8	440.1	361.4
5	1131	61	135	72.6	4.16	21.97	1.70	0.90	0.75	170.00	1.90	2.48	760.00	529.8	318.4	316.0	367.9	256.5	686.3	572.5	205.4	166.7	446.1	372.1
5	1130	62	135	72.6	4.23	22.82	1.70	0.90	0.75	170.00	1.90	2.52	760.00	539.1	327.6	328.2	367.9	261.0	695.5	589.2	213.3	169.6	452.1	383.0
5	1129	63	135	72.6	4.30	23.66	1.70	0.90	0.75	170.00	1.90	2.56	760.00	548.4	336.8	340.6	367.9	265.5	704.7	606.1	221.4	172.6	458.1	394.0
5	1128	64	135	72.6	4.37	24.51	1.70	0.90	0.75	170.00	1.90	2.61	760.00	557.6	346.0	353.3	367.9	269.9	713.9	623.2	229.6	175.5	464.1	405.1
5	1127	65	135	72.6	4.45	25.35	1.70	0.90	0.75	170.00	1.90	2.65	760.00	566.9	355.2	366.1	367.9	274.4	723.1	640.5	238.0	178.4	470.0	416.4
5	1126	66	135	72.6	4.52	26.20	1.70	0.90	0.75	170.00	1.90	2.69	760.00	576.1	364.4	379.2	367.9	278.9	732.4	658.1	246.5	181.3	476.0	427.8
5	1125	67	135	72.6	4.59	27.04	1.70	0.90	0.75	170.00	1.90	2.74	760.00	585.4	373.6	392.4	367.9	283.4	741.6	675.8	255.1	184.2	482.0	439.3
5	1124	68	135	72.6	4.66	27.89	1.70	0.90	0.75	170.00	1.90	2.78	760.00	594.6	382.9	405.9	367.9	287.9	750.8	693.8	263.8	187.1	488.0	451.0
5	1123	69	135	72.6	4.74	28.73	1.70	0.90	0.75	170.00	1.90	2.82	760.00	603.9	392.1	419.6	367.9	292.4	760.0	712.0	272.7	190.0	494.0	462.8
5	1122	70	135	72.6	4.81	29.58	1.70	0.90	0.75	170.00	1.90	2.87	760.00	613.1	401.3	433.5	367.9	296.8	769.2	730.3	281.8	192.9	500.0	474.7
5	1121	71	135	72.6	4.88	30.42	1.70	0.90	0.75	170.00	1.90	2.91	760.00	622.4	410.5	447.6	367.9	301.3	778.4	748.9	290.9	195.9	506.0	486.8
5	1120	72	135	72.6	4.95	31.27	1.70	0.90	0.75	170.00	1.90	2.95	760.00	631.7	419.7	461.9	367.9	305.8	787.6	767.7	300.2	198.8	512.0	499.0

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x89		
Depth/Diameter:	1.15	ft	20D
Web Thickness:	0.05	ft	23.0 ft
Flange Width:	1.23	ft	
Flange Thickness:	0.05	ft	
Perimeter:	4.75	ft	
Section Area:	0.18	ft^2	
Cutting Shoe End Area:	0.36	ft^2	
Plugged Section Area:	1.41	ft^2	
Ground Surface El.:	1203.6	ft	
Pile Head El.:	1194.0	ft	
Pile Cap El.:	1192.0	ft	
Q50 Water El.:	1196.5	ft	

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance	Dynamic Resistance
ϕ_{stat} = 0.45	ϕ_{dyn} = 0.65

Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Nominal Axial Res. kips	Nordlund Factored Axial Res. (kips)
0																									
1																									
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1												Bottom of Pile Cap at Elevation ±1192 feet													
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1	1192	0	125	62.6	0.00			0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1191	1	125	62.6	0.06			0.85	0.95			1.00	0.02			4.8	0.1	0.0	0.0	4.8	0.1	0.1	0.0	3.1	0.1
1	1190	2	125	62.6	0.13			0.85	0.95			1.00	0.04			9.5	0.3	0.0	0.0	9.5	0.3	0.2	0.0	6.2	0.2
1	1189	3	125	62.6	0.19			0.85	0.95			1.00	0.06			14.3	0.6	0.0	0.0	14.3	0.6	0.4	0.0	9.3	0.4
2	1188	4	122	59.6	0.25			0.85	0.95			0.00	0.00			14.3	0.6	0.0	0.0	14.3	0.6	0.4	0.0	9.3	0.4
2	1187	5	122	59.6	0.31			0.85	0.95			0.00	0.00			14.3	0.6	0.0	0.0	14.3	0.6	0.4	0.0	9.3	0.4
2	1186	6	122	59.6	0.37			0.85	0.95			0.00	0.00			14.3	0.6	0.0	0.0	14.3	0.6	0.4	0.0	9.3	0.4
2	1185	7	122	59.6	0.43			0.85	0.95			0.00	0.00			14.3	0.6	0.0	0.0	14.3	0.6	0.4	0.0	9.3	0.4
3	1184	8	128	65.6	0.49			0.85	0.95			0.40	0.15			16.2	1.3	0.0	0.0	16.2	1.3	0.8	0.0	10.5	0.8
3	1183	9	128	65.6	0.56			0.85	0.95			0.40	0.18			18.1	2.1	0.0	0.0	18.1	2.1	1.4	0.0	11.7	1.4
3	1182	10	128	65.6	0.62			0.85	0.95			0.40	0.20			20.0	3.1	0.0	0.0	20.0	3.1	2.0	0.0	13.0	2.0
3	1181	11	128	65.6	0.69			0.85	0.95			0.40	0.22			21.9	4.1	0.0	0.0	21.9	4.1	2.7	0.0	14.2	2.7
3	1180	12	128	65.6	0.75			0.85	0.95			0.40	0.24			23.8	5.2	0.0	0.0	23.8	5.2	3.4	0.0	15.4	3.4
3	1179	13	128	65.6	0.82			0.85	0.95			0.40	0.26			25.7	6.4	0.0	0.0	25.7	6.4	4.2	0.0	16.7	4.2
3	1178	14	128	65.6	0.89			0.85	0.95			0.40	0.28			27.6	7.8	0.0	0.0	27.6	7.8	5.0	0.0	17.9	5.0
3	1177	15	128	65.6	0.95			0.85	0.95			0.40	0.30			29.5	9.2	0.0	0.0	29.5	9.2	6.0	0.0	19.1	6.0
3	1176	16	128	65.6	1.02			0.85	0.95			0.40	0.32			31.4	10.7	0.0	0.0	31.4	10.7	7.0	0.0	20.4	7.0
3	1175	17	128	65.6	1.08			0.85	0.95			0.40	0.34			33.3	12.3	0.0	0.0	33.3	12.3	8.0	0.0	21.6	8.0
3	1174	18	128	65.6	1.15			0.85	0.95			0.40	0.36			35.2	14.0	0.0	0.0	35.2	14.0	9.1	0.0	22.8	9.1
3	1173	19	128	65.6	1.21			0.85	0.95			0.40	0.38			37.1	15.8	0.0	0.0	37.1	15.8	10.3	0.0	24.1	10.3
3	1172	20	128	65.6	1.28			0.85	0.95			0.40	0.40			39.0	17.8	0.0	0.0	39.0	17.8	11.5	0.0	25.3	11.5
3	1171	21	128	65.6	1.34			0.85	0.95			0.40	0.42			40.9	19.8	0.0	0.0	40.9	19.8	12.8	0.0	26.6	12.8
3	1170	22	128	65.6	1.41			0.85	0.95			0.40	0.44			42.8	21.9	0.0	0.0	42.8	21.9	14.2	0.0	27.8	14.2
3	1169	23	128	65.6	1.48			0.85	0.95			0.40	0.46			44.7	24.1	0.0	0.0	44.7	24.1	15.6	0.0	29.0	15.6
3	1168	24	128	65.6	1.54			0.85	0.95			0.40	0.48			46.6	26.4	0.0	0.0	46.6	26.4	17.1	0.0	30.3	17.1
3	1167	25	128	65.6	1.61			0.85	0.95			0.40	0.51			48.5	28.8	0.0	0.0	48.5	28.8	18.7	0.0	31.5	18.7
3	1166	26	128	65.6	1.67			0.85	0.95			0.40	0.53			50.4	31.3	0.0	0.0	50.4	31.3	20.3	0.0	32.7	20.3
3	1165	27	128	65.6	1.74			0.85	0.95			0.40	0.55			52.3	33.9	0.0	0.0	52.3	33.9	22.0	0.0	34.0	22.0
3	1164	28	128	65.6	1.80			0.85	0.95			0.40	0.57			54.2	36.6	0.0	0.0	54.2	36.6	23.8	0.0	35.2	23.8
4	1163	29	130	67.6	1.87			1.15	0.93			0.58	0.78			56.9	40.3	0.0	0.0	56.9	40.3	26.2	0.0	37.0	26.2
4	1162	30	130	67.6	1.94			1.15	0.93			0.58	0.81			59.7	44.1	0.0	0.0	59.7	44.1	28.7	0.0	38.8	28.7
4	1161	31	130	67.6	2.01			1.15	0.93			0.58	0.84			62.4	48.1	0.0	0.0	62.4	48.1	31.2	0.0	40.6	31.2
4	1160	32	130	67.6	2.07			1.15	0.93			0.58	0.86			65.2	52.2	0.0	0.0	65.2	52.2	33.9	0.0	42.4	33.9
4	1159	33	130	67.6	2.14			1.15	0.93			0.58	0.89			67.9	56.4	0.0	0.0	67.9	56.4	36.7	0.0	44.2	36.7
4	1158	34	130	67.6	2.21			1.15	0.93			0.58	0.92			70.7	60.8	0.0	0.0	70.7	60.8	39.5	0.0	45.9	39.5
4	1157	35	130	67.6	2.28			1.15	0.93			0.58	0.95			73.4	65.3	0.0	0.0	73.4	65.3	42.4	0.0	47.7	42.4
4	1156	36	130	67.6	2.34			1.15	0.93			0.58	0.98			76.2	69.9	0.0	0.0	76.2	69.9	45.5	0.0	49.5	45.5
4	1155	37	130	67.6	2.41			1.15	0.93			0.58	1.00			78.9	74.7	0.0	0.0	78.9	74.7	48.6	0.0	51.3	48.6
4	1154	38	130	67.6	2.48			1.15	0.93			0.58	1.03			81.7	79.6	0.0	0.0	81.7	79.6	51.7	0.0	53.1	51.7
4	1153	39	130	67.6	2.55			1.15	0.93			0.58	1.06			84.5	84.6	0.0	0.0	84.5	84.6	55.0	0.0	54.9	55.0
4	1152	40	130	67.6	2.62			1.15	0.93			0.58	1.09			87.2	89.8	0.0	0.0	87.2	89.8	58.4	0.0	56.7	58.4
4	1151	41	130	67.6	2.68			1.15	0.93			0.58	1.12			90.0	95.1	0.0	0.0	90.0	95.1	61.8	0.0	58.5	61.8
4	1150	42	130	67.6	2.75			1.15	0.93			0.58	1.15			92.7	100.6	0.0	0.0	92.7	100.6	65.4	0.0	60.3	65.4
4	1149	43	130	67.6	2.82			1.15	0.93			0.58	1.17			95.5	106.1	0.0	0.0	95.5	106.1	69.0	0.0	62.1	69.0
4	1148	44	130	67.6	2.89			1.15	0.93			0.58	1.20			98.2	111.8	0.0	0.0	98.2	111.8	72.7	0.0	63.8	72.7
4	1147	45	130	67.6	2.95			1.15	0.93			0.58	1.23			101.0	117.7	0.0	0.0	101.0	117.7	76.5	0.0	65.6	76.5
4	1146	46	130	67.6	3.02			1.15	0.93			0.58	1.26			103.7	123.7	0.0	0.0	103.7	123.7	80.4	0.0	67.4	80.4
4	1145	47	130	67.6	3.09			1.15	0.93			0.58	1.29			106.5	129.8	0.0	0.0	106.5	129.8	84.4	0.0	69.2	84.4
4	1144	48	130	67.6	3.16			1.15	0.93			0.58	1.31			109.3	136.0	0.0	0.0	109.3	136.0	88.4	0.0	71.0	88.4
4	1143	49	130	67.6	3.22			1.15	0.93			0.58	1.34			112.0	142.4	0.0	0.0	112.0	142.4	92.6	0.0	72.8	92.6
5	1142	50	135	72.6	3.30	1.00	0.87	1.70	0.90	0.75	170.00	2.00	1.96	69.57	420.2	121.5	151.7	25.1	151.8	146.6	303.6	98.6	98.7	95.3	197.3
5	1141	51	135	72.6	3.37	2.00	1.74	1.70	0.90	0.75	170.00	2.00	2.01	139.13	429.5	131.0	161.3	50.3	155.2	181.3	316.4	104.8	100.9	117.8	205.7
5	1140	52	135	72.6	3.44	3.00	2.61	1.70	0.90	0.75	170.00	2.00	2.05	208.70	438.8	140.5	171.0	75.4	158.5	215.9	329.5	111.1	103.0	140.3	214.2

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project:	Alder Stream Bridge #3265
Project No.:	19-1436
Soil profile based on:	BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x89			
Depth/Diameter:	1.15	ft	**20D**	
Web Thickness:	0.05	ft	23.0	ft
Flange Width:	1.23	ft		
Flange Thickness:	0.05	ft		
Perimeter:	4.75	ft		
Section Area:	0.18	ft^2		
Cutting Shoe End Area:	0.36	ft^2		
Plugged Section Area:	1.41	ft^2		
Ground Surface El.:	1203.6	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'$_q$	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	LRFD Method Factored End Resist (kips)	LRFD Method Meyerhoff Nominal Axial Res. kips	LRFD Method Nordlund Factored Axial Res. (kips)
5	1139	53	135	72.6	3.51	4.00	3.48	1.70	0.90	0.75	170.00	2.00	2.09	278.26	448.0	150.0	180.9	100.5	161.9	250.5	342.8	117.6	105.2	162.9	222.8
5	1138	54	135	72.6	3.59	5.00	4.35	1.70	0.90	0.75	170.00	2.00	2.14	347.83	457.3	159.5	191.1	125.7	165.2	285.2	356.3	124.2	107.4	185.4	231.6
5	1137	55	135	72.6	3.66	6.00	5.22	1.70	0.90	0.75	170.00	2.00	2.18	417.39	466.5	169.0	201.4	150.8	168.6	319.8	370.0	130.9	109.6	207.9	240.5
5	1136	56	135	72.6	3.73	7.00	6.09	1.70	0.90	0.75	170.00	2.00	2.22	486.96	475.8	178.5	212.0	175.9	171.9	354.4	383.9	137.8	111.7	230.4	249.5
5	1135	57	135	72.6	3.80	8.00	6.96	1.70	0.90	0.75	170.00	2.00	2.27	556.52	485.0	188.0	222.8	201.1	175.2	389.1	398.0	144.8	113.9	252.9	258.7
5	1134	58	135	72.6	3.88	9.00	7.83	1.70	0.90	0.75	170.00	2.00	2.31	626.09	494.3	197.5	233.7	226.2	178.6	423.7	412.3	151.9	116.1	275.4	268.0
5	1133	59	135	72.6	3.95	10.00	8.70	1.70	0.90	0.75	170.00	2.00	2.35	695.65	503.5	207.0	244.9	251.3	181.9	458.4	426.9	159.2	118.3	297.9	277.5
5	1132	60	135	72.6	4.02	11.00	9.57	1.70	0.90	0.75	170.00	2.00	2.40	765.22	512.8	216.5	256.3	276.5	185.3	493.0	441.6	166.6	120.4	320.4	287.0
5	1131	61	135	72.6	4.09	12.00	10.43	1.70	0.90	0.75	170.00	2.00	2.44	800.00	522.1	226.0	267.9	289.1	188.6	515.1	456.5	174.1	122.6	334.8	296.7
5	1130	62	135	72.6	4.17	13.00	11.30	1.70	0.90	0.75	170.00	2.00	2.48	800.00	531.3	235.5	279.7	289.1	192.0	524.6	471.7	181.8	124.8	341.0	306.6
5	1129	63	135	72.6	4.24	14.00	12.17	1.70	0.90	0.75	170.00	2.00	2.53	800.00	540.6	245.0	291.7	289.1	195.3	534.1	487.0	189.6	127.0	347.1	316.5
5	1128	64	135	72.6	4.31	15.00	13.04	1.70	0.90	0.75	170.00	2.00	2.57	800.00	549.8	254.5	303.9	289.1	198.7	543.6	502.5	197.5	129.1	353.3	326.7
5	1127	65	135	72.6	4.39	16.00	13.91	1.70	0.90	0.75	170.00	2.00	2.61	800.00	559.1	264.0	316.3	289.1	202.0	553.1	518.3	205.6	131.3	359.5	336.9
5	1126	66	135	72.6	4.46	17.00	14.78	1.70	0.90	0.75	170.00	2.00	2.66	800.00	568.3	273.5	328.9	289.1	205.3	562.6	534.3	213.8	133.5	365.7	347.3
5	1125	67	135	72.6	4.53	18.00	15.65	1.70	0.90	0.75	170.00	2.00	2.70	800.00	577.6	283.0	341.7	289.1	208.7	572.1	550.4	222.1	135.7	371.8	357.8
5	1124	68	135	72.6	4.60	19.00	16.52	1.70	0.90	0.75	170.00	2.00	2.74	800.00	586.9	292.5	354.8	289.1	212.0	581.6	566.8	230.6	137.8	378.0	368.4
5	1123	69	135	72.6	4.68	20.00	17.39	1.70	0.90	0.75	170.00	2.00	2.79	800.00	596.1	302.0	368.0	289.1	215.4	591.1	583.4	239.2	140.0	384.2	379.2
5	1122	70	135	72.6	4.75	21.00	18.26	1.70	0.90	0.75	170.00	2.00	2.83	800.00	605.4	311.5	381.4	289.1	218.7	600.6	600.2	247.9	142.2	390.4	390.1
5	1121	71	135	72.6	4.82	22.00	19.13	1.70	0.90	0.75	170.00	2.00	2.87	800.00	614.6	321.0	395.1	289.1	222.1	610.1	617.1	256.8	144.3	396.5	401.1
5	1120	72	135	72.6	4.89	23.00	20.00	1.70	0.90	0.75	170.00	2.00	2.92	800.00	623.9	330.5	408.9	289.1	225.4	619.6	634.3	265.8	146.5	402.7	412.3

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA
S.W. Cole Engineering, Inc.
Project: Alder Stream Bridge #3265
Project No.: 19-1436
Soil profile based on: BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x102			
Depth/Diameter:	1.17	ft	20D	
Web Thickness:	0.06	ft	23.3	ft
Flange Width:	1.23	ft		
Flange Thickness:	0.06	ft		
Perimeter:	4.80	ft		
Section Area:	0.21	ft^2		
Cutting Shoe End Area:	0.42	ft^2		
Plugged Section Area:	1.44	ft^2		
Ground Surface El.:	1203.9	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1
Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Nominal Axial Res. kips	Nordlund Factored Axial Res. (kips)
0																									
1																									
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1																									
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1												Bottom of Pile Cap at Elevation ±1192 feet													
1																									
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1																									
1	1192	0	125	62.6	0.00			0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1191	1	125	62.6	0.06			0.85	0.95			1.00	0.02			4.8	0.1	0.0	0.0	4.8	0.1	0.1	0.0	3.1	0.1
1	1190	2	125	62.6	0.13			0.85	0.95			1.00	0.04			9.6	0.3	0.0	0.0	9.6	0.3	0.2	0.0	6.2	0.2
1	1189	3	125	62.6	0.19			0.85	0.95			1.00	0.06			14.4	0.6	0.0	0.0	14.4	0.6	0.4	0.0	9.4	0.4
2	1188	4	122	59.6	0.25			0.85	0.95			0.00	0.00			14.4	0.6	0.0	0.0	14.4	0.6	0.4	0.0	9.4	0.4
2	1187	5	122	59.6	0.31			0.85	0.95			0.00	0.00			14.4	0.6	0.0	0.0	14.4	0.6	0.4	0.0	9.4	0.4
2	1186	6	122	59.6	0.37			0.85	0.95			0.00	0.00			14.4	0.6	0.0	0.0	14.4	0.6	0.4	0.0	9.4	0.4
2	1185	7	122	59.6	0.43			0.85	0.95			0.00	0.00			14.4	0.6	0.0	0.0	14.4	0.6	0.4	0.0	9.4	0.4
3	1184	8	128	65.6	0.49			0.85	0.95			0.40	0.15			16.3	1.3	0.0	0.0	16.3	1.3	0.9	0.0	10.6	0.9
3	1183	9	128	65.6	0.56			0.85	0.95			0.40	0.18			18.2	2.2	0.0	0.0	18.2	2.2	1.4	0.0	11.9	1.4
3	1182	10	128	65.6	0.62			0.85	0.95			0.40	0.20			20.2	3.1	0.0	0.0	20.2	3.1	2.0	0.0	13.1	2.0
3	1181	11	128	65.6	0.69			0.85	0.95			0.40	0.22			22.1	4.1	0.0	0.0	22.1	4.1	2.7	0.0	14.4	2.7
3	1180	12	128	65.6	0.75			0.85	0.95			0.40	0.24			24.0	5.3	0.0	0.0	24.0	5.3	3.4	0.0	15.6	3.4
3	1179	13	128	65.6	0.82			0.85	0.95			0.40	0.26			25.9	6.5	0.0	0.0	25.9	6.5	4.2	0.0	16.8	4.2
3	1178	14	128	65.6	0.89			0.85	0.95			0.40	0.28			27.8	7.8	0.0	0.0	27.8	7.8	5.1	0.0	18.1	5.1
3	1177	15	128	65.6	0.95			0.85	0.95			0.40	0.30			29.8	9.3	0.0	0.0	29.8	9.3	6.0	0.0	19.3	6.0
3	1176	16	128	65.6	1.02			0.85	0.95			0.40	0.32			31.7	10.8	0.0	0.0	31.7	10.8	7.0	0.0	20.6	7.0
3	1175	17	128	65.6	1.08			0.85	0.95			0.40	0.34			33.6	12.4	0.0	0.0	33.6	12.4	8.1	0.0	21.8	8.1
3	1174	18	128	65.6	1.15			0.85	0.95			0.40	0.36			35.5	14.2	0.0	0.0	35.5	14.2	9.2	0.0	23.1	9.2
3	1173	19	128	65.6	1.21			0.85	0.95			0.40	0.38			37.4	16.0	0.0	0.0	37.4	16.0	10.4	0.0	24.3	10.4
3	1172	20	128	65.6	1.28			0.85	0.95			0.40	0.40			39.4	17.9	0.0	0.0	39.4	17.9	11.7	0.0	25.6	11.7
3	1171	21	128	65.6	1.34			0.85	0.95			0.40	0.42			41.3	20.0	0.0	0.0	41.3	20.0	13.0	0.0	26.8	13.0
3	1170	22	128	65.6	1.41			0.85	0.95			0.40	0.44			43.2	22.1	0.0	0.0	43.2	22.1	14.4	0.0	28.1	14.4
3	1169	23	128	65.6	1.48			0.85	0.95			0.40	0.46			45.1	24.3	0.0	0.0	45.1	24.3	15.8	0.0	29.3	15.8
3	1168	24	128	65.6	1.54			0.85	0.95			0.40	0.48			47.0	26.7	0.0	0.0	47.0	26.7	17.3	0.0	30.6	17.3
3	1167	25	128	65.6	1.61			0.85	0.95			0.40	0.51			49.0	29.1	0.0	0.0	49.0	29.1	18.9	0.0	31.8	18.9
3	1166	26	128	65.6	1.67			0.85	0.95			0.40	0.53			50.9	31.6	0.0	0.0	50.9	31.6	20.5	0.0	33.1	20.5
3	1165	27	128	65.6	1.74			0.85	0.95			0.40	0.55			52.8	34.2	0.0	0.0	52.8	34.2	22.2	0.0	34.3	22.2
3	1164	28	128	65.6	1.80			0.85	0.95			0.40	0.57			54.7	36.9	0.0	0.0	54.7	36.9	24.0	0.0	35.6	24.0
4	1163	29	130	67.6	1.87			1.15	0.93			0.58	0.78			57.5	40.7	0.0	0.0	57.5	40.7	26.4	0.0	37.4	26.4
4	1162	30	130	67.6	1.94			1.15	0.93			0.58	0.81			60.3	44.6	0.0	0.0	60.3	44.6	29.0	0.0	39.2	29.0
4	1161	31	130	67.6	2.01			1.15	0.93			0.58	0.84			63.1	48.6	0.0	0.0	63.1	48.6	31.6	0.0	41.0	31.6
4	1160	32	130	67.6	2.07			1.15	0.93			0.58	0.86			65.9	52.7	0.0	0.0	65.9	52.7	34.3	0.0	42.8	34.3
4	1159	33	130	67.6	2.14			1.15	0.93			0.58	0.89			68.6	57.0	0.0	0.0	68.6	57.0	37.1	0.0	44.6	37.1
4	1158	34	130	67.6	2.21			1.15	0.93			0.58	0.92			71.4	61.4	0.0	0.0	71.4	61.4	39.9	0.0	46.4	39.9
4	1157	35	130	67.6	2.28			1.15	0.93			0.58	0.95			74.2	66.0	0.0	0.0	74.2	66.0	42.9	0.0	48.2	42.9
4	1156	36	130	67.6	2.34			1.15	0.93			0.58	0.98			77.0	70.7	0.0	0.0	77.0	70.7	45.9	0.0	50.0	45.9
4	1155	37	130	67.6	2.41			1.15	0.93			0.58	1.00			79.8	75.5	0.0	0.0	79.8	75.5	49.1	0.0	51.9	49.1
4	1154	38	130	67.6	2.48			1.15	0.93			0.58	1.03			82.6	80.4	0.0	0.0	82.6	80.4	52.3	0.0	53.7	52.3
4	1153	39	130	67.6	2.55			1.15	0.93			0.58	1.06			85.3	85.5	0.0	0.0	85.3	85.5	55.6	0.0	55.5	55.6
4	1152	40	130	67.6	2.62			1.15	0.93			0.58	1.09			88.1	90.8	0.0	0.0	88.1	90.8	59.0	0.0	57.3	59.0
4	1151	41	130	67.6	2.68			1.15	0.93			0.58	1.12			90.9	96.1	0.0	0.0	90.9	96.1	62.5	0.0	59.1	62.5
4	1150	42	130	67.6	2.75			1.15	0.93			0.58	1.15			93.7	101.6	0.0	0.0	93.7	101.6	66.1	0.0	60.9	66.1
4	1149	43	130	67.6	2.82			1.15	0.93			0.58	1.17			96.5	107.3	0.0	0.0	96.5	107.3	69.7	0.0	62.7	69.7
4	1148	44	130	67.6	2.89			1.15	0.93			0.58	1.20			99.3	113.0	0.0	0.0	99.3	113.0	73.5	0.0	64.5	73.5
4	1147	45	130	67.6	2.95			1.15	0.93			0.58	1.23			102.0	118.9	0.0	0.0	102.0	118.9	77.3	0.0	66.3	77.3
4	1146	46	130	67.6	3.02			1.15	0.93			0.58	1.26			104.8	125.0	0.0	0.0	104.8	125.0	81.2	0.0	68.1	81.2
4	1145	47	130	67.6	3.09			1.15	0.93			0.58	1.29			107.6	131.1	0.0	0.0	107.6	131.1	85.2	0.0	70.0	85.2
4	1144	48	130	67.6	3.16			1.15	0.93			0.58	1.31			110.4	137.4	0.0	0.0	110.4	137.4	89.3	0.0	71.8	89.3
4	1143	49	130	67.6	3.22			1.15	0.93			0.58	1.34			113.2	143.9	0.0	0.0	113.2	143.9	93.5	0.0	73.6	93.5
5	1142	50	135	72.6	3.30	1.00	0.86	1.70	0.90	0.75	170.00	2.00	1.96	68.57	420.2	122.8	153.3	28.7	176.1	151.5	329.4	99.7	114.5	98.5	214.1
5	1141	51	135	72.6	3.37	2.00	1.71	1.70	0.90	0.75	170.00	2.00	2.01	137.14	429.5	132.4	163.0	57.5	180.0	189.9	342.9	105.9	117.0	123.4	222.9
5	1140	52	135	72.6	3.44	3.00	2.57	1.70	0.90	0.75	170.00	2.00	2.05	205.71	438.8	142.0	172.8	86.2	183.9	228.2	356.7	112.3	119.5	148.3	231.8

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.
Project: Alder Stream Bridge #3265
Project No.: 19-1436
Soil profile based on: BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x102			
Depth/Diameter:	1.17	ft	20D	
Web Thickness:	0.06	ft	23.3	ft
Flange Width:	1.23	ft		
Flange Thickness:	0.06	ft		
Perimeter:	4.80	ft		
Section Area:	0.21	ft^2		
Cutting Shoe End Area:	0.42	ft^2		
Plugged Section Area:	1.44	ft^2		
Ground Surface El.:	1203.9	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	LRFD Method Factored End Resist (kips)	LRFD Method Meyerhoff Nominal Axial Res. kips	LRFD Method Nordlund Factored Axial Res. (kips)
5	1139	53	135	72.6	3.51	4.00	3.43	1.70	0.90	0.75	170.00	2.00	2.09	274.29	448.0	151.6	182.8	114.9	187.8	266.5	370.6	118.8	122.0	173.2	240.9
5	1138	54	135	72.6	3.59	5.00	4.29	1.70	0.90	0.75	170.00	2.00	2.14	342.86	457.3	161.2	193.1	143.7	191.6	304.9	384.7	125.5	124.6	198.2	250.1
5	1137	55	135	72.6	3.66	6.00	5.14	1.70	0.90	0.75	170.00	2.00	2.18	411.43	466.5	170.8	203.6	172.4	195.5	343.2	399.1	132.3	127.1	223.1	259.4
5	1136	56	135	72.6	3.73	7.00	6.00	1.70	0.90	0.75	170.00	2.00	2.22	480.00	475.8	180.4	214.2	201.2	199.4	381.5	413.6	139.3	129.6	248.0	268.9
5	1135	57	135	72.6	3.80	8.00	6.86	1.70	0.90	0.75	170.00	2.00	2.27	548.57	485.0	190.0	225.1	229.9	203.3	419.9	428.4	146.3	132.1	272.9	278.5
5	1134	58	135	72.6	3.88	9.00	7.71	1.70	0.90	0.75	170.00	2.00	2.31	617.14	494.3	199.6	236.2	258.6	207.1	458.2	443.4	153.5	134.6	297.8	288.2
5	1133	59	135	72.6	3.95	10.00	8.57	1.70	0.90	0.75	170.00	2.00	2.35	685.71	503.5	209.2	247.5	287.4	211.0	496.6	458.5	160.9	137.2	322.8	298.0
5	1132	60	135	72.6	4.02	11.00	9.43	1.70	0.90	0.75	170.00	2.00	2.40	754.29	512.8	218.8	259.0	316.1	214.9	534.9	473.9	168.4	139.7	347.7	308.0
5	1131	61	135	72.6	4.09	12.00	10.29	1.70	0.90	0.75	170.00	2.00	2.44	800.00	522.1	228.4	270.7	335.3	218.8	563.7	489.5	176.0	142.2	366.4	318.2
5	1130	62	135	72.6	4.17	13.00	11.14	1.70	0.90	0.75	170.00	2.00	2.48	800.00	531.3	238.0	282.6	335.3	222.7	573.3	505.3	183.7	144.7	372.6	328.4
5	1129	63	135	72.6	4.24	14.00	12.00	1.70	0.90	0.75	170.00	2.00	2.53	800.00	540.6	247.6	294.8	335.3	226.5	582.9	521.3	191.6	147.3	378.9	338.8
5	1128	64	135	72.6	4.31	15.00	12.86	1.70	0.90	0.75	170.00	2.00	2.57	800.00	549.8	257.2	307.1	335.3	230.4	592.5	537.5	199.6	149.8	385.1	349.4
5	1127	65	135	72.6	4.39	16.00	13.71	1.70	0.90	0.75	170.00	2.00	2.61	800.00	559.1	266.8	319.6	335.3	234.3	602.1	553.9	207.8	152.3	391.3	360.1
5	1126	66	135	72.6	4.46	17.00	14.57	1.70	0.90	0.75	170.00	2.00	2.66	800.00	568.3	276.4	332.4	335.3	238.2	611.7	570.6	216.0	154.8	397.6	370.9
5	1125	67	135	72.6	4.53	18.00	15.43	1.70	0.90	0.75	170.00	2.00	2.70	800.00	577.6	286.0	345.3	335.3	242.1	621.3	587.4	224.5	157.3	403.8	381.8
5	1124	68	135	72.6	4.60	19.00	16.29	1.70	0.90	0.75	170.00	2.00	2.74	800.00	586.9	295.6	358.5	335.3	245.9	630.9	604.4	233.0	159.9	410.1	392.9
5	1123	69	135	72.6	4.68	20.00	17.14	1.70	0.90	0.75	170.00	2.00	2.79	800.00	596.1	305.2	371.9	335.3	249.8	640.5	621.7	241.7	162.4	416.3	404.1
5	1122	70	135	72.6	4.75	21.00	18.00	1.70	0.90	0.75	170.00	2.00	2.83	800.00	605.4	314.8	385.4	335.3	253.7	650.1	639.1	250.5	164.9	422.5	415.4
5	1121	71	135	72.6	4.82	22.00	18.86	1.70	0.90	0.75	170.00	2.00	2.87	800.00	614.6	324.4	399.2	335.3	257.6	659.7	656.8	259.5	167.4	428.8	426.9
5	1120	72	135	72.6	4.89	23.00	19.71	1.70	0.90	0.75	170.00	2.00	2.92	800.00	623.9	334.0	413.2	335.3	261.5	669.3	674.7	268.6	169.9	435.0	438.5

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.

Project: Alder Stream Bridge #3265

Project No.: 19-1436

Soil profile based on: BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x117			
Depth/Diameter:	1.18	ft	20D	
Web Thickness:	0.07	ft	23.7	ft
Flange Width:	1.24	ft		
Flange Thickness:	0.07	ft		
Perimeter:	4.85	ft		
Section Area:	0.24	ft^2		
Cutting Shoe End Area:	0.48	ft^2		
Plugged Section Area:	1.47	ft^2		
Ground Surface El.:	1203.9	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	Factored End Resist (kips)	Meyerhoff Nominal Axial Res. kips	Nordlund Factored Axial Res. (kips)
0																									
1																									
1																									
1																									
1																									
1												Bottom of Pile Cap at Elevation ±1192 feet													
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1																									
1	1192	0	125	62.6	0.00			0.85	0.95			0.00	0.00			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1191	1	125	62.6	0.06			0.85	0.95			1.00	0.02			4.9	0.1	0.0	0.0	4.9	0.1	0.1	0.0	3.2	0.1
1	1190	2	125	62.6	0.13			0.85	0.95			1.00	0.04			9.7	0.3	0.0	0.0	9.7	0.3	0.2	0.0	6.3	0.2
1	1189	3	125	62.6	0.19			0.85	0.95			1.00	0.06			14.6	0.6	0.0	0.0	14.6	0.6	0.4	0.0	9.5	0.4
2	1188	4	122	59.6	0.25			0.85	0.95			0.00	0.00			14.6	0.6	0.0	0.0	14.6	0.6	0.4	0.0	9.5	0.4
2	1187	5	122	59.6	0.31			0.85	0.95			0.00	0.00			14.6	0.6	0.0	0.0	14.6	0.6	0.4	0.0	9.5	0.4
2	1186	6	122	59.6	0.37			0.85	0.95			0.00	0.00			14.6	0.6	0.0	0.0	14.6	0.6	0.4	0.0	9.5	0.4
2	1185	7	122	59.6	0.43			0.85	0.95			0.00	0.00			14.6	0.6	0.0	0.0	14.6	0.6	0.4	0.0	9.5	0.4
3	1184	8	128	65.6	0.49			0.85	0.95			0.40	0.15			16.5	1.3	0.0	0.0	16.5	1.3	0.9	0.0	10.7	0.9
3	1183	9	128	65.6	0.56			0.85	0.95			0.40	0.18			18.4	2.2	0.0	0.0	18.4	2.2	1.4	0.0	12.0	1.4
3	1182	10	128	65.6	0.62			0.85	0.95			0.40	0.20			20.4	3.1	0.0	0.0	20.4	3.1	2.0	0.0	13.2	2.0
3	1181	11	128	65.6	0.69			0.85	0.95			0.40	0.22			22.3	4.2	0.0	0.0	22.3	4.2	2.7	0.0	14.5	2.7
3	1180	12	128	65.6	0.75			0.85	0.95			0.40	0.24			24.3	5.3	0.0	0.0	24.3	5.3	3.5	0.0	15.8	3.5
3	1179	13	128	65.6	0.82			0.85	0.95			0.40	0.26			26.2	6.6	0.0	0.0	26.2	6.6	4.3	0.0	17.0	4.3
3	1178	14	128	65.6	0.89			0.85	0.95			0.40	0.28			28.1	7.9	0.0	0.0	28.1	7.9	5.2	0.0	18.3	5.2
3	1177	15	128	65.6	0.95			0.85	0.95			0.40	0.30			30.1	9.4	0.0	0.0	30.1	9.4	6.1	0.0	19.5	6.1
3	1176	16	128	65.6	1.02			0.85	0.95			0.40	0.32			32.0	10.9	0.0	0.0	32.0	10.9	7.1	0.0	20.8	7.1
3	1175	17	128	65.6	1.08			0.85	0.95			0.40	0.34			34.0	12.6	0.0	0.0	34.0	12.6	8.2	0.0	22.1	8.2
3	1174	18	128	65.6	1.15			0.85	0.95			0.40	0.36			35.9	14.3	0.0	0.0	35.9	14.3	9.3	0.0	23.3	9.3
3	1173	19	128	65.6	1.21			0.85	0.95			0.40	0.38			37.8	16.2	0.0	0.0	37.8	16.2	10.5	0.0	24.6	10.5
3	1172	20	128	65.6	1.28			0.85	0.95			0.40	0.40			39.8	18.1	0.0	0.0	39.8	18.1	11.8	0.0	25.9	11.8
3	1171	21	128	65.6	1.34			0.85	0.95			0.40	0.42			41.7	20.2	0.0	0.0	41.7	20.2	13.1	0.0	27.1	13.1
3	1170	22	128	65.6	1.41			0.85	0.95			0.40	0.44			43.7	22.3	0.0	0.0	43.7	22.3	14.5	0.0	28.4	14.5
3	1169	23	128	65.6	1.48			0.85	0.95			0.40	0.46			45.6	24.6	0.0	0.0	45.6	24.6	16.0	0.0	29.6	16.0
3	1168	24	128	65.6	1.54			0.85	0.95			0.40	0.48			47.5	26.9	0.0	0.0	47.5	26.9	17.5	0.0	30.9	17.5
3	1167	25	128	65.6	1.61			0.85	0.95			0.40	0.51			49.5	29.4	0.0	0.0	49.5	29.4	19.1	0.0	32.2	19.1
3	1166	26	128	65.6	1.67			0.85	0.95			0.40	0.53			51.4	31.9	0.0	0.0	51.4	31.9	20.8	0.0	33.4	20.8
3	1165	27	128	65.6	1.74			0.85	0.95			0.40	0.55			53.4	34.6	0.0	0.0	53.4	34.6	22.5	0.0	34.7	22.5
3	1164	28	128	65.6	1.80			0.85	0.95			0.40	0.57			55.3	37.3	0.0	0.0	55.3	37.3	24.3	0.0	35.9	24.3
4	1163	29	130	67.6	1.87			1.15	0.93			0.58	0.78			58.1	41.1	0.0	0.0	58.1	41.1	26.7	0.0	37.8	26.7
4	1162	30	130	67.6	1.94			1.15	0.93			0.58	0.81			60.9	45.0	0.0	0.0	60.9	45.0	29.3	0.0	39.6	29.3
4	1161	31	130	67.6	2.01			1.15	0.93			0.58	0.84			63.7	49.1	0.0	0.0	63.7	49.1	31.9	0.0	41.4	31.9
4	1160	32	130	67.6	2.07			1.15	0.93			0.58	0.86			66.5	53.3	0.0	0.0	66.5	53.3	34.6	0.0	43.3	34.6
4	1159	33	130	67.6	2.14			1.15	0.93			0.58	0.89			69.4	57.6	0.0	0.0	69.4	57.6	37.4	0.0	45.1	37.4
4	1158	34	130	67.6	2.21			1.15	0.93			0.58	0.92			72.2	62.1	0.0	0.0	72.2	62.1	40.3	0.0	46.9	40.3
4	1157	35	130	67.6	2.28			1.15	0.93			0.58	0.95			75.0	66.7	0.0	0.0	75.0	66.7	43.3	0.0	48.7	43.3
4	1156	36	130	67.6	2.34			1.15	0.93			0.58	0.98			77.8	71.4	0.0	0.0	77.8	71.4	46.4	0.0	50.6	46.4
4	1155	37	130	67.6	2.41			1.15	0.93			0.58	1.00			80.6	76.3	0.0	0.0	80.6	76.3	49.6	0.0	52.4	49.6
4	1154	38	130	67.6	2.48			1.15	0.93			0.58	1.03			83.4	81.3	0.0	0.0	83.4	81.3	52.8	0.0	54.2	52.8
4	1153	39	130	67.6	2.55			1.15	0.93			0.58	1.06			86.2	86.4	0.0	0.0	86.2	86.4	56.2	0.0	56.1	56.2
4	1152	40	130	67.6	2.62			1.15	0.93			0.58	1.09			89.0	91.7	0.0	0.0	89.0	91.7	59.6	0.0	57.9	59.6
4	1151	41	130	67.6	2.68			1.15	0.93			0.58	1.12			91.9	97.1	0.0	0.0	91.9	97.1	63.1	0.0	59.7	63.1
4	1150	42	130	67.6	2.75			1.15	0.93			0.58	1.15			94.7	102.7	0.0	0.0	94.7	102.7	66.7	0.0	61.5	66.7
4	1149	43	130	67.6	2.82			1.15	0.93			0.58	1.17			97.5	108.4	0.0	0.0	97.5	108.4	70.4	0.0	63.4	70.4
4	1148	44	130	67.6	2.89			1.15	0.93			0.58	1.20			100.3	114.2	0.0	0.0	100.3	114.2	74.2	0.0	65.2	74.2
4	1147	45	130	67.6	2.95			1.15	0.93			0.58	1.23			103.1	120.2	0.0	0.0	103.1	120.2	78.1	0.0	67.0	78.1
4	1146	46	130	67.6	3.02			1.15	0.93			0.58	1.26			105.9	126.3	0.0	0.0	105.9	126.3	82.1	0.0	68.9	82.1
4	1145	47	130	67.6	3.09			1.15	0.93			0.58	1.29			108.7	132.5	0.0	0.0	108.7	132.5	86.1	0.0	70.7	86.1
4	1144	48	130	67.6	3.16			1.15	0.93			0.58	1.31			111.6	138.9	0.0	0.0	111.6	138.9	90.3	0.0	72.5	90.3
4	1143	49	130	67.6	3.22			1.15	0.93			0.58	1.34			114.4	145.4	0.0	0.0	114.4	145.4	94.5	0.0	74.3	94.5
5	1142	50	135	72.6	3.30	1.00	0.85	1.70	0.90	0.75	170.00	2.00	1.96	67.61	420.2	124.1	154.9	32.7	203.4	156.8	358.4	100.7	132.2	101.9	232.9
5	1141	51	135	72.6	3.37	2.00	1.69	1.70	0.90	0.75	170.00	2.00	2.01	135.21	429.5	133.8	164.6	65.5	207.9	199.2	372.6	107.0	135.2	129.5	242.2
5	1140	52	135	72.6	3.44	3.00	2.54	1.70	0.90	0.75	170.00	2.00	2.05	202.82	438.8	143.5	174.6	98.2	212.4	241.7	387.0	113.5	138.1	157.1	251.6

AXIAL PILE RESISTANCE **Abutment No. 2**

Evaluated By/Date: MAS / March 2021
Reviewed By: TJB

PROJECT DATA

S.W. Cole Engineering, Inc.
Project: Alder Stream Bridge #3265
Project No.: 19-1436
Soil profile based on: BB-JPTAS-102 - 102A, - 102B

PILE DATA

Pile Size:	HP14x117			
Depth/Diameter:	1.18	ft	20D	
Web Thickness:	0.07	ft	23.7	ft
Flange Width:	1.24	ft		
Flange Thickness:	0.07	ft		
Perimeter:	4.85	ft		
Section Area:	0.24	ft^2		
Cutting Shoe End Area:	0.48	ft^2		
Plugged Section Area:	1.47	ft^2		
Ground Surface El.:	1203.9	ft		
Pile Head El.:	1194.0	ft		
Pile Cap El.:	1192.0	ft		
Q50 Water El.:	1196.5	ft		

LRFD (2017) Soil Resistance Factors
Table 10.5.5.2.3-1

Static Side/End Resistance: ϕ_{stat} = 0.45
Dynamic Resistance: ϕ_{dyn} = 0.65
Use ϕ_{dyn} based on LRFD Article C10.5.5.2.3

SOIL LAYER DATA

	Depth (ft)		γ_{moist} (pcf)	γ_{sat} (pcf)	See SPT Correlation ϕ (deg)	Su (psf)	$N1_{60}$	K_δ	C_F	α_t	N'_q	q_L
Fill	0	16	125	62.6	32	0	50	0.85	0.95			400
Alluvium	16	20	122	59.6	30	0	0	0.85	0.95			0
Glacial Outwash	20	41	128	65.6	32	0	20	0.85	0.95			160
Glacial Outwash	41	62	130	67.6	36	0	29	1.15	0.93			232
Glacial Till	62	85	135	72.6	40	0	100	1.70	0.9	0.75	170	800

Soil Layer	Pile Tip Elevation (ft)	Pile Length (ft)	Total Unit Wt. (pcf)	Eff. Unit Wt (lb/ft3)	Effective Stress (ksf)		Db/D	K_δ	C_F	α_t	N_q	10.7.3.8.6g-3 Meyerhoff Unit Side q_s ksf	10.7.3.8.6f-1 Nordlund Unit Side q_s ksf	Meyerhoff Unit Tip q_p ksf	10.7.3.8.6f-2 Nordlund Unit Tip q_p ksf	Meyerhoff Meyerhoff Nominal Side Rs kips	10.7.3.8.6a-4 Nordlund Nominal Side Rs kips	Meyerhoff Meyerhoff Nominal Tip Rp kips	Nordlund 10.7.3.8.6a-3 Nordlund Nominal Tip Rp kips	Meyerhoff Nominal Axial Res. kips	Nordlund Nominal Axial Res. kips	LRFD Method Factored Side Resist (kips)	LRFD Method Factored End Resist (kips)	LRFD Method Meyerhoff Nominal Axial Res. kips	LRFD Method Nordlund Factored Axial Res. (kips)
5	1139	53	135	72.6	3.51	4.00	3.38	1.70	0.90	0.75	170.00	2.00	2.09	270.42	448.0	153.2	184.7	130.9	216.9	284.1	401.6	120.1	141.0	184.7	261.1
5	1138	54	135	72.6	3.59	5.00	4.23	1.70	0.90	0.75	170.00	2.00	2.14	338.03	457.3	162.9	195.1	163.6	221.4	326.5	416.5	126.8	143.9	212.2	270.7
5	1137	55	135	72.6	3.66	6.00	5.07	1.70	0.90	0.75	170.00	2.00	2.18	405.63	466.5	172.6	205.7	196.4	225.9	368.9	431.5	133.7	146.8	239.8	280.5
5	1136	56	135	72.6	3.73	7.00	5.92	1.70	0.90	0.75	170.00	2.00	2.22	473.24	475.8	182.3	216.5	229.1	230.3	411.4	446.8	140.7	149.7	267.4	290.4
5	1135	57	135	72.6	3.80	8.00	6.76	1.70	0.90	0.75	170.00	2.00	2.27	540.85	485.0	192.0	227.5	261.8	234.8	453.8	462.3	147.8	152.6	295.0	300.5
5	1134	58	135	72.6	3.88	9.00	7.61	1.70	0.90	0.75	170.00	2.00	2.31	608.45	494.3	201.7	238.7	294.6	239.3	496.2	478.0	155.1	155.5	322.5	310.7
5	1133	59	135	72.6	3.95	10.00	8.45	1.70	0.90	0.75	170.00	2.00	2.35	676.06	503.5	211.4	250.1	327.3	243.8	538.7	493.9	162.5	158.5	350.1	321.0
5	1132	60	135	72.6	4.02	11.00	9.30	1.70	0.90	0.75	170.00	2.00	2.40	743.66	512.8	221.1	261.7	360.0	248.3	581.1	510.0	170.1	161.4	377.7	331.5
5	1131	61	135	72.6	4.09	12.00	10.14	1.70	0.90	0.75	170.00	2.00	2.44	800.00	522.1	230.8	273.5	387.3	252.7	618.1	526.3	177.8	164.3	401.7	342.1
5	1130	62	135	72.6	4.17	13.00	10.99	1.70	0.90	0.75	170.00	2.00	2.48	800.00	531.3	240.5	285.6	387.3	257.2	627.8	542.8	185.6	167.2	408.0	352.8
5	1129	63	135	72.6	4.24	14.00	11.83	1.70	0.90	0.75	170.00	2.00	2.53	800.00	540.6	250.2	297.8	387.3	261.7	637.5	559.5	193.6	170.1	414.3	363.7
5	1128	64	135	72.6	4.31	15.00	12.68	1.70	0.90	0.75	170.00	2.00	2.57	800.00	549.8	259.9	310.3	387.3	266.2	647.2	576.5	201.7	173.0	420.7	374.7
5	1127	65	135	72.6	4.39	16.00	13.52	1.70	0.90	0.75	170.00	2.00	2.61	800.00	559.1	269.6	323.0	387.3	270.7	656.9	593.6	209.9	175.9	427.0	385.9
5	1126	66	135	72.6	4.46	17.00	14.37	1.70	0.90	0.75	170.00	2.00	2.66	800.00	568.3	279.3	335.8	387.3	275.1	666.6	611.0	218.3	178.8	433.3	397.1
5	1125	67	135	72.6	4.53	18.00	15.21	1.70	0.90	0.75	170.00	2.00	2.70	800.00	577.6	289.0	348.9	387.3	279.6	676.3	628.6	226.8	181.8	439.6	408.6
5	1124	68	135	72.6	4.60	19.00	16.06	1.70	0.90	0.75	170.00	2.00	2.74	800.00	586.9	298.7	362.2	387.3	284.1	686.0	646.3	235.4	184.7	445.9	420.1
5	1123	69	135	72.6	4.68	20.00	16.90	1.70	0.90	0.75	170.00	2.00	2.79	800.00	596.1	308.4	375.7	387.3	288.6	695.7	664.3	244.2	187.6	452.2	431.8
5	1122	70	135	72.6	4.75	21.00	17.75	1.70	0.90	0.75	170.00	2.00	2.83	800.00	605.4	318.1	389.5	387.3	293.1	705.4	682.5	253.1	190.5	458.5	443.6
5	1121	71	135	72.6	4.82	22.00	18.59	1.70	0.90	0.75	170.00	2.00	2.87	800.00	614.6	327.8	403.4	387.3	297.6	715.1	700.9	262.2	193.4	464.8	455.6
5	1120	72	135	72.6	4.89	23.00	19.44	1.70	0.90	0.75	170.00	2.00	2.92	800.00	623.9	337.5	417.5	387.3	302.0	724.8	719.6	271.4	196.3	471.1	467.7

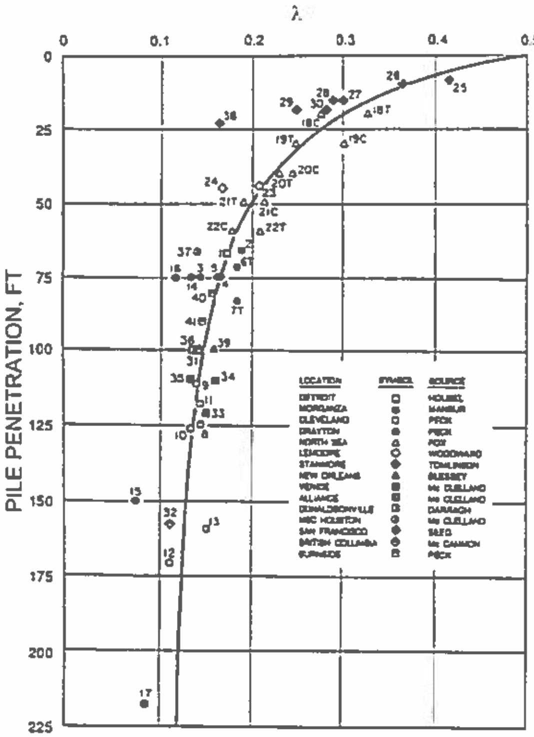


Figure 10.7.3.8.6d-1—λ Coefficient for Driven Pipe Piles after Vijayvergiya and Focht (1972)

10.7.3.8.6e—Tip Resistance in Cohesive Soils

The nominal unit tip resistance of piles in saturated clay, in ksf, shall be taken as:

$$q_p = 9S_u \qquad (10.7.3.8.6e\text{-}1)$$

where:

S_u = undrained shear strength of the clay near the pile tip (ksf)

10.7.3.8.6f—Nordlund/Thurman Method in Cohesionless Soils

This effective stress method should be applied only to sands and nonplastic silts. The nominal unit side resistance, q_s, for this method, in ksf, shall be taken as:

$$q_s = K_\delta C_F \sigma'_v \frac{\sin(\delta + \omega)}{\cos\ \omega} \qquad (10.7.3.8.6f\text{-}1)$$

where:

K_δ = coefficient of lateral earth pressure at mid-point of soil layer under consideration from Figures 10.7.3.8.6f-1 through 10.7.3.8.6f-4 (dim)

C10.7.3.8.6f

Detailed design procedures for the Nordlund/Thurman method are provided in Hannigan et al., (2006). This method was derived based on load test data for piles in sand. In practice, it has been used for gravelly soils as well.

The effective overburden stress is not limited in Eq. 10.7.3.8.6f-1.

For H-piles, the perimeter or "box" area should generally be used to compute the surface area of the pile side.

C_F = correction factor for K_δ when $\delta \neq \phi_f$, from Figure 10.7.3.8.6f-5

σ'_v = effective overburden stress at midpoint of soil layer under consideration (ksf)

δ = friction angle between pile and soil obtained from Figure 10.7.3.8.6f-6 (degrees)

ω = angle of pile taper from vertical (degrees)

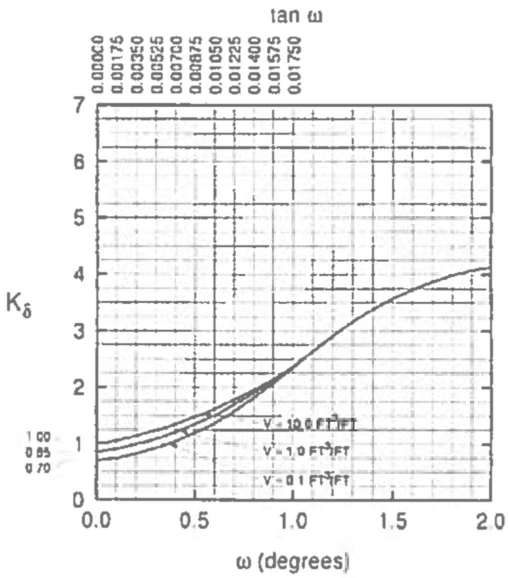


Figure 10.7.3.8.6f-1—Design Curve for Evaluating K_δ for Piles where ϕ_f = 25 degrees (Hannigan et al., 2006 after Nordlund, 1979)

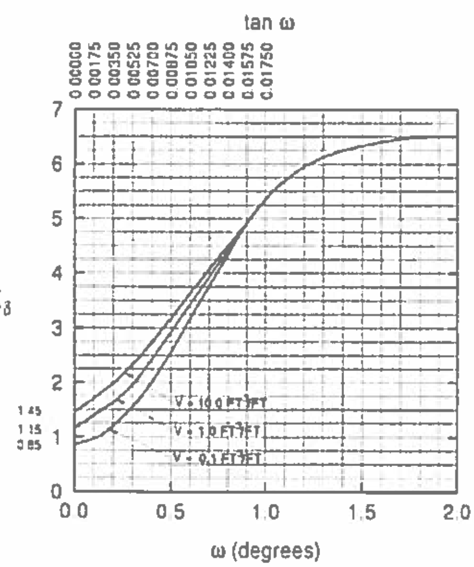


Figure 10.7.3.8.6f-2—Design Curve for Evaluating K_δ for Piles where ϕ_f = 30 degrees (Hannigan et al., 2006 after Nordlund, 1979)

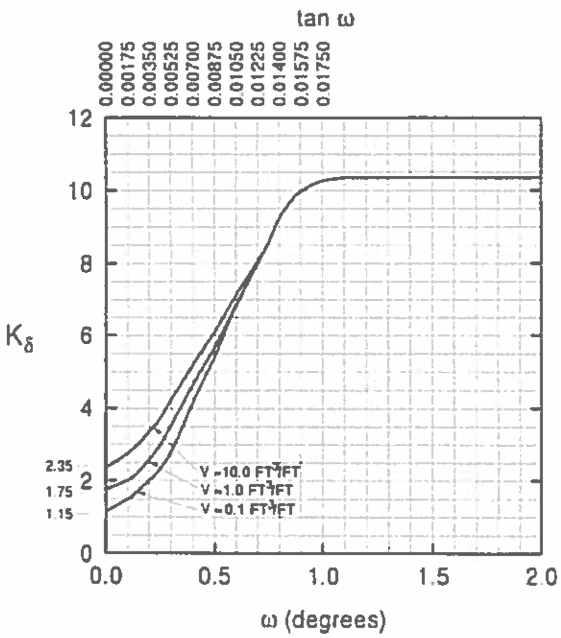


Figure 10.7.3.8.6f-3—Design Curve for Evaluating K_δ for Piles where ϕ_f = 35 degrees (Hannigan et al., 2006 after Nordlund, 1979)

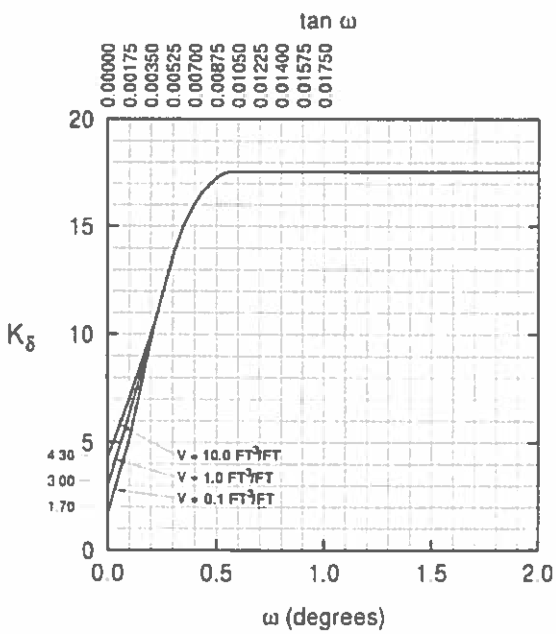


Figure 10.7.3.8.6f-4—Design Curve for Evaluating K_δ for Piles where ϕ_f = 40 degrees (Hannigan et al., 2006 after Nordlund, 1979)

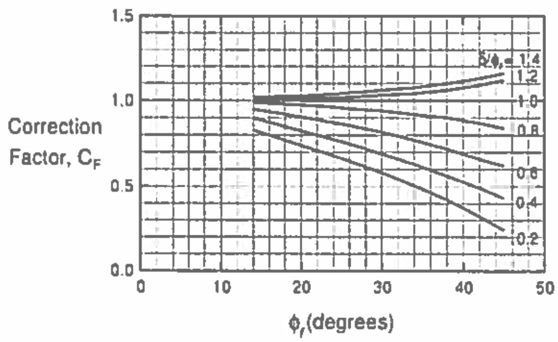


Figure 10.7.3.8.6f-5—Correction Factor for K_δ where $\delta \neq \phi_f$ (Hannigan et al., 2006 after Nordlund, 1979)

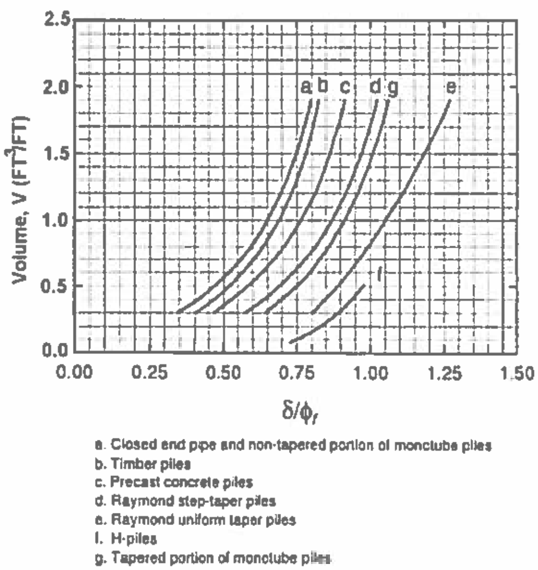


Figure 10.7.3.8.6f-6—Relation of δ/ϕ_f and Pile Displacement, V, for Various Types of Piles (Hannigan et al., 2006 after Nordlund, 1979)

The nominal unit tip resistance, q_p, in ksf by the Nordlund/Thurman method shall be taken as:

$$q_p = \alpha_t N'_q \sigma'_v \leq q_L \qquad (10.7.3.8.6f\text{-}2)$$

where:

α_t = coefficient from Figure 10.7.3.8.6f-7 (dim)

N'_q = bearing capacity factor from Figure 10.7.3.8.6f-8

σ'_v = effective overburden stress at pile tip (ksf) $\leq$3.2 ksf

q_L = limiting unit tip resistance from Figure 10.7.3.8.6f-9

If the friction angle, ϕ_f, is estimated from average, corrected *SPT* blow counts, $N1_{60}$, the $N1_{60}$ values should be averaged over the zone from the pile tip to two diameters below the pile tip.

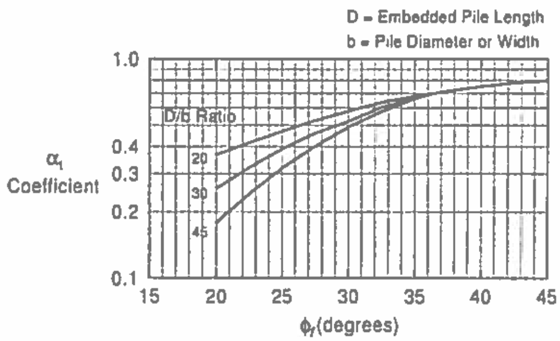


Figure 10.7.3.8.6f-7—α_f Coefficient (Hannigan et al., 2006 modified after Bowles, 1977)

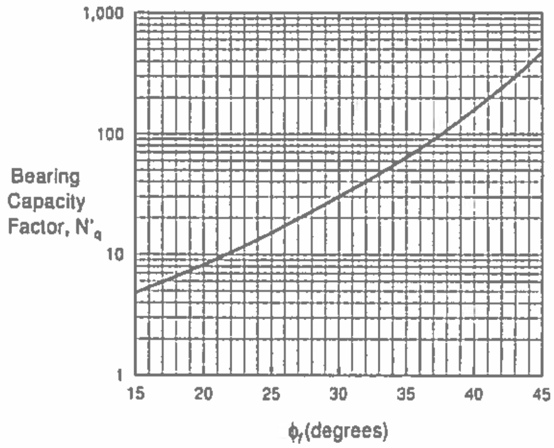


Figure 10.7.3.8.6f-8—Bearing Capacity Factor, N'_q (Hannigan et al., 2006 modified after Bowles, 1977)

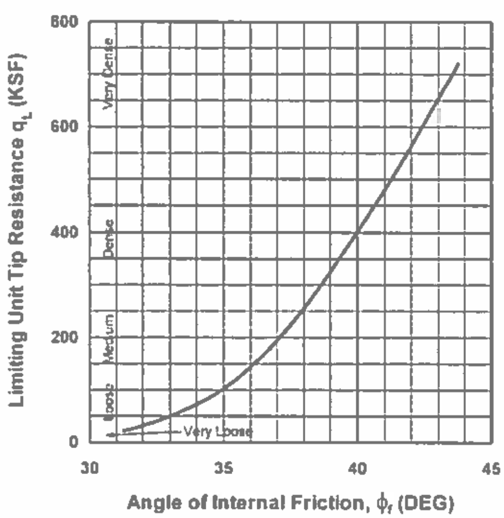
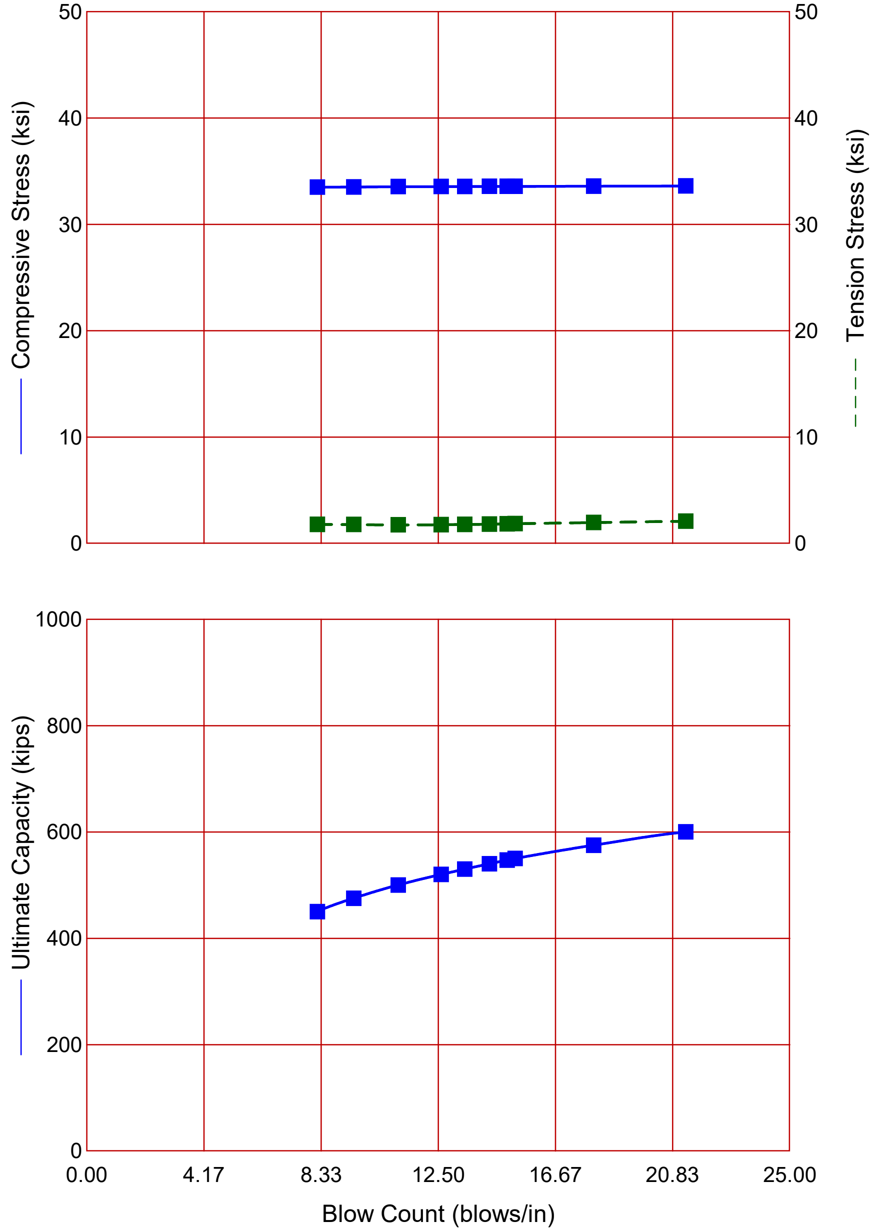


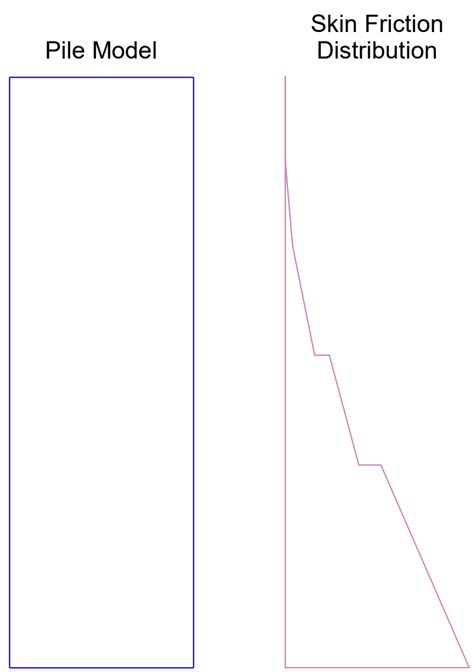
Figure 10.7.3.8.6f-9—Limiting Unit Pile Tip Resistance (Hannigan et al., 2006 after Meyerhof, 1976)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
450.0	33.49	1.78	8.2	10.81	24.47
475.0	33.51	1.77	9.5	10.81	24.41
500.0	33.54	1.74	11.1	10.81	24.35
520.0	33.55	1.76	12.6	10.81	24.30
530.0	33.56	1.78	13.4	10.81	24.27
540.0	33.56	1.81	14.3	10.81	24.24
547.0	33.57	1.84	15.0	10.81	24.22
550.0	33.57	1.85	15.2	10.81	24.21
575.0	33.59	1.97	18.0	10.81	24.15
600.0	33.60	2.09	21.3	10.81	24.17



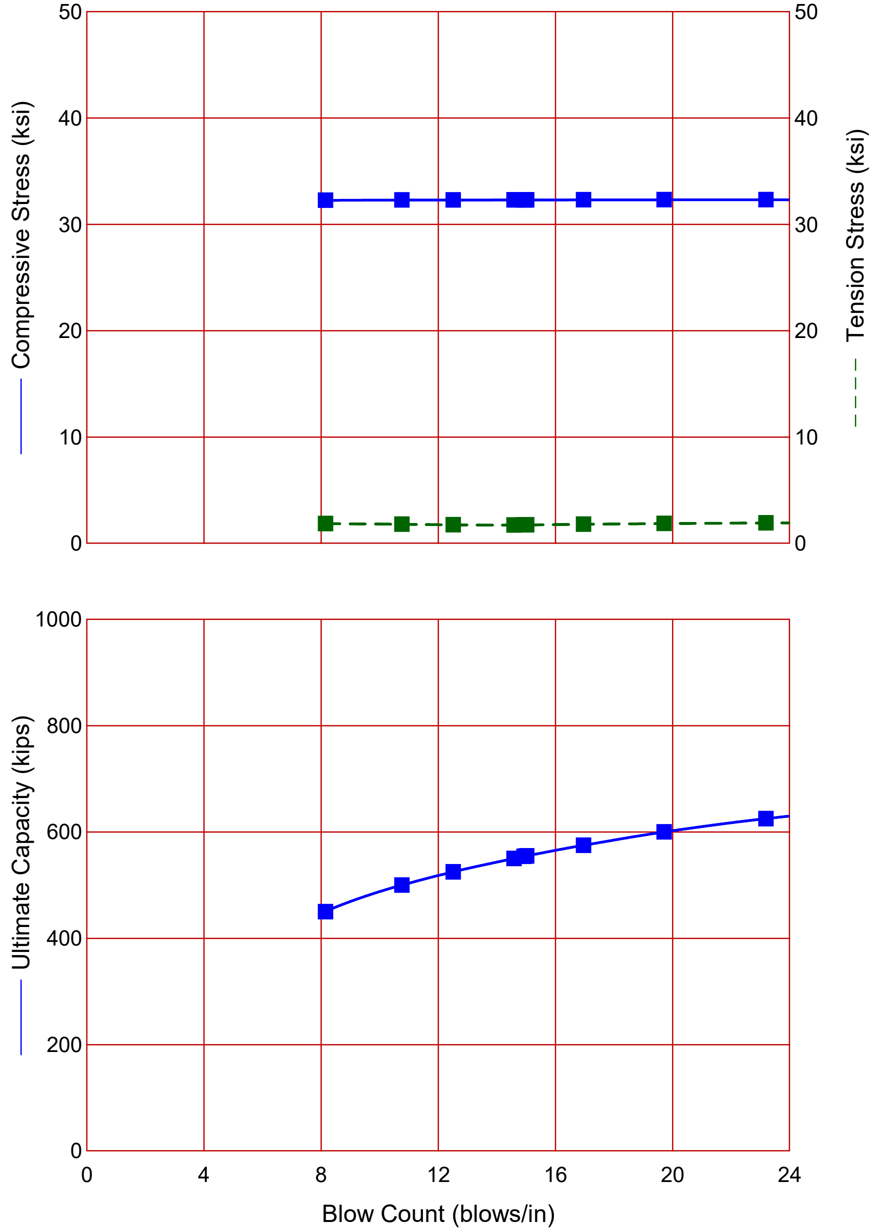
DELMAG D 19-42

Stroke	10.81	ft
Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	Variable	
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.300	in
Skin Damping	0.050	s/ft
Toe Damping	0.150	s/ft
Pile Length	70.00	ft
Pile Penetration	60.00	ft
Pile Top Area	26.10	in2



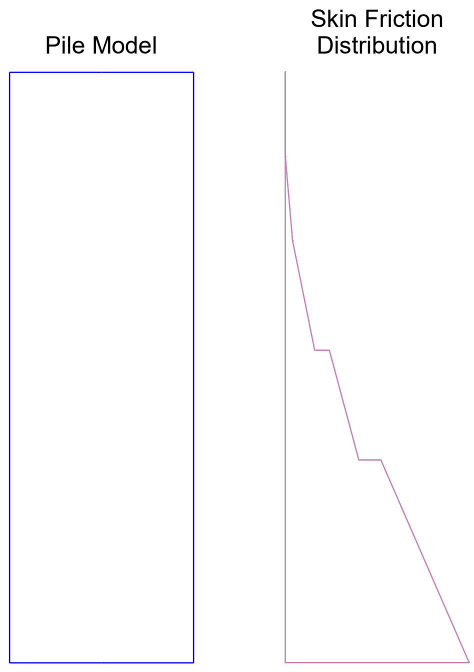
Res. Shaft = 35 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
450.0	32.26	1.87	8.2	10.81	23.90
500.0	32.28	1.81	10.8	10.81	23.80
525.0	32.29	1.75	12.5	10.81	23.74
550.0	32.30	1.73	14.6	10.81	23.68
554.0	32.30	1.74	14.9	10.81	23.67
555.0	32.30	1.74	15.0	10.81	23.67
575.0	32.30	1.80	17.0	10.81	23.62
600.0	32.31	1.87	19.7	10.81	23.55
625.0	32.31	1.93	23.2	10.81	23.49
650.0	32.32	1.98	27.8	10.81	23.42



DELMAG D 19-42

Stroke	10.81	ft
Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	Variable	
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.300	in
Skin Damping	0.050	s/ft
Toe Damping	0.150	s/ft
Pile Length	70.00	ft
Pile Penetration	60.00	ft
Pile Top Area	30.10	in2



Res. Shaft = 35 %
(Proportional)

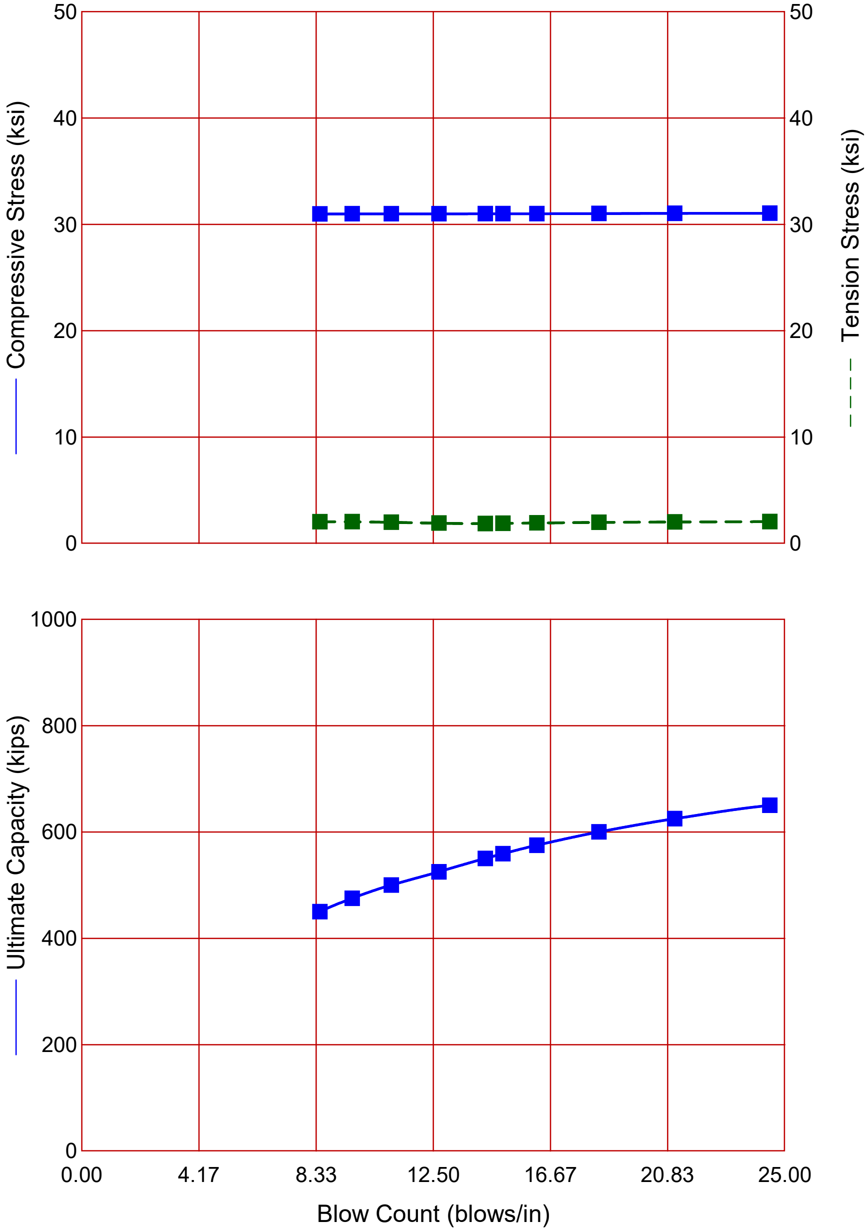
S.W. Cole Engineering, Inc.
WIN 021677 - HP14x117

24-Mar-2021
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
450.0	30.97	2.03	8.5	10.81	23.29
475.0	30.99	2.04	9.6	10.81	23.26
500.0	30.99	1.99	11.0	10.81	23.23
525.0	30.99	1.91	12.7	10.81	23.19
550.0	31.00	1.87	14.4	10.81	23.14
559.0	31.00	1.89	15.0	10.81	23.12
575.0	31.00	1.92	16.2	10.81	23.09
600.0	31.01	1.98	18.4	10.81	23.04
625.0	31.04	2.02	21.1	10.81	22.99
650.0	31.04	2.05	24.5	10.81	22.93

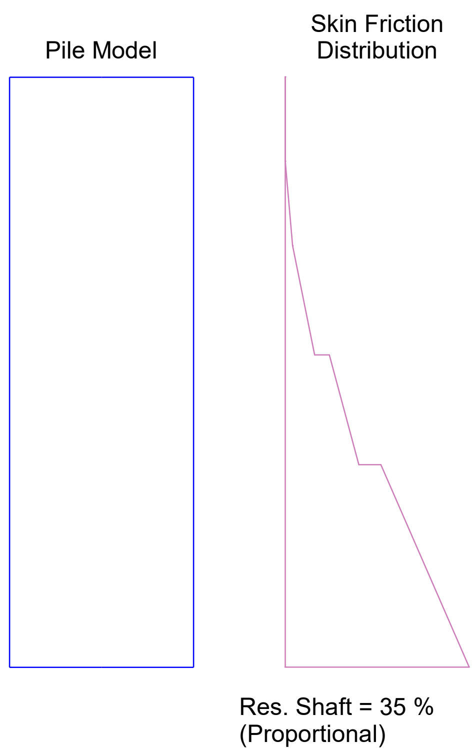
S.W. Cole Engineering, Inc.
WIN 021677 - HP14x117

24-Mar-2021
GRLWEAP Version 2010



DELMAG D 19-42

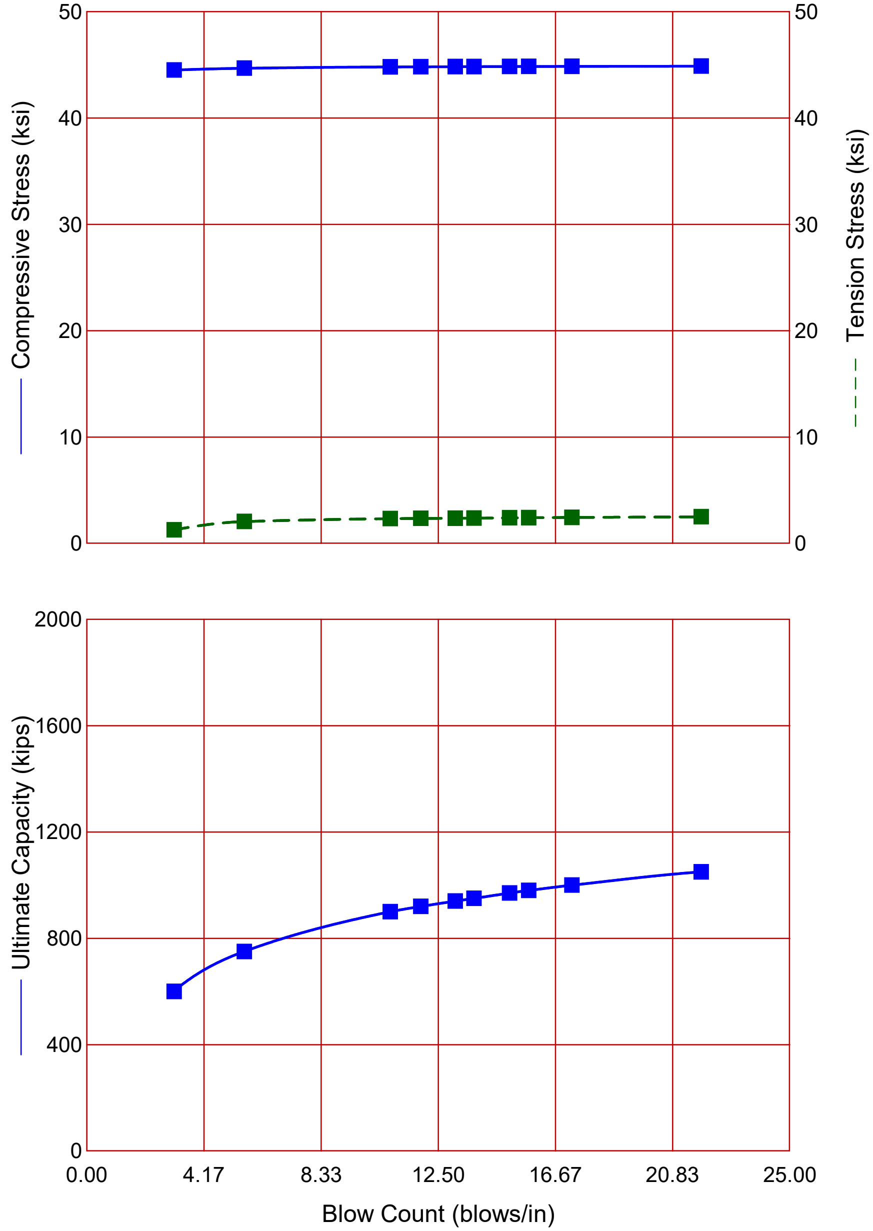
Stroke	10.81	ft
Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	Variable	
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.300	in
Skin Damping	0.050	s/ft
Toe Damping	0.150	s/ft
Pile Length	70.00	ft
Pile Penetration	60.00	ft
Pile Top Area	34.40	in2



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
600.0	44.50	1.27	3.1	11.42	54.86
750.0	44.67	2.06	5.6	11.42	54.14
900.0	44.80	2.33	10.8	11.42	53.46
920.0	44.81	2.35	11.9	11.42	53.38
940.0	44.82	2.37	13.1	11.42	53.30
950.0	44.83	2.38	13.8	11.42	53.25
970.0	44.84	2.40	15.0	11.42	53.17
980.0	44.84	2.42	15.7	11.42	53.13
1000.0	44.85	2.44	17.3	11.42	53.05
1050.0	44.87	2.50	21.9	11.42	52.85

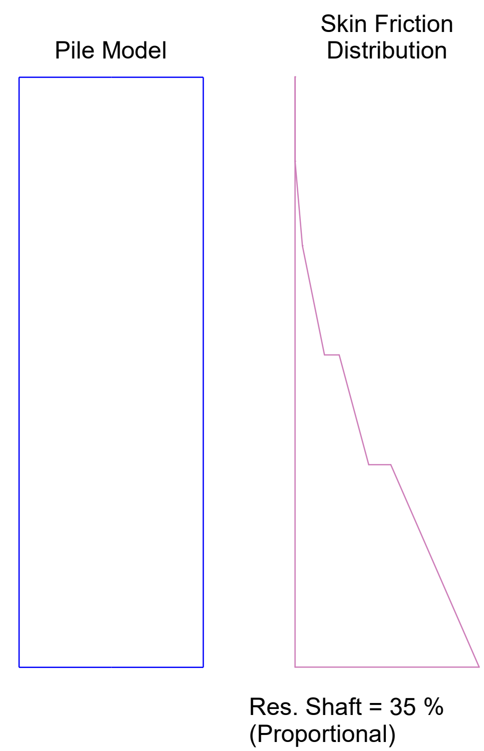
S.W. Cole Engineering, Inc.
WIN 021677 - HP14x117

24-Mar-2021
GRLWEAP Version 2010



DELMAG D 36-32

Stroke	11.42	ft
Ram Weight	7.93	kips
Efficiency	0.800	
Pressure	Variable	
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.300	in
Skin Damping	0.050	s/ft
Toe Damping	0.150	s/ft
Pile Length	70.00	ft
Pile Penetration	60.00	ft
Pile Top Area	34.40	in2



Evaluation of Passive Earth Pressure for IAB

Assumed Backfill Values

MaineDOT BDG Section 3.6.1 - Soil Type 4

$\gamma_1 := 125\ pcf$ Unit Weight

$\phi_1 := 32\ deg$ Friction Angle

$c_1 := 0\ psf$ Cohesion

Integral Abutment Wall Parameters

$\beta := 0\ deg$ Continous Backslope Angle(s) (from horizontal)

$\theta := 90\ deg$ Angle of back face of wall (from horizontal)

$\delta := 19.5\ deg$ For IAB, Interface Friction between Fill and Wall
LRFD Table 3.11.5.3-1, δ = 17 to 22 deg

Coulomb Theory Passive Earth Pressure Coefficient

$$\Gamma_{p\_c} := \left(1 - \sqrt{\frac{\sin(\phi_1 + \delta) \cdot \sin(\phi_1 + \beta)}{\sin(\theta + \delta) \cdot \sin(\theta + \beta)}}\right)^2$$

$$k_{p\_c} := \frac{\sin(\theta - \phi_1)^2}{\Gamma_{p\_c} \cdot (\sin(\theta))^2 \cdot (\sin(\theta + \delta))}$$

$k_{p\_c} = 6.73$ for $\beta = 0\ deg$

Rankine Theory Passive Earth Pressure Coefficient

$$k_{p\_r} := \left(\frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi_1)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi_1)^2}}\right)$$

$k_{p\_r} = 3.25$ for $\beta = 0\ deg$

Evaluated by / Date: MAS / March 2020
Checked by: TJB

Determine Seismic Site Classification per AASHTO LRFD Table C3.10.3.1-1 - Method B

Data From Boring BB-JPTAS-101A

Layer No.	Layer Description	Depth Range (ft)		N_{60} values recorded within layer										Average N_{60} value	Layer Thickness	d_i/N_i
		Top	End											Ni	di	
1	Fill	0	12	50	42									46.0	12	0.26
2	Alluvium	12	43	14	3	26	14	24	33	42				22.3	31	1.39
4	Glacial Till	43	85	100	100	100	100	100	100	100				100.0	42	0.42
														Σ =	**85**	**2.07**

N_bar = di/di/Ni = 41.03
Site Class D

Data From Boring BB-JPTAS-102B

Layer No.	Layer Description	Depth Range (ft)		N_{60} values recorded within layer										Average N_{60} value	Layer Thickness	d_i/N_i
		Top	End											Ni	di	
1	Fill	0	16.3	73	42	57								57.3	16.3	0.28
2	Alluvium	16.3	61.5	16	26	20	20	20	36	23	24	34		24.3	45.2	1.86
3	Glacial Till	61.5	83.2	100	100	100	100							100.0	21.7	0.22
														Σ =	**83.2**	**2.36**

N_bar = di/di/Ni = 35.27
Site Class D

NOTES:
1. Weight of rod (WOR) and weight of hammer (WOH) values taken as N=1
2. N60 values > 100 taken as N=100
3. N60 value for bedrock taken as N=100

Calculated by / Date: MAS / March 2020
Checked by: TJB / March 2020

WIN 023104 Alder Stream Bridge #3265

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
Latitude = 45.254232
Longitude = -070.547002
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.069	PGA - Site Class B
0.2	0.157	Ss - Site Class B
1.0	0.051	S1 - Site Class B

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Spectral Response Accelerations SDs and SD1
Latitude = 45.254232
Longitude = -070.547002
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class D - Fpga = 1.60, Fa = 1.60, Fv = 2.40
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.110	As - Site Class D
0.2	0.252	SDs - Site Class D
1.0	0.122	SD1 - Site Class D

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Design Response Spectra for Site Class D
Latitude = 45.254232
Longitude = -070.547002
As = FpgaPGA, SDs = FaSs, SD1 = FvS1
Site Class D - Fpga = 1.60, Fa = 1.60, Fv = 2.40
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	Sd in.	
0.000	0.110	0.000	T = 0.0, Sa = As
0.097	0.252	0.023	
0.200	0.252	0.098	T = 0.2, Sa = SDs
0.483	0.252	0.573	T = Ts, Sa = SDs
0.500	0.243	0.594	
0.600	0.203	0.712	
0.800	0.152	0.950	
1.000	0.122	1.187	T = 1.0, Sa = SD1
1.200	0.101	1.425	
1.400	0.087	1.662	
1.600	0.076	1.900	
1.800	0.068	2.137	
2.000	0.061	2.375	
2.200	0.055	2.612	
2.400	0.051	2.850	
2.600	0.047	3.087	
2.800	0.043	3.325	
3.000	0.041	3.562	

3.200	0.038	3.800
3.400	0.036	4.037
3.600	0.034	4.275
3.800	0.032	4.512
4.000	0.030	4.750

Estimated Frost Penetration Depth

Based on MaineDOT Bridge Design Guide Section 5.2.1

Site Location: Jim Pond Township, Maine

Soil Conditions: SAND, some gravel, little silt (SW-SM)
(Coarse Grained)

Step 1. From Figure 5-1: Design Freezing Index = ±2,275 freezing degree-days

Step 2. From laboratory test results:
natural soil water content: 2.9%
USE WC = 10%

Step 3. From Table 5-1: Interpolate frost penetration for w = 10%

$$DFI := 2275$$

$$DFI_1 := 2200 \quad d_1 := 100.0\ in$$

$$DFI_2 := 2300 \quad d_2 := 102.3\ in$$

$$d_{frost} := d_1 + (d_2 - d_1) \cdot \left(\frac{DFI - DFI_1}{DFI_2 - DFI_1} \right)$$

$$d_{frost} = 101.7\ in$$

$$d_{frost} = 8.5\ ft$$

Calculated by / Date: MAS / March 2020
Checked by: TJB / March 2020

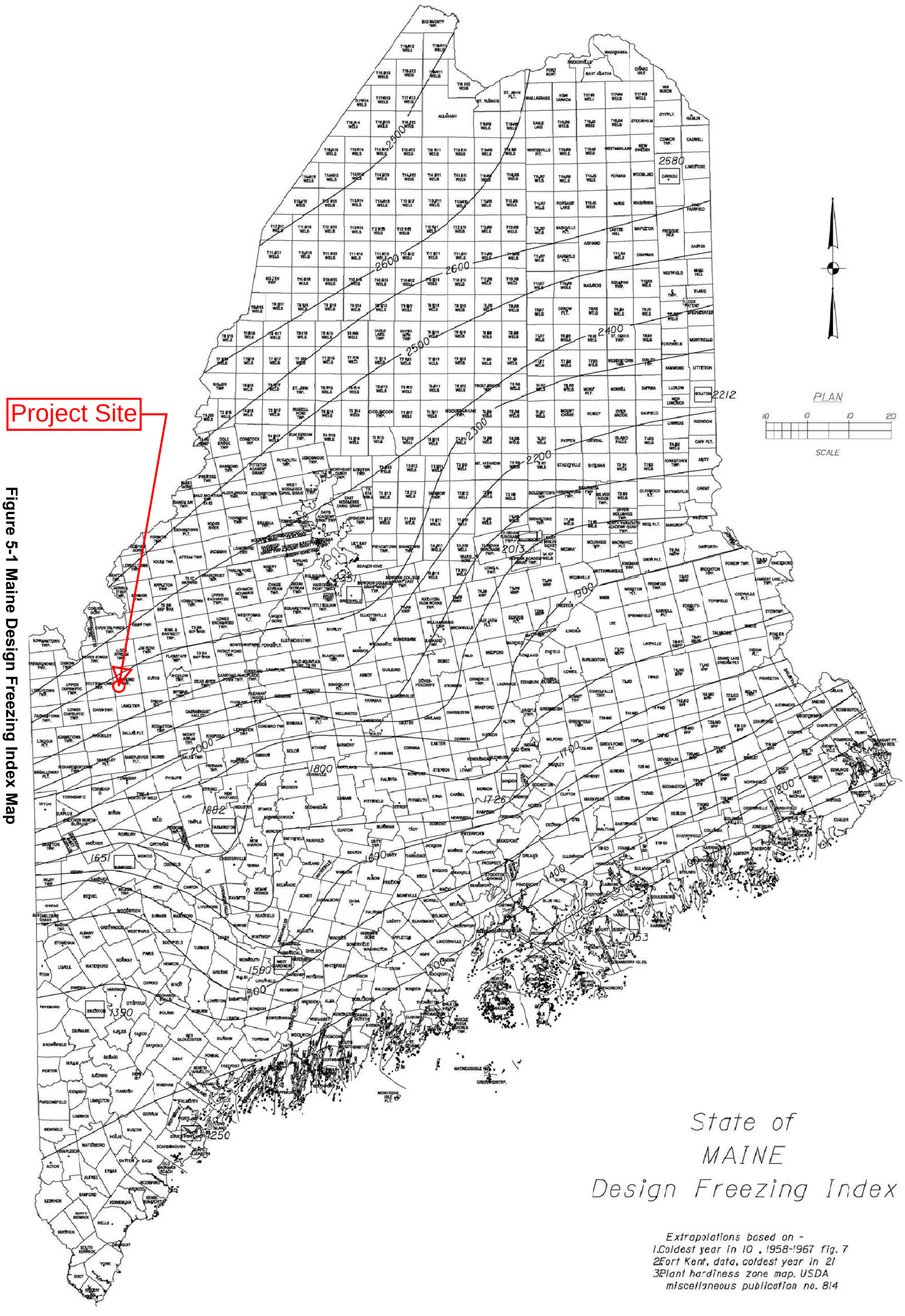


Figure 5-1 Maine Design Freezing Index Map

5.2 General

5.2.1 Frost

Any foundation placed on seasonally frozen soils must be embedded below the depth of frost penetration to provide adequate frost protection and to minimize the potential for freeze/thaw movements. Fine-grained soils with low cohesion tend to be most frost susceptible. Soils containing a high percentage of particles smaller than the No. 200 sieve also tend to promote frost penetration.

In order to estimate the depth of frost penetration at a site, Table 5-1 has been developed using the Modified Berggren equation and Figure 5-1 Maine Design Freezing Index Map. The use of Table 5-1 assumes site specific, uniform soil conditions where the Geotechnical Designer has evaluated subsurface conditions. Coarse-grained soils are defined as soils with sand as the major constituent. Fine-grained soils are those having silt and/or clay as the major constituent. If the make-up of the soil is not easily discerned, consult the Geotechnical Designer for assistance. In the event that specific site soil conditions vary, the depth of frost penetration should be calculated by the Geotechnical Designer.

Table 5-1 Depth of Frost Penetration

Design Freezing Index	Frost Penetration (in)					
	Coarse Grained			Fine Grained		
	w=10%	w=20%	w=30%	w=10%	w=20%	w=30%
1000	66.3	55.0	47.5	47.1	40.7	36.9
1100	69.8	57.8	49.8	49.6	42.7	38.7
1200	73.1	60.4	52.0	51.9	44.7	40.5
1300	76.3	63.0	54.3	54.2	46.6	42.2
1400	79.2	65.5	56.4	56.3	48.5	43.9
1500	82.1	67.9	58.4	58.3	50.2	45.4
1600	84.8	70.2	60.3	60.2	51.9	46.9
1700	87.5	72.4	62.2	62.2	53.5	48.4
1800	90.1	74.5	64.0	64.0	55.1	49.8
1900	92.6	76.6	65.7	65.8	56.7	51.1
2000	95.1	78.7	67.5	67.6	58.2	52.5
2100	97.6	80.7	69.2	69.3	59.7	53.8
2200	100.0	82.6	70.8	71.0	61.1	55.1
2300	102.3	84.5	72.4	72.7	62.5	56.4
2400	104.6	86.4	74.0	74.3	63.9	57.6
2500	106.9	88.2	75.6	75.9	65.2	58.8
2600	109.1	89.9	77.1	77.5	66.5	60.0