GEOTECHNICAL REPORT
for
USFWS FISH PASSAGE IMPROVEMENTS
COPPER RIVER HIGHWAY
CORDOVA, ALASKA

Prepared for:
Bratslavsky Consulting Engineers, Inc.
500 W. 27th Avenue, Suite A
Anchorage, AK 99503

Prepared by:
Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing

---

APRIL 2019

NGE-TFT Project # 5138-18

April 30, 2019 NGE-TFT Project # 5138-18

Bratslavsky Consulting Engineers, Inc.
500 W. 27th Avenue, Suite A
Anchorage, AK 99503

Attn: Egor Esipov

RE: GEOTECHNICAL RECOMMENDATIONS FOR THE PROPOSED USFWS FISH PASSAGE IMPROVEMENTS ALONG THE COPPER RIVER HIGHWAY IN CORDOVA, ALASKA

Egor,

We (Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing) have completed a geotechnical engineering assessment of the aforementioned project. Our assessment suggests that most of the sites are suitable for the proposed improvements provided that our engineering recommendations are incorporated into the design.

In the following report we provide a summary of our field and laboratory programs, as well as provide our conclusions and recommendations regarding the suitability of the project site to support the proposed improvements and our recommendations for the design and construction of the proposed site improvements.

We observed unsuitable materials at four of the sites: COP 25, COP 33, COP 45, and CAB 2. The unsuitable materials encountered at CAB 2 are at the anticipated footing depth and we anticipate they will be removed during excavation for the proposed improvements. Per the recommendation of the Alaska Department of Transportation, Northern Region Materials Section (ADOT, NRMS) all of the unsuitable materials should be over-excavated from the footprint of the proposed culverts.

We greatly appreciate the opportunity to provide you with our professional service. Please contact us directly with any questions or comments you may have regarding the information that we present in this report, or if you have any other questions, comments, and/or requests.

Sincerely,
Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing,

Shelley A. McCoy, P.E.
Project Engineer

Keith F. Mobley, P.E.
President

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Table of Contents

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

List of Figures

List of Appendices

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

1.0 INTRODUCTION

In this report, we (Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing) present the results of a geotechnical assessment that we conducted for the proposed U.S. Fish and Wildlife Service (USFWS) fish passage improvements along the Copper River Highway in Cordova, Alaska; hereafter referred to as "the project sites". We provided our professional service in accordance with our service fee proposal #18-159 which we submitted to Bratslavsky Consulting Engineers, Inc. (BCE) on August 10, 2018. BCE authorized our proposed scope of service on October 4, 2018 by signed agreement contract.

BCE subcontracted us to perform subsurface explorations and geotechnical engineering analysis and provide design recommendations to replace eleven existing culverts along the Copper River Highway and Cabin Lake Road near Cordova, Alaska. The purpose of this project is to improve fish habitat and migration across the Copper River Highway. In this report, we present the results of our geotechnical assessment conducted for the proposed U.S. Fish and Wildlife Service (USFWS) fish passage improvements.

2.0 PROJECT OVERVIEW

This project lies within a geographic area that has been identified to be affected by the Exxon Valdez Oil Spill (EVOS). The EVOS Trustee Council (EVOSTC) has made the restoration of this area a priority, as it has affected a wide range of wildlife. This project is aimed to support the previous restoration efforts by the EVOSTC.

The restoration effort consists of ten proposed fish passage sites along the Alaska State Highway 10, also known as the Copper River Highway and one site along Cabin Lake Road near Cordova, Alaska. The fish passage sites are shown on the attached Figure 1. The Copper River Highway east of the Cordova Airport is a 50-mile, two-lane gravel surface road that was previously used as the Copper River and Northwestern Railway. The 73 culverts along the highway were not properly designed and, as such, the highway functions similarly to a dike. The culvert design has reduced the ecological functions in the area and causes expensive road repair following major high-water events.

To improve the drainage and increase fish habitat within the Copper River Watershed and Delta, the USFWS is proposing to replace/install fish passages at the eleven sites deemed highest priority.

3.0 CURRENT PROJECT SITE ACTIVITIES

3.1 Subsurface Exploration

We coordinated and directed a subsurface exploration program at the project site to help characterize the subsurface conditions of the project site as they currently exist. We subcontracted Discovery Drilling, Inc. (DDI) to provide the necessary geotechnical exploration services. A

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

qualified representative from our office was present on-site during the entire exploration program to select the exploration locations, direct the exploration activities, log the geology of each exploration, and collect representative samples for further identification and laboratory analysis. Under our direction DDI advanced two soil borings, one upstream and one downstream, at each site for a total of 22 soil borings on October 12, 2018 through October 15, 2018 to depths of approximately 21.5 feet below the existing ground surface (bgs). General boring locations for each site are shown in Figures 2 through 12.

Under our direction, DDI performed a Modified Penetration Test (MPT) at regular intervals during the drilling of each borehole. An MPT can be used to assess the consistency of a soil interval and to collect representative soil samples. An MPT is performed by driving a 2.0-inch O.D. or 3.0-inch O.D. split-spoon sampler at least 18 inches past the bottom of the advancing augers with blows from a 340-lb drop-hammer, free-falling 30 inches onto an anvil attached to the top of the drill rod stem. Our field representative recorded the hammer blows required to drive the modified split-spoon sampler the entire length of each sample interval, or until sampler refusal was encountered. We have provided the field blow count data for each sample interval (in six-inch increments) on the graphical borehole logs contained in Appendix A of this report.

During the course of our subsurface exploration program, we encountered a physical phenomenon common to hollow-stem auger drilling known as “sand-heave” below the groundwater level. Sand-heave typically occurs when sampling saturated sand deposits with hollow stem augers/split-spoon samplers, as the increased hydrostatic pressure outside of the hollow-stem augers forces a sand slurry up into the hollow auger flights when the drill stem is removed (to allow for split-spoon sampling). At times, sand-heave can be significant; filling the inside of the hollow-stem auger flights with several feet of densely-packed sand. As a result, sand-heaving forces disturb the in-situ density of the sand deposit at the tip of the advancing augers and can lead to the collection of unrepresentative blow count data (i.e., soil resistance measurements) and a disturbed split-spoon sample.

Sand-heave can typically be controlled by filling the inside of the augers with an appropriate drilling fluid (e.g., water, drill mud, etc.) which equalizes the hydrostatic pressures inside and outside of the augers. In order to prevent sand heave, once below the water table, DDI primed the augers with water for each sample. We have noted on our borehole logs when efforts by DDI were ineffective in preventing the sand heave.

We corrected the field blow count data for all 22 boreholes for standard confining pressure, drill rod length, and drop-hammer operation procedure to estimate a standard $(N_1)_{60}$ value for each sample interval. $(N_1)_{60}$ values are a measure of the relative density (compactness) and consistency (stiffness) of cohesionless or cohesive soils, respectively. Our estimate of the $(N_1)_{60}$ values is based on the drop-hammer blows required to drive the spilt-spoon sampler the final 12-inches of an 18-inch MPT. We have provided our estimated $(N_1)_{60}$ values for each sample interval on the graphical borehole logs contained in Appendix A of this report. The automatic drop-hammer that DDI used for this project is not standard, so we applied a correction factor of 1.1 to the $(N_1)_{60}$ values to

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

account for the efficiency of the automatic drop-hammer used. We have provided a graphical plot of the field blow count corrections that we used to correct for confining pressure and drill rod length in Figure 13 of this report.

Our field representative photographed each split-spoon sample that they collected during our exploration program and we have included these photographs in Appendix A of this report. Our field representative sealed each sample that they collected during our subsurface exploration program inside of an air-tight bag and/or container, to help preserve the moisture content of each sample, and then submitted each sample to our laboratory for further identification and analysis.

Once the exploration activities were complete, we directed DDI to backfill the annulus of each exploration with its respective drill cuttings.

3.2 Survey

BCE and the U.S. Fish and Wildlife Service met on site on October 10, 2018. A surveyor, contracted by BCE, was also on site and placed stakes at each of the proposed culvert crossing improvements.

4.0 LABORATORY TESTING

We collected a total of 154 soil samples from the 22 geotechnical borings that DDI advanced at the project site and submitted all of the soil samples to our laboratory for further identification and geotechnical analysis. We tested select soil samples in accordance with the respective ASTM standard test methods including:

- moisture content analysis (ASTM D-2216);
- determination of fines content (a.k.a. P200 – ASTM D-1140);
- grain size sieve and hydrometer analysis (ASTM D-6913 & D-422); and
- organic content (ASTM D2974);

It is important to note that ASTM test method D-6913 requires that any soil sample specimen which is to be submitted for gradational analysis (by ASTM D-422 or other methods) must satisfy a minimum mass requirement based on the maximum particle size of the sample specimen. Split-spoon sampling techniques (standard or modified), as well as other small-diameter soil sampling techniques (e.g., macro-core, etc.), typically recover anywhere from approximately 1 to 10 pounds of sample specimen. The amount of sample specimen recovered can be influenced by (amongst other variables) the soil gradation, soil density, sample interval, sampler tooling, and soil moisture content. As a result, samples of coarse-grained soils (with individual soil particles greater than approximately 0.75 inches in diameter) collected with small-diameter sampling methods (e.g., split-spoons, macro-core, etc.) may not meet the minimum mass requirement specified by Table 2 of ASTM D-6913. This may result in inaccurate gradational and frost classification results. The use of small-diameter sampling devices in coarse-grained soils (e.g., sand and gravel) can result in the collection of unrepresentative samples due to: the exclusion of oversized particles (larger than

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

the opening of the sampler) from the sample; and the mechanical breakdown/degradation of coarse-grained particles by the sampling process (producing an unrepresentative increase in smaller-diameter particles in the sample). Both of these sampling biases can skew laboratory test results towards the fine-grained end of the gradational spectrum.

The laboratory test results, along with the observations we made during our subsurface exploration efforts, aid in our evaluation of the subsurface conditions at the project site and help us to assess the suitability of the subsurface materials located at the project site to support the proposed improvements. We have included the results of our geotechnical laboratory analyses on the graphical exploration logs contained in Appendix A of this report and on the laboratory data sheets contained in Appendix B of this report.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

We compiled our field observations with the results from our laboratory analyses to produce graphical logs of each subsurface exploration (Appendix A). The graphical exploration logs depict the subsurface conditions that we identified at each exploration location and help us to interpret/extrapolate the subsurface conditions for areas adjacent to, and immediately surrounding, each exploration location across the project site

5.1 General Subsurface Profile

Each site exploration was advanced through the road section at the locations where culverts are proposed to be installed/replaced. The road section generally consists of well-graded gravel with silt and sand to well-graded sand with silt and gravel and ranged between 4 and 10 feet in thickness. Differentiation between the road and the underlying native soils was not consistently apparent. Underlying the road section, the soils are consistent with streambed deposits, consisting of sands and gravels with varying amounts of silt. We provide more detailed subsurface profiles for each site in Section 7.0.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

6.1 General Site Conclusions

Based on the findings of our field efforts and laboratory testing, it is our conclusion that the sand and gravel soils which we observed across at each project site are generally suitable to support the proposed improvements; provided that our concerns and recommendations that we present in this report are addressed by the design and construction processes.

Based on our discussions with BCE and the USFWS, the new culverts will be aluminum box or arch culverts (as shown in Figure 14). We have based our recommendation and conclusions to accommodate this design. If the design is significantly different, we will revise our recommendations accordingly.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

6.2 Earthworks

Our recommendations assume that the culvert base will be founded either directly onto the undisturbed sand and gravel soils or compacted structural fill pads constructed directly above the undisturbed silty sand and gravel soils. Any material used as structural fill should conform to the ADOT, NRMS criteria for Type A or Subgrade, Type F material as shown in in Figure 15 of this report. Backfill outside of the embedment material zone, up to 3.5 feet below the road surface, can be Type B material as shown in Figure 15 of this report. All geotextile fabric should meet the requirements of Type 2 as shown in Figure 16 of this report.

All earthworks should be completed with quality control inspection, including bottom-of-hole inspections; fill gradation classification; and in-situ compacting testing. A bottom-of-hole inspection should be conducted by a qualified geotechnical engineer, geologist, or special inspector following site excavation activities (and before any foundation construction begins) in order to visually confirm the findings of this report and provide recommendations for any non-conforming conditions encountered during the excavation activities.

Any and all fill material used should be placed at 95 percent of the modified Proctor density as determined by ASTM D-1557, unless specifically stated otherwise in other sections of this report. All structural fill and backfill around the culvert should be placed in six-inch lifts. All earthworks should be completed with quality control inspection.

Any excavated fill or native sand and gravel soils (which are free of organic material and meet the criteria for the ADOT, NRMS Type A or subgrade Type F material) which are stockpiled on-site (for later use as structural backfill) should be protected from additional moisture inputs (precipitation, etc.) through the use of plastic tarps, etc. Additional moisture inputs can have detrimental effects on the effort needed to achieve proper compaction rates.

6.3 Shallow Foundations

Care should be taken during foundation excavation activities to limit the disturbance of the bottom of any foundation excavations. The bottom of any foundation excavation should be moisture conditioned and proof-rolled as necessary to return the exposed soils to their original in-situ density.

6.4 Dewatering

To excavate to the anticipated bottom of culvert depth, dewatering will most likely be necessary for the excavation and compaction efforts. We recommend that sheet piles be driven around the excavation area to limit the disturbance to the site. To avoid scouring and heave, the sheet piles should be driven a minimum of 1.3 times the depth of excavation. Pumps for dewatering should be placed at the elevation of the base of the sheet pile.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

6.5 Settlements

Settlements for shallow foundations should be within tolerable limits, provided that they are placed directly onto the undisturbed sand and gravel or structural fill. We anticipate a total settlement for aluminum box culvert foundations placed on either the undisturbed describe the foundation soils and/or or structural fill placed above the undisturbed describe the foundation soils to be less than three-quarters (3/4) of an inch, with differential settlements comprising about one-half (1/2) of the total anticipated settlement. Settlement amounts could increase substantially if the structural fill material used to bring any foundation pads to grade is not properly compacted. Most of the settlements should occur as the loads are applied, such that additional long-term settlements should be relatively small and within tolerable limits.

6.6 Seismic Design Parameters

The seismic site classification for the project site is D based on the $(N_1)_{60}$ values that we calculated for the sand and gravel soils that occur at the project site. We utilized the United States Geological Survey (USGS) Seismic Design Maps tool for the project site in Cordova, AK as shown at the website (http://earthquake.usgs.gov/designmaps/us/application.php) to calculate the seismic design parameters for the project site, which are F_a = 1.000 (S_s = 1.630 g) and F_v = 1.500 (S_1 = 0.823 g). A copy of the USGS Design Maps report for the project site is contained in Appendix C of this report.

During our field explorations, we encountered soils which have the potential to liquefy under a strong-motion seismic event. In the event liquefaction occurs, the soils under both the road and the culvert will be impacted equally. As such, measures to mitigate liquefaction of the soils are unlikely to cost effective.

The potential for earthquake-induced lateral spreading and pressure ridges is unlikely.

6.7 Winter Construction

It is imperative that shallow foundations remain in a thawed state for the entire construction period; even when dealing with soils that have little to no frost susceptibility. Foundation soils that are allowed to freeze during the initial construction may be compromised by the development of ice lenses. Upon thawing, which may take several weeks or months, potential differential settlements could distort the structure resulting in damaged foundations. If construction extends into the winter months, temporary enclosures should be constructed which completely enclose foundations and heat should be applied to the enclosure to prevent freezing of the soils located beneath any foundation.

Proper placement and compaction of structural fill is not possible when fill material is frozen, and as such, frozen fill material should never be used for structural support unless it has been subsequently thawed and compacted to 95 percent of the modified Proctor density (throughout its vertical extent). Furthermore, subgrade soils (fill or native) need to be completely thawed prior to

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

the placement and compaction of additional lifts of thawed fill material. In our professional experience, ambient soil temperatures need to be above 37 °F in order to achieve efficient compaction. It is extremely difficult to achieve compaction levels equal to 95 percent of the modified Proctor density in fill material that is between 32 °F to 37 °F.

7.0 DESIGN RECOMMENDATIONS

7.1 General Recommendations

We have based our calculations on the assumption that the culvert foundation will bear on soils approximately five to six feet below the groundwater table. This will vary depending on the size of the culvert and the thickness of the road section.

We anticipate that excavation will generally extend between one to two feet below the bottom of the culvert depending on the soil conditions. For sites COP 25, 33, and 45, the organic materials encountered below the anticipated depth of excavation should be over-excavated and backfilled with Type A material up to one foot below the bottom of the culvert. We have included a discussion on organic material in Appendix D of this report.

Culvert embedment material should be Subgrade Type F and extend a minimum of one foot below the bottom of the culvert, a minimum of 18 inches past the edge of the culvert, and a minimum of 12 inches vertical adjacent to the culvert. A layer of Type 2 geotextile fabric should be placed between the Type F material and the native soil or Type A backfill. If two feet of Type F is required, a second layer of Type 2 geotextile should be placed between each one-foot layer of Type F. We detail culvert embedment and backfill in Figure 14 of this report.

7.2 SITE COP 1

7.2.1 Subsurface Profile

The soils at this site are comprised of approximately five feet of well graded gravel with silt and sand. The gravel is underlain by approximately four feet of well graded sand with silt and gravel to well graded sand with gravel on the upstream side and two feet of silty sand overlaying well graded sand with silt and gravel on the downstream side. There is a thin (<2’) layer of stiff silt underlying the sand on the downstream side. The sand and silt are underlain by approximately ten feet of poorly graded sand with silt and gravel overlaying stiff silt.

We encountered groundwater at this site at approximately six to seven feet below the road surface.

7.2.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.2.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may also be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.2.3 Construction Recommendations

The culvert will likely be founded on soils approximately 12 to 13 feet below the road surface. The bearing soils consist of loose to medium dense poorly graded sand with silt. Excavation should extend a minimum of 2 feet below bottom of the culvert. The organic material will likely be removed during excavation; however, a bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of the excavation and place Type A up to two feet below the bottom of the culvert. Place geotextile fabric and Type F per the recommendations in Section 7.1.

7.3 SITE COP 9

7.3.1 Subsurface Profile

Upstream, the soils consist of approximately 5 feet of poorly graded gravel with sand overlaying approximately 5 feet of poorly graded sand with silt and gravel and approximately 2 feet of well graded gravel with silt and sand. Downstream, the soils consist of approximately 12 feet of well graded gravel with silt and sand. Underlying the gravel, the soils consist of silty sand to sandy silt to the extents of our exploration.

We encountered groundwater at this site at approximately seven to nine feet below the road surface.

7.3.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.3.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.3.3 Construction Recommendations

The culvert will likely be founded on soils approximately 13 to 15 feet below the road surface. The bearing soils consist of loose to medium dense silty sand to sandy silt. Excavation should extend a minimum of 2 feet below bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

7.4 SITE COP 20

7.4.1 Subsurface Profile

The upstream soils consist of approximately seven feet of poorly graded to well graded gravel and sand with varying amounts of silt overlaying approximately two feet of well graded sand. Underlying the sand, the soils consist of well graded gravel with sand. We encountered sand heaving in the auger during our exploration at approximately 20 feet below the road surface.

The downstream soils consist of approximately 10 feet of well graded to poorly graded sand with silt. Underlying the sand, the soils consist of approximately 5 feet of well graded gravel with sand overlaying well graded sand with silt and gravel.

We encountered groundwater at this site approximately five to six feet below the road surface.

7.4.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.4.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.4.3 Construction Recommendations

The culvert will likely be founded on soils approximately 12 to 13 feet below the road surface. The bearing soils consist of loose to medium dense well graded gravel with sand. Excavation should extend a minimum of 2 feet below bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

7.5 SITE COP 22

7.5.1 Subsurface Profile

In our upstream exploration, we encountered approximately seven feet of medium dense to loose, well graded sand with silt and gravel overlaying medium dense, well graded gravel with sand and varying amounts of silt.

In our downstream exploration, we encountered approximately five feet of medium dense, well graded gravel with silt and sand overlaying approximately five feet of loose to medium dense, well graded sand with silt and gravel. Underlaying the sand is approximately two feet of medium dense, well graded sand with gravel overlaying dense to loose poorly graded sand with gravel.

We encountered groundwater at this site at approximately six to seven feet below the road surface.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

7.5.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.5.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.5.3 Construction Recommendations

The culvert will likely be founded on soils approximately 12 to 13 feet below the road surface. The bearing soils consist of medium dense well graded gravel with sand. Excavation should extend a minimum of 1 foot below bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

7.6 SITE COP 25

7.6.1 Subsurface Profile

Upstream, the soils consist of approximately five feet of loose, well graded gravel overlaying approximately five feet of very loose to loose, well graded sand with gravel and varying amounts of silt. The soils underlaying the sand are approximately five feet of medium dense well graded gravel with sand overlaying medium dense sand to sand with silt and gravel.

Downstream, the soils consist of approximately 15 feet of medium dense to very loose sand with gravel and varying amounts of silt. Underlying the sand is approximately two to three feet of highly organic soil/peat underlain by loose sand with silt.

We encountered groundwater at this site at approximately five to seven feet below the road surface.

7.6.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.6.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

7.6.3 Construction Recommendations

The culvert will likely be founded on soils approximately 12 to 13 feet below the road surface. The bearing soils consist of loose well graded to poorly graded sand and gravel. Excavation should extend a minimum of 2 feet below bottom of the culvert. The organic material observed on the south side of the road will need to be completely removed during excavation. A bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of the excavation and place Type A up to two feet below the bottom of the culvert. Place geotextile fabric and Type F per the recommendations in Section 7.1.

7.7 SITE COP 33

7.7.1 Subsurface Profile

The soils we encountered in the upstream exploration consisted of approximately 12 feet of loose to very loose, well graded gravel with sand overlying approximately three feet of very loose, silty sand and approximately three feet of very loose sand with silt and gravel. We encountered a thin (<1') layer of decomposing wood debris at approximately 16 feet below the road surface overlaying soft silt and loose silty sand.

In the downstream exploration, we encountered loose, poorly graded gravel and loose silty sand to approximately eight feet below the road surface. Underlying the silty sand is approximately five feet of loose, poorly graded gravel with silt and sand overlaying medium dense, poorly graded sand with silt and gravel to loose silty sand and silty gravel.

We encountered groundwater at this site at approximately seven feet below the road surface.

7.7.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.7.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.7.3 Construction Recommendations

The culvert will likely be founded on soils approximately 12 to 13 feet below the road surface. The bearing soils consist of loose silty sand and gravel. Excavation should extend a minimum of 2 feet below bottom of the culvert. The organic material observed on the north side of the road will need to be completely removed during excavation. The very loose/soft soils should be removed during excavation of the unsuitable organic material. A bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

the excavation and place Type A up to two feet below the bottom of the culvert. Place geotextile fabric and Type F per the recommendations in Section 7.1.

7.8 SITE COP 43

7.8.1 Subsurface Profile

Upstream, we encountered approximately seven feet of medium dense to loose, well graded sand with silt and gravel overlaying loose to medium dense silty sand and gravel.

Downstream, we encountered approximately five feet of medium dense, well graded gravel with silt and sand overlaying approximately two feet of medium dense, well graded sand with gravel and approximately 15 feet of loose to very loose silty sand to medium dense, poorly graded sand with silt and gravel.

We encountered groundwater at this site at approximately three feet below the road surface.

7.8.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.8.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.8.3 Construction Recommendations

The culvert will likely be founded on soils approximately 8 to 9 feet below the road surface. The bearing soils consist of loose to very loose silty sand. Excavation should extend a minimum of two feet below bottom of the culvert. The organic material observed in the bearing soils will need to be completely removed during excavation. A bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of the excavation and place Type A up to two feet below the bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

7.9 SITE COP 44

7.9.1 Subsurface Profile

The soils upstream consist of approximately 10 feet of dense to medium dense, well graded gravel with sand overlaying approximately 3 feet of loose, sand with silt and gravel. Underlying the loose sand is very soft to medium stiff sandy silt to the bottom of the exploration.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

The soils downstream consist of approximately 10 feet of very dense to medium dense well graded gravel and sand overlaying approximately 5 feet of loose sand with gravel. Underlying the loose sand is very loose to loose, silty sand to the bottom of the exploration.

We encountered groundwater at this site at approximately 2.5 feet below the road surface.

7.9.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.9.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.9.3 Construction Recommendations

The culvert will likely be founded on soils approximately 8 to 9 feet below the road surface. The bearing soils consist of medium dense well graded gravel with sand to loose, poorly graded sand with silt and gravel and medium dense to loose, well graded to poorly graded sand with gravel. Excavation should extend a minimum of two feet below bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

7.10 SITE COP 45

7.10.1 Subsurface Profile

In our upstream exploration, we encountered approximately five feet of well graded sand with gravel overlaying very loose silty sand to ten feet below the road surface. Underlying the silty sand is approximately 10 feet of medium dense sand and gravel.

Downstream, the soils consist of approximately 10 feet of medium dense, well graded to poorly graded gravel and sand with silt. Underlying the sand and gravel is approximately three feet of very loose, silty sand overlaying medium dense gravel with silt and sand.

We encountered groundwater at this site at approximately three feet below the road surface.

7.10.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.10.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.10.3 Construction Recommendations

The culvert will likely be founded on soils approximately 8 to 9 feet below the road surface. The bearing soils consist of loose to medium dense well graded gravel with sand. Excavation should extend a minimum of 2 feet below bottom of the culvert. The organic material observed in the bearing soils on the south side of the road will need to be completely removed during excavation. A bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of the excavation and place Type A up to 2 feet below the bottom of the culvert. Place geotextile fabric and Type F per the recommendations in Section 7.1.

7.11 SITE CAB 2

7.11.1 Subsurface Profile

Due to utility conflicts at the site, both borings were advanced on the downstream side of the road on either side of the culvert. In the northern boring, we encountered approximately seven feet of medium dense, well graded gravel with silt and sand overlaying approximately eight feet of loose, well graded sand with silt and gravel. Underlying the sand is loose to medium dense silty sand.

The soils in the southern boring consisted of approximately three feet of gravel with silt and sand overlaying medium stiff silt with sand to approximately five feet below the road surface. Underlying the silt is approximately one foot of silty sand. We encountered solid wood debris at approximately six feet below the road surface overlaying approximately eight feet of medium dense, well graded gravel with silt and sand. Underlying the gravel is silt with sand to silty sand to the depth of the exploration.

We encountered groundwater at this site at approximately 4.5 below the road surface.

7.11.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.11.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

7.11.3 Construction Recommendations

The culvert will likely be founded on soils approximately 10 to 11 feet below the road surface. The bearing soils consist of loose well graded sand and gravel. Excavation should extend a minimum of two feet below bottom of the culvert. The organic material will likely be removed during excavation; however, a bottom-of-hole inspection should be conducted to ensure all organic materials have been completely removed. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

7.12 SITE SHER 1

7.12.1 Subsurface Profile

This site contained two culvert crossings. One crossing was immediately adjacent to the Copper River Highway. This culvert was smaller in diameter and we observed it to be completely submerged. The second culvert was approximately 500 feet from the highway and was in very poor condition. The culvert was large, contained no water around the entrance or exit, and appeared to have collapsed in the center of the road. Conversations with the design engineer led us to understand that the new culver crossing would be placed between the two existing culverts. The road at the site was very narrow, so our borings were placed adjacent to the existing culverts.

In the northern boring, we encountered approximately seven feet of poorly graded gravel with sand overlying medium dense to loose, well graded to poorly graded sand with silt and varying amounts of gravel.

In the southern boring, the soils consisted primarily of medium dense to loose sand and silty sand with varying amounts of gravel.

We encountered groundwater at this site at approximately six below the road surface.

7.12.2 Soil Bearing Capacity

The box culvert foundation placed on the undisturbed sand and gravel or properly placed and compacted structural fill may be designed for an allowable soil bearing capacity of 3,900 pounds per square foot (psf) given the construction recommendations in Section 7.12.3. The lateral resistance of the soil adjacent to the culvert will be a function of the height of the culvert and the depth of cover over the culvert. The lateral resistance can be calculated as shown in Figure 17. Lateral forces may be resisted by friction between the culvert bottom and the soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the metal and soil.

7.12.3 Construction Recommendations

The culvert will likely be founded on soils approximately 11 to 12 feet below the road surface. The bearing soils consist of loose poorly graded sand with silt and gravel. Excavation should

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

extend a minimum of two feet below bottom of the culvert. Proof-roll the base of the excavation and place geotextile fabric and Type F per the recommendations in Section 7.1.

8.0 THE OBSERVATIONAL METHOD

A comprehensive geoprofessional service (e.g., geotechnical, geological, civil, and/or environmental engineering, etc.) should consist of an interdependent, two-part process comprised of:

Part I - pre-construction site assessment, engineering, and design; and

Part II - continuous construction oversight and design support.

This process, commonly referred to in the geoprofessional industry as "The Observational Method", was developed to reduce the costs required to complete a construction project, while simultaneously reducing the overall risk associated with the design and construction of the project.

In geotechnical engineering, Part I of the Observational Method (OM) begins with a geotechnical assessment of the site, which typically consists of some combination of literature research, site reconnaissance, subsurface exploration, laboratory testing, and geotechnical engineering. These efforts are usually documented in a formal report (e.g., such as this report) that summarizes the findings of the geotechnical assessment, and presents provisional geotechnical engineering recommendations for design and construction. Geotechnical assessment reports (and the findings and recommendations contained within) are considered provisional due to the fact that their contents are typically based primarily on limited subsurface information for a site. Most conventional geotechnical exploration programs only physically characterize a very small percentage of a given site, as it is typically cost prohibitive to conduct extensive (i.e. high density/frequency) exploration programs. As an alternative, geoprofessionals use the subsurface information available for a site to extrapolate subsurface conditions between exploration locations and develop appropriate provisional recommendations based on the inferred site conditions. As a result, the geoprofessional of record cannot be certain that the provisional recommendations will be wholly applicable to the site, as subsurface conditions other than those identified during the geotechnical assessment may exist at the site which could present obstacles and/or increased risk to the proposed design and construction.

Part II of the OM is employed by geoprofessionals to help reduce the risk associated with unidentified and/or unexpected subsurface conditions. Geoprofessionals accomplish Part II of the OM by providing construction oversight (e.g., construction observation, inspection, and testing). Part II of the OM is a valuable service, as the geoprofessional of record is available if unexpected conditions are encountered during the construction process (e.g., during excavation, fill placement, etc.) to make timely assessments of the unexpected conditions and modify their design and construction recommendations accordingly; thus reducing considerable cost resulting from potential construction delays and reducing the risk of future problems resulting from inappropriate design and construction practices.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Oftentimes, a client may be persuaded to use an alternative geoprofessional firm to conduct Part II of the OM for a given project; as some geoprofessional firms offer the same services at discounted prices in order to help them obtain the overall construction materials engineering and testing (CoMET) commission. The geoprofessional industry as a whole recommends against this practice. An alternative geoprofessional firm cannot provide the same level of service as the geoprofessional of record. The geoprofessional of record has (amongst other things) a unique familiarity with the project including; an intimate understanding of the subsurface conditions, the proposed design, and the client's unique concerns and needs, as well as other factors that could impact the successful completion of a construction project. An alternative geoprofessional firm is not aware of the inferences made and the judgment applied by the geoprofessional of record in developing the provisional recommendations, and may overlook opportunities to provide extra value during Part II of the geoprofessional service.

Clients that prevent the geoprofessional of record from performing a complete service can be held solely liable for any complications stemming from engineering omissions as a result of unidentified conditions. The geoprofessional of record may not be liable for any resulting complications that occur, as the geoprofessional of record was not able to complete their services. Furthermore, the replacement geoprofessional firm may also be found to have no liability for the same reasons.

We are available at any time to discuss the OM in more detail, or to provide you with an estimate for any additional construction observation and testing services required.

9.0 CLOSURE

We (Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing) prepared this report exclusively for the use BCE and their consultants. for use in the design and construction of the proposed improvements. We should be notified if significant changes are to occur in the nature, design, or location of the proposed improvements in order that we may review our conclusions and recommendations that we present in this report and, if necessary, modify them to satisfy the proposed changes.

This report should always be read and/or distributed in its entirety (including all figures, exploration logs, appendices, etc.) so that all of the pertinent information contained within is effectively disseminated. Otherwise, an incomplete or misinterpreted understanding of the site conditions and/or our engineering recommendations may occur. Our recommended best practice is to make this report accessible, in its entirety, to any design professional and/or contractor working on the project. Any part of this report (e.g., exploration logs, calculations, material values, etc.) which is presented in the design/construction plans and/or specifications for the project should have an adequate reference which clearly identifies where the report can be obtained for further review.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

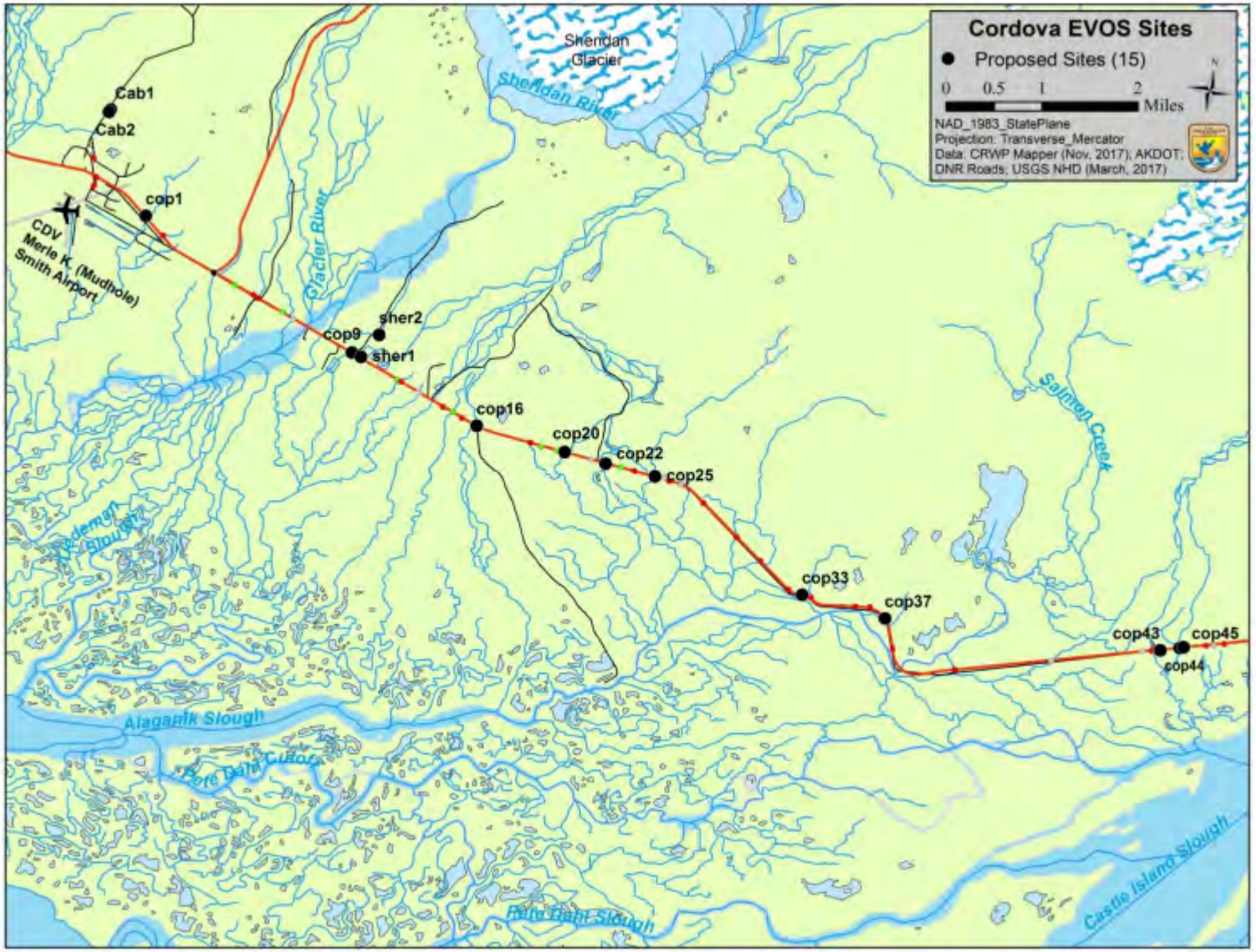
Due to the natural variability of earth materials, variations in the subsurface conditions across the project site may exist other than those we identified during the course of our geotechnical assessment. Therefore, a qualified geotechnical engineer, geologist, and/or special inspector be on-site during construction activities to provide corrective recommendations for any unexpected conditions revealed during construction (see our discussion of the Observational Method in Section 8.0 of this report for more detail). Furthermore, the construction budget should allow for any unanticipated conditions that may be encountered during construction activities.

We conducted this evaluation following the standard of care expected of professionals undertaking similar work in the State of Alaska under similar conditions. No warranty, expressed or implied, is made.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

REPORT
FIGURES

Location Map Copper River Watershed and Delta



NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE OVERVIEW		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 1

SITE COP 1:
N60.49168, W145.45538
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 1	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 2

SITE COP 9:
N60.4743, W145.3881
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 9	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 3

SITE COP 20:
N60.4630, W145.3207
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 20		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 4

SITE COP 22:
N60.4620, W145.3081
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 22	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 5

SITE COP 25:
N60.46078, W145.2444
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 25	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 6

SITE COP 33:
N60.4453, W145.2444
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 33	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 7

SITE COP 43:
N60.4425, W145.1342
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 43	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 8

SITE COP 44:
N60.443, W145.1285
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 44		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 9

SITE COP 45:
N60.44318, W145.12714
BORING IN ROAD SHOULDER
OWNED BY: ADOT

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE COP 45	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 10

SITE SHER 1:
N60.47399, W145.38571
BORING IN ROAD SHOULDER
OWNED BY: USFS?/ADOT?

= Approx. Culvert Location

= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE SHER 1		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 11

SITE CAB 2:
N60.50665, W145.46990
BORING IN ROAD SHOULDER
OWNED BY: USFS?/ CORDOVA?

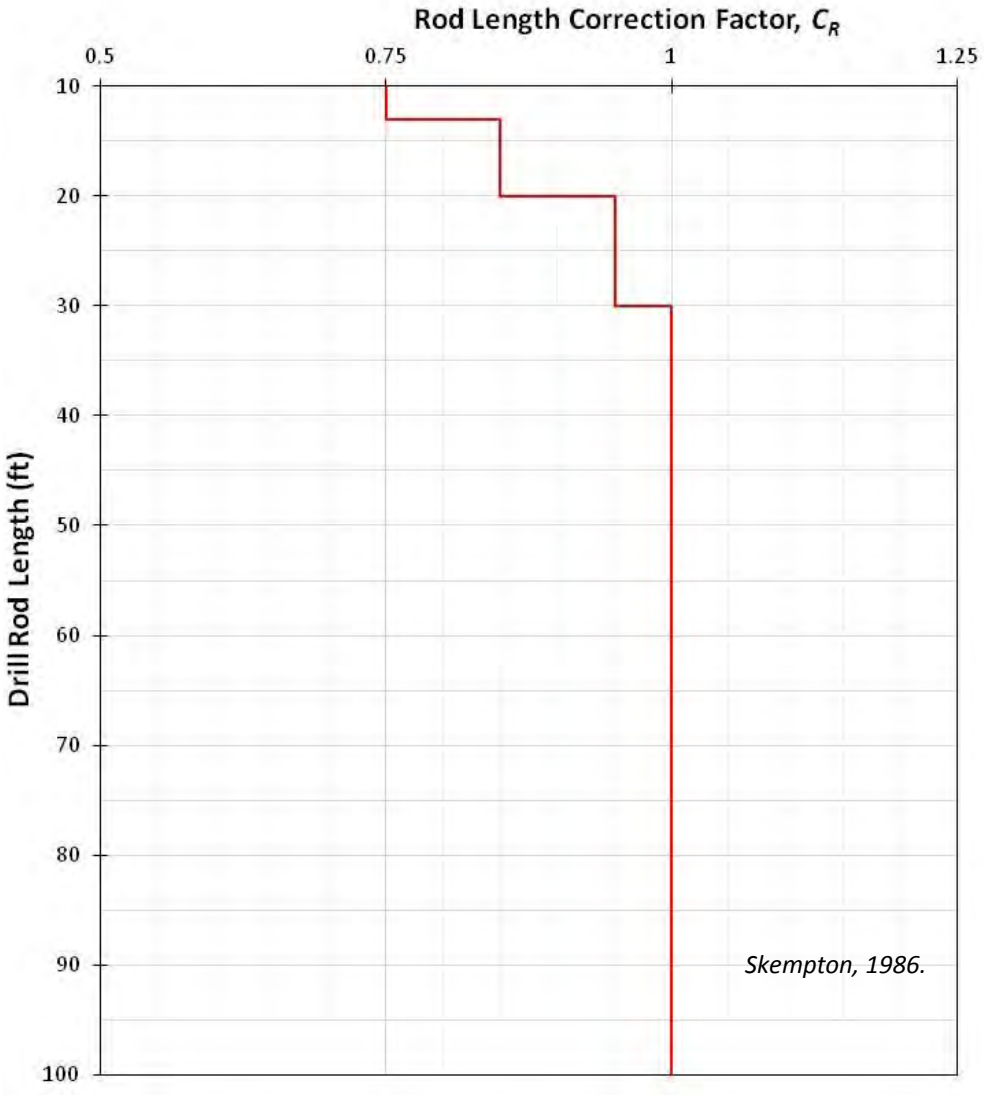
= Approx. Culvert Location

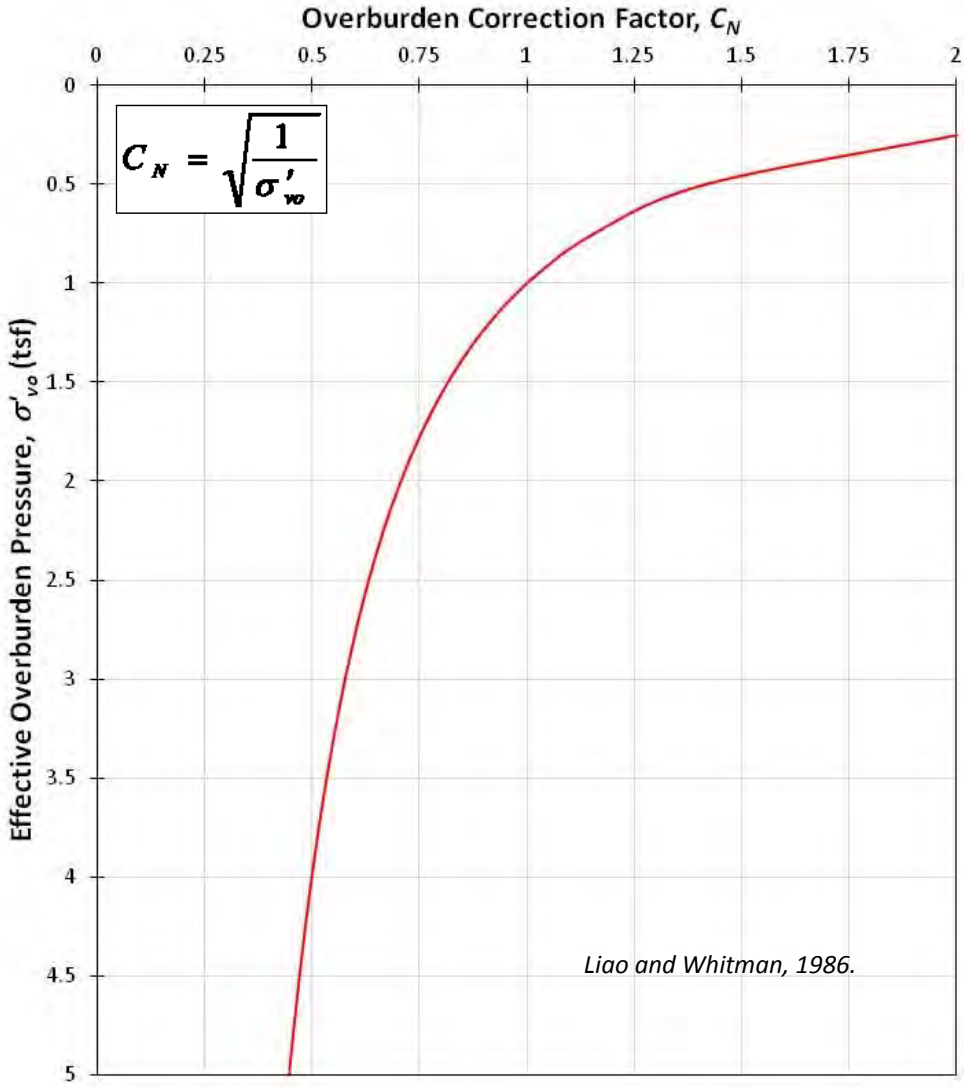
= Approx. Borehole Location

N

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: SITE CAB 2	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5638-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 12





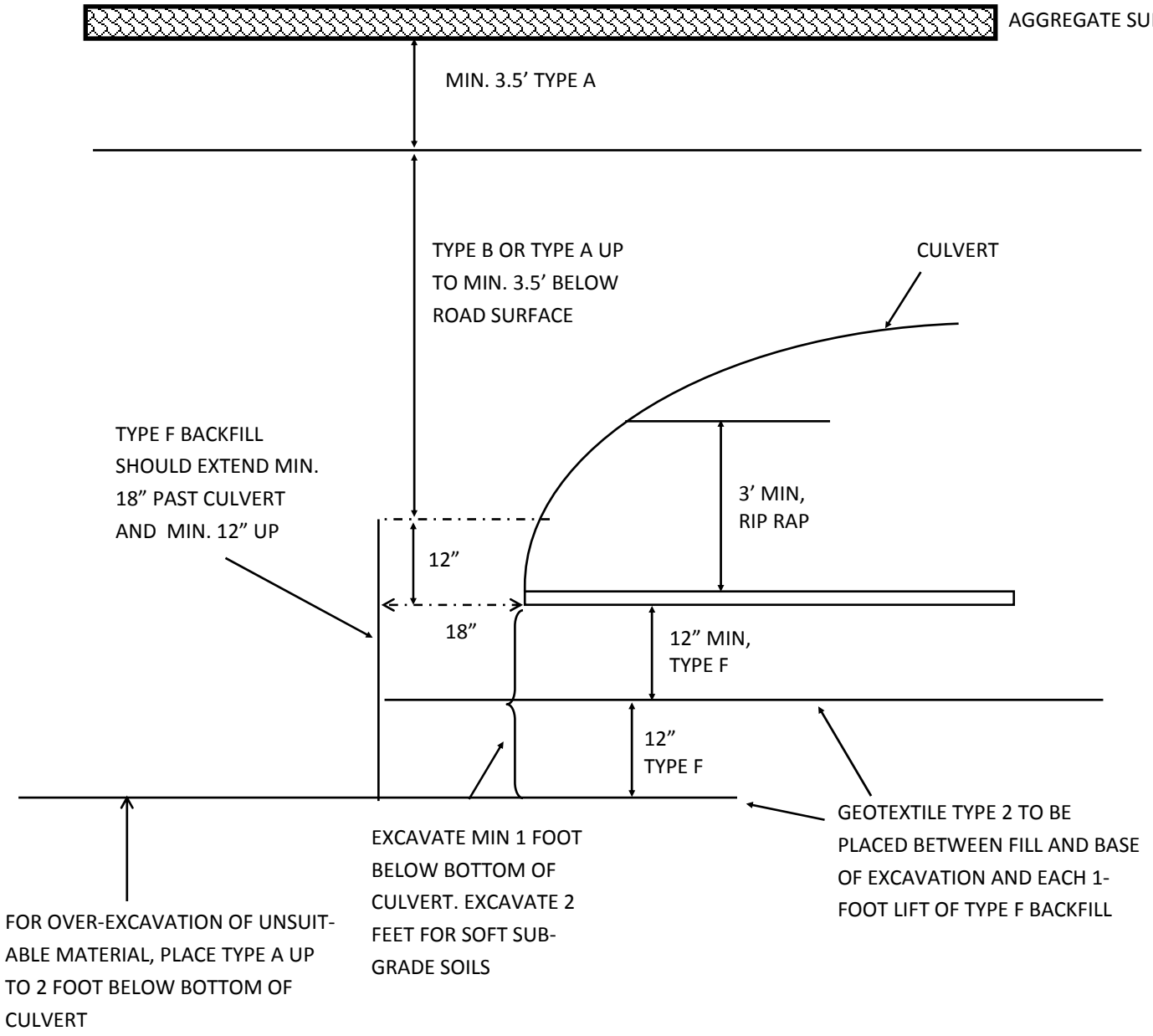
Notes:

- Overburden correction factor is used only for cohesionless soils
- C_N is the ratio of the measured blow count to what the blow count would be at an overburden pressure of 1 ton/ft^2
- σ'_{vo} is the effective overburden pressure at the point of measurement (ton/ft^2)

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: BLOW COUNT CORRECTIONS		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5138-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 13

*DRAWING NOT TO SCALE



*ALL FILL SHOULD BE PLACED IN 6-INCH LIFTS AND COMPACTED TO A MINIMUM 95% OF THE MODIFIED PROCTOR DENSITY

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: EMBEDMENT AND BACKFILL DETAIL	
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS	PROJECT ID: 5138-18
PROJECT LOCATION: CORDOVA, ALASKA	FIGURE NUMBER: 14

AGGREGATE GRADATION FOR BASE AND SURFACE COURSE

SIEVE SIZE	GRADATION - % BY MASS PASSING			
	BASE - (C-1)	BASE - (D-1)	SURFACE - (E-1)	SURFACE - (F-1)
1-1/2”	100			
1”	70-100	100	100	100
3/4”	60-90	70-100	70-100	85-100
3/8”	45-75	50-80	50-85	60-100
#4	30-60	35-65	35-65	50-85
#8	22-52	20-50	20-50	40-70
#50	6-30	6-30	15-30	25-45
#200	0-6	0-6	8-15	8-20
0.02	0-3	0-3	0-3	0-3

MATERIALS LISTED ABOVE MUST CONSIST OF CRUSHED STONE OR CRUSHED GRAVEL CONSISTING OF SOUND, TOUGH, DURABLE PEBBLES OR ROCK FRAGMENTS OF UNIFORM QUALITY. MUST BE FREE FROM CLAY BALLS, VEGTABLE MATTER AND OTHER DELETERIOUS MATERIALS.

SELECTED MATERIAL

TYPE A. AGGREGATE CONTAINING NO MUCK, FROZEN MATERIAL, ROOTS, SOD OR OTHER DELETERIOUS MATTER AND WITH A PLASTICITY INDEX NOT GREATER THAN 6 AS TESTED BY ATM 204 AND ATM 205. MEET THE FOLLOWING GRADATION AS TESTED BY ATM 304:

SIEVE	% BY MASS PASSING
#4	20-60
#200*	0-6

TYPE B. AGGREGATE CONTAINING NO MUCK, FROZEN MATERIAL, ROOTS, SOD OR OTHER DELETERIOUS MATTER AND WITH A PLASTICITY INDEX NOT GREATER THAN 6 AS TESTED BY ATM 204 AND ATM 205. MEET THE FOLLOWING GRADATION AS TESTED BY ATM 304:

SIEVE	% BY MASS PASSING
#200*	0-10

TYPE F. AGGREGATE CONTAINING NO MUCK, FROZEN MATERIALS, ROOTS, SOD OR OTHER DELETERIOUS MATTER AND WITH A PLASTICITY INDEX NOT GREATER THAN 6 AS TESTED BY ATM 204 AND ATM 205. MEET THE FOLLOWING GRADATIONS AS TESTED BY ATM 304:

SIEVE	% PASSING BY WEIGHT
2”	100%
#4	15-65%
#200	0-6%

* GRADATION SHALL BE DETERMINED ON THAT PORTION PASSING THE 3” SCREEN

AGGREGATE GRADATION FOR SUBBASE

SIEVE SIZE	GRADATION - % BY MASS PASSING				
	A	B	C	D	E
4”	100	--	--	--	--
2”	85-100	100	--	--	--
1”	--	--	100	--	--
3/4”	--	--	--	100	--
#4	15-60	15-60	40-75	45-80	--
#16	--	--	20-43	23-50	--
#200*	0-10	0-6	4-10	4-12	0-6
0.02*	0-3	0-3	0-3	0-3	0-3

* GRADATION SHALL BE DETERMINED ON THAT PORTION PASSING THE 3” SCREEN

MODIFIED FROM SECTIONS 703-2.03, 703-2.07 AND 703-2.9 OF AK DOT & PF STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION - 2015

TABLE 729-1

GEOTEXTILE REINFORCEMENT PROPERTIES

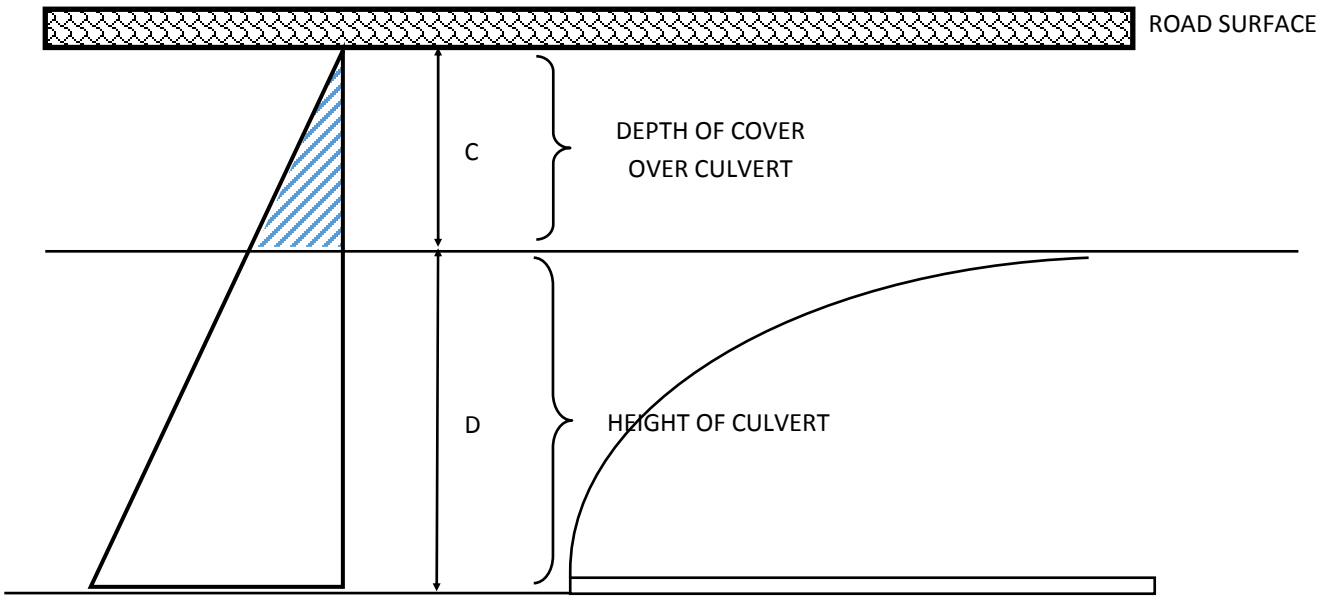
Property	Test Method	Units	Requirements[a]
			Type 2
Grab Tensile	ASTM D4632	lb.	400/400
Grab Elongation	ASTM D4632	% (MD)	10
Wide Width Tensile	ASTM D4595	lb/in. (ultimate)	400/400
Wide Width Tensile	ASTM D4595	lb/in. (@ 5% strain)	200/200
Seam Breaking Strength	ASTM D4632	lb./in.	360
Puncture	ASTM D6241	lb.	1500
Trapezoidal Tear	ASTM D4533	lb.	150
AOS	ASTM D4751	U.S. sieve size	#30[b]
Permittivity	ASTM D4491	sec^{-1}	0.40
Flow Rate	ASTM D4491	$gal./min./ft^2$	10

[a] Minimum Average Roll Values (MARV) in machine direction (MD) / cross-machine direction (XD) unless otherwise specified.

[b] Maximum average roll value

*SPECIFICATION PER ADOT, NRMS FOR TYPE 2 GEOTEXTILE

*DRAWING NOT TO SCALE



THE LATERAL RESISTANCE OF THE SOILS CAN BE DETERMINED BY THE FOLLOWING EQUATION:

$$P_0 = 118 * \frac{(C+D)^2}{2} - 118 * \frac{C^2}{2}$$

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: LATERAL RESISTANCE		
PROJECT NAME: USFWS FISH PASSAGE IMPROVEMENTS		PROJECT ID: 5138-18
PROJECT LOCATION: CORDOVA, ALASKA		FIGURE NUMBER: 17

APPENDIX A

GRAPHICAL BOREHOLE LOGS

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 1A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 2
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 6.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 50°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, brown - gray, moist to wet									
					S1	7	5 4 5	15		S1	S1 MC = 2.5% 49.3% gravel, 45.4% sand, 5.3% silt	Rock in sampler.
5			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), loose, brown - gray, moist to wet ▽		S2	8	4 3 1	5		S2	S2 MC = 6.0% 46.3% gravel, 48.3% sand, 5.4% silt	
			WELL GRADED SAND WITH GRAVEL (SW), loose, brown - gray, moist to wet		S3	6	10 5 4	10		S3	S3 MC = 8.5% 37.0% gravel, 58.6% sand, 4.4% silt P0.02 = 2.3% FC = NFS	Some fines washed out.
10			**POORLY GRADED SAND WITH SILT** (SP-SM), trace organics, medium dense to loose, dark gray, some fine sand lenses		S4	9	6 6 6	13		S4	S4 MC = 12.0% OC = 2.0%	
			Less silt		S5	5	10 5 3	9		S5	S5 MC = 12.5%	
15			Less silt		S6	6	6 4 4	9		S6	S6 MC = 11.1%	
20			**SILT** (ML), trace organics, stiff, gray, wet		S7	10	11 5 5	11		S7	S7 MC = 24.9% P200 = 73.2%	

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 1A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 1A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1A Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 1A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1A Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 1B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 2
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 7.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 50°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), dense, brown - gray, damp to wet								
					S1	5	6 7 9	26		S1	S1 MC = 8.5% 46.8% gravel, 43.9% sand, 9.3% silt
5			**SILTY SAND WITH GRAVEL** (SM), medium dense, brown - gray, damp to wet								
					S2	6	15 7 6	17		S2	S2 MC = 4.1% 21.5% gravel, 63.4% sand, 15.1% silt
			▽ **WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), loose, gray, wet								
					S3	12	11 4 5	10		S3	S3 MC = 9.3% 38.2% gravel, 52.7% sand, 9.1% silt P0.02 = 6.3% FC = F2
10			**SANDY SILT** (ML), trace organics, stiff, gray, wet								
					S4	12	6 5 4	10		S4	S4 MC = 25.3% 0.8% gravel, 36.0% sand, 63.2% silt P0.02 = 24.8% FC = F4
			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), loose to medium dense, dark gray, wet								
					S5	5	3 2 5	8		S5	S5 MC = 12.5%
15			Trace organics								
					S6	9	5 7 5	13		S6	S6 MC = 11.4%
20											
			SILT (ML), stiff, gray, wet		S7	9	9 5 6	13		S7	S7 MC = 29.1% P200 = 87.2%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 1B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 1B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1B Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 1B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 1B

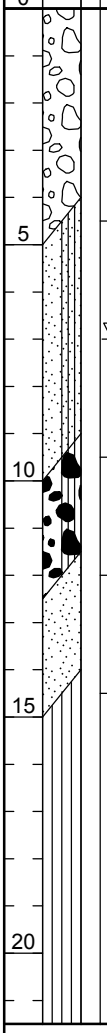
CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 1B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 9A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 5
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): Approx. 7.0 ft bgs
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 45°F



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0	**POORLY GRADED GRAVEL WITH SAND** (GP), dense, gray - brown, moist to wet								
			S1	12	5 10 10	33		S1	S1 MC = 7.7% 50.4% gravel, 45.2% sand, 4.4% silt
5	**POORLY GRADED SAND WITH SILT AND GRAVEL** (SP-SM), medium dense, gray - brown, moist to wet		S2	11	13 8 6	18		S2	S2 MC = 3.8% 39.4% gravel, 53.2% sand, 7.4% silt
	▽		S3	10	4 5 6	13		S3	S3 MC = 6.0%
10	**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, gray - brown, moist to wet		S4	9	7 8 15	25		S4	S4 MC = 6.8% 50.1% gravel, 44.3% sand, 5.6% silt P0.02 = 4.1% FC = S1
	POORLY GRADED SAND WITH GRAVEL (SP), medium dense, dark gray, wet		S5	6	10 10 6	18		S5	S5 MC = 7.0%
15	**SANDY SILT** (ML), trace organics, medium stiff to soft, gray, wet		S6	7	3 2 3	5		S6	S6 MC = 30.7% P200 = 57.5%
20			S7	9	2 1 2	3		S7	S7 MC = 32.4%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

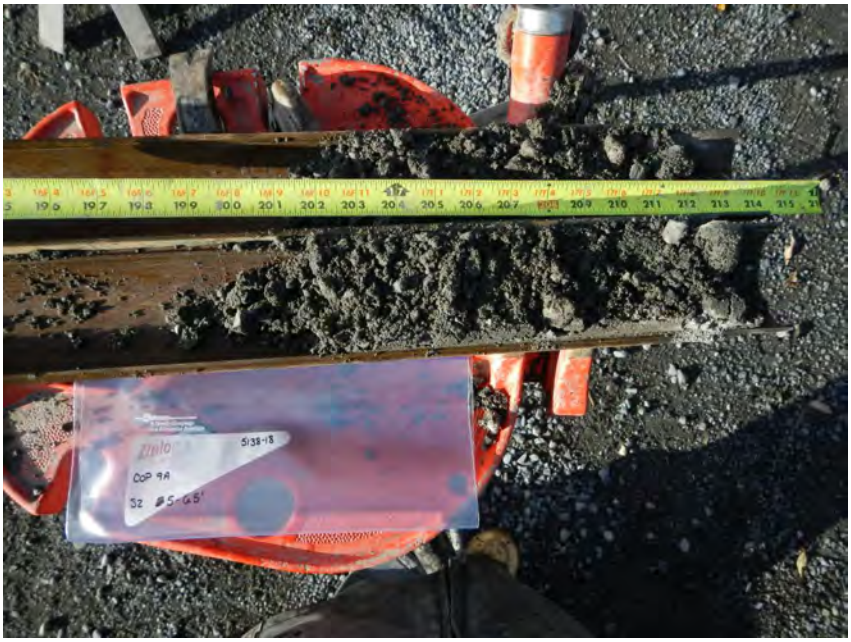
Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9A

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 9A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

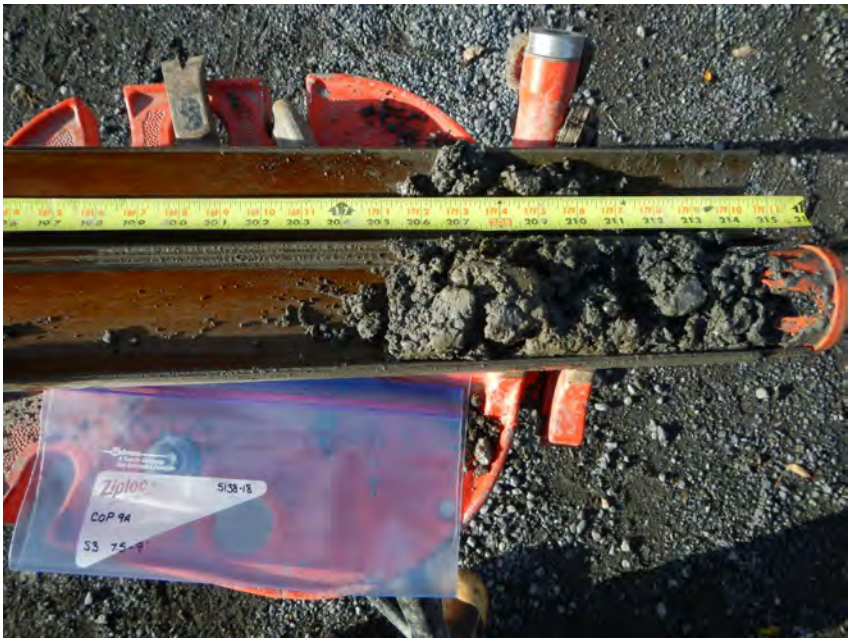


Exploration COP 9A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration COP 9A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 9A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 9A Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 9A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 9A Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 9B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 5
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): Approx. 9.0 ft bgs
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), dense to medium dense, brown - gray, moist to wet									
					S1	14	7 12 12	40		S1	S1 MC = 2.5% 48.6% gravel, 45.3% sand, 6.1% silt	
5					S2	6	10 8 8	21		S2	S2 MC = 3.8% 56.4% gravel, 35.5% sand, 8.1% silt	Rock in sampler.
					S3	11	19 8 6	15		S3	S3 MC = 3.7%	
10					S4	13	13 19 20	39		S4	S4 MC = 6.4% 50.5% gravel, 42.8% sand, 6.7% silt P0.02 = 4.5% FC = S1	
			SILTY SAND (SM), medium dense to loose, gray, wet, fine to medium grained		S5	13	16 8 9	17		S5	S5 MC = 24.3%	
15					S6	12	6 3 4	7		S6	S6 MC = 19.3%	
20			Tan/brown organic lens		S7	10	3 2 1	3		S7	S7 MC = 38.3%	

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 9B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 9B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 9B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 9B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 9B Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 9B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 9B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 9B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 20A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 6
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 5.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**POORLY GRADED GRAVEL WITH SAND** (GP), medium dense, brown - gray, moist									
					S1	11	5 5 5	17		S1	S1 MC = 2.4% 71.0% gravel, 24.9% sand, 4.1% silt	
5			▽ **WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, brown - gray, moist		S2	8	6 8 8	21		S2	S2 MC = 6.4% 49.8% gravel, 43.5% sand, 6.7% silt	
			WELL GRADED SAND WITH GRAVEL (SW), medium dense, dark gray - brown, wet		S3	7	8 5 4	11		S3	S3 MC = 8.2% 34.0% gravel, 61.1% sand, 4.9% silt P0.02 = 3.1% FC = S2	
10			**WELL GRADED GRAVEL WITH SAND** (GW), loose, dark gray, wet		S4	6	11 3 2	6		S4		
				○	S5	0	6 2 1	N/A		S5	S4 MC = 5.9% 69.2% gravel, 29.8% sand, 1.0% silt	
15					S6	4	2 0 1	1		S6	S6 MC = 10.1%	
20			Bottom of borehole at 20.0 ft bgs.									Approx. 2' of sand heave. Sampler stuck in auger, no sample attempted.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

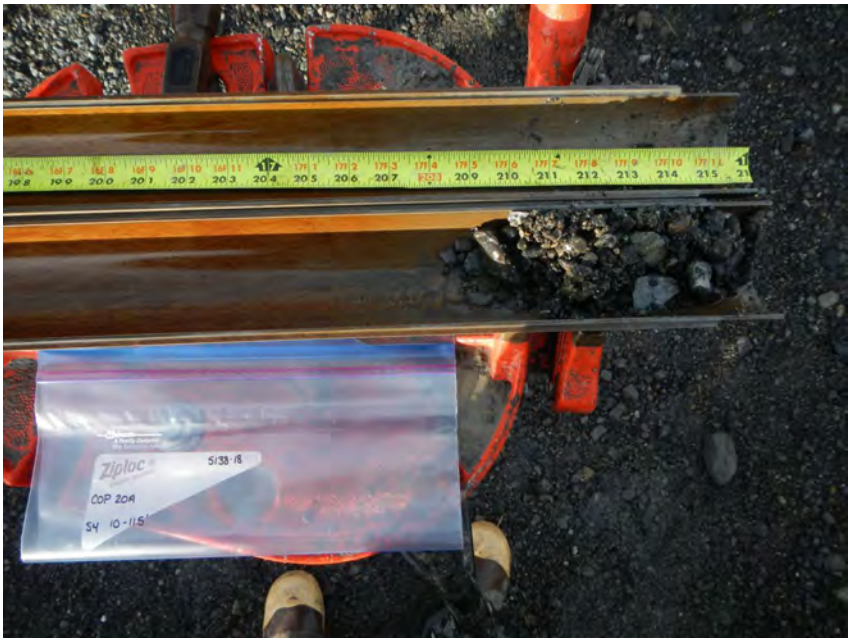
Exploration COP 20A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20A Sample S3
Sample Interval 7.5 - 9.0 ft bgs



Exploration COP 20A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 20B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 6
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 6.3 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), medium dense to loose, gray - brown, moist								
					S1	12	4 4 3	12		S1	S1 MC = 3.3%
5											
			▽		S2	10	8 4 3	9		S2	S2 MC = 5.7% 39.6% gravel, 51.5% sand, 8.9% silt
			POORLY GRADED SAND WITH GRAVEL (SP), medium dense, dark gray, wet		S3	9	10 6 5	13		S3	S3 MC = 9.1% 40.0% gravel, 55.3% sand, 4.7% silt P0.02 = 2.6% FC = NFS
10			**WELL GRADED GRAVEL WITH SAND** (GW), loose to medium dense, dark gray, wet, rounded gravel		S4	8	13 5 4	10		S4	S4 MC = 7.0% 55.1% gravel, 42.1% sand, 2.8% silt P0.02 = 1.7% FC = PFS
					S5	9	4 5 5	11		S5	S5 MC = 9.5%
15			**WELL GRADED SAND WITH GRAVEL** (SW), loose to very loose, dark gray, wet, organic lens		S6	8	5 3 6	9		S6	S6 MC = 11.8% 34.8% gravel, 60.4% sand, 4.8% silt
20					S7	8	8 2 2	4		S7	S7 MC = 14.5%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 20B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 20B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 20B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20B Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 20B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 20B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 20B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 22A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 7
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 7.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), medium dense to loose, gray - brown, moist									
					S1	7	16 4 5	15		S1	S1 MC = 4.1%	
5					S2	9	5 3 2	7		S2	S2 MC = 4.0% 44.7% gravel, 49.5% sand, 5.8% silt	
			▽ **WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, grayish brown to brown, wet to saturated		S3	12	12 7 9	18		S3	S3 MC = 5.8% 56.0% gravel, 38.0% sand, 6.0% silt	
10					S4	10	18 10 7	18		S4	S4 MC = 6.6% 51.1% gravel, 43.4% sand, 5.5% silt P0.02 = 3.2% FC = S1	
			WELL GRADED GRAVEL WITH SAND (GW), medium dense, dark gray, wet		S5	8	18 9 9	20		S5	S5 MC = 5.1%	
15					S6	9	20 8 9	17		S6	S6 MC = 4.1% 51.8% gravel, 47.2% sand, 1.0% silt	
20			Bottom of borehole at 20.0 ft bgs.									Approx. 5' of sand heave, no sample collected.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 22A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 22A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22A Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 22A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 22B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/14/2018
DATE COMPLETED: 10/14/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 7
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 6.5 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Clear, 40°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, gray - brown, moist to wet									
					S1	8	3 4 3	12		S1	S1 MC = 7.1% 52.7% gravel, 41.3% sand, 6.0% silt	
5			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), loose to medium dense, moist to wet		S2	8	6 3 3	8		S2	S2 MC = 8.7% 36.3% gravel, 54.0% sand, 9.7% silt	
			▽		S3	11	5 6 6	14		S3	S3 MC = 7.0% 41.5% gravel, 52.2% sand, 6.3% silt P0.02 = 4.3% FC = S2	
10			**WELL GRADED GRAVEL WITH SAND** (GW), medium dense, dark gray, wet		S4	9	17 6 6	13		S4	S4 MC = 6.4% 53.8% gravel, 42.2% sand, 4.0% silt P0.02 = 2.6% FC = PFS	
			POORLY GRADED SAND WITH GRAVEL (SP), dense to loose, dark gray		S5	6	13 13 11	27		S5	S5 MC = 10.4%	Fine grains possibly washed out.
15					S6	6	5 7 2	10		S6	S6 MC = 9.1%	
20			Fine sand lens		S7	5	5 4 12	18		S7	S7 MC = 9.1%	

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 22B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

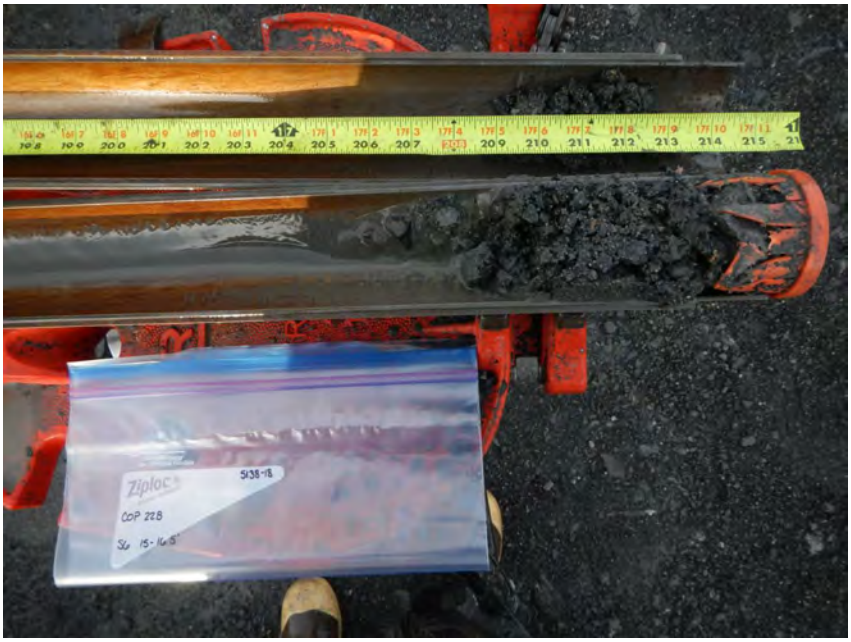
Exploration COP 22B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22B Sample S5
Sample Interval 12.5 - 14.0 ft bgs



Exploration COP 22B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 22B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 22B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 25A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 8
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 5.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SAND** (GW), loose, brown - gray, damp								
					S1	7	7 3 3	10		S1	S1 MC = 3.4% 53.1% gravel, 42.8% sand, 4.1% silt
5			▽ **WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), very loose, damp								
					S2	7	3 1 1	3		S2	S2 MC = 4.7% 39.7% gravel, 54.8% sand, 5.5% silt
			WELL GRADED SAND WITH GRAVEL (SW), loose, gray - brown, wet								
					S3	5	6 3 5	10		S3	S3 MC = 8.1% 44.2% gravel, 54.6% sand, 1.2% silt
10			**WELL GRADED GRAVEL WITH SAND** (GW), medium dense, gray - brown, wet, washed								
					S4	4	20 8 8	17		S4	P0.02 = 0.9% FC = NFS
											S4 MC = 3.7%
					S5	6	10 3 4	8		S5	S5 MC = 6.8% 52.2% gravel, 46.1% sand, 1.7% silt
15			**POORLY GRADED SAND** (SP), some gravel, medium dense, gray, wet, medium to coarse grained								
					S6	9	6 5 5	11		S6	S6 MC = 13.1%
			SAND WITH SILT AND GRAVEL (SP-SM), medium dense, gray - brown, wet								
20					S7	8	9 5 8	15		S7	S7 MC = 8.8% P200 = 10.6%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 25A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 25A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25A Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 25A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25A Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 25B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 8
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 7.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**POORLY GRADED SAND WITH SILT AND GRAVEL** (SP-SM), medium dense to very loose, brown - gray, moist to wet								
					S1	5	8 5 4	15		S1	S1 MC = 6.8%
5					S2	9	5 1 1	3		S2	S2 MC = 3.2% 38.1% gravel, 54.6% sand, 7.3% silt
			▽ **POORLY GRADED SAND WITH GRAVEL TO WELL GRADED SAND WITH GRAVEL** (SP/SW), very loose to loose, moist to wet		S3	7	2 1 2	3		S3	S3 MC = 8.5% 39.8% gravel, 56.9% sand, 3.3% silt
10					S4	7	4 2 4	6		S4	S4 MC = 8.1% 41.1% gravel, 56.8% sand, 2.1% silt
					S5	6	8 4 4	9		S5	P0.02 = 1.7% FC = NFS S5 MC = 8.1%
15			**POORLY GRADED SAND WITH SILT** (SP-SM), gray, wet								
			PEAT (PT), red - brown, fibrous, wet		S6	12	2 3 2	5		S6	S6 MC = 221.6%
20			**POORLY GRADED SAND WITH SILT** (SP-SM), loose, gray, wet		S7	9	3 5 4	10		S7	S7 MC = 11.5%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 25B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 25B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 25B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25B Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 25B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 25B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 25B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 33A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 9
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 7.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SAND** (GW), very loose, brown - gray, wet, angular gravel								
5				○	S1	0	4 4 3	N/A			
		▽									
10				✕	S2	9	4 2 1	3	■	S2	S2 MC = 5.2% 70.6% gravel, 25.6% sand, 3.8% silt P0.02 = 2.1% FC = PFS
			SILTY SAND (SM), very loose, brown, wet, red-brown organic lens	✕	S3	6	3 0 1	1	■	S3	S3 MC = 71.2% 11.2% gravel, 40.9% sand, 47.9% silt
15			**POORLY GRADED SAND WITH SILT AND GRAVEL** (SP-SM), very loose, gray brown, wet	✕	S4	4	1 1 1	2	■	S4	S4 MC = 20.7%
			(WOOD), decomposing wood debris								
			SILT (ML), very loose, gray, wet	✕	S5	7	3 3 1	4	■	S5	S5 MC = 34.0% P200 = 85.2%
20			**SILTY SAND** (SM), loose, gray - brown, wet	✕	S6	4	2 1 4	6	■	S6	S6 MC = 24.1%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 33A Sample S2
Sample Interval 10.0 - 11.5 ft bgs

Exploration COP 33A Sample S3
Sample Interval 12.5 - 14.0 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 33A Sample S4
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 33A Sample S5
Sample Interval 17.5 - 19.0 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 33A Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 33B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 9
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 7.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**POORLY GRADED GRAVEL WITH SILT AND SAND** (GP-GM), brown - gray, moist									
			SILTY SAND WITH GRAVEL (SM), loose, brown - gray, moist									
5					S1	6	6 3 2	7		S1	S1 MC = 10.1% 42.0% gravel, 45.2% sand, 12.8% silt	
			▽									
			GRAVEL WITH SILT AND SAND (GP-GM), loose, gray - brown, wet, angular gravel									
10					S2	6	6 3 2	5		S2	S2 MC = 8.6% 62.3% gravel, 29.9% sand, 7.8% silt P0.02 = 5.1% FC = S1	
			POORLY GRADED SAND WITH GRAVEL (SP), medium dense, gray - brown, wet, subrounded gravel		S3	2	8 9 5	16		S3	S3 MC = 21.5%	
15			**SILTY SAND** (SM), loose, gray, wet		S4	6	4 2 4	6		S4A S4B	S4A MC = 24.6% S4B MC = 20.2%	
			SILTY GRAVEL (GM), very loose, gray, wet		S5	5	3 1 2	3		S5	S5 MC = 26.4% OC = 5.4%	Woody debris in sampler shoe.
20			**POORLY GRADED SAND WITH SILT** (SP-SM), loose, gray, wet, angular gravel		S6	12	2 3 6	9		S6	S6 MC = 19.2%	
			POORLY GRADED GRAVEL WITH SILT (GP-GM), loose, gray, wet									

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

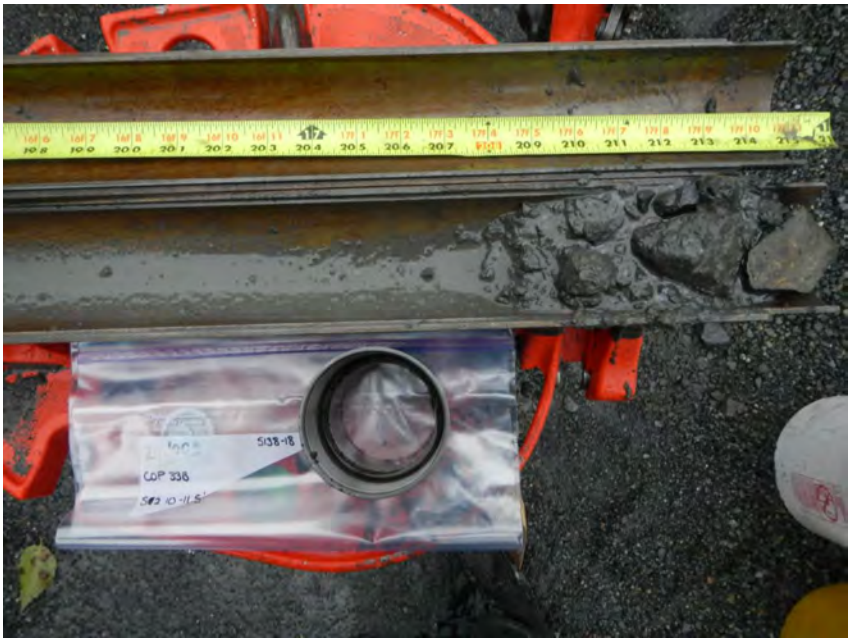
Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 33B Sample S1
Sample Interval 5.0 - 6.5 ft bgs



Exploration COP 33B Sample S2
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

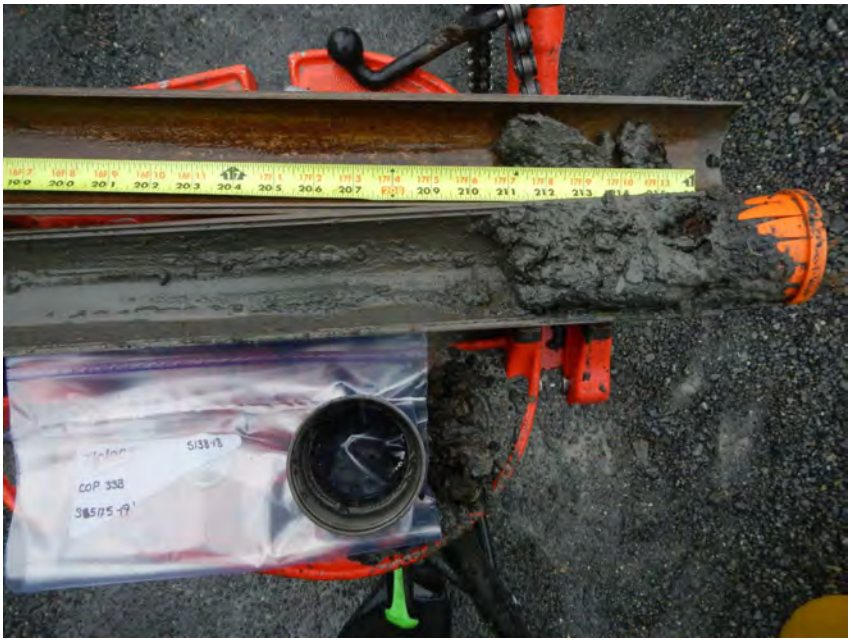
Exploration COP 33B Sample S3
Sample Interval 12.5 - 14.0 ft bgs

Exploration COP 33B Sample S4
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 33B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration COP 33B Sample S5
Sample Interval 17.5 - 19.0 ft bgs

Exploration COP 33B Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 43A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/12/2018
DATE COMPLETED: 10/12/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 10
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 3.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED SAND WITH GRAVEL** (SW), medium dense to loose, gray - brown, wet									
			▽		S1	14	7 7 6	21		S1	S1 MC = 7.4% 41.5% gravel, 55.0% sand, 3.5% silt	
5					S2	9	6 4 2	9		S2	S2 MC = 9.8%	
			SILTY SAND (SM), with organics, loose, gray, wet		S3	6	1 3 4	9		S3	S3 MC = 17.9% 3.2% gravel, 80.4% sand, 16.4% silt P0.02 = 5.9% FC = F2	
10					S4	10	3 4 3	9		S4	S4 MC = 16.9%	Fine grains possibly washed out.
			SILTY GRAVEL (GM)									
			SILTY SAND (SM), loose to medium dense, gray, wet, brown-red lens									
15					S5	9	4 3 4	9		S5	S5 MC = 26.1% P200 = 24.4%	
20					S6		5 4 5	11		S6	S6 MC = 20.2% P200 = 23.5%	

Bottom of borehole at 21.5 ft bgs.

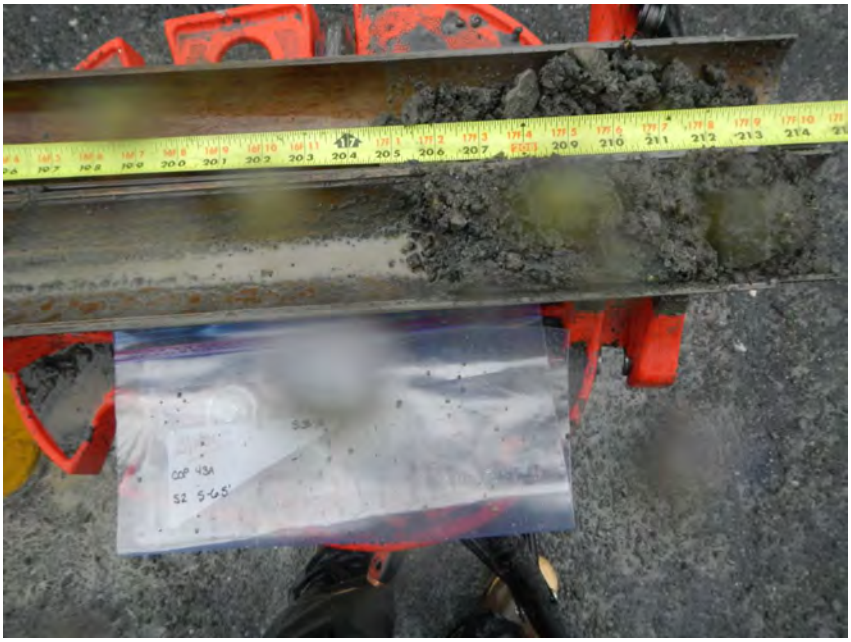
Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43A Sample S1
Sample Interval 2.5 - 4.0 ft bgs



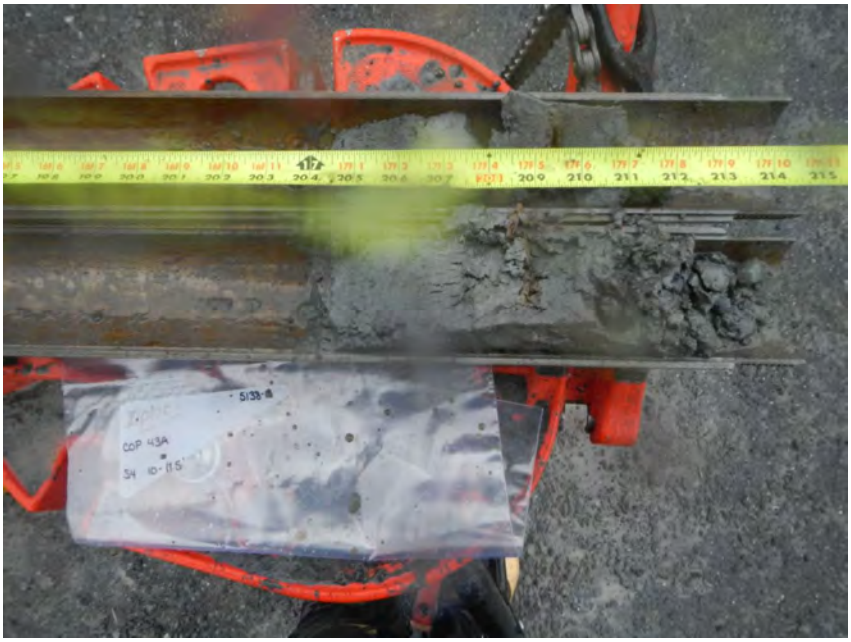
Exploration COP 43A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43A Sample S3
Sample Interval 7.5 - 9.0 ft bgs



Exploration COP 43A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43A Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 43A Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 43B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/13/2018
DATE COMPLETED: 10/13/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 10
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 3.0 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Light Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), medium dense, gray, wet								
			▽		S1	11	4 6 5	18		S1	S1 MC = 7.3% 48.6% gravel, 45.8% sand, 5.6% silt
5			**WELL GRADED SAND WITH GRAVEL** (SW), medium dense, brown - gray, wet		S2	11	7 7 7	22		S2	S2 MC = 7.5% 42.3% gravel, 53.6% sand, 4.1% silt P0.02 = 2.6% FC = NFS
			SILTY SAND (SM), loose to very loose, gray, red-brown organic lens		S3	2	7 2 2	6		S3	S3 MC = 45.8% P200 = 30.9%
10					S4	9	1 1 2	4		S4	S4 MC = 46.5% 8.5% gravel, 74.3% sand, 17.2% silt P0.02 = 6.6% FC = F2
15					S5	8	2 2 3	6		S5	S5 MC = 27.4%
			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), medium dense, gray - brown, wet								
20					S6	7	7 6 4	11		S6	S6 MC = 7.3%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 43B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 43B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 43B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 43B Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 43B Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 44A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/12/2018
DATE COMPLETED: 10/12/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 11
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 2.5 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SAND** (GW), dense to medium dense, gray to brownish gray, wet								
			▽		S1	12	4 9 8	28		S1	S1 MC = 5.0% 57.6% gravel, 38.2% sand, 4.2% silt
5					S2	12	7 6 7	20		S2	S2 MC = 7.2% 47.6% gravel, 47.5% sand, 4.9% silt P0.02 = 3.2% FC = S1
					S3	6	16 7 6	17		S3	S3 MC = 6.7% 53.3% gravel, 43.2% sand, 3.5% silt
10			**POORLY GRADED SAND WITH SILT AND GRAVEL** (SP-SM), loose, red - brown, wet		S4	7	4 3 2	6		S4	S4 MC = 8.9%
			SANDY SILT (ML), very soft to medium stiff, gray, wet, organic lens								
15					S5	6	1 0 1	1		S5	S5 MC = 26.9% P200 = 62.7%
20			Organic lens		S6	12	1 3 3	8		S6	S6 MC = 31.8%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44A

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 44A Sample S1
Sample Interval 2.5 - 5.0 ft bgs

Exploration COP 44A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 44A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 44A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44A

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration COP 44A Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 44A Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 44B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/12/2018
DATE COMPLETED: 10/12/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 11
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 2.5 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SAND** (GW), very dense, gray, wet, fractured								
			▽		S1	12	15 21 11	53		S1	S1 MC = 8.0% 58.9% gravel, 36.3% sand, 4.8% silt
5			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), medium dense, gray, wet, fractured to subrounded		S2	12	7 8 7	22		S2	S2 MC = 7.7% 47.1% gravel, 47.7% sand, 5.2% silt P0.02 = 3.6% FC = S2
					S3	9	10 8 8	21		S3	
10			**POORLY GRADED SAND WITH GRAVEL** (SP), loose, red - brown		S4	8	5 4 4	9		S4	S3 MC = 8.6% S4 MC = 9.3% 43.9% gravel, 53.7% sand, 2.4% silt
			SILTY SAND (SM), trace gravel, very loose to loose, gray, wet								
15					S5	10	1 1 1	2		S5	S5 MC = 25.8% P200 = 20.1%
20			No gravel		S6	10	4 3 3	8		S6	S6 MC = 23.8%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 44B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 44B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 44B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 44B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 44B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 44B Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 44B Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 45A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/12/2018
DATE COMPLETED: 10/12/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 12
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 3.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 40°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), gray - brown									
			▽		S1	9	16 11 8	N/A*		S1	S1 MC = 7.6% 45.3% gravel, 47.7% sand, 7.0% silt	*Small hammer used, blow counts not representative.
5			**SILTY SAND** (SM), gray, wet		S2	6	7 5 3	N/A*		S2	S2 MC = 25.3% 2.9% gravel, 58.1% sand, 39.0% silt P0.02 = 12.0% FC = F2	*Small hammer used, blow counts not representative.
					S3	10	0 0 1	1		S3		Sampler sank 10" under weight of hammer.
10			**POORLY GRADED SAND** (SP), medium dense to loose, gray, wet		S4	13	2 5 10	20		S4A S4B	S3 MC = 29.2% S4A MC = 8.7% S4B MC = 20.4%	
			POORLY GRADED GRAVEL WITH SAND (GP), medium dense, red / brown, wet									
15					S5	10	8 10 9	23		S5	S5 MC = 7.1% 55.9% gravel, 42.2% sand, 1.9% silt	
			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), medium dense, gray, wet, coarse grained									
20					S6	5	2 6 7	15		S6	S6 MC = 15.5%	Rock in sampler, low recovery.

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 45A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 45A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 45A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 45A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 45A Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration COP 45A Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION COP 45B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/12/2018
DATE COMPLETED: 10/12/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 12
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 3.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 40°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**WELL GRADED GRAVEL WITH SAND** (GW), medium dense, gray - brown, wet									
			▽		S1	12	5 7 7	23		S1	S1 MC = 6.6% 54.3% gravel, 41.5% sand, 4.2% silt	
5			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), medium dense, gray, wet		S2	12	20 7 8	22		S2	S2 MC = 7.3% 44.4% gravel, 49.0% sand, 6.6% silt P0.02 = 4.7% FC = S2	
			POORLY GRADED SAND (SP), medium dense, gray - brown, wet, fine to coarse grained		S3	11	12 5 3	11		S3	S3 MC = 18.5%	
10			**SILTY SAND** (SM), very loose, gray, wet, red to brown organic lenses		S4	9	1 0 1	1		S4	S4 MC = 42.0% P200 = 34.7%	
			POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), medium dense, wet									
15					S5	12	11 8 5	15		S5	S5 MC = 6.9%	Smaller grain sizes washed out of sampler bottom.
20												Sand heave in auger, no sample attempted.

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration COP 45B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration COP 45B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

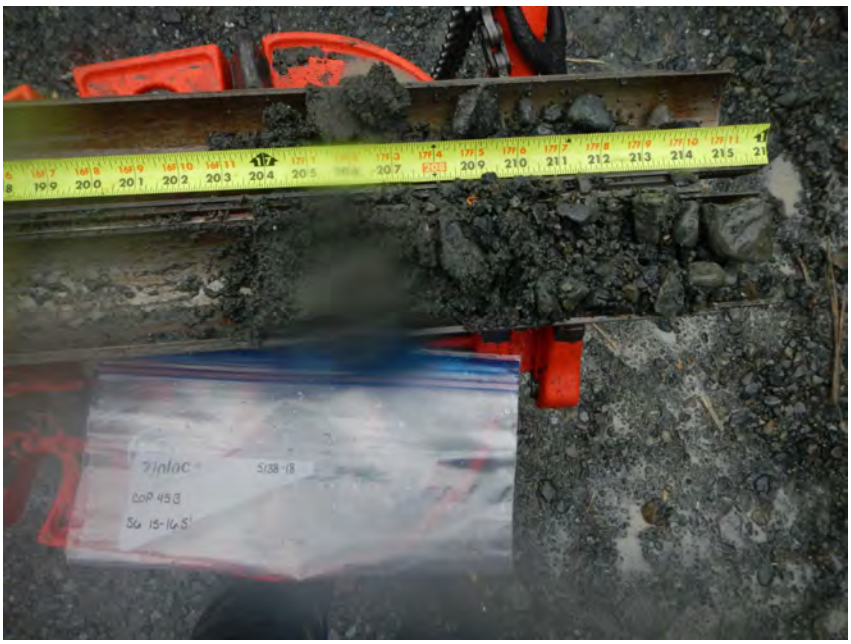
Exploration COP 45B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration COP 45B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION COP 45B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration COP 45B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION CAB 2A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/15/2018
DATE COMPLETED: 10/15/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 4
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): Approx. 4.5 ft bgs
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED GRAVEL WITH SILT AND SAND** (GW-GM), trace organics, medium dense, brown - gray, damp to wet								
					S1	9	7 5 3	13		S1	S1 MC = 10.5% 56.8% gravel, 36.1% sand, 7.1% silt
5			▽								
			Grades to gray		S2	10	3 4 4	11		S2	S2 MC = 10.1%
			WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM), loose, gray brown, wet		S3	7	5 2 3	6		S3	S3 MC = 12.0% 27.9% gravel, 64.7% sand, 7.4% silt P0.02 = 5.0% FC = S2
10					S4	7	4 3 4	8		S4	S4 MC = 7.6%
15					S5	10	9 2 2	5		S5	S5 MC = 26.4% P200 = 67.9%
			SANDY SILT (ML), medium stiff, gray, wet								
			SILTY SAND (SM), medium dense, gray, wet								
20					S6	8	10 9 6	19		S6	S6 MC = 11.7%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration CAB 2A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

Exploration CAB 2A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2A

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration CAB 2A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration CAB 2A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration CAB 2A Sample S5
Sample Interval 15.0 - 16.5 ft bgs

Exploration CAB 2A Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION CAB 2B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/15/2018
DATE COMPLETED: 10/15/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 4
GROUND ELEVATION: Not Known
▽ GROUNDWATER (ATD): Approx. 4.5 ft bgs
▼ GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**POORLY GRADED GRAVEL WITH SILT AND SAND** (GP-GM), brown - gray, moist								
			SILT WITH SAND (ML), medium dense, blue - gray, moist		S1	10	9 4 4	13		S1	S1 MC = 26.4% P200 = 64.2%
5			▽ **SILTY SAND WITH GRAVEL** (SM), medium dense, brown gray, moist to wet		S2	13	3 3 7	16		S2	S2 MC = 13.9%
			Wood								
			WELL GRADED GRAVEL WITH SAND (GW), medium dense, brown - gray, wet		S3	8	4 5 4	13		S3	S3 MC = 10.8% 48.0% gravel, 47.9% sand, 4.1% silt P0.02 = 2.4% FC = PFS
10					S4	8	5 3 4	9		S4	S4 MC = 11.0%
15			**SANDY SILT** (ML), stiff, gray, wet		S5	10	10 4 4	10		S5	S5 MC = 26.3% P200 = 60.1%
			SILTY SAND (SM), some gravel, medium dense, brown - gray, wet								
20					S6	8	6 8 8	20		S6	S6 MC = 10.6%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration CAB 2B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

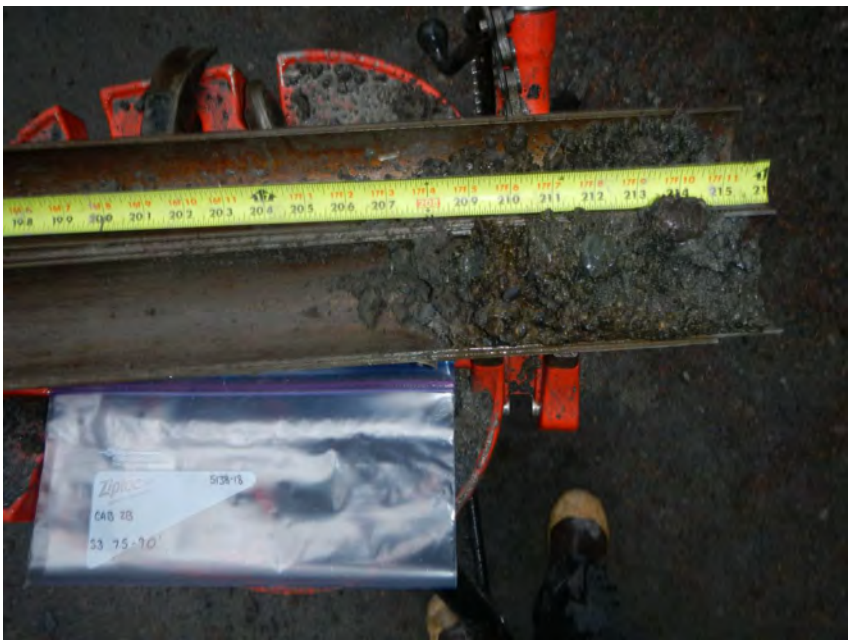
Exploration CAB 2B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK



Exploration CAB 2B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

Exploration CAB 2B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

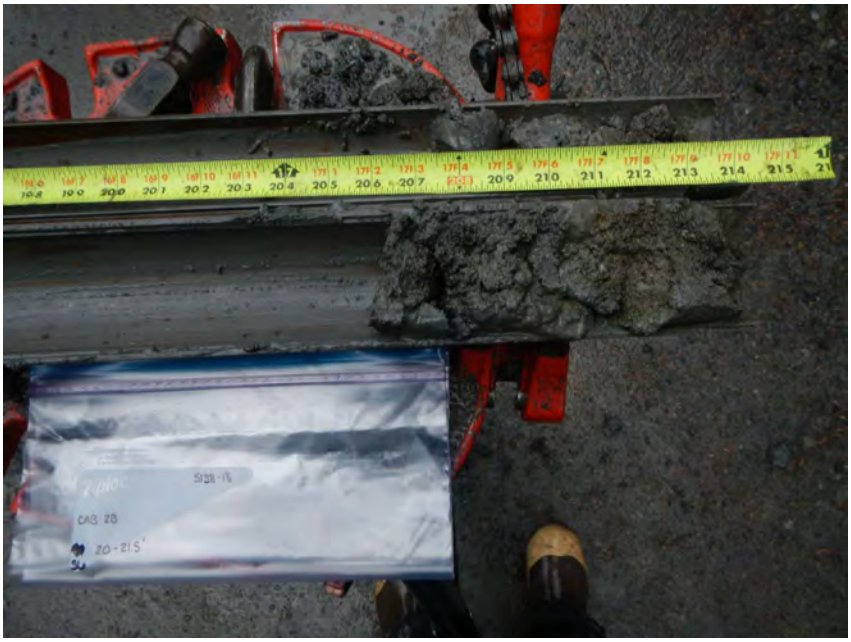
Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION CAB 2B

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

Exploration CAB 2B Sample S5
Sample Interval 15.0 - 16.5 ft bgs



Exploration CAB 2B Sample S6
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION SHER 1A

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/15/2018
DATE COMPLETED: 10/15/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 3
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** Approx. 6.0 ft bgs
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS	REMARKS/NOTES
0			**POORLY GRADED GRAVEL WITH SAND** (GP), medium dense, brown, damp									
					S1	8	3 4 9	21		S1	S1 MC = 4.7% 52.9% gravel, 44.3% sand, 2.8% silt	
5					S2	15	5 11 8	25		S2	S2 MC = 6.5%	
			WELL GRADED SAND WITH SILT (SW-SM), medium dense, brown to gray, fine to medium grained, silt lens		S3	12	12 6 7	16		S3	S3 MC = 16.4% 5.5% gravel, 83.9% sand, 10.6% silt P0.02 = 5.1% FC = S2	
10					S4	9	8 6 6	14		S4	S4 MC = 13.6%	Possible sand heave.
			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), loose to medium dense, gray, wet, silt lens		S5	6	4 3 4	9		S5	S5 MC = 10.6% 21.1% gravel, 68.7% sand, 10.2% silt P0.02 = 5.4% FC = S2	
15					S6	8	6 5 6	12		S6	S6 MC = 15.1%	
			POORLY GRADED SAND WITH SILT (SP-SM), loose, wet, fine grained									
20					S7		3 3 5	9		S7	S7 MC = 18.6%	

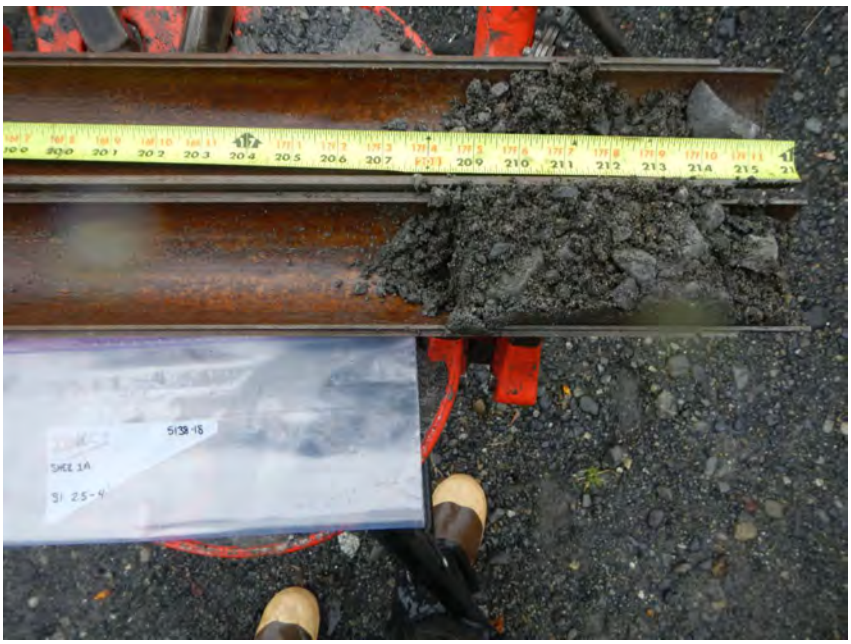
Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration SHER 1A Sample S1
Sample Interval 2.5 - 4.0 ft bgs

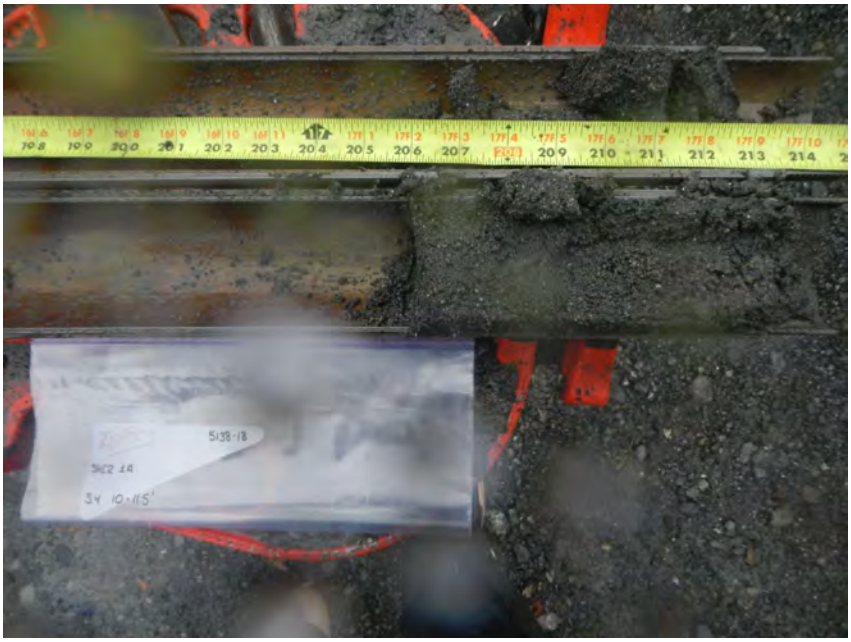
Exploration SHER 1A Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration SHER 1A Sample S3
Sample Interval 7.5 - 9.0 ft bgs

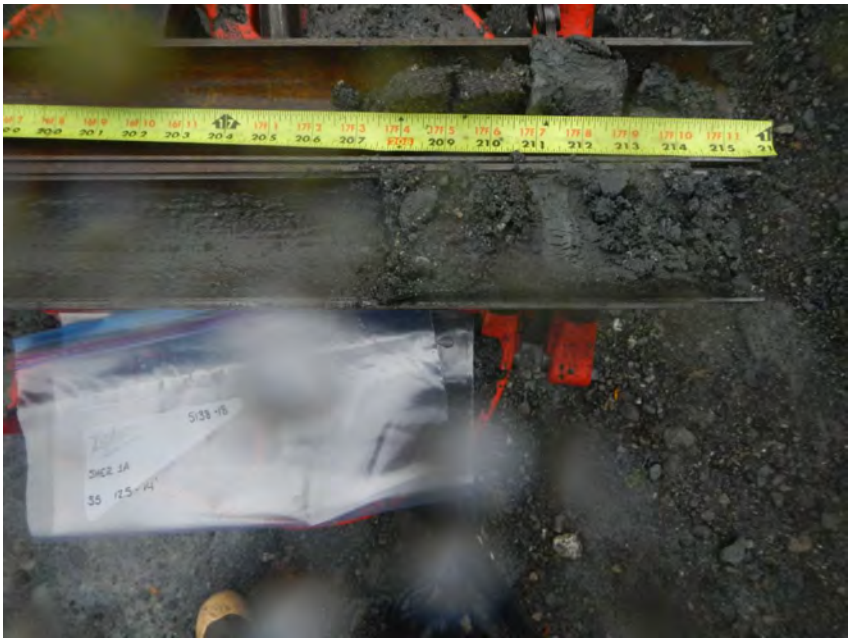


Exploration SHER 1A Sample S4
Sample Interval 10.0 - 11.5 ft bgs

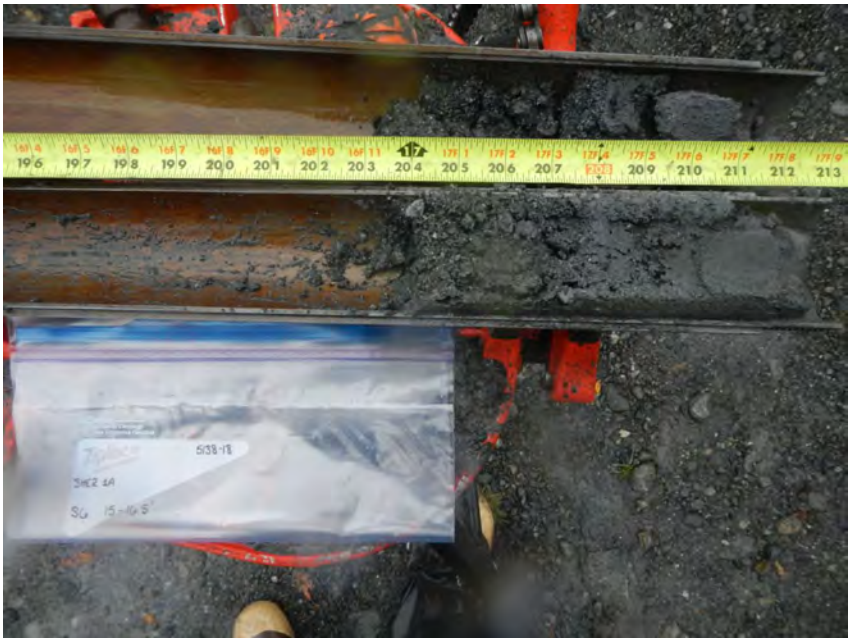
Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration SHER 1A Sample S5
Sample Interval 12.5 - 14.0 ft bgs

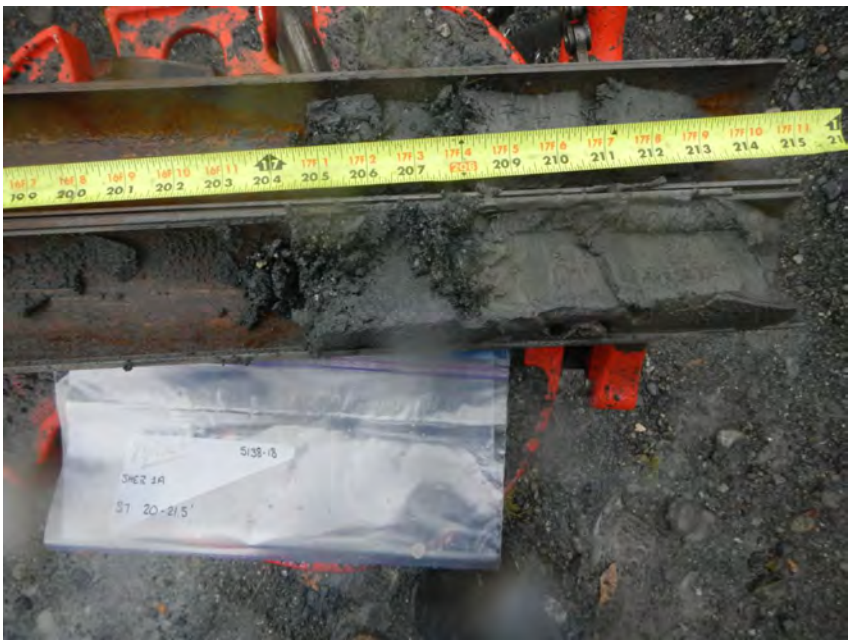


Exploration SHER 1A Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1A

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration SHER 1A Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION SHER 1B

NGE-TFT PROJECT NAME: USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER: 5138-18
PROJECT LOCATION: Copper River Hwy, Cordova, AK
EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
EXPLORATION EQUIPMENT: Truck-mounted CME 75
EXPLORATION METHOD: Hollow Stem Auger
SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
LOGGED BY: S. McCoy
DATE STARTED: 10/15/2018
DATE COMPLETED: 10/15/2018
EXPLORATION LOCATION: See report Figure 1 and Figure 3
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): Approx. 6.5 ft bgs
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with cuttings
WEATHER CONDITIONS: Overcast, Rain, 45°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	FIELD SAMPLE ID	RECOVERY (in)	FIELD BLOWS	$(N_1)_{60}$	SAMPLE INT. COLLECT	LAB SAMPLE ID	LAB RESULTS
0			**WELL GRADED SAND WITH SILT AND GRAVEL** (SW-SM), dense to medium dense, brown - gray, moist to wet								
					S1	13	19 11 13	40		S1	S1 MC = 8.5% 44.9% gravel, 49.2% sand, 5.9% silt
5					S2	12	23 8 7	20		S2	S2 MC = 4.7% 41.1% gravel, 50.5% sand, 8.4% silt
			▽ **SILTY SAND** (SM), medium dense, gray, wet		S3	5	12 7 6	15		S3	S3 MC = 7.7% 14.5% gravel, 69.2% sand, 16.3% silt P0.02 = 11.1% FC = F2
10			**POORLY GRADED SAND WITH GRAVEL** (SP), loose, dark gray, wet, coarse grained		S4	5	5 4 2	6		S4	S4 MC = 9.6%
			SILTY SAND (SM), loose, gray, wet		S5	7	5 1 4	6		S5	S5 MC = 20.0% P200 = 40.6%
15			**POORLY GRADED SAND** (SP), loose, dark gray, wet, coarse to medium grained		S6	9	9 4 4	9		S6	S6 MC = 10.2%
20			Grades to fine grained		S7	5	3 3 4	8		S7	S7 MC = 11.2%

Bottom of borehole at 21.5 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration SHER 1B Sample S1
Sample Interval 2.5 - 4.0 ft bgs

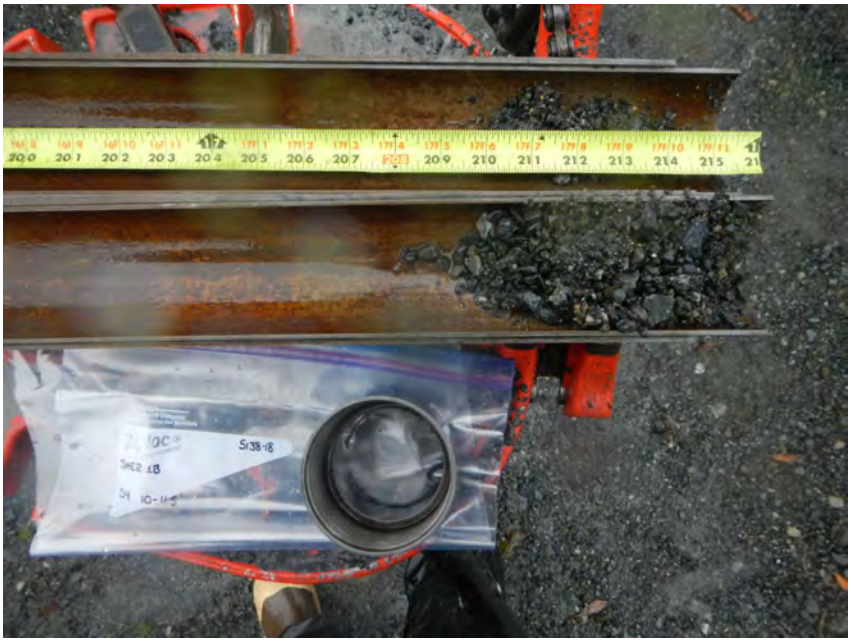
Exploration SHER 1B Sample S2
Sample Interval 5.0 - 6.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration SHER 1B Sample S3
Sample Interval 7.5 - 9.0 ft bgs

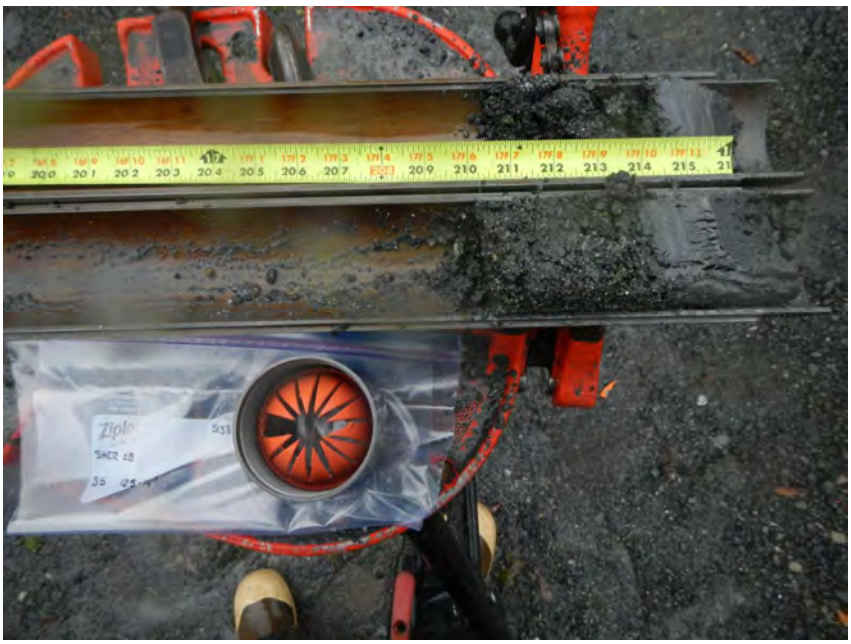


Exploration SHER 1B Sample S4
Sample Interval 10.0 - 11.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK



Exploration SHER 1B Sample S5
Sample Interval 12.5 - 14.0 ft bgs

Exploration SHER 1B Sample S6
Sample Interval 15.0 - 16.5 ft bgs

Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

PHOTO LOG
EXPLORATION SHER 1B

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

Exploration SHER 1B Sample S7
Sample Interval 20.0 - 21.5 ft bgs

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION LEGEND

CLIENT Bratslavsky Consulting Engineers, Inc.

NGE-TFT PROJECT NAME USFWS Fish Passage Improvements

NGE-TFT PROJECT NUMBER 5138-18

PROJECT LOCATION Copper River Hwy, Cordova, AK

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


GM: USCS Silty Gravel


GP: USCS Poorly-graded Gravel


GP-GM: USCS Poorly-graded Gravel with Silt


GW: USCS Well-graded Gravel


GW-GM: USCS Well-graded Gravel with Silt


ML: USCS Silt


PT: USCS Peat


SM: USCS Silty Sand


SP: USCS Poorly-graded Sand


SP-SM: USCS Poorly-graded Sand with Silt


SW: USCS Well-graded Sand


SW-SM: USCS Well-graded Sand with Silt


WOOD: Plywood

SAMPLER SYMBOLS


Modified Penetration Test


No Recovery

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
P200 - PERCENT PASSING NO. 200 SIEVE
P0.02- PERCENT PASSING 0.02mm SIEVE
PP - POCKET PENETROMETER (tons/ft^2)
S/U - CASING STICK-UP

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
N/E - NOT ENCOUNTERED

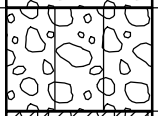
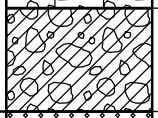
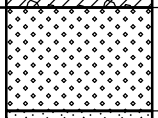
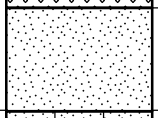
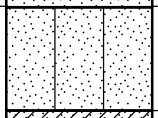
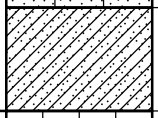
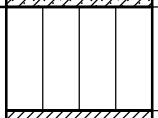
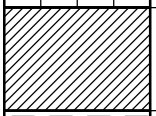
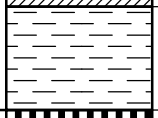
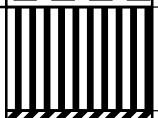
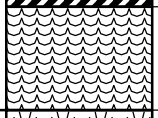
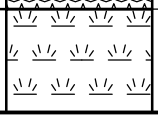
Water Level at Time Drilling, or as Shown


Water Level After 24 Hours, or as Shown

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

SOIL CLASSIFICATION CHART

CLIENT Bratslavsky Consulting Engineers, Inc.
PROJECT NAME USFWS Fish Passage Improvements
NGE-TFT PROJECT NUMBER 5138-18
PROJECT LOCATION Copper River Hwy, Cordova, AK

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS — MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS — MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	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
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS — MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	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 50% 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 SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.
DIAGONAL LINES INDICATE UNKNOWN DEPTH OF SOIL TRANSITION.

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION LOG KEY

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

NGE-TFT PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

SAMPLER SYMBOLS


SPT w/ 140# Hammer
30" Drop and 2.0" O.D. Sampler


Modified SPT w/ 340# Hammer
30" Drop and 3.0 O.D. Sampler


Grab Sample


Shelby Tube Sample


Rock Core Sample


Direct Push Sample


No Recovery

N/E Not Encountered

WELL SYMBOLS


1" Slotted Pipe
Backfilled with Silica Sand


1" PVC Pipe
Backfilled with Auger Cuttings


1" PVC Pipe
with Bentonite Seal


Capped Riser

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No. 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No. 4 (4.5 mm)
Sand	No. 4 (4.5 mm) to No. 200
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074 mm)

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	1-5%
Few	5-10%
Little	10-20%
Some	20-35%
And	35-50%

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
DENSITY	N (BLOWS/FT)	APPROXIMATE RELATIVE DENSITY (%)	CONSISTENCY	N (BLOWS/FT)	APPROXIMATE UNDRAINED SHEAR STRENGTH (PSF)
VERY LOOSE	0-4	0-15	VERY SOFT	0-1	< 250
LOOSE	5-10	15-35	SOFT	2-4	250-500
MEDIUM DENSE	11-25	35-65	MEDIUM STIFF	5-8	500-1000
DENSE	26-50	65-85	STIFF	9-15	1000-2000
VERY DENSE	> 50	85-100	VERY STIFF	16-30	2000-4000
			HARD	> 30	> 4000

Northern Geotechnical Engineering, Inc.
d.b.a. Terra Firma Testing
11301 Olive Lane
Anchorage, AK 99515
Telephone: 907-344-5934
Fax: 907-344-5993

EXPLORATION LOG KEY

CLIENT Bratslavsky Consulting Engineers, Inc. **PROJECT NAME** USFWS Fish Passage Improvements

NGE-TFT PROJECT NUMBER 5138-18 **PROJECT LOCATION** Copper River Hwy, Cordova, AK

FROST DESIGN SOIL CLASSIFICATION

FROST GROUP (USACOE)	FROST GROUP (M.O.A.)	SOIL TYPE	% FINER THAN 0.02mm BY MASS	TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM
NFS*	NFS*	(A) GRAVELS CRUSHED STONE CRUSHED ROCK (B) SANDS	0 - 1.5 0 - 3	GW, GP SW, SP
PFS+	NFS*	(A) GRAVELS CRUSHED STONE CRUSHED ROCK	1.5 - 3	GW, GP
	F2	(B) SANDS	3 - 10	SW, SP
S1	F1	GRAVELLY SOILS	3 - 6	GW, GP, GW-GM, GP-GM
S2	F2	SANDY SOILS	3 - 6	SW, SP, SW-SM, SP-SM
F1	F1	GRAVELLY SOILS	6 - 10	GM, GW-GM, GP-GM
F2	F2	(A) GRAVELLY SOILS (B) SANDS	10 - 20 6 - 15	GM, GW-GM, GP-GM SM, SW-SM, SP-SM
F3	F3	(A) GRAVELLY SOILS (B) SANDS, EXCEPT VERY FINE SILTY SANDS (C) CLAYS, PI>12	Over 20 Over 15 - - - - - -	GM, GC SM, SC CL, CH
F4	F4	(A) ALL SILTS (B) VERY FINE SILTY SANDS (C) CLAYS, PI<12 (D) VARVED CLAYS AND OTHER FINE GRAINED, BANDED SEDIMENTS	- - - - - - Over 15 - - - - - - - - - - - -	ML, MH SM CL, CL-ML CL & ML; CL, ML, & SM; CL, CH, & ML; CL, CH, ML, & SM

*Non-frost susceptible
+Possibly frost susceptible, but requires lab testing to determine frost design soils classification.

ICE CLASSIFICATION SYSTEM

GROUP	ICE VISIBILITY	DESCRIPTION		SYMBOL	
N	SEGREGATED ICE NOT VISIBLE BY EYE	POORLY BONDED OR FRIABLE		Nf	
		WELL BONDED	NO EXCESS ICE	Nb	Nbn
			EXCESS MICROSCOPIC ICE		Nbe
V	SEGREGATED ICE IS VISIBLE BY EYE AND IS ONE INCH OR LESS IN THICKNESS	INDIVIDUAL ICE CRYSTALS OR INCLUSIONS		Vx	
		ICE COATINGS ON PARTICLES		Vc	
		RANDOM OR IRREGULARY ORIENTED ICE		Vr	
		STRATIFIED OR DISTINCTLY ORIENTED ICE		Vs	
		UNIFORMLY DISTRIBUTED ICE		Vu	
ICE	ICE IS GREATER THAN ONE INCH IN THICKNESS	ICE WITH SOILS INCLUSIONS		ICE + Soil Type	
		ICE WITHOUT SOILS INCLUSIONS		ICE	

APPENDIX B

LABORATORY TEST RESULTS

Summary of Laboratory Test Results

USFWS Fish Passage Improvements

NGE-TFT Project #:5138-18

Exploration ID	Sample Number	Depth Interval (ft) Top	Depth Interval (ft) Bottom	Moisture Content ASTM D2216 (% By Dry Mass)	Particle Size Analysis ASTM C136/D422/D6913 (% By Mass) Gravel	Sand	Silt/Clay	Passing #200 ASTM D1140 (% By Mass)	Passing 0.02mm ASTM D422 (% By Mass)	Frost Class.	Organic Content (ASTM D2974) (% By Mass)	Unified Soil Classification ASTM D2487
COP 1A	S1	2.5	4.0	2.5	49.3	45.4	5.3					(GW-GM) Well-graded gravel w/ silt and sand
COP 1A	S2	5.0	6.5	6.0	46.3	48.3	5.4					(SW-SM) Well-graded sand w/ silt and gravel
COP 1A	S3	7.5	9.0	8.5	37.0	58.6	4.4		2.3	NFS		(SW) Well-graded sand w/ gravel
COP 1A	S4	10.0	11.5	12.0							2.0	
COP 1A	S5	12.5	14.0	12.5								
COP 1A	S6	15.0	16.5	11.1								
COP 1A	S7	20.0	21.5	24.9				73.2				
COP 1B	S1	2.5	4.0	8.5	46.8	43.9	9.3					(GW-GM) Well-graded gravel w/ silt and sand
COP 1B	S2	5.0	6.5	4.1	21.5	63.4	15.1					(SM) Silty sand w/ gravel
COP 1B	S3	7.5	9.0	9.3	38.2	52.7	9.1		6.3	F2		(SW-SM) Well-graded sand w/ silt and gravel
COP 1B	S4	10.0	11.5	25.3	0.8	36.0	63.2		24.8	F4		(ML) Sandy silt
COP 1B	S5	12.5	14.0	12.5								
COP 1B	S6	15.0	16.5	11.4								
COP 1B	S7	20.0	21.5	29.1				87.2				
COP 9A	S1	2.5	4.0	7.7	50.4	45.2	4.4					(GP) Poorly-graded gravel w/ sand
COP 9A	S2	5.0	6.5	3.8	39.4	53.2	7.4					(SP-SM) Poorly-graded sand w/ silt and gravel
COP 9A	S3	7.5	9.0	6.0								
COP 9A	S4	10.0	11.5	6.8	50.1	44.3	5.6		4.1	S1		(GW-GM) Well-graded gravel w/ silt and sand
COP 9A	S5	12.5	14.0	7.0								
COP 9A	S6	15.0	16.5	30.7				57.5				
COP 9A	S7	20.0	21.5	32.4								
COP 9B	S1	2.5	4.0	2.5	48.6	45.3	6.1					(GW-GM) Well-graded gravel w/ silt and sand
COP 9B	S2	5.0	6.5	3.8	56.4	35.5	8.1					(GW-GM) Well-graded gravel w/ silt and sand
COP 9B	S3	7.5	9.0	3.7								
COP 9B	S4	10.0	11.5	6.4	50.5	42.8	6.7		4.5	S1		(GW-GM) Well-graded gravel w/ silt and sand
COP 9B	S5	12.5	14.0	24.3								
COP 9B	S6	15.0	16.5	19.3								
COP 9B	S7	20.0	21.5	38.3								
COP 20A	S1	2.5	4.0	2.4	71.0	24.9	4.1					(GP) Poorly-graded gravel w/ sand
COP 20A	S2	5.0	6.5	6.4	49.8	43.5	6.7					(GW-GM) Well-graded gravel w/ silt and sand
COP 20A	S3	7.5	9.0	8.2	34.0	61.1	4.9		3.1	S2		(SW) Well-graded sand w/ gravel
COP 20A	S4	10.0	11.5	5.9	69.2	29.8	1.0					(GW) Well-graded gravel w/ sand
COP 20A	S5	12.5	14.0	NO SAMPLE								
COP 20A	S6	15.0	16.5	10.1								
COP 20A	S7	20.0	21.5	NO SAMPLE								
COP 20B	S1	2.5	4.0	3.3								

Summary of Laboratory Test Results

USFWS Fish Passage Improvements

NGE-TFT Project #:5138-18

COP 20B	S2	5.0	6.5	5.7	39.6	51.5	8.9					(SW-SM) Well-graded sand w/ silt and gravel
COP 20B	S3	7.5	9.0	9.1	40.0	55.3	4.7		2.6	NFS		(SP) Poorly-graded sand w/ gravel
COP 20B	S4	10.0	11.5	7.0	55.1	42.1	2.8		1.7	PFS		(GW) Well-graded gravel w/ sand
COP 20B	S5	12.5	14.0	9.5								
COP 20B	S6	15.0	16.5	11.8	34.8	60.4	4.8					(SW) Well-graded sand w/ gravel
COP 20B	S7	20.0	21.5	14.5								
COP 22A	S1	2.5	4.0	4.1								
COP 22A	S2	5.0	6.5	4.0	44.7	49.5	5.8					(SW-SM) Well-graded sand w/ silt and gravel
COP 22A	S3	7.5	9.0	5.8	56.0	38.0	6.0					(GW-GM) Well-graded gravel w/ silt and sand
COP 22A	S4	10.0	11.5	6.6	51.1	43.4	5.5		3.2	S1		(GW-GM) Well-graded gravel w/ silt and sand
COP 22A	S5	12.5	14.0	5.1								
COP 22A	S6	15.0	16.5	4.1	51.8	47.2	1.0					(GW) Well-graded gravel w/ sand
COP 22A	S7	20.0	21.5	NO SAMPLE								
COP 22B	S1	2.5	4.0	7.1	52.7	41.3	6.0					(GW-GM) Well-graded gravel w/ silt and sand
COP 22B	S2	5.0	6.5	8.7	36.3	54.0	9.7					(SW-SM) Well-graded sand w/ silt and gravel
COP 22B	S3	7.5	9.0	7.0	41.5	52.2	6.3		4.3	S2		(SW-SM) Well-graded sand w/ silt and gravel
COP 22B	S4	10.0	11.5	6.4	53.8	42.2	4.0		2.6	PFS		(GW) Well-graded gravel w/ sand
COP 22B	S5	12.5	14.0	10.4								
COP 22B	S6	15.0	16.5	9.1								
COP 22B	S7	20.0	21.5	9.1								
COP 25A	S1	2.5	4.0	3.4	53.1	42.8	4.1					(GW) Well-graded gravel w/ sand
COP 25A	S2	5.0	6.5	4.7	39.7	54.8	5.5					(SW-SM) Well-graded sand w/ silt and gravel
COP 25A	S3	7.5	9.0	8.1	44.2	54.6	1.2		0.9	NFS		(SW) Well-graded sand w/ gravel
COP 25A	S4	10.0	11.5	3.7								
COP 25A	S5	12.5	14.0	6.8	52.2	46.1	1.7					(GW) Well-graded gravel w/ sand
COP 25A	S6	15.0	16.5	13.1								
COP 25A	S7	20.0	21.5	8.8				10.6				
COP 25B	S1	2.5	4.0	6.8								
COP 25B	S2	5.0	6.5	3.2	38.1	54.6	7.3					(SP-SM) Poorly-graded sand w/ silt and gravel
COP 25B	S3	7.5	9.0	8.5	39.8	56.9	3.3					(SP) Poorly-graded sand w/ gravel
COP 25B	S4	10.0	11.5	8.1	41.1	56.8	2.1		1.7	NFS		(SW) Well-graded sand w/ gravel
COP 25B	S5	12.5	14.0	8.1								
COP 25B	S6	15.0	16.5	221.6								
COP 25B	S7	20.0	21.5	11.5								
COP 33A	S1	5.0	6.5									
COP 33A	S2	10.0	11.5	5.2	70.6	25.6	3.8		2.1	PFS		(GW) Well-graded gravel w/ sand
COP 33A	S3	12.5	14.0	71.2	11.2	40.9	47.9					(SM) Silty sand
COP 33A	S4	15.0	16.5	20.7								
COP 33A	S5	17.5	19.0	34.0				85.2				
COP 33A	S6	20.0	21.5	24.1								

Summary of Laboratory Test Results

USFWS Fish Passage Improvements

NGE-TFT Project #:5138-18

COP 33B	S1	5.0	6.5	10.1	42.0	45.2	12.8					(SM) Silty sand w/ gravel
COP 33B	S2	10.0	11.5	8.6	62.3	29.9	7.8		5.1	S1		(GP-GM) Poorly-graded gravel w/ silt and sand
COP 33B	S3	12.5	14.0	21.5								
COP 33B	S4A	15.0	16.0	24.6								
COP 33B	S4B	16.0	16.5	20.2								
COP 33B	S5	17.5	19.0	26.4							5.4	
COP 33B	S6	20.0	21.5	19.2								
COP 43A	S1	2.5	4.0	7.4	41.5	55.0	3.5					(SW) Well-graded sand w/ gravel
COP 43A	S2	5.0	6.5	9.8								
COP 43A	S3	7.5	9.0	17.9	3.2	80.4	16.4		5.9	F2		(SM) Silty sand
COP 43A	S4	10.0	11.5	16.9								
COP 43A	S5	15.0	16.5	26.1				24.4				
COP 43A	S6	20.0	21.5	20.2				23.5				
COP 43B	S1	2.5	4.0	7.3	48.6	45.8	5.6					(GW-GM) Well-graded gravel w/ silt and sand
COP 43B	S2	5.0	6.5	7.5	42.3	53.6	4.1		2.6	NFS		(SW) Well-graded sand w/ gravel
COP 43B	S3	7.5	9.0	45.8				30.9				
COP 43B	S4	10.0	11.5	46.5	8.5	74.3	17.2		6.6	F2		(SM) Silty sand
COP 43B	S5	15.0	16.5	27.4								
COP 43B	S6	20.0	21.5	7.3								
COP 44A	S1	2.5	4.0	5.0	57.6	38.2	4.2					(GW) Well-graded gravel w/ sand
COP 44A	S2	5.0	6.5	7.2	47.6	47.5	4.9		3.2	S1		(GW) Well-graded gravel w/ sand
COP 44A	S3	7.5	9.0	6.7	53.3	43.2	3.5					(GW) Well-graded gravel w/ sand
COP 44A	S4	10.0	11.5	8.9								
COP 44A	S5	15.0	16.5	26.9				62.7				
COP 44A	S6	20.0	21.5	31.8								
COP 44B	S1	2.5	4.0	8.0	58.9	36.3	4.8					(GW) Well-graded gravel w/ sand
COP 44B	S2	5.0	6.5	7.7	47.1	47.7	5.2		3.6	S2		(SW-SM) Well-graded sand w/ silt and gravel
COP 44B	S3	7.5	9.0	8.6								
COP 44B	S4	10.0	11.5	9.3	43.9	53.7	2.4					(SP) Poorly-graded sand w/ gravel
COP 44B	S5	15.0	16.5	25.8				20.1				
COP 44B	S6	20.0	21.5	23.8								
COP 45A	S1	2.5	4.0	7.6	45.3	47.7	7.0					(SW-SM) Well-graded sand w/ silt and gravel
COP 45A	S2	5.0	6.5	25.3	2.9	58.1	39.0		12.0	F2		(SM) Silty sand
COP 45A	S3	7.5	9.0	29.2								
COP 45A	S4A	10.0	11.0	8.7								
COP 45A	S4B	11.0	11.5	20.4								
COP 45A	S5	15.0	16.5	7.1	55.9	42.2	1.9					(GP) Poorly-graded gravel w/ sand
COP 45A	S6	20.0	21.5	15.5								
COP 45B	S1	2.5	4.0	6.6	54.3	41.5	4.2					(GW) Well-graded gravel w/ sand
COP 45B	S2	5.0	6.5	7.3	44.4	49.0	6.6		4.7	S2		(SW-SM) Well-graded sand w/ silt and gravel

Summary of Laboratory Test Results

USFWS Fish Passage Improvements

NGE-TFT Project #:5138-18

COP 45B	S3	7.5	9.0	18.5								
COP 45B	S4	10.0	11.5	42.0				34.7				
COP 45B	S5	15.0	16.5	6.9								
CAB 2A	S1	2.5	4.0	10.5	56.8	36.1	7.1					(GW-GM) Well-graded gravel w/ silt and sand
CAB 2A	S2	5.0	6.5	10.1								
CAB 2A	S3	7.5	9.0	12.0	27.9	64.7	7.4		5.0	S2		(SW-SM) Well-graded sand w/ silt and gravel
CAB 2A	S4	10.0	11.5	7.6								
CAB 2A	S5	15.0	16.5	26.4				67.9				
CAB 2A	S6	20.0	21.5	11.7								
CAB 2B	S1	2.5	4.0	26.4				64.2				
CAB 2B	S2	5.0	6.5	13.9								
CAB 2B	S3	7.5	9.0	10.8	48.0	47.9	4.1		2.4	PFS		(GW) Well-graded gravel w/ sand
CAB 2B	S4	10.0	11.5	11.0								
CAB 2B	S5	15.0	16.5	26.3				60.1				
CAB 2B	S6	20.0	21.5	10.6								
SHER 1A	S1	2.5	4.0	4.7	52.9	44.3	2.8					(GP) Poorly-graded gravel w/ sand
SHER 1A	S2	5.0	6.5	6.5								
SHER 1A	S3	7.5	9.0	16.4	5.5	83.9	10.6		5.1	S2		(SW-SM) Well-graded sand w/ silt
SHER 1A	S4	10.0	11.5	13.6								
SHER 1A	S5	12.5	14.0	10.6	21.1	68.7	10.2		5.4	S2		(SP-SM) Poorly-graded sand w/ silt and gravel
SHER 1A	S6	15.0	16.5	15.1								
SHER 1A	S7	20.0	21.5	18.6								
SHER 1B	S1	2.5	4.0	8.5	44.9	49.2	5.9					(SW-SM) Well-graded sand w/ silt and gravel
SHER 1B	S2	5.0	6.5	4.7	41.1	50.5	8.4					(SW-SM) Well-graded sand w/ silt and gravel
SHER 1B	S3	7.5	9.0	7.7	14.5	69.2	16.3		11.1	F2		(SM) Silty sand
SHER 1B	S4	10.0	11.5	9.6								
SHER 1B	S5	12.5	14.0	20.0				40.6				
SHER 1B	S6	15.0	16.5	10.2								
SHER 1B	S7	20.0	21.5	11.2								

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

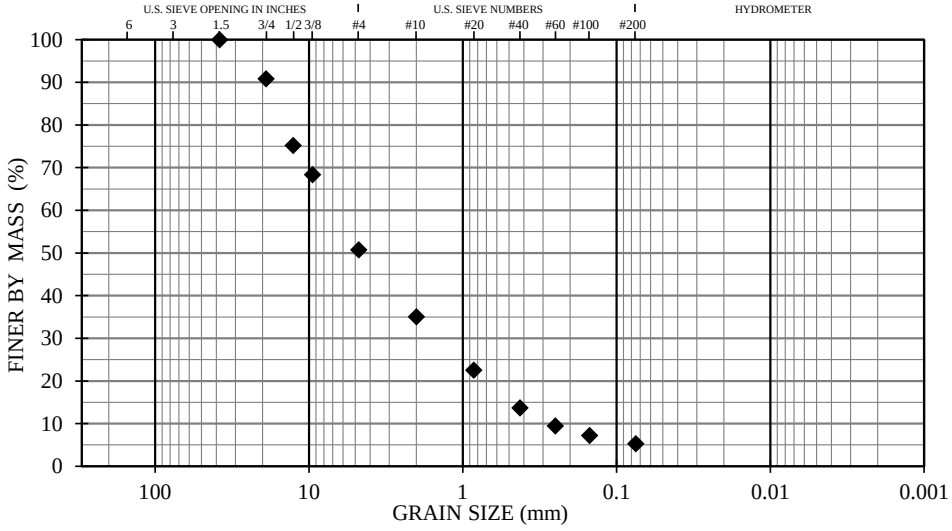
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**CH**
REVIEWED BY:	**SAM**

% GRAVEL	**49.3**	USCS	**GW-GM**
% SAND	**45.4**	USACOE FC	**N/A**
% SILT/CLAY	**5.3**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**2.5**	% PASS. 0.002 mm	**N/A**

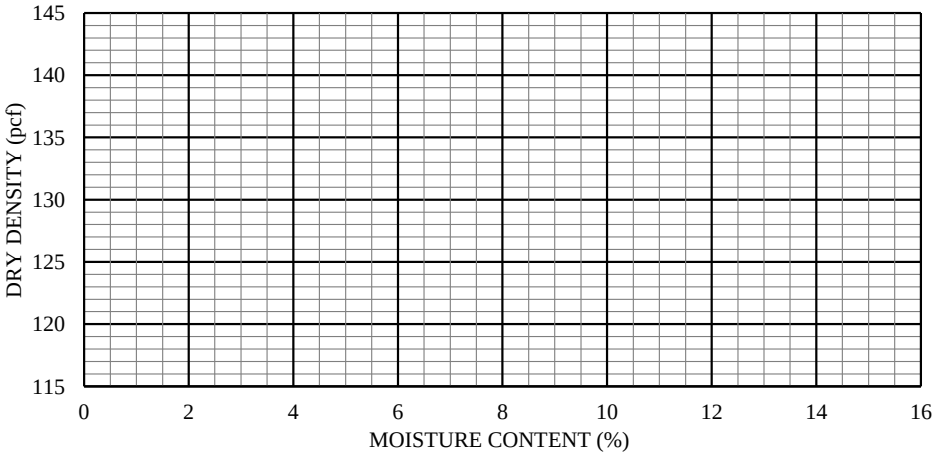
UNIFORMITY COEFFICIENT (C_u)	**26.6**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**91**	
12.70	1/2"	**75**	
9.50	3/8"	**68**	
4.75	#4	**51**	
2.00	#10	**35**	
0.85	#20	**23**	
0.43	#40	**14**	
0.25	#60	**9**	
0.15	#100	**7**	
0.075	#200	**5.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

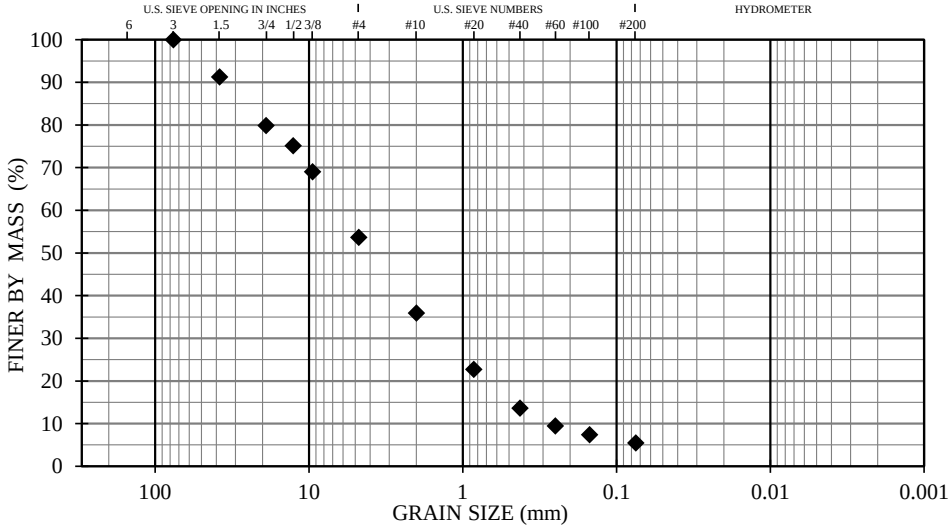
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**CH**
REVIEWED BY:	**SAM**

% GRAVEL	**46.3**	USCS	**SW-SM**
% SAND	**48.3**	USACOE FC	**N/A**
% SILT/CLAY	**5.4**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**6.0**	% PASS. 0.002 mm	**N/A**

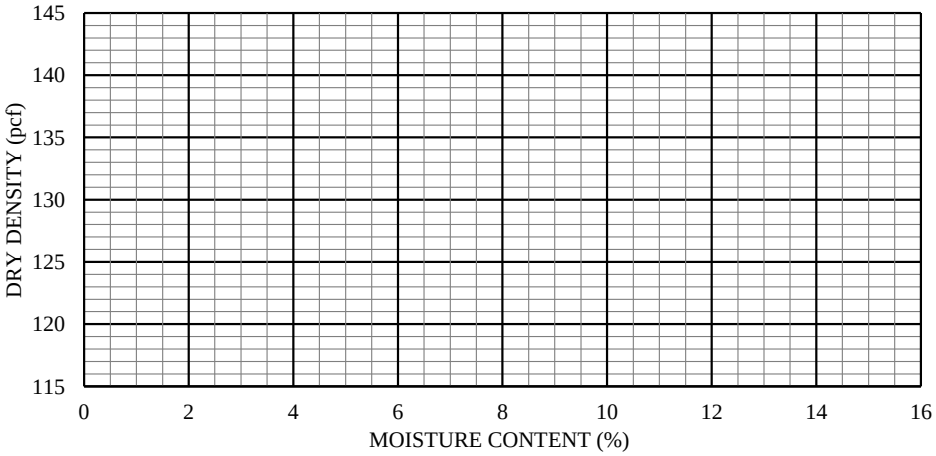
UNIFORMITY COEFFICIENT (C_u)	**24.6**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**91**	
19.00	3/4"	**80**	
12.70	1/2"	**75**	
9.50	3/8"	**69**	
4.75	#4	**54**	
2.00	#10	**36**	
0.85	#20	**23**	
0.43	#40	**14**	
0.25	#60	**9**	
0.15	#100	**7**	
0.075	#200	**5.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

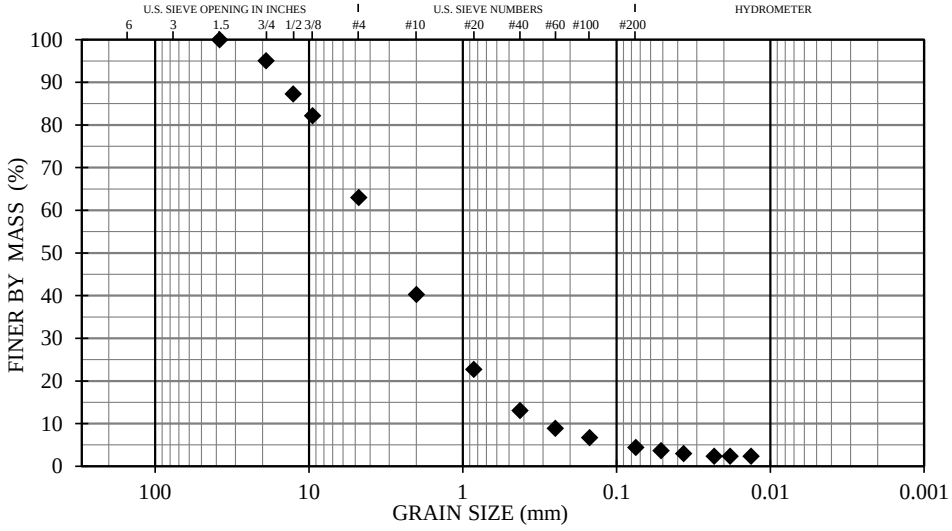
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**37.0**	USCS	**SW**
% SAND	**58.6**	USACOE FC	**NFS**
% SILT/CLAY	**4.4**	% PASS. 0.02 mm	**2.3**
% MOIST. CONTENT	**8.5**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**14.8**	
COEFFICIENT OF GRADATION (C_c)		**1.4**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

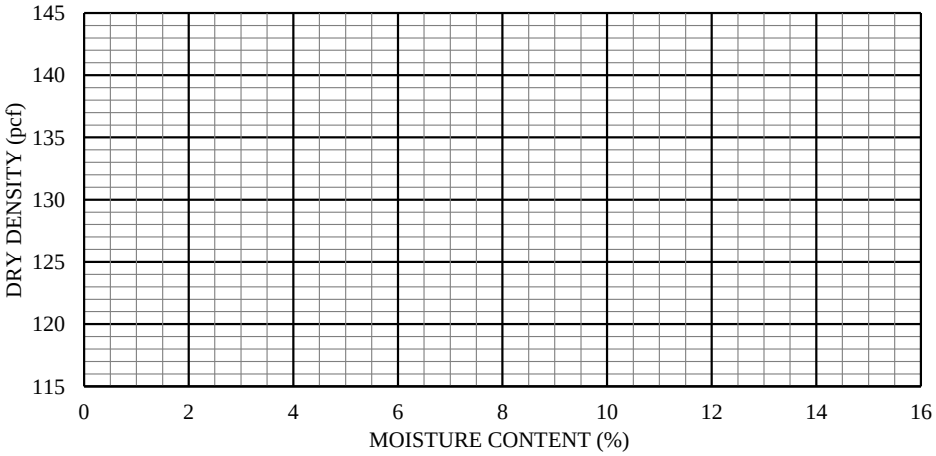


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**95**	
12.70	1/2"	**87**	
9.50	3/8"	**82**	
4.75	#4	**63**	
2.00	#10	**40**	
0.85	#20	**23**	
0.43	#40	**13**	
0.25	#60	**9**	
0.15	#100	**7**	
0.075	#200	**4.4**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0514	3.6
2	0.0366	3.0
5	0.0232	2.3
8	0.0183	2.3
15	0.0134	2.3
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

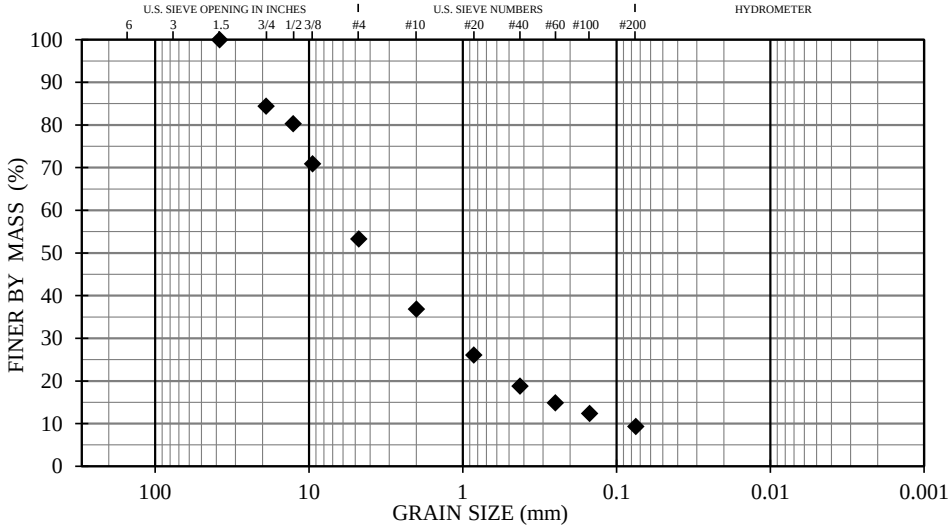
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**46.8**	USCS	**GW-GM**
% SAND	**43.9**	USACOE FC	**N/A**
% SILT/CLAY	**9.3**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**8.5**	% PASS. 0.002 mm	**N/A**

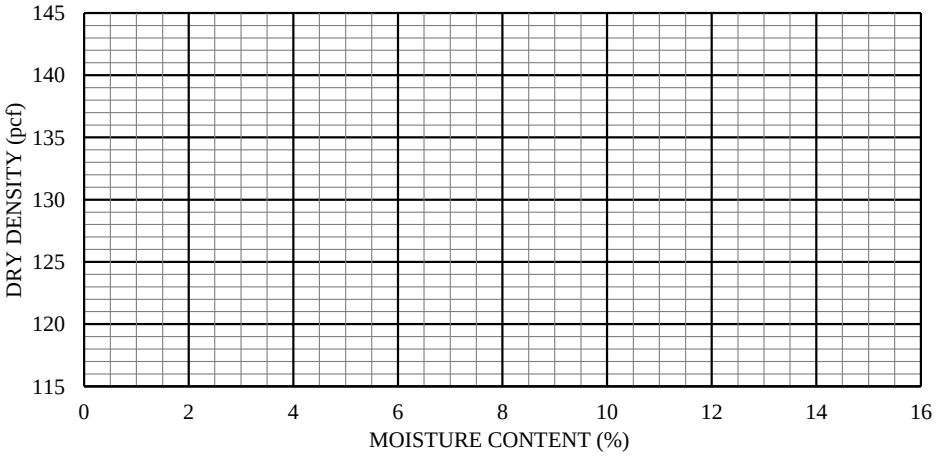
UNIFORMITY COEFFICIENT (C_u)	**71.9**
COEFFICIENT OF GRADATION (C_c)	**2.7**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**84**	
12.70	1/2"	**80**	
9.50	3/8"	**71**	
4.75	#4	**53**	
2.00	#10	**37**	
0.85	#20	**26**	
0.43	#40	**19**	
0.25	#60	**15**	
0.15	#100	**12**	
0.075	#200	**9.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

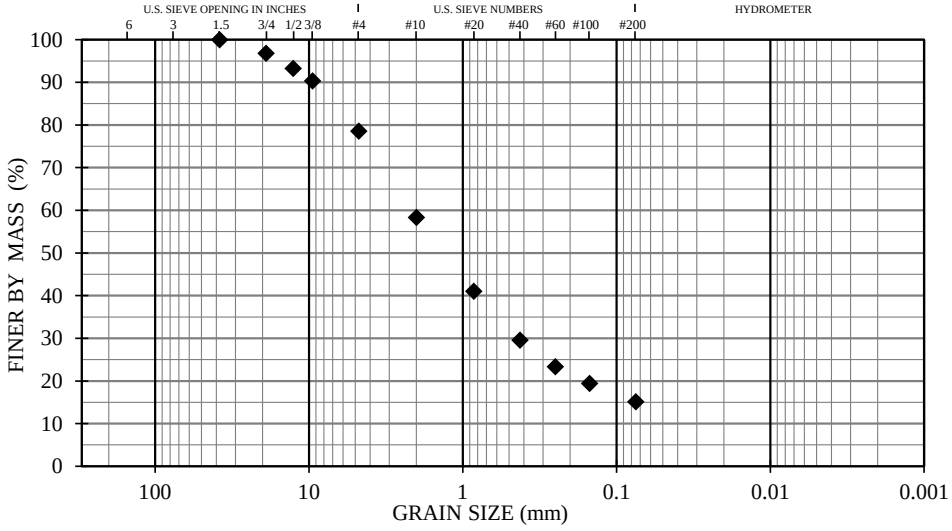
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Silty sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

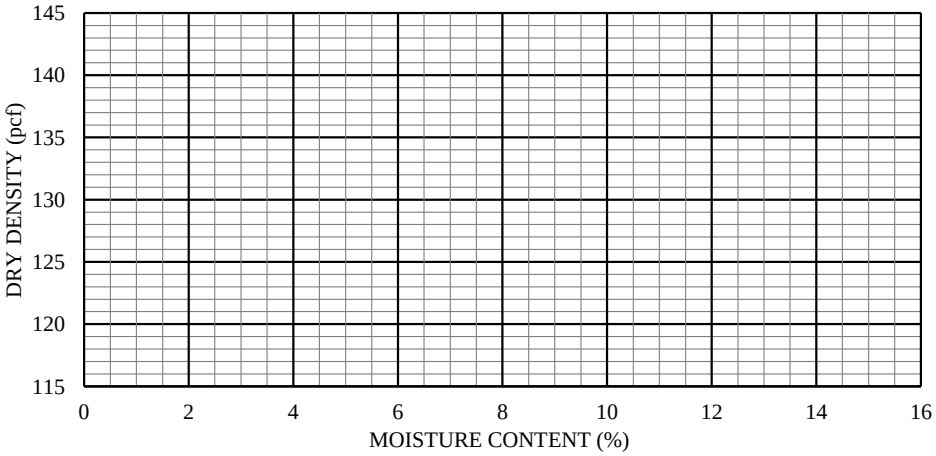
% GRAVEL	**21.5**	USCS	**SM**
% SAND	**63.4**	USACOE FC	**N/A**
% SILT/CLAY	**15.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.1**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)			**UNKNOWN**
COEFFICIENT OF GRADATION (C_c)			**UNKNOWN**
ASTM D1557 (uncorrected)			**N/A**
ASTM D4718 (corrected)			**N/A**
OPTIMUM MOIST. CONTENT. (corrected)			**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**97**	
12.70	1/2"	**93**	
9.50	3/8"	**90**	
4.75	#4	**79**	
2.00	#10	**58**	
0.85	#20	**41**	
0.43	#40	**30**	
0.25	#60	**23**	
0.15	#100	**19**	
0.075	#200	**15.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

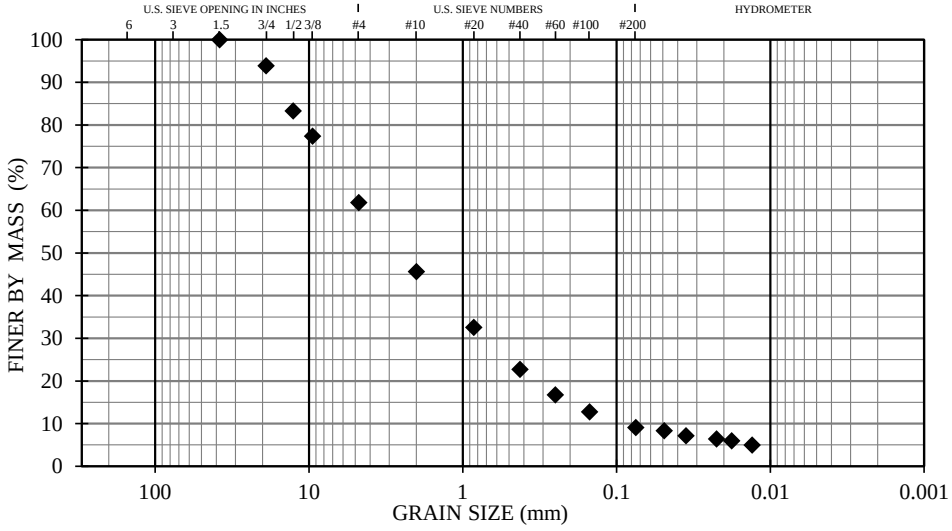
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

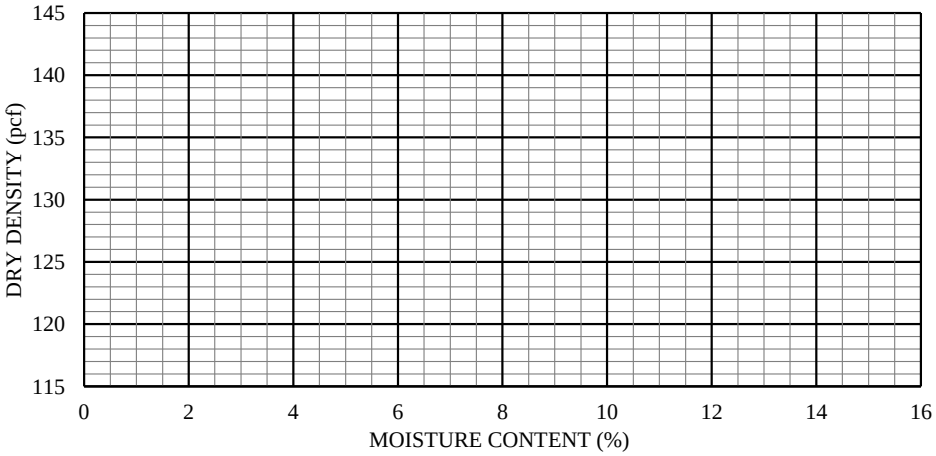
% GRAVEL	**38.2**	USCS	**SW-SM**
% SAND	**52.7**	USACOE FC	**F2**
% SILT/CLAY	**9.1**	% PASS. 0.02 mm	**6.3**
% MOIST. CONTENT	**9.3**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**47.4**	
COEFFICIENT OF GRADATION (C_c)		**1.3**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**94**	
12.70	1/2"	**83**	
9.50	3/8"	**77**	
4.75	#4	**62**	
2.00	#10	**46**	
0.85	#20	**33**	
0.43	#40	**23**	
0.25	#60	**17**	
0.15	#100	**13**	
0.075	#200	**9.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0490	8.3
2	0.0353	7.1
5	0.0223	6.4
8	0.0179	5.9
15	0.0131	5.0
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

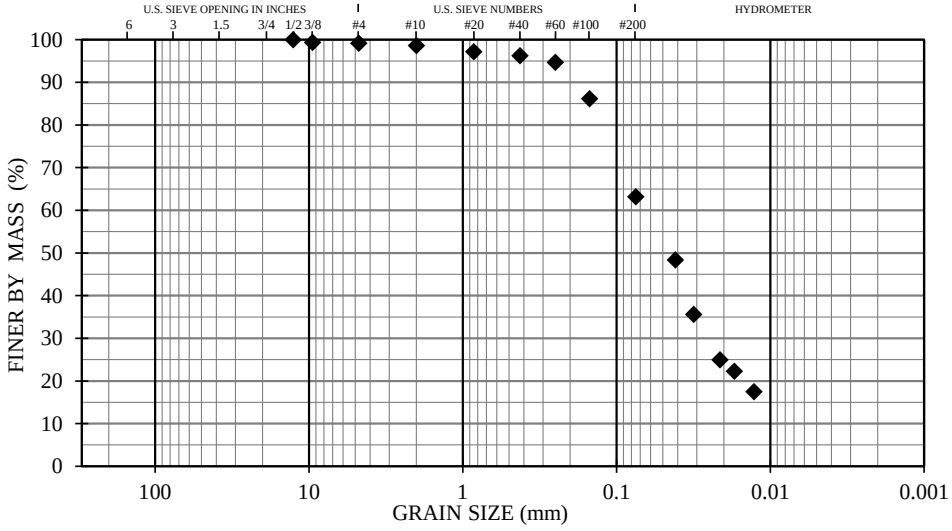
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP1B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Sandy silt**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

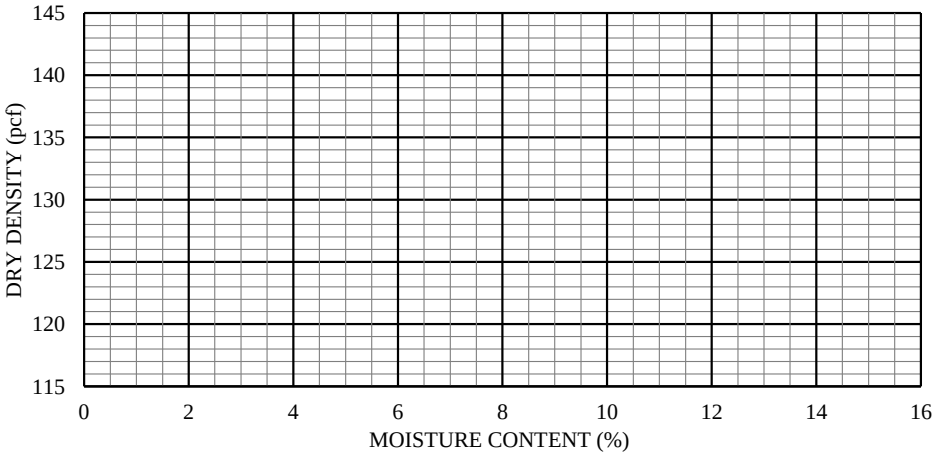
% GRAVEL	**0.8**	USCS	**ML**
% SAND	**36.0**	USACOE FC	**F4**
% SILT/CLAY	**63.2**	% PASS. 0.02 mm	**24.8**
% MOIST. CONTENT	**25.3**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)			**UNKNOWN**
COEFFICIENT OF GRADATION (C_c)			**UNKNOWN**
ASTM D1557 (uncorrected)			**N/A**
ASTM D4718 (corrected)			**N/A**
OPTIMUM MOIST. CONTENT. (corrected)			**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"		
12.70	1/2"	**100**	
9.50	3/8"	**99**	
4.75	#4	**99**	
2.00	#10	**99**	
0.85	#20	**97**	
0.43	#40	**96**	
0.25	#60	**95**	
0.15	#100	**86**	
0.075	#200	**63.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0414	48.3
2	0.0316	35.6
5	0.0212	24.9
8	0.0171	22.3
15	0.0128	17.5
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

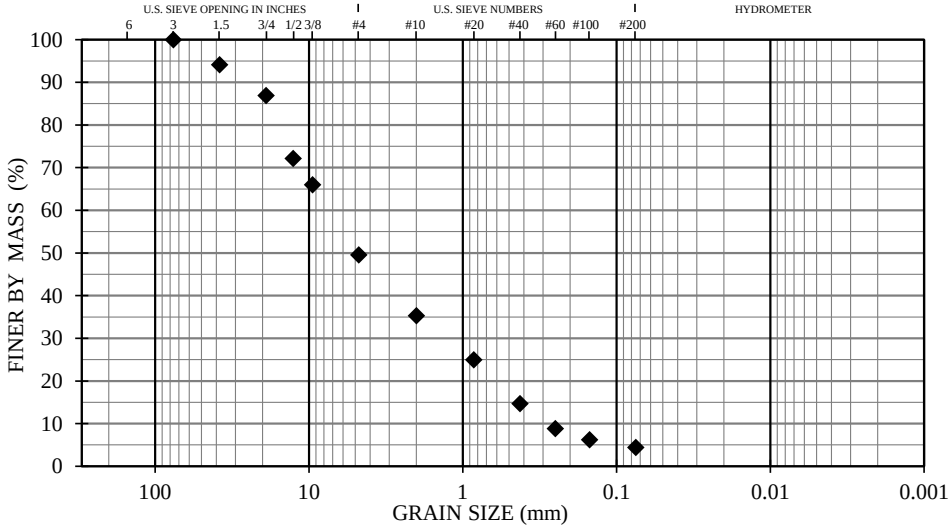
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**50.4**	USCS	**GP**
% SAND	**45.2**	USACOE FC	**N/A**
% SILT/CLAY	**4.4**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.7**	% PASS. 0.002 mm	**N/A**

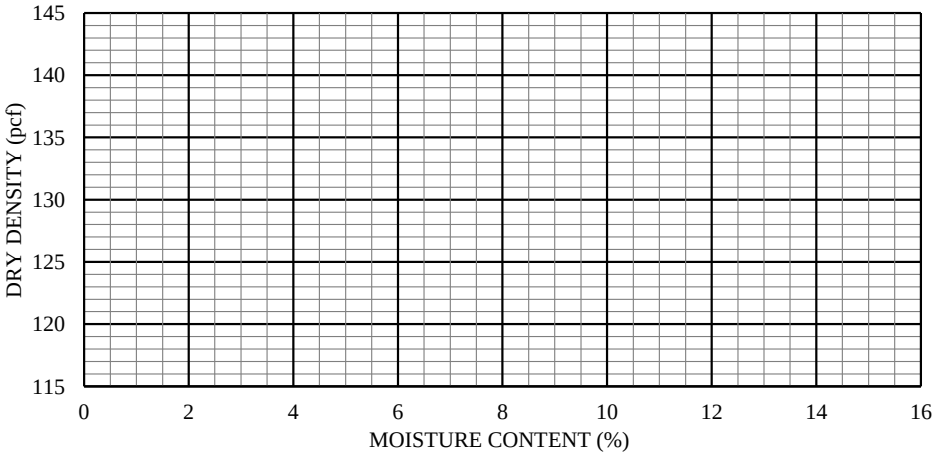
UNIFORMITY COEFFICIENT (C_u)	**27.2**
COEFFICIENT OF GRADATION (C_c)	**0.9**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**94**	
19.00	3/4"	**87**	
12.70	1/2"	**72**	
9.50	3/8"	**66**	
4.75	#4	**50**	
2.00	#10	**35**	
0.85	#20	**25**	
0.43	#40	**15**	
0.25	#60	**9**	
0.15	#100	**6**	
0.075	#200	**4.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

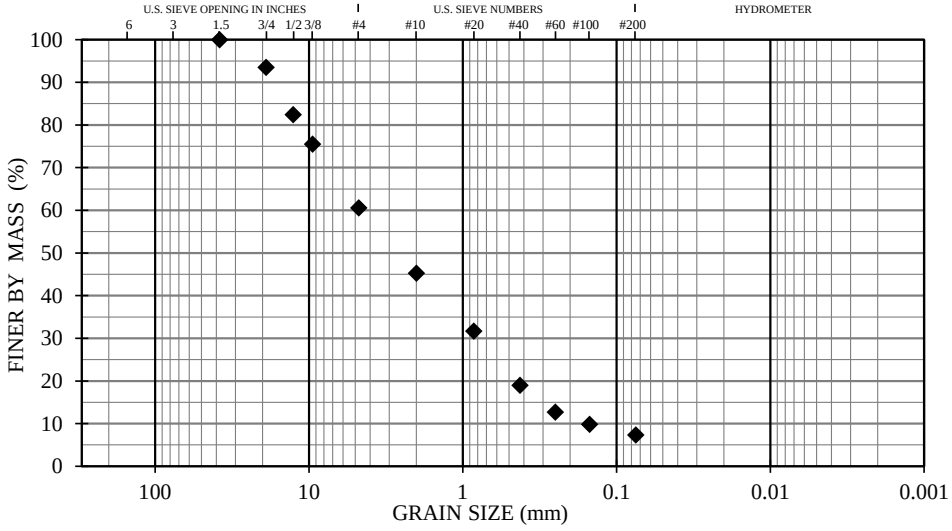
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Poorly-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**39.4**	USCS	**SP-SM**
% SAND	**53.2**	USACOE FC	**N/A**
% SILT/CLAY	**7.4**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**3.8**	% PASS. 0.002 mm	**N/A**

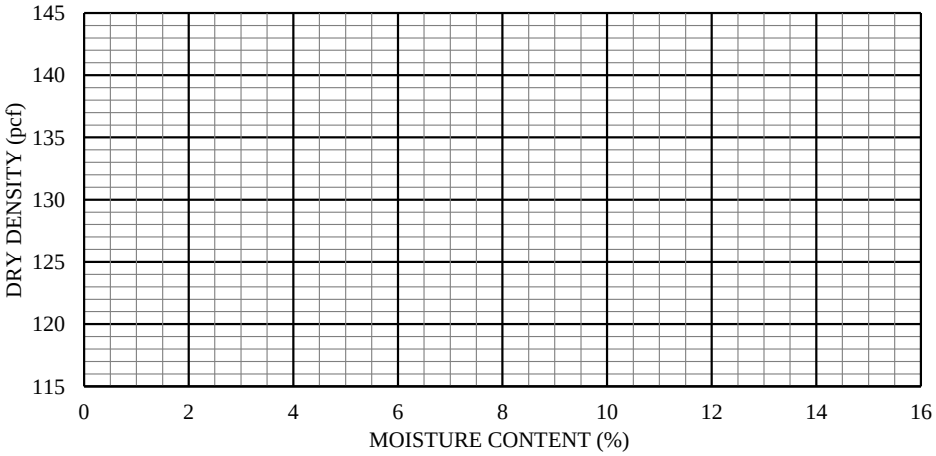
UNIFORMITY COEFFICIENT (C_u)	**29.8**
COEFFICIENT OF GRADATION (C_c)	**0.9**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**93**	
12.70	1/2"	**82**	
9.50	3/8"	**75**	
4.75	#4	**61**	
2.00	#10	**45**	
0.85	#20	**32**	
0.43	#40	**19**	
0.25	#60	**13**	
0.15	#100	**10**	
0.075	#200	**7.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

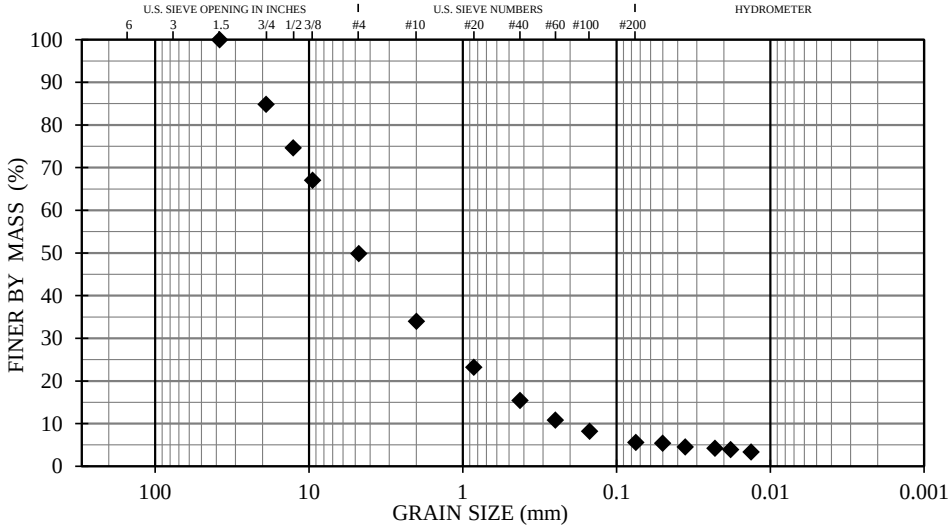
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9A**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**50.1**	USCS	**GW-GM**
% SAND	**44.3**	USACOE FC	**S1**
% SILT/CLAY	**5.6**	% PASS. 0.02 mm	**4.1**
% MOIST. CONTENT	**6.8**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**34.4**	
COEFFICIENT OF GRADATION (C_c)		**1.5**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

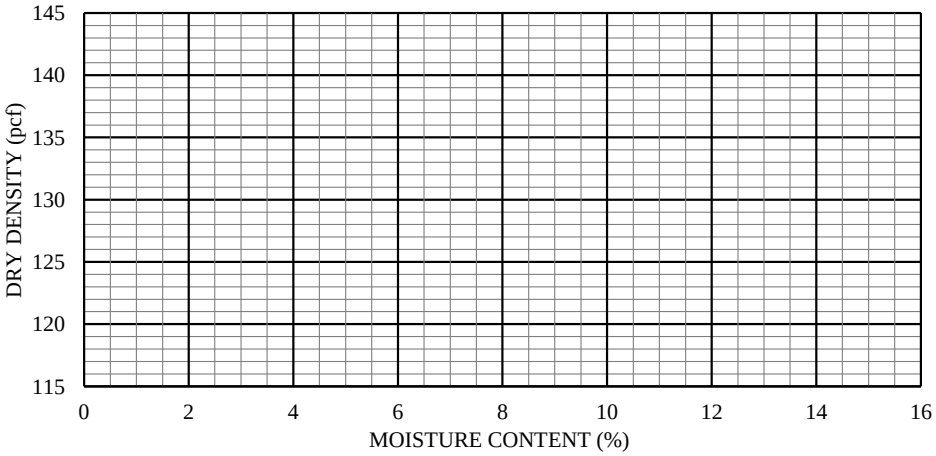


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**85**	
12.70	1/2"	**75**	
9.50	3/8"	**67**	
4.75	#4	**50**	
2.00	#10	**34**	
0.85	#20	**23**	
0.43	#40	**15**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**5.6**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0502	5.4
2	0.0358	4.5
5	0.0229	4.2
8	0.0181	3.9
15	0.0134	3.3
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

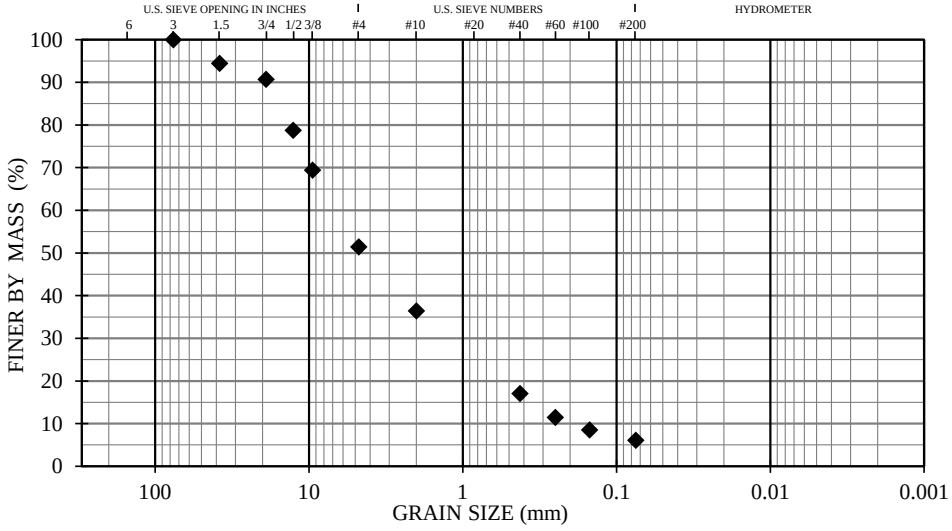
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**48.6**	USCS	**GW-GM**
% SAND	**45.3**	USACOE FC	**N/A**
% SILT/CLAY	**6.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**2.5**	% PASS. 0.002 mm	**N/A**

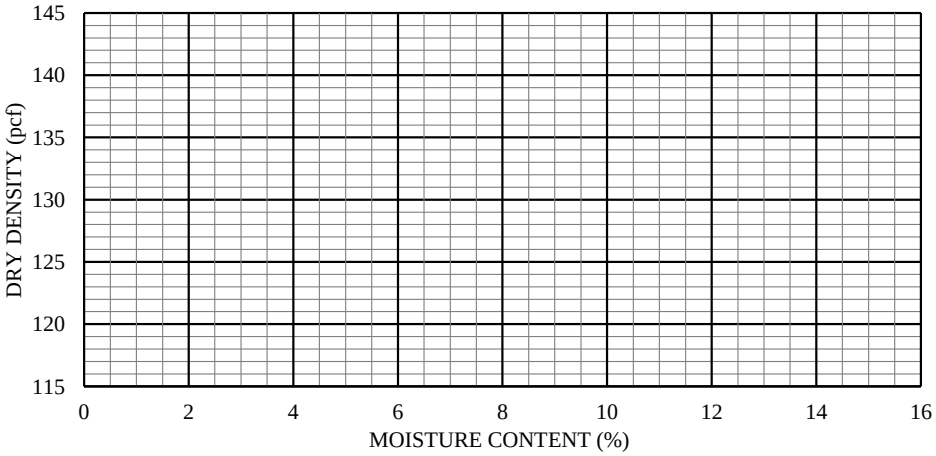
UNIFORMITY COEFFICIENT (C_u)	**28.0**
COEFFICIENT OF GRADATION (C_c)	**2.1**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**94**	
19.00	3/4"	**91**	
12.70	1/2"	**79**	
9.50	3/8"	**69**	
4.75	#4	**51**	
2.00	#10	**36**	
0.85	#20	**-54**	
0.43	#40	**17**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**6.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

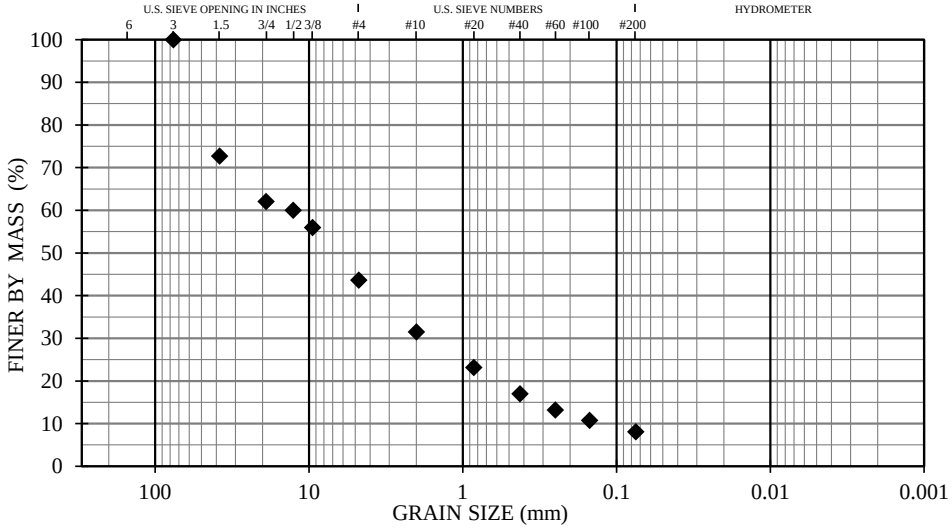
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**56.4**	USCS	**GW-GM**
% SAND	**35.5**	USACOE FC	**N/A**
% SILT/CLAY	**8.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**3.8**	% PASS. 0.002 mm	**N/A**

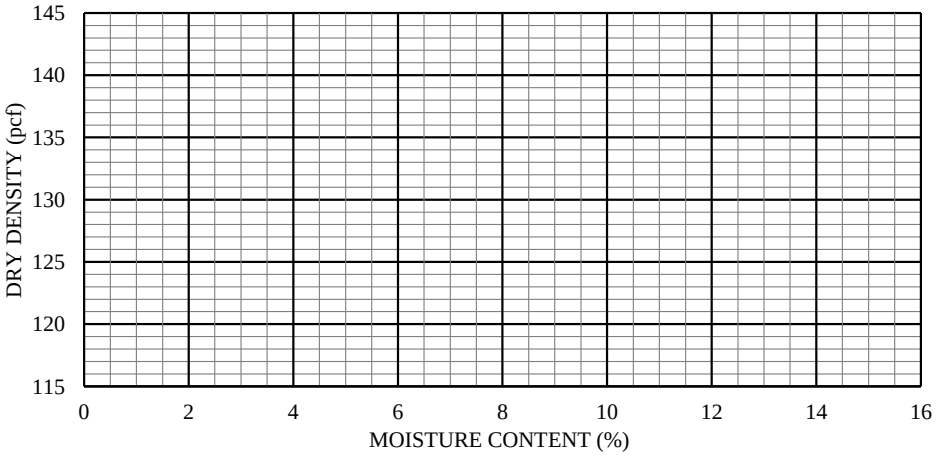
UNIFORMITY COEFFICIENT (C_u)	**99.1**
COEFFICIENT OF GRADATION (C_c)	**2.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**73**	
19.00	3/4"	**62**	
12.70	1/2"	**60**	
9.50	3/8"	**56**	
4.75	#4	**44**	
2.00	#10	**31**	
0.85	#20	**23**	
0.43	#40	**17**	
0.25	#60	**13**	
0.15	#100	**11**	
0.075	#200	**8.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

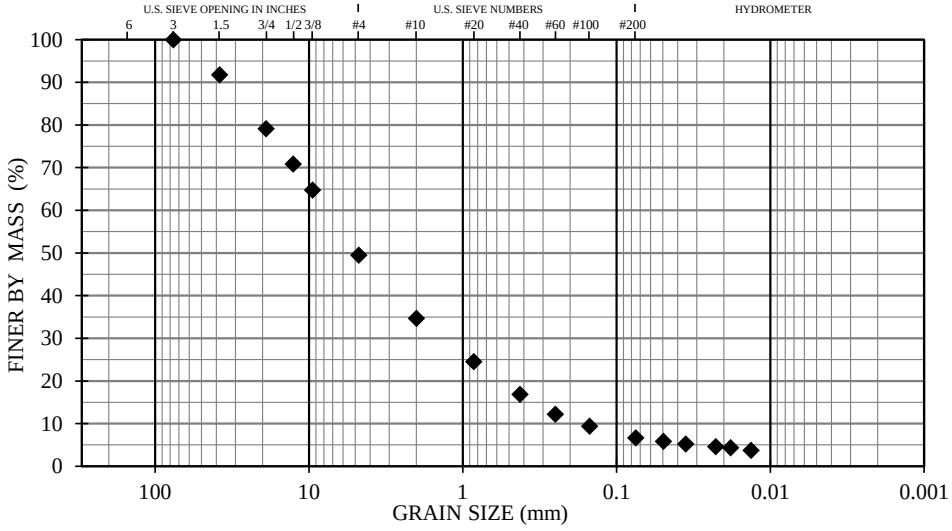
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP9B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**50.5**	USCS	**GW-GM**
% SAND	**42.8**	USACOE FC	**S1**
% SILT/CLAY	**6.7**	% PASS. 0.02 mm	**4.5**
% MOIST. CONTENT	**6.4**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**46.6**	
COEFFICIENT OF GRADATION (C_c)		**1.6**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

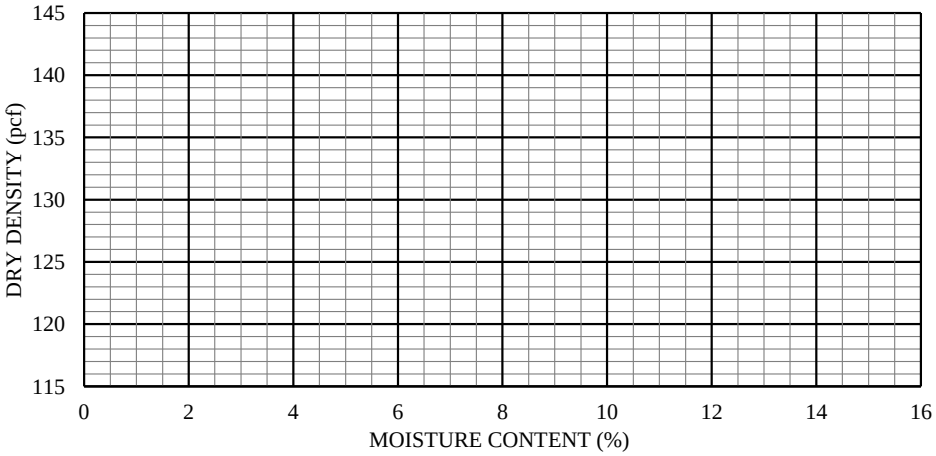


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**92**	
19.00	3/4"	**79**	
12.70	1/2"	**71**	
9.50	3/8"	**65**	
4.75	#4	**49**	
2.00	#10	**35**	
0.85	#20	**25**	
0.43	#40	**17**	
0.25	#60	**12**	
0.15	#100	**9**	
0.075	#200	**6.7**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0497	5.8
2	0.0355	5.2
5	0.0226	4.6
8	0.0181	4.3
15	0.0134	3.7
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

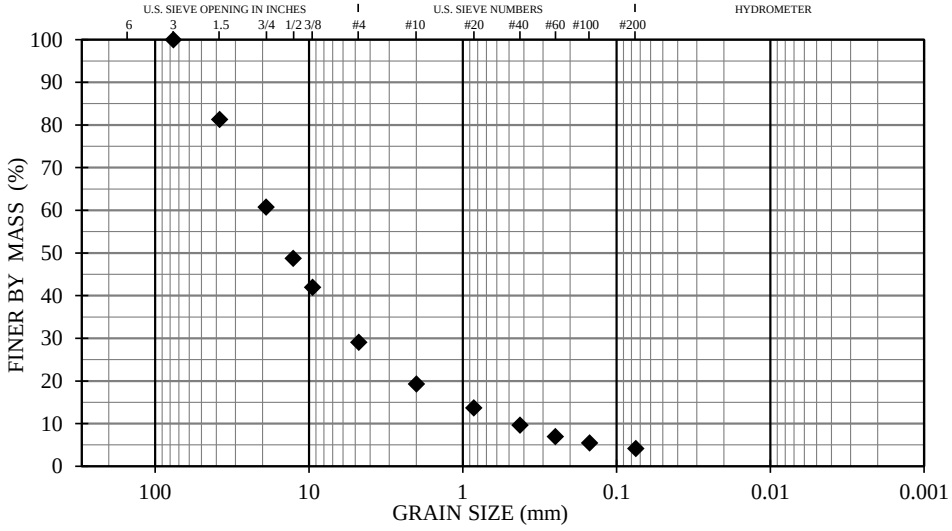
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**71.0**	USCS	**GP**
% SAND	**24.9**	USACOE FC	**N/A**
% SILT/CLAY	**4.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**2.4**	% PASS. 0.002 mm	**N/A**

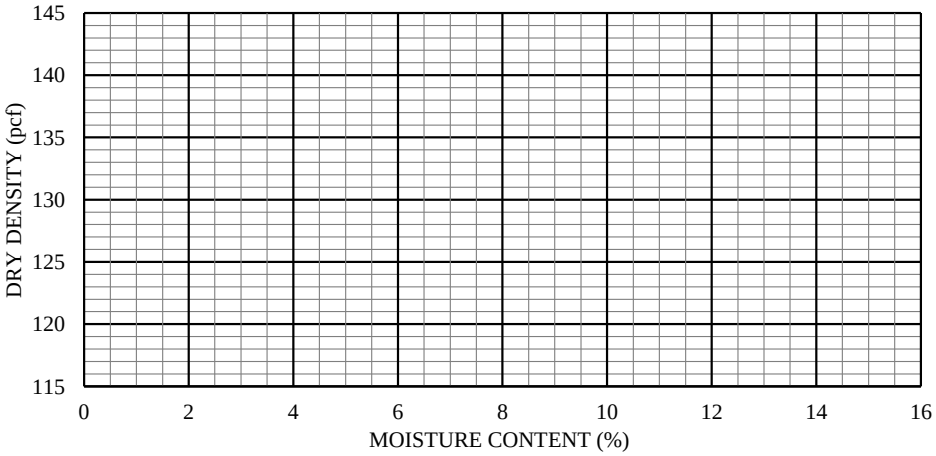
UNIFORMITY COEFFICIENT (C_u)	**40.1**
COEFFICIENT OF GRADATION (C_c)	**3.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**81**	
19.00	3/4"	**61**	
12.70	1/2"	**49**	
9.50	3/8"	**42**	
4.75	#4	**29**	
2.00	#10	**19**	
0.85	#20	**14**	
0.43	#40	**10**	
0.25	#60	**7**	
0.15	#100	**5**	
0.075	#200	**4.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

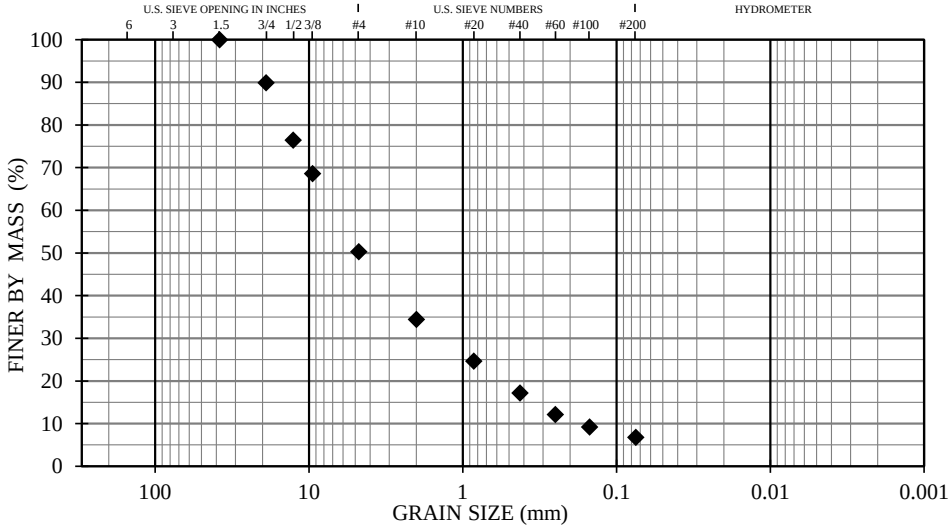
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**49.8**	USCS	**GW-GM**
% SAND	**43.5**	USACOE FC	**N/A**
% SILT/CLAY	**6.7**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**6.4**	% PASS. 0.002 mm	**N/A**

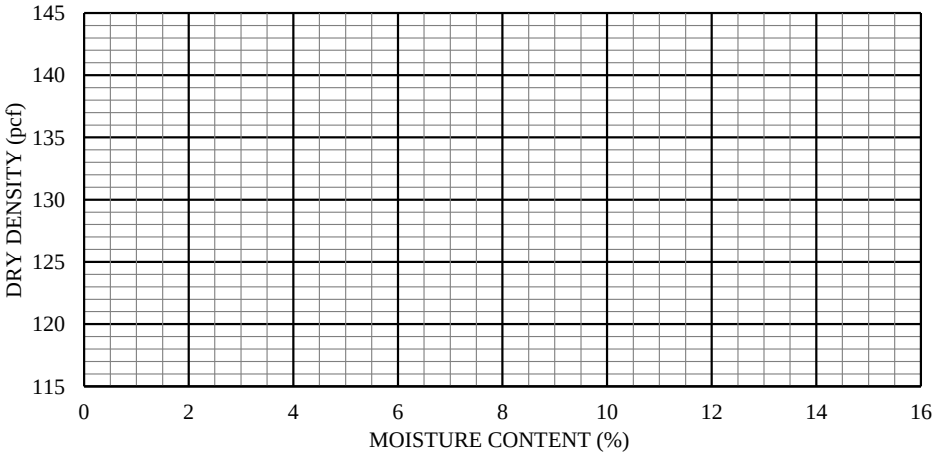
UNIFORMITY COEFFICIENT (C_u)	**40.9**
COEFFICIENT OF GRADATION (C_c)	**1.7**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**90**	
12.70	1/2"	**76**	
9.50	3/8"	**69**	
4.75	#4	**50**	
2.00	#10	**34**	
0.85	#20	**25**	
0.43	#40	**17**	
0.25	#60	**12**	
0.15	#100	**9**	
0.075	#200	**6.7**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

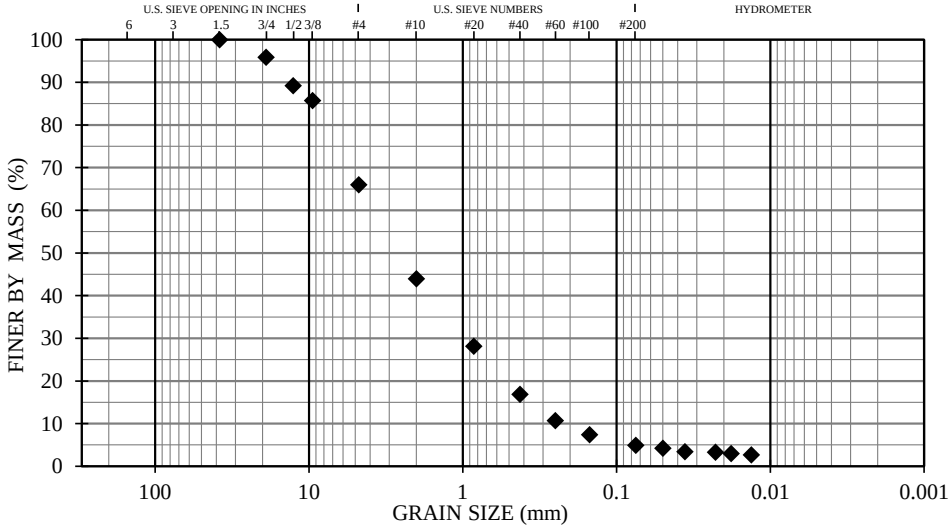
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**34.0**	USCS	**SW**
% SAND	**61.1**	USACOE FC	**S2**
% SILT/CLAY	**4.9**	% PASS. 0.02 mm	**3.1**
% MOIST. CONTENT	**37.9**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**17.5**	
COEFFICIENT OF GRADATION (C_c)		**1.1**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

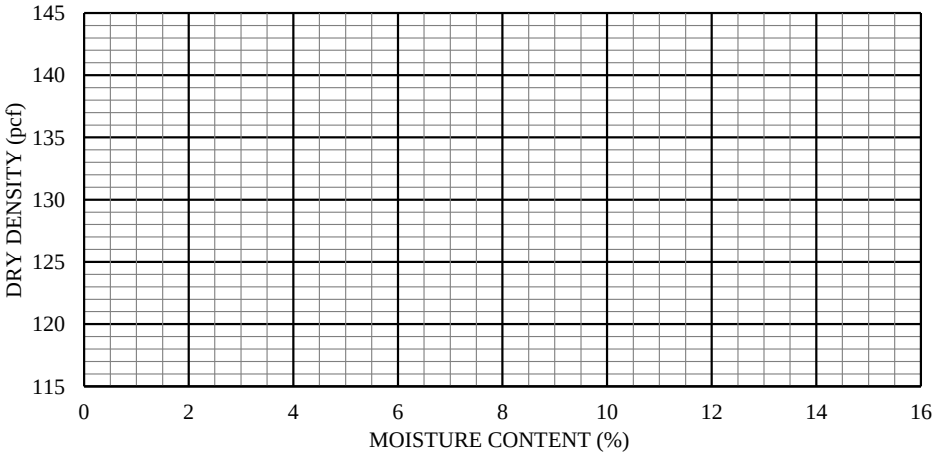


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**96**	
12.70	1/2"	**89**	
9.50	3/8"	**86**	
4.75	#4	**66**	
2.00	#10	**44**	
0.85	#20	**28**	
0.43	#40	**17**	
0.25	#60	**11**	
0.15	#100	**7**	
0.075	#200	**4.9**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0500	4.2
2	0.0360	3.4
5	0.0228	3.3
8	0.0180	3.0
15	0.0133	2.6
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

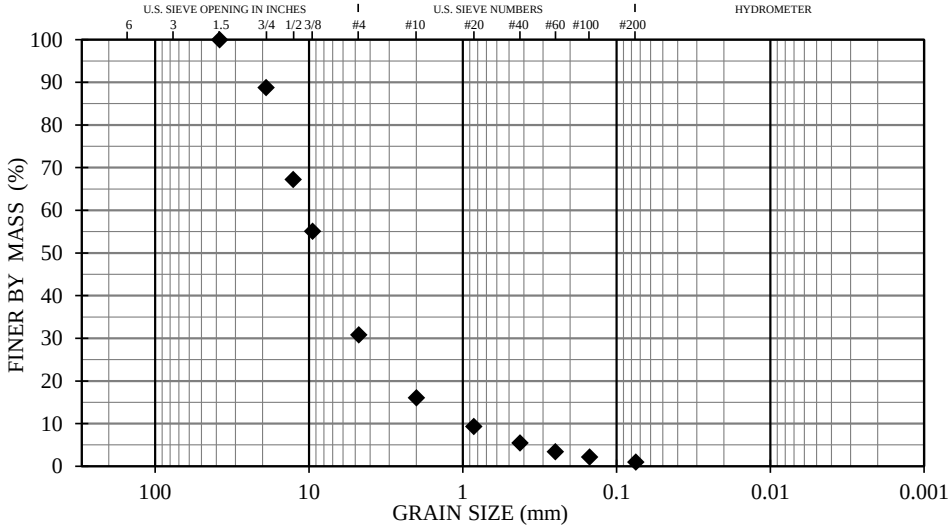
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20A**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**69.2**	USCS	**GW**
% SAND	**29.8**	USACOE FC	**N/A**
% SILT/CLAY	**1.0**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**5.9**	% PASS. 0.002 mm	**N/A**

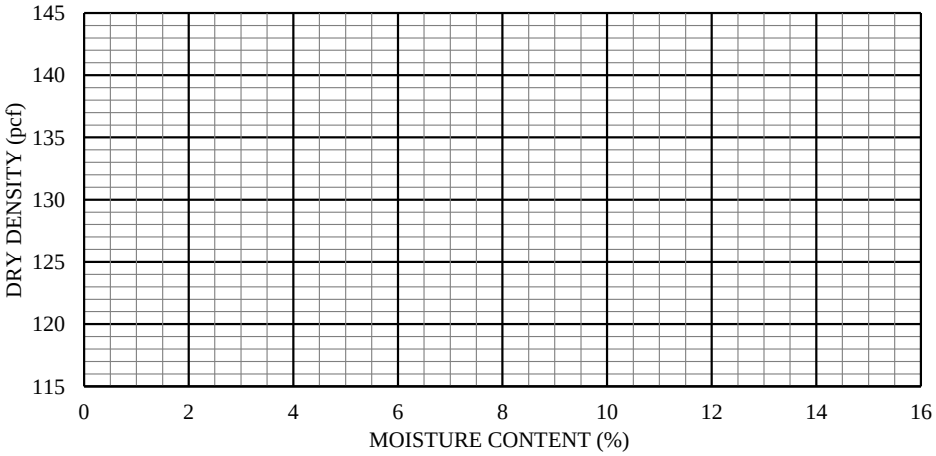
UNIFORMITY COEFFICIENT (C_u)	**11.2**
COEFFICIENT OF GRADATION (C_c)	**2.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**89**	
12.70	1/2"	**67**	
9.50	3/8"	**55**	
4.75	#4	**31**	
2.00	#10	**16**	
0.85	#20	**9**	
0.43	#40	**5**	
0.25	#60	**3**	
0.15	#100	**2**	
0.075	#200	**1.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

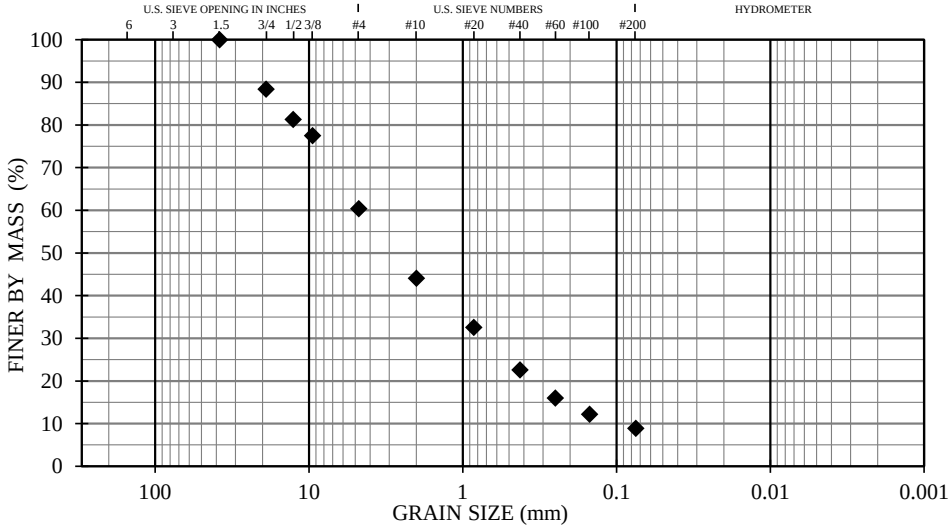
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**39.6**	USCS	**SW-SM**
% SAND	**51.5**	USACOE FC	**N/A**
% SILT/CLAY	**8.9**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**5.7**	% PASS. 0.002 mm	**N/A**

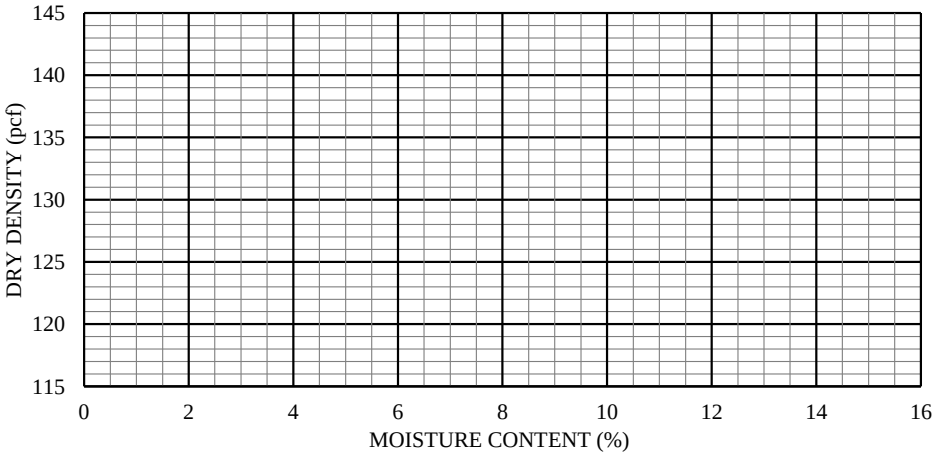
UNIFORMITY COEFFICIENT (C_u)	**46.7**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**88**	
12.70	1/2"	**81**	
9.50	3/8"	**77**	
4.75	#4	**60**	
2.00	#10	**44**	
0.85	#20	**33**	
0.43	#40	**23**	
0.25	#60	**16**	
0.15	#100	**12**	
0.075	#200	**8.9**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

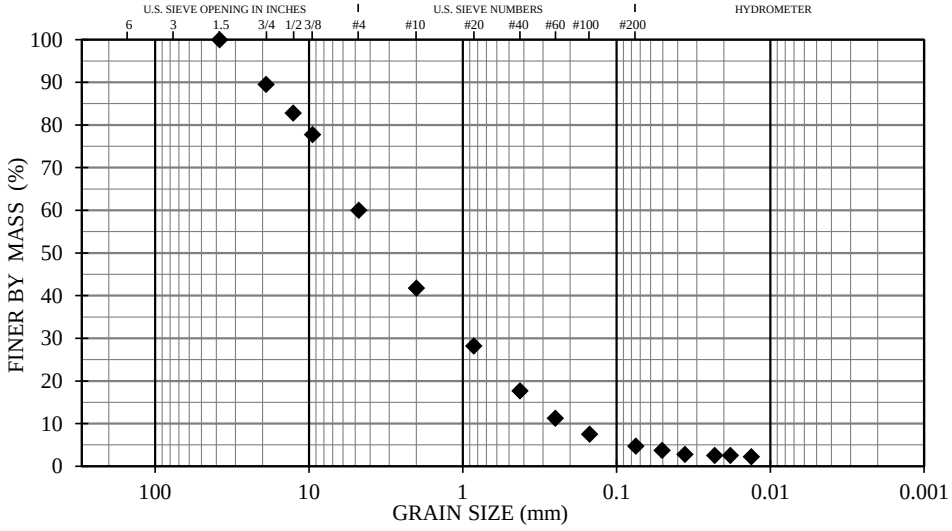
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Poorly-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

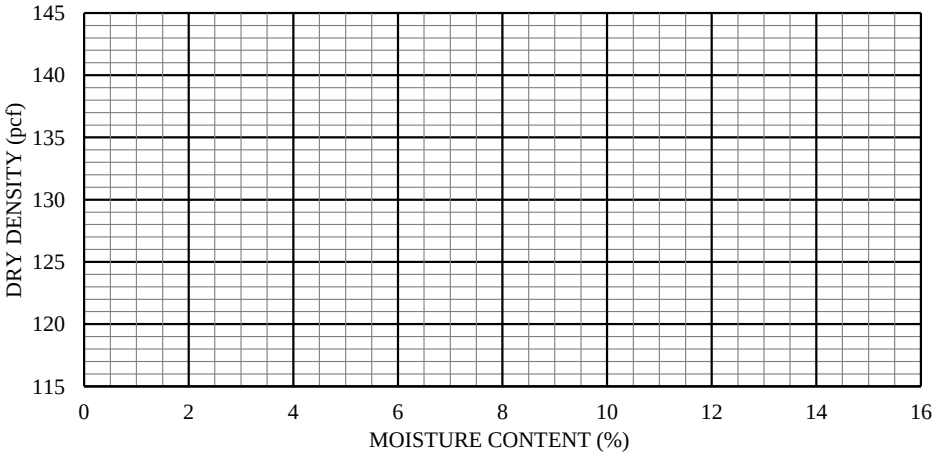
% GRAVEL	**40.0**	USCS	**SP**
% SAND	**55.3**	USACOE FC	**NFS**
% SILT/CLAY	**4.7**	% PASS. 0.02 mm	**2.6**
% MOIST. CONTENT	**9.1**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**21.9**	
COEFFICIENT OF GRADATION (C_c)		**1.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**90**	
12.70	1/2"	**83**	
9.50	3/8"	**78**	
4.75	#4	**60**	
2.00	#10	**42**	
0.85	#20	**28**	
0.43	#40	**18**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**4.7**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0505	3.7
2	0.0360	2.8
5	0.0230	2.5
8	0.0182	2.5
15	0.0133	2.2
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

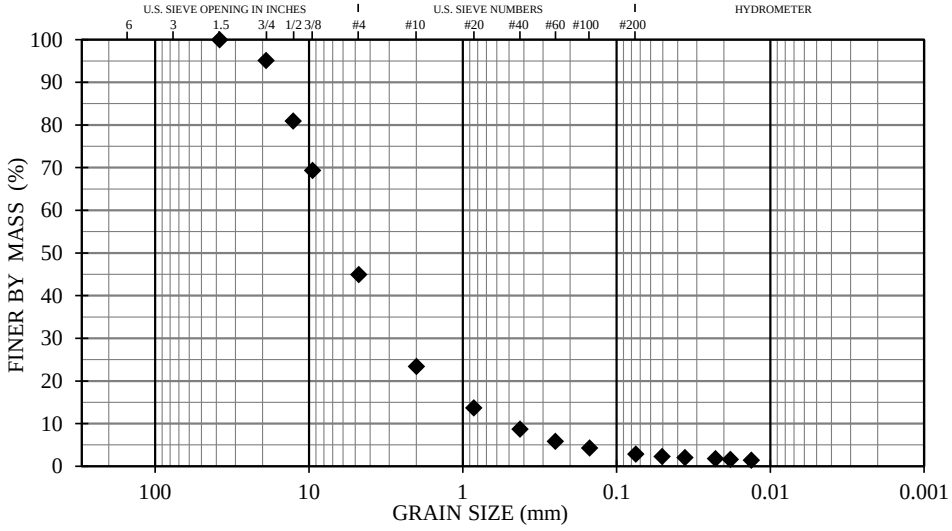
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**55.1**	USCS	**GW**
% SAND	**42.1**	USACOE FC	**PFS**
% SILT/CLAY	**2.8**	% PASS. 0.02 mm	**1.7**
% MOIST. CONTENT	**7.0**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**14.3**	
COEFFICIENT OF GRADATION (C_c)		**2.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

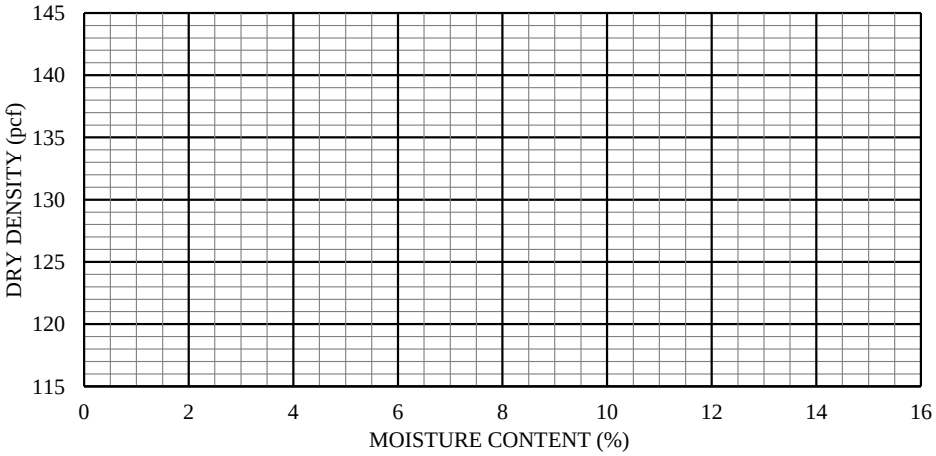


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**95**	
12.70	1/2"	**81**	
9.50	3/8"	**69**	
4.75	#4	**45**	
2.00	#10	**23**	
0.85	#20	**14**	
0.43	#40	**9**	
0.25	#60	**6**	
0.15	#100	**4**	
0.075	#200	**2.8**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0505	2.3
2	0.0360	2.0
5	0.0228	1.8
8	0.0182	1.6
15	0.0133	1.4
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

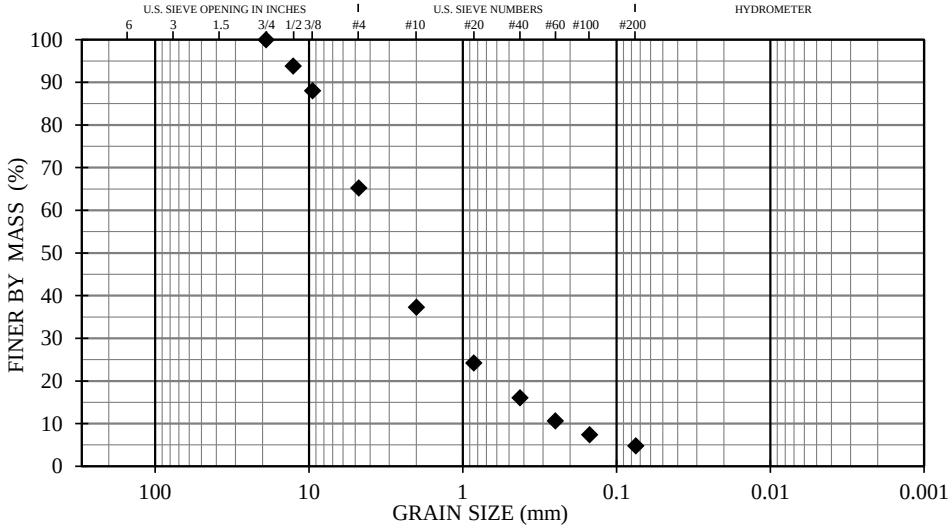
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP20B**
NUMBER/ DEPTH:	**S6 / 15 - 16.5'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

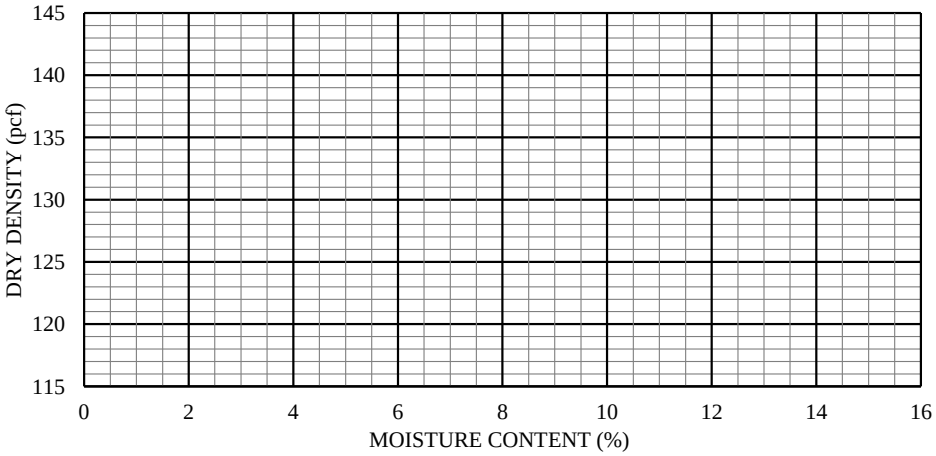
% GRAVEL	**34.8**	USCS	**SW**
% SAND	**60.4**	USACOE FC	**N/A**
% SILT/CLAY	**4.8**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**11.8**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**18.4**	
COEFFICIENT OF GRADATION (C_c)		**1.9**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"	**100**	
12.70	1/2"	**94**	
9.50	3/8"	**88**	
4.75	#4	**65**	
2.00	#10	**37**	
0.85	#20	**24**	
0.43	#40	**16**	
0.25	#60	**11**	
0.15	#100	**7**	
0.075	#200	**4.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

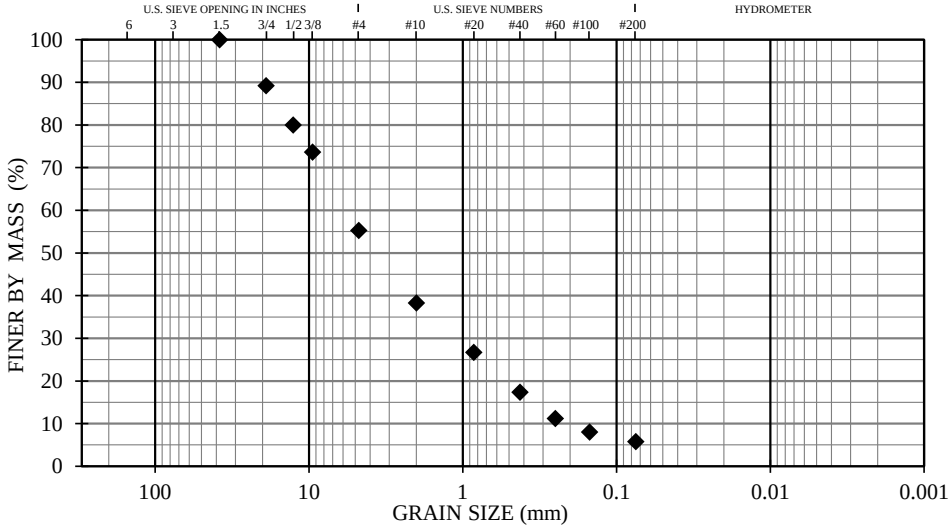
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**44.7**	USCS	**SW-SM**
% SAND	**49.5**	USACOE FC	**N/A**
% SILT/CLAY	**5.8**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.0**	% PASS. 0.002 mm	**N/A**

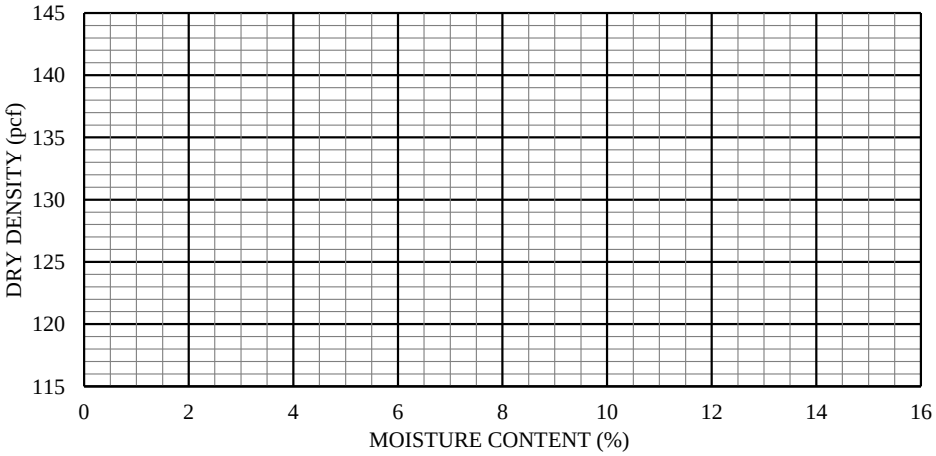
UNIFORMITY COEFFICIENT (C_u)	**28.2**
COEFFICIENT OF GRADATION (C_c)	**1.1**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**89**	
12.70	1/2"	**80**	
9.50	3/8"	**74**	
4.75	#4	**55**	
2.00	#10	**38**	
0.85	#20	**27**	
0.43	#40	**17**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**5.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

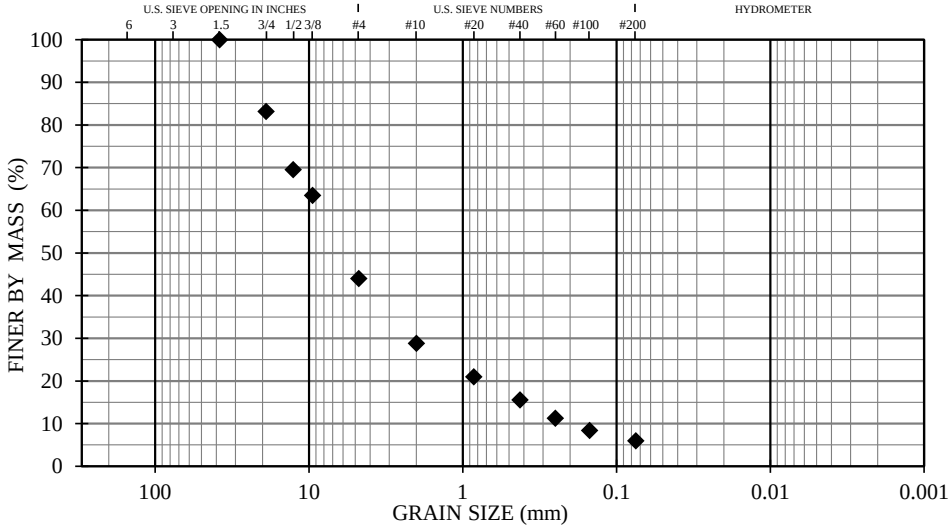
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**56.0**	USCS	**GW-GM**
% SAND	**38.0**	USACOE FC	**N/A**
% SILT/CLAY	**6.0**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**5.8**	% PASS. 0.002 mm	**N/A**

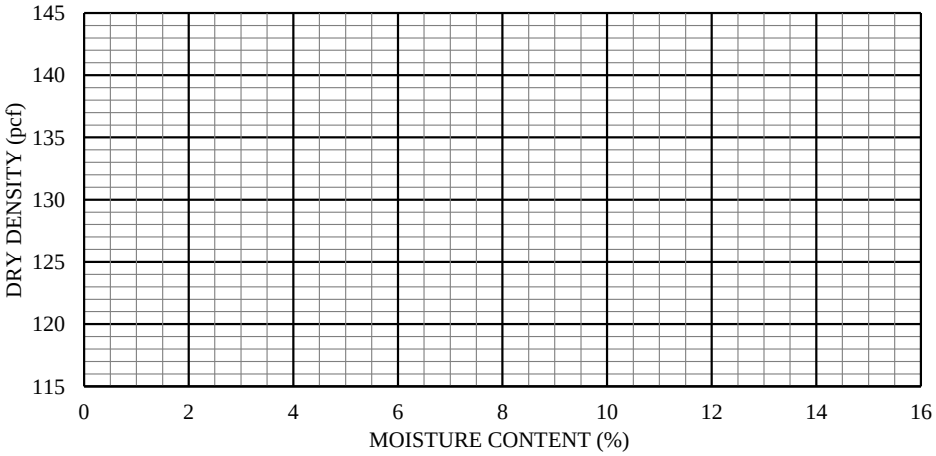
UNIFORMITY COEFFICIENT (C_u)	**41.8**
COEFFICIENT OF GRADATION (C_c)	**2.7**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**83**	
12.70	1/2"	**70**	
9.50	3/8"	**63**	
4.75	#4	**44**	
2.00	#10	**29**	
0.85	#20	**21**	
0.43	#40	**16**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**6.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

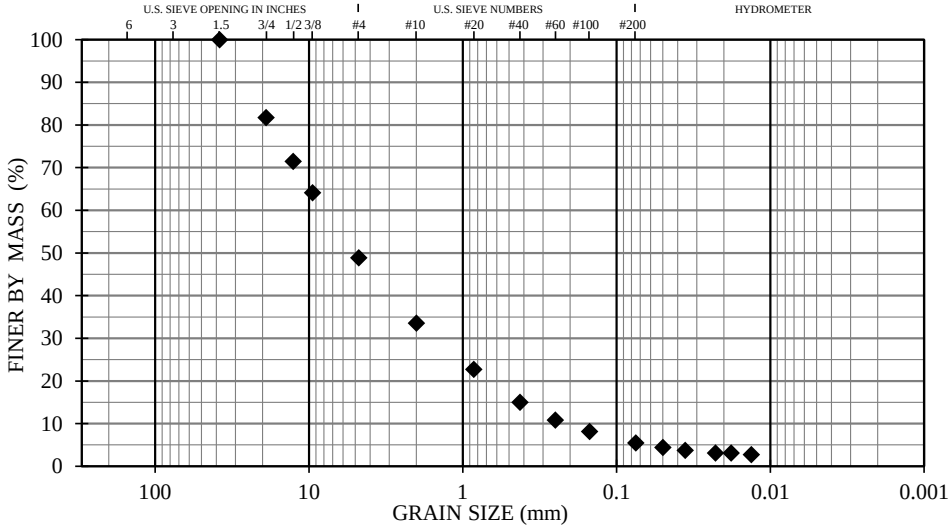
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22A**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**51.1**	USCS	**GW-GM**
% SAND	**43.4**	USACOE FC	**S1**
% SILT/CLAY	**5.5**	% PASS. 0.02 mm	**3.2**
% MOIST. CONTENT	**6.6**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**37.4**	
COEFFICIENT OF GRADATION (C_c)		**1.5**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

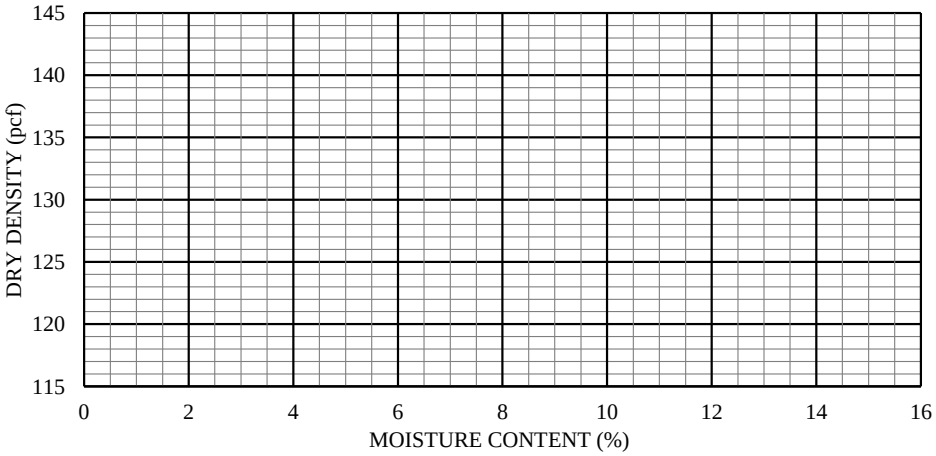


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**82**	
12.70	1/2"	**71**	
9.50	3/8"	**64**	
4.75	#4	**49**	
2.00	#10	**34**	
0.85	#20	**23**	
0.43	#40	**15**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**5.5**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0500	4.4
2	0.0357	3.7
5	0.0228	3.1
8	0.0180	3.1
15	0.0133	2.8
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

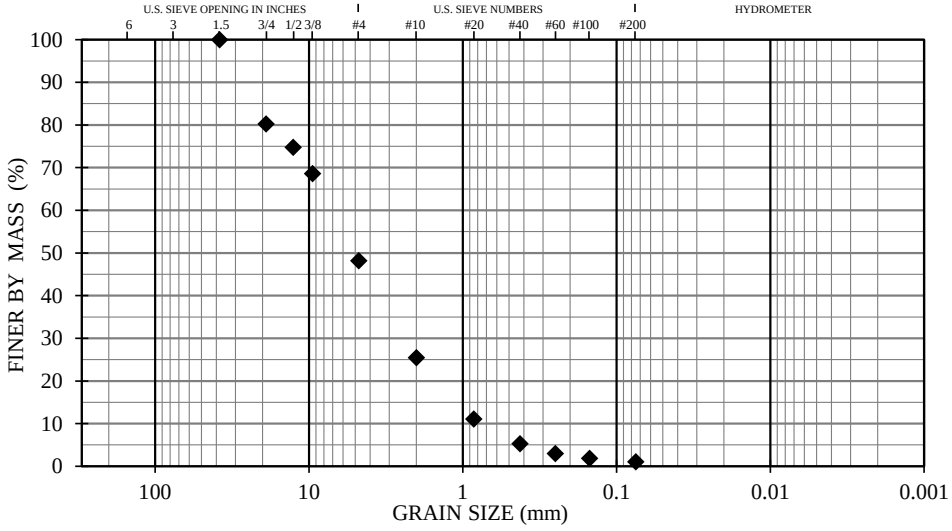
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22A**
NUMBER/ DEPTH:	**S6 / 15 - 16.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**51.8**	USCS	**GW**
% SAND	**47.2**	USACOE FC	**N/A**
% SILT/CLAY	**1.0**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.1**	% PASS. 0.002 mm	**N/A**

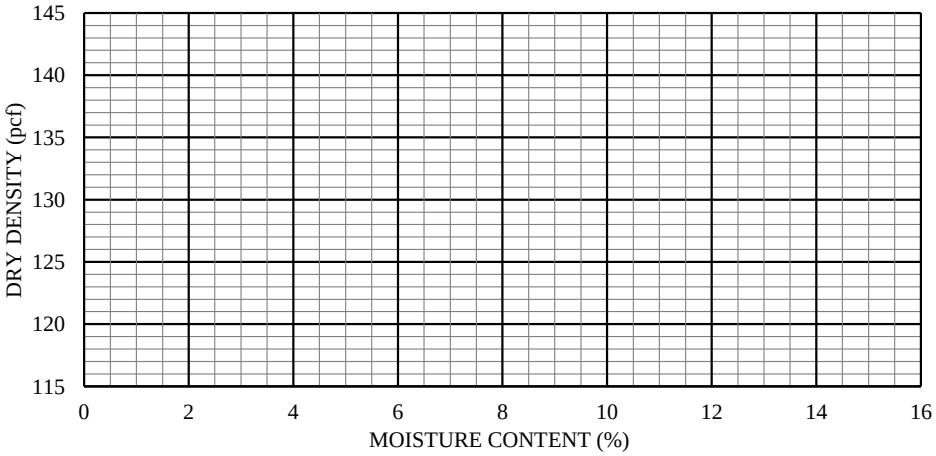
UNIFORMITY COEFFICIENT (C_u)	**9.7**
COEFFICIENT OF GRADATION (C_c)	**1.1**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**80**	
12.70	1/2"	**75**	
9.50	3/8"	**69**	
4.75	#4	**48**	
2.00	#10	**25**	
0.85	#20	**11**	
0.43	#40	**5**	
0.25	#60	**3**	
0.15	#100	**2**	
0.075	#200	**1.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

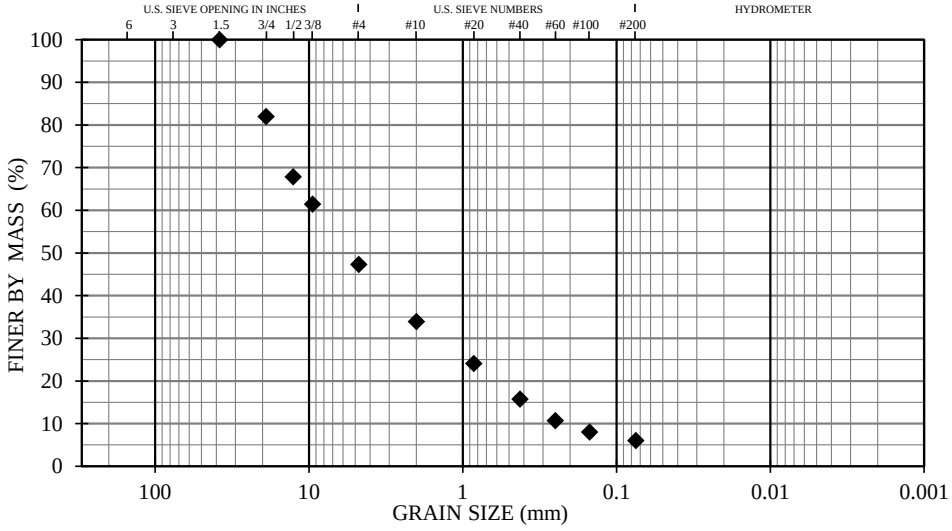
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**52.7**	USCS	**GW-GM**
% SAND	**41.3**	USACOE FC	**N/A**
% SILT/CLAY	**6.0**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.1**	% PASS. 0.002 mm	**N/A**

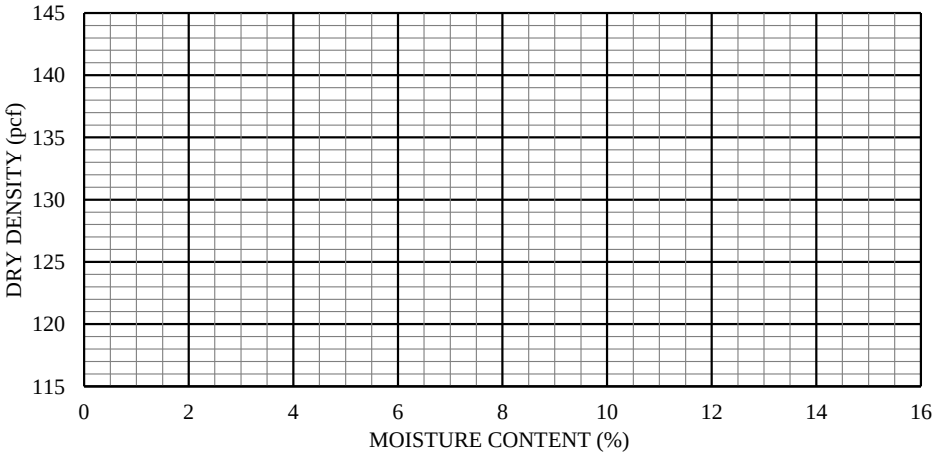
UNIFORMITY COEFFICIENT (C_u)	**40.2**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**82**	
12.70	1/2"	**68**	
9.50	3/8"	**61**	
4.75	#4	**47**	
2.00	#10	**34**	
0.85	#20	**24**	
0.43	#40	**16**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**6.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

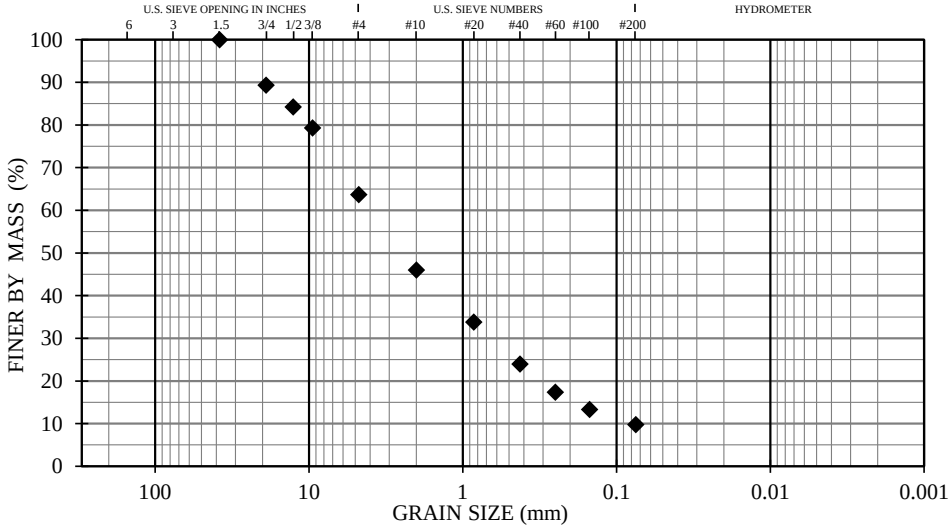
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**36.3**	USCS	**SW-SM**
% SAND	**54.0**	USACOE FC	**N/A**
% SILT/CLAY	**9.7**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**8.8**	% PASS. 0.002 mm	**N/A**

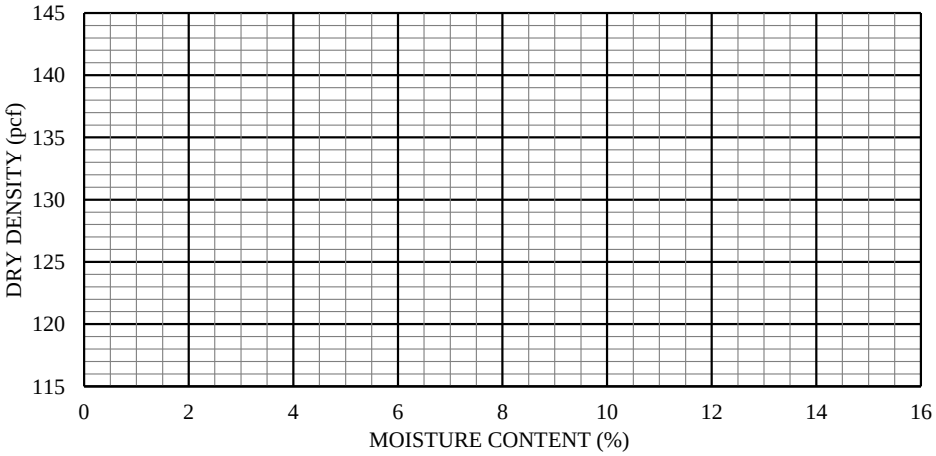
UNIFORMITY COEFFICIENT (C_u)	**52.0**
COEFFICIENT OF GRADATION (C_c)	**1.4**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**89**	
12.70	1/2"	**84**	
9.50	3/8"	**79**	
4.75	#4	**64**	
2.00	#10	**46**	
0.85	#20	**34**	
0.43	#40	**24**	
0.25	#60	**17**	
0.15	#100	**13**	
0.075	#200	**9.7**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

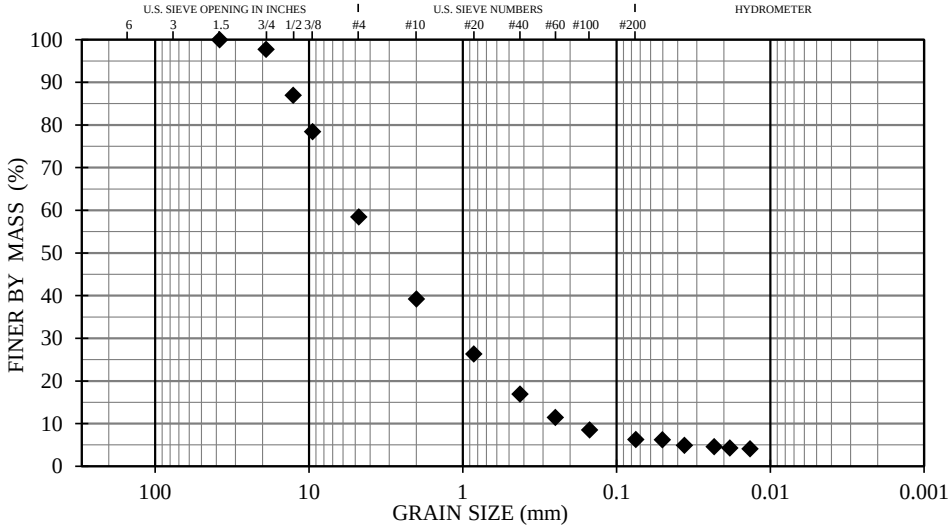
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**41.5**	USCS	**SW-SM**
% SAND	**52.2**	USACOE FC	**S2**
% SILT/CLAY	**6.3**	% PASS. 0.02 mm	**4.3**
% MOIST. CONTENT	**7.0**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**25.5**	
COEFFICIENT OF GRADATION (C_c)		**1.4**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

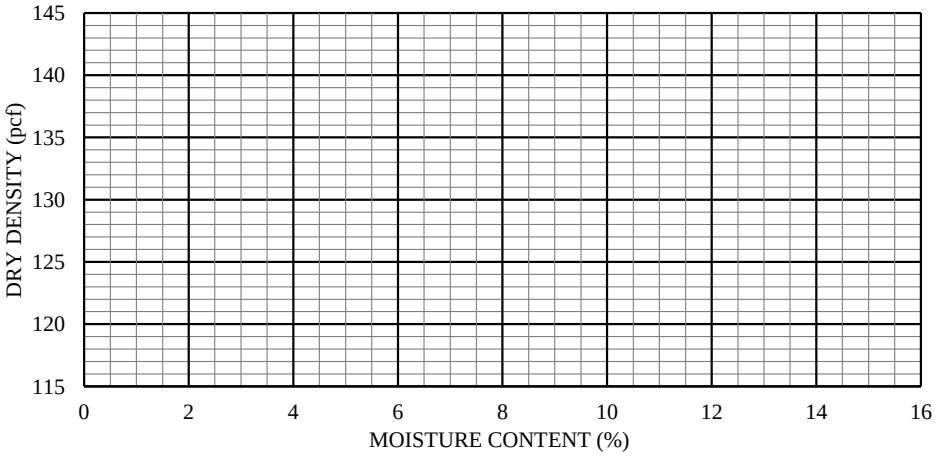


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**98**	
12.70	1/2"	**87**	
9.50	3/8"	**78**	
4.75	#4	**58**	
2.00	#10	**39**	
0.85	#20	**26**	
0.43	#40	**17**	
0.25	#60	**11**	
0.15	#100	**9**	
0.075	#200	**6.3**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0503	6.2
2	0.0363	4.9
5	0.0232	4.6
8	0.0183	4.3
15	0.0135	4.1
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

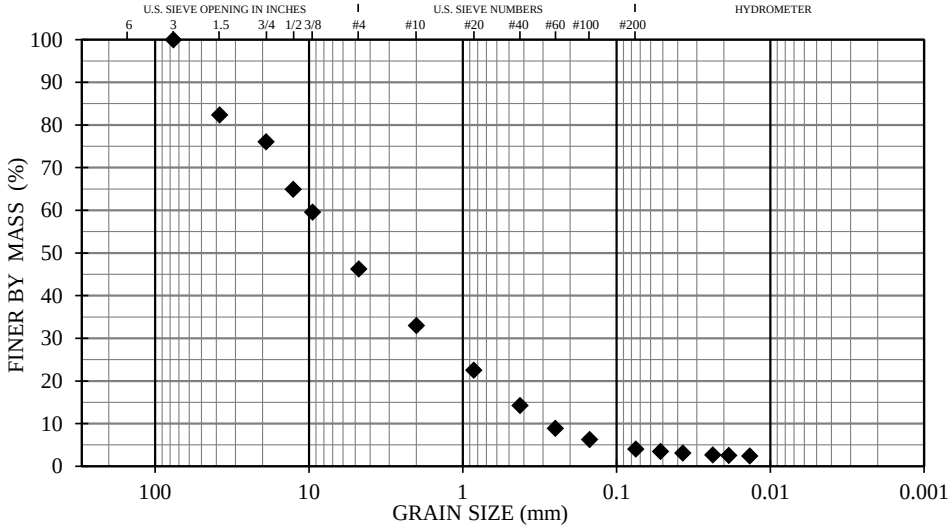
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP22B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**53.8**	USCS	**GW**
% SAND	**42.2**	USACOE FC	**PFS**
% SILT/CLAY	**4.0**	% PASS. 0.02 mm	**2.6**
% MOIST. CONTENT	**6.4**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**34.1**	
COEFFICIENT OF GRADATION (C_c)		**1.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

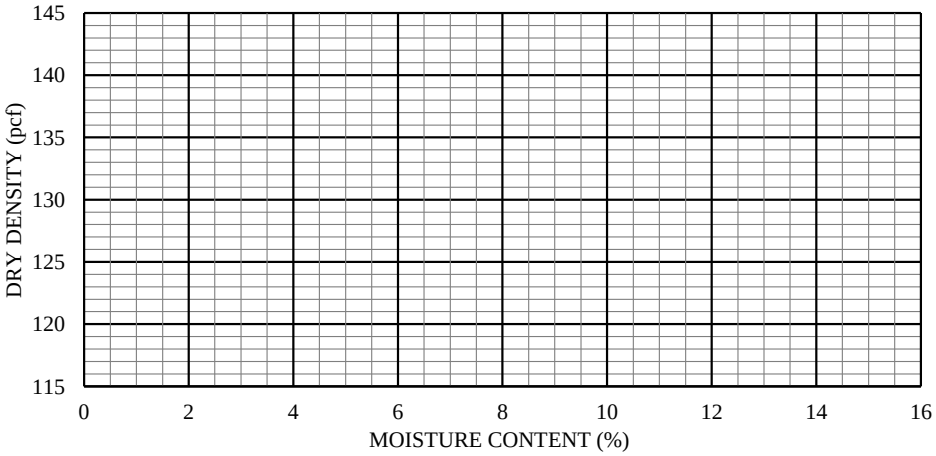


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**82**	
19.00	3/4"	**76**	
12.70	1/2"	**65**	
9.50	3/8"	**60**	
4.75	#4	**46**	
2.00	#10	**33**	
0.85	#20	**23**	
0.43	#40	**14**	
0.25	#60	**9**	
0.15	#100	**6**	
0.075	#200	**4.0**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0519	3.5
2	0.0371	3.1
5	0.0236	2.7
8	0.0187	2.5
15	0.0136	2.4
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

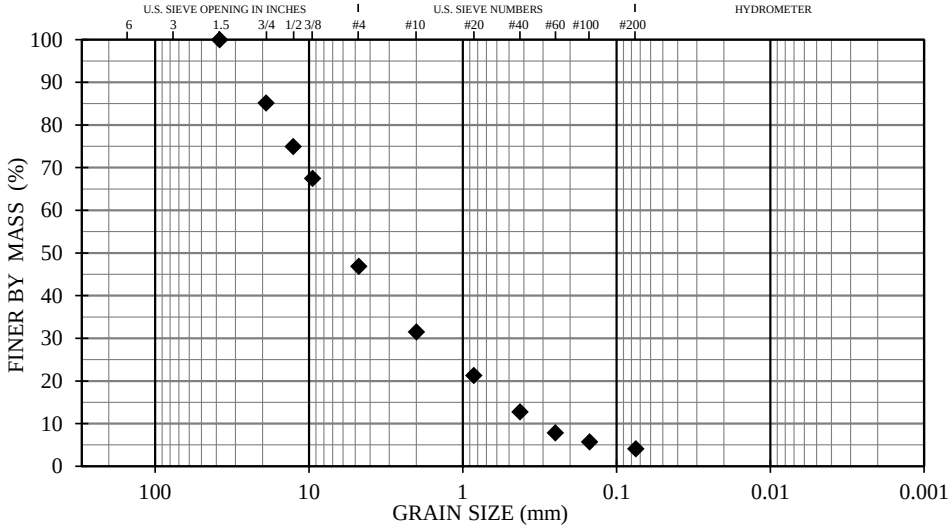
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**53.1**	USCS	**GW**
% SAND	**42.8**	USACOE FC	**N/A**
% SILT/CLAY	**4.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**3.4**	% PASS. 0.002 mm	**N/A**

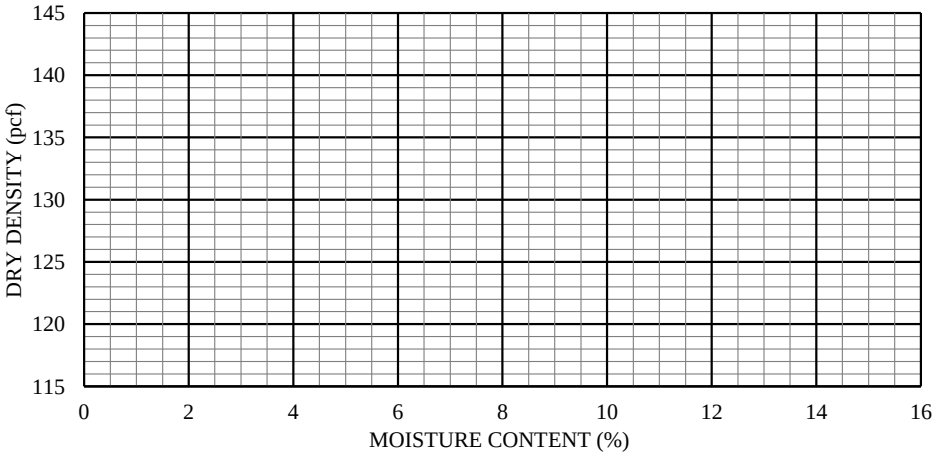
UNIFORMITY COEFFICIENT (C_u)	**23.8**
COEFFICIENT OF GRADATION (C_c)	**1.3**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**85**	
12.70	1/2"	**75**	
9.50	3/8"	**67**	
4.75	#4	**47**	
2.00	#10	**31**	
0.85	#20	**21**	
0.43	#40	**13**	
0.25	#60	**8**	
0.15	#100	**6**	
0.075	#200	**4.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

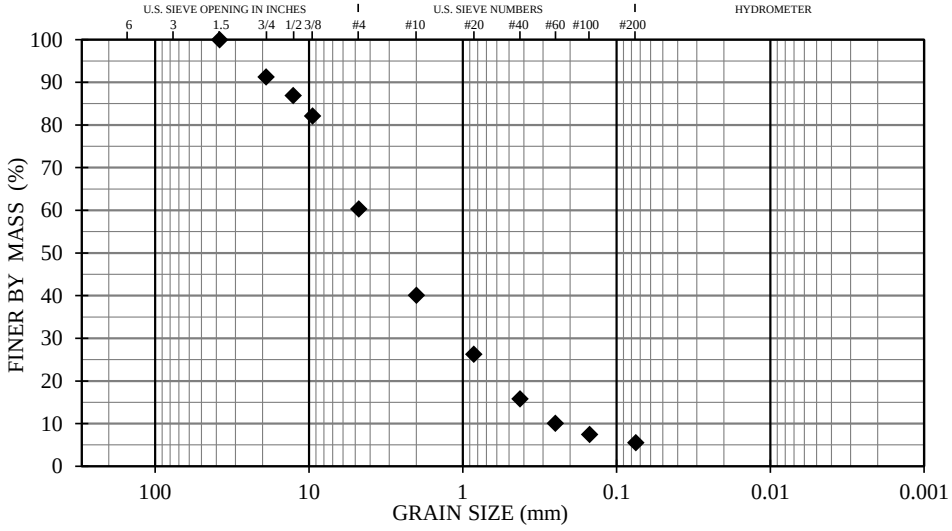
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**39.7**	USCS	**SW-SM**
% SAND	**54.8**	USACOE FC	**N/A**
% SILT/CLAY	**5.5**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.7**	% PASS. 0.002 mm	**N/A**

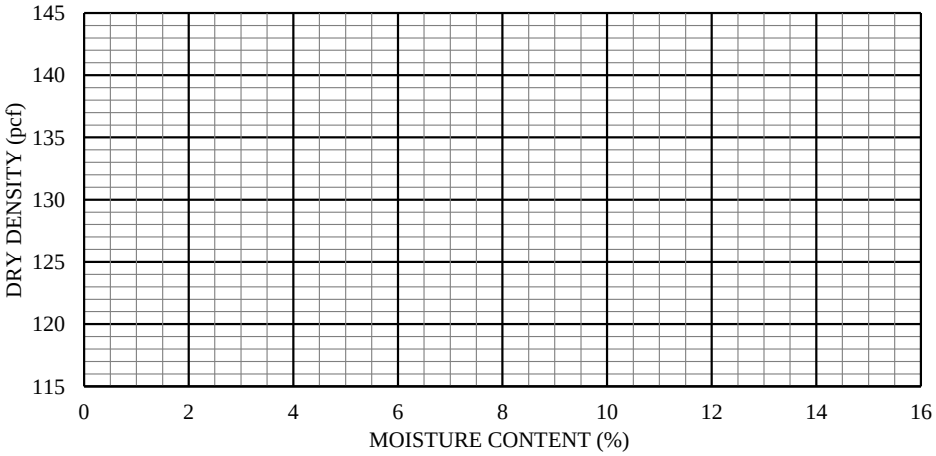
UNIFORMITY COEFFICIENT (C_u)	**19.1**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**91**	
12.70	1/2"	**87**	
9.50	3/8"	**82**	
4.75	#4	**60**	
2.00	#10	**40**	
0.85	#20	**26**	
0.43	#40	**16**	
0.25	#60	**10**	
0.15	#100	**7**	
0.075	#200	**5.5**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

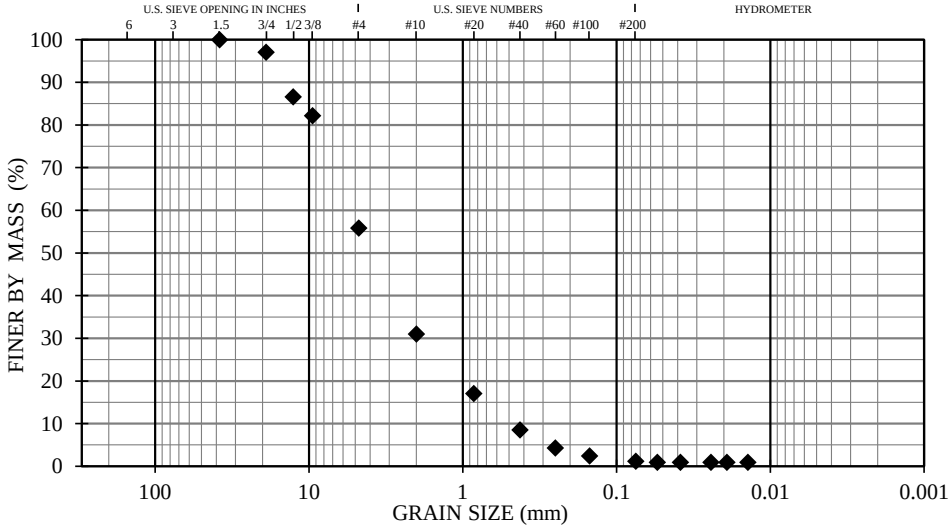
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

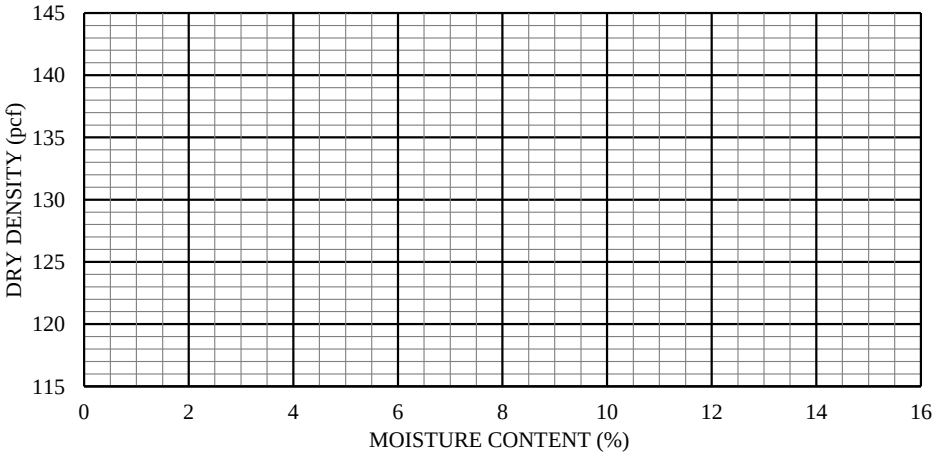
% GRAVEL	**44.2**	USCS	**SW**
% SAND	**54.6**	USACOE FC	**NFS**
% SILT/CLAY	**1.2**	% PASS. 0.02 mm	**0.9**
% MOIST. CONTENT	**8.1**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**11.0**	
COEFFICIENT OF GRADATION (C_c)		**1.3**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**97**	
12.70	1/2"	**87**	
9.50	3/8"	**82**	
4.75	#4	**56**	
2.00	#10	**31**	
0.85	#20	**17**	
0.43	#40	**8**	
0.25	#60	**4**	
0.15	#100	**2**	
0.075	#200	**1.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0543	0.9
2	0.0384	0.9
5	0.0243	0.9
8	0.0192	0.9
15	0.0140	0.9
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

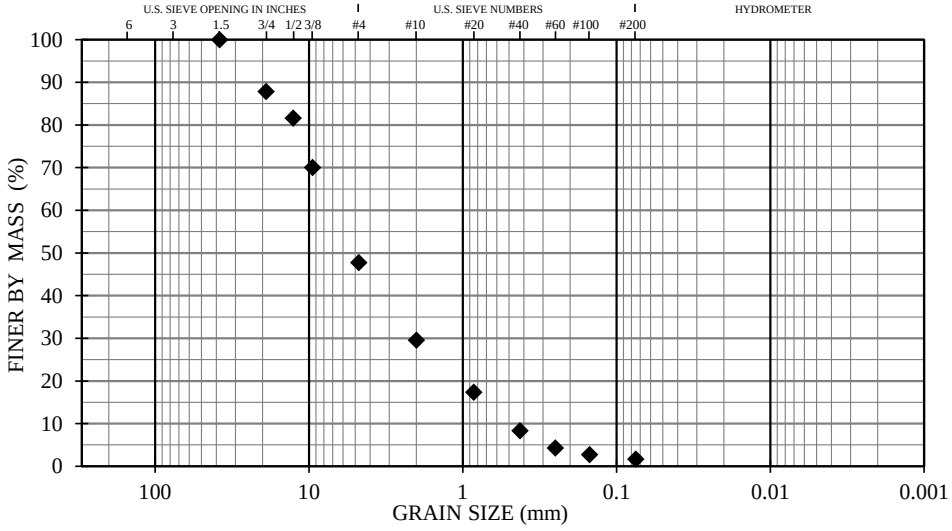
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25A**
NUMBER/ DEPTH:	**S5 / 12.5 - 14'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**52.2**	USCS	**GW**
% SAND	**46.1**	USACOE FC	**N/A**
% SILT/CLAY	**1.7**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**6.8**	% PASS. 0.002 mm	**N/A**

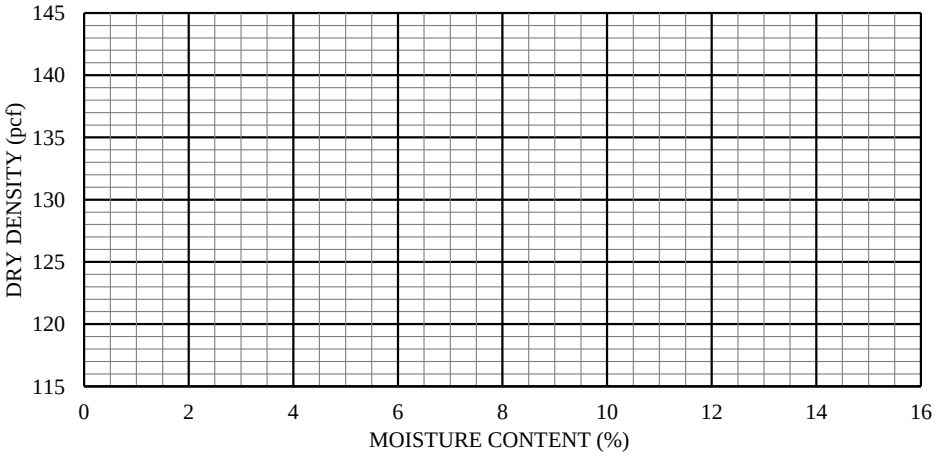
UNIFORMITY COEFFICIENT (C_u)	**14.6**
COEFFICIENT OF GRADATION (C_c)	**1.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**88**	
12.70	1/2"	**82**	
9.50	3/8"	**70**	
4.75	#4	**48**	
2.00	#10	**30**	
0.85	#20	**17**	
0.43	#40	**8**	
0.25	#60	**4**	
0.15	#100	**3**	
0.075	#200	**1.7**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

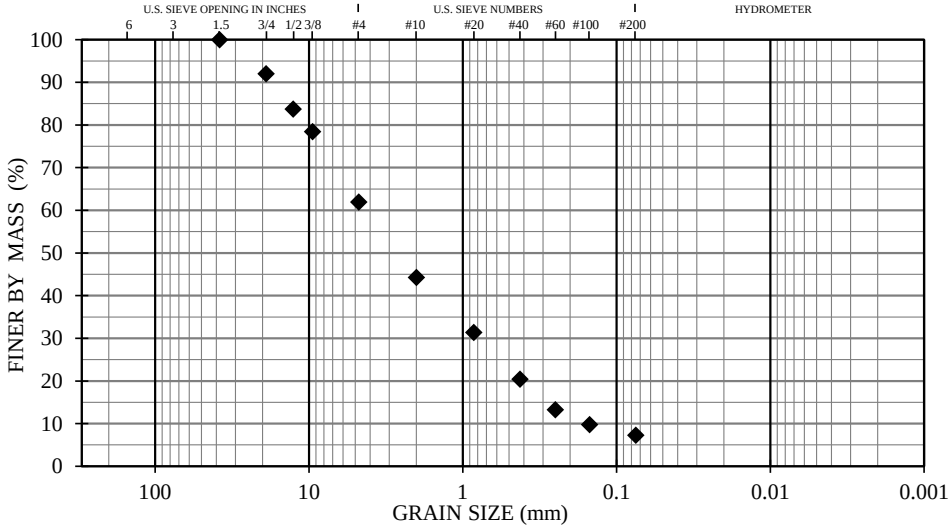
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Poorly-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**38.1**	USCS	**SP-SM**
% SAND	**54.6**	USACOE FC	**N/A**
% SILT/CLAY	**7.3**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**3.2**	% PASS. 0.002 mm	**N/A**

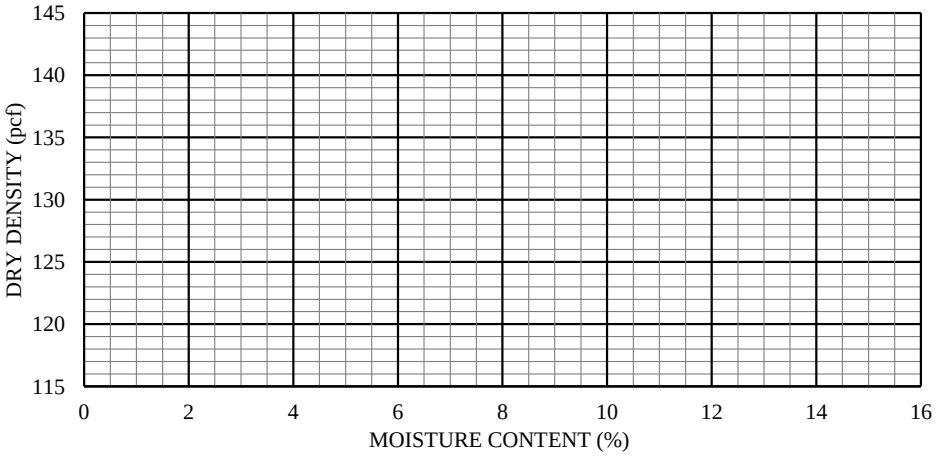
UNIFORMITY COEFFICIENT (C_u)	**28.5**
COEFFICIENT OF GRADATION (C_c)	**0.9**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**92**	
12.70	1/2"	**84**	
9.50	3/8"	**78**	
4.75	#4	**62**	
2.00	#10	**44**	
0.85	#20	**31**	
0.43	#40	**20**	
0.25	#60	**13**	
0.15	#100	**10**	
0.075	#200	**7.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

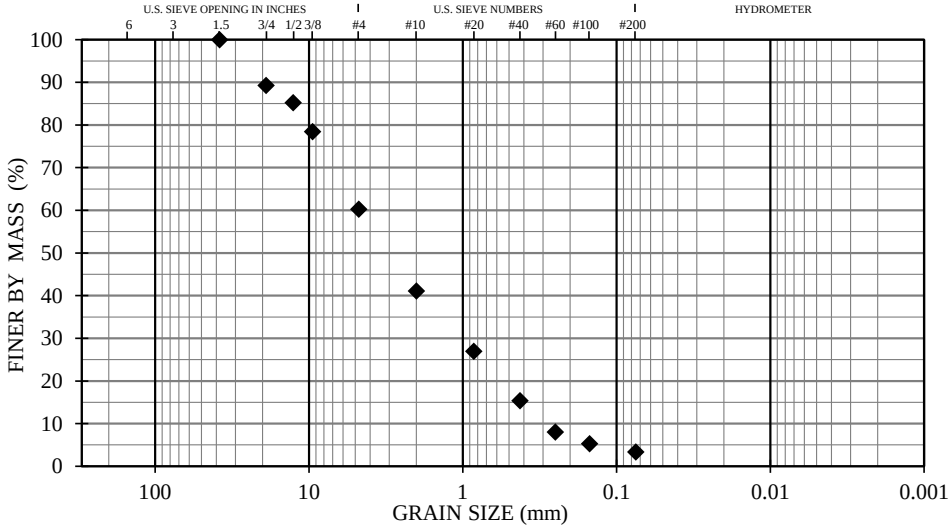
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Poorly-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

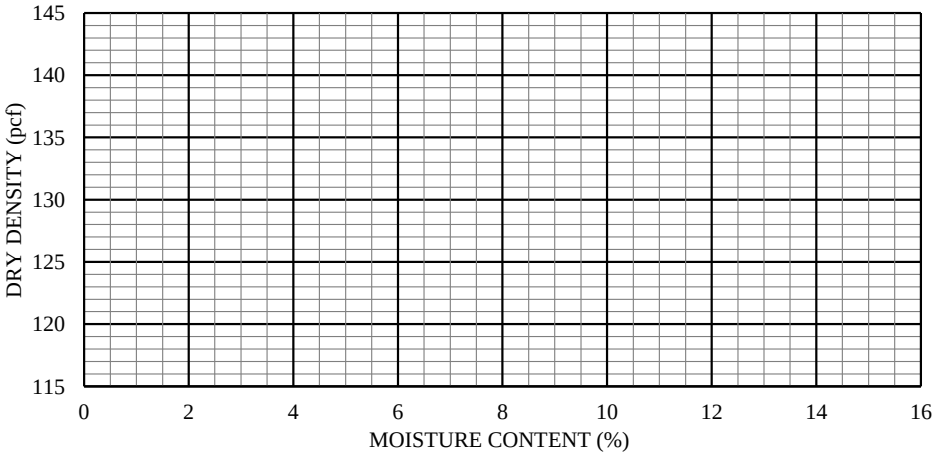
% GRAVEL	**39.8**	USCS	**SP**
% SAND	**56.9**	USACOE FC	**N/A**
% SILT/CLAY	**3.3**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**8.5**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**15.9**	
COEFFICIENT OF GRADATION (C_c)		**0.9**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**89**	
12.70	1/2"	**85**	
9.50	3/8"	**78**	
4.75	#4	**60**	
2.00	#10	**41**	
0.85	#20	**27**	
0.43	#40	**15**	
0.25	#60	**8**	
0.15	#100	**5**	
0.075	#200	**3.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

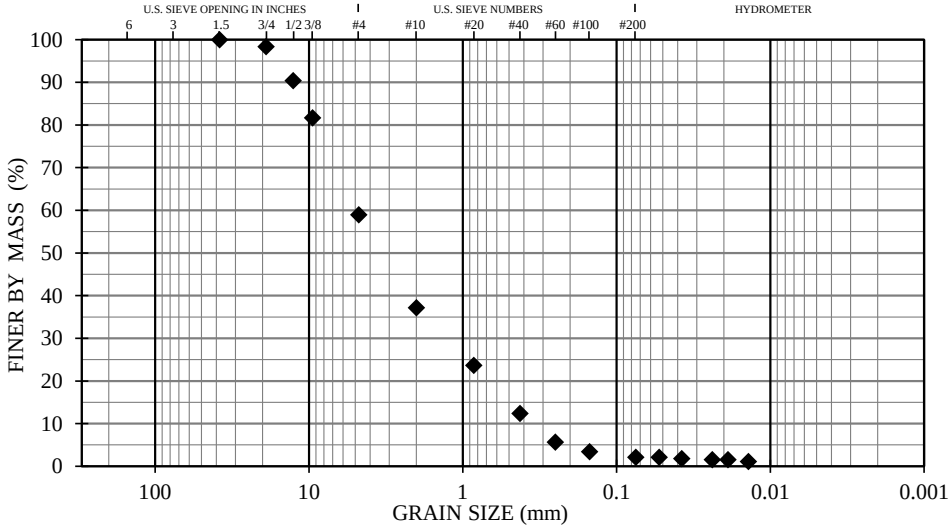
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP25B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**41.1**	USCS	**SW**
% SAND	**56.8**	USACOE FC	**NFS**
% SILT/CLAY	**2.1**	% PASS. 0.02 mm	**1.7**
% MOIST. CONTENT	**8.1**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**13.7**	
COEFFICIENT OF GRADATION (C_c)		**1.1**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

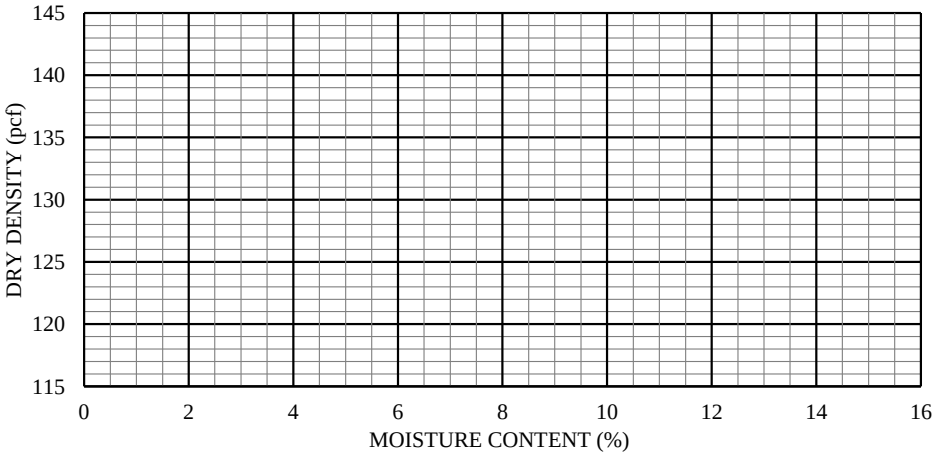
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**98**	
12.70	1/2"	**90**	
9.50	3/8"	**82**	
4.75	#4	**59**	
2.00	#10	**37**	
0.85	#20	**24**	
0.43	#40	**12**	
0.25	#60	**6**	
0.15	#100	**3**	
0.075	#200	**2.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0528	~~2.1~~
2	0.0378	1.8
5	0.0239	1.6
8	0.0189	1.6
15	0.0139	1.1
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

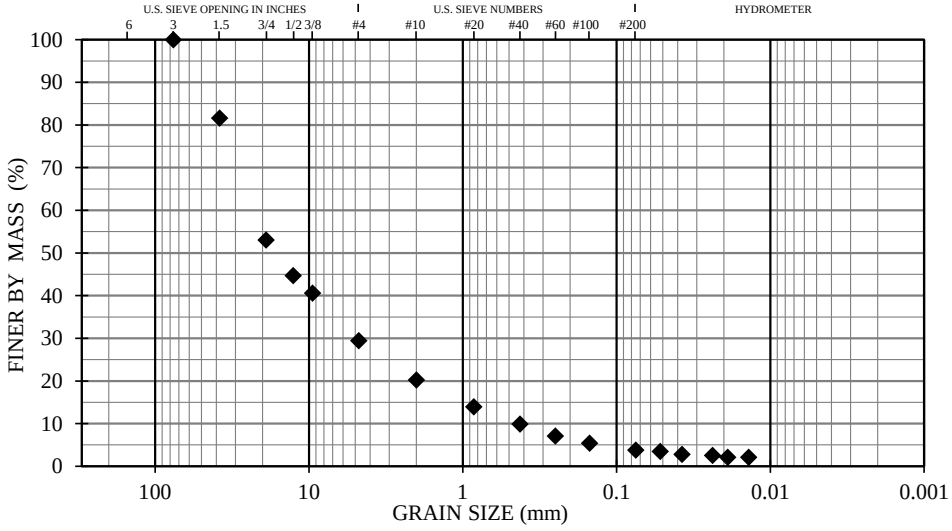
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP33A**
NUMBER/ DEPTH:	**S2 / 10 - 11.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**70.6**	USCS	**GW**
% SAND	**25.6**	USACOE FC	**PFS**
% SILT/CLAY	**3.8**	% PASS. 0.02 mm	**2.1**
% MOIST. CONTENT	**5.2**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**53.8**	
COEFFICIENT OF GRADATION (C_c)		**2.4**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

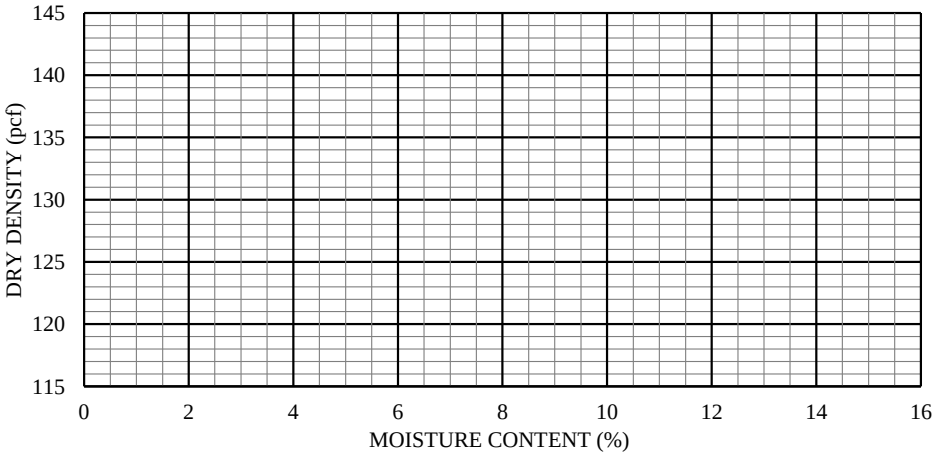


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**82**	
19.00	3/4"	**53**	
12.70	1/2"	**45**	
9.50	3/8"	**41**	
4.75	#4	**29**	
2.00	#10	**20**	
0.85	#20	**14**	
0.43	#40	**10**	
0.25	#60	**7**	
0.15	#100	**5**	
0.075	#200	**3.8**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0519	3.5
2	0.0376	2.8
5	0.0238	2.5
8	0.0189	2.1
15	0.0138	2.1
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

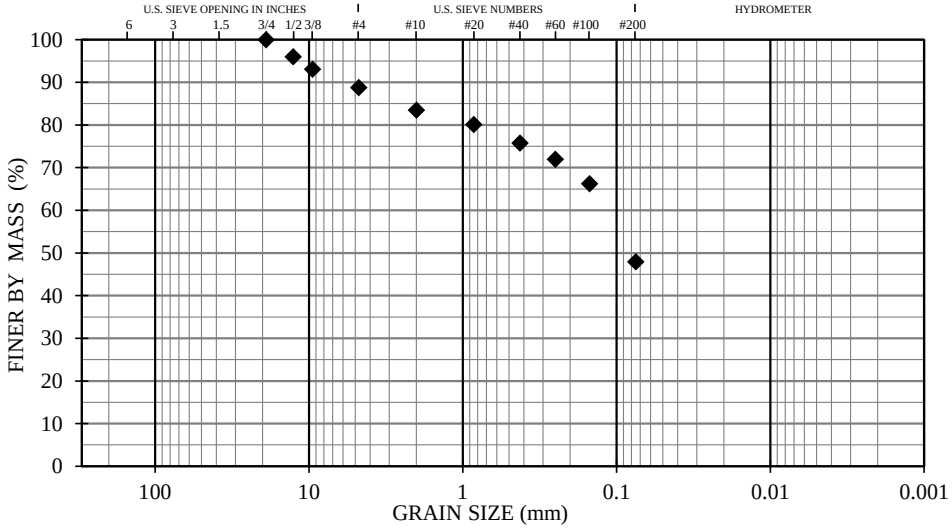
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP33A**
NUMBER/ DEPTH:	**S3 / 12.5 - 14'**
DESCRIPTION:	**Silty sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

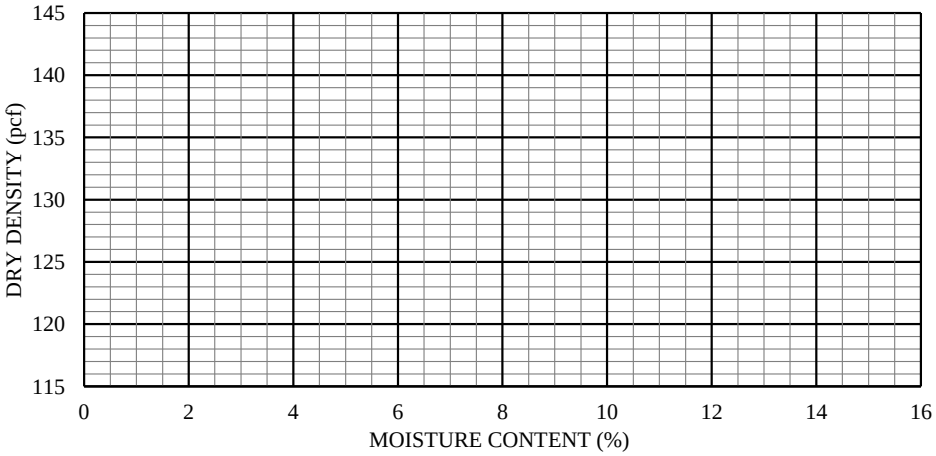
% GRAVEL	**11.2**	USCS	**SM**
% SAND	**40.9**	USACOE FC	**N/A**
% SILT/CLAY	**47.9**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**71.2**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)			**UNKNOWN**
COEFFICIENT OF GRADATION (C_c)			**UNKNOWN**
ASTM D1557 (uncorrected)			**N/A**
ASTM D4718 (corrected)			**N/A**
OPTIMUM MOIST. CONTENT. (corrected)			**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"	**100**	
12.70	1/2"	**96**	
9.50	3/8"	**93**	
4.75	#4	**89**	
2.00	#10	**83**	
0.85	#20	**80**	
0.43	#40	**76**	
0.25	#60	**72**	
0.15	#100	**66**	
0.075	#200	**47.9**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

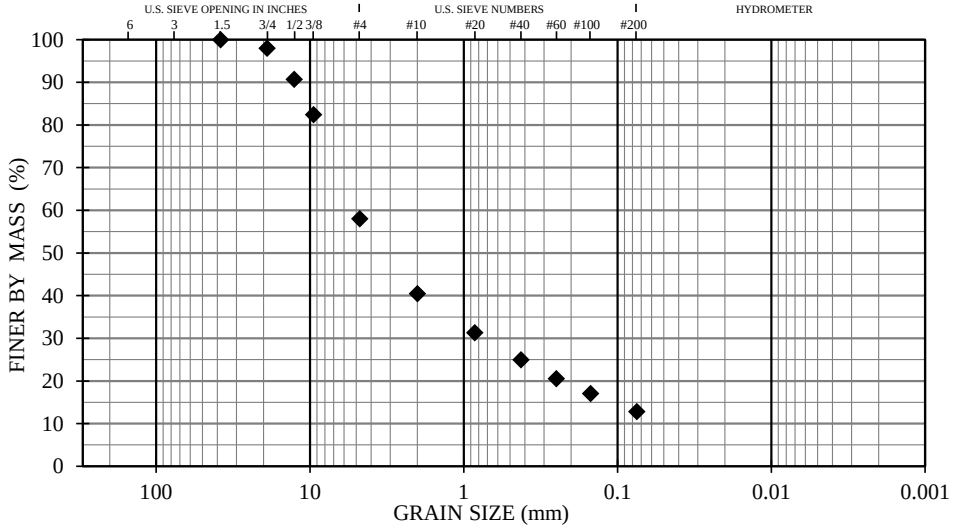
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP33B**
NUMBER/ DEPTH:	**S1 / 5 - 6.5'**
DESCRIPTION:	**Silty sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

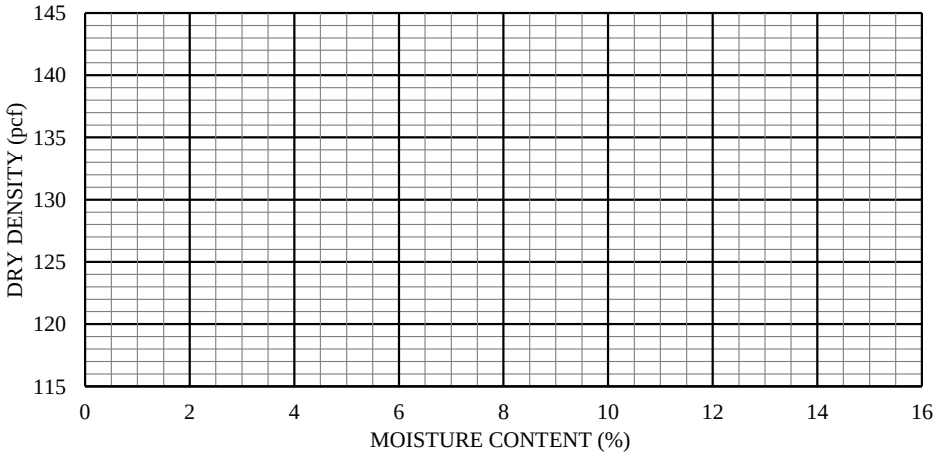
% GRAVEL	**42.0**	USCS	**SM**
% SAND	**45.2**	USACOE FC	**N/A**
% SILT/CLAY	**12.8**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**10.1**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)			**UNKNOWN**
COEFFICIENT OF GRADATION (C_c)			**UNKNOWN**
ASTM D1557 (uncorrected)			**N/A**
ASTM D4718 (corrected)			**N/A**
OPTIMUM MOIST. CONTENT. (corrected)			**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**98**	
12.70	1/2"	**91**	
9.50	3/8"	**82**	
4.75	#4	**58**	
2.00	#10	**40**	
0.85	#20	**31**	
0.43	#40	**25**	
0.25	#60	**21**	
0.15	#100	**17**	
0.075	#200	**12.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

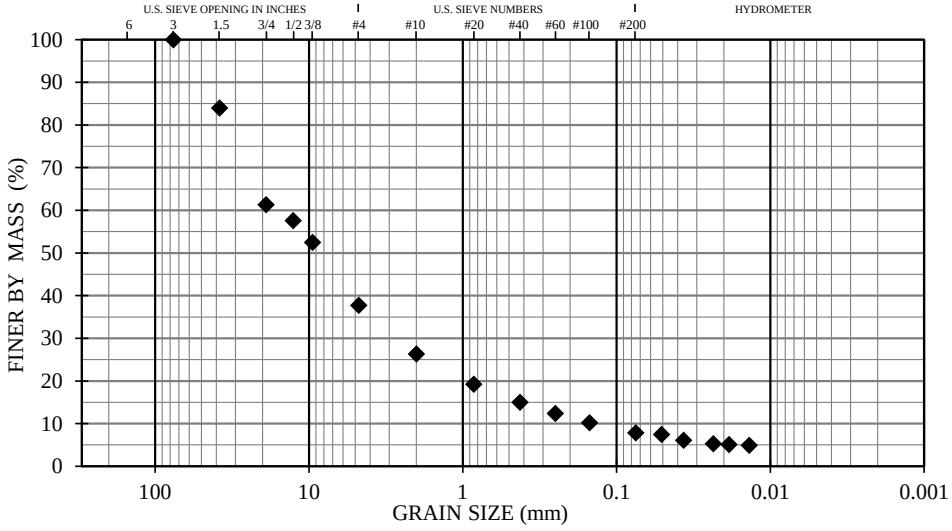
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP33B**
NUMBER/ DEPTH:	**S2 / 10 - 11.5'**
DESCRIPTION:	**Poorly-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

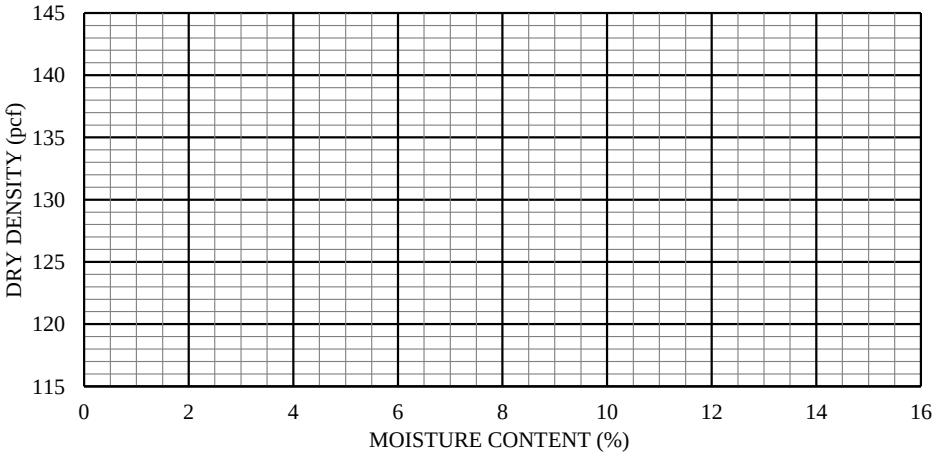
% GRAVEL	**62.3**	USCS	**GP-GM**
% SAND	**29.9**	USACOE FC	**S1**
% SILT/CLAY	**7.8**	% PASS. 0.02 mm	**5.1**
% MOIST. CONTENT	**8.6**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**116.9**	
COEFFICIENT OF GRADATION (C_c)		**3.4**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**84**	
19.00	3/4"	**61**	
12.70	1/2"	**58**	
9.50	3/8"	**52**	
4.75	#4	**38**	
2.00	#10	**26**	
0.85	#20	**19**	
0.43	#40	**15**	
0.25	#60	**12**	
0.15	#100	**10**	
0.075	#200	**7.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0509	7.4
2	0.0367	6.1
5	0.0235	5.3
8	0.0186	5.1
15	0.0137	4.9
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

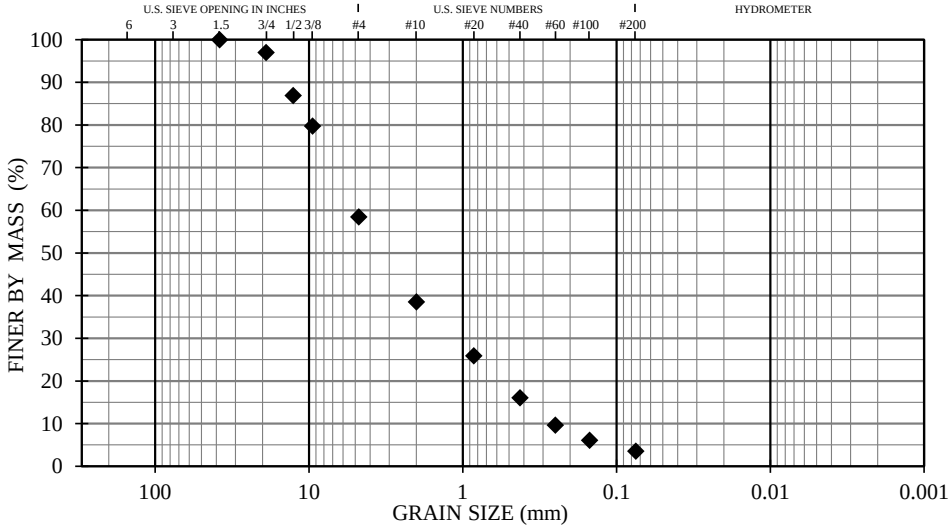
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP43A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJBC**
REVIEWED BY:	**SAM**

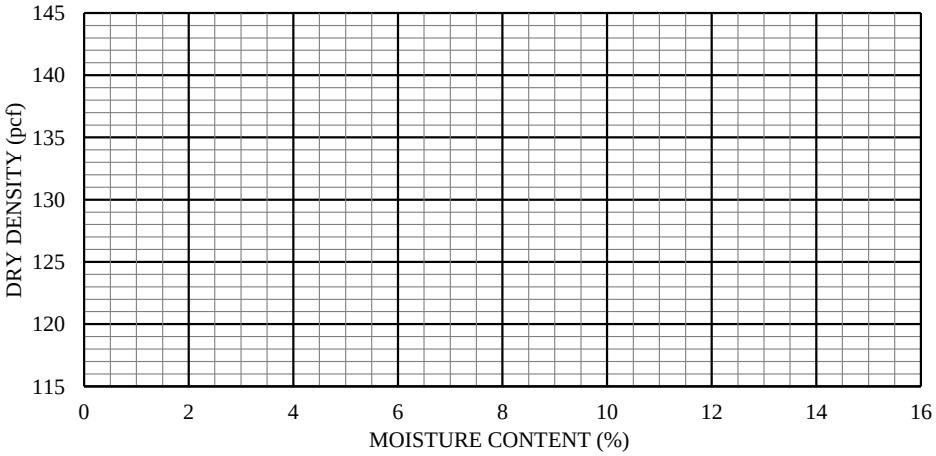
% GRAVEL	**41.5**	USCS	**SW**
% SAND	**55.0**	USACOE FC	**N/A**
% SILT/CLAY	**3.5**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.4**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**19.6**	
COEFFICIENT OF GRADATION (C_c)		**1.1**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**97**	
12.70	1/2"	**87**	
9.50	3/8"	**80**	
4.75	#4	**58**	
2.00	#10	**38**	
0.85	#20	**26**	
0.43	#40	**16**	
0.25	#60	**10**	
0.15	#100	**6**	
0.075	#200	**3.5**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

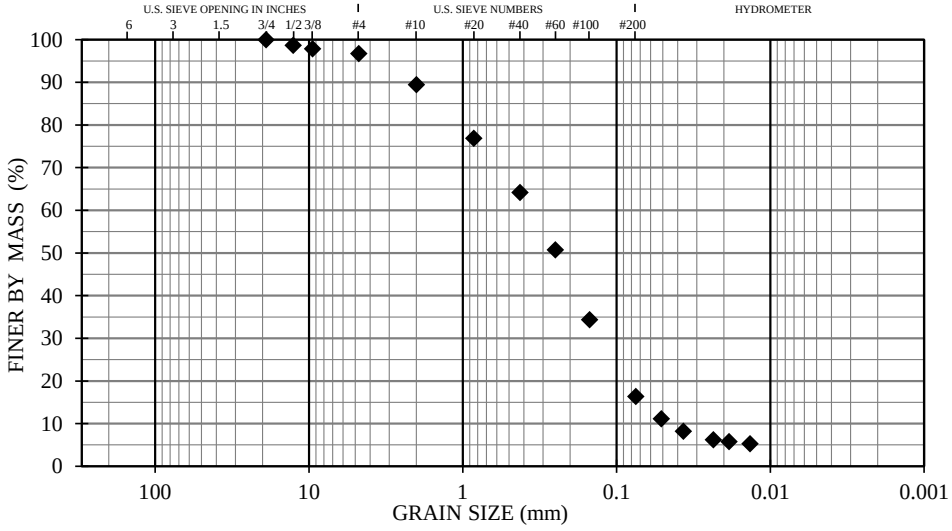
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP43A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Silty sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

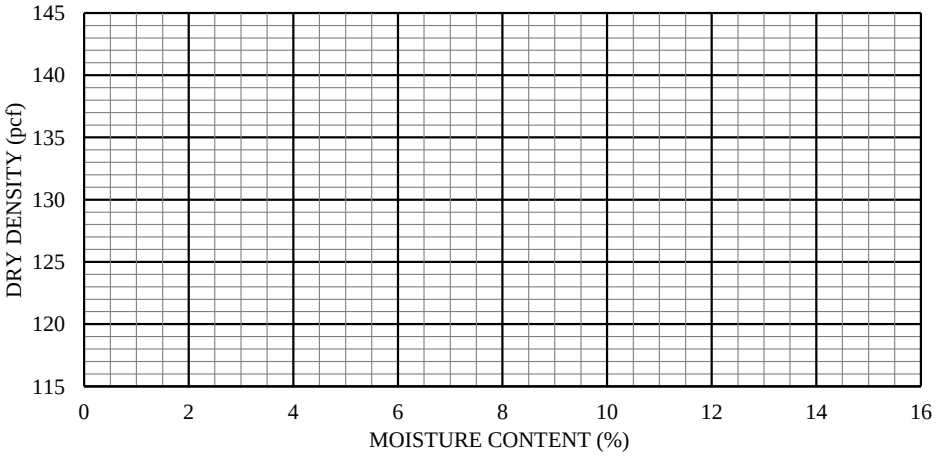
% GRAVEL	**3.2**	USCS	**SM**
% SAND	**80.4**	USACOE FC	**F2**
% SILT/CLAY	**16.4**	% PASS. 0.02 mm	**5.9**
% MOIST. CONTENT	**17.9**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**8.1**	
COEFFICIENT OF GRADATION (C_c)		**1.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"	**100**	
12.70	1/2"	**99**	
9.50	3/8"	**98**	
4.75	#4	**97**	
2.00	#10	**89**	
0.85	#20	**77**	
0.43	#40	**64**	
0.25	#60	**51**	
0.15	#100	**34**	
0.075	#200	**16.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0512	11.2
2	0.0368	8.2
5	0.0235	6.2
8	0.0185	5.7
15	0.0135	5.3
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

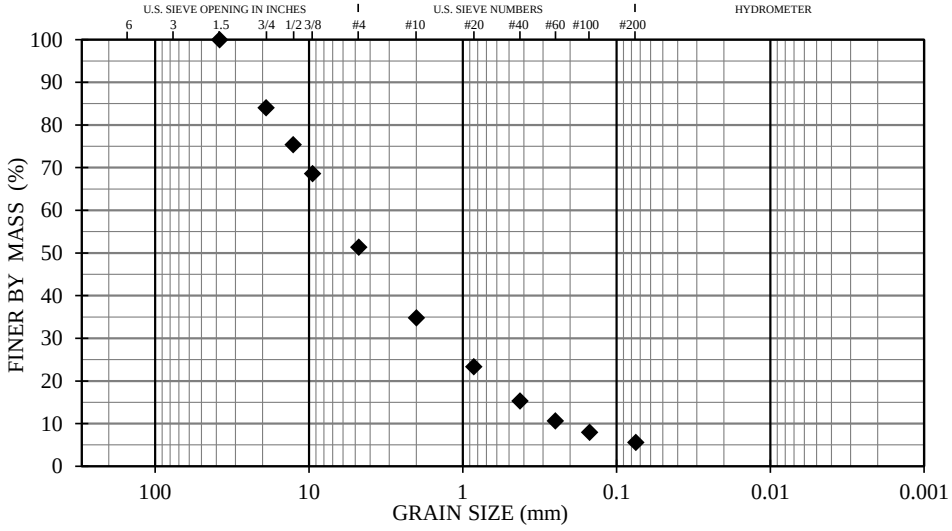
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP43B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**48.6**	USCS	**GW-GM**
% SAND	**45.8**	USACOE FC	**N/A**
% SILT/CLAY	**5.6**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.3**	% PASS. 0.002 mm	**N/A**

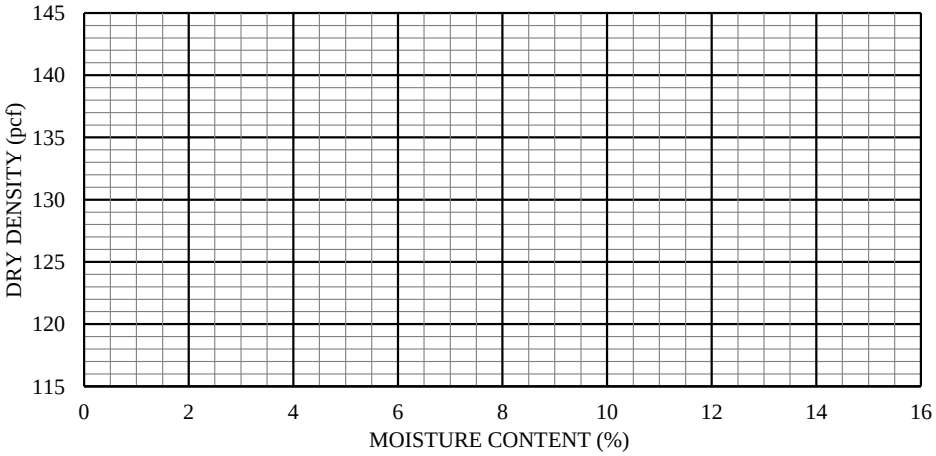
UNIFORMITY COEFFICIENT (C_u)	**31.5**
COEFFICIENT OF GRADATION (C_c)	**1.4**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**84**	
12.70	1/2"	**75**	
9.50	3/8"	**69**	
4.75	#4	**51**	
2.00	#10	**35**	
0.85	#20	**23**	
0.43	#40	**15**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**5.6**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

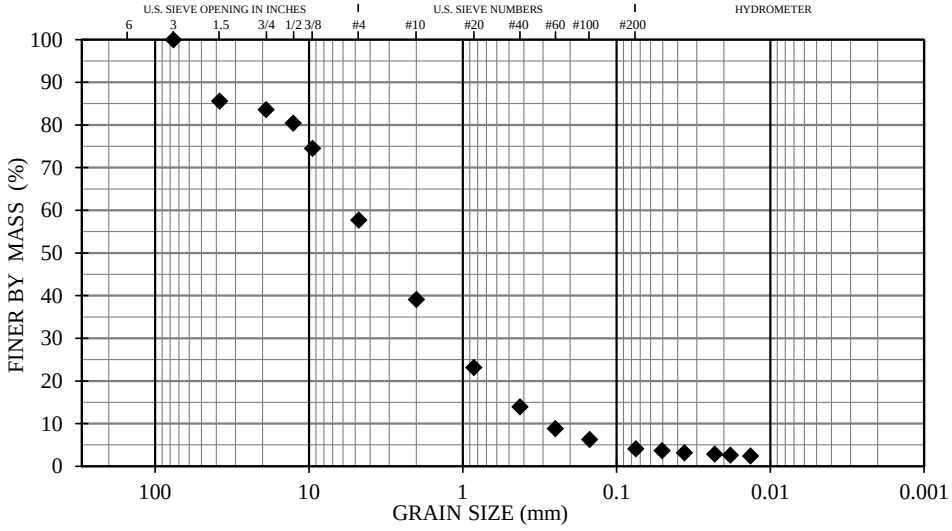
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP43B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**42.3**	USCS	**SW**
% SAND	**53.6**	USACOE FC	**NFS**
% SILT/CLAY	**4.1**	% PASS. 0.02 mm	**2.6**
% MOIST. CONTENT	**7.5**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**18.6**	
COEFFICIENT OF GRADATION (C_c)		**1.2**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

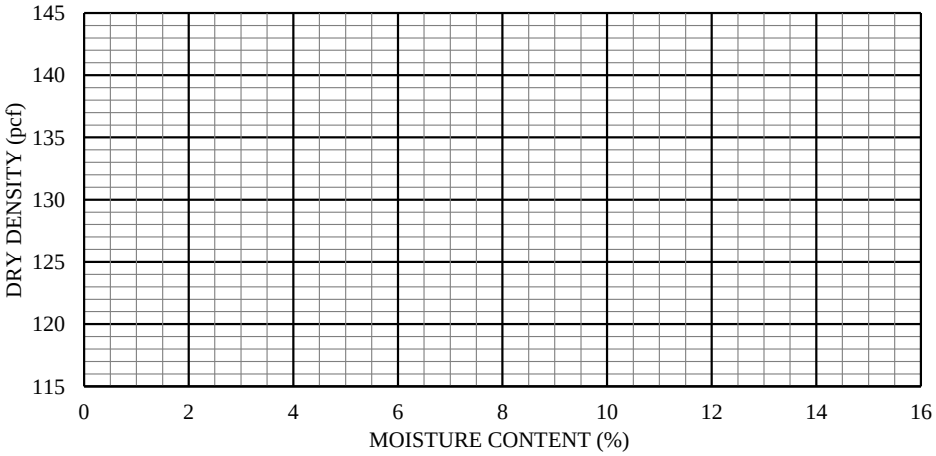


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**86**	
19.00	3/4"	**84**	
12.70	1/2"	**80**	
9.50	3/8"	**75**	
4.75	#4	**58**	
2.00	#10	**39**	
0.85	#20	**23**	
0.43	#40	**14**	
0.25	#60	**9**	
0.15	#100	**6**	
0.075	#200	**4.1**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0506	3.7
2	0.0362	3.1
5	0.0230	2.9
8	0.0182	2.6
15	0.0134	2.4
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

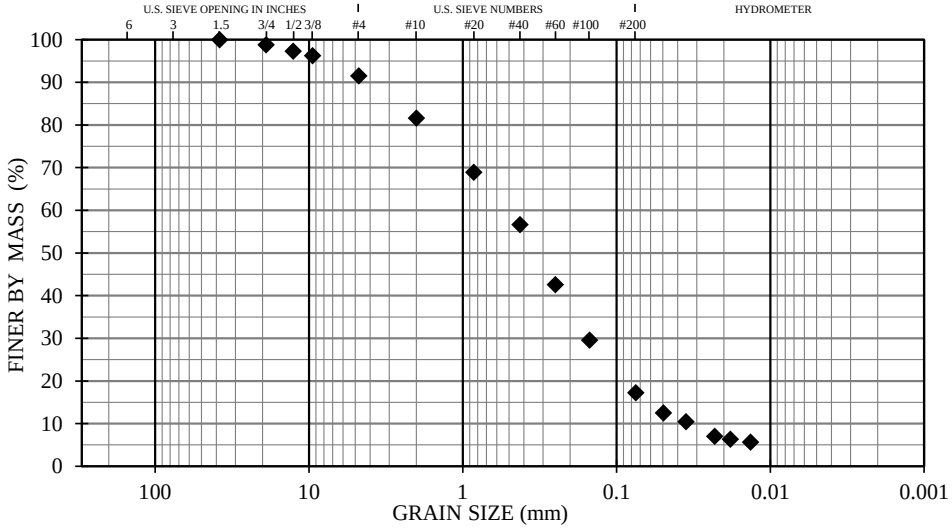
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP43B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Silty sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJCP**
REVIEWED BY:	**SAM**

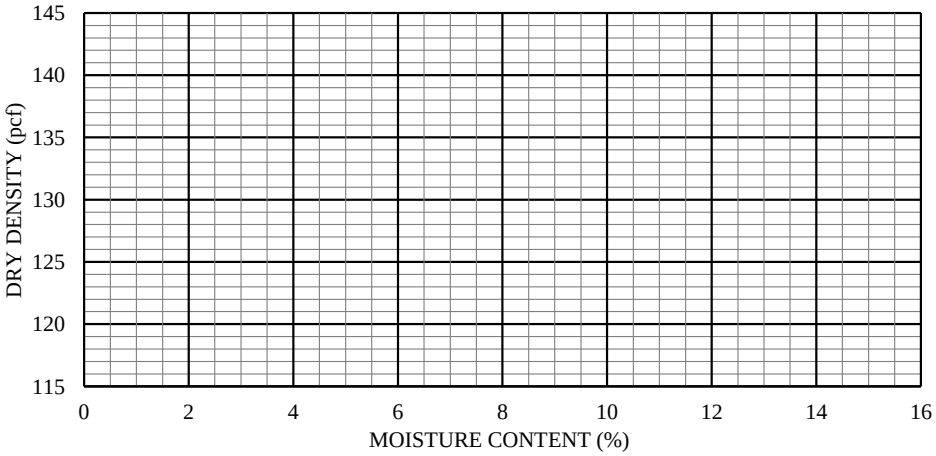
% GRAVEL	**8.5**	USCS	**SM**
% SAND	**74.3**	USACOE FC	**F2**
% SILT/CLAY	**17.2**	% PASS. 0.02 mm	**6.6**
% MOIST. CONTENT	**46.5**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**16.0**	
COEFFICIENT OF GRADATION (C_c)		**1.3**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**99**	
12.70	1/2"	**97**	
9.50	3/8"	**96**	
4.75	#4	**92**	
2.00	#10	**82**	
0.85	#20	**69**	
0.43	#40	**57**	
0.25	#60	**43**	
0.15	#100	**30**	
0.075	#200	**17.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0496	12.5
2	0.0354	10.4
5	0.0230	7.0
8	0.0182	6.4
15	0.0134	5.7
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

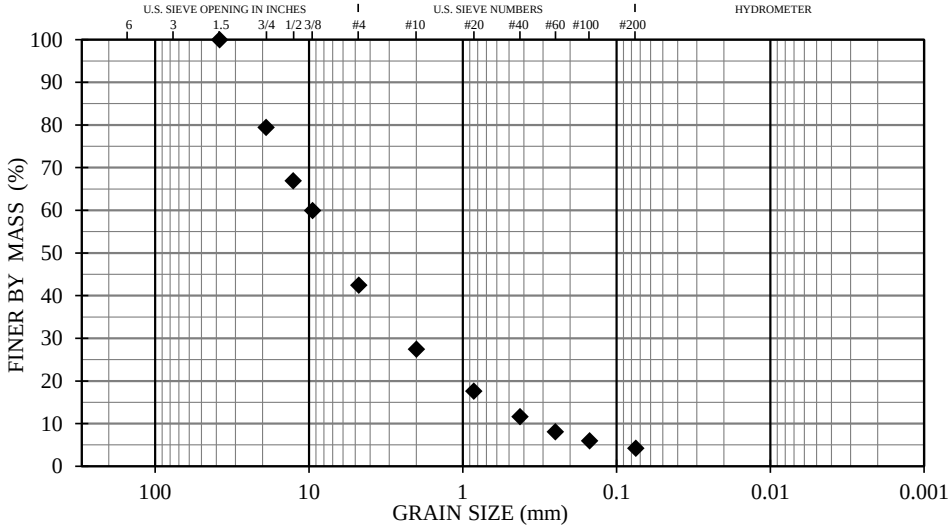
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**57.6**	USCS	**GW**
% SAND	**38.2**	USACOE FC	**N/A**
% SILT/CLAY	**4.2**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**5.0**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**27.6**
COEFFICIENT OF GRADATION (C_c)	**1.9**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

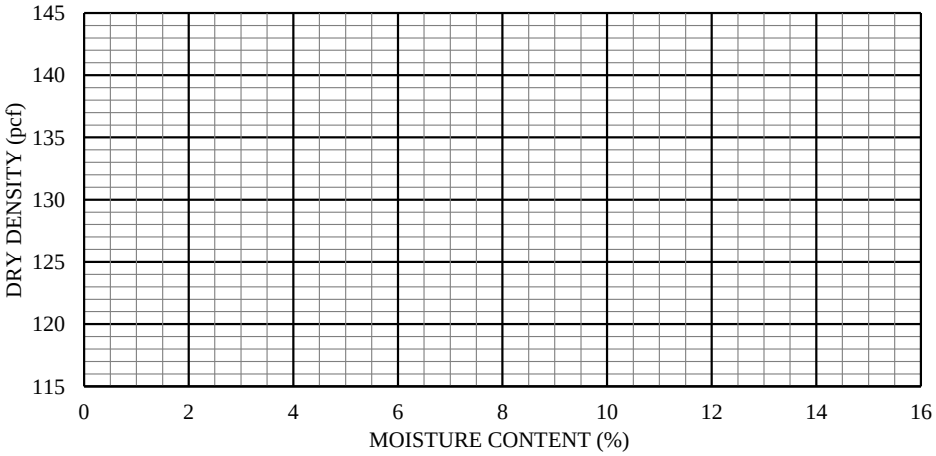
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**79**	
12.70	1/2"	**67**	
9.50	3/8"	**60**	
4.75	#4	**42**	
2.00	#10	**27**	
0.85	#20	**18**	
0.43	#40	**12**	
0.25	#60	**8**	
0.15	#100	**6**	
0.075	#200	**4.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

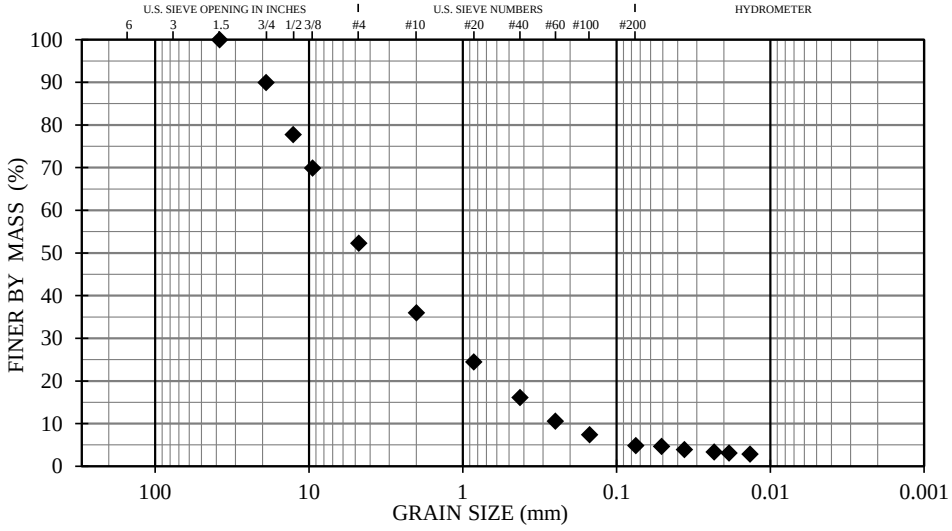
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**47.6**	USCS	**GW**
% SAND	**47.5**	USACOE FC	**S1**
% SILT/CLAY	**4.9**	% PASS. 0.02 mm	**3.2**
% MOIST. CONTENT	**7.2**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**29.5**	
COEFFICIENT OF GRADATION (C_c)		**1.2**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

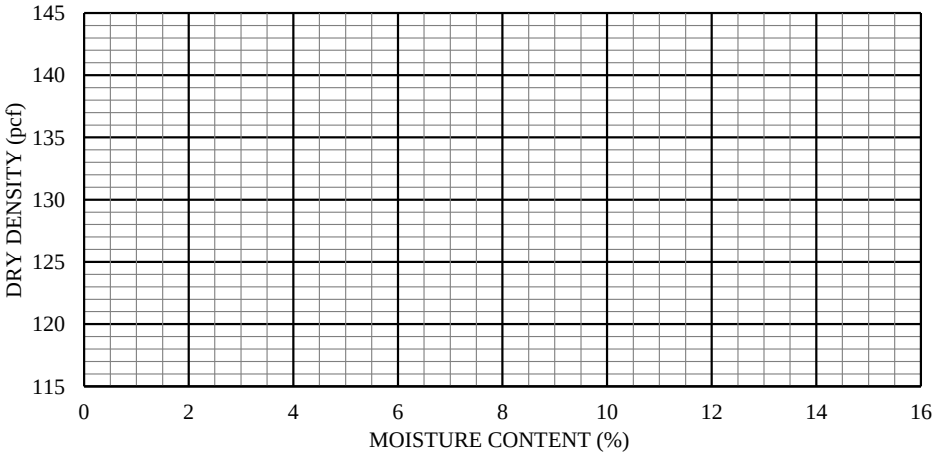


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**90**	
12.70	1/2"	**78**	
9.50	3/8"	**70**	
4.75	#4	**52**	
2.00	#10	**36**	
0.85	#20	**24**	
0.43	#40	**16**	
0.25	#60	**11**	
0.15	#100	**7**	
0.075	#200	**4.9**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0509	4.6
2	0.0363	3.9
5	0.0232	3.4
8	0.0185	3.1
15	0.0135	2.9
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

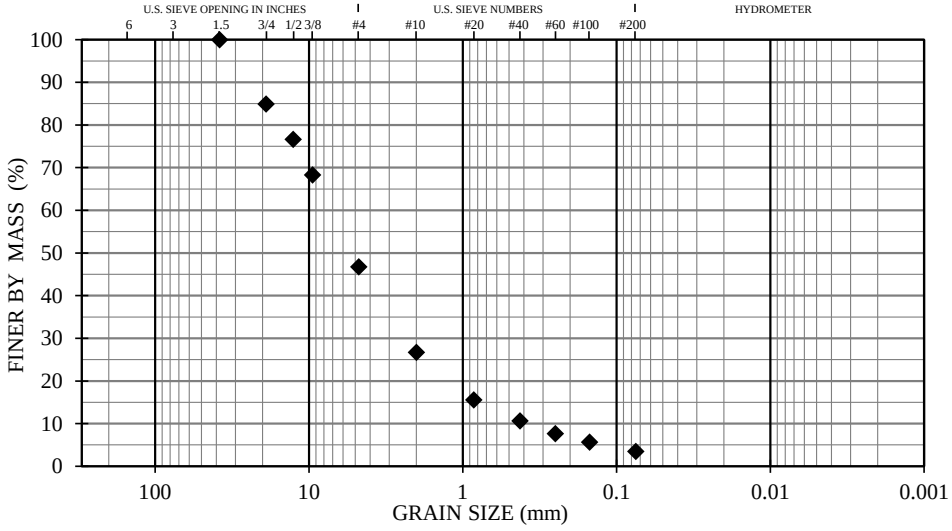
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**53.3**	USCS	**GW**
% SAND	**43.2**	USACOE FC	**N/A**
% SILT/CLAY	**3.5**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**6.7**	% PASS. 0.002 mm	**N/A**

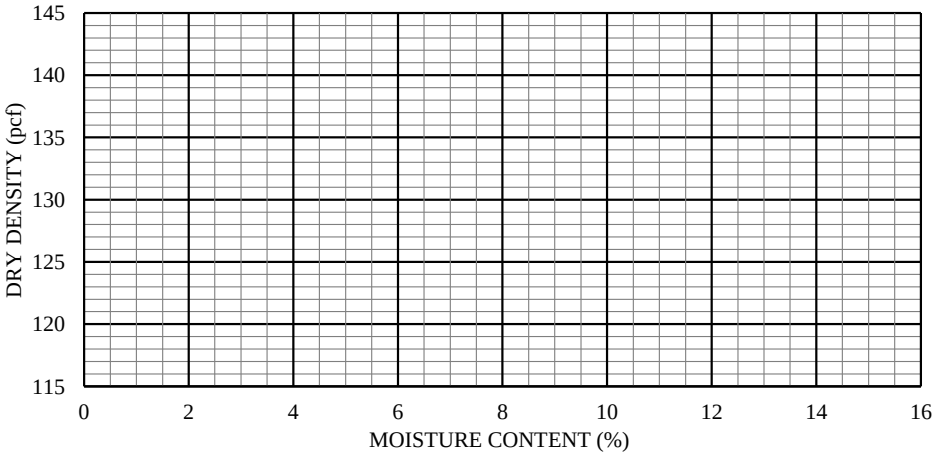
UNIFORMITY COEFFICIENT (C_u)	**19.7**
COEFFICIENT OF GRADATION (C_c)	**2.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**85**	
12.70	1/2"	**77**	
9.50	3/8"	**68**	
4.75	#4	**47**	
2.00	#10	**27**	
0.85	#20	**16**	
0.43	#40	**11**	
0.25	#60	**8**	
0.15	#100	**6**	
0.075	#200	**3.5**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

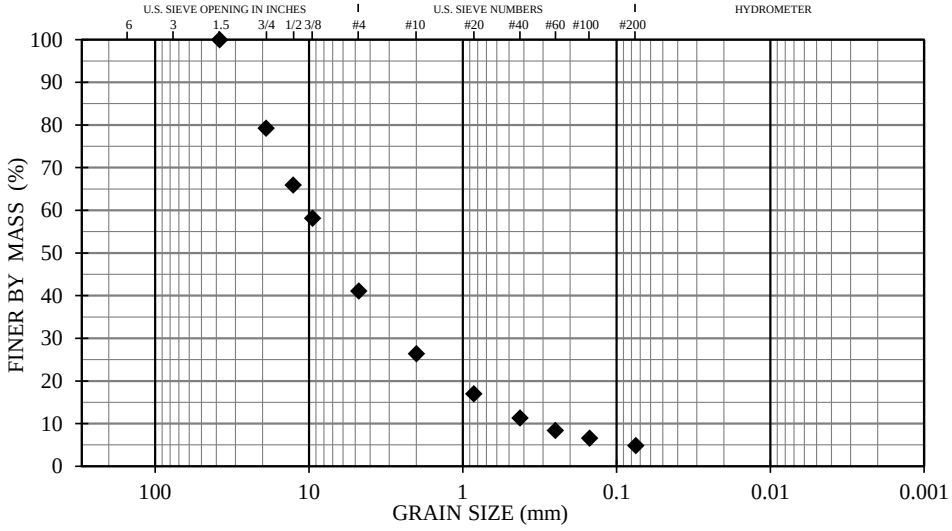
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**58.9**	USCS	**GW**
% SAND	**36.3**	USACOE FC	**N/A**
% SILT/CLAY	**4.8**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**8.0**	% PASS. 0.002 mm	**N/A**

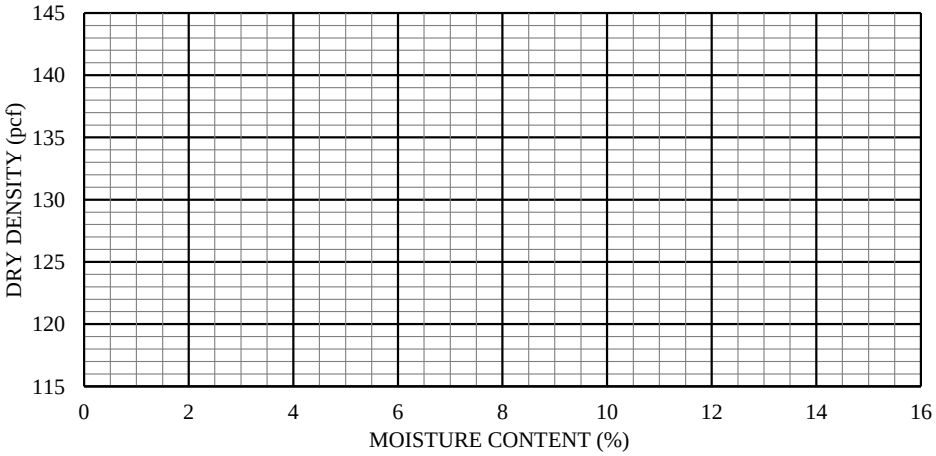
UNIFORMITY COEFFICIENT (C_u)	**29.8**
COEFFICIENT OF GRADATION (C_c)	**2.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**79**	
12.70	1/2"	**66**	
9.50	3/8"	**58**	
4.75	#4	**41**	
2.00	#10	**26**	
0.85	#20	**17**	
0.43	#40	**11**	
0.25	#60	**8**	
0.15	#100	**7**	
0.075	#200	**4.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

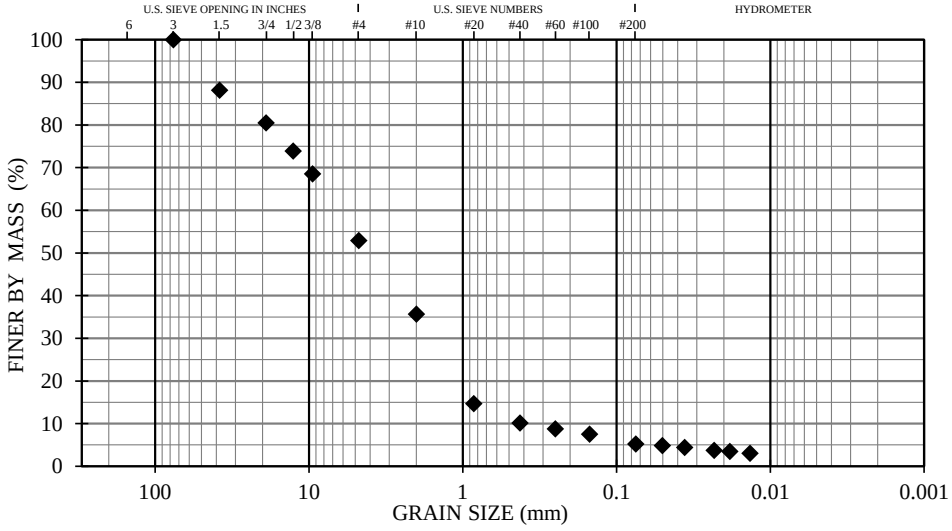
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**47.1**	USCS	**SW-SM**
% SAND	**47.7**	USACOE FC	**S2**
% SILT/CLAY	**5.2**	% PASS. 0.02 mm	**3.6**
% MOIST. CONTENT	**7.7**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**17.0**	
COEFFICIENT OF GRADATION (C_c)		**1.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

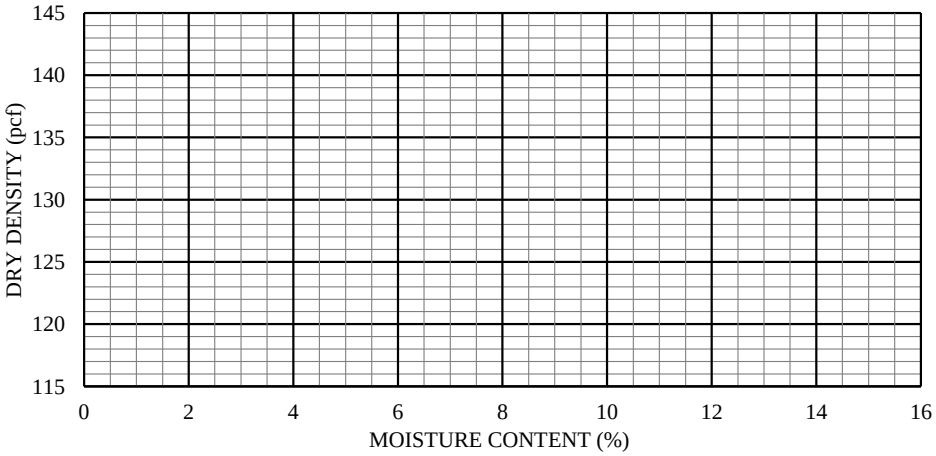


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**88**	
19.00	3/4"	**81**	
12.70	1/2"	**74**	
9.50	3/8"	**69**	
4.75	#4	**53**	
2.00	#10	**36**	
0.85	#20	**15**	
0.43	#40	**10**	
0.25	#60	**9**	
0.15	#100	**7**	
0.075	#200	**5.2**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0503	4.9
2	0.0360	4.4
5	0.0232	3.7
8	0.0184	3.5
15	0.0136	3.0
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

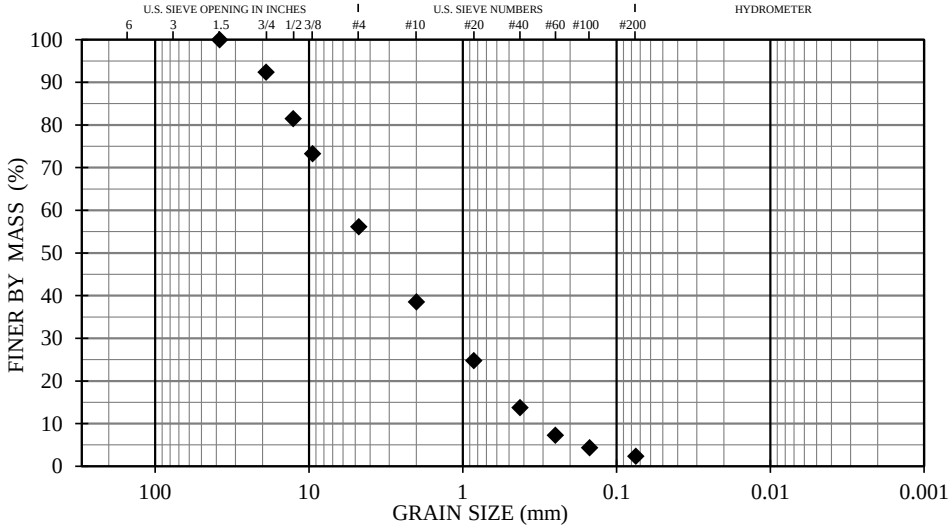
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP44B**
NUMBER/ DEPTH:	**S4 / 10 - 11.5'**
DESCRIPTION:	**Poorly-graded sand w/ gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**43.9**	USCS	**SP**
% SAND	**53.7**	USACOE FC	**N/A**
% SILT/CLAY	**2.4**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**9.3**	% PASS. 0.002 mm	**N/A**

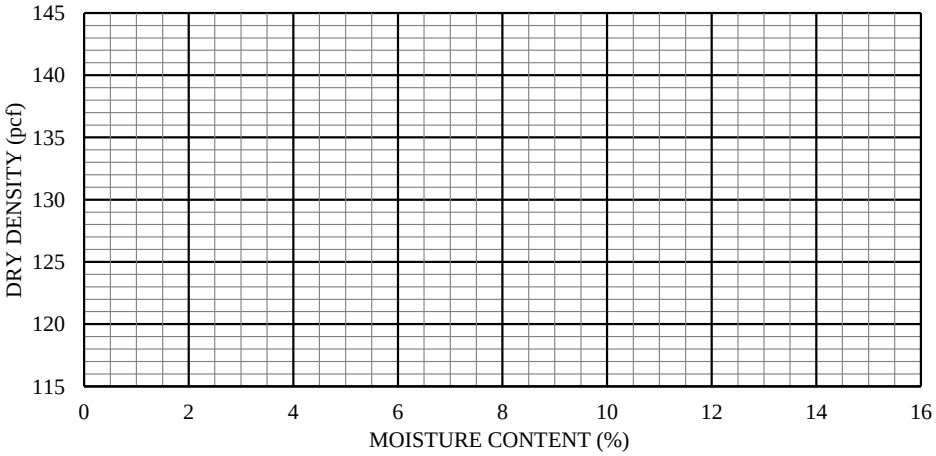
UNIFORMITY COEFFICIENT (C_u)	**18.0**
COEFFICIENT OF GRADATION (C_c)	**0.9**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**92**	
12.70	1/2"	**82**	
9.50	3/8"	**73**	
4.75	#4	**56**	
2.00	#10	**39**	
0.85	#20	**25**	
0.43	#40	**14**	
0.25	#60	**7**	
0.15	#100	**4**	
0.075	#200	**2.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

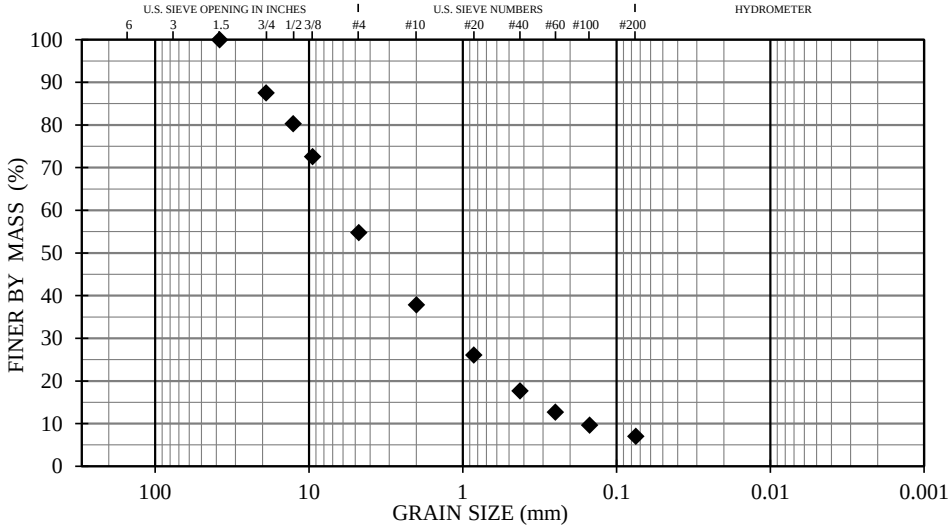
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP45A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**45.3**	USCS	**SW-SM**
% SAND	**47.7**	USACOE FC	**N/A**
% SILT/CLAY	**7.0**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.6**	% PASS. 0.002 mm	**N/A**

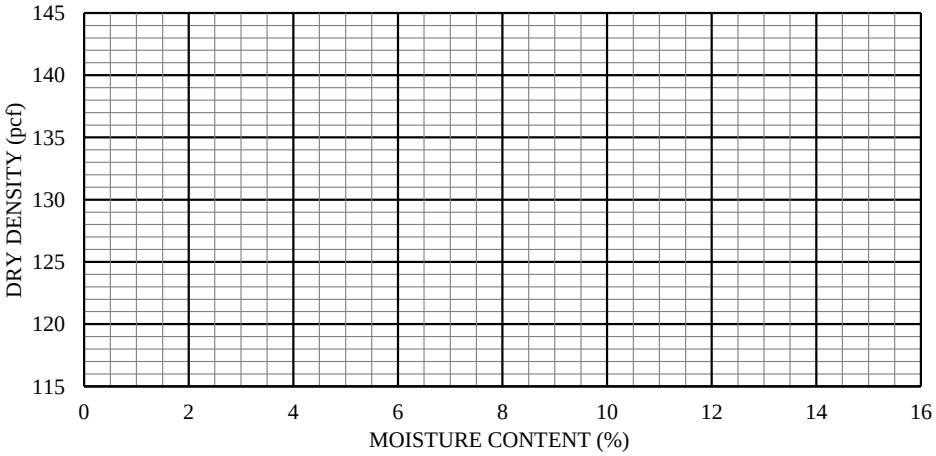
UNIFORMITY COEFFICIENT (C_u)	**37.9**
COEFFICIENT OF GRADATION (C_c)	**1.5**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**88**	
12.70	1/2"	**80**	
9.50	3/8"	**73**	
4.75	#4	**55**	
2.00	#10	**38**	
0.85	#20	**26**	
0.43	#40	**18**	
0.25	#60	**13**	
0.15	#100	**10**	
0.075	#200	**7.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

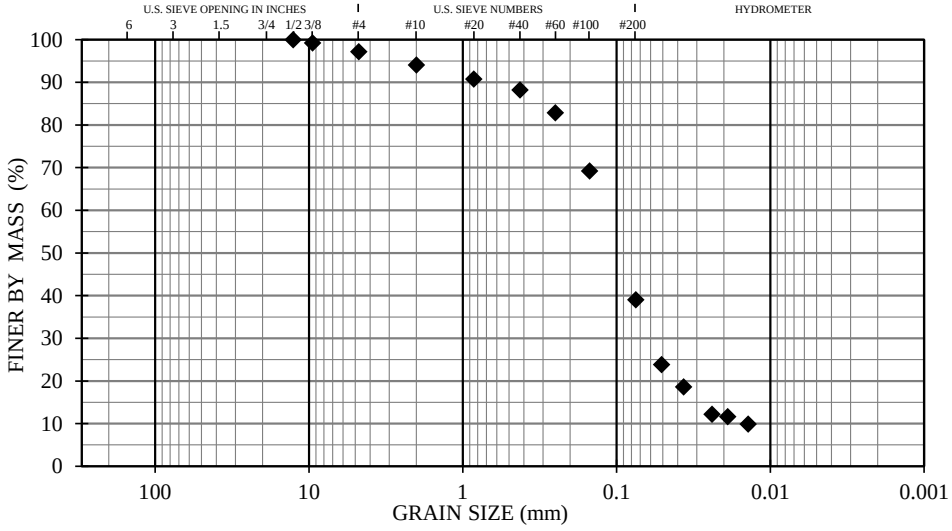
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP45A**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Silty sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

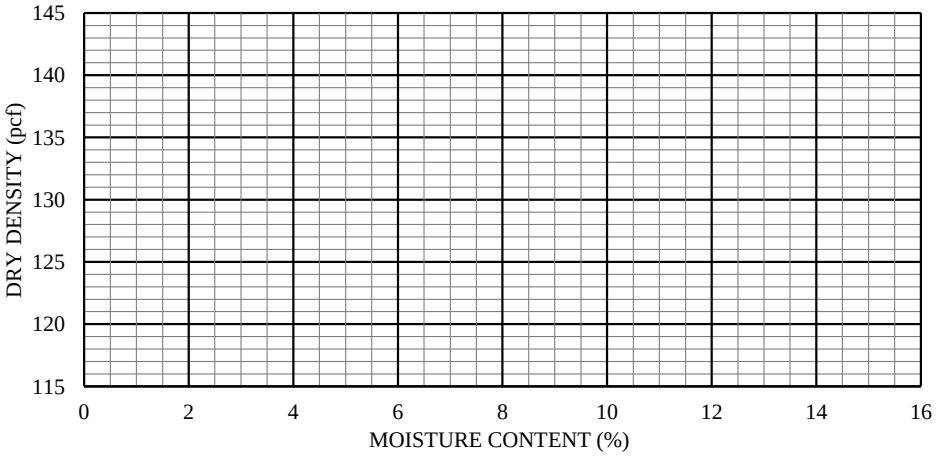
% GRAVEL	**2.9**	USCS	**SM**
% SAND	**58.1**	USACOE FC	**F2**
% SILT/CLAY	**39.0**	% PASS. 0.02 mm	**12.0**
% MOIST. CONTENT	**25.3**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**8.9**	
COEFFICIENT OF GRADATION (C_c)		**2.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"		
12.70	1/2"	**100**	
9.50	3/8"	**99**	
4.75	#4	**97**	
2.00	#10	**94**	
0.85	#20	**91**	
0.43	#40	**88**	
0.25	#60	**83**	
0.15	#100	**69**	
0.075	#200	**39.0**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0509	23.8
2	0.0367	18.6
5	0.0239	12.2
8	0.0189	11.6
15	0.0140	9.9
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

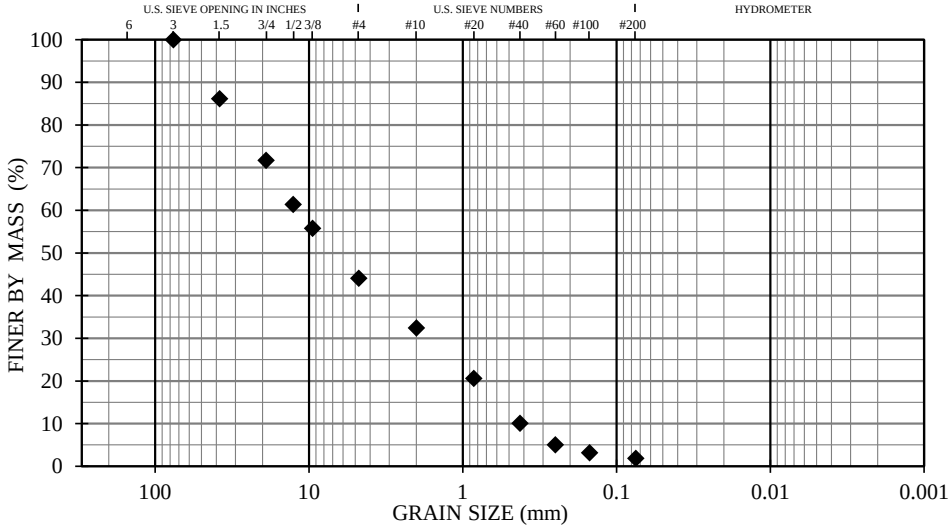
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP45A**
NUMBER/ DEPTH:	**S6 / 15 - 16.5'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**55.9**	USCS	**GP**
% SAND	**42.2**	USACOE FC	**N/A**
% SILT/CLAY	**1.9**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**7.1**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**28.2**
COEFFICIENT OF GRADATION (C_c)	**0.6**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

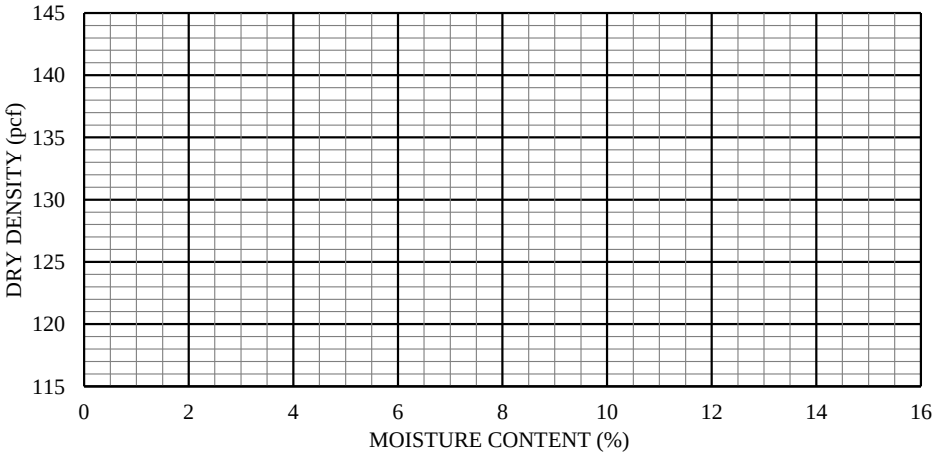


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**86**	
19.00	3/4"	**72**	
12.70	1/2"	**61**	
9.50	3/8"	**56**	
4.75	#4	**44**	
2.00	#10	**32**	
0.85	#20	**21**	
0.43	#40	**10**	
0.25	#60	**5**	
0.15	#100	**3**	
0.075	#200	**1.9**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

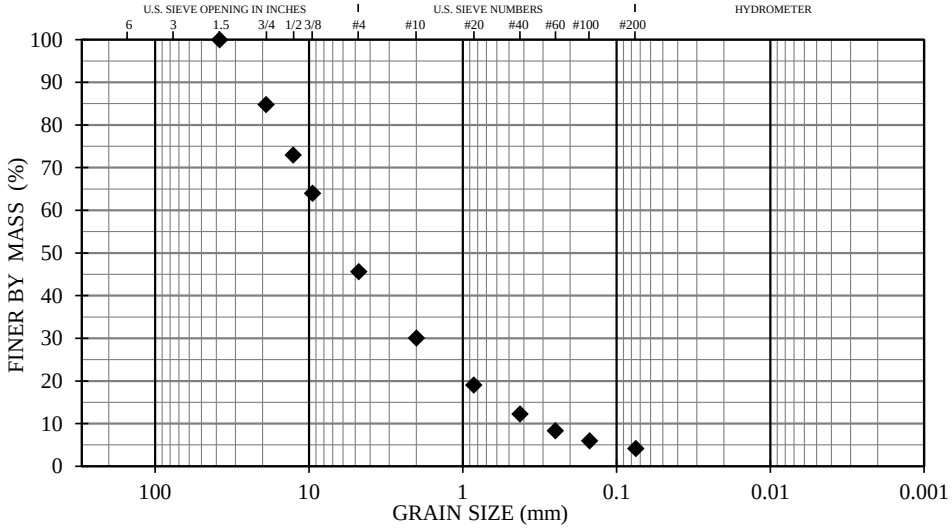
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP45B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**54.3**	USCS	**GW**
% SAND	**41.5**	USACOE FC	**N/A**
% SILT/CLAY	**4.2**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**6.6**	% PASS. 0.002 mm	**N/A**

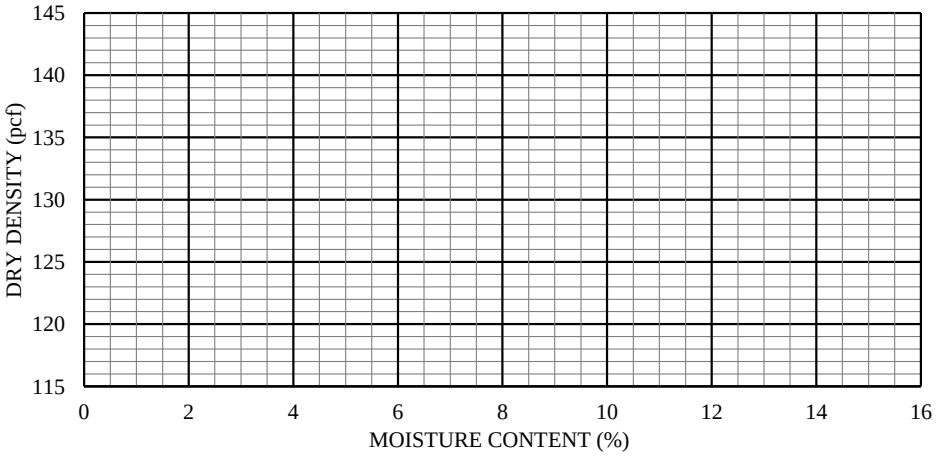
UNIFORMITY COEFFICIENT (C_u)	**26.0**
COEFFICIENT OF GRADATION (C_c)	**1.4**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**85**	
12.70	1/2"	**73**	
9.50	3/8"	**64**	
4.75	#4	**46**	
2.00	#10	**30**	
0.85	#20	**19**	
0.43	#40	**12**	
0.25	#60	**8**	
0.15	#100	**6**	
0.075	#200	**4.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

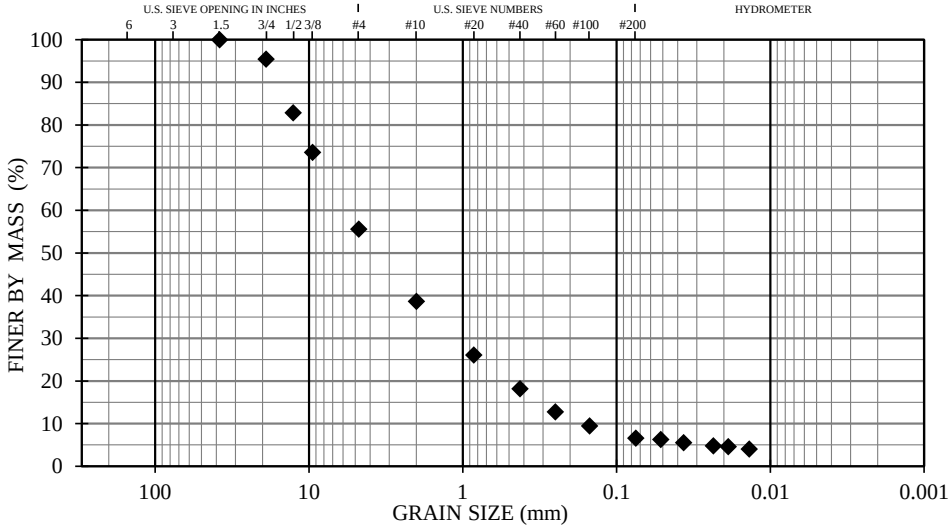
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**COP45B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**44.4**	USCS	**SW-SM**
% SAND	**49.0**	USACOE FC	**S2**
% SILT/CLAY	**6.6**	% PASS. 0.02 mm	**4.7**
% MOIST. CONTENT	**7.3**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**35.5**
COEFFICIENT OF GRADATION (C_c)	**1.5**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

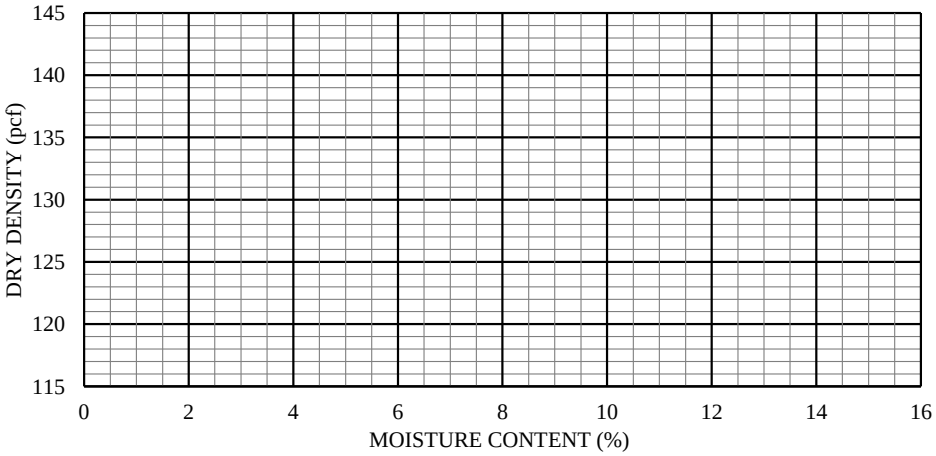


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**95**	
12.70	1/2"	**83**	
9.50	3/8"	**74**	
4.75	#4	**56**	
2.00	#10	**39**	
0.85	#20	**26**	
0.43	#40	**18**	
0.25	#60	**13**	
0.15	#100	**9**	
0.075	#200	**6.6**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0515	6.3
2	0.0367	5.5
5	0.0235	4.8
8	0.0188	4.6
15	0.0137	4.1
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

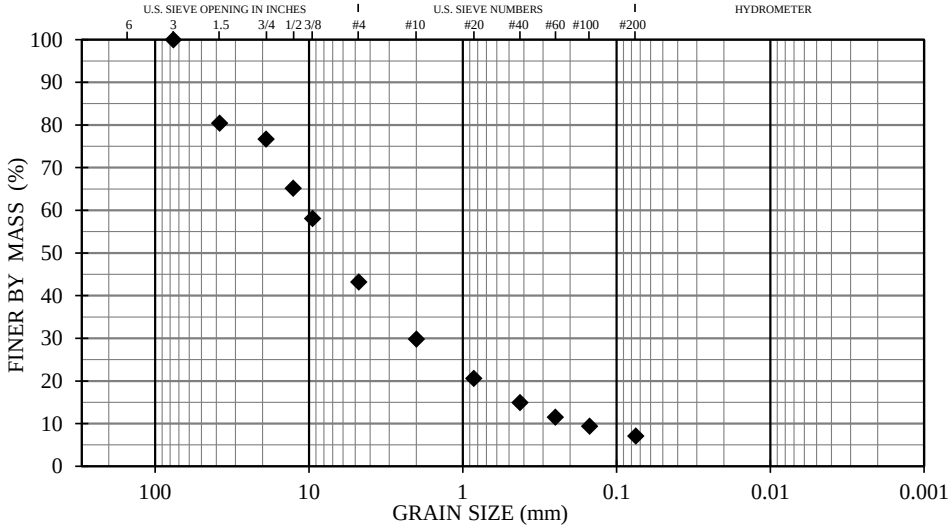
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**CAB2A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded gravel w/ silt and sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**56.8**	USCS	**GW-GM**
% SAND	**36.1**	USACOE FC	**N/A**
% SILT/CLAY	**7.1**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**10.5**	% PASS. 0.002 mm	**N/A**

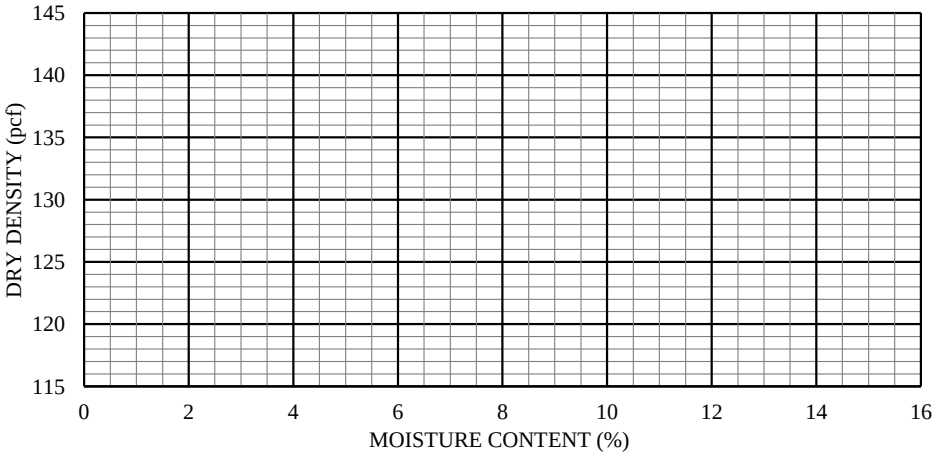
UNIFORMITY COEFFICIENT (C_u)	**57.8**
COEFFICIENT OF GRADATION (C_c)	**2.2**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"	**100**	
38.10	1.5"	**80**	
19.00	3/4"	**77**	
12.70	1/2"	**65**	
9.50	3/8"	**58**	
4.75	#4	**43**	
2.00	#10	**30**	
0.85	#20	**21**	
0.43	#40	**15**	
0.25	#60	**11**	
0.15	#100	**9**	
0.075	#200	**7.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

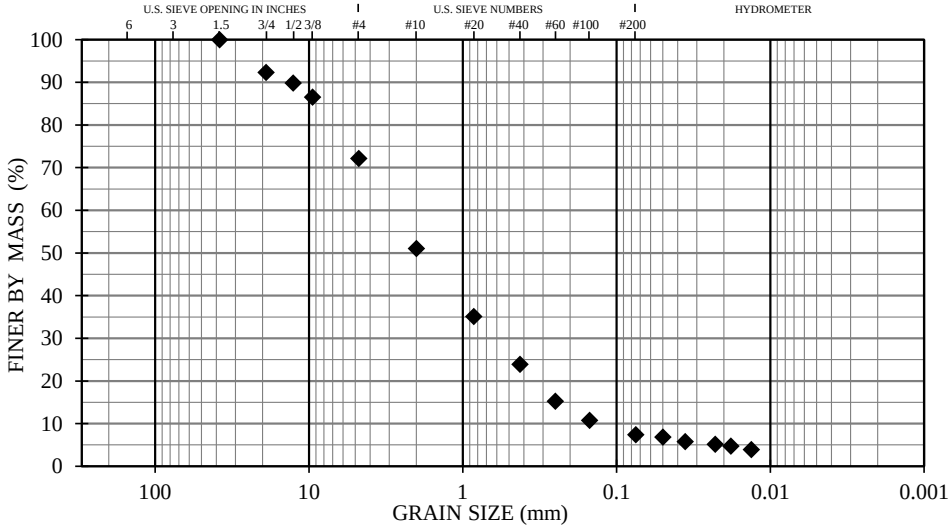
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**CAB2A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**27.9**	USCS	**SW-SM**
% SAND	**64.7**	USACOE FC	**S2**
% SILT/CLAY	**7.4**	% PASS. 0.02 mm	**5.0**
% MOIST. CONTENT	**12.0**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**23.9**
COEFFICIENT OF GRADATION (C_c)	**1.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

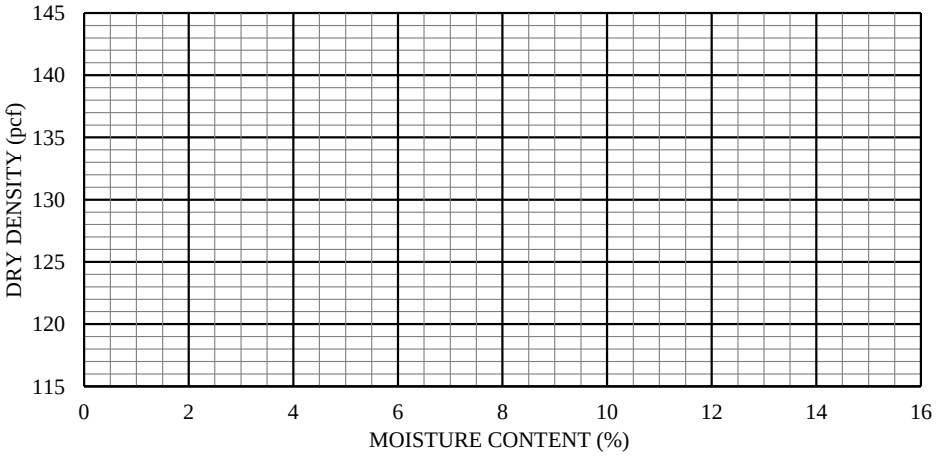


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**92**	
12.70	1/2"	**90**	
9.50	3/8"	**87**	
4.75	#4	**72**	
2.00	#10	**51**	
0.85	#20	**35**	
0.43	#40	**24**	
0.25	#60	**15**	
0.15	#100	**11**	
0.075	#200	**7.4**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0500	6.8
2	0.0358	5.8
5	0.0229	5.2
8	0.0181	4.7
15	0.0133	3.9
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

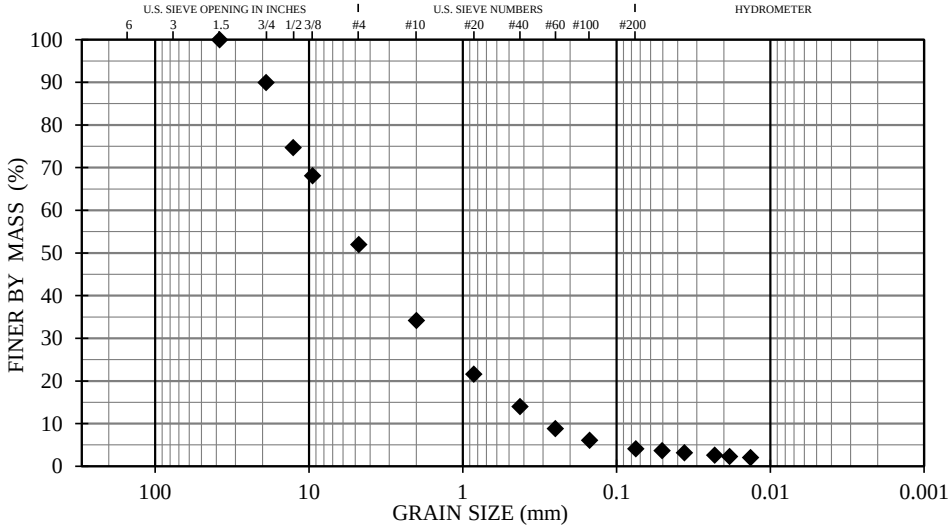
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**CAB2B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

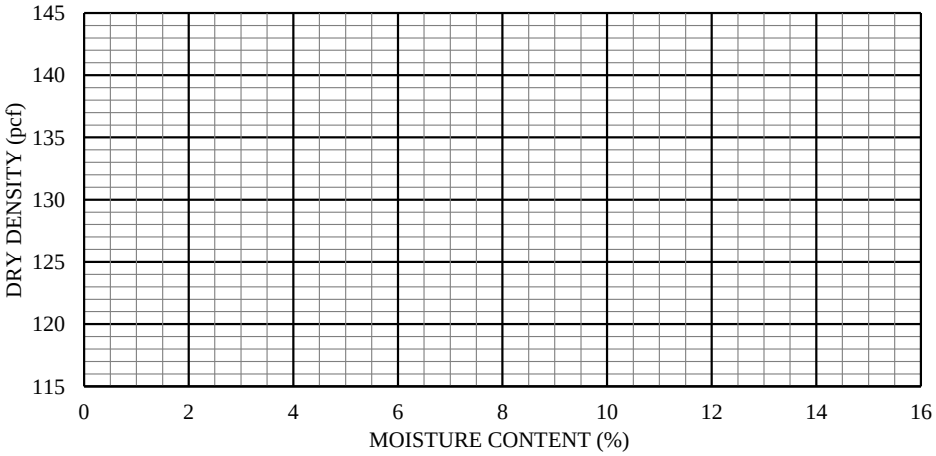
% GRAVEL	**48.0**	USCS	**GW**
% SAND	**47.9**	USACOE FC	**PFS**
% SILT/CLAY	**4.1**	% PASS. 0.02 mm	**2.4**
% MOIST. CONTENT	**10.8**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**24.5**	
COEFFICIENT OF GRADATION (C_c)		**1.3**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**90**	
12.70	1/2"	**75**	
9.50	3/8"	**68**	
4.75	#4	**52**	
2.00	#10	**34**	
0.85	#20	**22**	
0.43	#40	**14**	
0.25	#60	**9**	
0.15	#100	**6**	
0.075	#200	**4.1**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0506	3.7
2	0.0362	3.1
5	0.0230	2.6
8	0.0184	2.3
15	0.0134	2.0
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

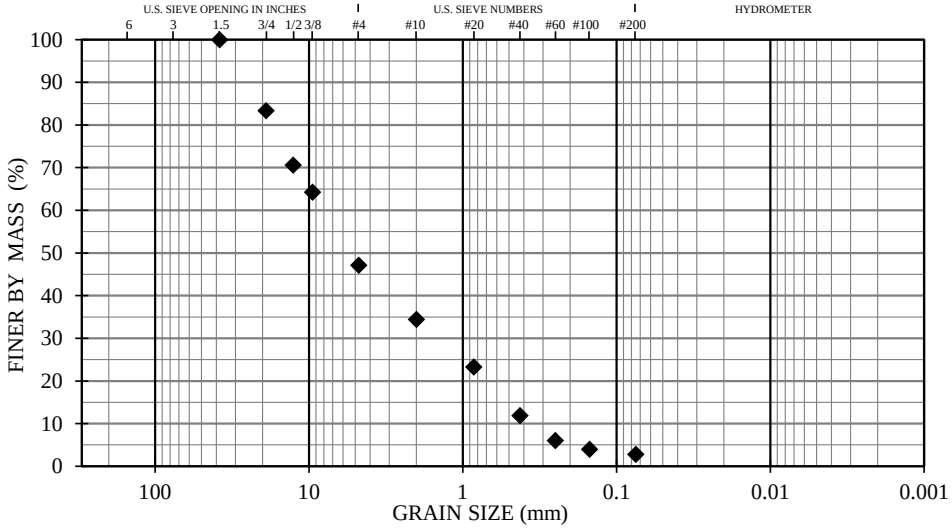
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1A**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**52.9**	USCS	**GP**
% SAND	**44.3**	USACOE FC	**N/A**
% SILT/CLAY	**2.8**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.7**	% PASS. 0.002 mm	**N/A**

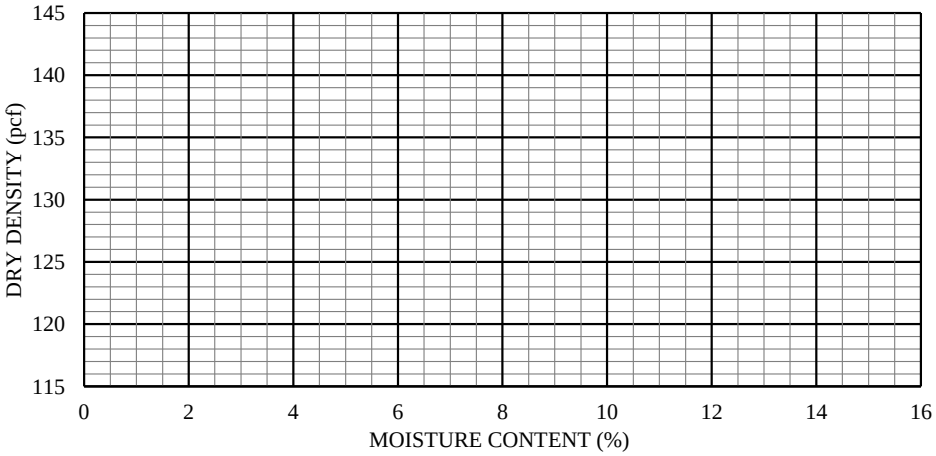
UNIFORMITY COEFFICIENT (C_u)	**22.5**
COEFFICIENT OF GRADATION (C_c)	**0.8**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**83**	
12.70	1/2"	**71**	
9.50	3/8"	**64**	
4.75	#4	**47**	
2.00	#10	**34**	
0.85	#20	**23**	
0.43	#40	**12**	
0.25	#60	**6**	
0.15	#100	**4**	
0.075	#200	**2.8**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

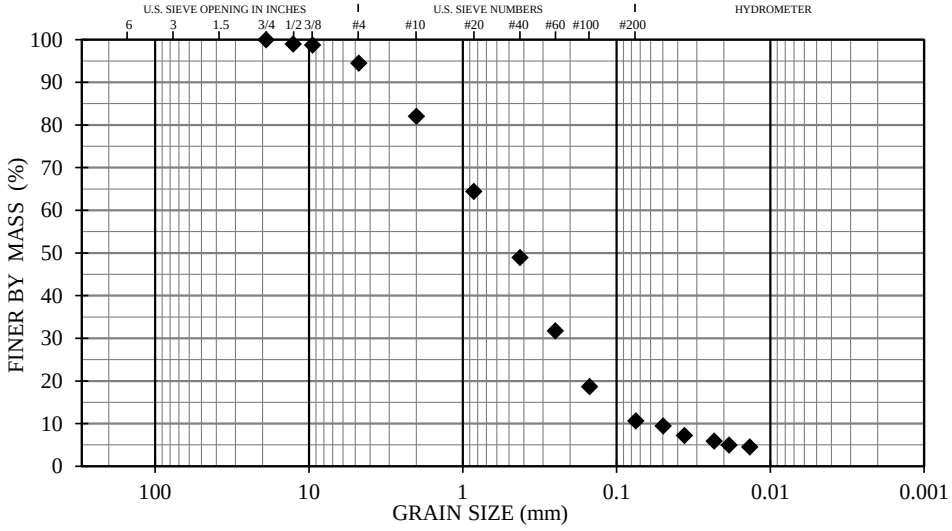
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1A**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Well-graded sand w/ silt**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

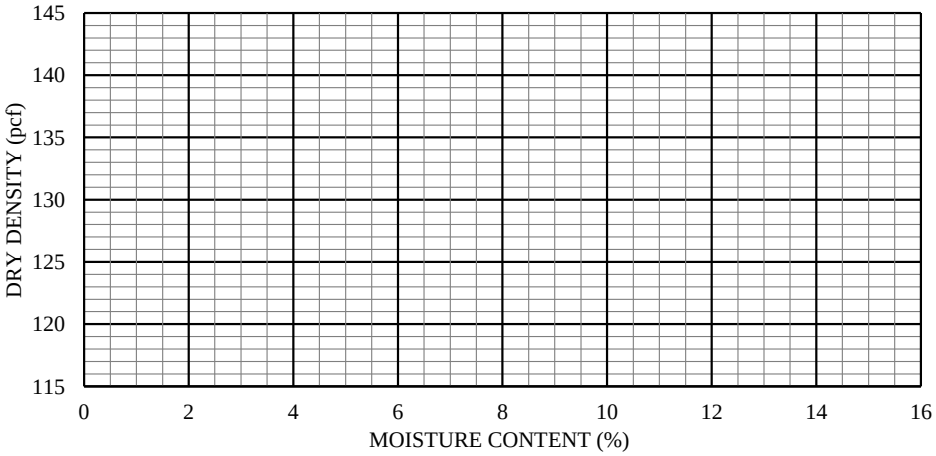
% GRAVEL	**5.5**	USCS	**SW-SM**
% SAND	**83.9**	USACOE FC	**S2**
% SILT/CLAY	**10.6**	% PASS. 0.02 mm	**5.1**
% MOIST. CONTENT	**16.4**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**11.9**	
COEFFICIENT OF GRADATION (C_c)		**1.2**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"	**100**	
12.70	1/2"	**99**	
9.50	3/8"	**99**	
4.75	#4	**94**	
2.00	#10	**82**	
0.85	#20	**64**	
0.43	#40	**49**	
0.25	#60	**32**	
0.15	#100	**19**	
0.075	#200	**10.6**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0497	9.4
2	0.0363	7.2
5	0.0232	5.9
8	0.0185	5.0
15	0.0136	4.5
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

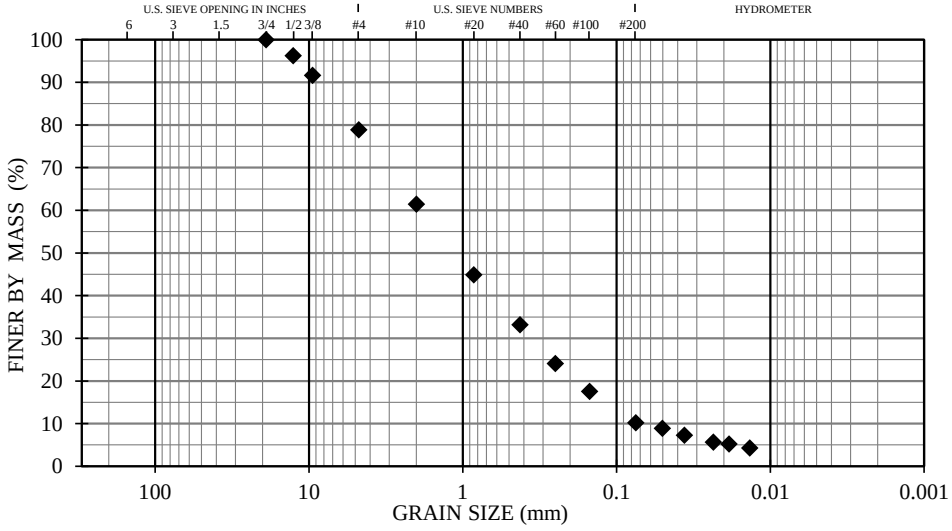
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1A**
NUMBER/ DEPTH:	**S5 / 12.5 - 14'**
DESCRIPTION:	**Poorly-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**21.1**	USCS	**SP-SM**
% SAND	**68.7**	USACOE FC	**S2**
% SILT/CLAY	**10.2**	% PASS. 0.02 mm	**5.4**
% MOIST. CONTENT	**10.6**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**26.6**	
COEFFICIENT OF GRADATION (C_c)		**1.0**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136

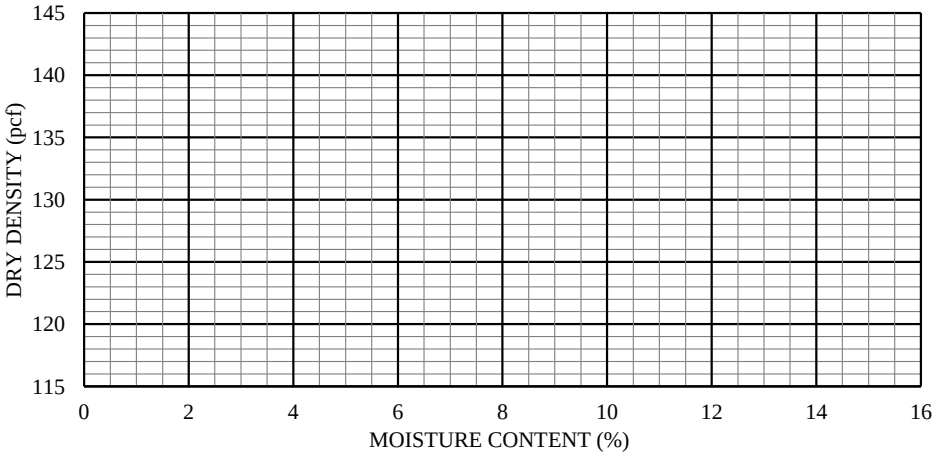


COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"		
19.00	3/4"	**100**	
12.70	1/2"	**96**	
9.50	3/8"	**92**	
4.75	#4	**79**	
2.00	#10	**61**	
0.85	#20	**45**	
0.43	#40	**33**	
0.25	#60	**24**	
0.15	#100	**18**	
0.075	#200	**10.2**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0503	8.9
2	0.0363	7.3
5	0.0235	5.7
8	0.0185	5.2
15	0.0136	4.3
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

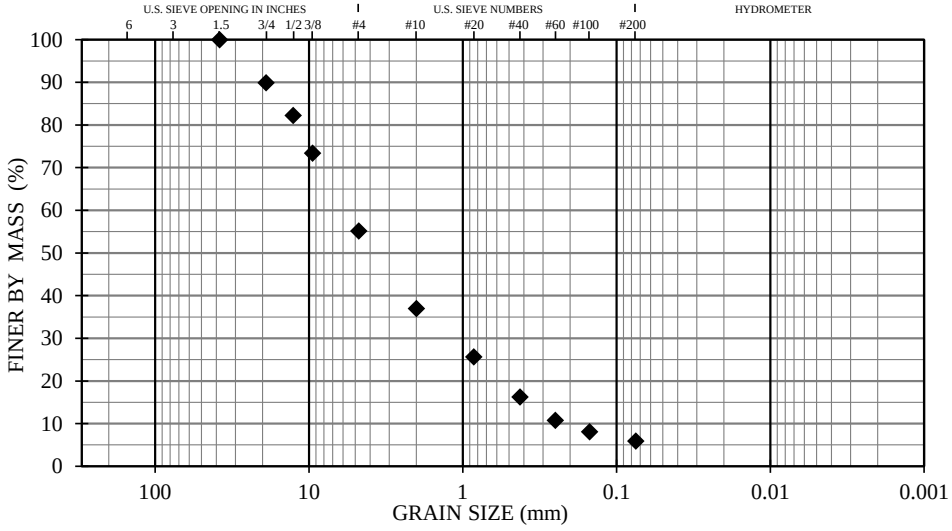
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1B**
NUMBER/ DEPTH:	**S1 / 2.5 - 4'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJCP**
REVIEWED BY:	**SAM**

% GRAVEL	**44.9**	USCS	**SW-SM**
% SAND	**49.2**	USACOE FC	**N/A**
% SILT/CLAY	**5.9**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**8.5**	% PASS. 0.002 mm	**N/A**

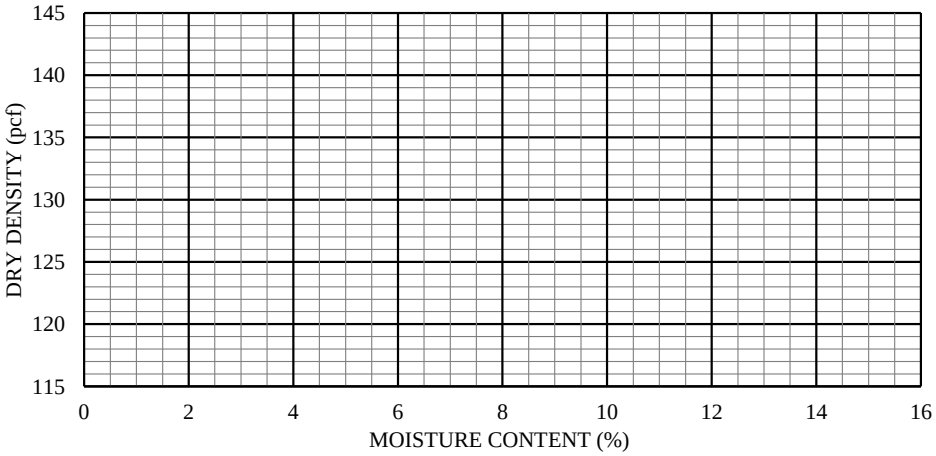
UNIFORMITY COEFFICIENT (C_u)	**27.2**
COEFFICIENT OF GRADATION (C_c)	**1.3**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**90**	
12.70	1/2"	**82**	
9.50	3/8"	**73**	
4.75	#4	**55**	
2.00	#10	**37**	
0.85	#20	**26**	
0.43	#40	**16**	
0.25	#60	**11**	
0.15	#100	**8**	
0.075	#200	**5.9**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

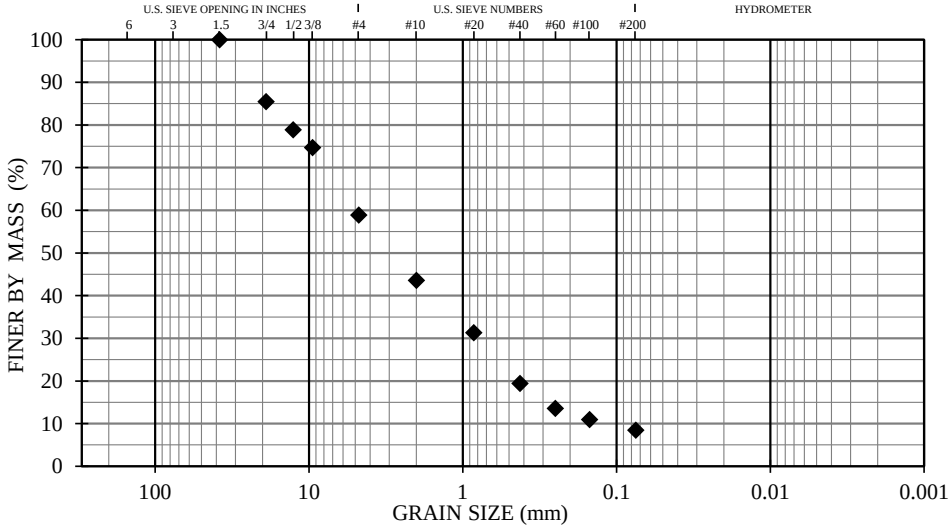
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1B**
NUMBER/ DEPTH:	**S2 / 5 - 6.5'**
DESCRIPTION:	**Well-graded sand w/ silt and gravel**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJCP**
REVIEWED BY:	**SAM**

% GRAVEL	**41.1**	USCS	**SW-SM**
% SAND	**50.5**	USACOE FC	**N/A**
% SILT/CLAY	**8.4**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.7**	% PASS. 0.002 mm	**N/A**

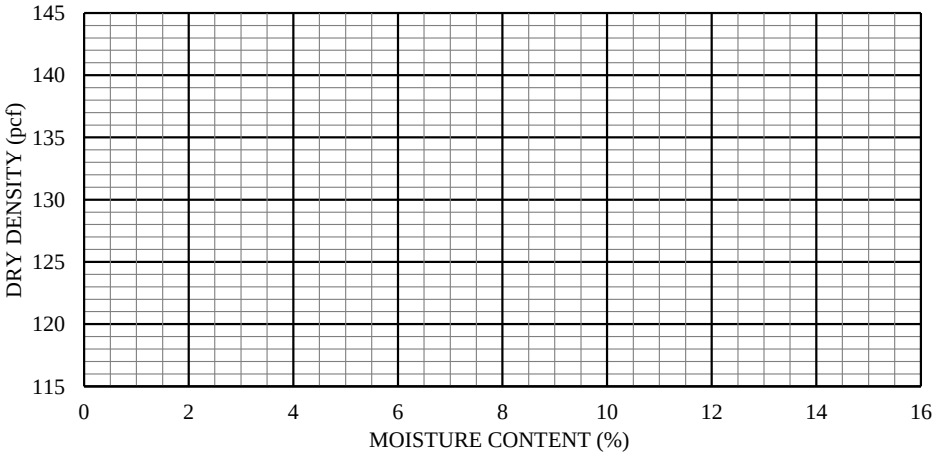
UNIFORMITY COEFFICIENT (C_u)	**42.0**
COEFFICIENT OF GRADATION (C_c)	**1.0**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**85**	
12.70	1/2"	**79**	
9.50	3/8"	**75**	
4.75	#4	**59**	
2.00	#10	**44**	
0.85	#20	**31**	
0.43	#40	**19**	
0.25	#60	**14**	
0.15	#100	**11**	
0.075	#200	**8.4**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1		
2		
5		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

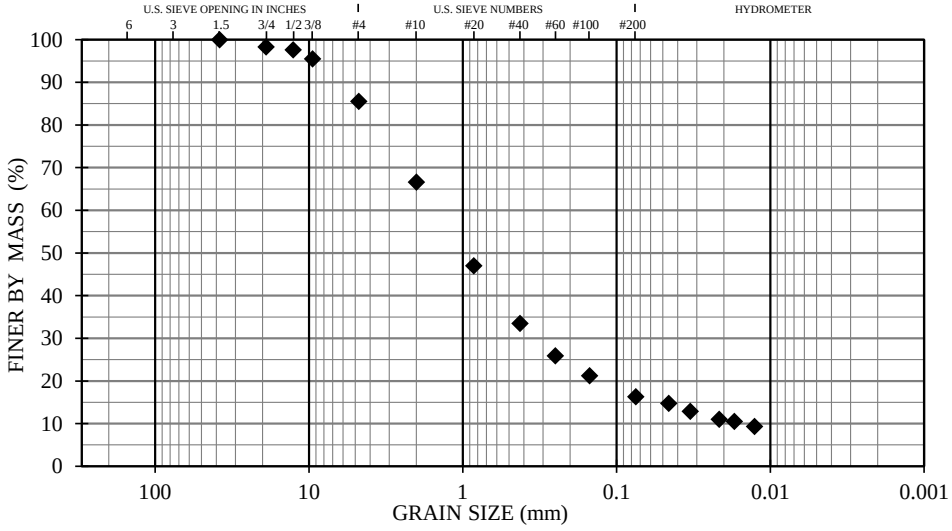
NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**Bratslavsky Consulting Engineers, Inc.**
PROJECT NAME:	**USFWS Fish Passage Improvements**
PROJECT NO.:	**5138-18**
SAMPLE LOC.:	**SHER1B**
NUMBER/ DEPTH:	**S3 / 7.5 - 9'**
DESCRIPTION:	**Silty sand**
DATE RECEIVED:	**10/18/2018**
TESTED BY:	**RJPC**
REVIEWED BY:	**SAM**

% GRAVEL	**14.5**	USCS	**SM**
% SAND	**69.2**	USACOE FC	**F2**
% SILT/CLAY	**16.3**	% PASS. 0.02 mm	**11.1**
% MOIST. CONTENT	**7.7**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**106.2**	
COEFFICIENT OF GRADATION (C_c)		**4.8**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D7928 / C136



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

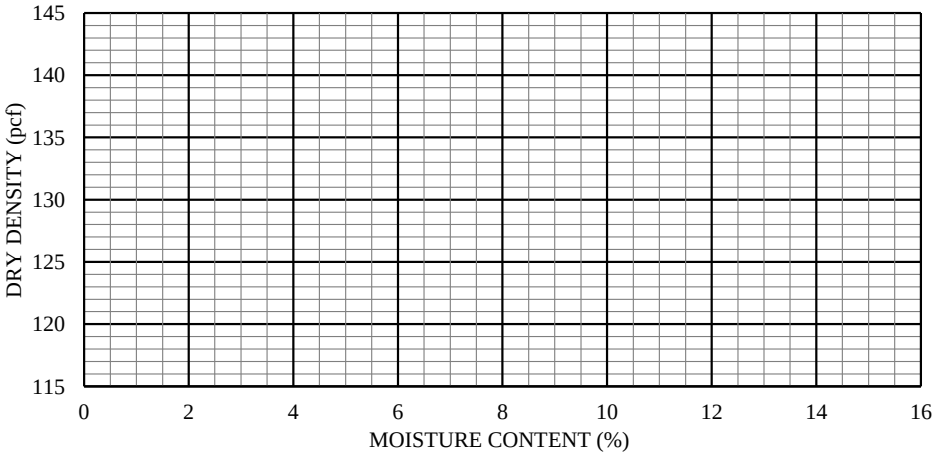
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
152.40	6"		
76.20	3"		
38.10	1.5"	**100**	
19.00	3/4"	**98**	
12.70	1/2"	**98**	
9.50	3/8"	**95**	
4.75	#4	**86**	
2.00	#10	**67**	
0.85	#20	**47**	
0.43	#40	**33**	
0.25	#60	**26**	
0.15	#100	**21**	
0.075	#200	**16.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
1	0.0458	14.7
2	0.0331	12.9
5	0.0215	11.0
8	0.0171	10.5
15	0.0127	9.3
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

11301 Olive Lane · Anchorage, Alaska 99515 · Phone: 907-344-5934 · Fax: 907-344-5993 · www.nge-tft.com

APPENDIX C

USGS SEISMIC SITE CLASSIFICATION REPORTS

USGS Design Maps Summary Report

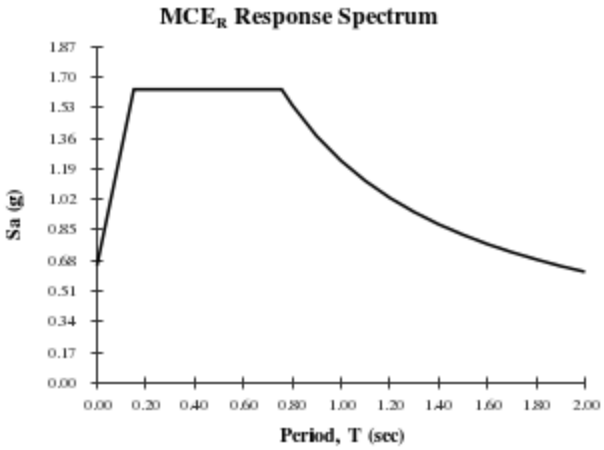
User–Specified Input

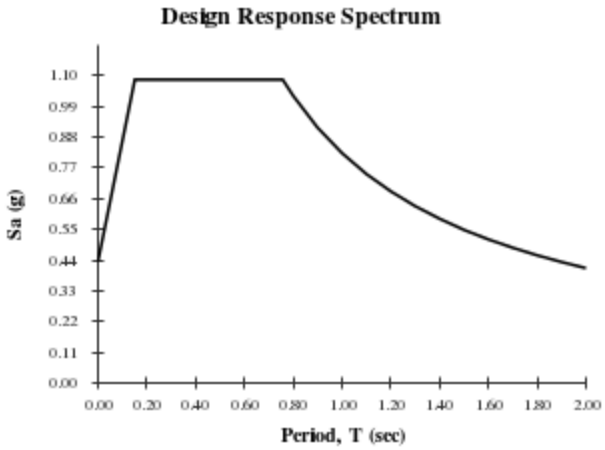
Report Title	USFWS Fish Passage Improvements Thu November 8, 2018 17:44:48 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	60.44096°N, 145.13214°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	1.630 g	S_{MS} =	1.630 g	S_{DS} =	1.086 g
S_1 =	0.823 g	S_{M1} =	1.234 g	S_{D1} =	0.823 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





USGS Design Maps Detailed Report

2012/2015 International Building Code (60.44096°N, 145.13214°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(4) [1] S_S = 1.630 g

From Figure 1613.3.1(5) [2] S_1 = 0.823 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\overline{v}_s$	$\overline{N}$ or $\overline{N}_{ch}$	$\overline{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\overline{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.630 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.823 g, F_v = 1.500

Equation (16-37): $S_{MS} = F_a S_S = 1.000 \times 1.630 = 1.630$ g

Equation (16-38): $S_{M1} = F_v S_1 = 1.500 \times 0.823 = 1.234$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 1.630 = 1.086$ g

Equation (16-40): $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 1.234 = 0.823$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.086 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.823 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = E

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(4)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(4).pdf
2. *Figure 1613.3.1(5)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(5).pdf

APPENDIX D

CLASSIFICATION OF ORGANIC SOILS

APPENDIX D - CLASSIFICATION OF ORGANIC SOILS

1.0 Introduction

In order to develop relevant geotechnical engineering recommendations for a given site, it is first necessary to properly identify the three primary soil types which can occur at a given site. These soil types are:

1. Inorganic soils – contain no organic matter, only mineral soil particles.
2. Organic soils – contain a mixture or organic matter and mineral soil particles with ≤50% organic matter (by mass).
3. Peat soils – contain a mixture or organic matter and mineral soil particles with ≥50% organic matter (by mass).

According to the Unified Soil Classification System (USCS), there is no specified classification for coarse-grained soils (i.e., sand & gravel) which contain some percentage of organic matter; only for fine-grained soils (i.e., silt & clay) which contain some percentage of organic matter. There is a USCS classification for peat soils (which are also referred to as a highly organic soils), however, within the USCS there are no established boundaries between peat soils and fine-grained organic soils.

There have been several studies conducted on the nature of organic soils and other soil classification systems have been suggested to better classify organic soils. The Alaska Department of Transportation and Public Facilities (AKDOT&PF), and several other state, federal, and academic organizations, have all proposed different classifications for organic soils. However, the majority of engineering professionals agree that there are four or five general classifications for organic soils. The classifications are as follows:

1. Inorganic soils
2. Soils with some organic content
3. Organic soils
4. Highly organic soils
5. Peat soils

The organic matter content of a soil may be determined by:

- visual estimation based on the volumetric percentage of organic matter present in a given soil, or
- direct measurement (by laboratory testing) based on the mass percentage of organic matter present in a given soil sample.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Due to the variable specific gravity of organic matter, the only reliable determination of the organic content of a given soil is by mass, which can be determined utilizing ASTM D-2974. It should be noted, however, that the organic content calculated using ASTM D-2974 does not include any organic particles retained on the #10 sieve or greater than approximately 0.08 inches in diameter. In the event that there are particles of coarse organic matter retained on the #10 sieve, then modifications to ASTM D-2974 must be made to account for the additional coarse organic matter (which we discuss in greater detail later in Section 2.0 of this Appendix).

There is not yet an accepted standard for delineating the percentages of organic matter in any given soil classification system, there are only recommendations derived from the proposed classifications. The AKDOT&PF classification specification states that soils with less than 2% organic matter by mass, or greater than 98% ash/mineral content (after lab testing), are deemed as inorganic soils. Ash content refers to the product of a Loss on Ignition (LOI) test (as per ASTM D-2974), where a soil sample is burned in an oven to determine its organic content. The organic matter in the test sample combusts under the high temperatures, leaving only inorganic minerals and the ash of the incinerated organic matter behind (which has a negligible mass).

The organic content of a soil can be approximated in the field by visually estimating the volume of organic matter present as part of the soil volume as a whole. These estimates tend to be highly unreliable (due to the variable density of organic soils), often resulting in erroneous organic content determinations. We therefore recommended that the organic content of a soil be determined solely through laboratory testing using the Loss on Ignition test (ASTM D-2974), which yields the mass percentage of organic material present in a given soil ample.

As we previously mention, a key to understanding the results of the ASTM D-2974 test procedure is that the test procedure first calls for the soil sample to be sieved over the #10 sieve. This procedure excludes pieces of coarse organic matter such as sticks, roots, and other fibrous organic matter which cannot pass the #10 sieve. This excluded coarse organic matter can have a significant impact on the structural performance of a given soil. To better assess the impact of all organic matter contained within a given soil sample (both coarse and fine organic matter), we have developed a modified procedure for ASTM D-2974, which includes the coarse organic matter retained on the #10 sieve. We have included a detailed explanation of our modified test procedure for ASTM D-2974 in Section 2.0 of this Appendix. Only by evaluating the total organic content of a soil can one properly evaluate the potential settlements risks associated with a given organic soil.

2.0 Modified Organic Content Test Method

The modified organic content test method that we have developed, which we have termed ASTM D2974m, considers the organic content of the entire soil sample as opposed to only the fine (i.e., smaller diameter) organic matter passing the #10 screen (as specified by ASTM D2974).

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

The coarse fraction of organic matter (that which is retained on the #10 sieve) in a sample is not considered by ASTM D2974 and can pose significant settlement potential in soils. Therefore, we feel that it is critical to properly evaluate the total organic content of any sample (both coarse and fine organic matter) in an effort to thoroughly evaluate the settlement potential of organic soils. We have detailed our procedure for determining the modified organic content of a soil below.

Step 1: Moisture Content – We determine the initial moisture content (mass fraction), *W*, of the as-received test specimen by measuring the mass of the sample both before and after drying. The moisture content of the test specimen can then be calculated from the relationship:

$$W = (A\text{-}B) / B \quad (1)$$

Where *A* is the mass of the wet (as-received) sample and *B* is the mass of the dry sample. Drying may take several days, dependent upon the particle sizes of any organic matter contained within the sample. We perform the sample drying as per ASTM D422.

Step 2: Split Sample – We sieve the dried sample over the #10 screen (as per ASTM D422). We then calculate the fraction (by mass) of material passing the #10 screen, *F*, using the equation:

$$F = E / B \quad (2)$$

Where *E* is the dry mass of material passing the #10 screen and *B* is defined in Step 1 of this procedure.

Step 3: Coarse Organic Matter Content – We calculate the fraction of organic matter retained on the #10 sieve by submerging and agitating the entire portion of the retained sample in water. The agitation process is as follows:

1. Submerge sample in water and agitate for one minute.
2. Collect floating fraction of sample (organic matter).
3. Agitate remaining sample for an additional 30 seconds.
4. Collect any additional floating material.
5. Repeat steps 3 & 4 until there is no floating material.

We then dry and measure the mass of all of the floating organic matter that we collect during the water immersion/agitation stage. The plus #10 organic fraction, O_{coarse}, is given by the equation:

$$O_{coarse} = C / B \quad (3)$$

Where *C* is the dry mass of the floating organic matter, dried per ASTM D422.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Step 4: Fine Organic Matter Content - The procedure we use to obtain the organic content of the material passing the #10 sieve is described by ASTM standard D2974, where the organic fraction, O_{fines}, is calculated from:

$$O_{fines} = (G-H) / (H-D) \quad (4)$$

Where G is the mass of the split sample (entire as-received sample passing #10 sieve) and crucible, H is the mass of the burnt residue (mineral plus ash content) and crucible and D is the mass of the crucible.

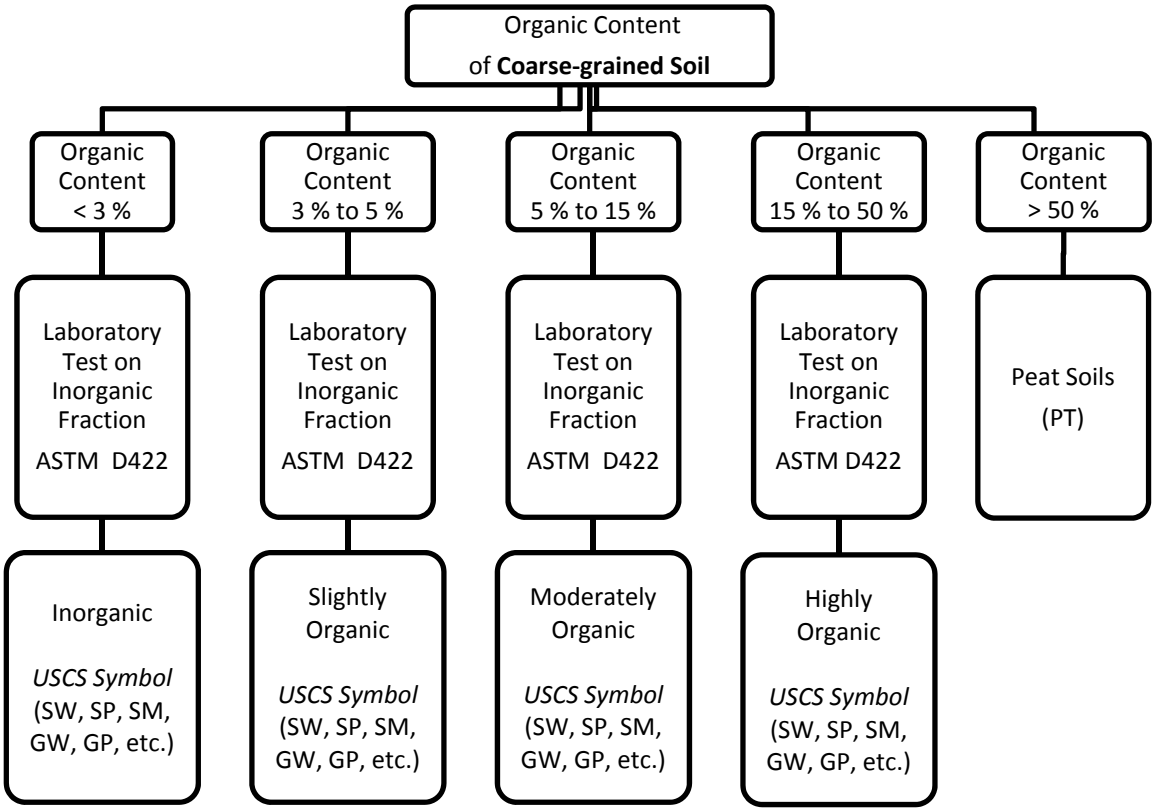
The total organic content by mass fraction, O_{total}, is finally given by:

$$O_{total} = (F \times O_{fines}) + O_{coarse} \quad (5)$$

3.0 Organic Soil Classification

Our classification for the organic content of coarse-grained soils is based on the AKDOT&PF classification for coarse-grained soils. We detail our recommended coarse-grained soil classification in Figure 1 of this appendix.

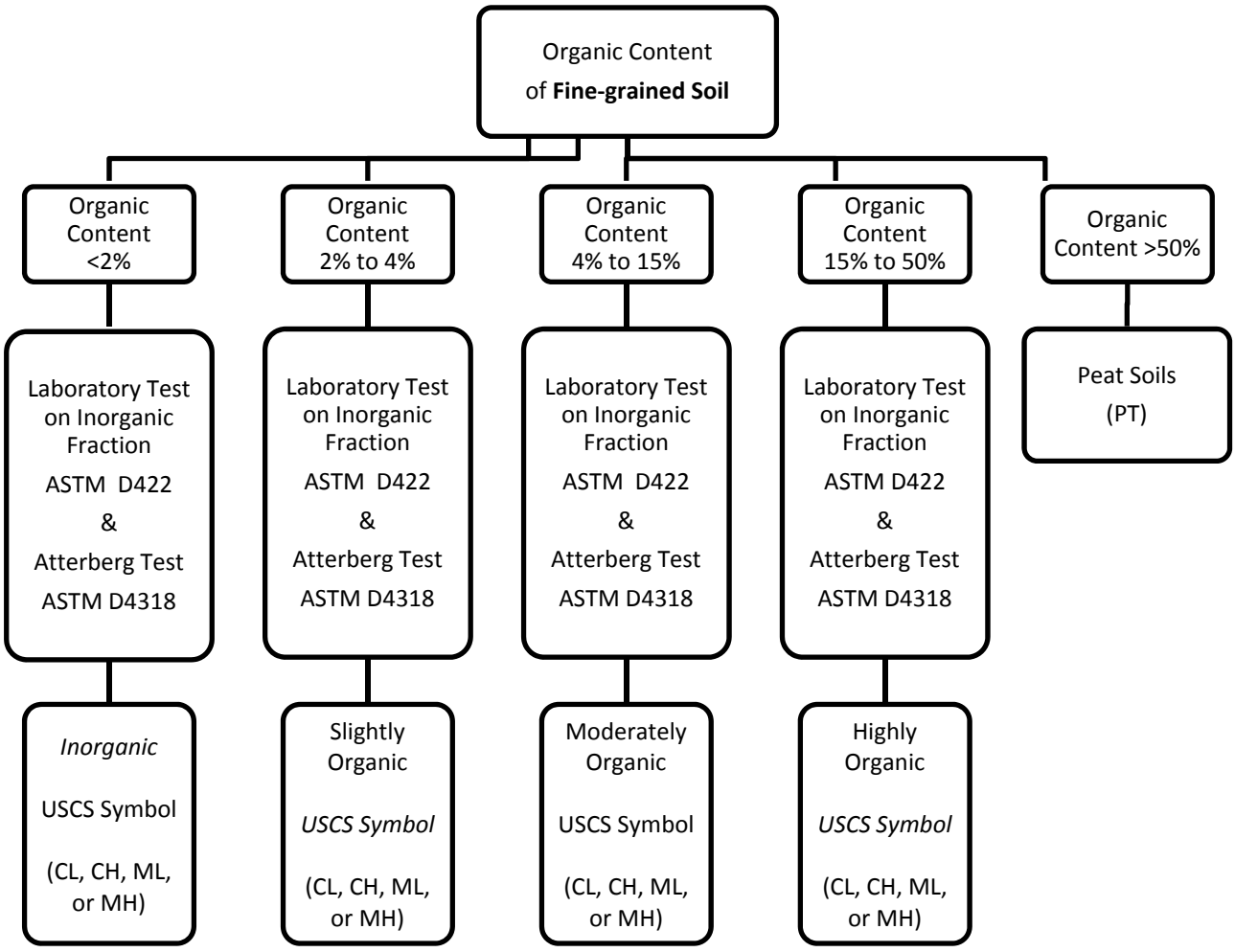
Figure 1: Organic Soil Classification for Coarse-grained Soils (using ASTM D2974m)



11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

The AKDOT&PF classification for the organic content of fine-grained soils is based on either visual-manual description of the soil or testing of the Atterberg limits of the soil as determined by ASTM D2487. However, the only quantifiable way to ascertain an organic soil based on the AKDOT&PF classification is to conduct an Atterberg limit test. If the liquid limit after oven drying is less than 75 percent of the liquid limit before oven drying, then the soil is classified as an organic silt/clay. This classification method does not determine the organic fraction of the soil by mass, and only describes the presence of organic matter. Therefore, we do not use the AKDOT&PF classification system for fine-grained organic soils. For stability considerations, we recommend that the organic content of fine-grained soils be defined by the chart that we present in Figure 2 of this appendix.

Figure 2: Organic Soil Classification for Fine-grained Soils (by ASTM D2974m)



11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

For both coarse-grained and fine-grained classifications, we first begin by sieving the sample as per test method ASTM D422 with the fine organic fraction retained in the portion of the sample passing the #10 sieve and with the coarse organic fraction removed for the portion of the sample retained on the #10 sieve.

4.0 Peat Soil Classifications

Peat is defined as a naturally occurring, highly organic substance composed primarily of vegetative matter in various stages of decomposition. It is fibrous to amorphous in texture, is usually dark brown to black, and usually has an organic odor. The organic mat commonly found at the ground surface (comprised of grass, roots, and decaying leaves) is not included in the peat classification.

Peat has been classified into subcategories based on the structure of the peat. There is no generalized classification system, as the necessity of classification changes according to the purpose for which the soil is to be classified. Two of the most common methods for classification of peats include the Von Post system and the Radforth system. From these two systems, other more simplistic methods have been developed.

The Von Post classification system is dependent on the degree of humification (i.e., decomposition) of the peat and is the basis for ASTM D-5715; which is a visual/manual classification of peat. The AKDOT&PF further simplified the Von Post and Radforth systems into three categories of peat:

1. fibric;
2. hemic; and
3. sapric.

The peat is classified based on the results of a humification test for fiber content. Where humification or other peat classification is not required, the material is simply classified as peat. For engineering purposes, the specific classification of peat type (i.e, fibric, hemic, etc.) provides minimal distinction and therefore further classification is typically unnecessary.

The AKDOT&PF *Alaska Guide to Description and Classification of Peat and Organic Soil* classifies a peat soil as any soil with at least 75% organic matter or 25% mineral content (post-LOI testing as per ATSM D2974). However, for sake of simplicity and to be consistent with general USCS gradation breaks, we define peat soils as any soil (coarse or fine-grained) with more than 50 percent organic matter (or less than 50 percent ash/mineral content.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

5.0 Engineering Properties of Organic and Peat Soils

The geotechnical properties of an organic/peat soil are a function of a number of factors, including:

1. organic content of the soil;
2. type of organic matter;
3. the degree of humification of the organic matter;
4. the soil void ratio;
5. mineral particle size distribution within the soil; and
6. soil moisture content.

As the organic content of an organic soil increases, so does its ability to retain water, and soil moisture contents of organic soils are typically much higher than inorganic soils. The Atterberg limits of fine-grained organic soils also typically increase, although the effects of the organic matter on Atterburg limits are not constant or predictable. However, as the organic content of a soil increases, the density of the soil decreases, as well as its ability to be mechanically compacted. The type of organic matter and the degree of humification has some effect on the strength and permeability of an organic/peat soil. The void ratio of a soil increases with organic content, and can affect the compressibility of the soil, which is an important factor in construction activities.

Peat soils are typically highly compressible and usually contain significantly higher natural moisture contents than mineral soils. Due to their compressibility, peat soils generally have a low bearing capacity, making them unsuitable for foundation, gravity-fed utility, and/or pavement support. Peat soils also have low lateral bearing capacities, and provide little lateral resistance to foundations (e.g., piles, grade beams, etc.) or other lateral load bearing features.

Organic soils are moderately compressible and have a low to moderate bearing capacity. These types of soils are also unsuitable for supporting foundations but may be suitable for gravity-fed utility and/or pavement section support (assuming proper engineering controls are implemented into the utility/pavement section design). Organic soils have a moderate lateral capacity and can typically support moderate lateral loading with minimal compression.

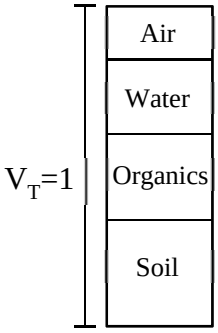
In order to further classify the suitability of a soil for engineering purposes (based solely upon the ash/mineral content of the soil as determined by ASTM D-2974(m), we have created a classification system of soils containing organic matter Our classification system, which we detail in Section 10.0 of this appendix is based upon previous work by AKDOT&PF and others and does not reflect the suitability of a specific soil with respect to its USCS classification or its in-situ density, only the ash/mineral content.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

6.0 Void Ratio and Degree of Saturation

The void ratio and degree of saturation for organic/peat soils involves an additional step to the void ratio determination typically used. We detail this procedure in Figure 3 of this appendix.

Figure 3: Void Ratio and Degree of Saturation Equations



$V_a = 1 - V_w - V_o - V_s$

$V_w = \frac{W_w}{(1)\gamma_w}$ γ_w = unit weight of water

$V_o = \frac{W_o}{(1.35)\gamma_w}$ where 1.35 is the specific gravity of cellulose

$V_s = \frac{W_s}{(G_s)\gamma_w}$ G_s = specific gravity of the mineral soil of the sample

The degree of saturation: $S = \frac{V_w}{V_a+V_w}$

The void ratio: $e = \frac{V_a+V_w}{V_o+V_s}$

The cellular structure of organic matter inherently produces a significant portion of air voids. This inherently high void ratio is the reason why cellular organic matter (when dry) will float on water and contributes to the very high moisture contents and low bulk densities typically associated with organic/peat soils. The high void ratio of organic matter and organic/peat soils is also why organic/peat soils have a significant settlement potential associated with them.

7.0 Bearing Capacity Properties of Soil

The bearing capacity properties of a soil depend upon their intended application. We have separated the general geotechnical bearing capacity properties of a soil into two primary applications:

1. building foundation support; and
2. pavement section support.

For inorganic and slightly organic soils the same bearing capacity properties can be used for both applications. The bearing capacity properties can be calculated using the standard USCS, coupled with strength testing and/or correlations between soil densities. The low amount of organic matter present in these soils will not add any additional settlement potential outside of the normal settlement limits that we detail in our report and can therefore be ignored.

For organic and highly organic soils, the bearing capacity should be appropriately reduced for building foundation applications, as there can be low to moderate risks of settlement associated with these soils.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Peat soils are not suitable for building foundation support as there is a significant risk of settlement once oundation loads are applied. Pavement sections can be effectively constructed above organic/peat soils, but will require proper engineering assessments to evaluate any potential settlement risks based on the intended pavement use. Typically, an engineered structural pavement section consisting of varying amounts of coarse-grained fill and a geo-fabric layer(s) is required to help distribute pavement loads and reduce the potential for differential settlements within the organic/peat soil subgrade.

We have provided a summary of the settlement risks associated with the various organic/peat soils in the tables contained in Section 10.0 of this appendix.

8.0 Lateral Strength Properties of Soil

For inorganic and slightly organic soils, the lateral bearing properties can be calculated assuming normal USCS classification; effectively ignoring any organic content. The low amount of organic material in these soils will not reduce the lateral capacity as we describe in our report.

For organic and highly organic soils, the lateral capacity will be reduced in proportion to the organic content. Lateral pile testing is recommended for pile foundations in organic soil and is required in highly organic soils.

Peat soils are not suitable for lateral pile foundation support, and lateral pile bracing will most likely be required for pile foundations installed in areas of excessively thick peat soils.

We have provided a summary of the decreases in lateral capacity associated with the various organic/peat soils in the tables contained in Section 10.0 of this appendix.

9.0 Embankment Properties of Soils

The embankment properties for road and parking sections are the same for both coarse-grained and fine-grained soils.

The embankment properties for inorganic and slightly organic soils can be taken as the normal USCS density. The low amount of organic material in these soils will not reduce the stability of embankments as described in the report.

For organic soils, the stability of embankments will be reduced to marginal and a slope stability analysis is recommended. Highly organic soils and peat are not suitable for the construction of earthen embankments. We have provided a summary of the decreases in embankment strength associated with the various organic/peat soils in the tables contained in Section 10.0 of this appendix.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

10.0 NGE-TFT Classifications for Organic Soils

As we discuss in Section 5.0 of this appendix, we have proposed a classification and suitability system of soils that contain organic matter as a part of determining suitability of a soil for its proposed engineering purpose. Our classification system, which we outline in Tables 1-4 of this appendix, does not reflect the suitability of a specific soil with respect to its USCS classification or its in-situ density. Our classification is based solely on the ash/mineral content of the soil as determined by ASTM D-2974 (or ASTM D-2974m).

Table 1: Classification for Coarse-grained Organic Soils and their Impact on Foundations

COARSE GRAINED – BUILDINGS & GRAVITY-FED UTILITIES					
	CATEGORY	ORGANIC CONTENT	ASH/MINERAL CONTENT	BASIS FOR BEARING PROPERTIES	BASIS FOR LATERAL CAPACITY
1.	INORGANIC	< 3 %	> 97 %	USCS / DENSITY	USCS / DENSITY
2.	SLIGHTLY ORGANIC	3 % - 5 %	97 % - 95 %	USCS / DENSITY	USCS / DENSITY
3.	ORGANIC	5 % - 17 %	95 % - 83 %	LOW TO MODERATE	MODERATE[1]
4.	HIGHLY ORGANIC	17 % - 50 %	83 % - 50 %	LOW	LOW[2]
5.	PEAT	> 50 %	< 50 %	NONE	NONE

Table 2: Classification for Coarse-grained Organic Soils and their Impact on Pavement

COARSE GRAINED – PAVEMENT					
	CATEGORY	ORGANIC CONTENT	ASH/MINERAL CONTENT	BASIS FOR BEARING PROPERTIES	BASIS FOR LATERAL CAPACITY
1.	INORGANIC	< 3 %	> 97 %	USCS / DENSITY	USCS / DENSITY
2.	SLIGHTLY ORGANIC	3 % - 5 %	97 % - 95 %	USCS / DENSITY	USCS / DENSITY
3.	ORGANIC	5 % - 17 %	95% - 83%	ENGINEERING[3]	MARGINAL[3]
4.	HIGHLY ORGANIC	17 % - 50 %	83 % - 50 %	ENGINEERING[3]	UNSUITABLE
5.	PEAT	> 50 %	< 50 %	ENGINEERING[3]	UNSUITABLE

Table 3: Classification for Fine-grained Organic Soils and their Impact on Foundations

FINE GRAINED – BUILDINGS & GRAVITY-FED UTILITIES					
	CATEGORY	ORGANIC CONTENT	ASH/MINERAL CONTENT	BASIS FOR BEARING PROPERTIES	BASIS FOR LATERAL CAPACITY
1.	INORGANIC	< 2 %	> 98 %	USCS / DENSITY	USCS / DENSITY
2.	SLIGHTLY ORGANIC	2 % - 4 %	98 % - 96 %	USCS / DENSITY	USCS / DENSITY
3.	ORGANIC	4 % - 15 %	96 % - 85 %	LOW TO MODERATE	MODERATE[1]
4.	HIGHLY ORGANIC	15 % - 50 %	85 % - 50 %	LOW	LOW[2]
5.	PEAT	> 50 %	< 50 %	NONE	NONE

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

Table 4: Classification for Fine-grained Organic Soils and their Impact on Pavement

FINE GRAINED – PAVEMENT					
	CATEGORY	ORGANIC CONTENT	ASH/MINERAL CONTENT	BASIS FOR BEARING PROPERTIES	BASIS FOR LATERAL CAPACITY
1.	INORGANIC	< 2 %	> 98 %	USCS / DENSITY	USCS / DENSITY
2.	SLIGHTLY ORGANIC	2 % - 4 %	98 % - 96 %	USCS / DENSITY	USCS / DENSITY
3.	ORGANIC	4 % - 15 %	96 % - 85 %	ENGINEERING[3]	MARGINAL[3]
4.	HIGHLY ORGANIC	15 % - 50 %	85 % - 50 %	ENGINEERING[3]	UNSUITABLE
5.	PEAT	> 50 %	< 50 %	ENGINEERING[3]	UNSUITABLE

Notes: [1]Lateral pile load testing recommended. [2]Lateral pile load testing required. [3]Compressibility and geo-fabric engineering studies needed. [4]Slope stability evaluation recommended.

11.0 Closure

We (*Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing*) prepared this Appendix using a combination of published literature and our own professional experiences and engineering judgements. Information contained within this appendix that is based on our engineering judgments is our intellectual property and cannot be used without our express written consent. We prepared this appendix following the standard of care expected of professionals undertaking similar work in the State of Alaska under similar conditions. No warranty expressed or implied is made.

12.0 References Cited

ASTM Standard D 2488. (2000). *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).* ASTM.

AASHTO (American Association of State Highway and Transportation Officials). (1993a). *Guide for Design of Pavement Structures.* Washington, D.C.: AASHTO.

Abdallah, I. H., Alawneh, A. S., & Abu-Safaqah, O. T. (1999). Effects of Organic Matter on the Physical and the Physicochemical Properties of an Illitic Soil. *Applied Clay Science, Vol 14*, 257-278.

Andersland, A. B., & Ladanyi, B. (2004). *Frozen Ground Engineering.* Hoboken: John Wiley & Sons, Inc.

ASTM Standard D 2487 - 06. (2006). *Classification of Soils for Engineering Purposes (Unified Classification System).* ASTM.

ASTM Standard D 2974 - 87. (1987). *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.* ASTM.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com

ASTM Standard D 5715. (2006). *Standard Test Method for Estimating the Degree of Humification of Peat and Other Organic Soils (Visual/Manual Method).*

Flaate, K. (1965). The Classification of Peat and Peat Deposits for Engineering Purposes. *11th Annual Conference on Muskeg Research, May 6-7, III*, pp. 13-25. Sudbury, Ontario, Canada.

Huang, P.-T., Patel, M., Santagata, M. C., & Bobet, A. (2009). *Classification of Organic Soils.* West Lafayett, Indiana: Joint Transportation Research Program, Indiana Department of Transportation and Purdue University.

Huwang, Y. (1993). *Pavement Analysis and Design.* Englewodd Cliffs, NJ: Prentice-Hall, Inc.

Jarret, P. (June 1982). Testing of Peats and Organic Soils. *A Symposium Sponsored by ASTM Committee D-18 on Soil and Rock.* Toronto, Canada.

Landva, A., Korpijaakko, E., & Pheeney, P. (1983). Geotechnical Classification of Peats and Organic Soils. (P. Jarrett, Ed.) *Testing of Peats and Organic Soils: ASTM STP 820*, 37-51.

McFarlane, I. (1969). Muskeg Engineerig Handbook. *Associate Comittee on Geotechnical Research.* Toronto: University of Toronto Press.

MOA Project Management & Engineering. (2007). *Design Criteria Manual.* Anchorage.

Myslinska, E. (2003). Classification of Organic Soils. *Geological Quarterly, Vol 47(1)*, 39-42.

Radforth, N. (1969). Classification of Muskeg. In I. McFarlane (Ed.), *Muskeg Engineering Handbook, National Research Council of Canada, Associate Committee on Geotechnical Research , Muskeg Subcommitee* (pp. 31-52). Toronto: University of Toronto Press.

Stanley, D. (2007). *Alaska Guide to Description and Classification of Peat and Organic Soil.* Anchorage: Alaska Department of Transportation and Public Facilities.

Sukumaran, B. (2002). Suitability of Using California Bearing Ratio Test to Prdicet Resilient Modulus. *Federal Aviation Administration Airport Technology Transfer Conference.* Glassboro, NJ.

U.S. Army Corps of Engineers. (1984). *EM 1110-3-138 Pavement Criteria for Seasonal Frost Conditions.* Washingtion D.C.

U.S. Department of Transportation Federal Highway Administration. (2006). *FHWA NHI-05-037 Geotechnical Aspects of Pavements.* Washington, D.C.: Federal Highway Administrations.

11301 Olive Lane Anchorage, Alaska 99515 · Phone: (907) 344-5934 · Fax: (907) 344-5993 · Website: www.nge-tft.com