ST. GEORGE HARBOR IMPROVEMENT FEASIBILITY STUDY

APPENDIX B: GEOTECHNICAL

ST. GEORGE, ALASKA

U.S. Army Corps
of Engineers
Alaska District

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1.1 Introduction

The purpose of this report is to summarize results of existing geotechnical information at the St. George Harbor located in Zapadni Bay and document anticipated geotechnical conditions as they pertain to the current proposed tentatively selected plan known as the North Anchorage Harbor site on St. George Island, referenced as Alternative N-3 in the Feasibility Report. This report also recommends geotechnical design criteria for proposed rubble-mound breakwater construction and dredging at the North Anchorage Harbor site. Information and assumptions in this report were developed through a desk study of existing geotechnical information and it is intended for use by design engineers and planners to evaluate feasibility alternatives for new harbor improvements on St. George Island. Information in this report is not intended for use in construction contract documents.

2.1 Location and Project Description

St. George Island is one of the Pribilof Islands located in the Bering Sea approximately 225 miles north of Dutch Harbor and 750 miles west of Anchorage, Alaska. The current St. George Harbor is located in Zapadni Bay and the proposed tentatively selected plan, referenced as Alternative N-3 in the Feasibility Report, is located just northwest of the community of St. George at the North Anchorage site seen in Figure 1.

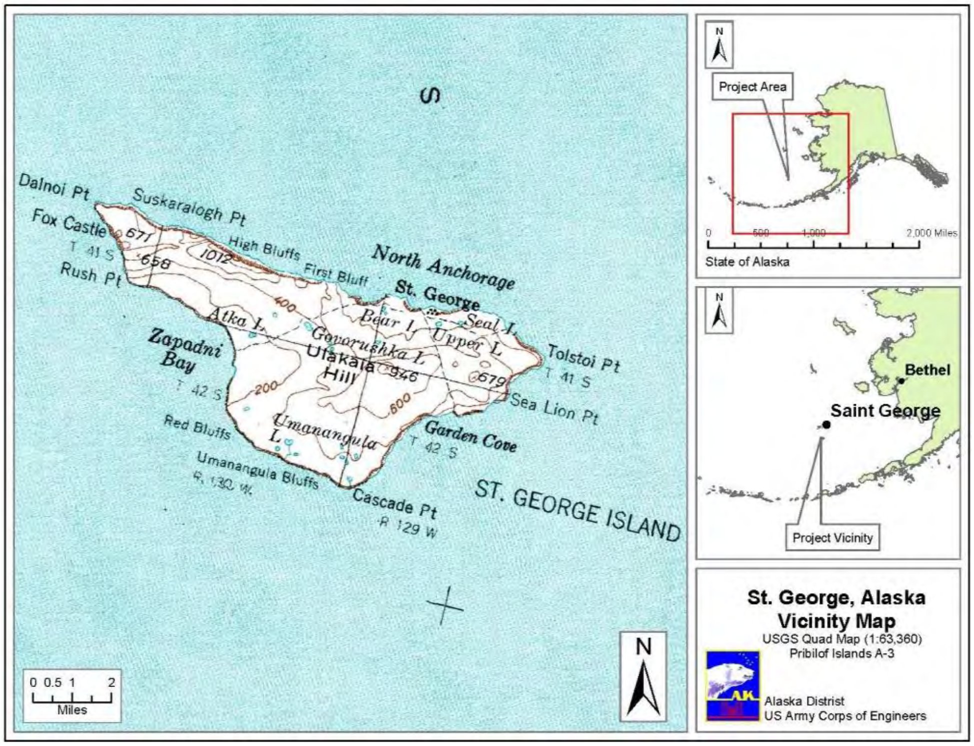

Figure 1: St. George Island Vicinity Map.

The existing St. George Harbor located in Zapadni Bay includes a navigation channel, turning basin, and three rubble mound breakwaters. These breakwaters were constructed from 1984 to 1987 and were designed as berm structures with 8 ton armor stone produced from a local material source on St. George Island. The size of armor stone used in the existing breakwaters has proven to be inadequate as major maintenance has been required to repair breakwater slopes after exposure to fall and winter storms from the Bering Sea. Figure 2 provides an aerial view of the existing St. George Harbor in Zapadni Bay. Note arrow showing breakwater slope repairs to the east breakwater caused from a December 2015 Bering Sea storm.

Figure 2: Aerial view of St. George Harbor in Zapadni Bay.

The current tentatively selected plan for harbor improvements on St. George is to construct a new harbor at the North Anchorage site located in a small cove northwest of the community of St. George. Figure 3 provides an aerial view of the community of St. George and Figure 4 provides a plan view of the tentatively selected plan Alternative N-3 at the North Anchorage site. Figures 5 and 6 provide views of the North Anchorage Cove and community of St. George.

Figure 3: Community of St. George and adjacent North Anchorage Site.

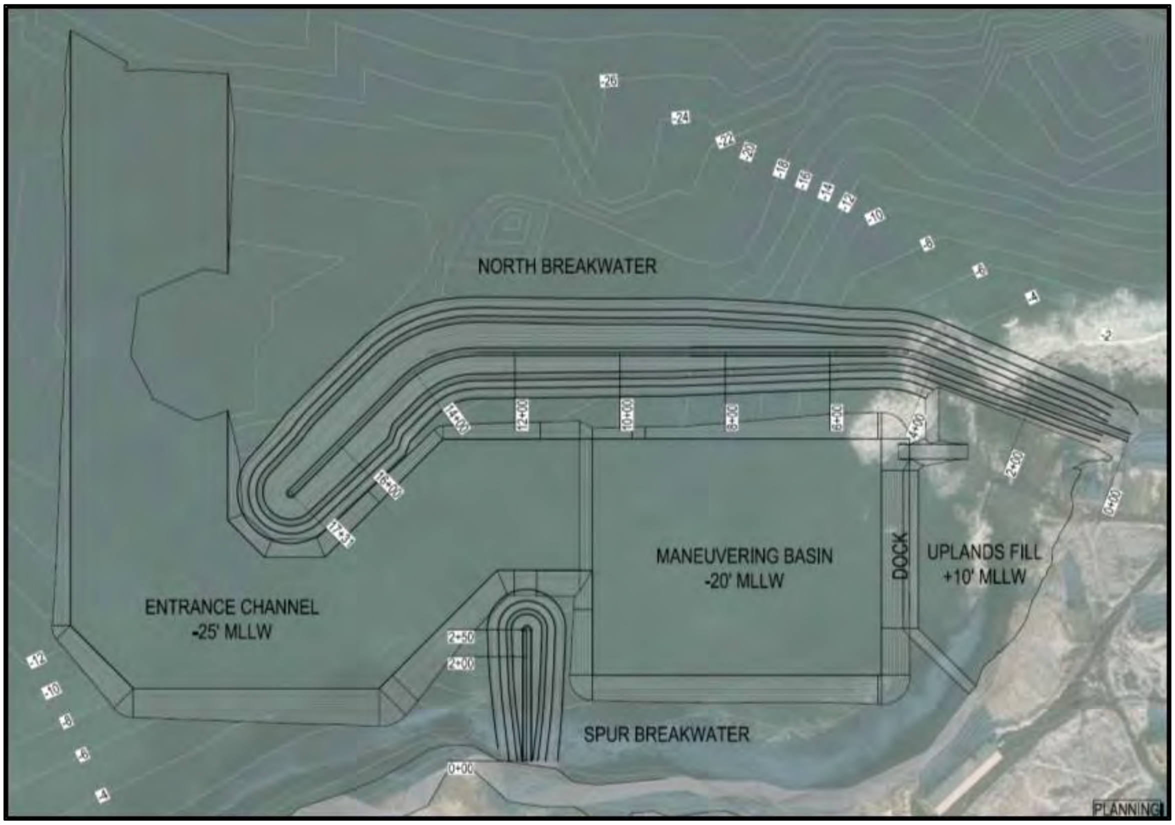

Figure 4: Alternative N-3 North Anchorage Harbor Site.

Figure 5: North Anchorage Cove.

Figure 6: Community of St. George.

Proposed breakwater alternatives for the North Anchorage Harbor site share the same conceptual cross-sectional breakwater design. These breakwaters will be exposed to the open ocean environment and are designed as 3-layer rubble mound breakwaters constructed at slopes of 1.5 and 2 horizontal to 1 vertical with 10-ton armor stones to a crest elevation of +25 feet MLLW. Figure 7 provides conceptual breakwater slopes and dimensions that were used for geotechnical evaluation purposes in this report.

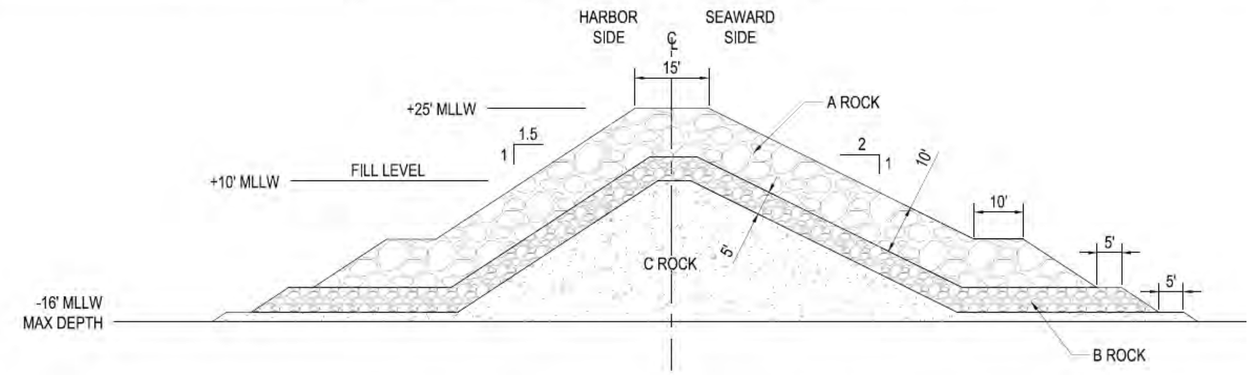

Figure 7: Conceptual North Anchorage Harbor Breakwater Cross Section.

3.1 Historical Geotechnical Information

Shannon & Wilson, Inc. in partnership with The Watson Company performed two geotechnical site investigations which included drilling test borings and geophysical surveys at the St. George Zapadni Bay Harbor in 2014 for the Alaska Department of Transportation. The existing site investigations were performed approximately five miles southeast of the proposed harbor. These field exploration efforts are documented in the St. George Harbor and Breakwater Improvements Project Geotechnical Data Report dated March 2015. For reference this report has been included in Appendix B.1.

3.1.1 Geotechnical Exploration

During the Shannon & Wilson geotechnical site investigation a total of nine test borings were drilled; seven borings were drilled within the Zapadni Bay Harbor and two borings were drilled at the Airport Quarry along with excavating six test pits. Test borings B-1 through B-7 drilled in the vicinity of Zapadni Bay Harbor varied in drill depths from 12 feet to 43 feet below the ground surface. Overburden soils encountered during drilling consisted of medium dense to dense coarse-grained and fine-grained soils with cobbles and boulders. The depth to bedrock varied greatly with ranges from 0.5 feet to 30.5 feet below the ground surface. Below the overburden soils moderately weathered to fresh vesicular basalt bedrock was encountered with reported rock quality designation (RQD) values ranging from 0 to 30. These RQD values indicate poor to very poor rock quality; however in boring B-6, higher RQD values were reported below an approximate elevation of -16.5 feet MLLW.

3.1.2 Geophysical Explorations

The offshore geophysical exploration performed in May 2014 by The Watson Company under contract with Shannon & Wilson was used to investigate and identify the thicknesses of sediments over bedrock within the existing harbor basin, entrance channel, and area adjacent to the harbor in Zapadni Bay. The offshore geophysical exploration found sediments varied in thickness from six feet close to shore and increased in thickness to approximately 45 feet a distance of 2800 feet offshore. Onshore geophysical explorations performed by Shannon & Wilson in the Fall of 2014 also identify and correlate the thickness of soil over bedrock. Cross-sections and isopach maps displaying the inferred bedrock elevations are provided in the St. George Harbor and Breakwater Improvements Project Geotechnical Data Report dated March 2015.

3.1.3 Rock Quality Testing

Geologic mapping and reconnaissance was also performed in the Airport Quarry to delineate differing rock types, orientation of structural features, and exposed rock faces. Result of rock quality testing from samples collected at the Airport Quarry are summarized in Table 1. A full discussion of test results are provided in Shannon & Wilson report provided in Appendix B.1.

Table 1: Airport Quarry Rock Quality Test Results

Sample	Degradation Value	LA Abrasion (% loss)	Soundness (% loss)	Bulk Specific Gravity	Absorption (%)	Ethylene Glycol (% loss)	Freeze/ Thaw (average % loss)
Quarry Harbor	91	42	1	2.65	2.6	0	0.08
Quarry "A"	57	64	2	2.60	2.3	0	0.02
Quarry "B"	91	43	1	2.59	0.8	0	0.22

Rock quality test results reported for the Airport Quarry do not meet typical LA Abrasion U.S. Army Corps of Engineers rock quality testing requirements for shore protection projects. Typically USACE breakwater stone requires LA Abrasion percent loss values to be 20 percent or less. Further evaluation of the Airport Quarry would be required before consideration could be given to using the material source to produce Armor stone for St. George Harbor improvements.

4.0 Geotechnical Engineering Analysis and Recommendations

4.1 North Anchorage Harbor

Review of existing geotechnical information collected at the St. George Harbor located in Zapadni Bay and aerial photos provided of the proposed North Anchorage Harbor site indicate very favorable breakwater foundation conditions for all North Anchorage Harbor alternatives.

4.1.1 Breakwater Slope Stability and Settlement

For engineering analysis and evaluation purposes, we assumed proposed breakwater foundations located at the North Anchorage Harbor site would most likely consist of relatively thin layers of medium dense to dense sediments consisting of coarse-grained soils with cobbles and boulders. The depth to bedrock may vary greatly but for evaluation purposes it was assumed bedrock would be within 10-feet of the seafloor since the proposed breakwater alignments are close to shore. Given the current geotechnical information available on St. George Island we do not anticipate any changes to the current proposed breakwater cross-sections referenced in Figure 7.

Breakwater slope stability and settlement analysis were not performed for North Anchorage Harbor alternatives because expected foundation conditions were assumed to be very similar to the existing St. George Harbor in Zapadni Bay.

4.1.2 Seismic Hazards

Shannon & Wilson evaluated seismic conditions and performed seismic analysis of the existing St. George Harbor breakwaters as part of their March 2015 Geotechnical Data Report. Peak ground acceleration (PGA) were predicted to be approximately 0.18g with a corresponding earthquake magnitude of M5.2. Shannon & Wilson suggested that seismically induced liquefaction or slope failures associated with Harbor infrastructure were not likely to occur with the predicted low magnitude and low acceleration earthquakes associated with the Pribilof Island area. Given the current geotechnical information available we do not anticipate additional design considerations or special foundations requirements to address seismic hazards for breakwater or navigation channel construction.

4.1.3 Dredging

Currently the proposed North Anchorage Harbor entrance channel and maneuvering basin is planned to be dredged to a depth of -25 feet and -20 feet MLLW. The thickness of sediment and depth to bedrock is unknown within the proposed harbor entrance channel and maneuvering basin. For estimating purposes, we anticipate bedrock will be encountered very near the surface, three feet or less, within the south side of the entrance channel and maneuvering basin. The thickness of surface sediment may gradually get thicker as the entrance channel moves north away for the shoreline. Drilling and controlled blasting of bedrock will be required within the navigation channel and harbor basin before material can be mechanically dredged by clamshell or long-reach excavator. Dredge cuts in the surface sediment can be assumed to be stable at slopes of 1.5 horizontal to 1 vertical. Dredge cuts in bedrock may be cut at slopes of 0.25 horizontal to 1 vertical.

4.1.4 Future Geotechnical Site Investigation Recommendations

The main goal with conducting a geotechnical site investigation at the North Anchorage Harbor site would be to properly characterize proposed dredge material, allow evaluation and recommendations of the suitability of breakwater foundation material, and identify any geological conditions that would require special considerations during preconstruction engineering and design of the harbor. Geotechnical information will also be used to establish the basis for accurate dredging cost estimates. The following geotechnical investigations are recommended for the North Anchorage Harbor site if this alternative is selected for the next phase of design:

1. Conduct an offshore geotechnical site investigation consisting of drilling between 15 and 20 test borings below the proposed rubble mound breakwaters, entrance channel, and maneuvering basin. The preferred drilling method would consist of using a sonic drill rig that would be able to penetrate dense coarse-grained sediments with cobbles and boulders and also able to advance into the bedrock to depths below the proposed bottom of the navigation channel.
2. Conduct an offshore marine geophysical investigation to further define sub-seafloor conditions and complement the geotechnical drilling by providing a broader understanding of subsurface stratigraphy and the depth to the top of bedrock within the dredging areas. The geophysical investigation should consist of survey track lines collected at a nominal spacing of 25-feet parallel and perpendicular to the proposed breakwater alignments, navigation channel, and maneuvering basin.

5.0 Reference

Shannon & Wilson, Inc. March 2015. “St. George Harbor and Breakwater Improvements Project, Geotechnical Data Report”.

6.0 APPENDIX B.1

Shannon & Wilson, Inc. March 2015. “St. George Harbor and Breakwater Improvements Project, Geotechnical Data Report”.

Geotechnical Data Report
St. George Harbor and Breakwater Improvements Project
St. George Island, Alaska

March 2015

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GEOTECHNICAL DATA REPORT
ST. GEORGE HARBOR AND BREAKWATER IMPROVEMENTS PROJECT
ST. GEORGE ISLAND, ALASKA

1.0 INTRODUCTION

This report presents the results of subsurface explorations and laboratory testing conducted by Shannon & Wilson, Inc. for harbor and breakwater improvements to St. George Harbor on St. George Island, Alaska. The improvements include construction of additional breakwater features, and potential dredging for reconfiguration and expansion of the existing harbor. The purpose of this geotechnical study was to gather subsurface geotechnical data to support project design. To accomplish this, we advanced nine geotechnical borings and six test pits, conducted seismic refraction data along eight survey lines, performed offshore sub-bottom profiling in and around the harbor, and conducted geologic mapping of exposed rock faces in the likely on-island borrow source (Airport Quarry). Selected soil samples recovered from the borings were tested in our Anchorage laboratory. Presented in this report are descriptions of the site and project, subsurface exploration and laboratory test results, and an interpretation of subsurface conditions, including geophysical profiles.

Authorization to proceed with this work was received in the form of a Subconsultant Agreement signed by Mr. Mark Dalton of HDR Alaska, Inc. (HDR) on April 4, 2014. The work was performed in general accordance with the scope of services included in the Subconsultant Agreement. The scope of services was developed based on a preliminary site visit by Shannon & Wilson, the findings of which are provided in our *Geotechnical Reconnaissance Report, Harbor and Breakwater Improvement Project, St. George, Alaska*, submitted in July 2014. Subsequent to the submittal of our July 2014 report, we prepared a geotechnical explorations plan that was based on several coordination meetings with the ADOT&PF and HDR's design team.

2.0 SITE AND PROJECT DESCRIPTION

St. George Island is the southern-most Pribilof Island in the Bearing Sea, approximately 750 air miles west-southwest of Anchorage, Alaska. At its widest points, the island is approximately 10 miles (east to west) by 4 miles (north to south). The existing harbor on St. George Island is on the southwestern coast of the island in what is known as Zapadni Bay. The harbor is adjacent to the air strip and is accessed from the village of St. George on the north side of the island by a roughly 4-mile long gravel road. A vicinity map is provided on Figure 1 of this report. The harbor itself consists of two outer breakwaters, the northern arm trending northeast-southwest and the southern arm trending northwest-southeast, that protrude from the shoreline to form the entrance to the outer harbor area. A third, inner breakwater (trending northwest-southeast) forms a secondary entrance from the outer harbor area to the inner harbor area. The inner harbor entrance is offset from the outer harbor entrance such that upon entering the outer harbor, a sharp turn to the south is needed to enter the inner harbor. A site plan showing the existing harbor and the approximate boring locations is included on Figure 2.

The St. George Harbor and Breakwater Improvement Project is focused on improving the entrance and expanding the inner basin of the existing St. George Harbor. We understand that the existing harbor was constructed in the mid to late 1980's, and all of the armor rock and fill used to construct the original breakwater structures was generated from material sources on the island. Based on information provided by HDR, it is evident that the existing breakwater configuration provides protection of the inner harbor area from moderate storm waves, but that wave action in the inner harbor can be significant during the larger storms that frequently impact this area. In addition, we understand that navigation in and out of the harbor can be challenging and hazardous depending on the direction of the wind and waves. The overall goal of the project is to modify the harbor so that navigation into and out of the inner harbor is safer.

3.0 SUBSURFACE EXPLORATIONS

Subsurface explorations for this study consisted of drilling and sampling nine borings designated Borings B-1 through B-9, and excavating and sampling six test pits designated Test Pits TP-1 through TP-6, between September 25 and October 2, 2014. Additional explorations consisted of a seismic refraction survey consisting of eight seismic lines near the Airport Quarry (the proposed borrow source), and geologic mapping of the exposed rock face at the Airport Quarry site. The general boring locations were selected in the field by our representative to provide relatively even coverage of the harbor and Airport Quarry areas and to avoid conflicts with buried utilities. The exploration locations, shown on Figure 2, were recorded using a Global Positioning System (GPS). Elevations for this project, where they appear, were measured using a rod and level survey, with base points established based on sea level at the time of the survey, or published maps indicating a peak elevation for Maynard Hill of 116 meters. Therefore, all locations and elevations provided for this project should be considered approximate.

3.1 Drilling Explorations

Drilling services for this project were provided by Discovery Drilling of Anchorage, Alaska, using a track mounted CME-850 drill rig. A representative from our firm was present during drilling to locate the borings, observe drill action, collect samples, log subsurface conditions, and observe groundwater conditions.

In general, the borings were advanced through soils (0.5 to 30.5 feet below ground surface [bgs]) to bedrock using an ODEX air hammer, which pulverizes the soil and removes cuttings using air pressure. The hammering action also advances a 4-inch conductor casing as the bit advances. As the borings were advanced, soil samples were recovered with a 3-inch outer diameter (OD) split spoon sampler using Modified Penetration Test (MPT) procedures. In this test, samples were recovered by driving the sampler into the bottom of the advancing hole with blows of a 340 pound, auto-hammer, free-falling 30 inches onto the drilling rod. The number of blows required to advance the sampler the final 12 inches of a total 18-inch penetration is termed the penetration resistance, which was recorded for each sample. Sampler refusal is indicated by an excess of 50 blows for 6 inches. When sampler refusal was encountered, it is noted on the boring log. These values are shown graphically on the boring logs adjacent to the sample depth. The values give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless or cohesive soils, respectively. Split-spoon samples were generally taken at 5-foot intervals to estimate subsurface conditions.

When casing refusal was encountered while drilling in the existing harbor area, we confirmed the presence of bedrock by penetrating into the rock using a 5-foot long, NQ (1 7/8-inch inside diameter) core barrel with a diamond impregnated bit. In Borings B-8 and B-9, rock coring was conducted to deeper depths (73 to 83 feet bgs) to assist in evaluating the suitability of the rock for armor rock. The rock core extracted from each 5 foot or less run was classified in the field by our engineer and placed in 2-foot long core boxes for transport. The depths of the top and bottom of each run, percent recovery, and other drilling notes were recorded. Core samples were shipped to our Anchorage laboratory for more detailed classification and testing.

The soils observed through sampling were visually described in the field, and samples selected for gradation testing were classified according to the Unified Soils Classification System (USCS) that is presented on Figure A-1. Frost classifications were also estimated for samples based on laboratory testing and are shown on the boring logs. The frost classification system is presented on Figure A-2. Rock classifications were made in general accordance with the Federal Highway Administration (FHWA) Generalized Rock Classification System presented on Figure A-3. Generalized subsurface conditions are shown on the summary logs of the borings, included in Appendix A, Figures A-4 through A-12. Photo pages of the rock core for each boring are included in Appendix A, Figures A-13 through A-15. Soil and rock samples collected during drilling were transported to Anchorage for testing (See Section 5.0 and Appendix B).

3.2 Test Pit Explorations

A Caterpillar 320B excavator provided by the City of St. George was used to advance test pits within the project area. A representative from our firm was present to locate the test pit locations, observe excavations, log subsurface conditions, and observe groundwater conditions. Test pits were advanced until excavator refusal, which generally appeared to correspond with the top of bedrock.

The soils observed through sampling were visually described in the field. Generalized subsurface conditions are shown on the summary logs of the test pits, included in Appendix A, Figures A-16 through A-21.

3.3 Geophysical Explorations

Seismic refraction data was collected between September 24 and September 27, 2014. Seismic data was recorded with a DAQLINK® III Recording System connected to a 24-geophone array. Geophones were spaced 10 feet apart for the seismic lines conducted around the harbor, resulting in a line length of 230 feet. Geophone spacing near the Airport Quarry was expanded to 20 feet, resulting in a line length of 460 feet. Seismic energy was generated using either a sledge-hammer impact on a steel plate or 400-grain black powder shells fired from a Betsy Gun.

Analysis of the refraction data was performed using Geometrics SeisImager/2D software and the refraction delay-time (reciprocal) method. Arrival times were identified on the seismic records using Geometrics PickWin software, and all arrival times were manually selected. The locations of our seismic lines are included on Figure 2 and in Appendix C, Figure C-1. Survey results are included in Appendix C.

Additional offshore geophysical work was conducted by The Watson Company, Inc. (Watson), between May 8 and May 12, 2014. Watson's report describing their methods, equipment, and results is included in Appendix D.

3.4 Geologic Mapping and Reconnaissance

Geologic mapping of exposed rock faces was conducted on September 28, 2014 by a representative from our firm at the Airport Quarry. Observations consisted of generalized delineation of differing rock type and structure, and included measurements of the orientations of observed structural features. Photographs of the observed quarry face are included in Appendix D. In addition to the mapping effort, several rock samples were collected at the quarry site to give a representative sample of the rock available for borrow. We intended to also collect samples of the existing breakwater rock, but the aggregate was too large to be transported.

4.0 LITERATURE RESEARCH

Literature research was conducted to evaluate the existing subsurface information available for the project area. The primary existing data sources reviewed for this work were prior geotechnical engineering studies conducted for construction of the existing harbor and existing geologic maps of the area by the United States Geologic Survey (USGS). We also reviewed records from the existing harbor construction and were able to briefly interview a local resident of St. George (Mr. Rodney Lekanof) who worked on the construction of the existing harbor. The sources of information reviewed are listed below, and the following sections were developed based on the cumulative review of the existing information available for the project.

- *Geology of Pavlof Volcano and Vicinity, Alaska*; Kennedy, G.C., and Waldron, H.H.; USGS, 1955
- *Geological Investigation, St. George Island Breakwater*; June 1981, ADOT&PF Central Region
- *Preliminary Report, Surface Boulder, Quantity, Quality, and Location, St. George Island*; Dames & Moore, November 12, 1982
- *Preliminary Report, Geotechnical Studies for St. George Dock and Harbor Design*; Dames & Moore, November 12, 1982
- *St. George Breakwater, Steering Committee Meeting*; PND, November 16, 1982
- *Report of Geotechnical Studies, St. George Dock and Harbor Project*; Dames & Moore, November 24, 1982
- *St. George, Pribilof Island Breakwater Model Test*; Oregon State University, December 28, 1982
- *Report of Additional Rock Testing, St. George Dock and Harbor Project*; Dames & Moore, January 6, 1983
- *Seismic Refraction Survey of Quarry Sites, St. George Island*; R&M Consultants, February 4, 1987
- *Final Report, St. George Island Harbor Project*; Dames & Moore, March 26, 1987
- *Review of Final Report Prepared by Dames & Moore for Fireman's Fund*; PND, 1987
- *Jet Probe Locations (Drawing, Sheet 1 of 1)*; PND, no date (probes conducted between August 1982 and September 1987

- *Reconnaissance Geologic Map for the Kuskokwim Bay Region of Southwest Alaska*; USGS, 2008
- Various other field notes and correspondence letters by others as provided by HDR

A summary of our findings from the literature review can be seen in our *Geotechnical Reconnaissance Report, Harbor and Breakwater Improvement Project, St. George, Alaska,* dated July 2014. The report includes information on the geologic setting of the Pribilof Islands, the design of the existing harbor, rock fill and armor rock production, and seafloor conditions, as well as observations and limited lab testing results from our preliminary site visit in April 2014. The report also includes preliminary engineering recommendations; however, those recommendations are not intended for final design and are superseded by the project plans and specifications.

5.0 LABORATORY TESTING

Laboratory tests were performed on selected soil and rock samples recovered from the borings or collected from the rock quarry to confirm our field classifications and to estimate the index and strength and durability properties of the typical materials encountered at the site.

5.1 Soil Testing

Soil testing was formulated with an emphasis on determining gradation properties, natural water content, and frost characteristics. Water content tests were performed in general accordance with ASTM D2216. The results of the water content measurements are presented graphically on the boring logs in Appendix A, on Figures A-4 through A-12.

Grain size classification (gradation) testing was performed to estimate the particle size distribution of selected samples from the borings. The gradation testing generally followed the procedures described in ASTM C117/C136. The test results are presented in Appendix B, on Figure B-1 (2 sheets) and summarized on the boring logs as percent gravel, percent sand, and percent fines. Percent fines on the boring logs are equal to the sum of the silt and clay fractions indicated by the percent passing the No. 200 sieve. Plasticity characteristics (Atterberg Limits results) are required to differentiate between silt and clay soils under USCS.

Atterberg Limits were evaluated for one sample of cohesive/fine grained soil encountered during drilling to estimate plasticity characteristics. This test generally followed procedures described in ASTM D4318. The result of this test is presented on the boring log for Boring B-6 in Appendix A, on Figure A-9.

5.2 Rock Testing

Rock testing was formulated with emphasis on determining the density, strength, durability, and degradation characteristics of the rock. Selected rock samples taken from the Airport Quarry were tested for:

Test Method	Standard
Resistance to Degradation by Impact and Abrasion	AASHTO T96
Sulfate Soundness	AASHTO T104
Degradation	ATM 313
Absorption and Specific Gravity of Coarse Aggregate	AASHTO T85
Expansive Breakdown on Soaking with Ethylene Glycol	COE CRD-C 148-69
Durability of Rock for Erosion Control Under Freezing and Thawing Conditions	ASTM D5312

Testing for Ethylene Glycol and Freeze-Thaw was performed by R&M Consultants of Anchorage, Alaska. All other rock testing was performed by our Fairbanks, Alaska laboratory. Results of the rock testing are summarized in Section 6.2 and presented in Appendix B in the form of reports from our Fairbanks laboratory and the R&M Consultants laboratory.

In addition to the rock testing on the above samples, two gradation measurements were taken of the existing breakwater armor rock in general accordance with ASTM D5519 Method D. The gradations were performed by walking a path of each side of the north (gradation #1) and south (gradation #2) breakwater. The general location of the armor rock gradation testing is shown on the Site Plan presented as Figure 2. The results of the gradation testing are presented in Appendix B, Figures B-2 and B-3.

6.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered during drilling are presented graphically in the boring and test pit logs in Appendix A. Borings B-1 through B-7 were advanced in the general vicinity of the existing harbor, while Borings B-8 and B-9 as well as Test Pits TP-1 through TP-6 were advanced near the Airport Quarry. Additional subsurface information is provided from geophysical surveys in Appendix C and D.

6.1 Harbor Conditions

In general, our borings in the harbor area encountered sands and gravels overlying basalt bedrock. In Boring B-2 cobbles and boulders were encountered, which we believe are associated with armor rock layers that may have shifted or been buried during construction of the breakwater. Cobbles were occasionally encountered in the other harbor borings. In general, fines (silt and clay) content was low (less that 12 percent) in each of the borings except immediately above bedrock in Boring B-6 where a thin (approximately 6-inch) layer of silt was encountered. The relative density of the granular soils varied greatly and was likely biased high at times due to the presence of gravel and cobbles in the soil.

Water content in the soils varied from 4 to 34 percent, with higher water contents generally correlating to sands below sea level. Groundwater was encountered in each boring between 5 and 13 feet below ground surface at the approximate elevation of sea level during drilling, except in Boring B-4 where groundwater was likely encountered but the level was not measurable due to the use of water during coring activities. Note that water levels in soils around the harbor likely fluctuate with the tide, which is typically between 2 and 3 feet.

The depth to bedrock varied greatly depending on location within the harbor. Bedrock was encountered between 0.5 and 30.5 feet bgs (approximate elevations 9.5 to -17 feet Mean Lower Low Water [MLLW]). Typically, deeper bedrock was encountered to the west. The top of bedrock was generally inferred by drill action and should be considered approximate.

Rock core recovered from the harbor borings was typically basalt with varying vesicularity. The rock was dark gray to dark red and appeared fresh to moderately weathered. Joints were typically closely spaced and did not show a dominate orientation. Based on the classification system presented in Appendix A, Figure A-3, Rock quality designation (RQD) values ranged from 0 to 30 indicating poor to very poor rock in the near surface, except in Boring B-6 where fair rock was encountered below 33 feet bgs (approximately -16.5 feet MLLW). Recovery was typically high (greater than 90 percent), however several runs did encounter poor recovery.

Two seismic refraction lines were conducted near the harbor, Line 1 on the inner breakwater and Line 2 on the south breakwater (Appendix C, Figures C-3 and C-4). The refraction lines indicated the velocity of the breakwater above the water to be approximately 2,000 feet per second. The velocity of the breakwater material below water was masked on each line by the velocity of water (approximately 5,000 feet per second). Typical seismic velocity values for varying rock types can be seen in Appendix C, Figure C-2.

Offshore sediment thickness inside the harbor, as well as west of the harbor, was measured by Watson, using a Falmouth Scientific Bubble Pulser acquisition system. An isopach map of sediment thickness is provided in their report included in Appendix D. In general, no sediment was encountered inside of the harbor; however, layers of sediment thinner than the resolution of the survey (approximately 5 feet) may exist. Sediment outside of the harbor appears to be approximately 8 to 18 feet in thickness up to approximately 1,000 feet west of the existing harbor. Sediment thickness generally increases from east to west. Based on a bathymetric survey conducted by the US Army Corps of Engineers in 1995, it appears as though the seafloor generally slopes gently from east to west. Based on a bathymetric survey conducted by TerraSond in 2013 it appears as though the seafloor generally slopes gently from east to west. Based on the bathymetry and isopach data, it appears that the bedrock surface likely also dips from east to west in this area. Note the sea floor bathymetry may have changed dramatically since 1995 based on the wave action experienced in this area.

6.2 Airport Quarry Conditions

In general, our test pits and borings near the Airport Quarry encountered cobbles and boulders overlying bedrock. The void space between boulders was typically in-filled with silty sands with gravel and cobbles and a frequent organic mat of moss and native vegetation. The boulder field varied in thickness over bedrock from approximately 4.5 to 9 feet. Boulders were frequently greater than 3 feet in diameter.

Below the boulder field, our borings generally encountered basalt bedrock with varying vesicularity. The rock was dark gray to dark red and appeared fresh to moderately weathered. Joint spacing varied from very close to moderately close. Joint orientation was generally horizontal to subhorizontal with occasional near vertical (possibly columnar) jointing observed in the core. RQD values varied widely over the depth of the borings. Recovery was typically high (greater than 90 percent), however several runs did encounter poor recovery. Recovery and RQD for the borings is plotted on the boring logs and are also shown on the rock core photo pages, each included in Appendix A. These rock conditions were generally consistent with the rock observed in the existing quarry face which generally consisted of an approximately 10 to 12-foot thick band of relatively massive, low vesicularity (less than about 10 percent) rock overlying an undulating base of moderate to high vesicularity rock. Occasional 1 to 2-foot thick bands, as well as smaller inclusions, of moderate to high vesicularity basalt were observed within the relatively low vesicularity rock mass.

Seismic refraction testing was conducted in the area. Seismic refraction profiles are included in Appendix C, Figures C-3 through C-9. It is important to note that velocity inversions (when a high velocity layer overlies a low velocity layer) cannot be seen with the seismic refraction method. Therefore, slower layers may exist beneath faster layers and would not be shown by the velocity contours.

Rock samples collected from the Airport Quarry were tested in our Fairbanks, Alaska laboratory and by R&M Consultants of Anchorage, Alaska. Three rock samples were collected from the quarry and were designated Quarry A, Quarry B, and Quarry Harbor. Quarry A consisted of generally non-vesicular basalt that appeared competent. Quarry B was generally highly vesicular rock. Quarry Harbor was generally similar to Quarry A, but included some slightly vesicular samples. Quarry Harbor was meant to approximate the existing breakwater rocks as closely as possible due to the inability to collect the actual harbor rock. In general, the rocks were basalt with varying amounts of vesicularity. The samples ranged in bulk specific gravity from 2.59 to 2.65 and in absorption from 0.8 to 2.6 percent. The samples were generally not susceptible to loss by sulfate soundness, ethylene glycol, or freeze thaw. Durability testing results are summarized in the following table and provided in Appendix B.

Sample	Degradation Value	Los Angeles Abrasion (percent loss)	Soundness (percent loss)	Bulk Specific Gravity	Absorption (percent)	Ethylene Glycol (percent loss)	Freeze/ Thaw (average percent loss)
Quarry Harbor	91	42	1	2.65	2.6	0	0.08
Quarry “A”	57	64	2	2.60	2.3	0	0.02
Quarry “B”	91	43	1	2.59	0.8	0	0.22

7.0 SEISMIC CONDITIONS

The Pribilof Islands are located in the Bering Sea approximately 200 miles northwest of Unalaska, Alaska. This zone is relatively quiet seismically with no known mapped quaternary faults within a 200 mile radius.

According to the 2012 International Building Code (IBC 2012), seismic site classifications are generally based on the average soil conditions within the top 100 feet of the soil column. Based on the subsurface conditions described above, and assuming that the soils encountered in our borings are similar in the upper 100 feet of the soil column, the site class according to the IBC

2012 would be C for a very stiff soil or soft rock profile based on estimated soil density and shallow depth to bedrock. Note that this site classification is based on assumed conditions beyond the depth of our deepest explorations (50 feet bgs) and on area experience. Actual conditions may differ from our assumptions. The only way to confirm conditions at the site and evaluate the presence of soil conditions that would change the site classification is to conduct deeper explorations. In our opinion, based on the conditions encountered by our borings we believe the site may be susceptible to liquefaction and seismically induced slope failures. However, due to the low expected magnitude and accelerations associated with earthquakes that may occur in this area, we do not believe liquefaction or seismically induced slope failures are likely.

Based on the ground motions in Figures 1613.3.1(4) and 1613.3.1(5), from IBC 2012, the mapped spectral accelerations for short-period (S_s) and 1-second period (S_1) were estimated at 0.335 times the gravitational coefficient (g) and 0.163g, respectively. The site class C, site specific modifying coefficients for the spectral response accelerations are $F_A = 1.2$ and $F_v = 1.63$ for the short and long periods, respectively. Consequently, SM_S and SM_1 for site class C were calculated to be 0.402g and 0.266g, respectively, and the corresponding SD_S and SD_1 are 0.268g and 0.178g, respectively.

We conducted a brief seismic hazard analysis of the site using software developed by the USGS to calculate the peak ground acceleration (PGA). Using this software, the PGA for the site was calculated with a value roughly equivalent to what would be calculated using probabilistic estimates of ground motions with a 2 percent probability of exceedance in 50 years (2,475-year return period). Based on the expected average soil conditions at the site, the peak rock ground acceleration obtained was then modified by an empirical amplification factor (1.0) corresponding to subsurface soil conditions to obtain a design soil acceleration (PGA_{soil}) of approximately 0.18g. The corresponding earthquake magnitude (M) is M5.2.

8.0 CLOSURE AND LIMITATIONS

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the geotechnical aspects discussed herein. The data and report may be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report. The information contained in this report is based on site conditions as they existed at the time of our explorations, and further assume that the explorations are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations.

If there is a substantial lapse of time between the submittal of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the conclusions considering the changed conditions and time lapse. Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs. Shannon & Wilson has prepared the attachments in Appendix F *Important Information About Your Geotechnical/Environmental Report* to assist you and others in understanding the use and limitations of the reports.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

We appreciate this opportunity to be of service. Please contact the undersigned at (907) 561-2120 with questions or comments concerning the contents of this report.

SHANNON & WILSON, INC.

Thomas Keatts, E.I.T.
Geotechnical Engineer III

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Vice President

TMK:KLB/sjg

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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

VICINITY MAP

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32-1-02388

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FIG. 1

Existing Harbor Area

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Airport Quarry Area

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth™ Mapping Service.

N

0 200 400 800

APPROXIMATE SCALE IN FEET

LEGEND

B-I ● Approximate Location of Boring B-1, Advanced by Shannon & Wilson, September, 2014

0 LI 230 Approximate Location of Seismic Refraction Line L1 (length = 230 feet), Survey Performed by Shannon & Wilson, September, 2014

TP-I ▨ Approximate Location of Test Pit TP-1, Advanced by Shannon & Wilson, September, 2014

⬡ Breakwater Gradation Collection Area

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SITE PLAN

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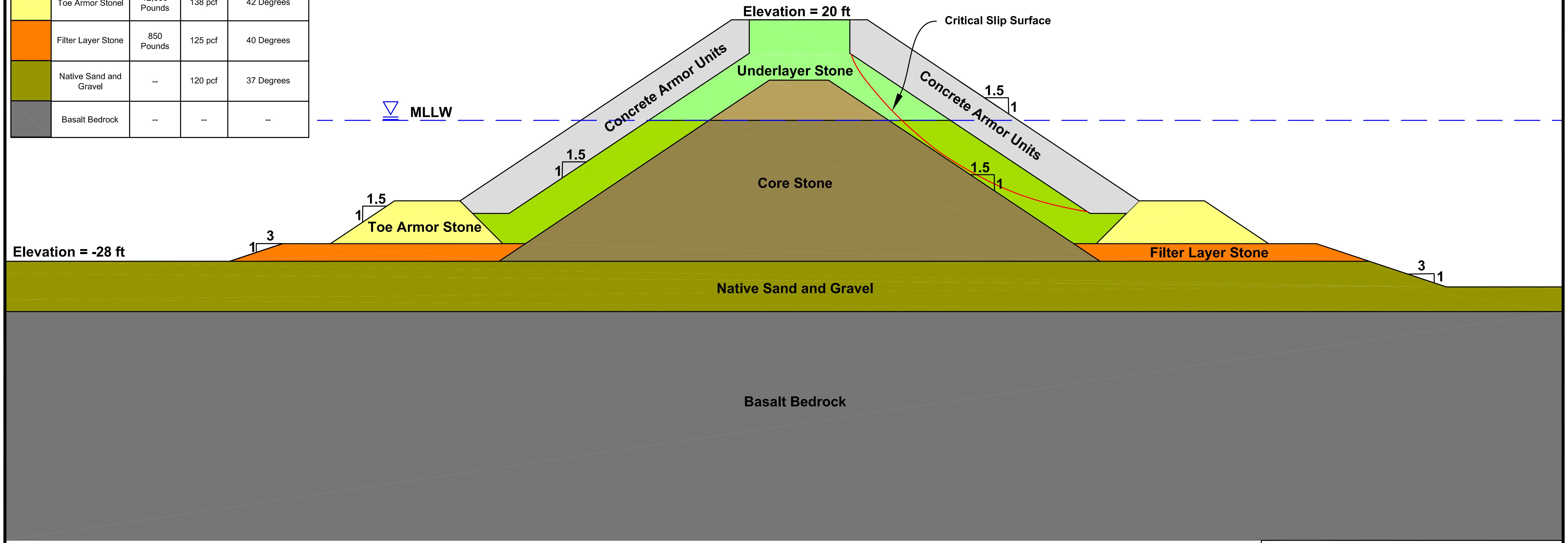
FIG. 2

Material Properties

Layer	Description	Stone Weight	Dry Unit Weight	Friction Angle
⬜	Concrete Armor Units	16.4 Tons	110 pcf	--
🟩	Under Layer Stone Above Water	3,280 Pounds	138 pcf	44 Degrees
🟩	Under Layer Stone Below Water	3,280 Pounds	130 pcf	42 Degrees
🟫	Core Stone Above Water	100-300 Pounds	133 pcf	42 Degrees
🟫	Core Stone Below Water	100-300 Pounds	128 pcf	40 Degrees
🟨	Toe Armor Stonel	12,000 Pounds	138 pcf	42 Degrees
🟧	Filter Layer Stone	850 Pounds	125 pcf	40 Degrees
🟫	Native Sand and Gravel	--	120 pcf	37 Degrees
⬛	Basalt Bedrock	--	--	--

Slope Stability Analysis

Description	Factor of Safety
Static	1.6
Seismic	1.4



NOTES

1. Figure based on Typical Section A-C1 Sheet C1 dated 01/30/15, Provided by HDR Alaska
2. Water level based on Mean Lower Low Water (MLLW) level.
3. Concrete Armor Unit's (CAU) are modeled as a dead load surcharge on underlying rock fill, without strength properties. These units should be placed per the manufacturer's recommendations.
4. Stone weight recommendations are based on drawings by HDR and should be verified by an engineer experienced in ocean engineering and breakwater design.
5. Seismic slope stability is based on a horizontal acceleration of 0.09 times the force of gravity.

0 10 20 40
APPROXIMATE VERTICAL AND HORIZONTAL SCALE IN FEET

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TYPICAL BREAKWATER DETAIL AND SLOPE STABILITY ANALYSIS

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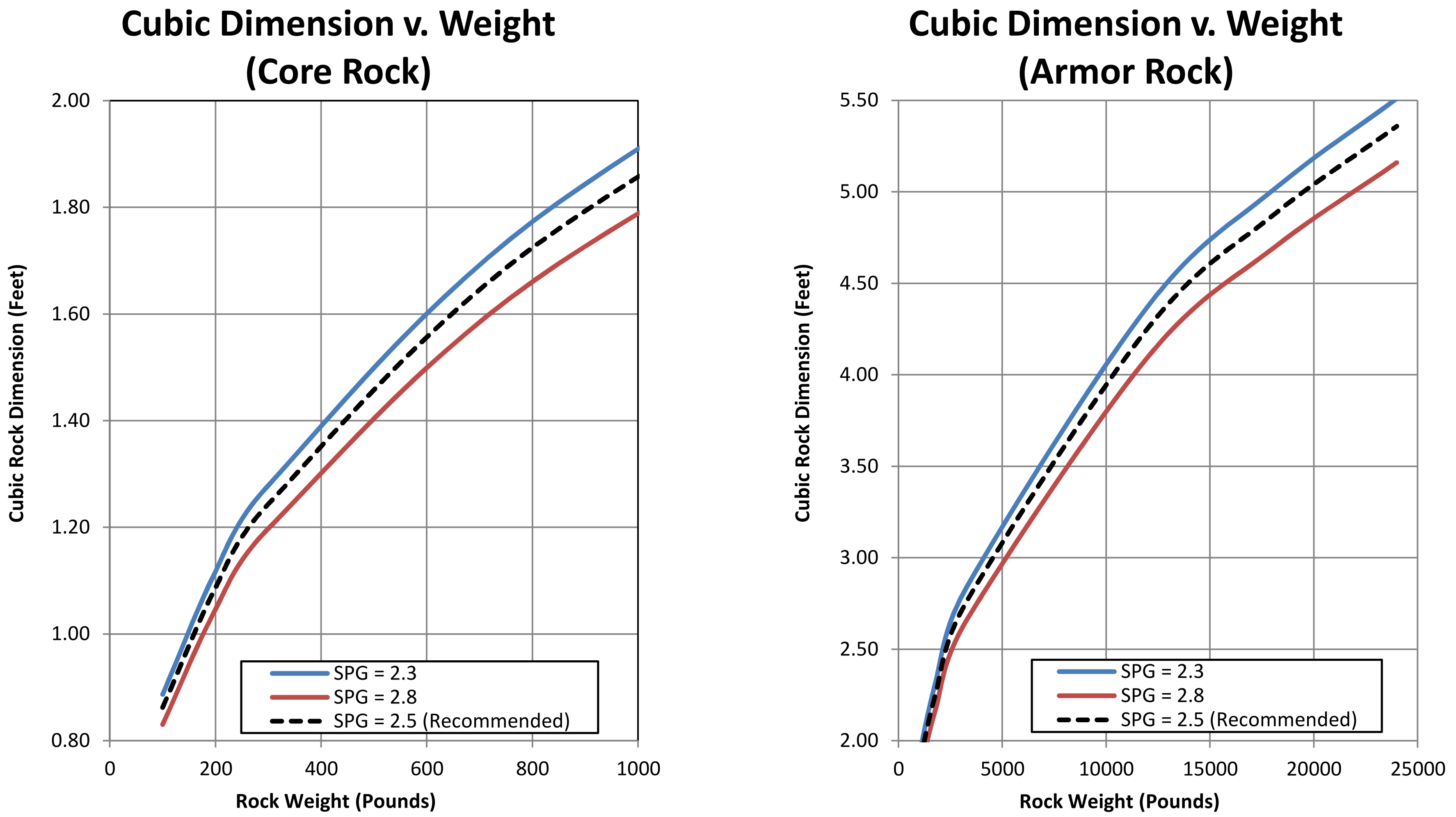
FIG. 3



Notes

1. The red line indicating a specific gravity of 2.8 is based on the maximum specific gravity found in historical testing. The blue line indicating a specific gravity of 2.3 is based on the minimum specific gravity found in historical testing. The dashed black line indicating a specific gravity of 2.5 is our recommended, assumed specific gravity for estimation purposes.

2. Rock weight based on a cubic rock with the indicated side dimensions. Actual dimensions of rock will vary based on individual rock shape and elongation.

3. SPG - Bulk Specific Gravity

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AIRPORT QUARRY APPROXIMATE ROCK SIZE VERSUS WEIGHT

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FIG. 4

APPENDIX A

BORING/TEST PIT LOGS AND ROCK CORE PHOTOS

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1] All percentages are by weight of total specimen passing a 3-inch sieve.
[2] The order of terms is: *Modifying Major with Minor*.
[3] Determined based on behavior.
[4] Determined based on which constituent comprises a larger percentage.
[5] Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

▧	Bentonite Cement Grout	░	Surface Cement Seal
▨	Bentonite Grout	■	Asphalt or Cap
▩	Bentonite Chips	▨	Slough
░	Silica Sand	▥	Inclinometer or Non-perforated Casing
▤	Perforated or Screened Casing	▮	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1] Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 1 of 3

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).
2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

2013 BORING CLASS2 02388 GINT.GPJ SWNEW.GDT 3/13/15

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICTY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It take considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

St. George Harbor & Breakwater
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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
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FROST CLASSIFICATION

(after Municipality of Anchorage, 2009 Rev. 3)

GROUP		0.02 Mil.	P-200*	USC SYSTEM (based on P-200 results)
NFS	Sandy Soils Gravelly Soils	0 to 3 0 to 3	0 to 6 0 to 6	SW, SP, SW-SM, SP-SM GW, GP, GW-GM, GP-GM
F1	Gravelly Soils	3 to 10	6 to 13	GM, GW-GM, GP-GM
F2	Sandy Soils Gravelly Soils	3 to 15 10 to 20	6 to 19 13 to 25	SP-SM, SW-SM, SM GM
F3	Sands, except very fine silty sands** Gravelly Soils Clays, PI>12	Over 15 Over 20	Over 19 Over 25	SM, SC GM, GC CL, CH
F4	All Silts Very fine silty sands** Clays, PI<12 Varved clays and other fined grained, banded sediments	Over 15	Over 19	ML, MH SM, SC CL, CL-ML CL and ML CL, ML, and SM; SL, SH, and ML; CL, CH, ML, and SM

P-200 = Percent passing the number 200 sieve
0.02 Mil. = Percent material below 0.02 millimeter grain size

*Approximate P-200 value equivalent for frost classification.
Value range based on typical, well-graded soil curves.

** Very fine sand : greater than 50% of sand
fraction passing the number 100 sieve

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FROST CLASSIFICATION LEGEND

March 2015

32-1-02388

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FIG. A-2

Federal Highway Administration (FHWA) Generalized Rock Classification System:

1. **Rock Type:**
   Written descriptions of rock types in geological or engineering logs, as described below, present a uniform approach, allowing continuity of description from location to location, and project to project. The following standard sequence of systematic description is used on the boring logs.

   Weathered state, structure, color, grain size, rock material strength, ROCK TYPE

2. **Weathering:**
   The following terminology was used to describe degrees of weathering. These descriptions refer primarily to chemical weathering which results in discoloration of the rock and leads to eventual descomposition of silicates to clay mineral. Some minerals, notably quartz, resist this action and may survive unchanged.

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or disolored rock is present either as a discontinuous framework or as corestones	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

3. **Strength:**
   The rock strength classifications are referenced to simple field hardness tests shown below.

Grade	Description	Field Identification	Approx. Range of Uniaxial Compressive Strength (psi)
R0	Extremely Weak Rock	Indented by thumbnail.	50 - 150
R1	Very Weak Rock	Crumbles under fim blows with point of geological hammer, can be peeled by a pocket knife.	150 - 750
R2	Weak Rock	Can be peeled by a pocket knife with difficulty, shallow indentation made by firm blow with point of geologic hammer.	750 - 3,500
R3	Medium Strong Rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	3,500 - 7,500
R4	Strong Rock	Specimen requires more than one blow of geological hammer to fracture it.	7,500 - 15,000
R5	Very Strong Rock	Specimen requires many blows of a geological hammer to fracture it.	15,000 - 35,000
R6	Extremely Strong Rock	Speciman can only be chipped with geological hammer.	> 35,000

4. **Core Recovery:**
   Core recovery is determined as the ratio of core recovered to the total drilled run length expressed as a percentage; the value may be recorded on a run by run basis, or over a normalized core length. The recovery percent is plotted in order to highlight weaker zones or core. From the point of view of most geotechnical drilling, it is the core that is the most difficult to recover which will indicate most clearly the weakest parts of the rock fabric, and is usually the most important to design.

5. **Rock Quality Designation (RQD):**
   RQD defines the fraction of solid core recovered greater than 100 millimeters in length as the Rock Quality Designation. It is calculated as the ratio of the sum of the length of core fragments longer than 4 inches to the total drilled footage per run, expressed as a percentage. The core is measured along the centerline from fracture to fracture. Cores containing discontinuities parallel to the core axis should be given an RQD of zero.

   RQD may be used to classify the rock mass as follows:

RQD	Rock Classification
0% - 25%	Very Poor
25% - 50%	Poor
50% - 75%	Fair
75% - 90%	Good
90% - 100%	Excellent

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

FHWA ROCK CLASSIFICATION SYSTEM

March 2015
32-1-02388

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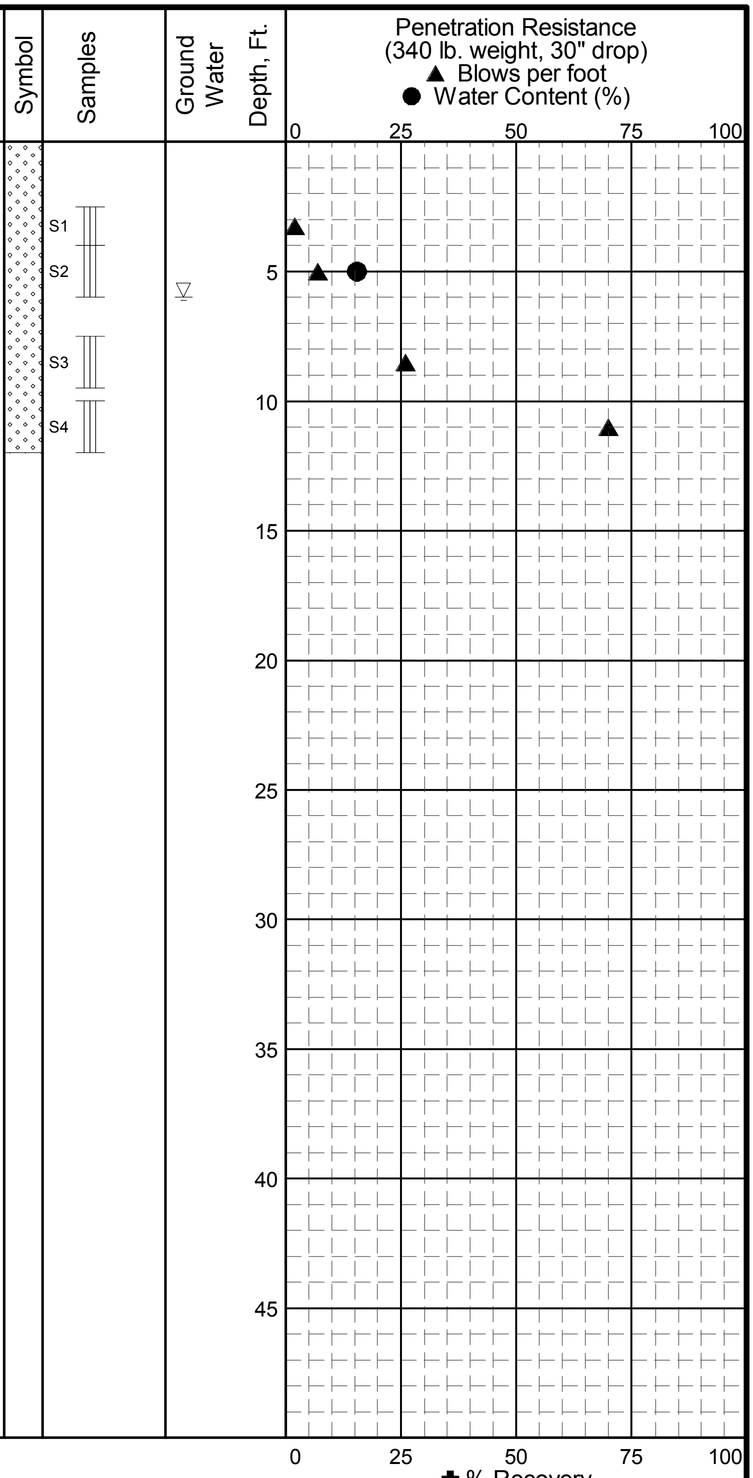
FIG. A-3

MATERIAL DESCRIPTION Approx. Elevation: 5 Ft.	Depth, Ft.
Very loose to very dense, black, *Poorly-Graded Sand (SP)*; moist to wet S2: 0% Gravel, 99% Sand, 1% Fines (NFS (P200))	
Bottom of Boring Boring Completed 9/25/2014	12.0



LEGEND

* Sample Not Recovered
Ⅲ 3" O.D. Split Spoon Sample
Ⅰ Rock Core Sample
▽ Ground Water Level At Time Of Drilling

✚ % Recovery
◆ % RQD
Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-1

March 2015
32-1-02388

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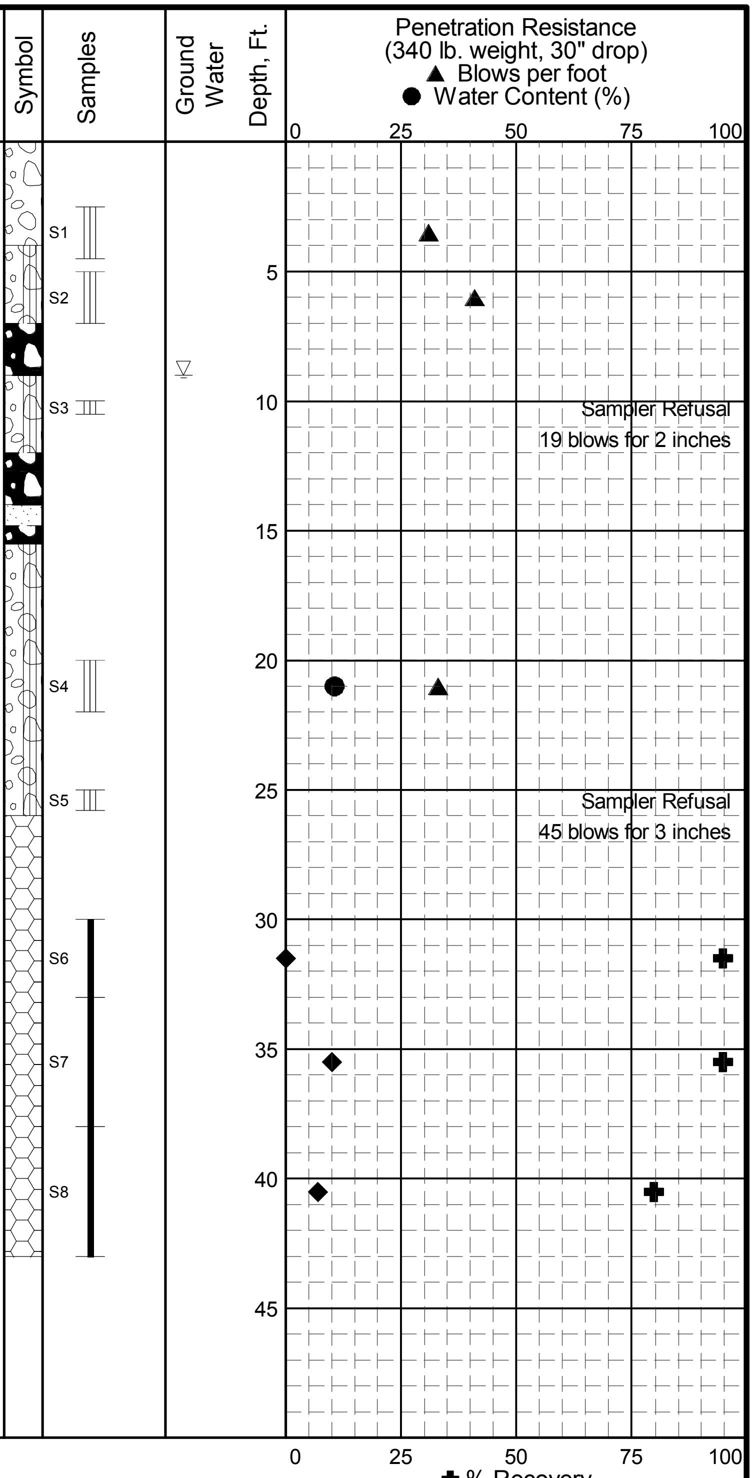
FIG. A-4

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION Approx. Elevation: 9 Ft.	Depth, Ft.
Dense, dark brown, *Poorly-Graded Gravel with Sand (GP)*; moist; some cobbles	4.0
Dense, dark brown, *Poorly-Graded Gravel with Silt and Sand (GP-GM)*; moist; some cobbles	7.0
Boulder [Armor rock] (inferred by drill action)	9.0
Very dense, dark brown, *Poorly-Graded Gravel with Silt and Sand (GP-GM)*; moist, trace cobbles	12.0
Boulder [Armor rock] (inferred by drill action)	14.0
Black, *Poorly-Graded Sand with Gravel (SP)*; wet (inferred by drill action and cuttings)	14.8
Boulder [Armor rock] (inferred by drill action)	15.5
Dense, gray-brown, *Well-Graded Gravel with Silt and Sand (GW-GM)*; wet S4: 53% Gravel, 39% Sand, 8% Fines (F2 (P200))	26.0
Basalt: Fresh to moderately weathered, slightly vesicular to highly vesicular, very close to close joints at low to high angles; dark gray to dark red, low to medium strength	43.0
Bottom of Boring Boring Completed 9/26/2014	



LEGEND

* Sample Not Recovered

Ⅲ 3" O.D. Split Spoon Sample

I Rock Core Sample

▽ Ground Water Level At Time Of Drilling

✚ % Recovery

◆ % RQD

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-2

March 2015 32-1-02388

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FIG. A-5

MATERIAL DESCRIPTION

Approx. Elevation: 8 Ft.

Medium dense, gray, *Well-Graded Gravel (GW)*; moist to wet; some cobbles

6.0

Medium dense, dark gray-black, *Poorly-Graded Sand with Silt and Gravel (SP-SM)*; wet; trace cobbles

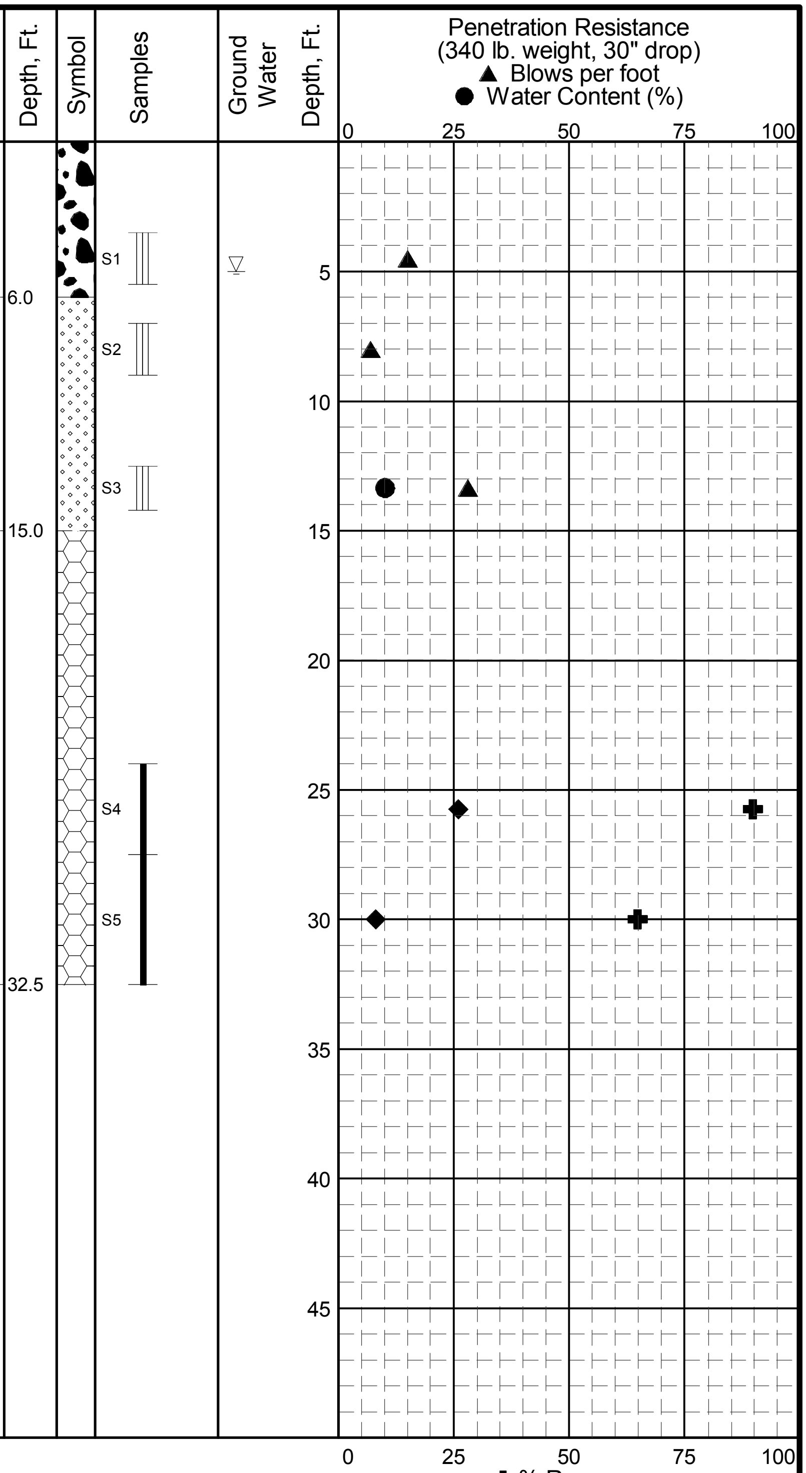
S3: 37% Gravel, 51% Sand, 12% Fines (F2 (P200))

15.0

Basalt: slightly to moderately weathered, moderately vesicular, very close to close joints at low to high angles; dark gray to dark red, low to medium strength

32.5

Bottom of Boring
Boring Completed 9/26/2014



LEGEND

* Sample Not Recovered
Ⅲ 3" O.D. Split Spoon Sample
Ⅰ Rock Core Sample
⊻ Ground Water Level At Time Of Drilling

✚ % Recovery
◆ % RQD
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-3

March 2015 32-1-02388

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FIG. A-6

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION

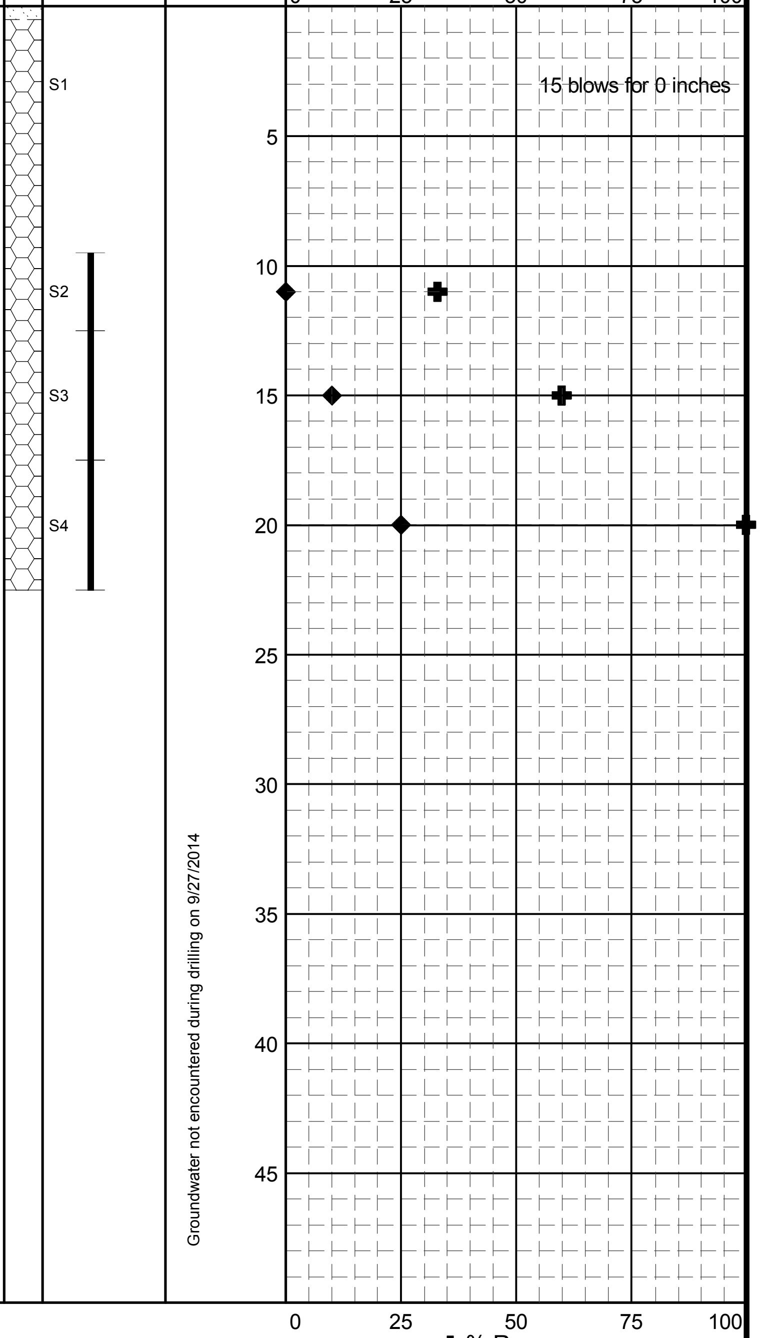
Approx. Elevation: 10 Ft.

Depth, Ft. | Symbol | Samples | Ground Water | Depth, Ft.

Penetration Resistance
(340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)

Material Description	Depth, Ft.
Light brown, *Poorly-Graded Sand with Gravel (SP)*; moist	0.5
Basalt: Fresh to moderately weathered, slightly to moderately vesicular, close joints at low to high angles; dark gray to dark red, low to medium strength	22.5

Bottom of Boring
Boring Completed 9/27/2014



LEGEND

* Sample Not Recovered
Ⅲ 3" O.D. Split Spoon Sample
I Rock Core Sample

✚ % Recovery
◆ % RQD
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-4

March 2015 32-1-02388

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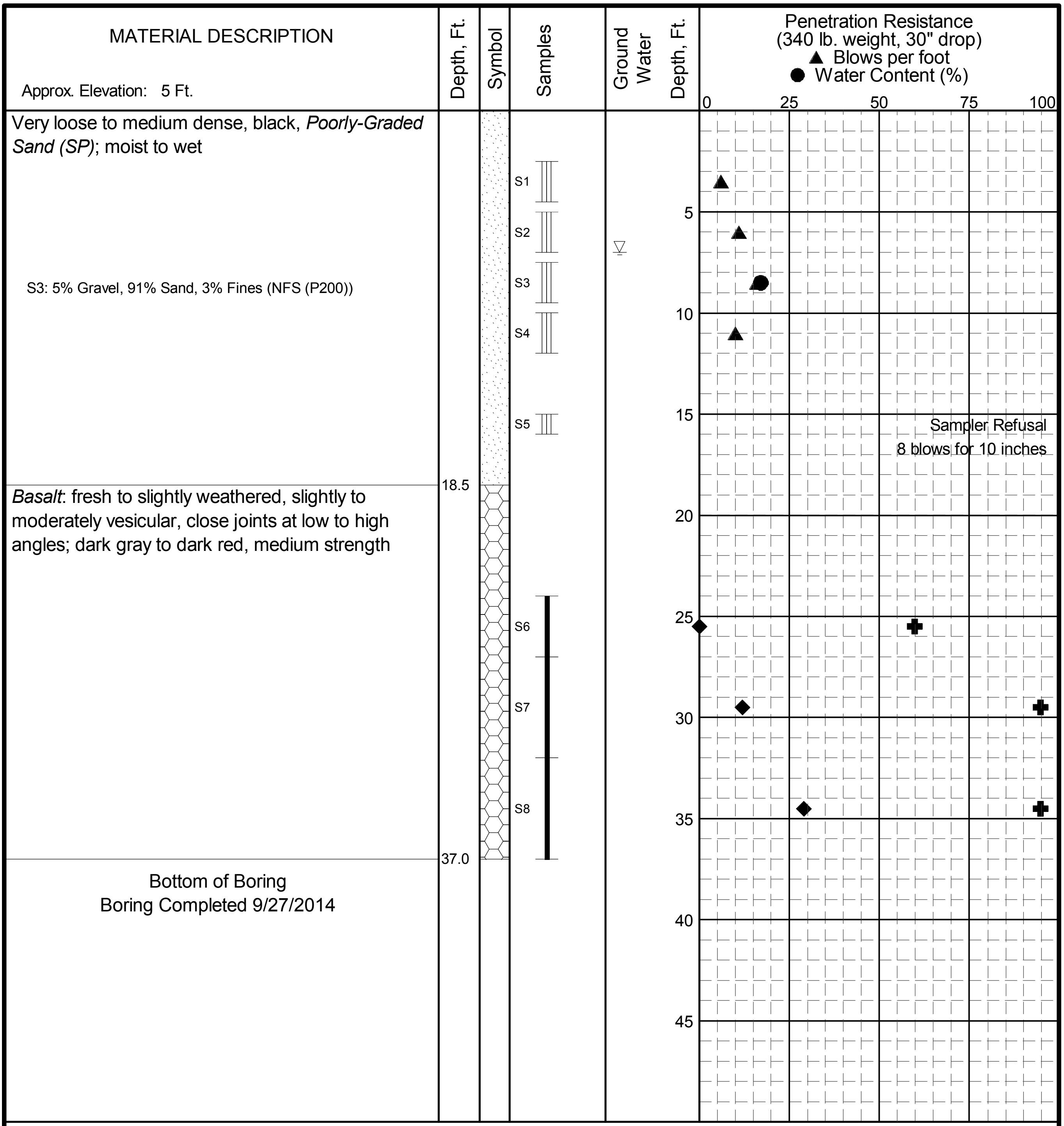
FIG. A-7

REV 3 - Approved for Submittal

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15



Very loose to medium dense, black, *Poorly-Graded Sand (SP)*; moist to wet

S3: 5% Gravel, 91% Sand, 3% Fines (NFS (P200))

Basalt: fresh to slightly weathered, slightly to moderately vesicular, close joints at low to high angles; dark gray to dark red, medium strength

Bottom of Boring
Boring Completed 9/27/2014

0 25 50 75 100
✚ % Recovery
◆ % RQD
Plastic Limit |—●—| Liquid Limit
Natural Water Content

LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Rock Core Sample
∇ Ground Water Level At Time Of Drilling

NOTES

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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-5

March 2015 32-1-02388

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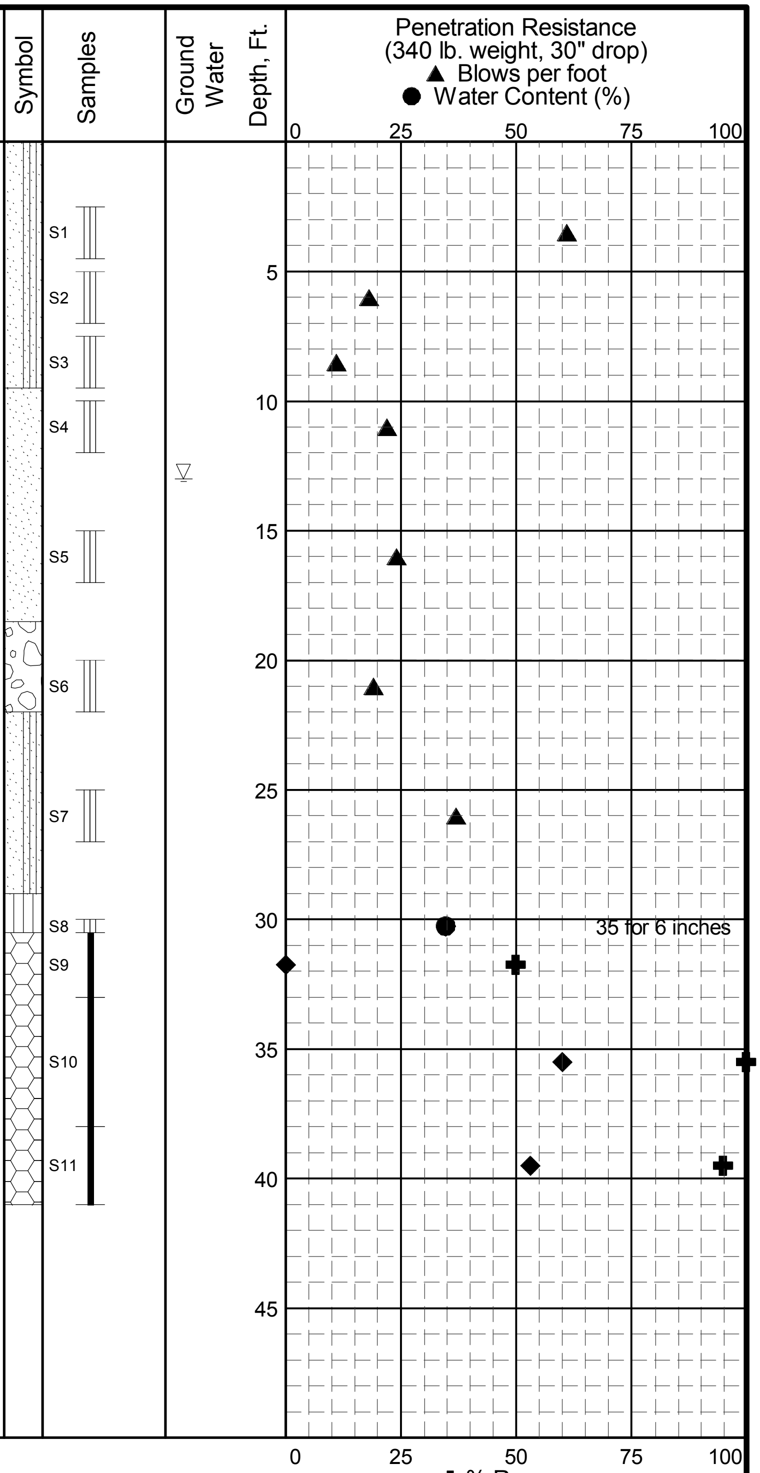
FIG. A-8

REV 3 - Approved for Submittal

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

MATERIAL DESCRIPTION Approx. Elevation: 14 Ft.	Depth, Ft.
Medium dense to very dense, dark gray-brown, *Poorly-Graded Sand with Silt and Gravel (SP-SM)* to *Silty Sand with Gravel (SM)*; moist Trace cobbles from 7.5-9.5 feet bgs	
Medium dense, dark gray, *Poorly-Graded Sand with Gravel (SP)*; moist to wet; trace to some cobbles	9.5
Medium dense, dark gray, *Poorly-Graded Gravel (GP)*; wet	18.5
Dense, dark gray, *Poorly-Graded Sand with Silt and Gravel (SP-SM)*; wet; trace shells	22.0
Hard, red-orange, *Silt (ML)*; moist S8: Non-Plastic	29.0
Basalt: fresh to moderately weathered, moderately vesicular, close joints at low to high angles; dark gray to dark red, low to medium strength	30.5
Bottom of Boring Boring Completed 9/28/2014	41.0



✚ % Recovery

◆ % RQD

Plastic Limit |—●—| Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

3" O.D. Split Spoon Sample

Rock Core Sample

∇ Ground Water Level At Time Of Drilling

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-6

March 2015 32-1-02388

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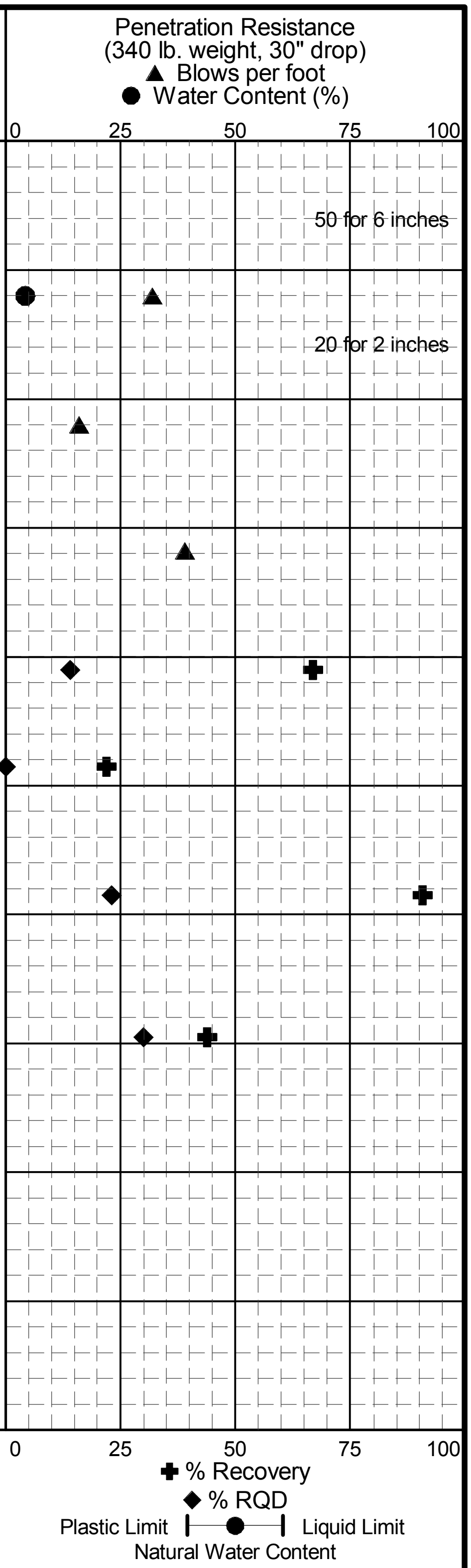
FIG. A-9

MATERIAL DESCRIPTION Approx. Elevation: 12 Ft.	Depth, Ft.	Samples	Ground Water
Very dense to medium dense, dark gray, Poorly-Graded Gravel with Silt and Sand (GP-GM); *moist* S2: 65% Gravel, 26% Sand, 9% Fines (F1 (P200))	7.3	S1 S2	
Very dense, brown, *Silty Sand with Gravel (SM)*; moist	9.0	S3	▽
Medium dense, dark gray, *Poorly-Graded Gravel (GP)*; moist; some cobbles	13.0	S4	
Dense, dark gray, *Poorly-Graded Sand with Gravel (SP)*; wet	17.0	S5	
Basalt: fresh to slightly weathered, moderately to highly vesicular, close joints at low to high angles; dark gray, low to medium strength	37.0	S6 S7 S8 S9	
Bottom of Boring Boring Completed 9/28/2014			



LEGEND

* Sample Not Recovered
⫼ 3" O.D. Split Spoon Sample
I Rock Core Sample
▽ Ground Water Level At Time Of Drilling

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

LOG OF BORING B-7

March 2015 32-1-02388

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FIG. A-10

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

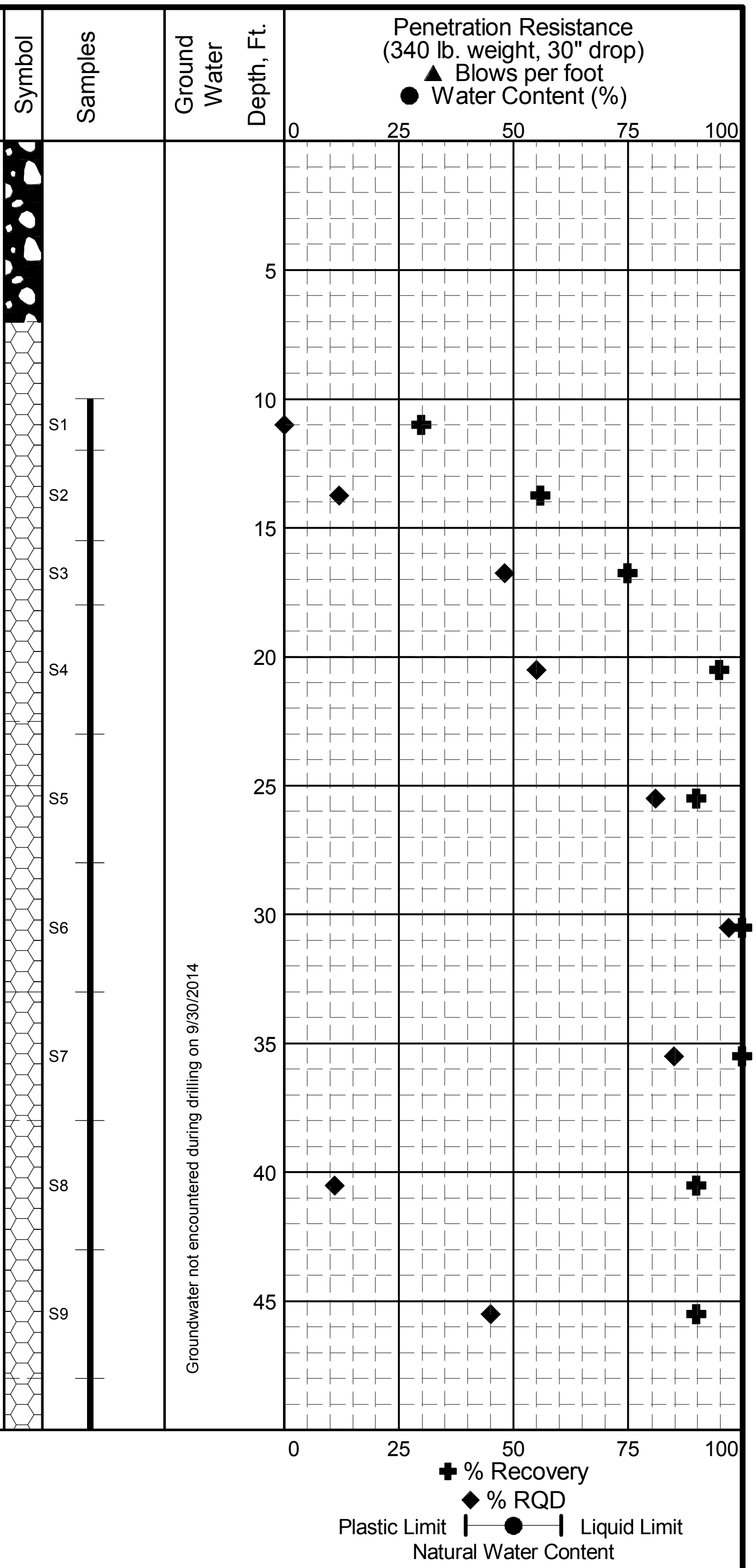
REV 3 - Approved for Submittal

MATERIAL DESCRIPTION

Approx. Elevation: 217 Ft.

Depth, Ft.	Material Description
	Mostly Boulders; approximately 20-30 percent voids, partially filled with dark brown, Sandy Silt and organics.
7.0	*Basalt*: Fresh to moderately weathered, slightly vesicular to highly vesicular, very close to moderately close joints at low to high angles; dark gray to dark red, low to medium strength moderately vesicular; slight to moderately weathered
22.5	slightly vesicular; fresh to slightly weathered
25.0	moderately vesicular; slight to moderately weathered
33.0	slightly vesicular; fresh to slightly weathered
38.0	moderately vesicular; fresh to slightly weathered
48.0	slightly vesicular; fresh to slightly weathered

CONTINUED NEXT PAGE



LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Rock Core Sample

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-8

March 2015
32-1-02388

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FIG. A-11
Sheet 1 of 2

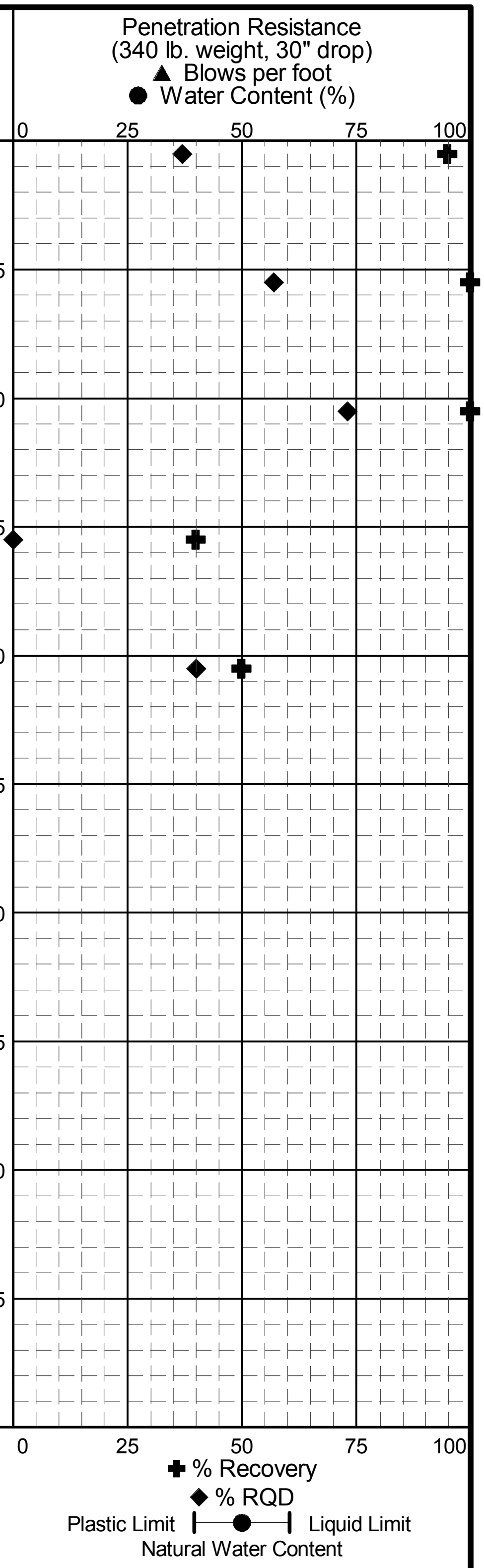
REV 3 - Approved for Submittal

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

Approx. Elevation: 217 Ft.

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Basalt: Fresh to slightly weathered, slightly vesicular, very close to moderately close joints at low to high angles; dark gray to dark red, low to medium strength		S10 S11 S12
moderately to highly vesicular; moderately weathered	62.0	S13
slightly vesicular; fresh to slightly weathered	70.5	S14
Bottom of Boring Boring Completed 9/30/2014	73.0	

Ground Water: Groundwater not encountered during drilling on 9/30/2014



LEGEND

* Sample Not Recovered
Ⅲ 3" O.D. Split Spoon Sample
I Rock Core Sample

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-8

March 2015 32-1-02388

SHANNON & WILSON, INC.
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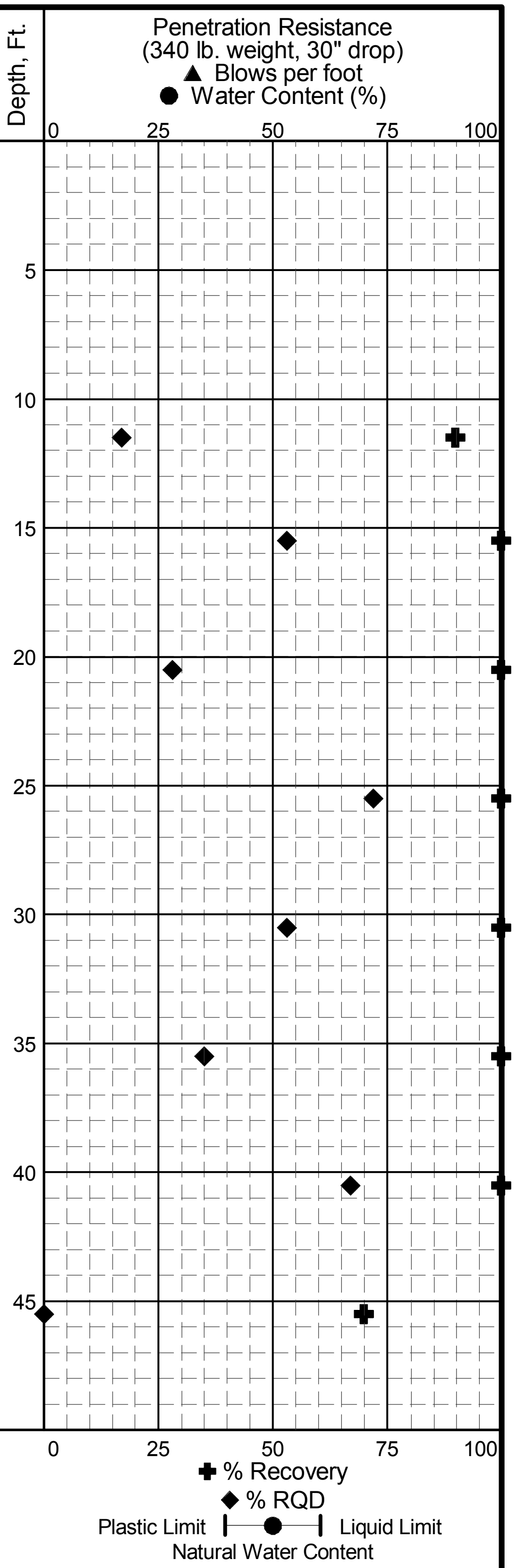
FIG. A-11
Sheet 2 of 2

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION Approx. Elevation: 181 Ft.	Depth, Ft.	Samples	Ground Water
Mostly Boulders; approximately 20-30 percent voids, partially filled with dark brown, Sandy Silt and organics.			
Basalt: Fresh to moderately weathered, slightly vesicular to highly vesicular, very close to moderately close joints at low to high angles; dark gray to dark red, low to medium strength moderately to higly vascular, fresh to moderately weathered	6.0	S1 S2 S3	
slightly vascular, fresh to slightly weathered	24.0	S4 S5	
moderately vascular, fresh to slightly weathered	32.0		Groundwater not encountered during drilling on 10/1/2014
slightly vascular, fresh to slightly weathered	36.0	S6 S7	
moderately vascular, slightly to moderately weathered	42.0		
slightly to moderately vascular, fresh to slightly weathered	45.0	S8	

CONTINUED NEXT PAGE



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Rock Core Sample

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-9

March 2015
32-1-02388

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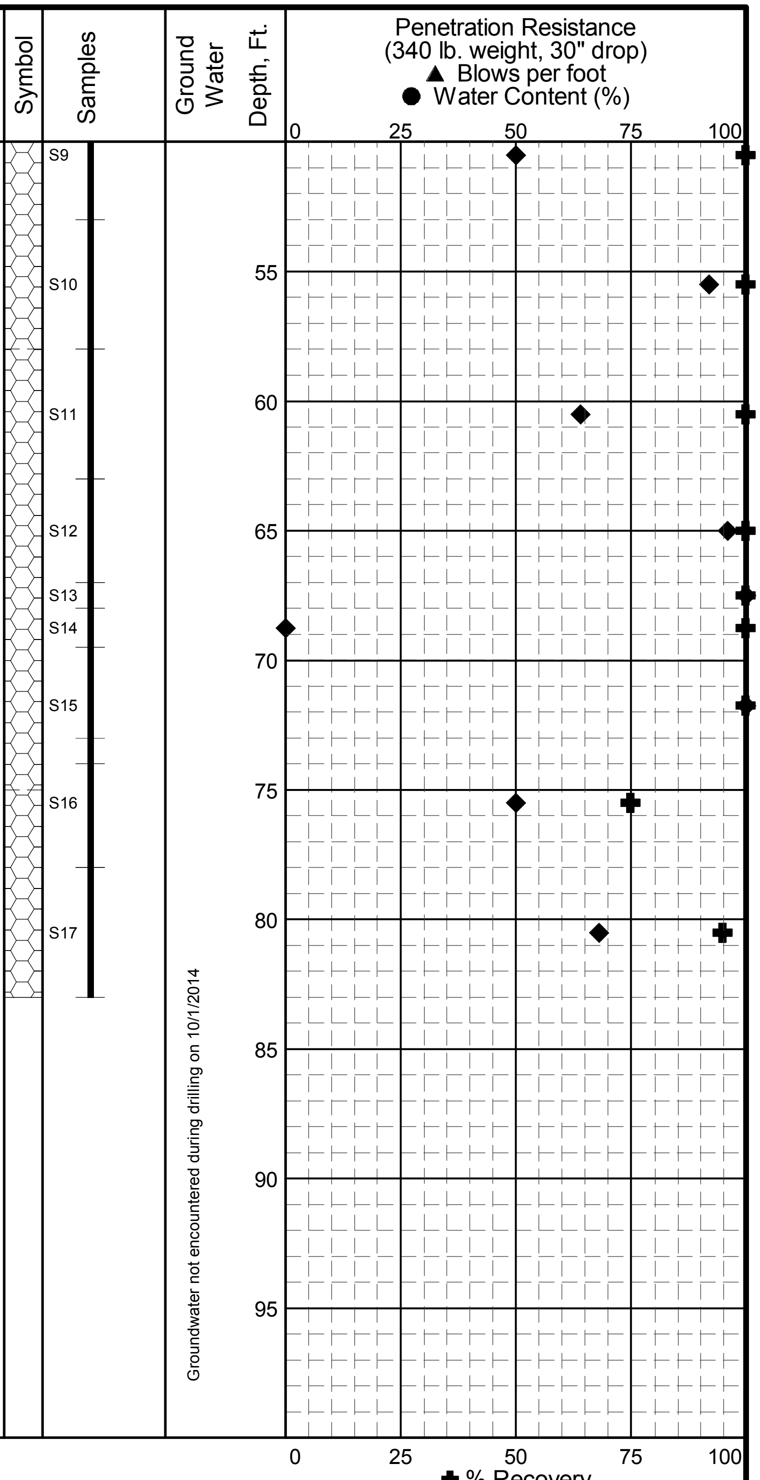
FIG. A-12
Sheet 1 of 2

REV 3 - Approved for Submittal

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

MATERIAL DESCRIPTION Approx. Elevation: 181 Ft.	Depth, Ft.
Basalt: Fresh to slightly weathered, slightly vesicular to moderately vesicular, very close to moderately close joints at low to high angles; dark gray to dark red, low to medium strength	
slightly vascular, fresh	58.0
moderately vascular, fresh to moderately weathered	75.0
Bottom of Boring Boring Completed 10/1/2014	83.0



LEGEND

- * Sample Not Recovered
- Ⅲ 3" O.D. Split Spoon Sample
- I Rock Core Sample

✚ % Recovery
◆ % RQD
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF BORING B-9

March 2015
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FIG. A-12
Sheet 2 of 2

GEOTECHNICAL LOG 02388 GINT.GPJ S&W GEO1.GDT 3/13/15

REV 3 - Approved for Submittal

Boring B-2

Run	Interval (feet bgs)	RQD (%)	REC (%)
S6	30' - 33'	0	95
S7	33' - 38'	10	95
S8	38' - 43'	7	80

Boring B-3

Run	Interval (feet bgs)	RQD (%)	REC (%)
S4	24' - 27.5'	26	90
S5	27.5' - 32.5'	8	65

Boring B-4

Run	Interval (feet bgs)	RQD (%)	REC (%)
S2	9.5' - 12.5'	0	33
S3	12.5' - 17.5'	10	60
S4	17.5' - 22.5'	25	100

Boring B-5

Run	Interval (feet bgs)	RQD (%)	REC (%)
S6	24' - 27'	0	60
S7	27' - 32'	12	95
S8	32' - 37'	29	95

Boring B-6

Run	Interval (feet bgs)	RQD (%)	REC (%)
S9	30.5' - 33'	0	50
S10	33' - 38'	60	100
S11	38' - 41'	53	95

Boring B-7

Run	Interval (feet bgs)	RQD (%)	REC (%)
S6	19' - 22'	14	67
S7	22' - 26.5'	0	22
S8	26.5' - 32.5'	23	91
S9	32.5' - 37'	30	44

Rock Quality Description

RQD Value	Description of Rock Quality
0% - 25%	Very Poor
26% - 50%	Poor
51% - 75%	Fair
76% - 90%	Good
91% - 100%	Excellent

NOTES

1. Rock Quality Description adapted from ADOT&PF, *Alaska Field Rock Classification and Structural Mapping Guide*, Table 2-7
2. RQD - Rock Quality Designation
3. REC - Recovery

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

ROCK CORE PHOTOGRAPHS - BORINGS B-2 THROUGH B-7

March 2015
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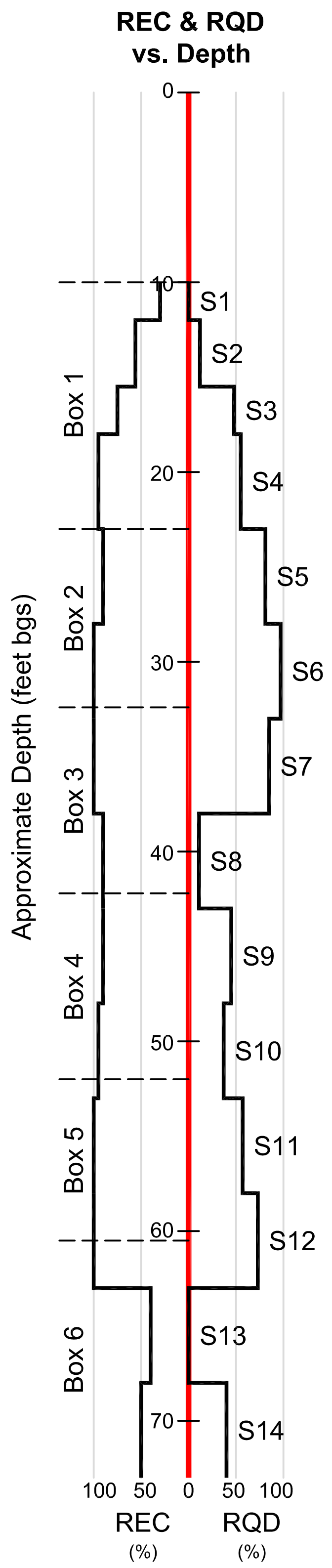
FIG. A-13



Box 1 of 6

Run	RQD (%)	REC (%)
S1	0	30
S2	12	56
S3	48	75
S4	55	95

Box 2 of 6

Run	RQD (%)	REC (%)
S5	81	90
S6	97	100

Box 3 of 6

Run	RQD (%)	REC (%)
S6	97	100
S7	85	100
S8	11	90

Box 4 of 6

Run	RQD (%)	REC (%)
S8	11	90
S9	45	90
S10	37	95

Box 5 of 6

Run	RQD (%)	REC (%)
S10	37	95
S11	57	100
S12	73	100

Box 6 of 6

Run	RQD (%)	REC (%)
S12	73	100
S13	0	40
S14	40	50

Rock Quality Description

RQD Value	Description of Rock Quality
0% - 25%	Very Poor
26% - 50%	Poor
51% - 75%	Fair
76% - 90%	Good
91% - 100%	Excellent

NOTES

1. Rock Quality Description adapted from ADOT&PF, *Alaska Field Rock Classification and Structural Mapping Guide*, Table 2-7
2. RQD - Rock Quality Designation
3. REC - Recovery

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

ROCK CORE PHOTOGRAPHS - BORING B-8

March 2015

32-1-02388

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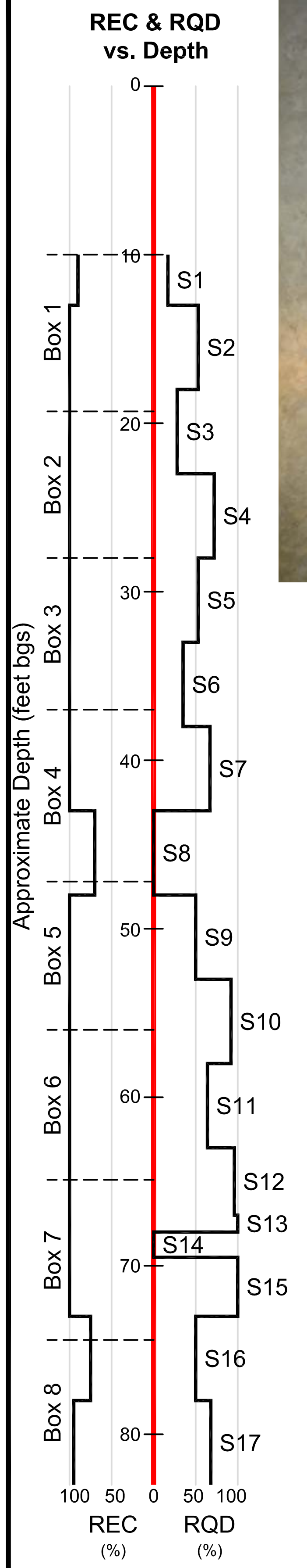
FIG. A-14



Box 1 of 8		
Run	RQD (%)	REC (%)
S1	17	90
S2	53	100
S3	28	100

Box 2 of 8		
Run	RQD (%)	REC (%)
S3	28	100
S4	72	100

Box 3 of 8		
Run	RQD (%)	REC (%)
S5	53	100
S6	35	100

Box 4 of 8		
Run	RQD (%)	REC (%)
S6	35	100
S7	67	100
S8	0	70

Box 5 of 8		
Run	RQD (%)	REC (%)
S8	0	70
S9	50	100
S10	92	100

Box 6 of 8		
Run	RQD (%)	REC (%)
S10	92	100
S11	64	100
S12	96	100

Box 7 of 8		
Run	RQD (%)	REC (%)
S12	96	100
S13	100	100
S14	0	100
S15	100	100
S16	50	75

Box 8 of 8		
Run	RQD (%)	REC (%)
S16	50	75
S17	68	95

Rock Quality Description	
RQD Value	Description of Rock Quality
0% - 25%	Very Poor
26% - 50%	Poor
51% - 75%	Fair
76% - 90%	Good
91% - 100%	Excellent

NOTES

1. Rock Quality Description adapted from ADOT&PF, *Alaska Field Rock Classification and Structural Mapping Guide*, Table 2-7
2. RQD - Rock Quality Designation
3. REC - Recovery

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

ROCK CORE PHOTOGRAPHS - BORING B-9

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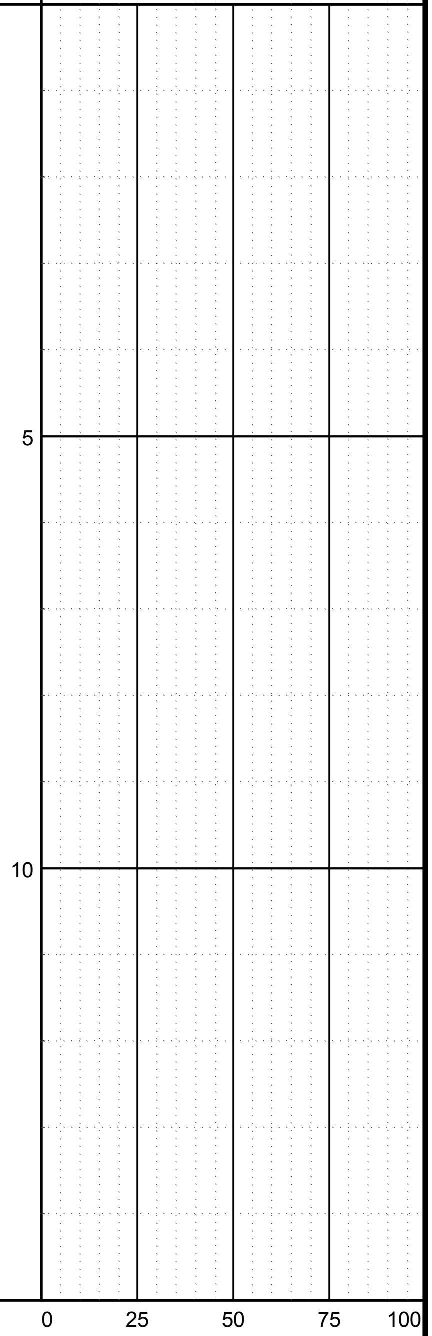
FIG. A-15

MATERIAL DESCRIPTION Approximate Surface Elevation: 190 Ft.	Depth, Ft.	Symbol	Samples	Ground Water Depth, Ft.
Boulders and Cobbles, Organic Silt and Sand Matrix; moist				Groundwater Not Encountered During Excavation on 9/30/14
Basalt: Moderately weathered, highly vesicular, dark red, low to medium strength	5.2 5.3			
Bottom of Test Pit Observed on 9/30/14				



● % Water Content

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF TEST PIT TP-1

March 2015 32-1-02388

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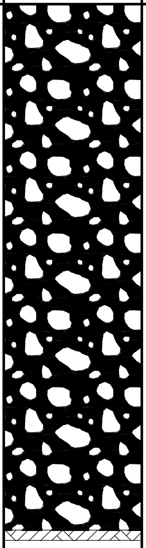
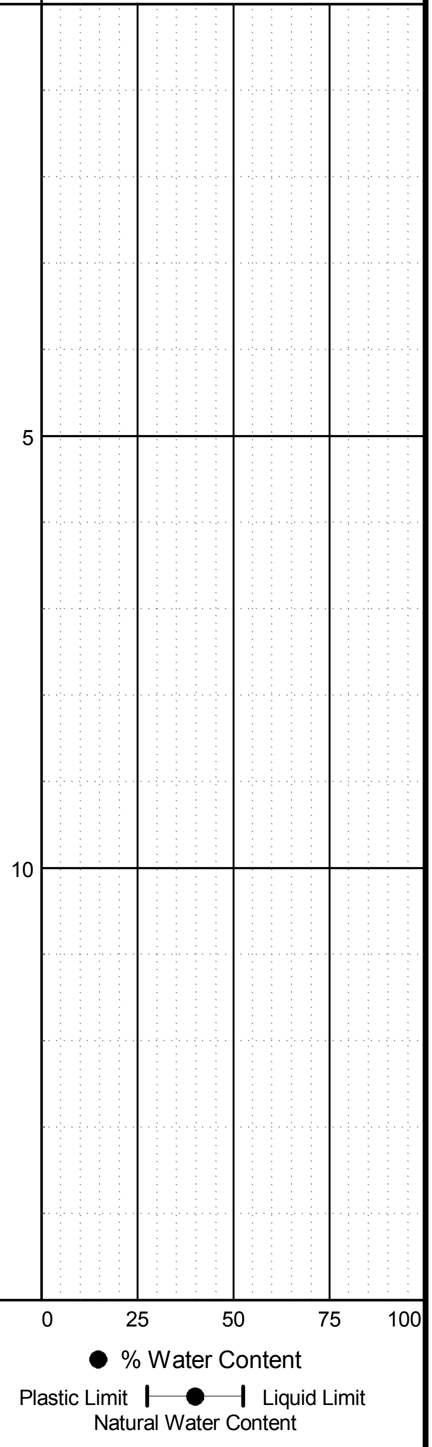
FIG. A-16

MATERIAL DESCRIPTION Approximate Surface Elevation: 210 Ft.	Depth, Ft.	Symbol	Samples	Ground Water Depth, Ft.
Boulders and Cobbles, Organic Silt and Sand Matrix; moist	6.1			
Basalt: Moderately weathered, slightly vesicular, dark gray, low to medium strength	6.2			

Bottom of Test Pit
Observed on 9/30/14



Groundwater Not Encountered During Excavation on 9/30/14



NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

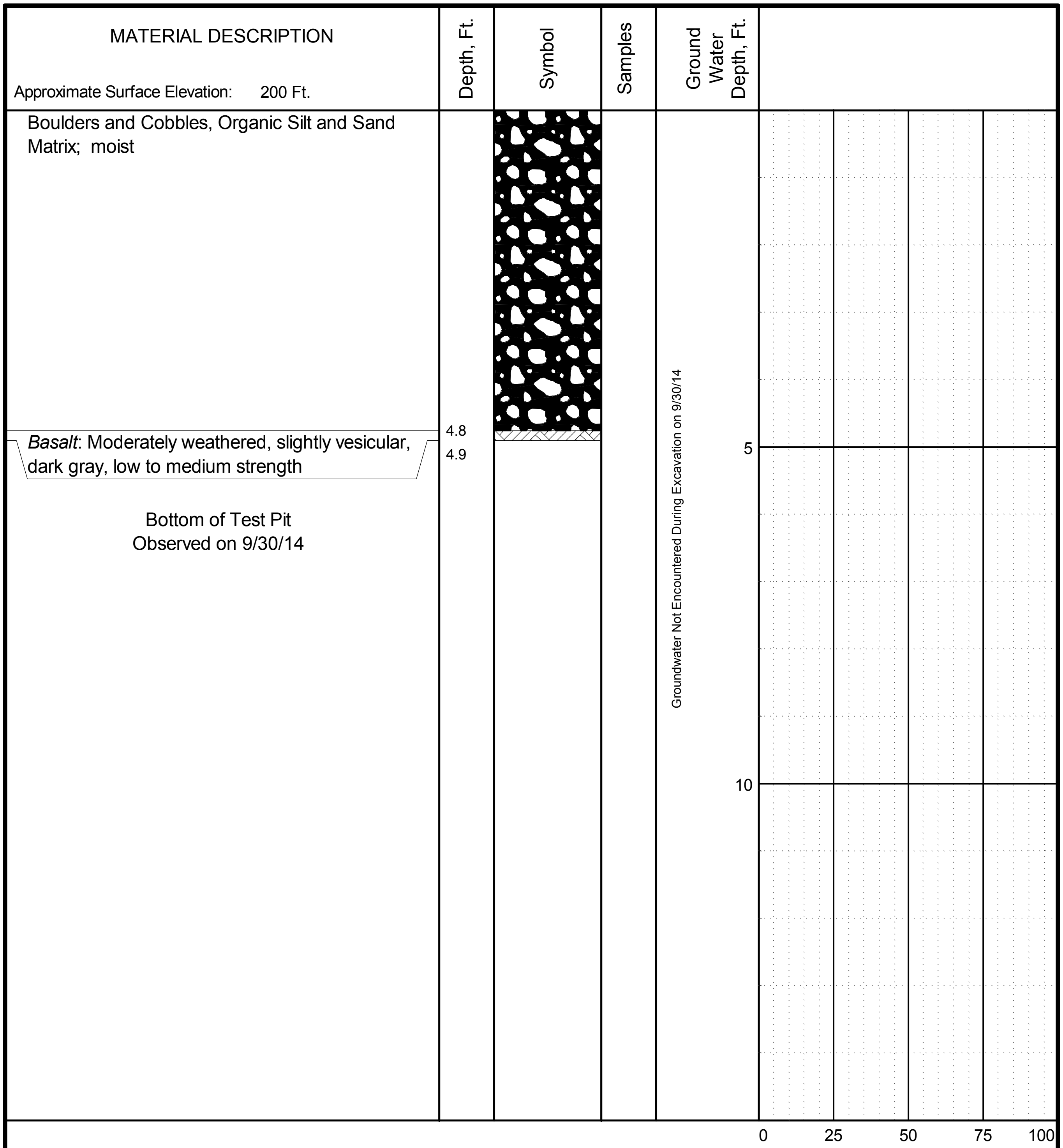
St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF TEST PIT TP-2

March 2015 32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-17



St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF TEST PIT TP-3

March 2015

32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

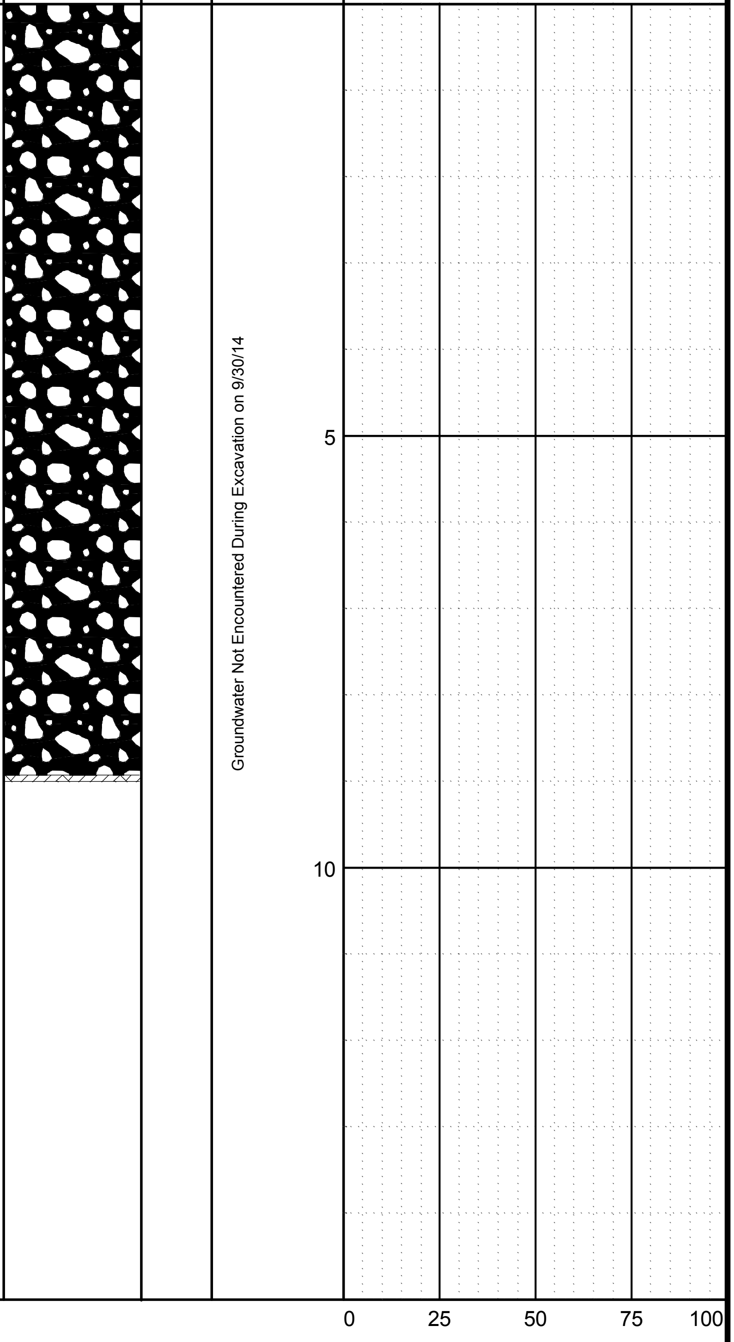
FIG. A-18

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

TEST_PIT 02388 GINT.GPJ S&W_GEO.GDT 3/13/15

MATERIAL DESCRIPTION Approximate Surface Elevation: 211 Ft.	Depth, Ft.	Symbol	Samples	Ground Water Depth, Ft.
Boulders and Cobbles, Red Brown Silt ,Sand and Gravel Matrix; moist				
Basalt: Moderately weathered, highly vesicular, dark red, low to medium strength	8.9			
Bottom of Test Pit Observed on 9/30/14	9.0			



● % Water Content

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

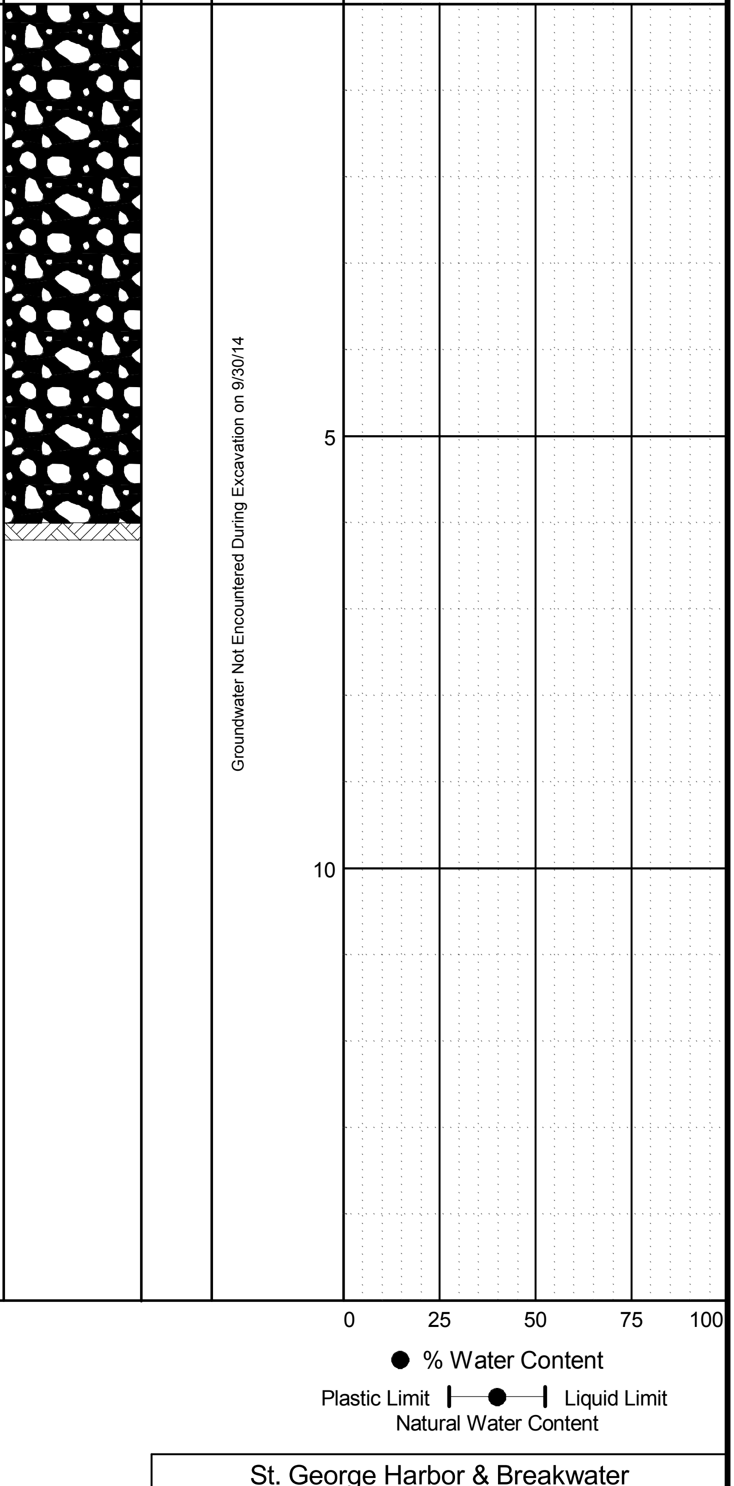
LOG OF TEST PIT TP-4

March 2015 32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-19

MATERIAL DESCRIPTION Approximate Surface Elevation: 178 Ft.	Depth, Ft.	Samples	Ground Water Depth, Ft.
Boulders and Cobbles, Organic Silt and Sand Matrix; moist			Groundwater Not Encountered During Excavation on 9/30/14
Basalt: Moderately weathered, slightly vesicular, dark gray, low to medium strength	6.0		
Bottom of Test Pit Observed on 9/30/14	6.2		



NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF TEST PIT TP-5

March 2015 32-1-02388

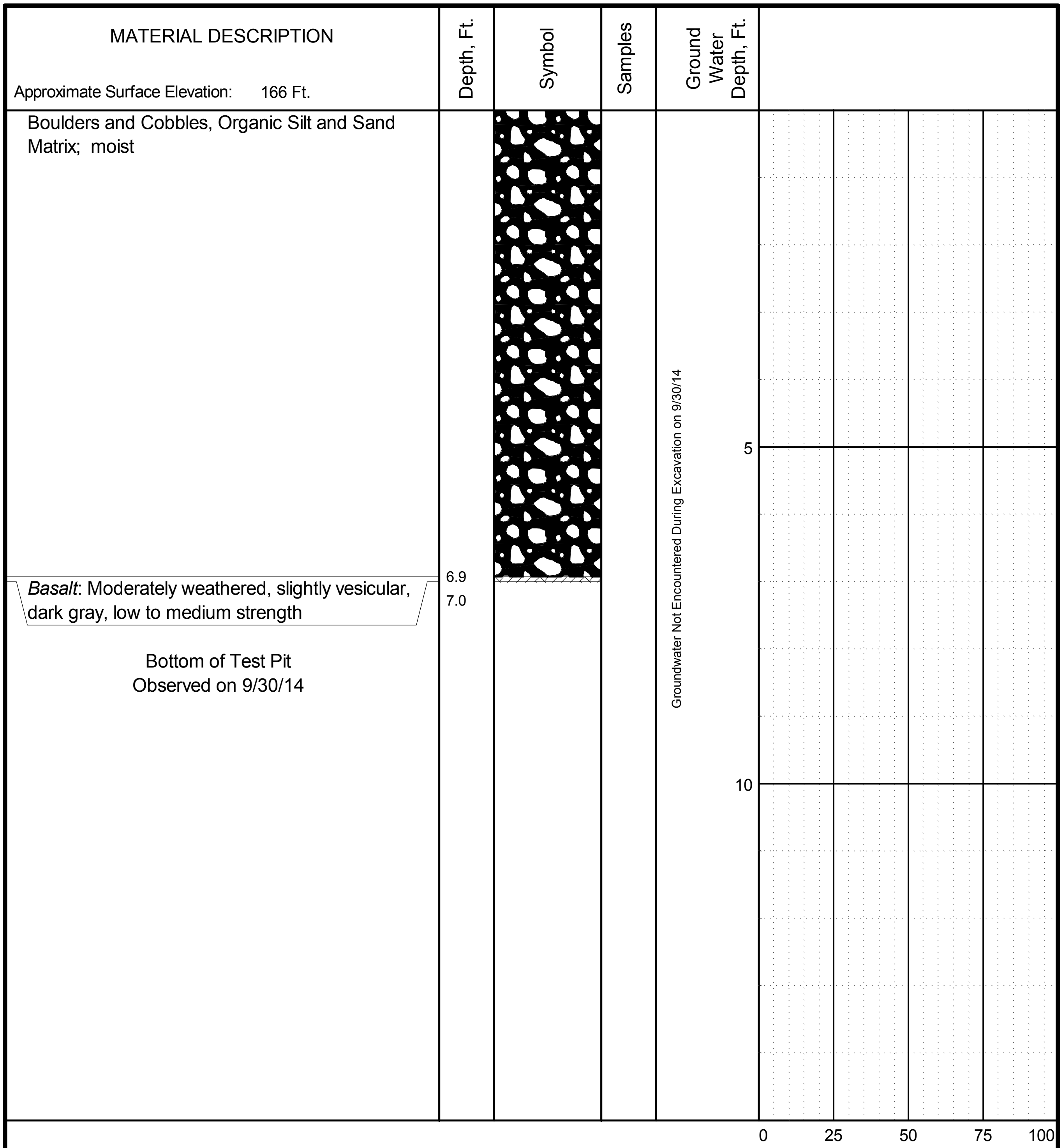
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-20

TEST_PIT 02388 GINT.GPJ S&W_GEO.GDT 3/13/15

MATERIAL DESCRIPTION

Approximate Surface Elevation: 166 Ft.



Boulders and Cobbles, Organic Silt and Sand Matrix; moist

Basalt: Moderately weathered, slightly vesicular, dark gray, low to medium strength

Bottom of Test Pit
Observed on 9/30/14

● % Water Content

Plastic Limit |—●—| Liquid Limit
Natural Water Content

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

LOG OF TEST PIT TP-6

March 2015 32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-21

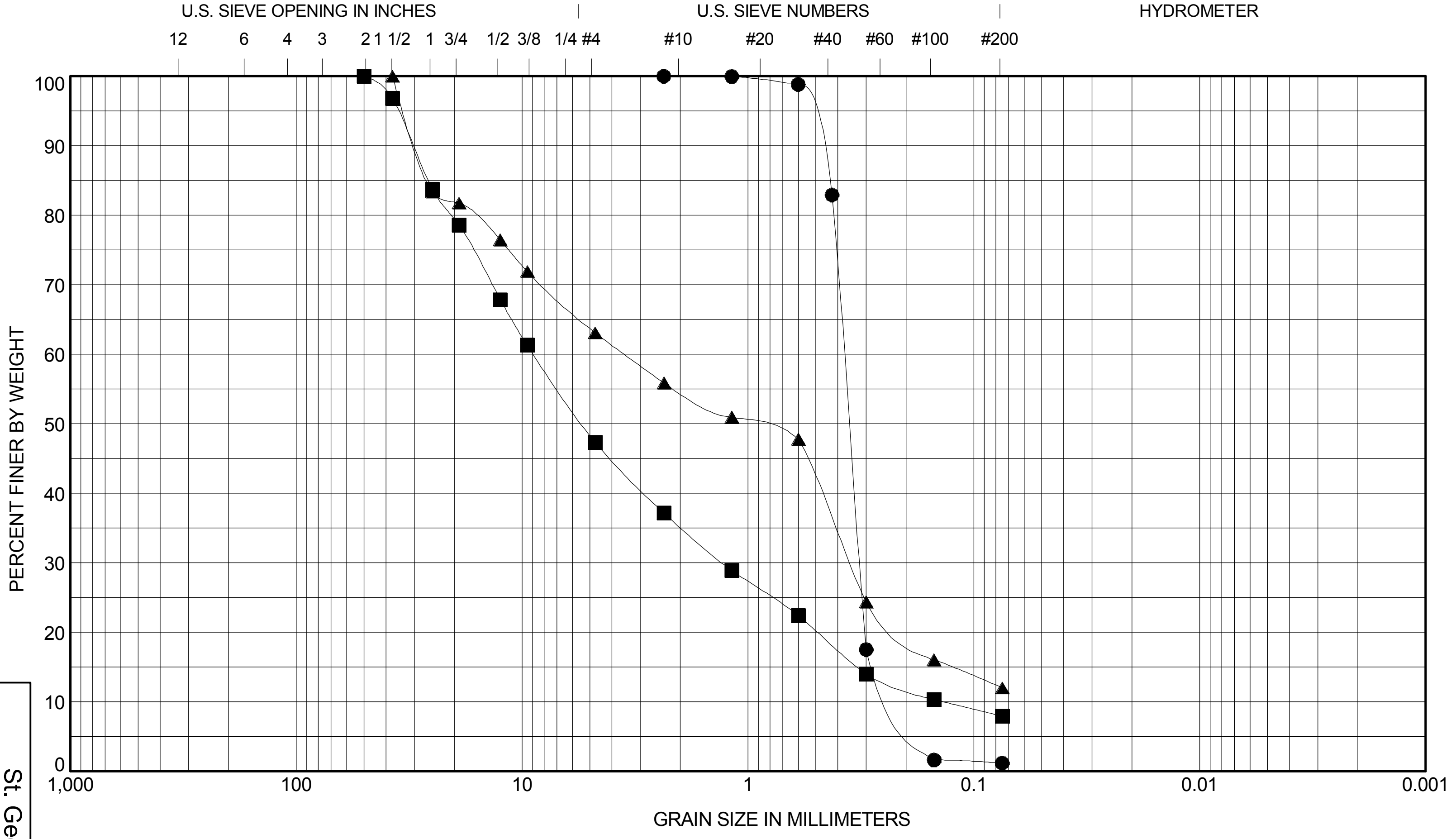
NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

TEST_PIT 02388 GINT.GPJ S&W_GEO.GDT 3/13/15

APPENDIX B

SOIL AND ROCK LABORATORY TESTING RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● **B-1 S2**	**4.0 - 5.5**	***Poorly-Graded Sand (SP)***				**1.3**	**1.7**
■ **B-2 S4**	**20.0 - 21.5**	***Well-Graded Gravel with Silt and Sand (GW-GM)***				**1.4**	**64.9**
▲ **B-3 S3**	**12.5 - 14.0**	***Poorly-Graded Sand with Silt and Gravel (SP-SM)***				**0.7**	**66.3**

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-1 S2**	**4.0 - 5.5**	**2.36**	**0.38**	**0.32**	**0.22**	**0**	**99**	**1**	
■ **B-2 S4**	**20.0 - 21.5**	**50**	**8.9**	**1.29**	**0.14**	**53**	**39**	**8**	
▲ **B-3 S3**	**12.5 - 14.0**	**37.5**	**3.52**	**0.35**		**37**	**51**	**12**	

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

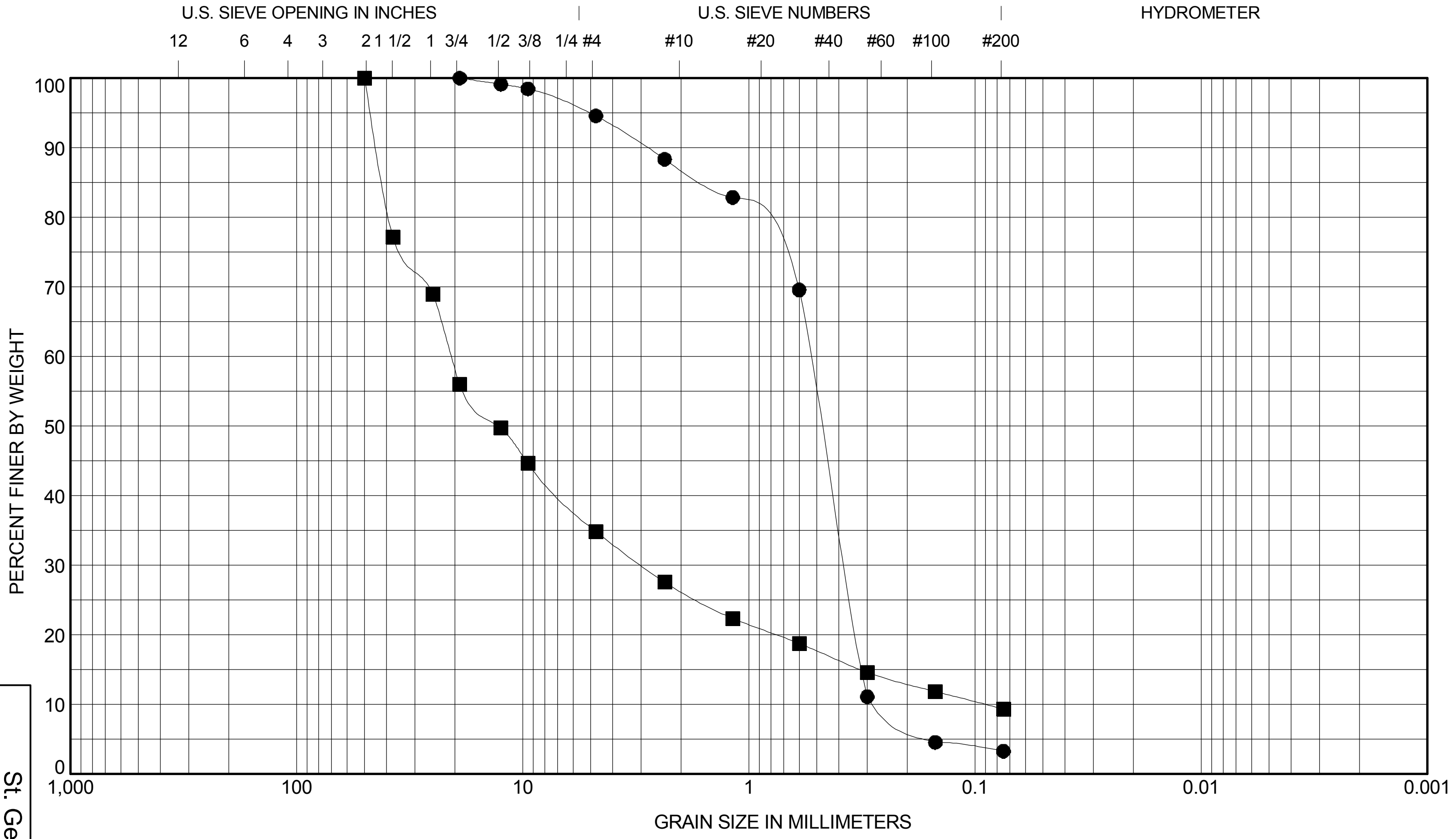
GRAIN SIZE CLASSIFICATION

March 2015

32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. B-1
Sheet 1 of 2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-5 S3**	**7.5 - 9.0**	***Poorly-Graded Sand (SP)***				**1.0**	**2.0**
■	**B-7 S2**	**5.0 - 6.5**	***Poorly-Graded Gravel with Silt and Sand (GP-GM)***				**4.8**	**228.5**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-5 S3**	**7.5 - 9.0**	**19**	**0.54**	**0.38**	**0.27**	**5**	**91**	**3**	
■	**B-7 S2**	**5.0 - 6.5**	**50**	**20.69**	**2.99**	**0.09**	**65**	**26**	**9**	

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

GRAIN SIZE CLASSIFICATION

March 2015

32-1-02388

SHANNON & WILSON, INC.
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FIG. B-1
Sheet 2 of 2

Armor Rock Gradation #1, North Breakwater, St. George Harbor

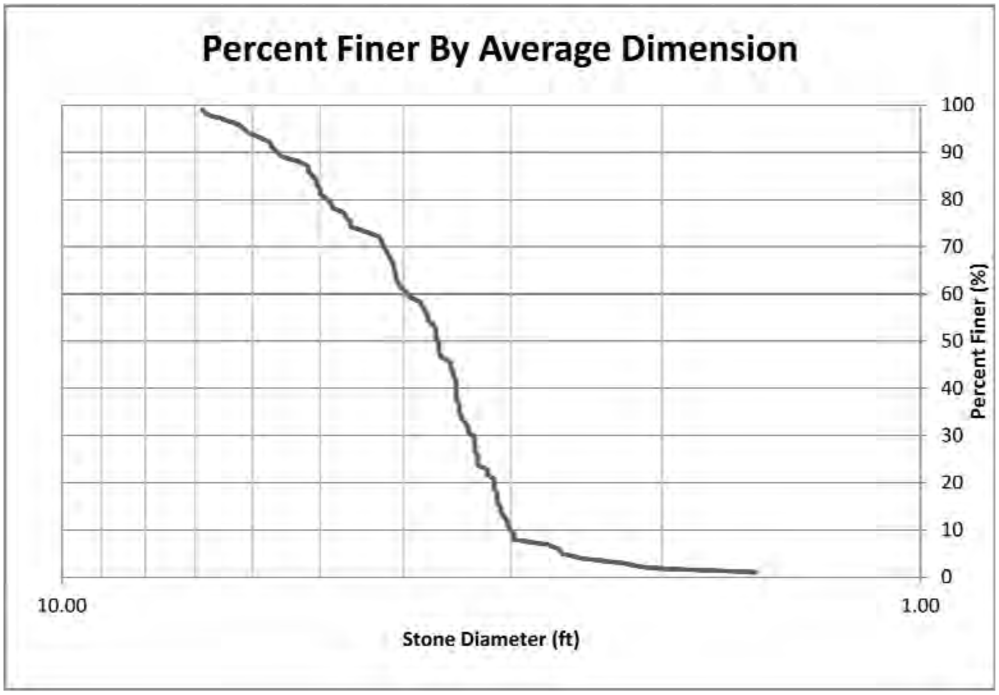
ASTM D5519 Method D

Rirap Sample Summary Statistics

Total number of stones measured:	100			
Assumed Specific Gravity	2.5	**Total estimated weight of sample**	536,252	**pounds**

Rank Percentile	100%	85%	50%	15%
Calculated Weight (pounds)	22,952	9,228	3464	2131
Calculated Average Dimension (ft)	6.86	5.06	3.65	3.11
Measured Middle Dimension (ft)	6.92	—	—	—

Elongation Ratios:	Sample
Percent of total number of stones with a length exceeding 2.5 times the breath or thickness:	24%
Percent of the total number of stones with a length exceding 3.0 times the breath or thickness:	11%
Percent of the total number of stones with a length exceding 3.5 times the breath or thickness:	6%



St George Harbor &
Breakwater Improvements
St George, Alaska

Armor Rock Gradation - 1

March 2015
32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. B-2

Armor Rock Gradation #2, South Breakwater, St. George Harbor

ASTM D5519 Method D

Sample Summary Statistics

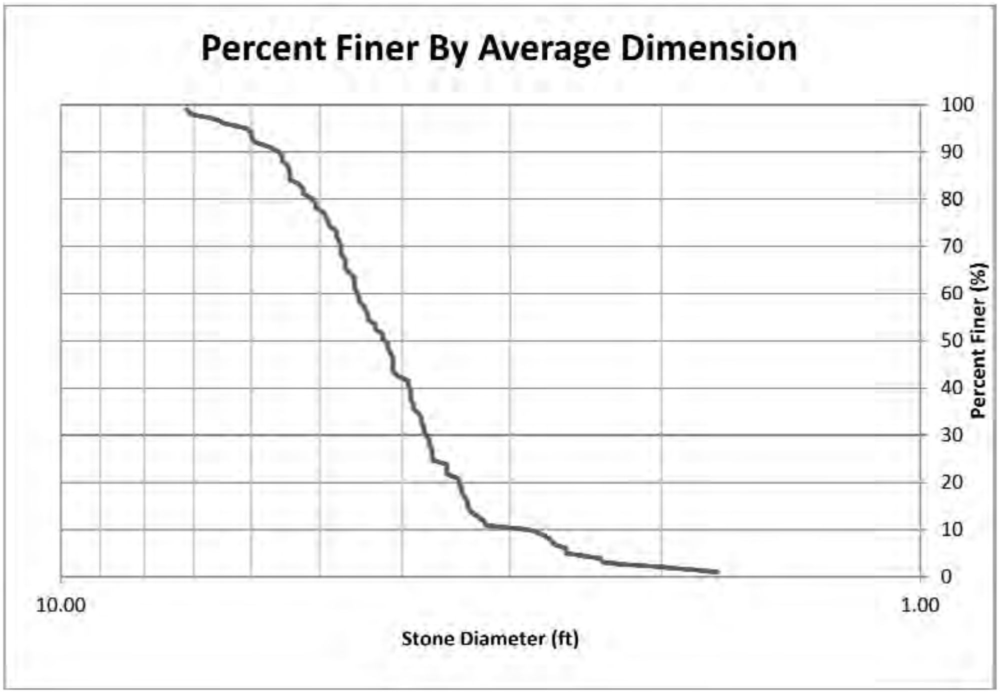
Total number of stones measured: 100

Assumed Specific Gravity 2.5

Total estimated weight of sample 660,760 pounds

Rank Percentile	100%	85%	50%	15%
Calculated Weight (pounds)	25,854	11,294	5245	2698
Calculated Average Dimension (ft)	7.14	5.42	4.19	3.36
Measured Middle Dimension (ft)	7.67	—	—	—

Elongation Ratios:	Sample
Percent of total number of stones with a length exceeding 2.5 times the breath or thickness:	15%
Percent of the total number of stones with a length exceding 3.0 times the breath or thickness:	7%
Percent of the total number of stones with a length exceding 3.5 times the breath or thickness:	5%



St George Harbor &
Breakwater Improvements
St George, Alaska

Armor Rock Gradation - 2

March 2015 32-1-02388

SHANNON & WILSON, INC.
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FIG. B-3

ALASKA
CALIFORNIA
COLORADO
FLORIDA
MINNESOTA
MISSOURI
OREGON
WASHINGTON

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

November 18, 2014

SHANNON & WILSON, INC.
5430 Fairbanks Street, Suite 3
Anchorage, Alaska 99518

Attn: Mr.Thomas Keatts.

RE: SAINT GEORGES HARBOR BORROW SOURCE INVESTIGATION

This letter is provided to submit results of the samples delivered to our Fairbanks laboratory. At your request we conducted the following analysis: *AASHTO T96 Resistance to Degradation by Impact and Abrasion, AASHTO T104 Sulfate Soundness, ATM T313 Degradation and Specific Gravity of Coarse Aggregate AASHTO T85.* The samples were received on 10-29-14. The results are presented below:

Client Test Identification	Los Angeles Wear %	Soundness Loss%	Degradation Value	Bulk Specific Gravity	Bulk Specific Gravity (SSD)	Bulk Specific Gravity (Apparent)	Absorption %
Quarry Harbor	**42**	**1**	**91**	**2.65**	**2.72**	**2.85**	**2.6**
Quarry "A"	**64**	**2**	**57**	**2.60**	**2.66**	**2.77**	**2.3**
Quarry "B"	**43**	**1**	**91**	**2.59**	**2.61**	**2.64**	**0.8**

If you have any questions regarding the information presented above, please do not hesitate to call.

SHANNON & WILSON, INC.

Alan Vetter, C.E.T.
Laboratory Manager

2355 HILL ROAD
FAIRBANKS, ALASKA 99709
(907) 479-0600 FAX (907) 479-5691

Laboratory Test Results Lab # 293-2014

R & M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

AASHTO R18
AMRL Lab #793

Client & Sample Information Field #: QB

Client: Shannon Wilson
Client Address: Anchorage, AK
Project: St. George Quarry Investigation
Material/Use: Armor Rock
Test Location: N/A
Sampled From: Quarry B
Sampled By: Client
Date Sampled: 8/22/2014
Source: N/A
Depth: N/A
Quantity Rep: N/A
PO Number:

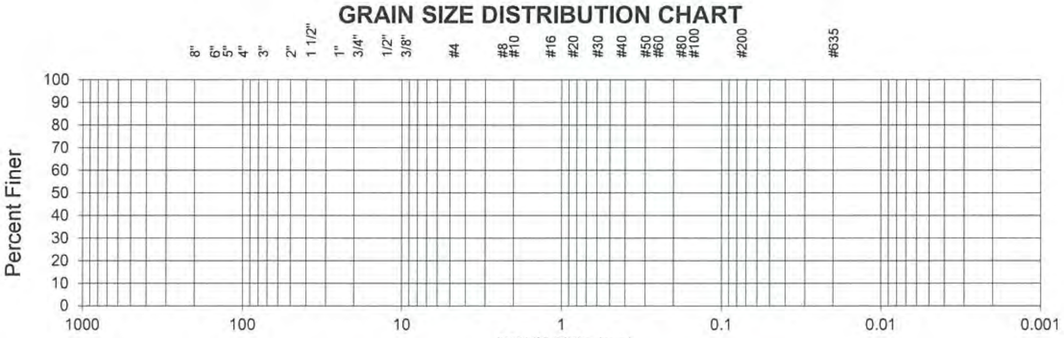
Laboratory Sample Data

Received By: R. McCormick
Date Received: 10/28/2014
Tech Assigned: SH, TS, RM
R&M Project No: 2148.01
Lab No: 293-2014
Date Completed: 12/5/2014

Aggregate & Soils Classification, Atterberg, SpG, etc.

Grain Size Distribution			
Sieve	Indv. % Ret.	Cum. % Pass	Spec.
6"			
5"			
4"			
3"			
2 1/2"			
2"			
1 1/2"			
1 1/4"			
1"			
3/4"			
5/8"			
1/2"			
3/8"			
5/16"			
1/4"			
#4			
#5			
#6			
#8			
#10			
#12			
#16			
#20			
#30			
#40			
#50			
#60			
#70			
#80			
#100			
#140			
#200			
.02mm			
.005mm			
.002mm			
.001mm			
Fineness Modulus:			

R&M performs sieve analyses using one or more of the following test methods (whichever apply): **P200 Wash**: ASTM-C117 or D1140 or AASHTO-T11; **Standard Gradation Only**: ASTM-C136 or AASHTO-T27 or T88; **Gradation w/ Hydrometer**: ASTM-D422 or ATM T-1; **Sieve Analysis of Mineral filler for Asphalt**: ASTM-D546 or AASHTO-T37; **Sieve Analysis of Extracted Aggregate**: ASTM-D5444 or AASHTO-T30



ASTM-USCS Classification

Boulders	Cobbles	Gravel		Sand			Silt Clay		
		Coarse	Fine	Coarse	Medium	Fine	Silt Clay	Silt Size[1]	C.S.[2]

[1]ASTM D653 defines "Silt Size" as soil finer than .02mm and coarser than .002mm; [2]ASTM D653 defines "Clay Size" as soil finer than .002mm

USCS % Boulders & Cobbles	USCS % Gravel	USCS % Sand	USCS % Silt Clay	USCS Classification	AASHTO % Boulders & Cobbles	AASHTO % Gravel	AASHTO % Sand	AASHTO % Silt Clay	AASHTO Classification

Note: The USCS (ASTM) and AASHTO classifications were determined using the following test methods, respectively: ASTM-D2487 and AASHTO-M145.
For both USCS and AASHTO: % boulders & cobbles is based on the original field sample; % gravel, sand and silt clay are based on only minus 3 inch material.

Test Methods used are as follows:
D_{100}, D_{60}, D_{30}, D_{10}, C_C , C_U- ASTM D2487
Atterberg Limits- ASTM D421, D2217, D4318 or AASHTO T87, T89, T90, T146;
Specific Gravity- ASTM C127, C128, D854 or AASHTO T84, T85, or T100;
Fineness Modulus - ASTM C136 or AASHTO T27

Chart for Coefficients of Curvature and Uniformity					
D_{100}	D_{60}	D_{30}	D_{10}	C_C	C_U

Note: D100 = particle diameter (mm) corresponding to 100% finer on the particle-size distribution curve. Similarly, D60, D30 and D10 = particle diameter (mm) corresponding to 60, 30 or 10% finer on the particle-size distribution curve, respectively. These values may have been obtained through interpolation or extrapolation. These values are based on only the minus 3-inch material.

Atterberg Limits			
Prep:	Wet	Dry	Spec.
LL			
PL			
PI			

Specific Gravity					
Coarse			Fine		
	Actual	Spec.		Actual	Spec.
Bulk:			Bulk:		
Bulk SSD:			Bulk SSD:		
Apparent:			Apparent:		
Absorption:			Absorption:		

More Test Results on the Following Page →

R&M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

Laboratory Test Results Lab # 293-2014

Density, Moisture, Unit Weight, etc. Field #: QB

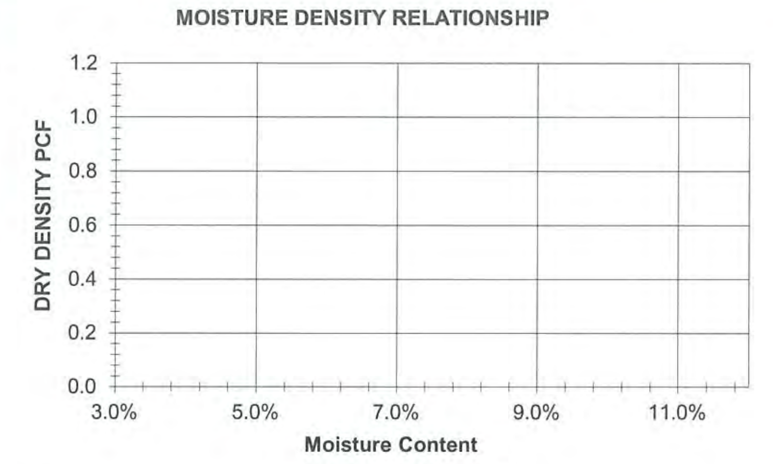
R&M uses the following methods for these tests: **Proctor**: ASTM-D698 or D1557 or D4718 or AASHTO-T99 or T180 or T224 or T272; **Moisture**: ASTM-C566 or D2216 or AASHTO-T217 or T255 or T265; **Unit Weight of Aggregate**: ASTM-C29 or AASHTO-T19; **Brass Liner Dry Density**: ASTM-D2937

Density (BLDD/Proctor)
Natural Density(BLDD)
Max Dry Density
Corr. Max Density

Moisture
Natural Moisture
Optimum Moisture
Corr. Opt. Moisture

Density - Vibratory Table (D4253)	
Maximum Index Density:	

Unit Weight			
Weight Loose:		Weight Rodded:	



Proctor Points

Moisture						
DD (pcf)						

Note: These points are based on only the soil passing the 3/4" (or #4) screen.

Aggregate Quality (Degradation, LA Abrasion, Sodium Sulfate)

R&M performs aggregate quality tests using the following methods (whichever apply): **Degradation**: ATM-T13; **LA Abrasion**: ASTM-C131 or C535 or AASHTO-T96; **Sodium Sulfate**: ASTM-C88 or AASHTO-T104

	Reading	D-Value	Spec.
ATM Deg.			

	Grading	% Loss	Spec.
LA Abrasion			

	Fine	Spec.	Coarse	Spec.
Sodium Sulfate				

Fracture, SE, Organic, pH, Friable Particles, etc.

Test Methods Used are as follows: **Sand Equivalent**: ASTM-D2419 or AASHTO T176; **Organic Content**: ASTM-D2974 or AASHTO-T267; **pH Level**: ASTM-D4972 or AASHTO T-289 or ATM-T29; **Friable Particles**: ASTM-C142 or AASHTO-T112; **Uncompacted Voids**: ASTM-C1252 or AASHTO-T304; **Permeability**: ASTM-D2434 or AASHTO-T215

	Actual	Spec.
Sand Equivalent Value:		
Organic Content:		
pH in H_2O:		
pH in $CaCl_2$:		
Friable Particles:		
Uncompacted Voids:		
Permeability:		

Fracture Count				
Size	1 Face	Spec.	2 Face	Spec.
+ 1"				
1" - 3/4"				
3/4" - 3/8"				
3/8" - #4				
#4 - #10				
Combined				

ASTM DESCRIPTION:

REMARKS: C.O.E. CRD-C 148-69 ethylene glycol test results: 0% loss over 15 day period. Test pictures attached.

More Test Results on the Previous Page

Checked By:

Signed By:

Michael K. Wariner P.E., Group Manager Lab and SI

R&M CONSULTANTS, INC.
9101 Vanguard Drive • Anchorage, Alaska 99507 • rmconsult.com
phone: 907.522.1707 • fax: 907.522.3403 • email@rmconsult.com

PHOTO LOG

R&M No.	2148.01	**Report No:**	293-2014
Project:	St. George Quarry Investigation	**Date:**	11/20/2014 to 12/5/2014
Client:	Shannon Wilson	**Field #:**	QB

Before soaking. All samples

Before soaking. Specific samples

Day 15. After soaking. All samples. No visable change.

Day 15. After soaking. Specific samples. No visible change.

Laboratory Test Results Lab # 291-2014

R & M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

AASHTO R18
AMRL Lab #793

Client & Sample Information

Field #: QH

Client: Shannon Wilson
Client Address: Anchorage, AK
Project: St. George Quarry Investigation
Material/Use: Armor Rock
Test Location: N/A
Sampled From: Quarry Harbor
Sampled By: Client
Date Sampled: 8/22/2014
Source: N/A
Depth: N/A
Quantity Rep: N/A
PO Number:

Laboratory Sample Data

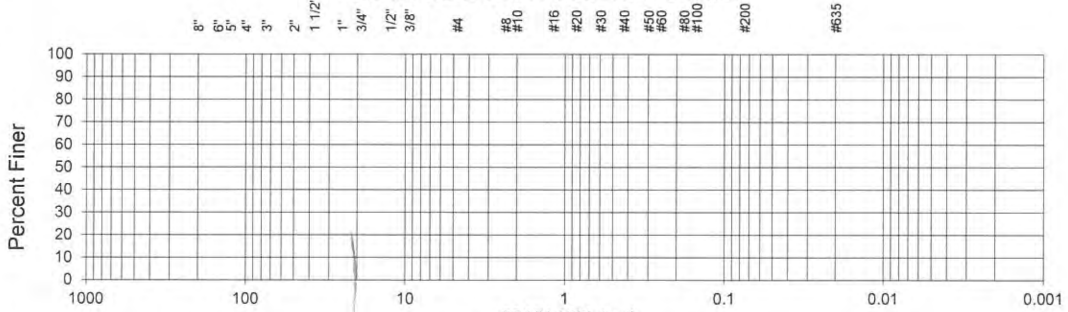
Received By: R. McCormick
Date Received: 10/28/2014
Tech Assigned: SH, TS, RM
R&M Project No: 2148.01
Lab No: 291-2014
Date Completed: 12/5/2014

Aggregate & Soils Classification, Atterberg, SpG, etc.

Grain Size Distribution			
Sieve	Indv. % Ret.	Cum. % Pass	Spec.
6"			
5"			
4"			
3"			
2 1/2"			
2"			
1 1/2"			
1 1/4"			
1"			
3/4"			
5/8"			
1/2"			
3/8"			
5/16"			
1/4"			
#4			
#5			
#6			
#8			
#10			
#12			
#16			
#20			
#30			
#40			
#50			
#60			
#70			
#80			
#100			
#140			
#200			
.02mm			
.005mm			
.002mm			
.001mm			
Fineness Modulus:			

R&M performs sieve analyses using one or more of the following test methods (whichever apply): **P200 Wash**: ASTM-C117 or D1140 or AASHTO-T11; **Standard Gradation Only**: ASTM-C136 or AASHTO-T27 or T88; **Gradation w/ Hydrometer**: ASTM-D422 or ATM T-1; **Sieve Analysis of Mineral filler for Asphalt**: ASTM-D546 or AASHTO-T37; **Sieve Analysis of Extracted Aggregate**: ASTM-D5444 or AASHTO-T30

GRAIN SIZE DISTRIBUTION CHART



ASTM-USCS Classification

Boulders	Cobbles	Gravel		Sand			Silt Clay		
		Coarse	Fine	Coarse	Medium	Fine	Silt Clay	Silt Size[1]	C.S.[2]

[1]ASTM D653 defines "Silt Size" as soil finer than .02mm and coarser than .002mm; [2]ASTM D653 defines "Clay Size" as soil finer than .002mm

USCS % Boulders & Cobbles	USCS % Gravel	USCS % Sand	USCS % Silt Clay	USCS Classification	AASHTO % Boulders & Cobbles	AASHTO % Gravel	AASHTO % Sand	AASHTO % Silt Clay	AASHTO Classification

Note: The USCS (ASTM) and AASHTO classifications were determined using the following test methods, respectively: ASTM-D2487 and AASHTO-M145. For both USCS and AASHTO, % boulders & cobbles is based on the original field sample; % gravel, sand and silt clay are based on only minus 3 inch material.

Test Methods used are as follows:
D_{100}, D_{60}, D_{30}, D_{10}, C_C, C_U- ASTM D2487
Atterberg Limits - ASTM D421, D2217, D4318 or AASHTO T87, T89, T90, T146;
Specific Gravity - ASTM C127, C128, D854 or AASHTO T84, T85, or T100;
Fineness Modulus - ASTM C136 or AASHTO T27

Chart for Coefficients of Curvature and Uniformity					
D_{100}	D_{60}	D_{30}	D_{10}	C_C	C_U

Note: D100 = particle diameter (mm) corresponding to 100% finer on the particle-size distribution curve. Similarly, D60, D30 and D10 = particle diameter (mm) corresponding to 60, 30 or 10% finer on the particle-size distribution curve, respectively. These values may have been obtained through interpolation or extrapolation. These values are based on only the minus 3-inch material.

Atterberg Limits			
Prep:	Wet	Dry	Spec.
LL			
PL			
PI			

Specific Gravity					
Coarse			Fine		
	Actual	Spec.		Actual	Spec.
Bulk:			Bulk:		
Bulk SSD:			Bulk SSD:		
Apparent:			Apparent:		
Absorption:			Absorption:		

More Test Results on the Following Page →

Laboratory Test Results Lab # 291-2014

R&M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

Density, Moisture, Unit Weight, etc. Field #: QH

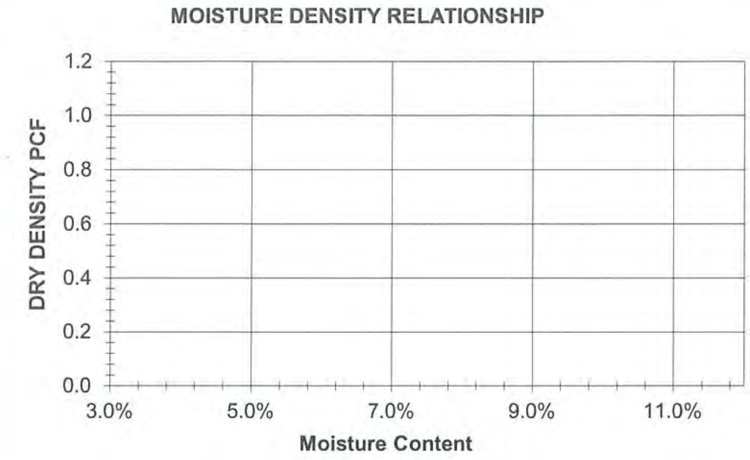
R&M uses the following methods for these tests: **Proctor**: ASTM-D698 or D1557 or D4718 or AASHTO-T99 or T180 or T224 or T272; **Moisture**: ASTM-C566 or D2216 or AASHTO-T217 or T255 or T265; **Unit Weight of Aggregate**: ASTM-C29 or AASHTO-T19; **Brass Liner Dry Density**: ASTM-D2937

Density (BLDD/Proctor)
Natural Density(BLDD)
Max Dry Density
Corr. Max Density

Moisture
Natural Moisture
Optimum Moisture
Corr. Opt. Moisture

Density - Vibratory Table (D4253)	
Maximum Index Density:	

Unit Weight			
Weight Loose:		Weight Rodded:	



Proctor Points

Moisture							
DD (pcf)							

Note: These points are based on only the soil passing the 3/4" (or #4) screen.

Aggregate Quality (Degradation, LA Abrasion, Sodium Sulfate)

R&M performs aggregate quality tests using the following methods (whichever apply): **Degradation**: ATM-T13; **LA Abrasion**: ASTM-C131 or C535 or AASHTO-T96; **Sodium Sulfate**: ASTM-C88 or AASHTO-T104

	Reading	D-Value	Spec.
ATM Deg.			

	Grading	% Loss	Spec.
LA Abrasion			

	Fine	Spec.	Coarse	Spec.
Sodium Sulfate				

Fracture, SE, Organic, pH, Friable Particles, etc.

Test Methods Used are as follows: **Sand Equivalent**: ASTM-D2419 or AASHTO T176; **Organic Content**: ASTM-D2974 or AASHTO-T267; **pH Level**: ASTM-D4972 or AASHTO T-289 or ATM-T29; **Friable Particles**: ASTM-C142 or AASHTO-T112; **Uncompacted Voids**: ASTM-C1252 or AASHTO-T304; **Permeability**: ASTM-D2434 or AASHTO-T215

	Actual	Spec.
Sand Equivalent Value:		
Organic Content:		
pH in H_2O:		
pH in $CaCl_2$:		
Friable Particles:		
Uncompacted Voids:		
Permeability:		

Fracture Count				
Size	1 Face	Spec.	2 Face	Spec.
+ 1"				
1" - 3/4"				
3/4" - 3/8"				
3/8" - #4				
#4 - #10				
Combined				

ASTM DESCRIPTION:

REMARKS: C.O.E. CRD-C 148-69 ethylene glycol test results: 0% loss over 15 day period. Test pictures attached.

Checked By: Ralph P. McCormack

Signed By:

Michael K. Wariner P.E., Group Manager Lab and SI

More Test Results on the Previous Page

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phone: 907.522.1707 • fax: 907.522.3403 • email@rmconsult.com

PHOTO LOG

R&M No.	2148.01	**Report No:**	291-2014
Project:	St. George Quarry Investigation	**Date:**	11/20/2014 to 12/5/2014
Client:	Shannon Wilson	**Field #:**	QH

Before soaking. All samples

Before soaking. Specific samples

Day 15. After soaking. All samples. No visible change.

Day 15. After soaking. Specific samples. No visible change.

Laboratory Test Results Lab # 292-2014

R & M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

AASHTO R18
AMRL Lab #793

Client & Sample Information

Field #: QA

Client: Shannon Wilson
Client Address: Anchorage, AK
Project: St. George Quarry Investigation
Material/Use: Armor Rock
Test Location: N/A
Sampled From: Quarry A
Sampled By: Client
Date Sampled: 8/22/2014
Source: N/A
Depth: N/A
Quantity Rep: N/A
PO Number:

Laboratory Sample Data

Received By: R. McCormick
Date Received: 10/28/2014
Tech Assigned: SH, TS, RM
R&M Project No: 2148.01
Lab No: 292-2014
Date Completed: 12/5/2014

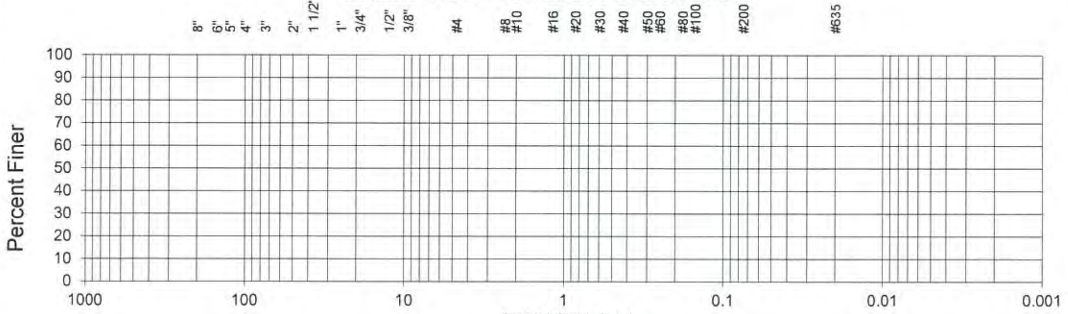
Aggregate & Soils Classification, Atterberg, SpG, etc.

Grain Size Distribution

Sieve	Indv. % Ret.	Cum. % Pass	Spec.
6"			
5"			
4"			
3"			
2 1/2"			
2"			
1 1/2"			
1 1/4"			
1"			
3/4"			
5/8"			
1/2"			
3/8"			
5/16"			
1/4"			
#4			
#5			
#6			
#8			
#10			
#12			
#16			
#20			
#30			
#40			
#50			
#60			
#70			
#80			
#100			
#140			
#200			
.02mm			
.005mm			
.002mm			
.001mm			
Fineness Modulus:			

R&M performs sieve analyses using one or more of the following test methods (whichever apply): **P200 Wash**: ASTM-C117 or D1140 or AASHTO-T11; **Standard Gradation Only**: ASTM-C136 or AASHTO-T27 or T88; **Gradation w/ Hydrometer**: ASTM-D422 or ATM T-1; **Sieve Analysis of Mineral filler for Asphalt**: ASTM-D546 or AASHTO-T37; **Sieve Analysis of Extracted Aggregate**: ASTM-D5444 or AASHTO-T30

GRAIN SIZE DISTRIBUTION CHART



ASTM-USCS Classification

Boulders	Cobbles	Gravel		Sand			Silt Clay		
		Coarse	Fine	Coarse	Medium	Fine	Silt Clay	Silt Size¹	C.S.²

¹ASTM D653 defines "Silt Size" as soil finer than .02mm and coarser than .002mm; ²ASTM D653 defines "Clay Size" as soil finer than .002mm

USCS % Boulders & Cobbles	USCS % Gravel	USCS % Sand	USCS % Silt Clay	USCS Classification	AASHTO % Boulders & Cobbles	AASHTO % Gravel	AASHTO % Sand	AASHTO % Silt Clay	AASHTO Classification

Note: The USCS (ASTM) and AASHTO classifications were determined using the following test methods, respectively: ASTM-D2487 and AASHTO-M145. For both USCS and AASHTO: % boulders & cobbles is based on the original field sample; % gravel, sand and silt clay are based on only minus 3 inch material.

Test Methods used are as follows:
D_{100}, D_{60}, D_{30}, D_{10}, C_C, C_U- ASTM D2487
Atterberg Limits- ASTM D421, D2217, D4318 or AASHTO T87, T89, T90, T146;
Specific Gravity- ASTM C127, C128, D854 or AASHTO T84, T85, or T100;
Fineness Modulus - ASTM C136 or AASHTO T27

Chart for Coefficients of Curvature and Uniformity

D_{100}	D_{60}	D_{30}	D_{10}	C_C	C_U

Note: D100 = particle diameter (mm) corresponding to 100% finer on the particle-size distribution curve. Similarly, D60, D30 and D10 = particle diameter (mm) corresponding to 60, 30 or 10% finer on the particle-size distribution curve, respectively. These values may have been obtained through interpolation or extrapolation. These values are based on only the minus 3-inch material.

Atterberg Limits

Prep:	Wet	Dry	Spec.
LL			
PL			
PI			

Specific Gravity

Coarse	Actual	Spec.	Fine	Actual	Spec.
Bulk:			Bulk:		
Bulk SSD:			Bulk SSD:		
Apparent:			Apparent:		
Absorption:			Absorption:		

More Test Results on the Following Page →

Laboratory Test Results Lab # 292-2014

R&M Consultants, Inc.
9101 Vanguard Dr., Anchorage, AK 99507, (907) 522-1707, Fax (907) 533-3403

Density, Moisture, Unit Weight, etc. Field #: QA

R&M uses the following methods for these tests: **Proctor**: ASTM-D698 or D1557 or D4718 or AASHTO-T99 or T180 or T224 or T272; **Moisture**: ASTM-C566 or D2216 or AASHTO-T217 or T255 or T265; **Unit Weight of Aggregate**: ASTM-C29 or AASHTO-T19; **Brass Liner Dry Density**: ASTM-D2937

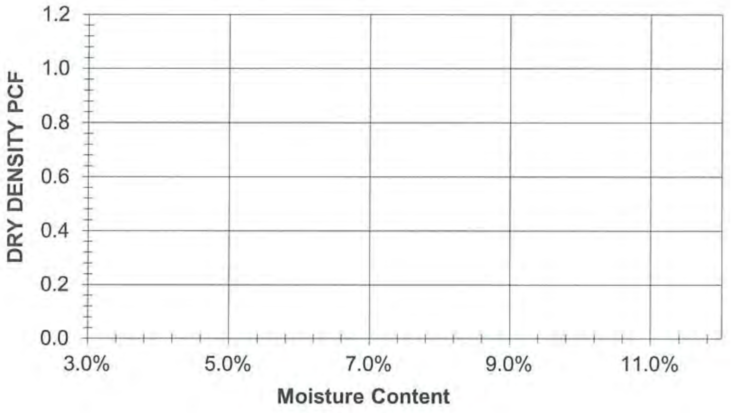
Density (BLDD/Proctor)
Natural Density(BLDD)
Max Dry Density
Corr. Max Density

Moisture
Natural Moisture
Optimum Moisture
Corr. Opt. Moisture

Density - Vibratory Table (D4253)	
Maximum Index Density:	

Unit Weight			
Weight Loose:		Weight Rodded:	

MOISTURE DENSITY RELATIONSHIP



Proctor Points

Moisture							
DD (pcf)							

Note: These points are based on only the soil passing the 3/4" (or #4) screen.

Aggregate Quality (Degradation, LA Abrasion, Sodium Sulfate)

R&M performs aggregate quality tests using the following methods (whichever apply): **Degradation**: ATM-T13; **LA Abrasion**: ASTM-C131 or C535 or AASHTO-T96; **Sodium Sulfate**: ASTM-C88 or AASHTO-T104

	Reading	D-Value	Spec.
ATM Deg.			

	Grading	% Loss	Spec.
LA Abrasion			

	Fine	Spec.	Coarse	Spec.
Sodium Sulfate				

Fracture, SE, Organic, pH, Friable Particles, etc.

Test Methods Used are as follows: **Sand Equivalent**: ASTM-D2419 or AASHTO T176; **Organic Content**: ASTM-D2974 or AASHTO-T267; **pH Level**: ASTM-D4972 or AASHTO T-289 or ATM-T29; **Friable Particles**: ASTM-C142 or AASHTO-T112; **Uncompacted Voids**: ASTM-C1252 or AASHTO-T304; **Permeability**: ASTM-D2434 or AASHTO-T215

	Actual	Spec.
Sand Equivalent Value:		
Organic Content:		
pH in H_2O:		
pH in $CaCl_2$:		
Friable Particles:		
Uncompacted Voids:		
Permeability:		

Fracture Count				
Size	1 Face	Spec.	2 Face	Spec.
+ 1"				
1" - 3/4"				
3/4" - 3/8"				
3/8" - #4				
#4 - #10				
Combined				

ASTM DESCRIPTION:

REMARKS: C.O.E. CRD-C 148-69 ethylene glycol test results: 0% loss over 15 day period. Test pictures attached.

Checked By:

Signed By:

Michael K. Wariner P.E., Group Manager Lab and SI

More Test Results on the Previous Page ←

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PHOTO LOG

R&M No.	2148.01	**Report No:**	292-2014
Project:	St. George Quarry Investigation	**Date:**	11/20/2014 to 12/5/2014
Client:	Shannon Wilson	**Field #:**	QA

Before soaking. All samples

Before soaking. Specific samples

Day 15. After soaking. All samples. No visable change.

Day 15. After soaking. Specific samples. No visible change.

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CLIENT: Shannon & Wilson

PROJECT: St. Goerge Quarry Investigation

R&M PROJECT: 2148.01 Task 02

LAB NO.: 292

FIELD NO.: Quarry A

LOCATION SAMPLED: Quarry A

LOCATION OF USE: To Be Determined

DATE SAMPLED: Client Provided

DATE RECEIVED: 10/28/2014

DATE REPORTED: 12/24/2014

General Information

Rock Type: Basalt with small vesicles

Geologic Formation: Unknown

Geologic Setting: Unknown

Quarry A						
Sample	**QA FT-1**	**QA FT-2**	**QA FT-3**	**QA FT-4**	**QA FT-5**	**Quantitative**
Initial Mass	2538.3	2960.9	2316.7	2725.1	2225.4	
Final Mass	2537.7	2959.9	2316.5	2724.2	2225.3	
% Loss	0.02%	0.03%	0.01%	0.03%	0.00%	

PreFreeze: QA FT-1	Clean Rock surface with few small Vesicles occasionally present. No obvious failure planes or cracks. Some small scaled areas on one side could allow for moisture penetration and deterioration. Vesicle dimensions range from less than 1mm up to approx. 3 mm with greatest depth being approximately 2 mm.	**Qualitative Assessment, Before Freezing Cycles**
PreFreeze: QA FT-2	Clean Rock surface with few small Vesicles occasionally present. No obvious failure planes or cracks. Possible weakness plane along string of Vesicles approximately 1 inch from edge. Vesicle dimensions range from less than 1mm up to approx. 8 mm with greatest depth being approximately 4 mm.	
PreFreeze: QA FT-3	Clean Rock surface with slightly larger Vesicles occasionally present. No obvious failure planes or cracks. Small crack on one side approximately 5 mm deep by 3 mm at widest point. Vesicle dimensions range from less than 1mm up to approx. 8 mm with greatest depth being approximately 6 mm.	
PreFreeze: QA FT-4	Clean Rock surface with few small Vesicles occasionally present. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 3 mm with greatest depth being approximately 2 mm.	
PreFreeze: QA FT-5	Clean Rock surface with slightly larger Vesicles occasionally present. No obvious failure planes or cracks. Vesicle dimensions range from less than 1 mm up to approx. 7 mm with greatest depth being approximately 3 mm.	

PostFreeze: QA FT-1	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "Vesicles" . scaled areas in original notes did not expand. Vesicles remained essentially equal in size throughout testing process.	**Qualitative Assessment, After Freezing Cycles**
PostFreeze: QA FT-2	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QA FT-3	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "Vesicles". No expansion of crack noted in original observations occurred. Vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QA FT-4	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QA FT-5	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process.	

12/24/14

Michael K. Wariner, P.E.
V.P. Materials Lab and Special Inspections

PICTURES

QA-FT-1

0 Cycles

10 Cycles

25 Cycles A

25 Cycles B

PICTURES

QA-FT-2

0 Cycles

10 Cycles

10 Cycles

25 Cycles

PICTURES

QA-FT-3

0 Cycles

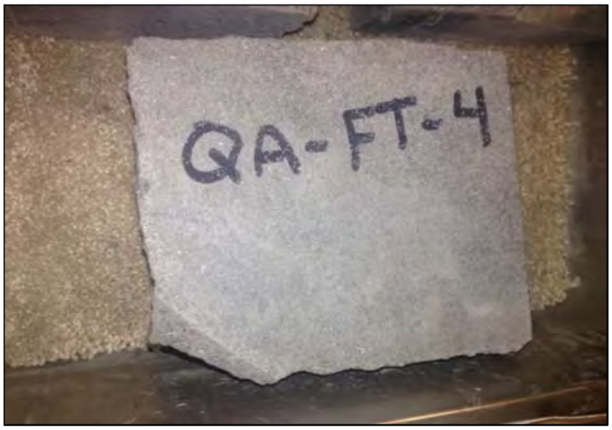
10 Cycles

25 Cycles A

25 Cycles

PICTURES

QA-FT-4



0 Cycles

10 Cycles

25 Cycles A

25 Cycles B

PICTURES

QA-FT-5

0 Cycles

25 Cycles A

10 Cycles

25 Cycles

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CLIENT: Shannon & Wilson
PROJECT: St. Goerge Quarry Investigation
R&M PROJECT: 2148.01 Task 02
LAB NO.: 293
FIELD NO.: Quarry B

LOCATION SAMPLED: Quarry B
LOCATION OF USE: To Be Determined
DATE SAMPLED: Client Provided
DATE RECEIVED: 10/28/2014
DATE REPORTED: 12/24/2014

General Information

Rock Type: Scoria
Goelogic Formation: Unknown
Goelogic Setting: Unknown

	Quarry B					
Sample	**QB FT-1**	**QB FT-2**	**QB FT-3**	**QB FT-4**	**QB FT-5**	**Quantitative**
Initial Mass	1771.9	2052.1	2664.3	2186.9	1603.9	
Final Mass	1767.3	2047.6	2659.5	2182.3	1600.1	
% Loss	0.26%	0.22%	0.18%	0.21%	0.24%	

PreFreeze: QB FT-1	Clean Rock surface with a high number of Vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 9 mm with greatest depth being approximately 5 mm.	**Qualitative Assessment, Before Freezing Cycles**
PreFreeze: QB FT-2	Clean Rock surface with a high number of Vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 9 mm with greatest depth being approximately 5 mm.	
PreFreeze: QB FT-3	Clean Rock surface with a high number of Vesicles throughout. No obvious failure planes or cracks. Vesicle's dimensions range from less than 1mm up to approx. 15 mm with greatest depth being approximately 14 mm.	
PreFreeze: QB FT-4	Clean Rock surface with fewer Vesicles than previous samples, but still a relatively high number of Vesicles throughout. No obvious failure planes or cracks. Vesicle's dimensions are typically slighlty larger than previsou rocks on average with maximum dimsions being 9 mm with greatest depth being approximately 6 mm.	
PreFreeze: QB FT-5	slightly rough rock surface with fewer Vesicles than previous samples, but still a relatively high number of Vesicles throughout. No obvious failure planes or cracks. Vesicle's dimensions are typically slighlty larger than samples 1-3 on average with maximum dimsions being 11 mm with greatest depth being approximately 8 mm.	
PostFreeze: QB FT-1	After 25 Cycles, little to no visible change. Slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process. Possible slight scaling area on unmarked face contributing to slight loss of weight.	**Qualitative Assessment, After Freezing Cycles**
PostFreeze: QB FT-2	After 25 Cycles, little to no visible change. Slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QB FT-3	After 25 Cycles, little to no visible change. Slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process. Possible slight scaling area on unmarked face near corner contributing to slight loss of weight.	
PostFreeze: QB FT-4	After 25 Cycles, little to no visible change. Slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QB FT-5	After 25 Cycles, little to no visible change. Slight roughening of surfaces included interior edges of "Vesicles" However no cracking, scaling or chipping was visible. Vesicles remained essentially equal in size throughout testing process. Possible slight scaling area on unmarked face contributing to slight loss of weight.	

12/24/14

Michael K. Wariner. P.E.
V.P. Materials Lab and Special Inspections

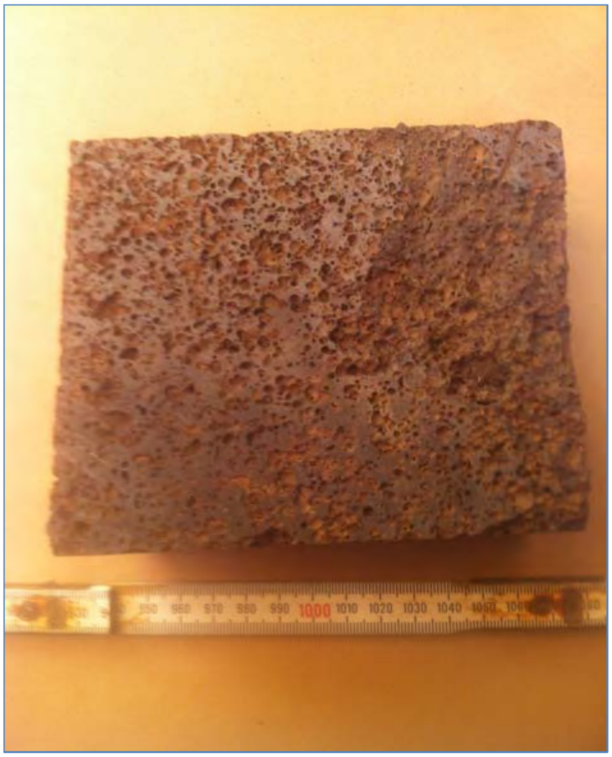
PICTURES

QB-FT-1

0 Cycles

10 Cycles

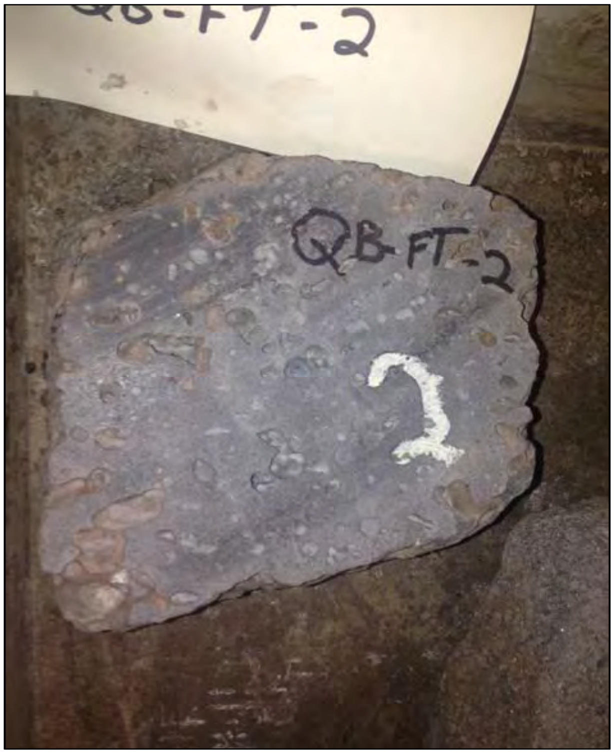
25 Cycles A



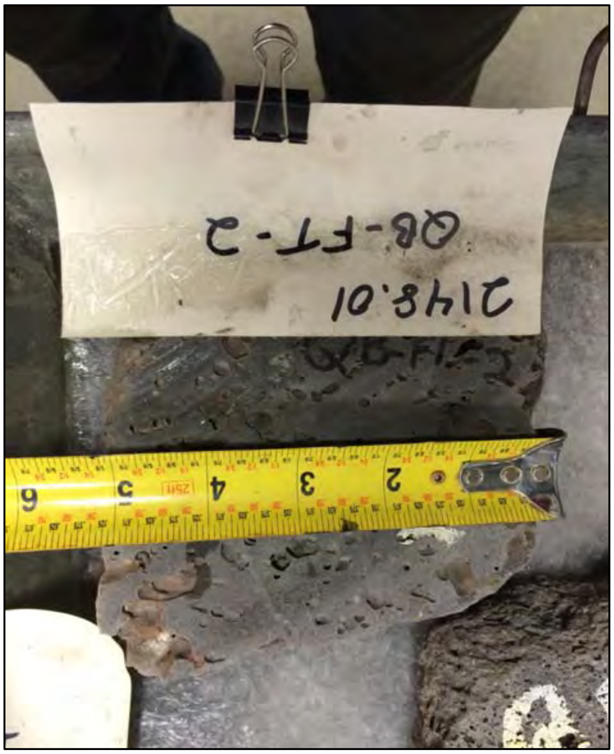
25 Cycles B

PICTURES

QB-FT-2



0 Cycles



10 Cycles

25 Cycles A

25 Cycles B

PICTURES

QB-FT-3

0 Cycles

10 Cycles

25 Cycles A

25 Cycles B

PICTURES

QB-FT-4

0 Cycles

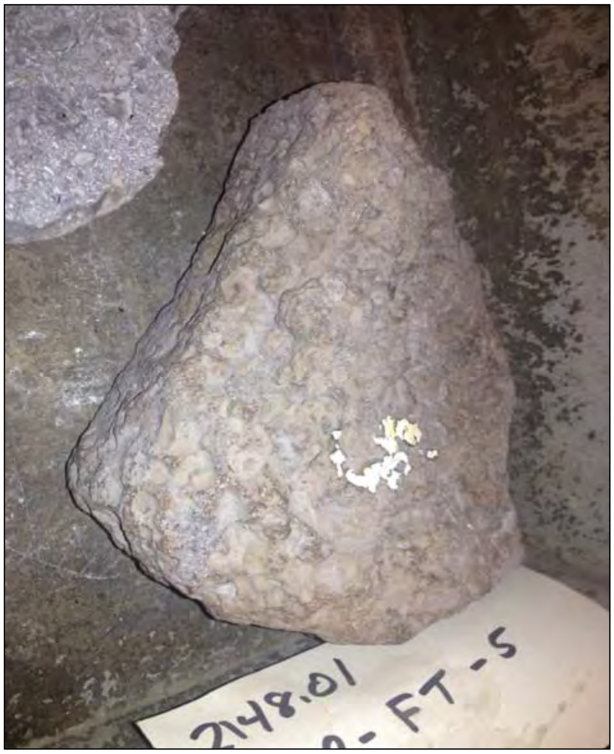
10 Cycles

25 Cycles A

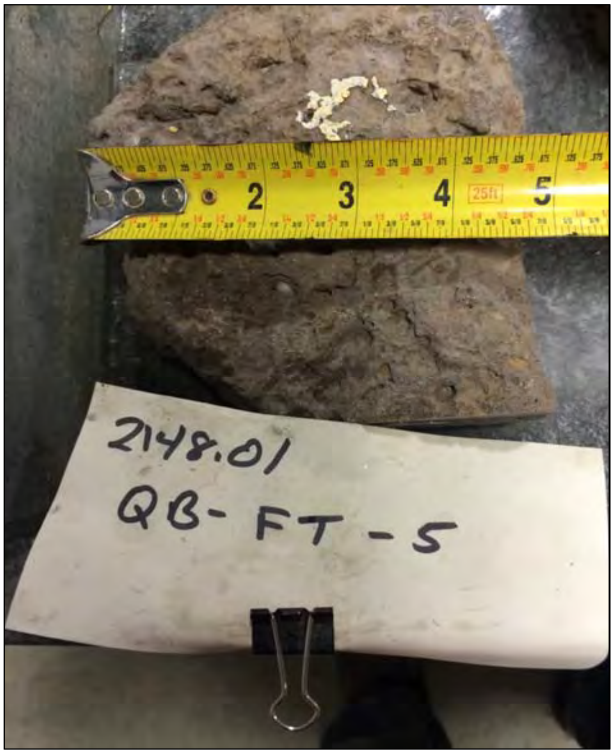
25 Cycles B

PICTURES

QB-FT-5



0 Cycles



10 Cycles

25 Cycles A

25 Cycles B

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phone: 907.522.1707 • fax: 907.522.3403 • email@rmconsult.com

CLIENT: Shannon & Wilson
PROJECT: St. George Quarry Investigation
R&M PROJECT: 2148.01 Task 02
LAB NO.: 291
FIELD NO.: Quarry H

LOCATION SAMPLED: Quarry H
LOCATION OF USE: To Be Determined
DATE SAMPLED: Client Provided
DATE RECEIVED: 10/28/2014
DATE REPORTED: 12/24/2014

General Information

Rock Type: Basalt with small vesicles
Geologic Formation: Unknown
Geologic Setting: Unknown

Quarry H

Sample	QH FT-1	QH FT-2	QH FT-3	QH FT-4	QH FT-5	
Initial Mass	3216.3	2186.2	2735.5	3020.4	2596.9	Quantitative
Final Mass	3215.4	2184.3	2734.8	3018.4	2592.4	
% Loss	0.03%	0.09%	0.03%	0.07%	0.17%	

PreFreeze: QH FT-1	Clean Rock surface with a small number of vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 4 mm with greatest depth being approximately 2 mm. Occasional minor, non structural cracks less than 1 mm in width. one noticeable crack approx. 16.5 mm below "Q" mark on rock. approx. 1 mm in width. Does not appear to be a failure plane.	Qualitative Assessment, Before Freezing Cycles
PreFreeze: QH FT-2	Clean Rock surface with a small number of vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 4 mm with greatest depth being approximately 2 mm. Occasional minor, non structural cracks less than 1 mm in width.	
PreFreeze: QH FT-3	Clean Rock surface with a small number of vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 3 mm with greatest depth being approximately 1 mm. Occasional minor, non structural cracks less than 1 mm in width.	
PreFreeze: QH FT-4	Clean Rock surface with a small number of vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 3 mm with greatest depth being approximately 1 mm. Occasional minor, non structural cracks less than 1 mm in width.	
PreFreeze: QH FT-5	Clean Rock surface with a small number of vesicles throughout. No obvious failure planes or cracks. Vesicle dimensions range from less than 1mm up to approx. 3 mm with greatest depth being approximately 1 mm. Occasional minor, non structural cracks less than 1 mm in width.	

PostFreeze: QH FT-1	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "vesicles" However no cracking, scaling or chipping was visible. vesicles remained essentially equal in size throughout testing process.	Qualitative Assessment, After Freezing Cycles
PostFreeze: QH FT-2	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "vesicles" However no cracking, scaling or chipping was visible. vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QH FT-3	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "vesicles" However no cracking, scaling or chipping was visible. vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QH FT-4	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "vesicles" However no cracking, scaling or chipping was visible. vesicles remained essentially equal in size throughout testing process.	
PostFreeze: QH FT-5	After 25 Cycles, little to no visible change. VERY slight roughening of surfaces included interior edges of "vesicles" Small chipping/scaling was visible in picture 25B. Vesicles remained essentially equal in size throughout testing process.	

12/24/14

Michael K. Wariner. P.E.
V.P. Materials Lab and Special Inspections

PICTURES

QH-FT-1

0 Cycles

10 Cycles

25 Cycles A

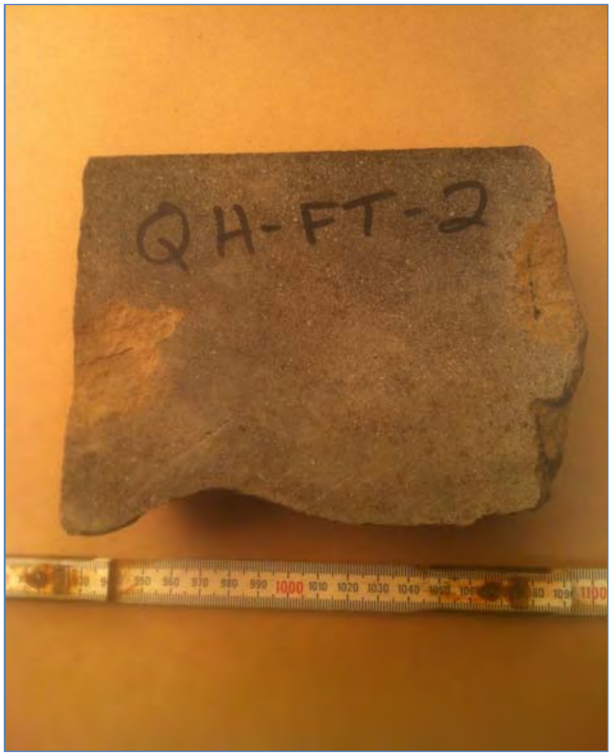
25 Cycles B

PICTURES

QH-FT-2

0 Cycles

10 Cycles



25 Cycles A

25 Cycles B

PICTURES

QH-FT-3

0 Cycles

25 Cycles A

25 Cycles B

25 Cycles C

PICTURES

QH-FT-4

10 Cycles

25 Cycles A

25 Cycles B

25 Cycles C

PICTURES

QH-FT-5

0 Cycles

10 Cycles

25 Cycles A

25 Cycles B

APPENDIX C

ONSHORE GEOPHYSICAL SURVEY RESULTS

Existing Harbor Area

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth^{TM} Mapping Service.

Airport Quarry Area

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth^{TM} Mapping Service.

N

0 200 400 800

APPROXIMATE SCALE IN FEET

LEGEND

0 LI 230 Approximate Location of Seismic Refraction Line L1 (length = 230 feet), Survey Performed by Shannon & Wilson, September, 2014

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION SURVEY LOCATIONS

March 2015

32-1-02388

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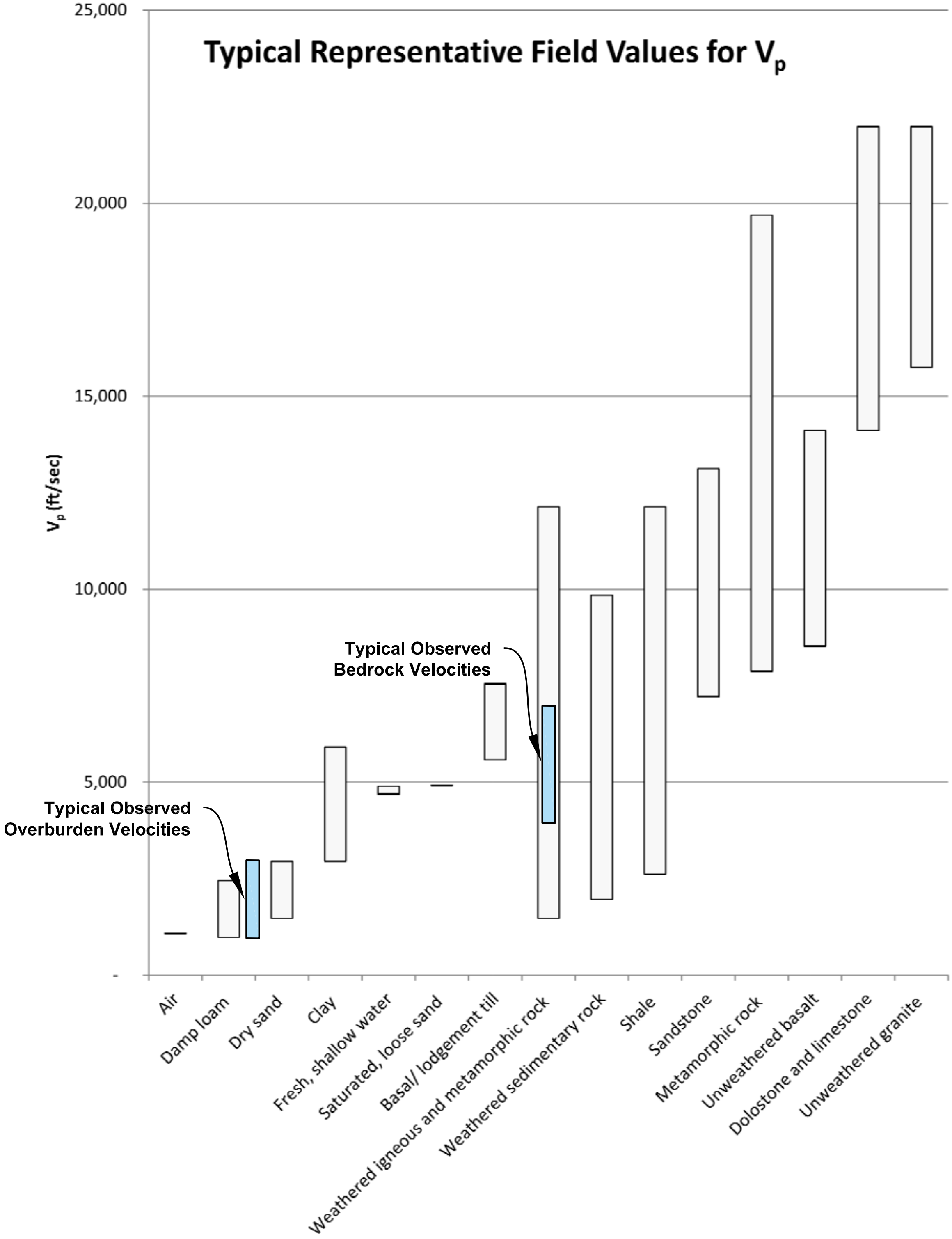
Geotechnical and Environmental Consultants

FIG. C-1



Derived from the U.S. Corps of Engineers Engineering Manual, "Geophysical Exploration For Engineering and Environmental Investigations", August 1995

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

TYPICAL COMPRESSION WAVE VELOCITIES

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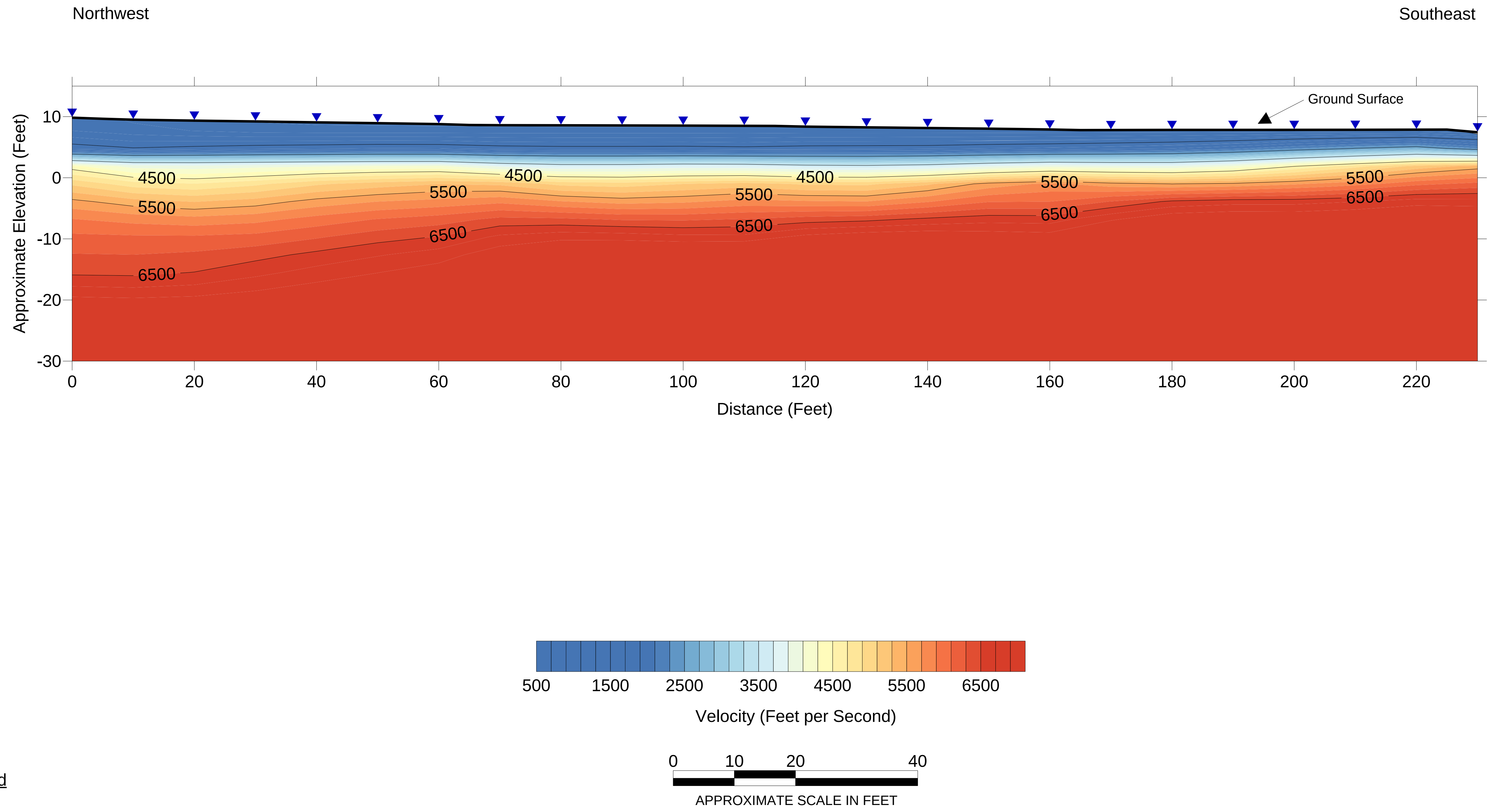
FIG. C-2



Legend

▼ Geophone

5500 Velocity Contour Interval (Feet per Second)

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L1

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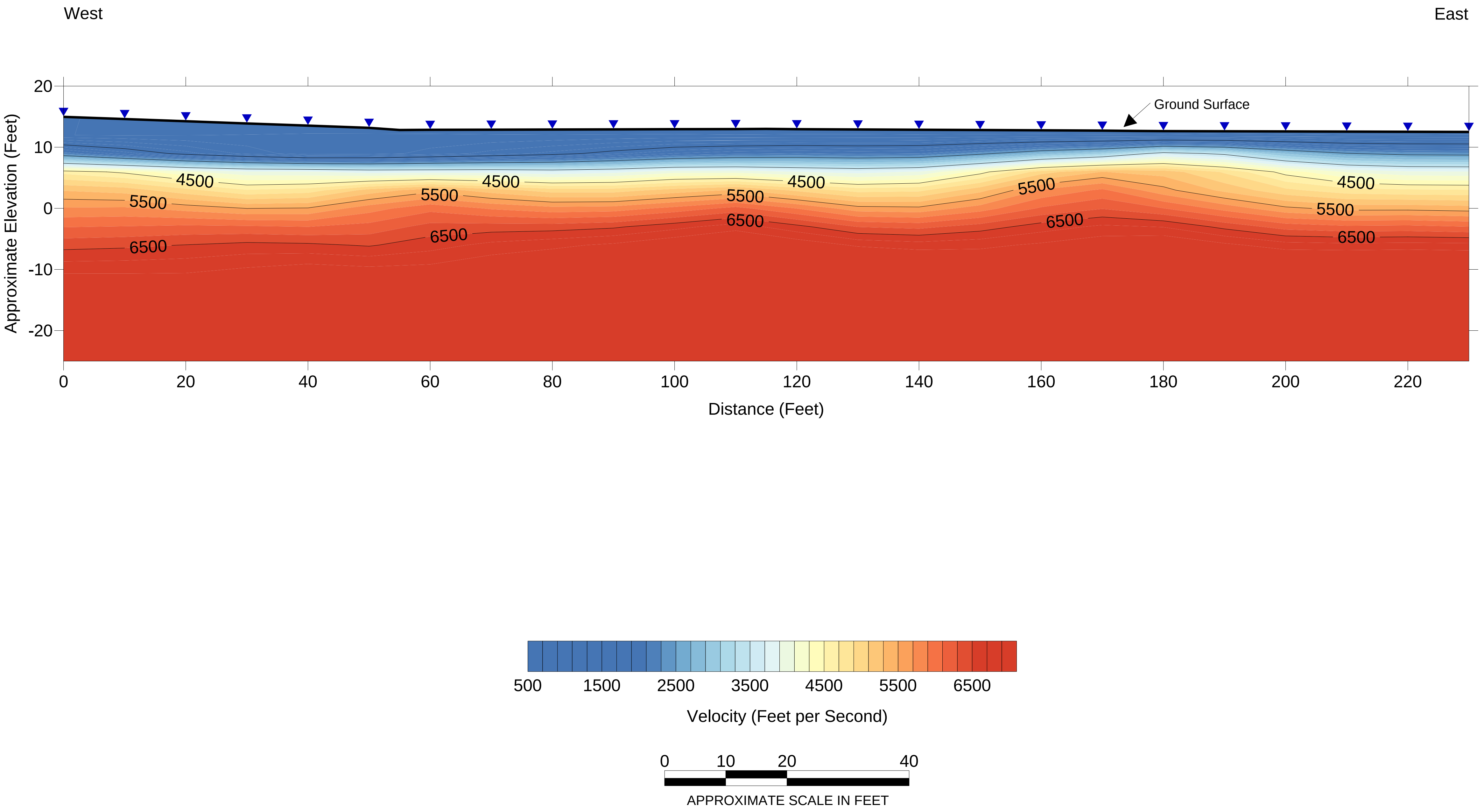
FIG. C-3



Legend

▼ Geophone

5500 Velocity Contour Interval (Feet per Second)

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L2

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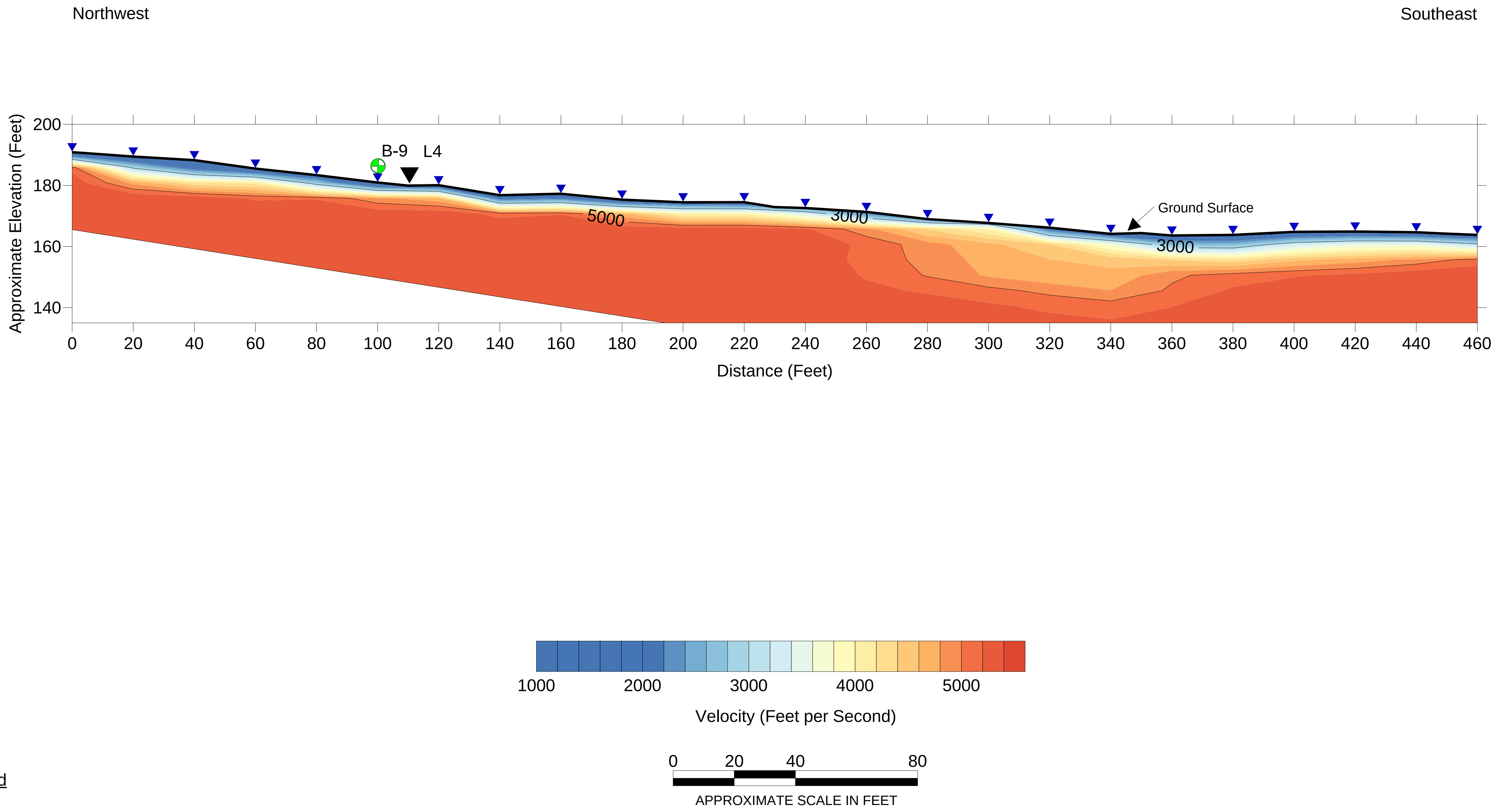
FIG. C-4



Legend

▼ Geophone

5000 Velocity Contour Interval (Feet per Second)

B-9 ⊕ Location of Boring B-9 Along Profile

L4 ▼ Location of Line L4 Along Profile

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L3

March 2015 32-1-02388

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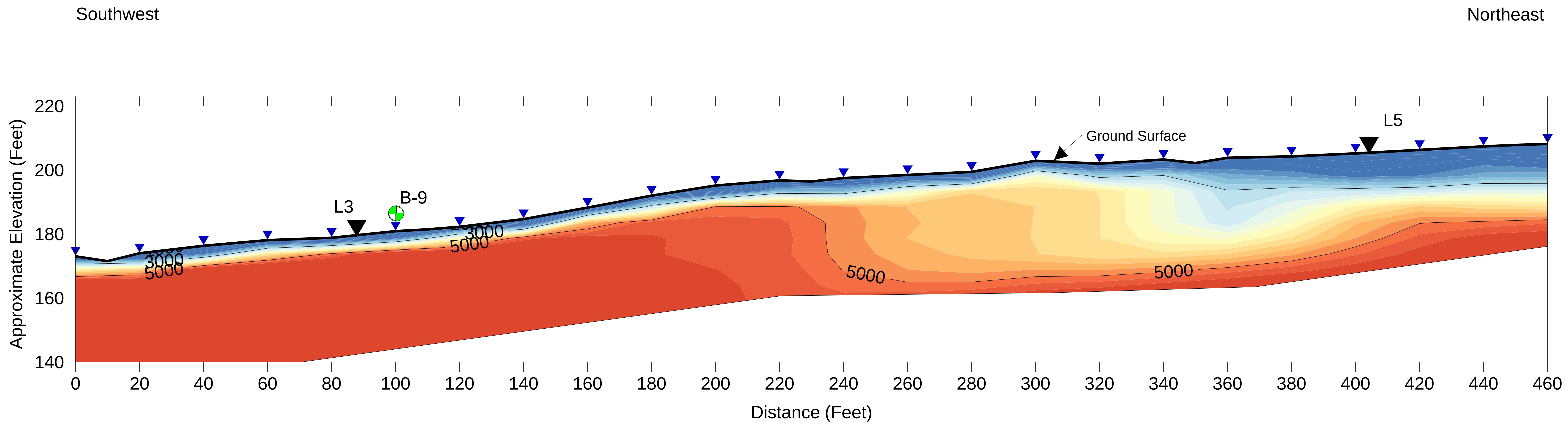
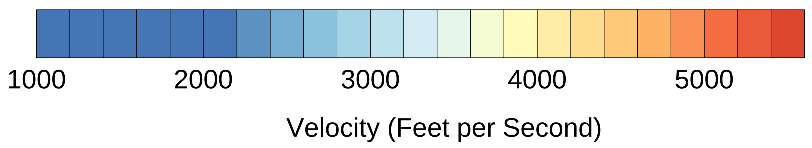
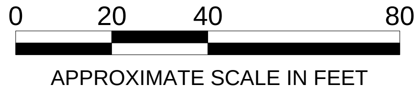
FIG. C-5







Legend

▼ Geophone

5000 Velocity Contour Interval (Feet per Second)

B-9 ⊕ Location of Boring B-9 Along Profile

L3 ▼ Location of Line L3 Along Profile

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L4

March 2015
32-1-02388

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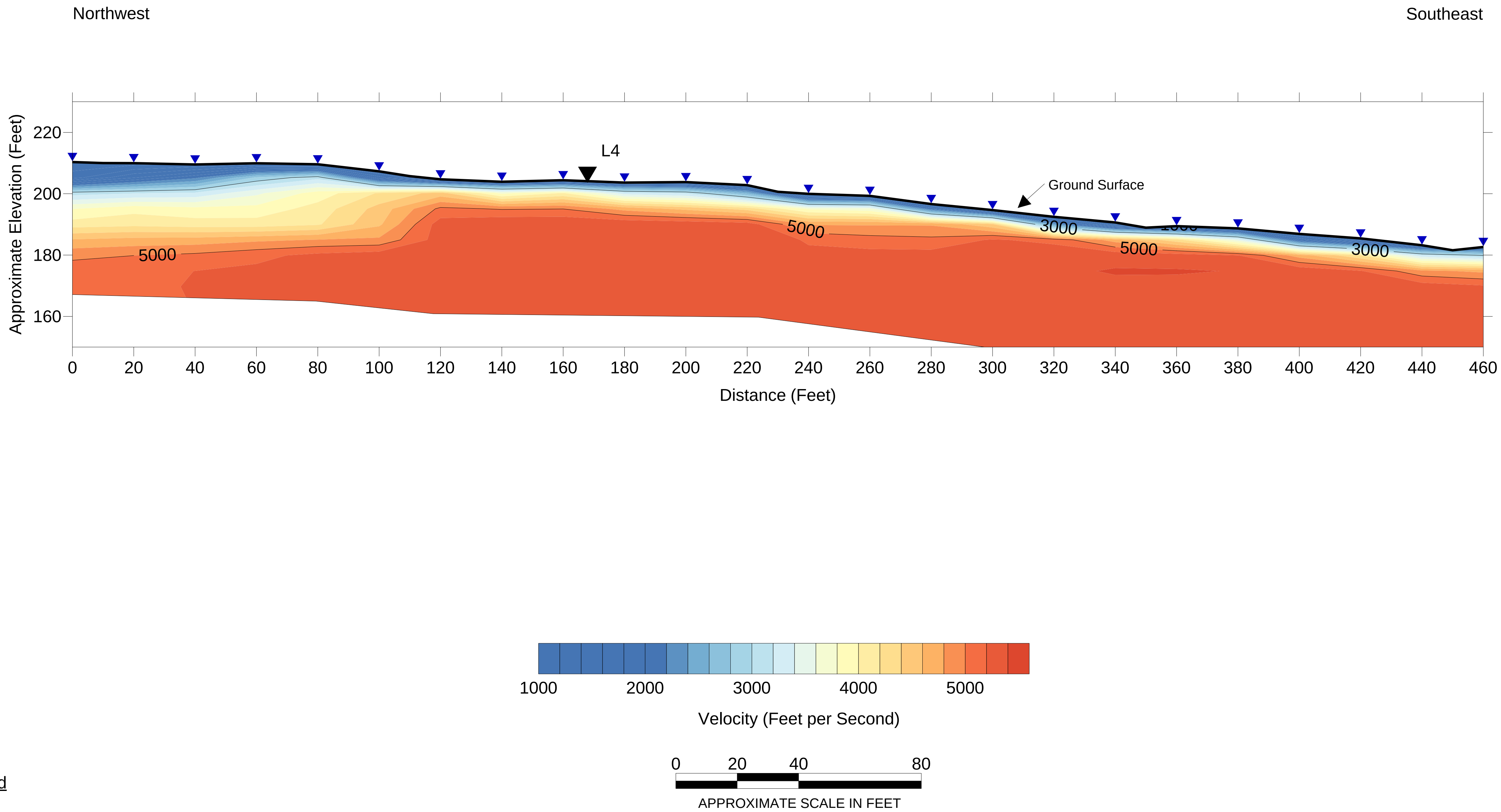
FIG. C-6



Legend

▼	Geophone
5000	Velocity Contour Interval (Feet per Second)
L4 ▼	Location of Line L4 Along Profile

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L5

March 2015
32-1-02388

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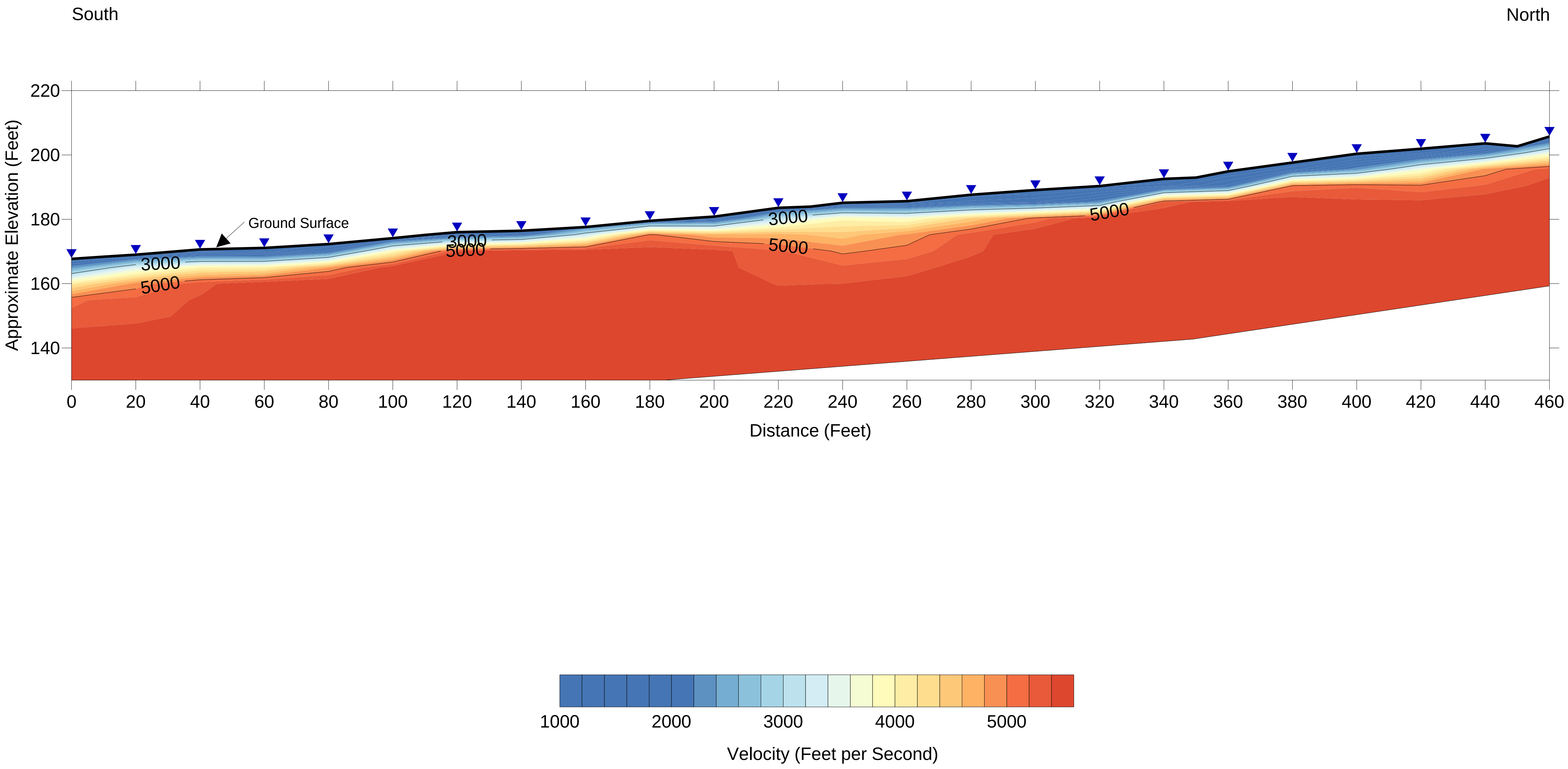
FIG. C-7



0 20 40 80

APPROXIMATE SCALE IN FEET

Legend

▼ Geophone

5000 Velocity Contour Interval (Feet per Second)

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L6

March 2015 32-1-02388

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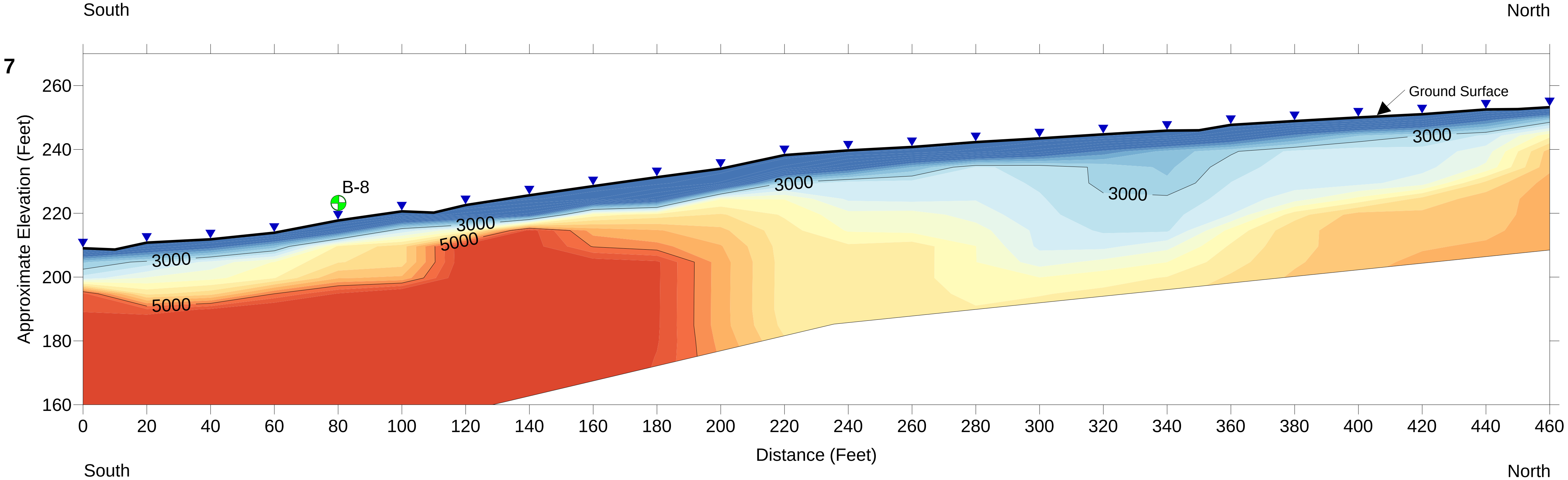
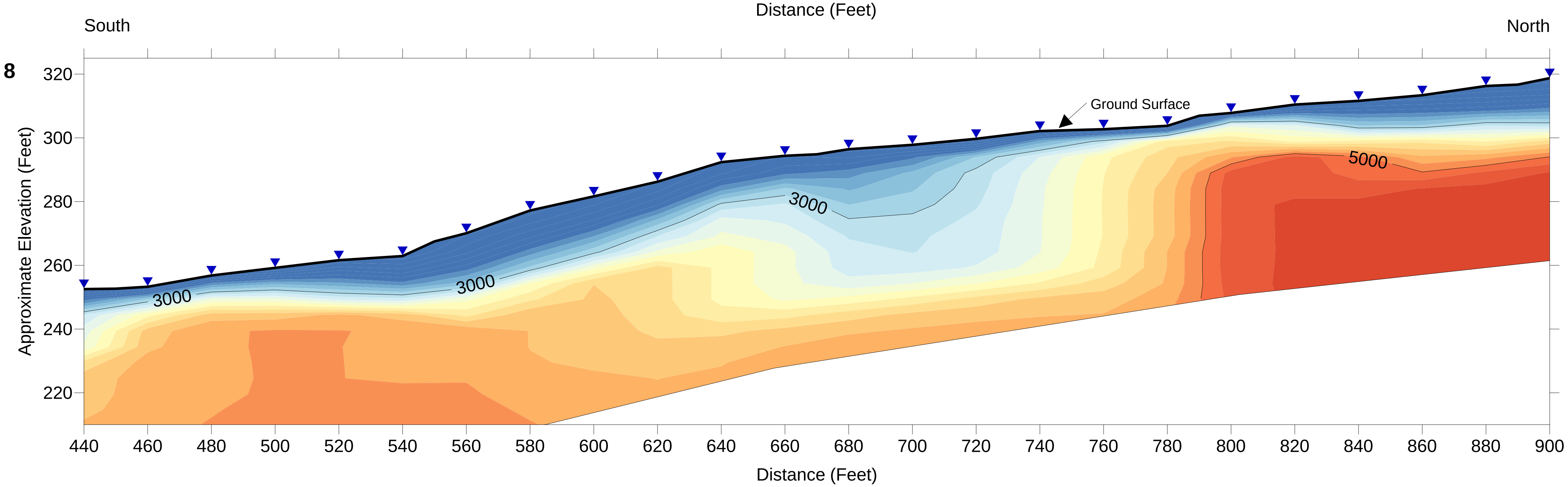
Geotechnical and Environmental Consultants

FIG. C-8

Line 7



Line 8

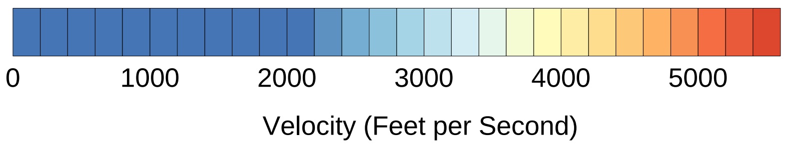


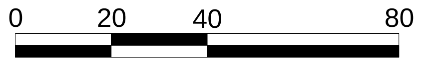
Legend

▼ Geophone

5000 Velocity Contour Interval (Feet per Second)

B-8 Locations of Boring B-8 Along Profile





APPROXIMATE SCALE IN FEET

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

SEISMIC REFRACTION PROFILE
LINE L7 & L8

March 2015
32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. C-9

APPENDIX D

OFFSHORE GEOPHYSICAL SURVEY BY THE WATSON COMPANY

WATSON COMPANY, INC.
ANCHORAGE, ALASKA

Shannon and Wilson, Inc.
5430 Fairbanks Street, Suite 3
Anchorage, AK 99518

Attn: Kyle Brennan, Senior Engineer

RE: St. George Geophysical Survey Isopach Map Submittal

November 30, 2014

Dear Mr. Brennan:

Please find with this transmittal a copy of the isopach map and summary report developed from the geophysical data collected at St. George Island.

Two 11" x 17" figures accompany the summary report, including the isopach of sediments overlying the apparent bedrock. The second figure is a trackline map delineating survey coverage. A shape file of the isopach will be forwarded to you via email.

Thank you and Mr. Heilman for your help and support for this program.

Sincerely,

Will Watson

William Watson
President

Cc: Mr. Daniel Heilman, Senior Engineer, HDR

Watson Company, Inc.•3705 Arctic Blvd., #125 • Anchorage, AK 99503 • Phone (907) 278-5352 • www.watsoncompany.net

Summary Report:
Saint George Harbor Geophysical Survey
Saint George, Alaska

For:

Shannon & Wilson Inc. with HDR
for the State of Alaska

1.0 INTRODUCTION

1.1 General

Watson Company Inc. was contracted by Shannon & Wilson, Inc. in consultation with HDR to collect subbottom data in the vicinity of the harbor on Saint George Island, Alaska, for the Alaska Department of Transportation & Public Facilities (ADOT&PF). St. George is one of the volcanic Pribilof Islands in the Bering Sea, approximately 200 miles north of the Aleutian Islands and 300 miles west of the Alaska mainland. Survey operations were conducted in support of the State of Alaska's St. George harbor expansion planning. Operations were conducted offshore in Zapadni Bay. The site survey included areas both outside and inside the harbor.

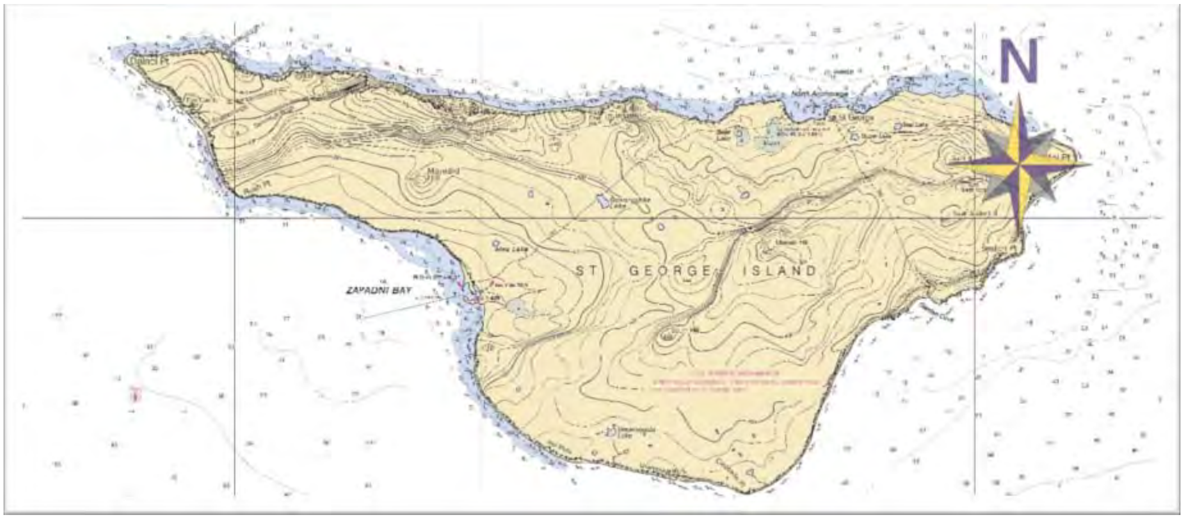


Figure 1. NOAA chart of St. George Island. Operations conducted offshore, southwest of island.

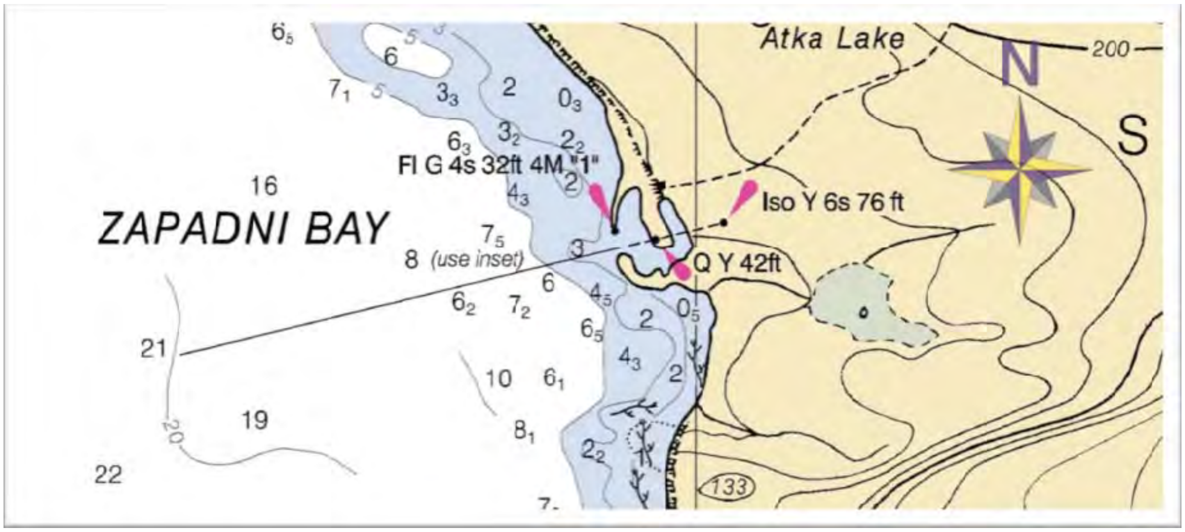


Figure 2. Zapadni Bay, location of 2014 Subottom Survey.

1.2 Purpose

The purpose of the geophysical investigation was to investigate site conditions in the subseafloor, specifically to detect a changes in acoustic impedance that could be indicative of dense materials, including bedrock. It is our understanding that Shannon & Wilson/HDR is in the process of collecting additional geotechnical data to support harbor expansion. The data collected for this survey in concert with geotechnical data will provide key information as to the extent of subsurface horizons and their geologic makeup.

1.3 Scope of Services

The scope of services for completing the seafloor investigation included only the collection of subbottom data. No bathymetric or side scan sonar data was collected. Perpendicular tie lines data were acquired during survey operations. Trackline coverage is illustrated in Figure 3 (11" x 17") accompanying this report.

1.5 Limitations of Services

This report is intended for use only in accordance with the purpose described herein. It should be understood that the geophysical interpretations developed and presented herein are based on the data set collected in the field, and controlled by assumptions such as speed of sound through sea water, sea state, wave conditions, limitations of subbottom source, and accurate navigation coordinates. The information should also be considered representative of conditions at the time of the survey as natural offshore erosion and sediment processes may change the nature of seafloor cover over time. Therefore, our interpretations are limited, as actual site conditions may vary.

Figure 4. Wave condition during St. George subbottom survey.

2.0 SITE ACQUISITION AND DATA PROCESSING

2.1 General

Data acquisition was conducted from a locally chartered 25-foot vessel the "Oceanmists". Deployment of the subbottom equipment was deployed as weather permitted. Operational details are discussed later in this section.

2.2 Navigation Data

Differential Global positioning system (DGPS) navigation data was acquired using a survey grade Trimble DGPS. Differential signals were utilized in navigation for all survey operations.

2.3 High Resolution Geophysical System

A Falmouth Scientific HMS 620 Bubble Pulser seismic reflection system was utilized with the Trimble differential GPS system. The subbottom reflection data were collected on board the vessel using a data acquisition and mapping system. The Bubble Pulser operates in a frequency range of 70 to 700 Hz, with a peak frequency of 100 Hz. The two-part, towed system includes a source and separate multi-element hydrophone array.

Figure 5. Falmouth Scientific Bubble Pulser. Acquisition system consisted of tow vehicle and transceiver.

2.4 Mobilization/Operations

Due to unfavorable weather, equipment was delayed for twelve days in Anchorage. Survey personnel were transported to St. George on May 7th and returned to Anchorage May 12th. Survey operations commenced on the afternoon of May 8 after vessel mobilization was complete. Due to the remote location and weather, the survey equipment was delayed returning to Anchorage and Homer.

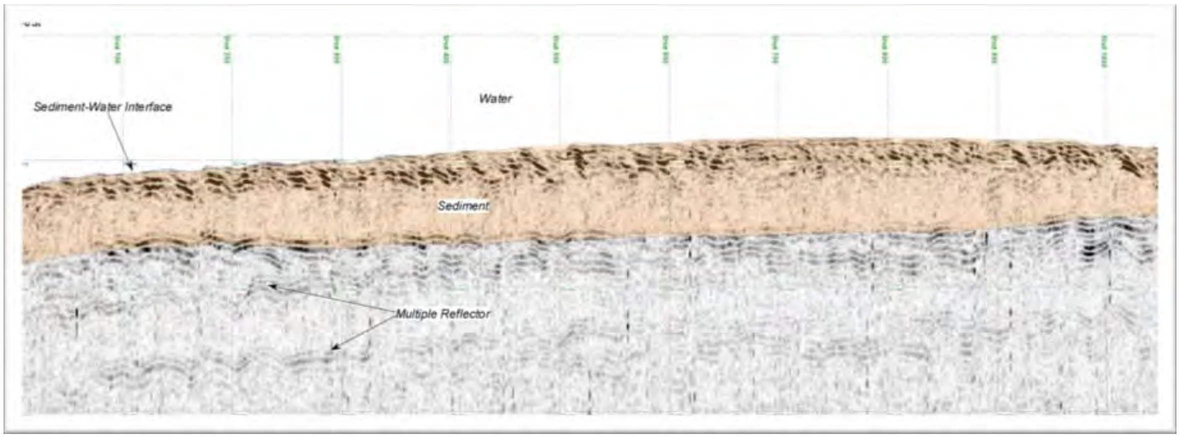


Figure 5. Sample record demonstrating apparent unconsolidated sediments over bedrock

2.5 Data Processing

The subbottom data was interpreted to map the sediments over the underlying bedrock. The data were processed to provide the best indication of the acoustic interface between the underlying geologic materials. A time-to-distance conversion correction was applied using the speed of sound in water (4920 feet/second). During processing vessel offsets, bottom tracking, filters and gain adjustments were applied to the data.

As is typical in sea conditions above 3-feet (approximate average wave height) there are effects on the streamer sensors making it difficult to tie the data vertically. The sea state during the survey was generally above 3-feet. To offset the effects of wave action, historical jet probe data provided ground truth of the subbottom data during processing. The jet probe data that was utilized in data analysis was acquired in 1982, 1985 and 1987 and provided by Shannon & Wilson.

3.0 SITE CONDITIONS

The usable data collected in the field consisted of 50 lines. Line spacing varied from approximately 50 feet to 500 feet (see Figure 3). Survey line alignment was oriented both parallel and perpendicular to the breakwater. Survey line length ranged from 400-feet to 4750-feet. Tie lines were run to check the navigation and accuracy of vertical offsets in data processing.

After reflectors were interpreted, overlying unconsolidated sediment thicknesses were determined and a isopach contour map was produced. Contour intervals were generated from 6 to 44-feet.

Sediments of less than 10-feet were difficult to map due to sea state and other limitations. Wave action can cause the streamer to porpoise whereby discrete transducers within the streamer are not in a line. This condition can make the subbottom signal challenging to differentiate. Another limitation is the low frequency of the Bubble Pulser sound source. Due to the use of a small vessel no crane was available therefore a higher frequency source (heavier) such as a tuned transducer could not be utilized. Further, a common issue with higher frequency sources is limitation of penetration. In coarse grained sand penetration can be limited to 3 to 10-feet. For this project a tuned transducer would not have suitable based on the coarse grained sediments recovered in the jet probes. The detectable limit of the geophysical system utilized on this project was 6-feet.

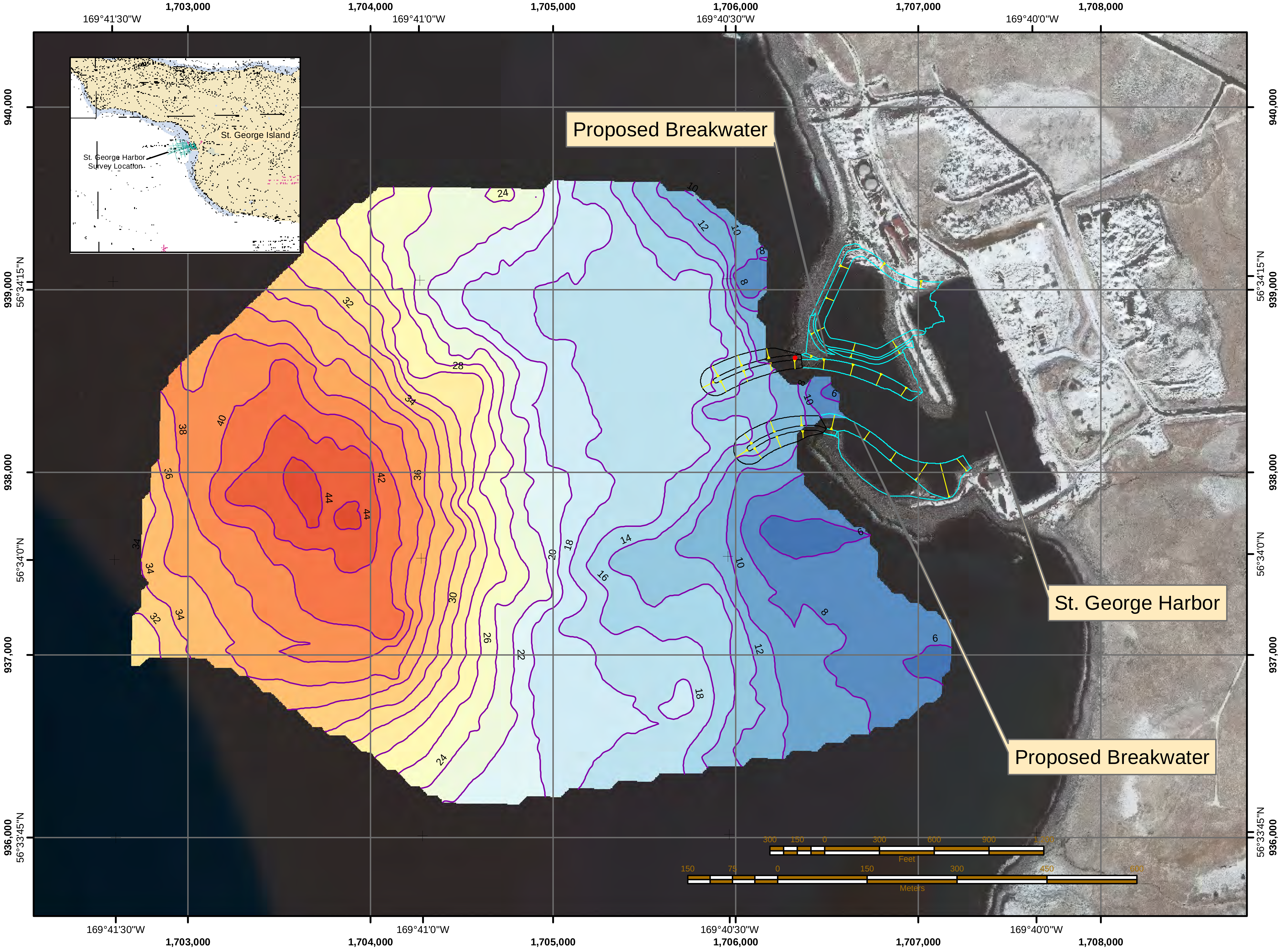
Within the harbor unconsolidated sediments were not detected within the subbottom data. This condition was also present in the historic jet probe data. The thickness in the vicinity of the planned breakwater expansion ranges from 6 to 16-feet. Approximately 2,800-feet offshore (west) of the existing breakwater the thickness of overlying sediments increased to a maximum of 45-feet.

An isopach of the sediments interpreted to overly bedrock are shown in Figure 6 (11” x 17”) accompanying this report. Figure 6 incorporates the drawing of the planned expansion of the harbor as provided by Shannon & Wilson, Inc. and HDR.

The historical jet probe data indicate the materials overlying bedrock consist of fine to coarse sand with limited gravels.

4.0 CLOSURE

We appreciated this opportunity to conduct the St. George subbottom survey. Should Shannon & Wilson or HDR require additional information please contact us.



2014
Shannon & Wilson Inc.
with HDR

St. George Harbor
Geophysical Survey

Isopach Map

N

Legend

Isopach Contours

— Contour Interval - 2 Feet

Shaded Scale
Sediment
Thickness

46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4

Watson Company, Inc.
3705 Arctic Blvd. #125
Anchorage, Alaska 99503
Tel: (907) 278-5352
Fax: (907) 278-5353
watson@alaska.net
www.watsoncompany.net

PREPARED BY: G. Aronwits	CHECKED BY: W. Watson		GEOPHYSICIST: W. Watson
PROJECTION: AK State Plane	DATUM: NAD 83	GRID ZONE: 9 (Feet)	ELLIPSOID: GRS 80
SURVEY DATE: May 2014	DATE PREPARED: November 2014		FIGURE: 6

2014
Shannon & Wilson Inc.
with HDR

St. George Harbor
Geophysical Survey

Post Plot Map

N

Legend

🟩 Postplot Survey Lines

Watson Company, Inc.
3705 Arctic Blvd. #125
Anchorage, Alaska 99503
Tel: (907) 278-5352
Fax: (907) 278-5353
watson@alaska.net
www.watsoncompany.net

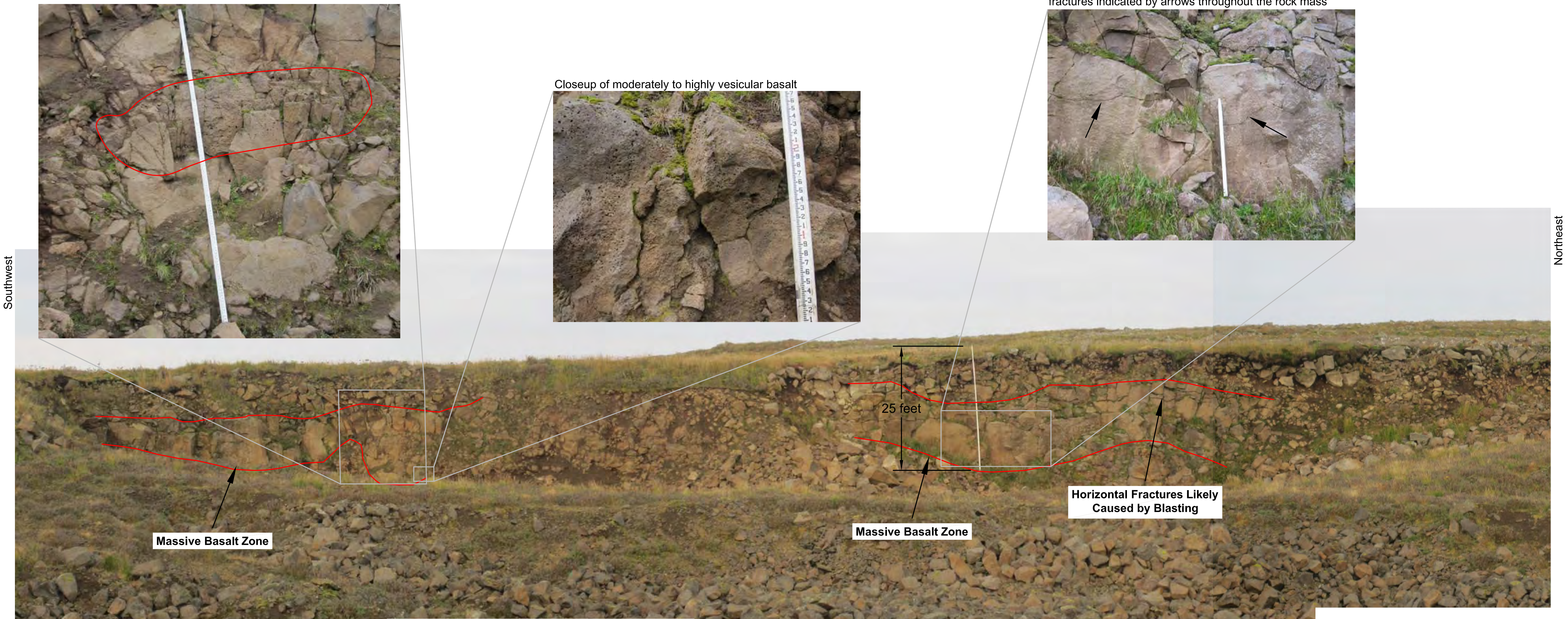
PREPARED BY: G. Aronwits	CHECKED BY: W. Watson	GEOPHYSICIST: W. Watson

PROJECTION: AK State Plane	DATUM: NAD 83	GRID ZONE: 9 (Feet)	ELLIPSOID: GRS 80

SURVEY DATE: May 2014	DATE PREPARED: November 2014	FIGURE: 3

APPENDIX E

SITE AND OUTCROP PHOTO PAGES



Typical section showing zone of highly vesicular basalt within an otherwise massive rock mass

Closeup of moderately to highly vesicular basalt

Typical massive basalt observed on quarry face. Note random fractures indicated by arrows throughout the rock mass


4 to 5-foot diameter boulders observed on quarry floor


1 to 2.5-foot diameter boulders observed on quarry floor

St. George Harbor and Breakwater
Improvements Project
St. George, Alaska

AIRPORT QUARRY PHOTOGRAPHS

March 2015
32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. E-1

Seismic Refraction Line L6, Airport Rock Quarry

Rod and Level Survey Seismic Refraction Line L5, Aiport Rock Quarry

Drilling Boring B-8 Near Maynard Hill, Airport Rock Quarry

View of Airport Runway and St. George Harbor, Airport Rock Quarry

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

AIRPORT QUARRY & MAYNARD HILL PHOTOPAGES

March 2015

32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. E-2


Drilling Boring B-3 on Inner Breakwater, St. George Harbor


Seismic Refraction Line L2 South Breakwater, St. George Harbor


View of Inner Breawater from South Breakwater, St. George Harbor


View of North Breawater from Inner Breakwater, St. George Harbor

St. George Harbor & Breakwater
Improvements Project
St. George, Alaska

**ST. GEORGE HARBOR
PHOTO PAGES**

March 2015 32-1-02388

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. E-3

APPENDIX F

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Attachment to 32-1-02388

Date: February 2015
To: HDR Engineering, Inc.
Re: St. George Harbor and Breakwater Improvements Project, St. George, Alaska

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland

ST. GEORGE HARBOR IMPROVEMENT FEASIBILITY STUDY

APPENDIX C: ECONOMICS

ST. GEORGE, ALASKA

U.S. Army Corps
of Engineers
Alaska District

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. OVERVIEW

1.1 Bottom Line Up Front

This appendix presents the evaluation of four alternatives to provide navigation improvements at St. George, Alaska. These alternatives were carried forward from an initial array of ten alternatives.

The initial analysis included multiple alternatives at the Zapadni Bay site (the location of the existing harbor). Initial analysis revealed Zapadni Bay alternatives did not meet the project goals and objectives and would have higher costs. Therefore, these alternatives were not carried forward for further analysis.

Table C-1. Alternatives Carried Forward

Alt. No	Description
N-1	Local Subsistence Fleet
N-2	Fuel Barge, Freight, Subsistence, 25% Crabber Fleet
N-3	Fuel Barge, Freight, Subsistence, 85% Crabber Fleet
N-4	Local Subsistence Fleet, Fuel Barge

The National Economic Development (NED) analysis did not yield any plans with a benefit-cost ratio greater than one, so Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was utilized to support plan selection in accordance with the Remote and Subsistence Harbors authority.[1] The Recommended Plan is Alternative N-3, a 450-foot wide by 550-foot-long mooring basin dredged to -20 feet MLLW protected by a 1,731 foot long north breakwater and a 250-foot-long navigation channel dredged to -25 feet MLLW. A summary of the NED and CE/ICA analyses can be found in Table C-2 and Table C-3 below.[2]

Table C-2. Summary of Costs and Benefits by Alternative

Alternative	Present Value Benefits	Average Annual Benefits	Present Value Costs	Average Annual Costs	Net Annual Benefits	Benefit-Cost Ratio
No Action	N/A	N/A	N/A	N/A	N/A	N/A
N-1	$3,138,000	$116,000	$52,856,000	$1,958,000	($1,842,000)	0.06
N-2	$29,344,000	$1,087,000	$178,148,000	$6,599,000	($5,512,000)	0.16
N-3	$29,560,000	$1,095,000	$187,639,000	$6,950,000	($5,855,000)	0.16
N-4	$29,266,000	$1,084,000	$107,070,000	$3,966,000	($2,882,000)	0.27

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[1] Section 2006 of WRDA 2007 – Remote and Subsistence Harbors, as modified by Section 2104 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) and further modified by Section 1105 of WRDA 2016

[2] These tables show comparable costs, which were Class 4 and differ slightly from certified costs for the Recommended Plan.

The CE/ICA metric utilized in this analysis is “increased vessel opportunity days for safe access and moorage.” This metric directly addresses the project’s overall objective to increase safe accessibility of marine navigation to the community of St. George. The CE/ICA identified N-3 and N-4 as the best buy plans.

The selection of a recommended alternative was further refined through analysis of the type of access and moorage provided by the two Best Buy plans. Alternative N-3 provides a total of 34.4 days of access/moorage for the crabbing fleet, while Alternative N-4 provides none. Based on the CE/ICA and given that the CDQ/IFQ crabbing fleet is a driver of community viability, Alternative N-3 is identified as the Recommended Plan.

Table C-3. Cost Effectiveness/Incremental Cost Analysis Summary

Alternative	Average Annual Cost	Days Gained	Annual Cost of Day Gained	Cost Effective	Best Buy	Incremental Cost of Day Gained (Annualized)
N-1	$1,958,000	38	$51,900	Yes	No	$51,900
N-4	$3,966,000	127	$31,200	Yes	Yes	$22,500
N-2	$6,599,000	149	$44,400	Yes	No	$121,900
N-3	$6,950,000	179	$38,800	Yes	Yes	$11,500

1.2 Introduction

The overall objective of the study is to increase the safe accessibility of marine navigation to the community of St. George by meeting the following:

- Provide for the safe maneuverability and protected mooring of the existing and anticipated fleet
- Increase the percentage of time that harbor facilities can be safely accessed

The economic analysis evaluates the proposed navigational improvements from both the NED and CE/ICA perspectives, as allowed by the study authority. NED benefits are defined as the change in value of goods and services that accrue to the nation as a whole as a result of constructing the project. For St. George, these benefit categories include avoided damages to infrastructure and vessels, reduced delays, transportation cost savings, and the increase of subsistence foods harvested. The CE/ICA includes two distinct analyses that are conducted to evaluate the effects of alternative plans when selection of a plan is based in part or whole on non-monetary units such as through the Environment Quality (EQ) and Other Social Effects (OSE) accounts.

1.3 Study Authority

This study utilizes the project justification allowed under Section 2006 of WRDA 2007 – Remote and Subsistence Harbors, as modified by Section 2104 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) and further modified by Section

1105 of WRDA 2016. The authority states that in conducting a study of harbor and navigation improvements the Secretary may recommend a project without demonstrating that the improvements are justified solely by NED benefits if the Secretary determines that the improvements meet the following criteria:

1. The community to be served by the improvements is at least 70 miles from the nearest surface accessible commercial port and has no direct rail or highway link to another community served by a surface accessible port or harbor; or the improvements would be located in the State of Hawaii or Alaska, the Commonwealth of Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, the United States Virgin Islands; or American Samoa:

2. The harbor is economically critical such that over 80 percent of the goods transported through the harbor would be consumed within the region served by the harbor and navigation improvement as determined by the Secretary, including consideration of information provided by non-Federal interest; and

3. The long-term viability of the community in which the project is located, or the long-term viability of a community that is located in the region that is served by the project and that will rely on the project, would be threatened without the harbor and navigation improvement.

While determining whether to recommend a project under the criteria above, the Secretary will consider the benefits of the project to the following:

- Public health and safety of the local community and communities that are located in the region to be served by the project and that will rely on the project, including access to facilities designed to protect public health and safety;

- Access to natural resources for subsistence purposes;

- Local and regional economic opportunities;

- Welfare of the local population; and

- Social and cultural value to the local community and communities located in the region to be served by the project and will rely on the project.

According to the United States Army Corps of Engineers' (USACE) Implementation Guidance for Section 1105 of WRDA 2016, an NED analysis and identification of the NED Plan, if any, is required in conjunction with analyzing the benefits described above. If there is no NED Plan and/or selection of a plan other than the NED Plan is based in part or whole on non-monetary units. The selection will be supported by a CE/ICA consistent with USACE ecosystem restoration evaluation procedures.

1.4 Meeting the Study Authority

Navigation improvements at St. George meet the criteria of the Remote and Subsistence Harbors authority to recommend a project. Compliance with the previously described criteria of the authority are as follows and were confirmed by the Vertical Team during an In-Progress Review conducted on January 23, 2018:

1. The project is in Alaska.

2. Based upon weight, commodities transported in the future with-project condition were analyzed to determine that over 80 percent of the goods transported through the harbor (after construction) would be consumed within the region. Using metric tons as the basis of consumption is consistent with the Planning Guidance Notebook (PGN), the Waterborne Commerce Statistics Center (WCSC), and the Deep Draft Navigation Planning Center of Expertise (DDN-PCX). The region served by the navigation improvements was determined to be the island of St. George and the immediately surrounding marine area (about a 25-mile radius).

   To provide economic opportunities for the community, consistent with the authority, alternatives supporting fish and crab product exports from the island are considered. However, these exports were projected to weigh less than 20 percent of the total weight going through the harbor when considering market and institutional factors such as Community Development Quotas and prices. Total imports minus total exports was used in the projection. Imports included the weight of fuel, the weight of freight and construction materials, and the weight of raw fish. Exports included the weight of processed fish products leaving the island. Exports are estimated to range between 11 and 19 percent of harbor throughput, with an average of about 14 percent.

3. The cultural identity of Alaska Native Tribes is highly dependent upon subsistence activities tied to specific locations and deep historical knowledge of land and subsistence resources. Rural economies in Alaska, including that which exists on St. George, can be characterized as a mixed, subsistence-cash economy in which the subsistence and cash sectors are interdependent and mutually supportive. The ability to successfully participate in subsistence activities is highly dependent on the opportunity to earn some form of monetary income and access the resources needed to engage in subsistence activities. Without a safe and functioning harbor, economic opportunities in the community would continue to be hindered and the costs of basic essential goods required to support a subsistence lifestyle would remain prohibitively high, contributing to continued out-migration from St. George. When subsistence communities are forced to disband due to high costs of essential goods, including fuel, tribal identities and cultural communities are endangered. Reductions in costs of such basic essential goods are essential to community viability. In addition, a safe and functioning harbor would provide opportunities for development of a local economy based upon the marine resources of the region. Such economic opportunities are essential for supporting the mixed, cash-

subsistence economies common throughout rural Alaska, combating out-migration, and helping to support the viability of the community on St. George.

1.5 Project Description

The City of St. George is located on the northeast shore of St. George Island, the southernmost of five islands in the Pribilof Islands, in the middle of the Bering Sea (Figure C-1). It lies 49.4 miles south of St. Paul Island, 750 air miles southwest of Anchorage, and 250 miles northwest of Unalaska. St. George is accessible only by water and air. The Island is 34.8 square miles, approximately 12 miles across at its widest point from Dalnoi Point to Tolstoi Point, and 5.33 miles across in the perpendicular direction from Cascade Point to Bear Point. The Island rises to a maximum elevation of 1012 feet in the High Bluffs. The sea meets the island at large cliff faces along many sides, posing challenges to navigating to shore in these areas. Dangerous wave and seiche conditions at the existing harbor at Zapadni Bay prevent safe access and moorage to the current fleet. This limits subsistence opportunities, impacts delivery of goods to the community, and threatens the long-term viability of the community.

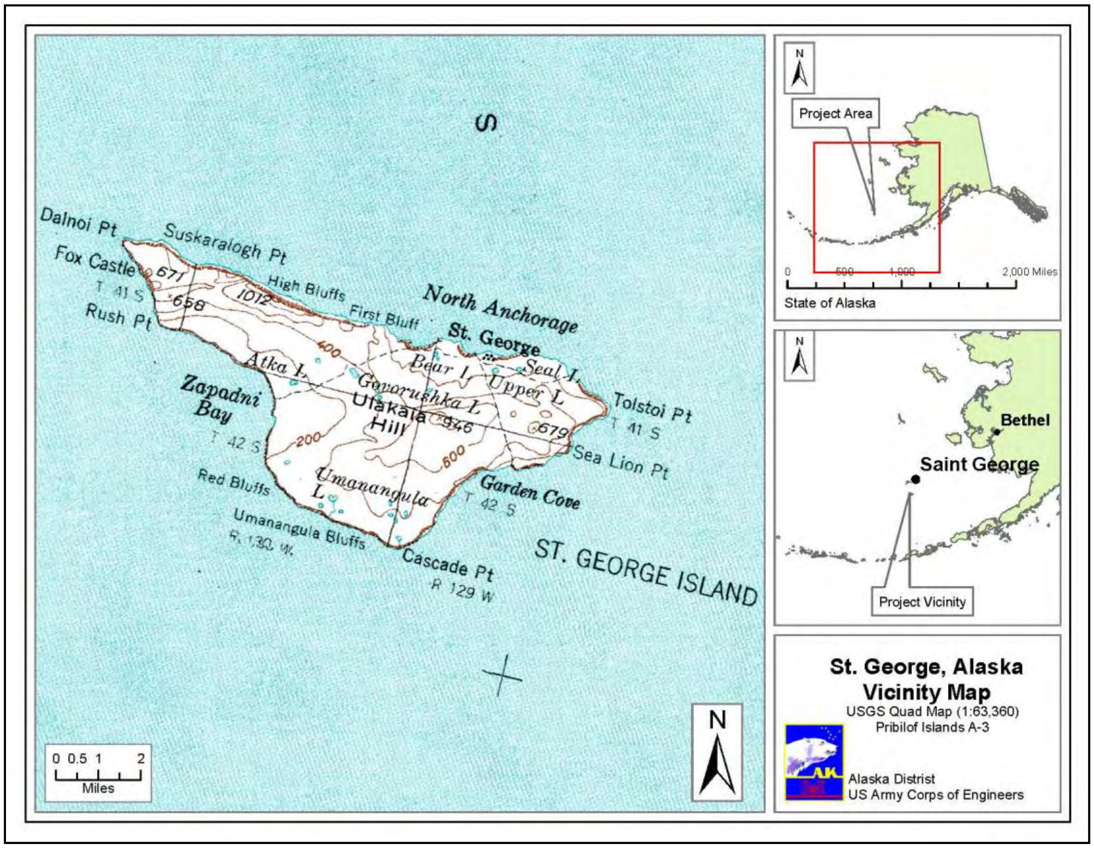

Figure C-1. St. George Island

1.6 Problems and Opportunities

Conducting navigation improvements at St. George would reduce risk and better provide safe navigation of subsistence vessels, fuel barges, cargo vessels, and a limited commercial fleet.

- **High costs of essential goods.** Barge operators have difficulty delivering fuel and supplies to the community utilizing the existing harbor at Zapadni Bay. As such costs of goods remain prohibitively high.
- **Unrealized Revenues.** The community is legally entitled to percentage of the Community Development Quota (CDQ) from the Aleutian Pribilof Island Community Development Association (APICDA) for crab. However without a safe harbor, commercial fishing fleet is unable to effectively utilize and access the harbor and St George is unable to realize that revenue benefit and the crab is delivered to neighboring St. Paul.
- **Reduced subsistence and activities and access to resources.** Residents at St. George have not attained a stable and sustainable marine resource economy sufficient to support their mixed, subsistence-cash economy.
- **Continued out-migration.** Lack of economic opportunities in the community without a safe functioning harbor continues to result in out-migration from St. George.

The above problems threaten the long term viability of St. George. However, the following are potential opportunities to be realized by improving navigation to/from St. George:

- Promote community viability and survival
- Expand economic opportunities:
- Establish a self-sustaining, marine-resource-based economy
- Realize allocated Community Development Quota for crab
- Provide more affordable access to goods, services, and marine resources
- Improve access to subsistence resources resulting in improved food security
- Increase response capacity to environmental hazards (eg.oil spills)
- Provide functional Harbor of Refuge during storms in the central Bering Sea

2.0 GENERAL METHODOLOGY

This section describes the methods used to conduct the economic analysis of the proposed navigation improvements at St. George. The study was conducted, and the report prepared in accordance with goals and procedures for water resources planning as contained in Engineer Regulation 1105-2-100, Planning Guidance Notebook, and the project authorization. Alternatives were examined for their feasibility, considering engineering, economic, environmental, and other criteria. The analysis follows implementation guidance for Section 2006 authorized projects, as referenced in the Study Authority section.

Compilation of this report included a literature review of published information on the history, present status, and future prospects for harbor operations at St. George. Primary data collection was conducted through personal interviews with local officials, harbor users, and maritime specialists operating at St. George. Additionally, an Office of Management and Budget (OMB)-approved survey was distributed and completed by mail as well as in-person at the community with the Economics Team. Survey efforts encountered challenges to response rate and current arrangement of quota transfers at St. George. Data collection was strengthened through focus groups, personal interviews, and other follow-up research and data gathering.

Next, a selection and description of NED benefits and related construction and life cycles were made for the proposed alternatives that appear cost effective and achievable. For the NED analysis, average annual benefits are compared to average annual costs expected to be derived from each alternative evaluated. All costs were calculated using Fiscal Year (FY) 2020 (October 2019) price levels and then converted to Average Annual Equivalent values using the FY 2020 Federal discount rate of 2.750 percent, assuming a 50-year period of analysis.

NED benefits are assessed for the alternatives identified in the Project Alternatives section and follow the methodology for small boat harbor navigation analysis described in the Planning Guidance Notebook and other relevant USACE regulations and policy guidance. Benefits equal the difference between without- and with-project costs associated with transportation delays, damages to vessels and harbor infrastructure, and enhanced access for commercial fishing and subsistence activities.

As previously noted, this study utilizes the authority of Section 2006 of WRDA, Remote and Subsistence Harbors, as modified by Section 2104 of the WRRDA of 2014 and further modified by Section 1105 of WRDA 2016. The authority specifies that in the absence of a NED Plan and/or the selection of a plan other than the NED Plan is based in part or whole on non-monetary units (Environmental Quality (EQ) and Other Social Effects (OSE) accounts, then the selection will be supported by a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) consistent with ecosystem restoration evaluation procedures. The with- and without-project evaluation framework is similar for both the NED analysis and CE/ICA and is described in subsequent sections as appropriate.

3.0 OVERVIEW OF REGION AND SOCIOECONOMICS

This section provides an overview of the region and the socioeconomic composition of the study area. It aims to support planners and report reviewers' understanding of the community and region, infrastructure, local and state government organizations, and the level of economic activity where data allows.

3.1 Climate

Please see Appendix A, Hydraulic Design, for a detailed description of St. George's climate. Of special note, St. George is the northernmost ice-free port in the United States; St. George's harbor can be open when St. Paul's harbor is closed due to ice. However, rare freezing conditions that would limit safe access and moorage are still considered as part of the analysis.

St. George gets 49 inches of snow and 23 inches of total precipitation yearly; mean temperatures vary from 24 to 52 degrees Fahrenheit. Cloudy, foggy weather is common during summer months. The maritime climate zone is characterized by persistent overcast skies, high winds, and frequent cyclonic storms. During storms, the sea presses into the island on all sides. High wave height and long-period waves cause difficulty in creating harbor designs that increase safe access and moorage.

3.2 Population

Census data shows a varying population over time, with a population of 92 in 1880 and 264 in 1960. Since then, decadal assessments illustrate a decline in population with the only exception being an isolated instance of population increase between 1990 and 2000, which corresponds with when SnoPac Seafoods had a floating crab processor moored inside St. George Harbor. St. George population estimates over time are shown in Table C-4.

Table C-4. St. George Population[3]

Year	Population
1880	92
1890	93
1900	92
1910	90
1920	138
1930	153
1940	183
1950	No Data
1960	264
1970	163
1980	158
1990	138
2000	152
2010	102
2013	97
2017	72
2018	70

The DCCED commissioner certified the 2018 population as 70, which is historically low. The population decline also appears to be more rapid than the predicted trend for the Aleutians West Census Area, in which St. George lies. The Alaska Department of Labor and Workforce Development's trend for the borough predicts an increasing decline, from 0.16 to 0.33 percent annually in 2045, before the decline eases back towards 0.16 percent annually.

Without a safe harbor to support a viable marine resource economy to support the local mixed, subsistence-cash economy, St. George residents will increasingly choose to relocate to other communities, threatening the very existence of the community. Improved harbor conditions are essential to ensure the economic and cultural survival of the community of St. George.

According to the 2010 census, there were 102 residents on St. George. Native Alaskans make up 89 percent of the population. The gender breakdown is approximately 58 percent male and 42 percent female compared to 52 percent male and 48 percent female for the State of Alaska. The median age of St. George residents is 39 years,

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[3] Population data for 1880 through 2010 are from the US Census and the Alaska Department of Commerce, Community, and Economic Development department (DCCED). Population estimates after 2010 are from the State of Alaska and the Aleutian Pribilof Island Community Development Association (APICDA).

slightly above the median age of 34 years for the state. The 2010 census shows the community's age and sex profile as follows:

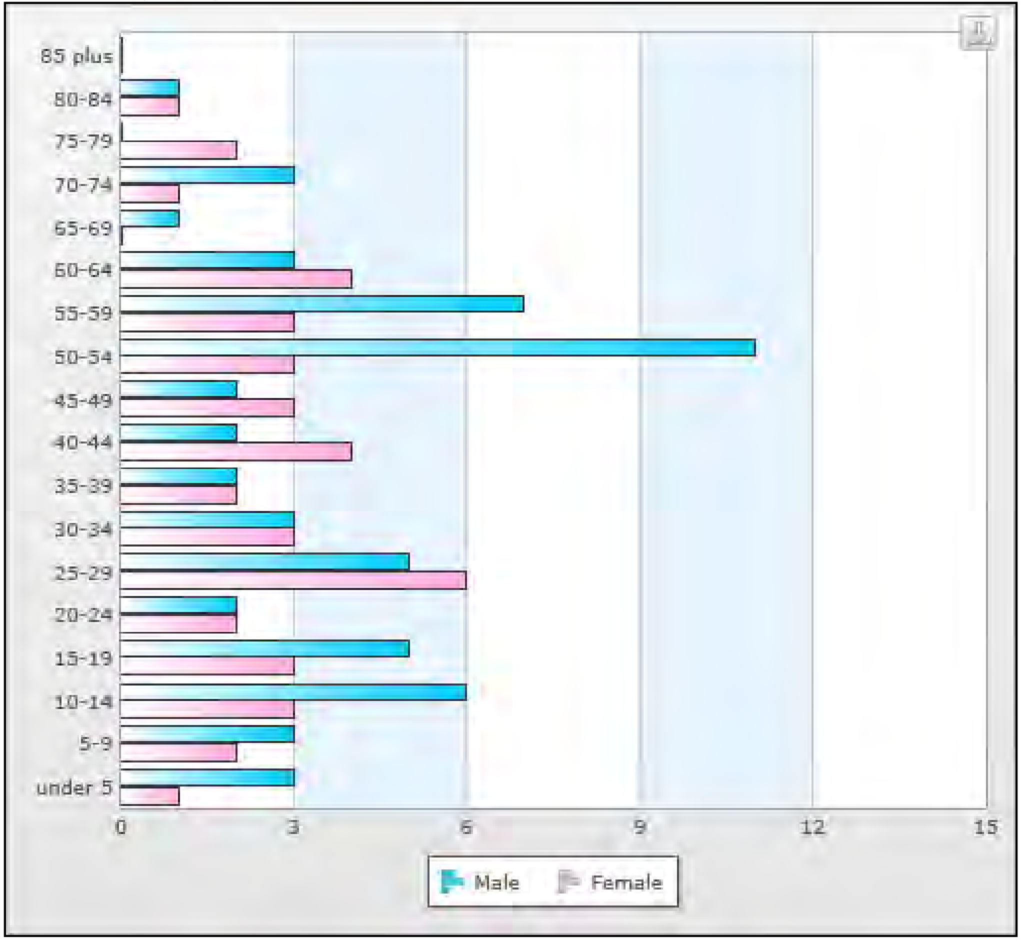

Figure C-2. St. George Demographics (Age vs. Number of Residents)

3.3 Employment and Income

The City of St. George serves as a major employer for residents; however, the tax base is not sufficient to sustain employee pay or the City's expenses (Colt, 2018). The St. George Tanaq Corporation, an Alaska Native Claims Settlement Act (ANCSA) village corporation, and St. George Tribe are other major employers.

The Aleutian Pribilof Island Community Development Association (APICDA), a 501(c)(3) non-profit, and APICDA joint ventures (AJV) employed 92 residents across its six communities with a payroll of approximately \$2.4 million in 2016.[4] APICDA participates with the State of Alaska in the Community Development Quota (CDQ) program set out in the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA, or Magnuson-Stevens Act). The CDQ program, including how revenues are distributed to participating communities, is described in section 4.4 of this appendix. APICDA may also receive money from various grants for community development projects. For

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[4] Akutan, Atka, False Pass, Nelson Lagoon, Nikolski, and St. George.

example, a grant from the U.S. Department of Commerce's Economic Development Administration helped fund the seafood handling facility, which is currently dormant at the existing harbor at Zapadni Bay (APICDA, 2014).

AJV also works with the St. George Fishermen's Association to harvest halibut in the region. AJV owns (or has partial interest in) a portion of the halibut fleet operating out of St. George. The joint venture is also referred to as Puffin Seafoods LLC. Puffin Seafoods would likely operate a seafood handling facility, owned by Kayuk Development if it was functional. The existing facility was worth approximately $3.5 million at the time it was constructed. AJV also purchases crab, such as through Ocean Prowler LLC. AJV purchases both individual fishing quota (IFQ) as well as CDQ crab share.

The DCCED reported that while there were 14 halibut permit holders in St. George in 2016, only six permit holders fished. That accounted for a little more than 50,000 pounds of halibut caught. One local resident described in June 2017, that if he caught enough halibut, it would likely be the only source of income for his family that year. An estimated eleven residents live below the poverty line. This number has held steady while the overall population has declined; therefore, the percentage of residents below the poverty line has increased (from 7.9 percent in 2000 to 17.2 percent in 2010; DCCED estimated 24.2 percent in 2014). Income from the Alaska Department of Labor and Workforce Development is shown in Table C-5.

Table C-5. St. George Income Levels

Year	Employed	Total Wages	Average Wages
2001	72	$1,528,803	$21,233
2002	73	$1,453,976	$19,917
2003	79	$1,787,105	$22,622
2004	70	$1,367,195	$19,531
2005	65	$1,321,065	$20,324
2006	62	$1,401,945	$22,612
2007	59	$1,310,116	$22,205
2008	58	$1,160,552	$20,010
2009	59	$1,139,455	$19,313
2010	62	$1,453,575	$23,445
2011	52	$1,369,758	$26,342
2012	49	$1,199,667	$24,483
2013	53	$1,414,019	$26,680
2014	54	$1,417,153	$26,244
2015	47	$1,198,904	$25,509
2016	39	$1,096,585	$28,118
Average	**60**	**$1,351,242**	**$23,037**

3.4 Government

3.4.1 City of St. George

The City of St. George was incorporated in 1983 as a second class city in the Aleutians West Census Area. The City's incorporation was in coordination with the Fur Seal Act Amendments of that year. The City operates under a Mayor elected to one-year terms and seven council members, all of whom are elected at-large. Currently, the City levies a 0.00 mill property tax, 3 percent sales tax, and 6 percent raw fish tax.

3.4.2 Saint George Island/St. George Traditional Council

The federally recognized tribe is Saint George Island, which is also referred to as the St. George Traditional Council.

3.4.3 St. George Tanaq Village Corporation

The St. George Tanaq Corporation is the ANCSA village corporation. Tanaq has many business interests, including joint ventures with APICDA, land ownership, and rent generating projects.

3.4.4 Aleut Corporation

The Aleut Corporation is one of the 13 regional Native corporations that was established in 1972 under the terms of the Alaska Native Claims Settlement Act (ANCSA). The Aleut Corporation received a settlement of $19.5 million, 66,000 acres of surface lands, and 1.572 million acres of subsurface estate. The corporation has economic, social, and cultural responsibilities to its approximately 3,250 shareholders. Operations of the Aleut Corporation and subsidiaries include Government Contracting, Telecommunications, Environmental Remediation, Fuel Sales, and Real Estate Management. The Company also participates in various partnerships, joint ventures, and other business activities.

3.4.5 Other Entities

3.4.5.1 Aleutian Pribilof Island Community Development Association

The Aleutian Pribilof Island Community Development Association (APICDA) was initially established in 1992 as an Alaska Seafood company dedicated to sustaining six rural villages in the Aleutian-Pribilof region. These six village communities are Akutan, Atka, False Pass, Nelson Lagoon, and St. George. APICDA has evolved over the years to become one of the Western Alaska Community Development Quota (CDQ) corporations. The CDQ program allocates a percentage of all Bering Sea and Aleutian Islands quotas for groundfish, halibut, and crab to eligible CDQ groups that represent 65 villages. APICDA and its subsidiary companies generate proceeds through the management of the quotas and uses proceeds to sustaining the communities of which St. George is included. APICDA projects on St. George include harbor improvements at Zapadni Bay and building a fish handling facility.

3.4.5.2 Aleutian Pribilof Islands Association Inc

The Aleutian Pribilof Islands Association Inc. (APIA) provides an array of services under health care, education, employment, and family services to its member communities. On St. George Island, APIA operates the health clinic. APIA represents the following 13 communities: Akutan, Atka, Belkofski, False Pass, King Cove, Nelson Lagoon, Nikolski, Pauloff Harbor, Sand Point, St. George, St. Paul, Unalaska, and Unga. It also partners with APICDA, the Aleut Corporation, and others on renewable energy initiatives.

3.5 Public Social Services

3.5.1 Health Clinic

The St. George Health Center is a community health center managed by APIA. The health center offers emergency, primary, and behavioral healthcare as well as community wellness activities with a focus on elders. It is equipped with a telepharmacy, x-ray, small lab, and treatment room. The health clinic lacks beds, but there is a holding area since the health center serves as an emergency stabilization site for medical evacuations to Anchorage.

3.5.2 Schools

The closure of the public school in 2017 further indicates the continued out-migration from St. George. St. George School held classes from pre-kindergarten to 12th grade on St. George. Only six students were enrolled in 2016/2017, declining from 10 students in the previous school year. The students were taught by one teacher. As a result of the school closure, students must attend school on neighboring St. Paul or attend Mt. Edgecumbe High School, a boarding school in Sitka, AK. Other options include the Pribilof School District Correspondence Program, which teaches grade levels from kindergarten to 10th grade. Eight students were enrolled in this program for the 2017/2018 school year.

St. George has taken steps to ensure that the school is in a position to reopen if enrollment surpasses the minimum threshold of 10 students, such as happened formerly in the remote Alaskan communities of Adak, Rampart, and Clarks Point. Steps the community has taken to do so include implementing a distance learning program for children remaining on the island, assuming upkeep and maintenance of the school, and recruitment of families to the island. The one major component lacking, however, are the economic opportunities that a safe and functioning harbor could provide.

3.6 Retail Services and Lodging

St. George's remoteness and inaccessibility are reaffirmed by the limited services available on the island. The community is serviced by two small stores that sell frozen and canned foods as well as subsistence products such as locally produced caribou sausage, halibut cheeks, and other items. Basic sundries can also be found. For visitors, there is the Aikow Inn, also known as the St. George Hotel, which was built in the 1930s. It has ten rooms and a community kitchen. The hotel is closed when there are too few guest bookings, in which case visitors find accommodation at the school or other establishments.

3.7 Infrastructure

3.7.1 Utilities

The City of St. George operates the public water systems, including distribution, wastewater collection, and wastewater treatment. The city also operates a landfill. Fire and emergency medical services (EMS) is a volunteer service. In addition to municipal facilities, state, tribal, educational, and health service organizations may assist with providing utility and community services.

Electricity is a City diesel and wind project; however, the wind turbine caught fire and is in disrepair at this time. Fuel is delivered several times per year. Fuel costs for electricity are subsidized by the State of Alaska's power cost equalization (PCE) program.[5] Approximately 73 percent of fuels used in St. George is used for electricity generation (AEA, 2017). The 27 percent of remaining fuel use largely goes towards heating needs, but a portion also goes to powering vehicles and generators, construction projects, and halibut fishing vessels.

3.7.2 Road System

St. George has a road system including a 6-mile long road out to Zapadni Bay and the airport, with turnoffs to the landfill and two rock quarries. Roads are unpaved, and 4-wheelers are used more prevalently than trucks for short trips between residences, workplaces, and locations of interest.

3.7.3 Airport

The St. George Airport is normally serviced by Grant Aviation. The airport has a 4,980 foot long paved runway. Flights go Dutch Harbor/Unalaska to St. Paul and St. George, then back. One way from Dutch Harbor to St. George takes about 1.5 hours. The airport has fuel storage for Jet-A, brought in by barge; however, if refueling is done in the Pribilofs, it's usually done in St. Paul. Perishable and ordered goods arrive by jet. Tourists, construction, and government workers, as well as St. George residents typically use Grant Aviation flights to get on and off the island. (According to an interview with a Grant Aviation employee, 02Jan2020)

3.7.4 Marine Facilities

3.7.4.1 Village Boat Launch

The village boat launch, on the north side of the island, near the village site, is a rough graded drive down type launch. The rutted dirt connects to a broken concrete slab that is mostly covered with beach rock. This boat launch was formerly used to launch small skiff but no longer functions as intended.

3.7.4.2 St. George Harbor at Zapadni Bay

The city-constructed St. George Harbor (Figure C-3) in St. George's current boat harbor. It is a 3-acre boat basin enclosed by two rubble mound breakwaters. A third inner breakwater protects the inner harbor. The entrance channel is 280 feet wide at the

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[5] The Power Cost Equalization Program provides economic assistance to communities and residents of rural electric utilities where the cost of electricity can be three to five times higher than for customers in more urban areas of the state. The program's purpose is to equalize power costs to near the average cost of power in Anchorage, Fairbanks, and Juneau. Residential and community facility buildings in nearly 200 communities are eligible for the reduced rate.

waterline. In its existing condition, the depth of the entrance channel varies from -26 to -18 feet MLLW with shallow areas consisting of rock pinnacles. Maneuvering is limited by pinnacles, by breakwaters that are too long, and a wind and wave climate that causes damages and delays to vessels entering, exiting, and moored within the harbor.

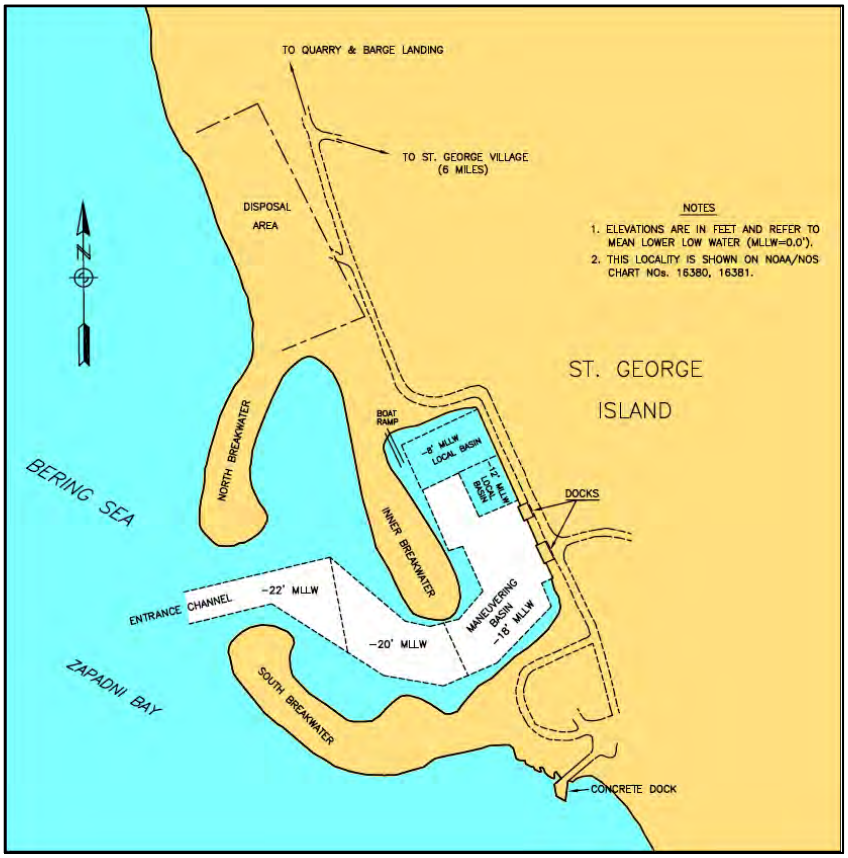


Figure C-3. St. George Harbor in Zapadni Bay

The design of the harbor utilizing conventional breakwaters was initiated by the Alaska Department of Transportation & Public Facilities (AKDOT&PF) at the Danish Hydraulic Institute in the early 1980s. Physical model testing of harbor designs consisting of conventional breakwaters were completed at the Danish Hydraulic Institute and Oregon State University's coastal engineering lab. Due to lack of sufficient state funding for construction, the project was put on hold. The City felt that the harbor could be constructed for less by utilizing a recently developed breakwater technology known as berm breakwater design. Final design of the harbor incorporating the berm breakwater design was completed by the City pursuant to a Transfer of Responsibility Agreement from the State of Alaska. The City awarded a construction contract in September 1984. The contractor was unable to complete the terms of the contract by 1986. The City completed the project by mining local armor rock in 1986 and 1987 and constructing the north, south, and inner breakwaters and utilizing the excavated quarry as the harbor basin. The harbor, ultimately constructed by the City, differed markedly from the original design physically modeled in that it utilized a berm breakwater design placed further inland in shallower water (Figure C-4).

Figure C-4. Comparison of Constructed Harbor to Original Design (courtesy DOT&PF)

In 1988, the City entered into a Section 107 Agreement with USACE to deepen the St. George Harbor and entrance channel to design depth. Dredging of the Federal project, consisting of a 3-acre boat basin and two feet of advance maintenance dredging, was initiated in April 1989. Dredging efforts were completed the following summer. Federal project channel depths, ranging from -22 feet MLLW to -18 feet MLLW, were achieved in most areas; however, due to difficulties encountered, the contractor failed to achieve contract depth in some areas, leaving several rock pinnacles within the entrance channel. Further attempts to attain project depth throughout the project in 1995 were unsuccessful. Since the City was unable to enter into a cost-sharing agreement to complete the dredging project, Federal maintenance obligations were suspended in 1996.

In 2004, the south breakwater was damaged, and displaced rock was deposited in the entrance channel, limiting the use of the harbor. The Federal Emergency Management Agency (FEMA) provided $8 million for repairs, which included placing 15,000 CY of armor rock in 2006 and removing 12,000 CY of material from the entrance channel in 2008.

From 2011 to 2015, the City-AKDOT&PF Feasibility Study was completed at the cost of $2 million. The study included hydrographic and topographic surveys, geotechnical studies, wave modeling, and sedimentation analysis. In cooperation with the users, over

15 alternatives plans were developed, evaluated, and compared. All alternatives considered were constrained to an estimated maximum construction cost of $30 million due to financial limitations. This constraint limited the identification of an alternative addressing all the problems experienced in the harbor, and some issues, such as inner harbor seiche and fuel barge navigation, were not addressed with these concepts. The City selected a preferred plan based on the numerous meetings, technical studies, and evaluation of a wide array of viable alternatives. The USACE has utilized work completed as part of these efforts to the greatest extent possible.

Shortly after the initiation of this study in December 2015, the south breakwater of the existing harbor suffered damage again from storm-generated waves (Figure C-5 and Figure C-6). The damage is evident in the following before-and-after photos. As a result of this damage, the City obtained state and Federal disaster funding to repair the south breakwater. The FEMA program under which repair funds were obtained only allows repairs to restore existing structures to their pre-damaged state. Repairs included adding 6- to 10-ton stone to the breakwater trunk in 2016 to return the breakwater crest to its design elevation and adding a 50-foot rock berm in 2017 to the seaward face of the south breakwater. The problem of navigation to and within the harbor or problems with harbor resonance discussed in this report will not be improved by these repair efforts since disaster funding is only available to restore the breakwater to its pre-storm condition as opposed to improving the ability of boats, barges, and other watercraft to safely navigate into the harbor.

Figure C-5. Breakwater after December 2015 Storms

Given the current state of the harbor, St. George residents continue to face difficulties in attaining a stable and sustainable marine resource economy sufficient to support a local seafood processing facility and related services as envisioned by the CDQ program and other legislative acts. The City of St. George believes that the survival of the community is dependent upon a more accessible harbor as there can be no viable long-term economy on St. George without it.

Figure C-6. Breakwater after Repairs, 2017

4.0 MARINE RESOURCES

In the Pribilof Islands, there is a subsistence fishery, a commercial crab and fish industry, and potential for a small sport/tourism fishery. Fisheries are managed such that subsistence needs are prioritized, followed by commercial participation and sport.

4.1 Subsistence

Fishing activities can be year-round under subsistence rights. For St. George, halibut, cod, sablefish, salmon, snails, and urchins are essential to community livelihood. These species, together with fur seals, provide about 40 percent of the dietary needs for the community. Other subsistence foods are also traded with other Aleutian communities. Local knowledge adds value to the subsistence harvest in many ways, such as understanding species diversification. The harvest, stock, and community demand of all of these species vary from year-to-year and from family-to-family. The supply of subsistence seafood resources generally exceeds demand; however, accessing marine resources is still costly, both in monetary terms and in terms of required effort. Since periods of safe access and moorage conditions in St. George Harbor are limited, there is additional demand for fishing activity that is not being met. Subsistence vessels need a wave of four feet or less in the entrance channel and 1.6 feet at the boat launch to haul out.

Subsistence activities also include terrestrial hunting and gathering. Caribou and the northern fur seal may be hunted for subsistence on St. George. Land-based subsistence activities may be initiated by boat or have a portion of the activity that use navigable waters. For example, caribou herds which roam parts of the island inaccessible on land may be reached by vessel. In addition, wild berries, greens, roots, birds and bird eggs are harvested on land or from cliff faces by vessel

4.2 Commercial

In the Bering Sea, the annual harvest quota for groundfish (consisting of pollock, Pacific cod, flatfish Atka mackerel, Pacific Ocean Perch, and other species) is approximately two million metric tons. St. George is located right in the middle of these fisheries. In addition to groundfish, there are also shellfish or crab fisheries that harvest tens of millions of pounds of king, snow, and bairdi crab every year.

Most fisheries in the Bering Sea are rationalized, which means one of several management systems is in place to manage over-capitalization and eliminate the race to fish. These generally consist of an Individual Fishing Quota (IFQ) issued to an individual or a corporation, usually coupled with an Individual Processing Quota (IPQ) issued to a processing company, or harvest and/or catch rights issued to a cooperative. Transfers of both IFQ and IPQ are allowed, meaning they can be sold from one harvester or processor to another or leased. Either system results in the same outcome: the harvester, whether an individual or a corporation, and the processor each have a defined amount of the species’ quota they can harvest and process each year. When the programs were designed and implemented, each participant in a fishery about to be rationalized was given credit for their historical catching or processing history, which is then converted into a percentage of all future quota available for harvesting and processing. These are generically referred to as catch share systems. The three catch share systems most germane to St. George are the crab IFQ/IPQ program, the Pacific cod Freezer Longline Cooperative, and the halibut IFQ program.

In the crab IFQ/IPQ program, 100 percent of the quota available for harvest is issued to crab harvesters to catch. Ninety percent of that quota is issued to crab processors who purchase from the harvesters to process and market the crab. The 10 percent difference allows the crab harvesters to sell their catch to any processing company they wish, thus encouraging competition. The prices paid to crab harvesters are determined by a formula agreed to by both the harvesters and the processors, with disputes settled by binding arbitration.

The crab fleet consists of large vessels generally longer than 100 feet. The crab fisheries in the Bering Sea begin in October with red king crab, followed immediately by St. Matthew’s blue king crab (when there is a season), and then by snow crab and bairdi generally beginning in January. The length of each season is primarily dependent upon the size of the quota, although weather and ice have resulted in lengthy delays in the past.

The Freezer Longline Cooperative is a different catch share system than the IFQ/IPQ program. Freezer longline vessels are large vessels (generally 100 to 160 feet long) that fish with longlines baited with hooks on the bottom. Some vessels are capable of fishing 60,000 or more hooks per day. The vessels are also equipped with factories on board, so they are also referred to as “catcher-processing vessels.” They produce the finest quality cod in the world. The amount of Pacific cod allocated to the Freezer Longline Coalition in 2018 was 89,000 metric tons.

About 28 vessels belong to the Freezer Longline Coalition, which manages the cooperative. Each company is allocated a percentage of the annual quota and a percentage of the prohibited species (halibut – which must be immediately returned to sea when taken as bycatch) allocated to the cooperative. The percentage is based upon each company’s historical harvest during a defined number of years prior to the cooperative’s creation. As with crab, cooperative percentages may be traded among companies.

The last catch share program of importance to St. George is the halibut IFQ program. This program was the first IFQ program implemented in Alaska, going into effect in 1995. This is a simply IFQ plan where individual harvesters received an initial IFQ based upon their historical landings or subsequently bought into the program. There is no associated IPQ allocation; IFQ holders can deliver where they wish.

There are approximately 12,000 pounds of IFQ owned by residents of St. George. There is significantly more owned by residents of St. Paul, possibly in excess of 200,000 pounds. APICDA also owns approximately 30,000 pounds of halibut IFQ in the area around the Pribilof Islands.

For many years, the halibut harvested by St. George fishermen was transported to St. Paul for processing at the Trident Seafoods processing plant. According to the Alaska Department of Commerce, Community and Economic Development (DCCED), a total of 50,000 pounds of halibut was harvested in 2016 by St. George residents and commercial fishing permit holders. The halibut fishery could be open any time from March to mid-November with season dates established by the International Pacific Halibut Commission under the Halibut Act. This fish is iced, handled, and transported by tender vessels over to Trident Seafoods in St. Paul, where it is processed with another 400,000 pounds from St. Paul.

4.3 Sport

St. George does not have any known charter or lodge businesses; however, the opportunity to sell Bering Sea experiences to tourists is possible and would be better served with a fully functioning harbor. While there is an abundant opportunity for sport fishing and crabbing, the expense of travel and the difficulty of access limits participation.

4.4 Community Development Quota Program

The CDQ program was designed to provide a means for economically distressed communities in the Bering Sea/Aleutian Islands to generate capital that would, in turn, allow them to invest in Alaska's seafood industry to generate jobs and financial resources to build local economies. There are 67 communities (some 27,000 residents) that participate in the program; those communities formed six CDQ groups, more or less along geographical lines (St. Paul is the only single-community CDQ group). This section discussion allocations to APICDA as the CDQ Corporation for St. George.

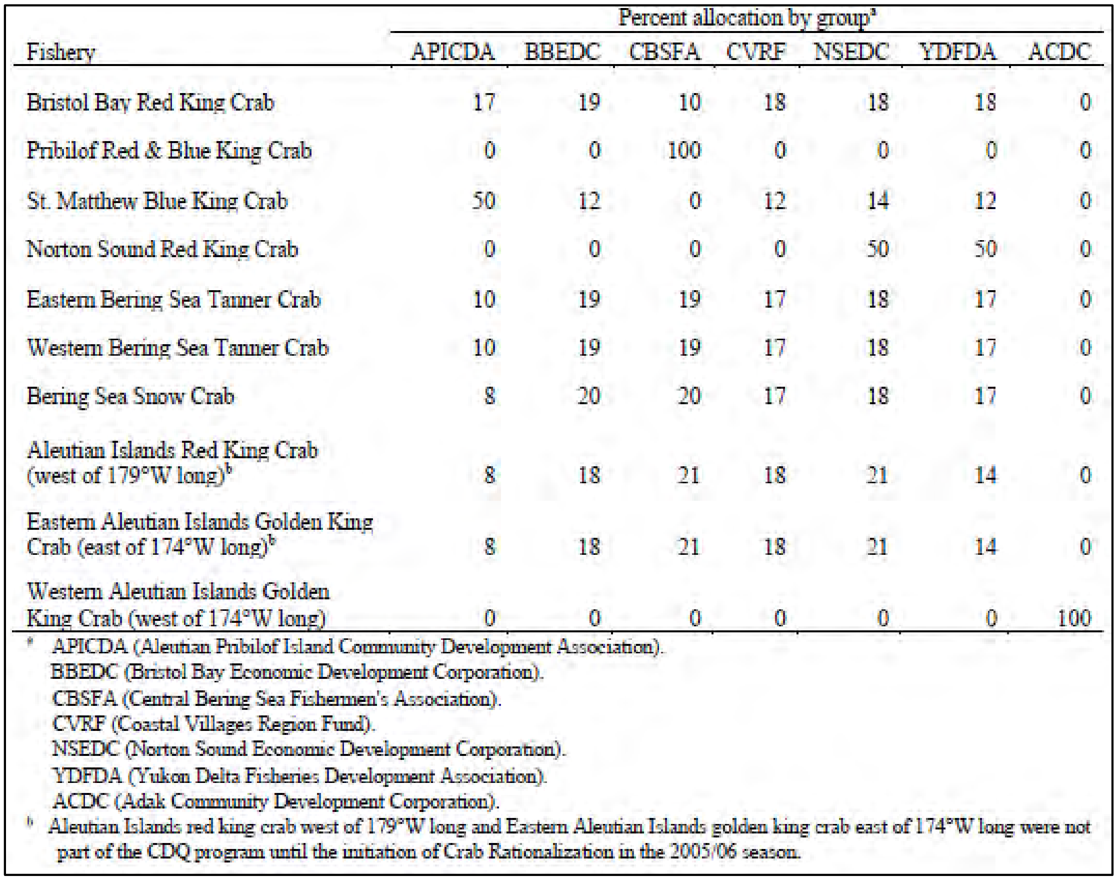
4.4.1 Fisheries CDQ Allocations

APICDA receives a CDQ allocation of roughly 31,000 metric tons of groundfish and 315,000 pounds of crab to help support the communities of Akutan, Atka, False Pass, Nelson Lagoon, Nikolski, and St. George. These allocations generate over $12 million a year in royalties to APICDA. By quantity, the largest allocation is of pollock (19,400 metric tons). APICDA's pollock allocation is harvested by trawl catcher processors.

The second most important species to APICDA is Pacific cod, for which they receive an allocation of slightly more than 3,000 metric tons. APICDA's Pacific cod allocation has nearly always been harvested by longline catcher processors. APICDA does retain the right to harvest Pacific cod using vessels other than longline catcher processors in order to meet community needs.

4.4.2 Crab Fishery CDQ Allocation

The Bering Sea and Aleutian Islands (BSAI) Crab Rationalization Program was implemented in 2005. All federal crab fisheries are subject to the crab rationalization program except for the Norton Sound red crab and Pribilof golden crab. The crab catch limits in the BSAI management area are based on a complex set of regulations found in 50 Code of Federal Regulations (CFR) 680. The data collection from commercial vessels is done by the North Pacific Fishery Management Council (NPFMC), which is a program under National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Services (NMFS). The crab rationalization program consists of two components. The first allocates 10 percent of the annual Total Allowable Catch (TAC) of each crab stock to the CDQ. The second component is the Individual Fishing Quota (IFQ) discussed further in section 4.2. The CDQ allocations is divided among the following community development corporations: APICDA, Bristol Bay Economic Development Corporation (BBEDC), Central Bering Sea Fishermen's Association (CBSFA), Coastal Village Region Fund (CVRF), Norton Sound Economic Development Corporation (NSEDC), Yukon Delta Fisheries Development Association (YDFDA) and the Adak Community Development Corporation (ACDC). The percentage allocation of the different crab fisheries among the CDQ groups for the period 2003 to 2015/16 is shown in Figure C-7.



Fishery	Percent allocation by group[a]						
	APICDA	BBEDC	CBSFA	CVRF	NSEDC	YDFDA	ACDC
Bristol Bay Red King Crab	17	19	10	18	18	18	0
Pribilof Red & Blue King Crab	0	0	100	0	0	0	0
St. Matthew Blue King Crab	50	12	0	12	14	12	0
Norton Sound Red King Crab	0	0	0	0	50	50	0
Eastern Bering Sea Tanner Crab	10	19	19	17	18	17	0
Western Bering Sea Tanner Crab	10	19	19	17	18	17	0
Bering Sea Snow Crab	8	20	20	17	18	17	0
Aleutian Islands Red King Crab (west of 179°W long)[b]	8	18	21	18	21	14	0
Eastern Aleutian Islands Golden King Crab (east of 174°W long)[b]	8	18	21	18	21	14	0
Western Aleutian Islands Golden King Crab (west of 174°W long)	0	0	0	0	0	0	100

[a] APICDA (Aleutian Pribilof Island Community Development Association).
BBEDC (Bristol Bay Economic Development Corporation).
CBSFA (Central Bering Sea Fishermen's Association).
CVRF (Coastal Villages Region Fund).
NSEDC (Norton Sound Economic Development Corporation).
YDFDA (Yukon Delta Fisheries Development Association).
ACDC (Adak Community Development Corporation).

[b] Aleutian Islands red king crab west of 179°W long and Eastern Aleutian Islands golden king crab east of 174°W long were not part of the CDQ program until the initiation of Crab Rationalization in the 2005/06 season.

Figure C-7. Community Development Quota (CDQ) and Adak Community Allocation percent allocation by crab fishery to each group, 2003-2015/16

Of the 10 percent of Bering Sea catch that goes to the above-listed CDQ groups, APICDA is allocated 50 percent of St. Matthew Blue (SMB), 17 percent of Bristol Bay Red (BBR), 10 percent of Eastern and Western Bering Tanner (EBT and WBT), and 8 percent of Snow Crab (BSS), Western Aleutian Scarlet King (WAI), and Eastern Aleutians Golden (EAG) (See Figure C-7).

APICDA supports the communities of Akutan, Atka, False Pass, Nelson Lagoon, Nikolski, and St. George. As such, profits from APICDA CDQs for crab allocation is further divided to support the six communities. CDQ are divided among the communities based on population size. For St. George, this is 7.9 percent (Colt, 2018).

Since 2007 there has been 7.8 million to 20.3 million pounds of crab harvested in the Bering Sea annually. The crab fishery is a $120 million to $240 million industry depending on the year. Of the APICDA allocations to its six communities, the St. George allocation is assumed to comprise of 7.9 percent of the crab catch or 62,000 pounds on average (Colt, 2018). This amounts to an ex-vessel value of $182,000 on average. Due to the unsafe harbor conditions, St. George's crab allocation is processed at neighboring St. Paul Island, and the St. George community foregoes this net profit. APICDA has the legal right and can direct this amount of crab to be processed by a processor in St. George if safe access and moorage for commercial vessels and a floating processor were available. According to a letter from APICA and directed to USACE,

> In order to preserve crab processing opportunity for St. George, in 2008 APICDA purchased a significant amount of [IPQ shares]… These IPQ shares had been earned in the community and historically processed with a floating operation in St. George but moved to St. Paul due to damage at the harbor's breakwater in early 2006 that made deliveries to St. George unsafe. APICDA's purchase of these IPQ shares was done with the intention of reinstating crab processing in St. George for when there is a safe and functioning harbor (1).

While fluctuations in the fishery quota levels could impact APICDA's decision on the appropriate level of processing at St. George if moorage requirements were met, the letter also indicates that the CDQ program was established to provide villages the opportunity to participate in fisheries, alleviate poverty, and support sustainable economic development. The letter further states, "…the harbor is critical to reinstating crab processing in St. George. In fact, the harbor is critical to the survival of St. George as a community."[6] Reinstatement of processing at St. George would potentially create some jobs and benefits associated with USACE navigation improvements. This is further discussed in Section 7.0 Future With-Project Conditions.

The crab rationalization program also issues quota shares (QS) and processor quota shares (PQS), which are revocable privileges that allow its holder to harvest or process a specific percentage of the annual TAC. The corresponding annual allocations which are expressed in pounds are referred to as Individual Fishing Quota (IFQ) and Individual Processing Quota (IPQ). The allocation of IFQ and IPQs differ from the CDQ allocation. The different types of harvesting IFQs are called Class A, B, and C. Under the QS qualifying vessel, captains are issued class C IFQs and represent 3 percent of the harvesting quota share pool. Class A IFQ requires the catch to be delivered to a processor holding available IPQ (under a share-match agreement subject to regional delivery requirements), and Class B IFQ allows the catch to be delivered to any processor. The program also allows for the voluntary formation of harvesting cooperatives to coordinate the harvest of crab IFQ. The location of the processing of IFQ catches, with the exception of Class C IFQs, are directed by the IPQ holder that is share-matched with the IFQ holder. This means that for the IPQs purchased by APICDA, the corporation has the choice of the processor to which the catch is delivered to. APICDA can also contractually direct its CDQ shares, which are not share-matched, to a specific location. For the northern designated IPQs and IFQs harvested in the St. George region, APICDA directs the quota to the closest (and only northern) operating processor, which is at St. Paul Island. As such, the community of St. George foregoes the net profits and employment opportunities associated with IPQ crab processing, as it does for its CDQ allocation. Additionally, there are other IFQ shares with specific requirements; the Opilio fishery has delivery requirements; for those harvesting shares

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[6] Letter from APICDA Director of Fisheries and Government Affairs, dated 8 November 2019.

designated to the north, the only delivery port is St. Paul. These shares are matched with corresponding northern designated processing shares.

Based on harvest data reported by APICDA, the average annual combined harvest for CDQ and IFQ crab is approximately 2,424,000 pounds. This includes the red, snow, blue, and tanner crab harvest. With 7.9 percent of this harvest being allocated to St. George, this results in 192,000 pounds harvested annually that could be delivered to St. George. Using a conservative $2.00 per pound average ex-vessel value across these species, the harvest value equals $383,000 annually. Therefore, the conservative estimate of the benefit from crab processing is $383,000 annually for both the CDQ and IFQ.

5.0 EXISTING CONDITIONS

The preceding Overview and Marine Resources sections discussed the facilities on St. George and current conditions of the existing harbor at Zapadni Bay. This section describes current conditions, including vessel classifications and operations at the harbor.

5.1 Vessel Classifications

The following table presents the characteristics of existing and anticipated future fleet to call regularly at St. George.

Table C-6. Vessel Class Summary

Class	Dimensions (in feet)	Entrance Wave (in feet)	Dock Wave (in feet)
Barge & Tug	200L, 54W*, 10D	3.3	1.6
Subsistence Vessels	28L, 10W, 4D	3.9	1.6
Crabbing Vessels	155L, 38W, 14D	9.8	1.6
Water Taxi	81L, 24W, 8D	9.8	1.6

*Tug and barge deliveries require the tug to make up alongside the barge outside the harbor. Tugs for the fleet can be up to 32 feet wide, which would create a maximum vessel beam of 84 feet for the tug on hip.

5.1.1 Subsistence Vessels

The total number of subsistence vessels that operate at the harbor is between 8 and 12, depending on the year. According to ADF&G, six of the subsistence vessels which consider St. George as home port are permitted to participate in longline fishing, mechanical jig, and fish for miscellaneous finfish. The longest vessel of this class is 28 feet, and all are under 230 horsepower. As indicated in Table C-6, entrance wave requirements for this vessel class into the current harbor is a four-foot wave at the entrance channel and approximately a 1.5-foot wave at the dock and boat launch, necessary to safely moor or trailer these vessels.

An opportunity exists to increase subsistence harvests by improving access to subsistence resources. The valuation of subsistence harvests is based on assumed replacement values and production cost values for these resources. A study conducted by the ADF&G Division of Subsistence found that the replacement value of subsistence resources ranged from $4.00 to $8.00 per pound in 2012, or $4.46 to $8.92 in FY19 dollars. A study conducted for the Alaska District about subsistence harvest values on Little Diomede found maximum harvest values of $25.52 per pound, updated to FY19 dollars. The values from the Little Diomede study are higher than those reported by ADF&G, in part, because they represent the total production costs of acquiring subsistence resources rather than a replacement value. Replacement values only consider the cost of purchasing proteins whereas the production cost method used for Little Diomede considers all of the resources utilized to harvest subsistence resources. The intent of this method is to better quantify the value of subsistence beyond a simple replacement value of protein.

The values calculated for Little Diomede are specific to that community and do not necessarily represent the costs to harvest subsistence resources in St. George. However, including this cost on the distribution of possible subsistence valuations is appropriate for this analysis to address the range of methodologies for valuing subsistence. The method used for the Little Diomede feasibility study is a production cost method which considers that subsistence resources are worth at least as much as the harvesters invest in them through expenditures of cash and labor. This is thought to be a more comprehensive approach than simply considering the grocery story (or equivalent) replacement value of these resources.

The subsistence data presented in the Little Diomede feasibility study is based on comprehensive surveys to estimate subsistence production time and costs. The level of data needed to conduct a detailed update of this method is not available for St. George. As such, updating the value from the Little Diomede study using an economic index is an appropriate method to utilize this data for St. George. This value is used as one point on the distribution of subsistence values to represent the uncertainty in quantifying these resources.

Subsistence harvest values used in this analysis are based on the ADF&G and USACE studies previously mentioned and using @Risk, a Microsoft Excel add-in. To address variation and uncertainty in harvest values, this analysis uses an @Risk distribution with the following parameters: $4.46 (minimum), $8.92 (most likely), and $25.52 (maximum). This analysis uses the mean value of $16.17 per pound from the distribution for further calculations.

The value of foregone subsistence harvest is based on the mean harvest value of $16.17 per pound and the estimated increase in subsistence harvest. Absent Federal action, it is assumed that subsistence harvests would be 14,832 pounds, which is the per capita subsistence harvest for St. George based on ADF&G subsistence data multiplied by the estimated number of participants (206 pounds per person x 72 people = 14,832 pounds or 136 pounds per day for the 109 days spent harvesting under existing conditions). With navigation improvements, it is assumed that access days will increase by 29 days (182 potential harvest days in the April-September season x .75 percent = 138 days minus the 109 days spent harvesting under existing conditions = 29 additional days) and the subsistence harvest will have a net increase of 3,882 pounds on average (29 days x 136 pounds per day = 3,882 pounds). Based on the @risk simulation, the value of foregone subsistence harvest would range from $16,000 to $97,000 annually, with a 1000 iteration mean of $49,000 annually.

Costs associated with the increased access days are then removed from the value of this potential harvest to estimate the value of the foregone subsistence. An assumed $23.03 per hour vessel opportunity cost (based off vessels 0-28 feet in length from an analysis previously conducted for Whittier by the Alaska District) was multiplied by the hours spent harvesting per day (with a low of 1 hour and a high of 14 hours modeled in @risk) to determine the associated cost range of $668 to $9,350 annually with a 1,000 iteration mean of $5,000. Average annual net benefit is $44,000 ($49,000 - $5,000 = $44,000). Input data used to estimate the value of the foregone subsistence harvest is summarized in Table C-7.

Table C-7. Foregone Subsistence Harvest Summary

Variable Description	**Value**
Per Capita Annual Subsistence Harvest (pounds)	206
Total Annual Subsistence Harvest (pounds)	14,832
Expected Increase in Harvest (days)	29
Total Annual Expected Future Harvest (pounds)	18,714
Expected Harvest Increase (pounds)	3,882
Average Price per Pound	$16.17
Annual Forgone Subsistence Harvest Value	$49,000
Associated Annual Vessel Operating Cost	$5,000
Annual Potential Benefit	**$45,000**

In consideration of the analysis presented above, potential benefits associated with improving subsistence harvesting opportunities have a present value of $1.2 million over the period of analysis with an AAEQ value of $45,000.

Opportunity cost associated with foregone subsistence trips due to poorer access conditions at the existing Zapadni Bay harbor site creates an additional economic loss to the community. Annual average damages are estimated by multiplying the number of subsistence trips avoided due to unsafe access conditions at the existing harbor site (74 trips) by the size of the fleet (8-12 vessels) and the typical hours spent subsisting per trip (1-14 hours) and the average hourly opportunity cost of $23.03. The AAEQ value of $68,000 is attributed to foregone subsistence trips under existing conditions.

5.1.2 Sport Fish Vessels

St. George Island does not have any charter or lodge businesses; however, the opportunity to sell Bering Sea experiences to tourists is possible and would be better served with a fully functioning harbor. Local sport fishing is nearly non-existent; for example, even if fish are caught by locals during an open sport season, they are usually caught for subsistence purposes. While there is an abundance of opportunity for sport fishing and sport crabbing, the expense of travel and the difficulty of access limits participation.

5.1.3 Commercial Crabbing Vessels

Numerous vessels harvest crab in the Bering Sea and Pribilof Island region. Commercial vessel operators were surveyed during the study. There is a total of 84 vessels with lengths ranging between 80 to 170 feet, between 24 and 46 feet wide, and drafting 7.9 to 16.5 feet. Commercial vessels often seek safe refuge to escape extreme weather conditions or make repairs. The harbor entry requirement for this vessel class is approximately a 10-foot wave, while the requirement for safe moorage is approximately a 2-foot wave. There are 37 days in the winter and 12 days in the summer when entrance conditions exceed the vessel class criteria. While these vessels currently do not process crab harvests in St. George, with safer harbor access and moorage these vessels would bring in an amount of CDQ crab into St. George. From the crab density maps in Figure C-11 and Figure C-12, a general estimate is that fishing grounds are equally good in any direction from a midway point, halfway between St. George and St. Paul. The sailing distance from the existing harbor at Zapadni Bay to the St. Paul Harbor is approximately 49.4 miles. Therefore, vessels south of the midway point (50 percent of the crab fleet) bypass St. George and travel to St. Paul to offload product currently. As very little of the fleet actually fishes between the two islands, the most likely distance for boats bypassing St. George to travel is 49.4 miles.[7] Increased transportation costs of $5,000 to $25,000 are incurred by the commercial crabbing fleet annually with (80 percent certainty). Additionally, APICDA currently transfers $181,900 to $383,800 of CDQ crab to St. Paul to be processed.

5.1.4 Barges, Tugs, and Landing Craft

Barge and tug vessels bring fuel, freight, and construction material into St. George. Landing crafts are also occasionally used. Other tugs and barges can be seen sailing by the north side of the island from time to time en route to St. Paul. For the fuel barge or tug, it is set up as a line haul. Vessel dimensions for the primary barge for St. George are 180 feet in length, 54 feet wide, and a 13-foot draft. However, for maneuverability, the fuel vessel loads to a 10-foot draft and is towed by a tug measuring 80 feet long, 25 feet wide, and a 10-foot draft. Tug and barge deliveries require the tug to make up alongside the barge outside the harbor. Tugs for the fleet can be up to 32 feet wide, which would create a maximum vessel beam of 84 feet for the tug on hip.

According to an interview with the delivery company in 2017, the tug and barge wait for weather on the north side of the island or outside the existing harbor at Zapadni Bay until the tug can make up alongside the barge’s hip and bring it in. This requires a 3-foot wave outside the harbor and is one of the limiting factors causing delays and increasing costs. With this configuration, the tug captain is able to maneuver the tug and barge past underwater pinnacles, shallows, and outer and inner breakwaters, and swing the barge into the inner basin. However, breaking waves near the harbor entrance or outside breakwaters, significant directional wind that would blow the barge sideways into obstacles (especially with the tug on hip limiting maneuverability), or seiche activity

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[7] A triangular distribution with a minimum bypass distance of 24.7 miles, a maximum bypass distance of 49.4 miles, and most likely bypass distance of 49.4 miles was used.

in the inner basin also delay delivery. The barge requires a 2-foot wave at the dock to unload.

The fuel barge and tug currently call on St. George two to six times a year. There are 100 days in the winter (October to March) when sea conditions are too rough to enter the current harbor, and there are 90 days in the summer (April to September) when the harbor is inaccessible. Additionally, there are 36 days annually when the 1.5-foot threshold inside the harbor is exceeded. If a barge was moored at the dock during these conditions, extreme pressure on the docks, cables, and bollards pulling and beating against one another could cause lines to break and damages to the vessel and harbor infrastructure.

Inaccessibility and unsafe moorage days for freight vessels are the same as for the fuel barge discussed above. Interviewed stakeholders reported that weather attempted to be timed, but delays per trip were up to 20 hours with an average annual value of $45,000.

Additionally, under existing conditions physical damages to barges are estimated to range from $0 to their historical maximum of $64,000 annually. Utilizing an @Risk distribution and estimated moorability durations under current conditions (based on H&H modeling), annual damages experienced at the current harbor are calculated at $4,400 (90.2 percent annual duration of moorable conditions multiplied by the @risk mean of $45,000). Potential avoided damages under with project conditions are subsequently calculated based on the increase in moorable conditions (92.6 percent) resulting in estimated annual avoided damages of $1,000 at the fuel dock under improved conditions.

5.1.5 Water Taxi

There is demand for a water taxi or inter-island ferry service between St. George and St. Paul; however, this vessel class is only made up of the Atka Pride at this time. As such, the water taxi’s safe entrance and moorage requirements are the same as the crab fleet. The Atka Pride could transport six passengers and up to 30,000 pounds of cargo.

Figure C-8. FV Atka Pride, Used for an Inter-Island Ferry Service

5.1.6 Fuel and Freight

It is anticipated that a project which could lower fuel and freight cost may increase fuel and freight quantity ordered; however, survey instruments and focus groups were not successful in determining the response to lowered prices. At the same time, it is expected that shipping companies would be able to respond to any increase in demand for fuel and freight ordered.

For heating oil, the most conservative assumption is that homes are heated to the level of warmth comfortable for a family, and thus no price elasticity exists. Other energy sources are similar, except for when used in vehicles or for subsistence purposes. In these cases, more diesel and other energy would be purchased in line with lower prices and the availability of increased safe access to resources from a harbor.

Residential construction material purchases could also increase with easier and less expensive importation. Similarly, purchases of durable goods and household furnishings may increase. Barge service to bring in large items like new private vehicles (including skiffs) has been rare in the past several years, but their demand is unknown. Non-perishable foods and dry goods are also expected to increase, potentially by 500 pounds per week, if a freight service was established and could replace expensive air transportation for these goods.

Fuel and freight in total metric tons received is shown in the table below. This table does not include fish. Other data, such as fuel deliveries and recent construction materials, also appears to be lacking. Despite those gaps in the data, this table provides a range of historical commodity demand in St. George.

Table C-8. Example - Commodities Transported (in Metric Tons)

Waterborne Commerce Statistics Center Reported Commodities Received	
Year	**Metric Tons**
1998	539
1999	7,382
2000	35,153
2001	97,700
2002	599
2003	1,112
2004	967
2005	513
2006	5,056
2007	0
2008	0
2009	206
2010	678
2011	797
2012	10,805
2013	0
2014	0
2015	0
2016	0

Figure C-9. Brice Marine Barge Hauling Rock

Figure C-10. Locking Armor Stone into the Breakwater

5.2 Crab Fishery Outlook

Given the significant crab fishery economic opportunities across the region and the currently unrealized profits at St. George due to harbor inaccessibility and lack of processing facility, a project at St. George would have a significant impact on long-term community viability. Analyses on the outlook of crab fishery is conducted here utilizing limited data available at present.

The outlook for the crabbing industry is largely a function of managing the stock to maintain its stability. A crab handling or processing facility would process any amount of crab that St. George could bring in. This amount is dependent on management institutions and quotas previously described in the section on the CDQ Program.

NOAA's Alaska Fisheries Science Center- Shellfish Assessment Program provides a representation of location and amount of snow crab in the Pribilof Islands region in 2017. These figures are only meant to be illustrative – depicting the millions of crab found in the waters around St. George. As indicated by the Map legend, stars represent more than 100,000 animals in an area where large circles represent 10,000 to 100,000 animals, medium-sized and small circles represent 100 to 10,000 animals.

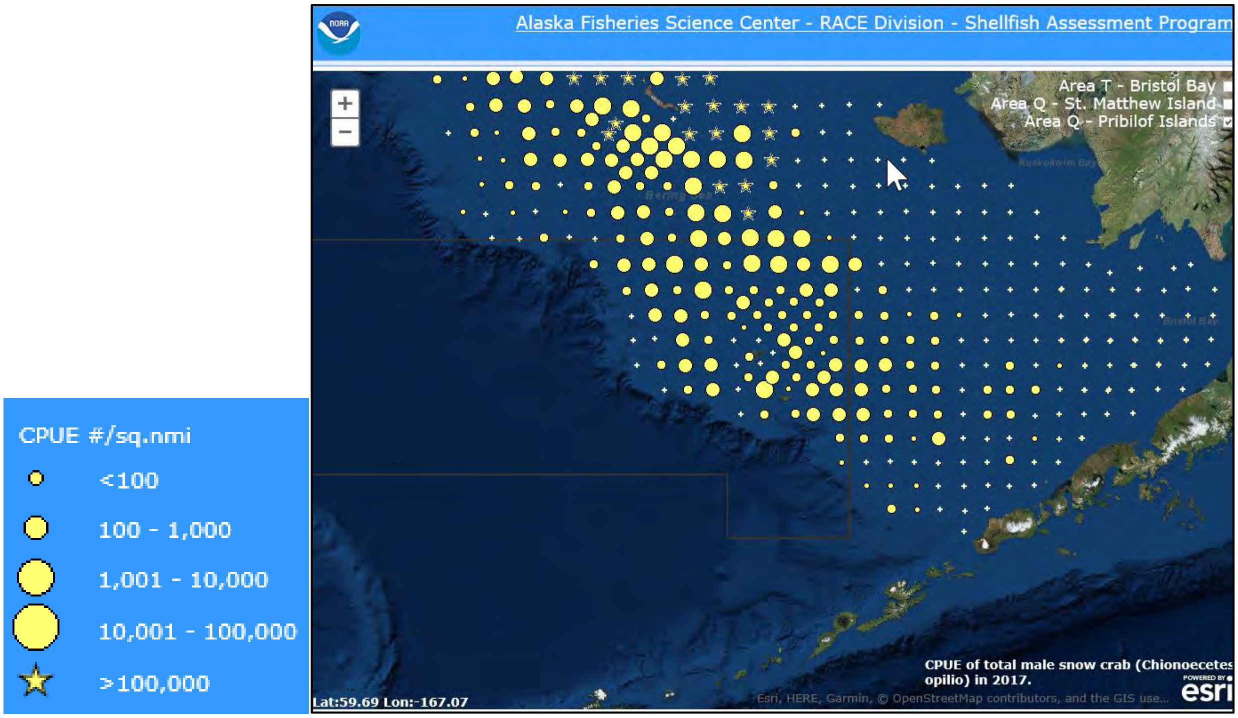

Figure C-11. Snow Crab numbers across the Bering Sea, 2014-2017

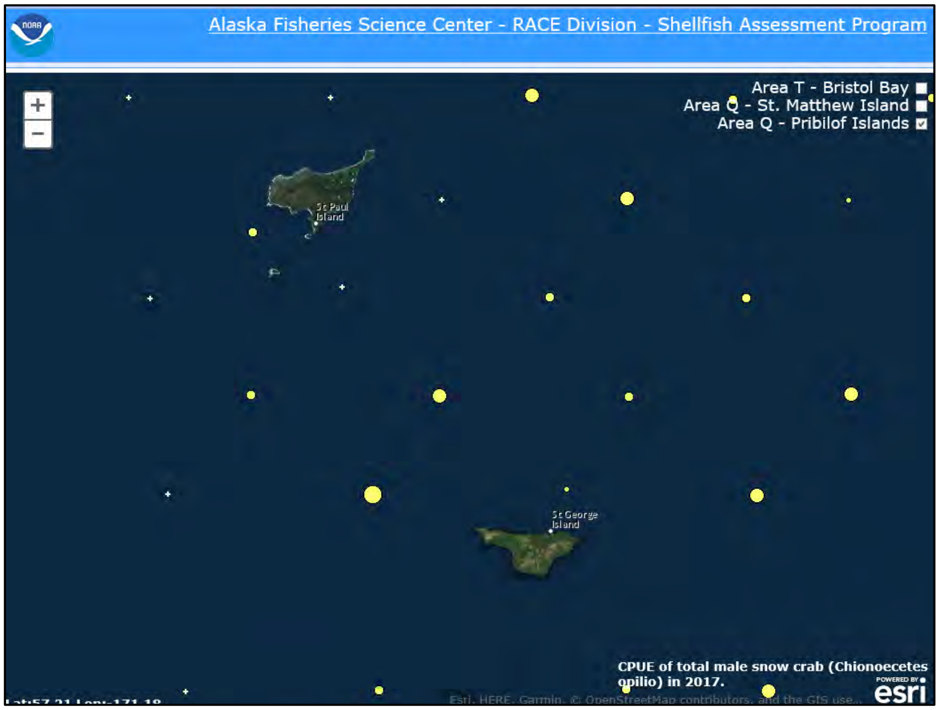

Figure C-12. Snow Crab numbers in close proximity to St. George, 2017

The observed crab counts include specimens that are outside of the harvestable range (whether due to sex, weight, or specific size requirements) while TAC numbers are derived based on estimated populations within those harvest limitations and to allow harvests to occur at a level that will maintain the health of the fishery in the long term. Therefore, in practice, the established Total Allowable Catch (TAC), rather than the number of crabs observed, provides a clearer outlook of the crab fishery. The following tables show the harvest values for select species from the Bering Sea from 2007 to 2016. An example of the allowable catch amounts of Bristol Bay Red king crab, and the ex-vessel value of that catch, can be seen in Table C-9.

Table C-9. Example - Bristol Bay Red King Crab Annual Catch and Harvest Value

Year	Total Allowable Catch	Harvest	Percent of Total Allowable Catch Harvested	Price Per Pound	Total (Millions)
2007	15,527,000	15,616,816	100.60%	$3.45	$52.80
2008	20,383,000	20,366,065	99.90%	$4.15	$84.00
2009	20,364,000	20,329,402	99.80%	$4.98	$100.40
2010	16,009,000	15,932,654	99.50%	$4.43	$70.10
2011	14,839,000	14,833,828	100.00%	$6.28	$92.50
2012	7,834,000	7,833,594	100.00%	$8.96	$69.90
2013	7,853,000	7,849,835	100.00%	$7.27	$56.90
2014	8,600,000	8,600,476	100.00%	$6.36	$54.40
2015	9,986,000	9,987,008	100.00%	$6.05	$59.80
2016	9,974,000	9,969,964	100.00%	$7.03	$68.80

While the price for red king crab varied from $3.45 to $8.96 per pound depending on the year, 99.5 to 100.6 percent of the catch was harvested each season (TAC can exceed 100 percent for a variety of reasons including: the population of the stock is actually larger than estimated and catch rates are higher than anticipated; fisherman catch more than expected as bycatch in another fishery; or because new reporting requirements for fisherman provide better data than was captured historically). Additionally, the decline in supply from 2011 to 2012 was nearly 7 million pounds; however, an increase in price can be seen, indicating price elasticity.

Under BSAI, nine crab fisheries were looked at: Bristol Bay Red king crab (BBR), Bering Sea Snow crab (BSS), Eastern Aleutian Golden king crab (EAG), Eastern Bering Sea Tanner crab (EBT), Pribilof Island King crab (PIK), St. Matthew Island Blue king crab (SMB), Western Aleutian Golden king crab (WAG), Aleutian Island Red King Crab (WAI), and Western Bering Sea Tanner crab (WBT). Only BBR, BSS, EAG, and WAG were open every year of the period analyzed, indicating that some stocks of crab could be at-risk populations. The total Bering Sea harvest for the 2015/2016 fishing season is shown in
Table C-10.

Table C-10. Example - 2015/2016 Crab Fishery Value

2015/2016		**Harvest**			**Reported Exvessel Value**	
Fishery	**Total Allowable Catch**	**Harvest**	**Percent of Total Allowable Catch Harvested**	**Deadloss**	**Price Per Pound**	**Total (Millions)**
BBR	9,974,000	9,969,964	100.0%	182,833	$7.03	$68.8
BSS	40,611,000	40,611,446	100.0%	379,167	$1.97	$79.2
EAG	3,310,000	3,302,480	99.8%	53,160	$3.64	$11.9
EBT	11,272,000	11,263,562	99.9%	120,187	$2.19	$24.4
PIK	Fishery Closed					
SMB	411,000	106,449	25.9%	1,439	$4.03	$0.4
WAG	2,980,000	Confidential	N/A	Confidential	$3.25	$7.0
WAI	Fishery Closed					
WBT	8,396,000	8,378,816	99.8%	52,546	$2.19	$18.2
Total	76,954,000				$3.47	$209.9

Based on accessible and available data, the total ex-vessel value ranged from $120 million to $240 million from 2006/2007 to 2015/2016. These are the profits made by fishing vessels and processors. While SMB had less than full effort to harvest the total allowable catch in the 2015/2016 example above, this was an outlier. In most years, most fisheries, saw close to 100 percent of the allowable catch harvested.

Despite current and historic closures of some fisheries, and catch limits in the region, the crabbing industry in the Bering Sea is sustainable. Over the 50-year period of analysis considered for this study, the total biological stock available is expected to vary from year-to-year but is considered to be stable overall.

As with any navigation project which relies on benefits to a commercial fishery, there is always uncertainty with fish stocks. However, given the previously presented data and considering the resiliency of the commercial fishing industry and their ability to adjust gear in the case of a change to the distribution of harvestable species, the outlook for commercial fisheries in St. George is positive.

5.3 Infrastructure Damages

5.3.1 Harbor

The harbor currently suffers damages from storms. Operations and maintenance expenses were financed in 1994 and 1995 for $30,500 and $1,991,300 ($63,900 and $4,053,000 in FY20 dollars). Repairs were needed but never occurred. The cost of 2006 and 2008 breakwater repairs (from the 2004 storm) was $8 million ($10.7 million in FY20 dollars). The cost of 2016 and 2017 breakwater repairs (from the 2015 storm) was $14 million ($15.2 million in FY20 dollars). The cost of repairs is estimated to be $909,000 annually (FY20 dollars).

5.3.2 Other

The fish handling facility and former crab processing facilities are in disrepair due to non-use. The tank farm and gas pumps potentially need maintenance as they have rust damage. St. George's windmill is currently inoperable and likely needs complete replacement. The status of other infrastructure is unknown, but again, infrastructure projects could benefit from reduced transportation costs stemming from a harbor project.

6.0 FUTURE WITHOUT-PROJECT CONDITIONS

The future without-project (FWOP) conditions mirror those under the Existing Conditions. Absent USACE action, it is unlikely that another entity will take action to improve the harbor due to budgetary constraints. FEMA does not make improvements and instead will only make repairs to restore the harbor to its "as-built" condition. The expected without project conditions form the basis of evaluation against which FWP conditions are compared.

Infrastructure Damages Infrastructure damages to the existing harbor at Zapadni Bay are expected to continue to occur from storms in the frequency and severity of the existing condition. Repairs by FEMA are also expected to continue. The existing harbor at Zapadni Bay will continue to be severely underutilized, inaccessible with limited safe moorage days as described in the existing conditions for all vessel classes.

Vessel Damages. Damages to vessels calling on St. George are expected to continue without harbor improvements. Under without project conditions, average annual damages experienced by the barge fleet are estimated at $4,400, but could be as high as the historical maximum of $64,000.

Vessel Delays. Delays to fuel and freight vessels will continue at the rate they have been seen historically, with costs of fuel and supplies remaining prohibitively high.

Unrealized Revenues. The value of CDQ crab allocated to APICDA and intended for St George is estimated at approximately $384,000 annually. Without a project, this will continue to be delivered to St. Paul for processing, leading to not only an unrealized economic opportunity for St. George but also higher transportation costs for crabbers that must deliver their catch to St. Paul. Given the remote and mixed subsistence-cash economy of St. George, this unrealized profit would continue to hamper the community's economy. Lack of economic opportunity in the community due to lack of a functioning harbor will continue to result in out-migration, leading to increased concerns about the long-term viability.

Subsistence Harvests. The opportunity to subsist will continue to be impacted under without-project conditions. Following the historical trend, access the subsistence fleet has to resources will continue to be impacted. Given the high dependence of the community on subsistence resources, both culturally and economically, this will continue to be a major factor in long-term community viability.

Community Viability. Due to the factors described above, under without-project conditions the cost of essential goods remains high, which is coupled with dwindling economic opportunities and impacts to the accessibility of subsistence resources. All of these conditions will continue to limit the community's ability to develop a stable and sustainable local marine resource-based economy sufficient to support their mixed, subsistence-cash economy. The likely outcome of this condition is that the health of the community will follow its historical trend and St. George residents will continue to out-migrate for better opportunities.

7.0 FUTURE WITH-PROJECT CONDITIONS

The following section describes the anticipated conditions at St. George, assuming that a project has been constructed. The expected changes in the operating procedures at the harbor are the basis for the economic analysis.

Several critical assumptions were made when conducting the future with-project economic analysis. Chief among them is that the existing fisheries in the region will continue to support the fleet. This is a critical assumption supported by the fact that all fisheries present in the St. George area are highly regulated in order to assure the future viability of the resource.

Additional key assumptions are related to processing capacity at St. George. While a floating processor can be located anywhere that has protected moorage for operability and additional space for crab vessels to transfer their catch onto the processor, under with-project conditions it is assumed that APICDA will retrofit a crab floating processor to operate out of St. George (typically 300-400 foot length overall) for any alternatives where the minimum moorage requirements are met. Given that availability of a floating processor, it is assumed that a quota portion of the Bering Sea commercial crab and fish catch would be transferred back to St. George (currently all of this quota is processed in St. Paul). There would also be transportation cost savings and improved efficiencies by having a floating processor in St. George, but these efficiency gains are not significant enough to affect regional ex-vessel profits.

7.1 Future of the Fleet

The future fleet at St. George is expected to be similar in size to the current fleet calling on St. George and St. Paul, the neighboring island about 50 miles north of St. George. The proposed harbor is designed to accommodate vessels up to the size of the design vessel that may seek refuge during storms. Also, by constructing a harbor on the north side of St. George Island, conditions would exist where storms would cause waves outside of St. Paul Harbor to be too high for vessels to enter, but at St. George, the island would shelter the harbor from the storm waves and vessels would still be able to navigate to the dock.

7.2 Project Alternatives

A final array of four alternatives was evaluated along with the future without-project conditions (No Action alternative). Details on these alternatives can be found in the Main Report, Hydraulics and Hydrology appendix, and Cost Engineering appendix. This section focuses on the costs and benefits associated with each alternative.

7.2.1 No Action

The no action alternative does not improve harbor conditions. Access, use, moorage, damages, and delays are those described in the FWOP condition. The study objectives would not be met, no project benefits or opportunities would be realized, and the long-term viability of the community would continue to be threatened.

7.2.2 Alternative N-1: Local Subsistence Fleet

Alternative N-1 is a subsistence vessel launch harbor with a 775-foot long breakwater, a 700-foot long entrance channel dredged to -10 feet MLLW, and a launch zone dredged to -8 feet MLLW. Subsistence vessels access the harbor through a concrete launch ramp to -5 feet MLLW providing full tide access for launching.

Figure C-13. Alternative N-1 Design

Fuel (and occasional freight or construction materials) would still have to come into Zapadni Bay; therefore, the existing harbor at Zapadni Bay would still need repairs averaging more than $900,000 annually. N-1 would provide additional safe access and moorage for subsistence vessels.

7.2.3 Alternative N-2: Fuel Barge, Freight, Subsistence, 25% Crabber Fleet

Alternative N-2 consists of a 450-foot wide by 550-foot-long mooring basin dredged to -16 feet MLLW protected by a 1,731-foot-long north breakwater and a 250-foot-long spur breakwater at the west edge of the basin. The basin connects to the Bering Sea with a 250-foot wide navigation channel dredged to -18 feet MLLW.

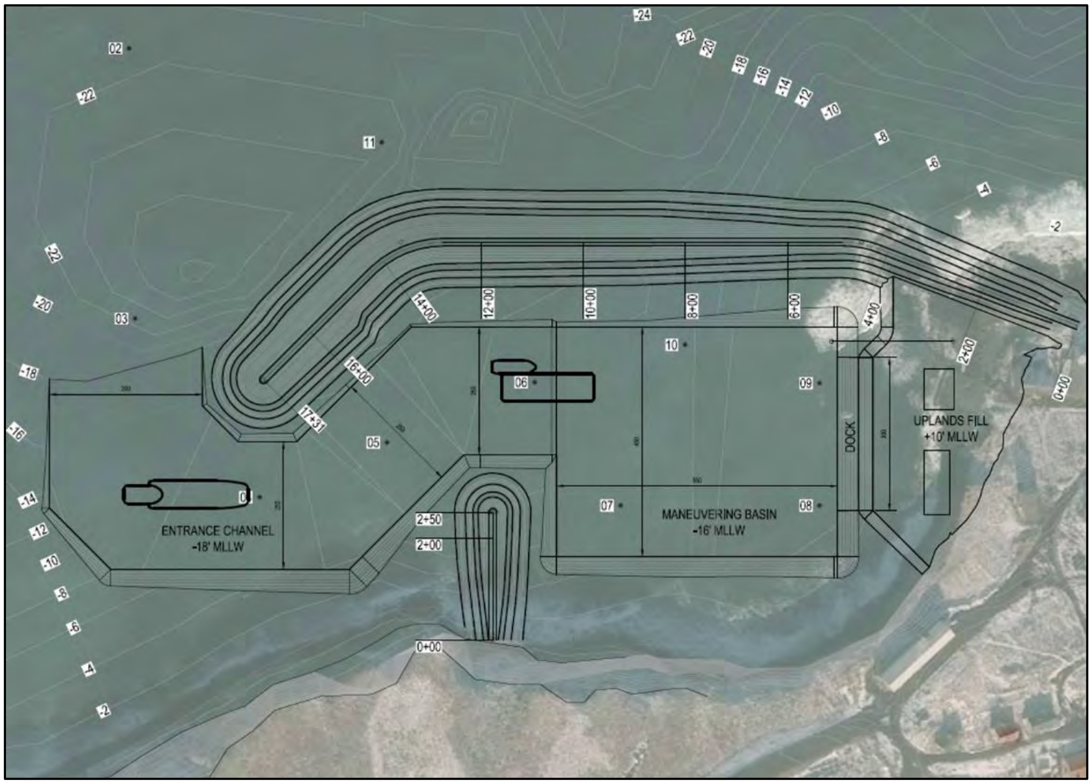

Figure C-14. Alternative N-2 Design

Dredging the channel and basin for this alternative requires removal of approximately 230,000 cubic yards of material. Inner harbor facilities would be created by filling an area to +10 feet MLLW with a 300-foot-long pile-supported dock and a concrete boat launch ramp to -5 feet MLLW for full tide launching access. This alternative provides access for the subsistence fleet, the fuel barge, and approximately 25 percent of the commercial fishing fleet (those vessels drafting less than 10 feet).

This harbor also reduces the probability of fuel and freight barge delays, and damages, and provides an opportunity for increased subsistence activity, and water taxi activity, as well as travel cost savings for a portion of the crabbing fleet (although the sailing distance is only 0.4 miles shorter than to Zapadni Bay).

7.2.4 Alternative N-3: Fuel Barge, Freight, Subsistence, 85% Crabber Fleet

Alternative N-3 is the same as N-2 but dredged to -20 feet MLLW to allow access for 85 percent of the crabbing fleet.

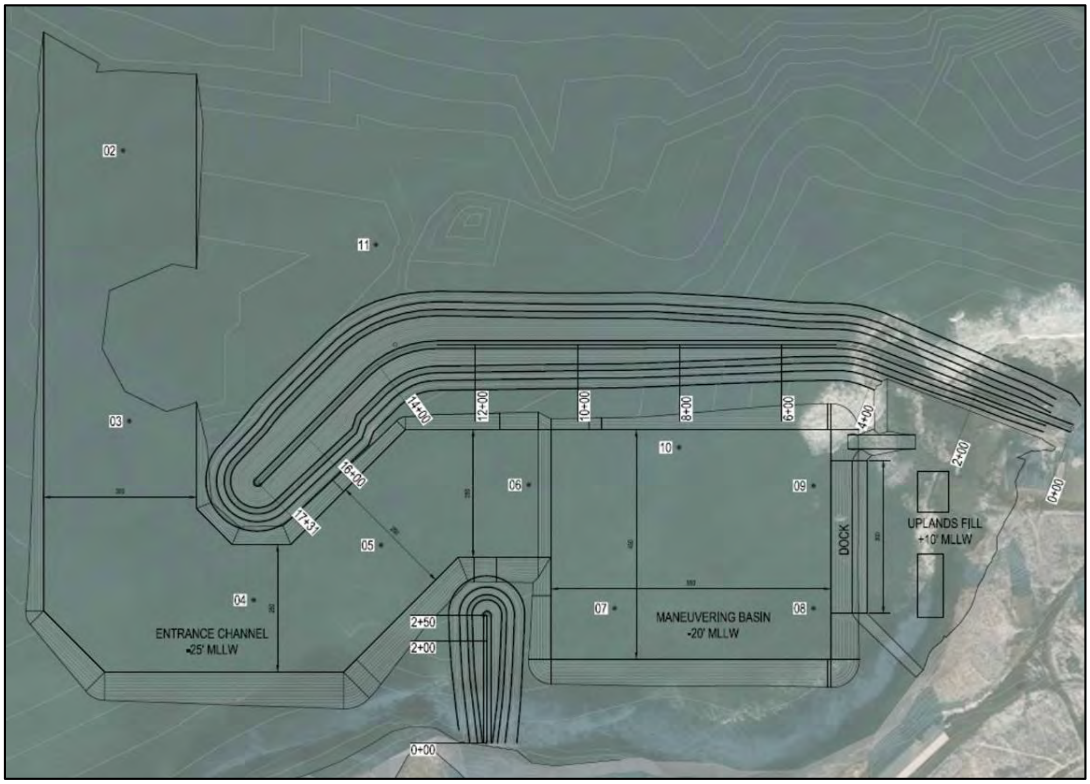

Figure C-15. Alternative N-3 Design

Primary armor stone on the north breakwater has a median weight of 10 tons. Total 10-ton armor rock is 93,871 CY. This rock is larger than what is used at Zapadni Bay, so no material from that harbor could be moved to the North site for construction. Dredging the channel and basin for this alternative requires removal of approximately 430,000 cubic yards of material. Inner harbor facilities include 2.6 acres of uplands area filled to +10 feet MLLW. A 300-foot-long pile-supported dock and a concrete boat launch ramp to -5 feet MLLW for full tide launching access would be constructed. The dock would support two crabbing vessels at a time.

7.2.5 Alternative N-4: Local Subsistence Fleet, Fuel Barge

Alternative N-4 is a subsistence vessel launch harbor with a 1,100-foot long breakwater, and entrance channel dredged to -18 feet MLLW with a maneuvering basin dredged -16 feet MLLW. Dredging the channel and basin for this alternative requires removal of approximately 150,000 cubic yards of material. Under this alternative, fuel barge access is improved as well as the subsistence fleet's access to resources. Access days for the subsistence fleet increased by 38 days, the fishing fleet by 0 days, and the fuel and freight barge by 45 days.

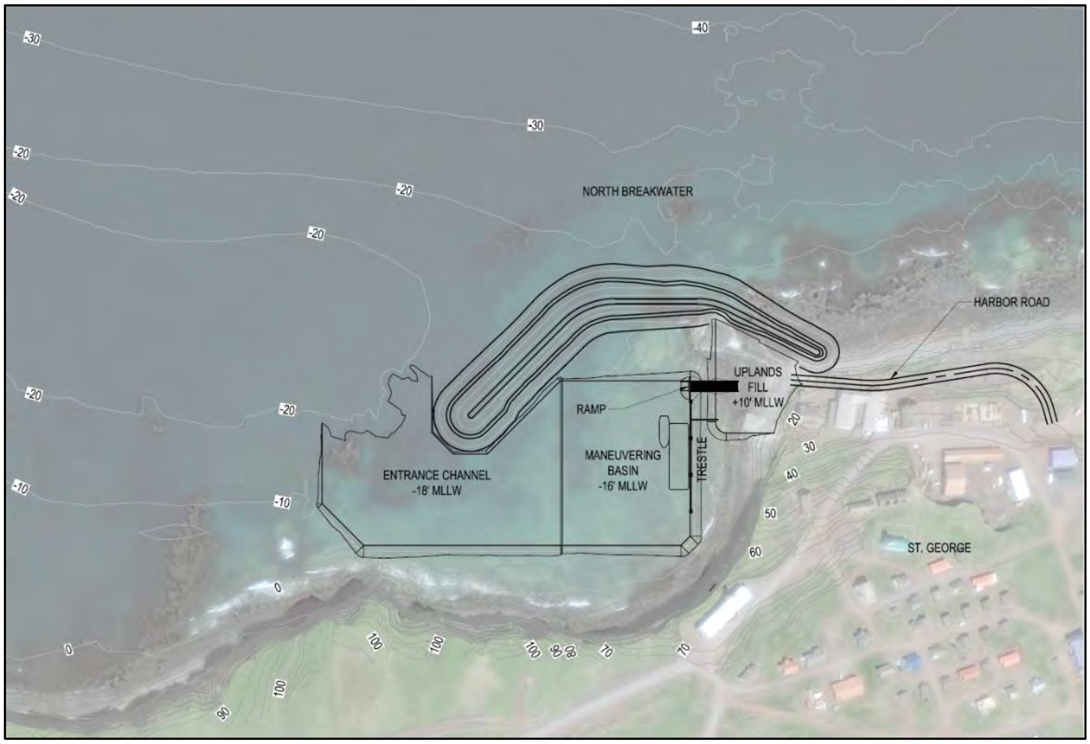

Figure C-16. Alternative N-4 Design

7.3 Project Costs

USACE Alaska District cost engineers developed Rough Order of Magnitude (ROM) cost estimates for the alternatives, including those to construct and maintain facilities. The Cost Engineering Appendix details the procedures and assumptions used to calculate the estimates. Interest during construction assumes a 2-year construction window. Initial estimates of operations and maintenance assume dredging would occur every 10 years, and 2.5 percent of breakwater armor rock would be replaced in 25 years. Project costs were developed without escalation and are in 2020 dollars. Project costs include a 39 percent contingency.

Table C-11. Detailed Project Costs by Alternative

Cost Description	Alternative N-1	Alternative N-2	Alternative N-3	Alternative N-4
Mobilization and Demobilization	$15,382,000	$15,382,000	$15,382,000	$10,255,000
Breakwater and Seawalls	$15,387,000	$84,925,000	$84,925,000	$39,577,000
Harbor Road	$49,000	$158,000	$158,000	$158,000
Navigation Ports & Harbors (Inner Harbor Facility)	$985,000	$2,297,000	$2,297,000	$587,000
Navigation Ports & Harbors (Dock)	$0	$24,165,000	$24,165,000	$9,537,000
Bank Stabilization (Slope Protection)	$449,000	$449,000	$449,000	$449,000

Navigation Ports & Harbors (Boat Launch)	$2,156,000	$3,233,000	$3,233,000	$3,233,000
Navigation Ports & Harbors (Nave Markers-lighted)	$19,000	$24,000	$24,000	$24,000
Navigation Ports & Harbors (Drill/Blast/Dredge) (GNF)	$565,000	$5,946,000	$14,377,000	$4,581,000
Navigation Ports & Harbors (Drill/Blast/Dredge) (LSF)	$0	$1,239,000	$1,798,000	$2,103,000
Lands and Damages	$28,000	$28,000	$28,000	$28,000
PED	$5,249,000	$9,730,000	$9,730,000	$9,730,000
Construction Management	$2,799,000	$13,900,000	$13,900,000	$13,900,000
Total	**$43,068,000**	**$161,476,000**	**$170,466,000**	**$94,162,000**
Note: All costs include 39 percent contingency.				

Table C-12. Project Costs by Alternative

Cost Description	**Alt. N-1**	**Alt. N-2**	**Alt. N-3**	**Alt. N-4**
Project First Cost (compounded to base year)*	$44,553,000	$166,476,000	$175,713,000	$97,309, 000
Interest During Construction	$1,231,000	$4,599,000	$4,854,000	$2,688,000
Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)	$7,073,000	$7,073,000	$7,073,000	$7,073,000
Total PV Cost	**$52,856,000**	**$178,148,000**	**$187,639,000**	**$107,070,000**
Annual Cost	**$1,958,000**	**$6,599,000**	**$6,950,000**	**$3,966,000**
*For economic analysis, costs and benefits are compared at the same price level. The Project First Cost referenced here is compounded to the base year and will differ from the Project First Cost referenced elsewhere in the report. Costs include contingency.				

7.4 Net Benefits and Benefit-Cost Ratio

Net benefits and the benefit-cost ratio (BCR) are determined using the average annual benefits and average annual costs for each alternative. Net benefits are determined by subtracting the average annual equivalent costs from the average annual benefits for each alternative; the benefit-cost ratio is determined by dividing average annual benefits by average annual costs. Project costs, benefits, and the benefit-cost ratio by alternative are summarized in Table C-13. Benefits by category and alternative are summarized in

Table C-14. Since no alternative has positive net benefits, plan selection is based on CE/ICA per USACE guidance on remote and subsistence harbors projects.[8]

Table C-13. NED Summary

Item	No Action	N-1	N-2	N-3	N-4
Present Value Benefits	N/A	$3,138,000	$29,344,000	$29,560,000	$29,266,000
Average Annual Benefits	N/A	$116,000	$1,087,000	$1,095,000	$1,084,000
Present Value Costs	N/A	$52,856,000	$178,148,000	$187,639,000	$107,070,000
Average Annual Costs	N/A	$1,958,000	$6,599,000	$6,950,000	$3,966,000
Net Annual Benefits	N/A	($1,842,000)	($5,512,000)	($5,855,000)	($2,882,000)
Benefit-Cost Ratio	N/A	0.06	0.16	0.16	0.27

Note: Alternative N-1 has the least negative net benefits, however there is no plan with positive net benefits so plan selection is determined through CE/ICA.

Categorical benefits for each alternative are as follows:

Table C-14. Average Annual NED Benefits by Category

Benefit Category	No Action	N-1	N-2	N-3	N-4
Expected Infrastructure Damages Prevented	N/A	$0	$964,000	$964,000	$964,000
Vessel Damages Prevented	N/A	$1,000	$1,000	$1,000	$1,000
Fuel & Freight Vessel Delays Prevented	N/A	$0	$4,000	$4,000	$4,000
Crabber Transportation Costs Savings	N/A	$0	$3,000	$11,000	$0
Subsistence Opportunity Cost Savings	N/A	$70,000	$70,000	$70,000	$70,000
Increased Subsistence Foods Harvested Value	N/A	$45,000	$45,000	$45,000	$45,000
Total	**N/A**	**$116,000**	**$1,087,000**	**$1,095,000**	**$1,084,000**

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[8] Section 2006 of WRDA 2007 – Remote and Subsistence Harbors, as modified by Section 2104 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) and further modified by Section 1105 of WRDA 2016.

While these values represent NED benefits resulting from navigation improvements at St. George, they do not represent the full scale of benefits that could be realized if Federal action is taken. The NED analysis does not tell the whole story of the importance of a safe and functioning harbor at St. George, so additional benefits are considered based on guidelines of the Remote and Subsistence Harbors authority. These include benefits of the proposed project to the public health and safety of the community, access to natural resources for subsistence purposes, local and regional economic opportunities, welfare of the local and regional population, and social and cultural value to the community of St. George.

7.5 Regional Economic Development Analysis

The Regional Economic Development (RED) account measures changes in the distribution of regional economic activity that would result from each alternative. Evaluations of regional effects are measured using nationally consistent projection of income, employment, output, and population. In addition to these regional effects, there is potential to realize local and regional economic opportunities through the delivery of commercial fishing harvests to St. George. It is estimated that approximately $383,000 worth of CDQ & IFQ crab that is allocated to St. George but currently delivered to St. Paul could be processed at St. George annually.

The community would potentially get several permanent jobs as a direct result of an implemented project. The jobs could include seafood plant manager, quality assurance manager, and perhaps one other processing job. Two other jobs are captain and deckhand on the water taxi. Indirect jobs come from increased activity on the island, like store sales, hotel use, marine services, tourism, etc. Benefits from the navigation improvement project related to tourism might also include additional imports of supplies for visitors, or new hard goods for the hotel transported by barge. Charter and ferry services is another potential opportunity. Subsistence is also a job, so the increase in foods harvested also supports livelihood.

The USACE Online Regional Economic System (RECONS) is a system designed to provide estimates of regional, state, and national contributions of Federal spending associated with Civil Works and American Recovery and Reinvestment Act (ARRA) Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE Recreation, Navigation, and Formally Utilized Sites Remedial Action Program (FUSRAP). Contributions are measured in terms of economic output, jobs, earnings, and/or value-added. The system was used to perform the following regional analysis for the St. George Navigation Improvements Project. A summary of the USACE regional economic system (RECONS) analysis is included below. Construction of a new harbor would also create jobs and regional economic opportunities (for purposes of the RECONS analysis, the region was defined as the Aleutians West Census Area). Most of the work would be contracted to firms operating or based out of Alaska. Some work could benefit national firms. A smaller portion would benefit companies based in the Aleutians West Borough. The break out of benefits for N-3 is shown below.

Table C-15. RECONS Summary for Alternative N-3

Area	Local Capture ($000)	Output ($000)	Jobs*	Labor Income ($000)	Value Added ($000)
Local					
Direct Impact		$70,290	263.9	$26,874	$33,061
Secondary Impact		$9,010	47.6	$2,744	$5,634
Total Impact	$70,290	$79,300	311.5	$29,617	$38,695
State					
Direct Impact		$80,955	317.3	$30,018	$37,983
Secondary Impact		$35,432	197.1	$11,477	$21,247
Total Impact	$80,955	$116,388	514.3	$41,495	$59,229
US					
Direct Impact		$99,772	398.3	$34,898	$45,464
Secondary Impact		$122,071	606.3	$37,787	$64,096
Total Impact	$99,772	$221,843	1,004.6	$72,685	$109,561

* Jobs are presented in full-time equivalency (FTE)

Additionally, moving the harbor to the north side of the island creates a regional benefit in conjunction with St. Paul Harbor. Both St. Paul Harbor and St. George Harbor are subject to storms from the southwest. A storm that would produce unsafe entrance conditions at St. George Harbor would also affect St. Paul Harbor, and both harbors would be shut down for the same storm events. By constructing a harbor on the north side of St. George Island, conditions would exist where storms would cause waves outside of St. Paul Harbor to be too high for vessels to enter, but at St. George, the island would shelter the harbor from the storm waves and vessels would still be able to navigate to the dock. The occurrence of such events would parallel the increases in safe access and moorage days detailed in the next section; however, a comparison of the regional benefits for the alternatives carried forward follows next. Additional discussion on the CDQ transfers displayed in the table below can be found in Section 4.4 of this appendix.

Table C-16. RED Account Summary

Alternative	CDQ & IFQ Transfer	Direct and Secondary Project Expenditures Captured within the Local Impact Area (estimated by RECONS)*
N-1	$0	$19,000
N-2	$100,000	$74,000
N-3	$326,000	$79,000
N-4	$0	$38,000

*RECONS Local Impact Area is defined as the Aleutians West Census Area
Note: Assumes a total potential CDQ/IFQ transfer value of $383,000. Alternatives N-1 and N-4 assume no transfer given that the design depths of these alternatives preclude access for the commercial fleet. Based on vessel draft and design depth of the alternatives, Alternative N-2 assumes only 26 percent of the fleet have the opportunity to capture the transfer, w hereas Alternative N-3 assumes 85 percent of the fleet w ould have this opportunity.

7.6 Other Social Effects (OSE)

The Other Social Effects (OSE) account focuses on social well-being factors that represent non-monetary benefits to the people and residents of a community. It includes cultural vulnerability, environmental justice (or disproportionate environmental impacts on segments of the population), and health and safety issues. Additionally, in Alaska, “subsistence,” or the ability to live off of the land, is a source of well-being for Alaskans, and especially Alaska native groups. As discussed previously, OSE factors that apply to St. George include impacts to long term viability of the community as a result of out-migration driven by a lack of economic opportunity which leads directly to cultural vulnerability.

Given that the National Economic Development analysis did not yield any plans with a benefit-cost ratio greater than one, a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was utilized to support plan selection.

7.6.1 Cost Effectiveness/Incremental Cost Analysis

7.6.1.1 Metric Description

The CE/ICA metric for this study is increased safe access and moorage days. Increased vessel opportunity days for safe access and moorage allows for vessel-class specific evaluation of improved wave and seiche conditions in comparison to the existing entrance channel and inner harbor. It also allows for the evaluation of vessel-class specific safe maneuverability and mooring of the anticipated fleet and the percentage of time (in days) that harbor facilities can be safely accessed. Therefore, this metric directly addresses the study’s objectives.

As the output of the CE/ICA, increased vessel opportunity days for safe access and moorage are also significant for non-monetary benefits in terms of the output’s institutional, public, and technical significance, as defined in ER 1105-2-100.

By analyzing harbor designs that crabbers and fishing vessels can access as part of the anticipated fleet, the metric brings institutional significance to the study—specifically, crab quota regulations intended to support community development, and life, health, and safety laws that help protect mariners.

Increased vessel opportunity days for safe access and moorage is publically significant in that it specifies the amount of additional local subsistence use and procurement of resources expected to occur, while also increasing the continuity of cultural heritage customs associated with subsistence harvests.

Last, the metric is technically significant in that without increased vessel opportunities for safe access and moorage, out-migration from St. George is likely to continue. This has consequences that include sociological, psychological, health, and anthropological effects that are tied to the cultural identity associated with a narrow geographic range (i.e., St. George Island).

7.6.1.2 CE/ICA Calculation

The draft characteristics of the anticipated vessel fleet was used to develop the wave criteria for accessibility and moorage at St George. The wave criteria for safe access and moorage differ. The wave criteria for safe access ranged from 3 to 10 feet at the harbor entrance for the anticipated fleet (fuel and freight barge, subsistence, crabbing and water taxis). A separate wave criteria of 1.6 feet at the dock dictates safe moorage inside the harbor for all vessel classes. As such, access and moorage days are calculated separately and then combined into a single metric.

To calculate access days, Alaska District Hydraulics & Hydrology (H&H) engineers modeled the annual accessibility of a harbor on the south side of the island at Zapadni Bay and on the north side of the island at the North Anchorage site. A comparison of access conditions between the two sites showed a higher percentage of accessibility at the North Anchorage site as shown in Table C-17. To determine annual access days, the percentage of accessibility is multiplied by 365 opportunity days.

Table C-17. Accessibility Wave Criteria

Vessel Class	Wave Criteria (feet)	South Site	North Site	Δ_{North}	Annual Opportunity Days	Access Days Gained at North Site
Fuel Barge	3.2	48%	58%	10%	365	36.0
Subsistence Vessel	4	54%	62%	8%	365	29.0
Crabber	10	87%	89%	2%	365	8.6
Water Taxi	10	87%	89%	2%	365	8.6

To calculate moorage days, H&H modeling determined conditions at the existing dock in Zapadni Bay would exceed the moorage threshold for the vessel fleet 27.3 days annually. The maximum access days gained (36 days) is assumed as the maximum opportunity days for moorage. Moorage days gained by each alternative is calculated as the difference between maximum opportunity moorage days and the days in which the moorage threshold is exceeded.

These access and moorage days are applied to each vessel class by alternative and range between a low of 38 days (Alternative N-1) to a high of 179 days (Alternative N-3). The analysis of safe access and moorage by alternative is then further refined by conducting the CE/ICA and comparing the vessel classes that are served as described in Section 7.6.1.3.

7.6.1.3 CE/ICA Evaluation

Based on the anticipated fleet and the wave criteria for safe access and moorage shown in Table C-18 and Table C-19, a CE/ICA was conducted to support the selection of the recommended plan.

Table C-18. Future With-Project Anticipated Fleet

Vessel Class	Vessel Draft (ft)
Fuel Barge & Tug	10 (Light Loaded)
Freight Barge & Tug	10
Subsistence Vessels	4
Crabbing Vessels (x2)	14
Water Taxi	14

Table C-19. Wave Criteria for Anticipated Fleet

Wave Location	Fuel Barge	Freight Barge	Subsistence Vessel	Crabber	Water Taxi
Entrance and Outside Harbor Wave Height (ft)	3.3	3.3	3.9	9.8	9.8
Dock Wave Height (ft)	1.6	1.6	1.6	1.6	1.6

The IWR Planning Suite output for the cost effectiveness analysis is shown in Figure C-17. This analysis yielded four cost effective plans, two of which are best buy plans (Alternatives N-3 and N-4).

Table C-20. Cost Effectiveness Analysis Summary

Alternative	Average Annual Cost	Days Gained	Cost Effective	Best Buy
N-1	$1,958,000	38	Yes	No
N-4	$3,966,000	127	Yes	Yes
N-2	$6,599,000	149	Yes	No
N-3	$6,950,000	179	Yes	Yes

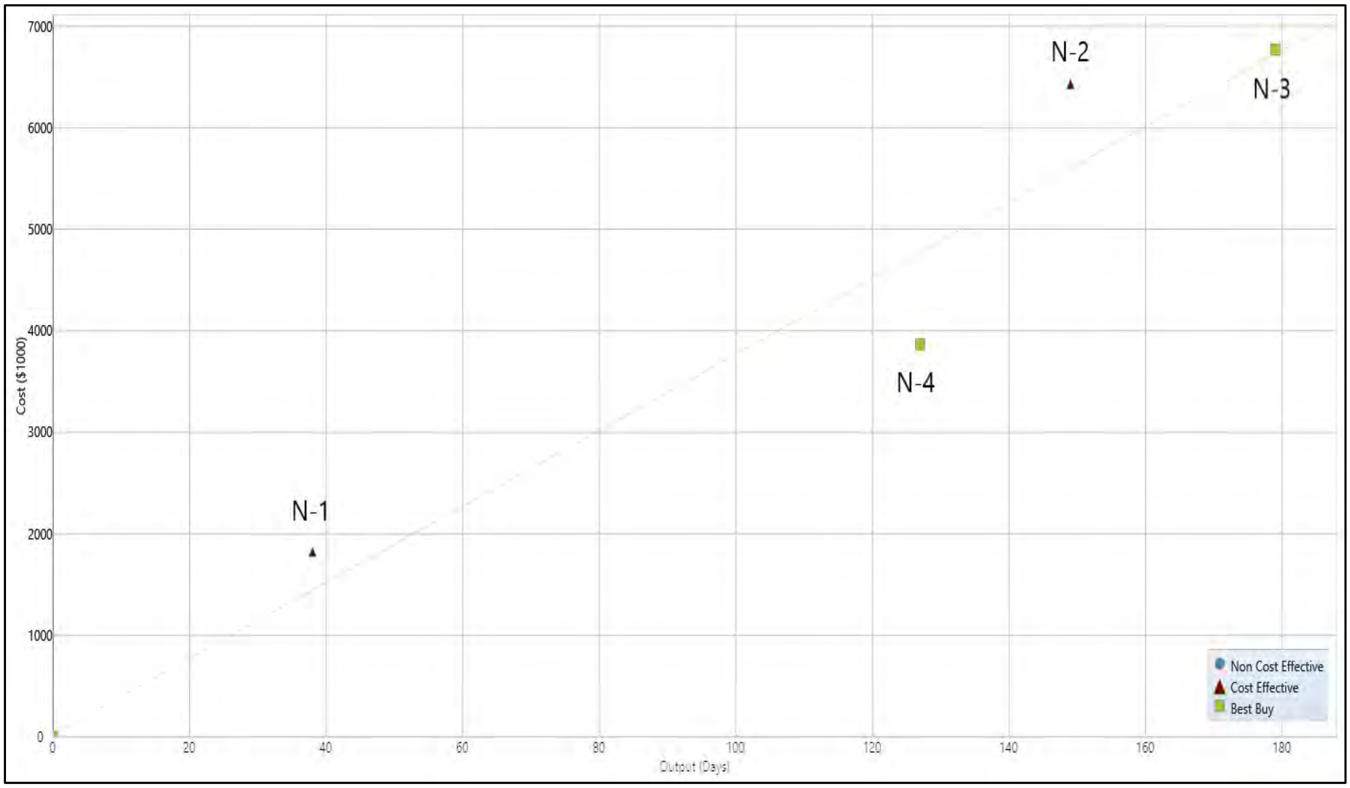

Figure C-17. Cost Effectiveness Analysis: Increased Vessel Opportunity Days for Safe Access and Moorage

The best buy plans were further evaluated through incremental cost analysis (ICA). The ICA compared the incremental cost per unit of output (vessel opportunity days for safe access and moorage) for Alternatives N-3 and N-4, as shown in Table C-21 and Figure C-18.

Table C-21. Annual Incremental Cost vs. Output for Best Buy Alternatives

Alternative	Incremental Days Gained	Incremental Cost	Incremental Cost Per Day Gained
N-4	127	$3,966,000	$31,200
N-3	52	$2,984,000	$57,300

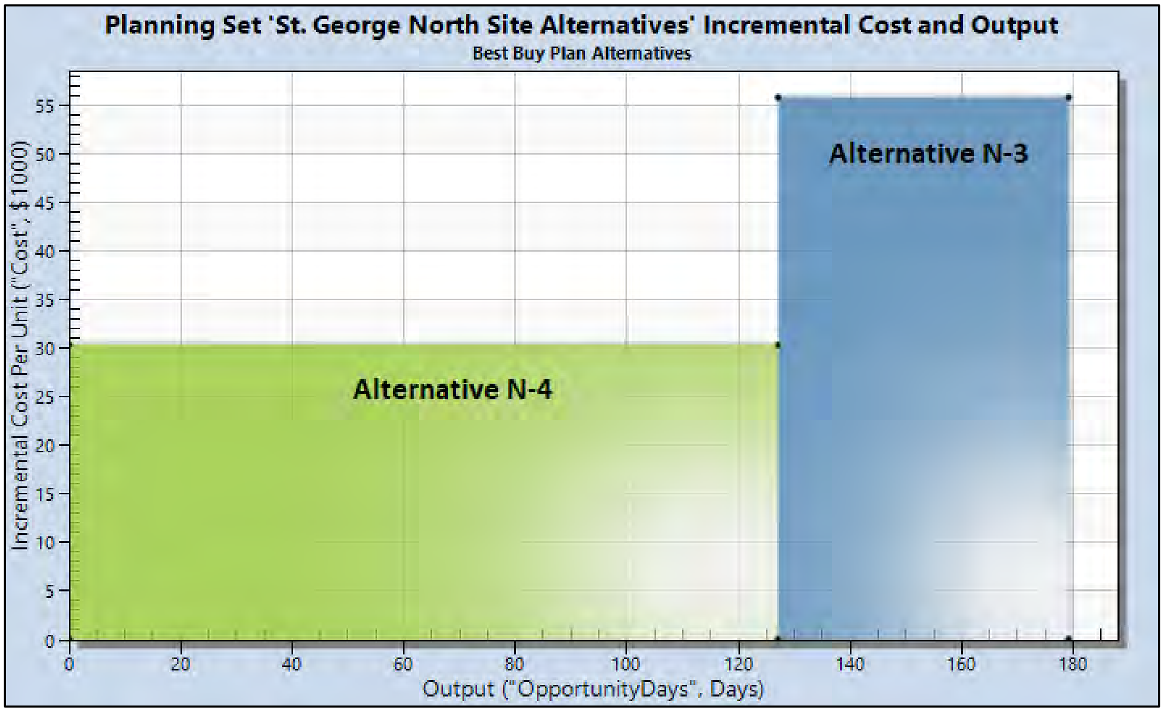

Figure C-18. Incremental Cost Analysis: Increased Vessel Opportunity Days for Safe Access and Moorage

The selection of a recommended alternative was further refined through analysis of the type of access and moorage provided by the two Best Buy plans. While Alternative N-4 provides a gain of 127 days of access when compared to the No Action alternative, none of these days are associated with the crabbing (CDQ and IDQ) fleet. In comparison, Alternative N-3 provides 179 days of access, which includes 17 days of safe access and 17.4 days of safe moorage for the crabbing fleet (Table C-22). Based on the CE/ICA and given that the CDQ/IFQ crabbing fleet is a driver of community viability, Alternative N-3 is identified as the Recommended Plan.

Table C-22. Annual Access/Moorage Days Gained by Fleet Type for Best Buy Alternatives

	Alternative N-4	Alternative N-3
Access Days Gained		
Fuel Barge	36.0	36.0
Freight	36.0	36.0
Subsistence Vessel	29.0	29.0
Crabber x2	0.0	17.0
Taxi	0.0	9.0
Moorage Days Gained		
Fuel Barge	8.7	8.7
Freight	8.7	8.7
Subsistence Vessel	8.7	8.7
Crabber x2	0.0	17.4
Taxi	0.0	8.7
Total Days Gained	**127.1**	**179.2**

7.7 Recommended Plan

In consideration of the CE/ICA presented above, the Recommended Plan is Alternative N-3. This alternative consists of a 450-foot wide by 550-foot-long mooring basin dredged to -20 feet MLLW protected by a 1,731-foot-long north breakwater and a 250-foot-long stub breakwater at the west edge of the basin. The basin connects to the Bering Sea with a 250-foot wide navigation channel dredged to -25 feet MLLW. Inner harbor facilities include 2.6 acres of uplands area filled to +10 feet MLLW with a 300-foot-long pile-supported dock and a concrete boat launch ramp to -5 feet MLLW for full tide launching access.

The north breakwater requires approximately 85,000 cubic yards of armor stone, 54,000 cubic yards of B rock, and 80,000 CY of core rock. The stub breakwater requires approximately 9,000 CY of armor stone, 6,500 CY of B rock, and 5,000 CY of core rock. The basin and navigation channel require removal of approximately 430,000 CY of material to reach the proposed maximum depths for the project. Uplands construction requires approximately 45,000 CY of fill.

The dredging characteristics of the bottom material at the north site are not well known. Large boulders on the shoreline could be representative of bottom conditions, but it is not known if material within the dredge prism is sand and gravel, cobbles and boulders, or bedrock. The characteristic of this material greatly affects the requirements for dredging, and it is currently assumed that blasting and mechanical removal is required. Alternative N-3 is expected to produce an additional 179 safe access and moorage days for the anticipated fleet. There are still 153 calendar days in a year when sea conditions are too rough for the fuel barge or freight barges to access N-3. There are also 139 calendar days in a year when subsistence vessels would not launch, and 40 when crabbers would bypass St. George. Similarly, there are 40 days when the anticipated water taxi would not sail. And last, there are 27 days when no vessel could safely moor within the harbor.

7.8 Four Accounts Summary

USACE planning guidance establishes four accounts to facilitate and display the effects of alternative plans. Previous studies have relied primarily on the use of the NED account, showing the changes in the economic value of the national output of goods and services. As previously noted, the analysis described in this report follows implementation guidance for Section 2006 authorized projects, which allows for plan selection based on CE/ICA.

7.8.1 National Economic Development (NED)

The results of the NED analysis were discussed in previous sections. No alternative has a benefit-cost ratio greater than one, so CE/ICA was used to inform plan selection.

7.8.2 Regional Economic Development (RED)

Economic benefits that accrue to the region but not necessarily the nation include increased income and employment associated with the construction of a project, as well as realization of local and regional economic opportunities through the delivery of commercial fishing harvests to St. George.

7.8.3 Environmental Quality (EQ)

Environmental Quality displays the non-monetary effects of the alternatives on natural resources and is described in the environmental assessment sections of the draft feasibility report. Qualitative enhancements to the environment include a reduction in fossil fuel usage and emissions due to decreased delays for vessels along with reduced transportation distances for vessels to access fishing grounds. Those benefits would be overshadowed by negative impacts to the environment from harbor construction, increased vessel traffic, increased risks associated with inadvertent release of environmentally persistent pollutants (i.e., fuel spill, oil spill), etc. Additional information is available in the Consequences of the Recommended Plan in the main feasibility report.

7.8.4 Other Social Effects (OSE)

St. George, like many rural economies throughout Alaska, is a mixed, subsistence-cash economy in which the subsistence and cash sectors are interdependent and mutually supportive. The ability to successfully participate in subsistence activities is highly dependent on the opportunity to earn some form of monetary income and access the resources need to engage in these activities. Without a safe and functioning harbor that provides access for subsistence vessels, fuel and freight delivery, and a portion of the commercial fishing fleet, economic opportunities in the community would continue to be hindered, and the costs of basic essential goods required to support a subsistence lifestyle would remain prohibitively high, contributing to continued out-migration from St. George. When community viability is threatened by high costs of essential goods (including fuel), tribal identities and cultural communities can be lost.

A safe and functioning harbor that improves access to St. George would provide opportunities for the development of a local economy based upon the marine resources of the region. Such economic opportunities are essential for supporting St. George’s mixed, subsistence-cash economy, combating out-migration, and helping to strengthen the viability of the community on St. George.

Under Alternative N-3, the socioeconomic paradigm within the community of St. George would be positively impacted. As such, impacts to the community’s population and demographics, and employment and income would be likely to occur at some level in both the short- and long-term.

Facets of the community’s population and demographics would be impacted by all aspects of the proposed project. An increase in transient laborers during construction and then more permanent-type positions during long-term harbor operations would beget requirements for support services. All of which would generate employment opportunities that may attract potential residents to St. George. Increased economic opportunity at St. George would likely impact the trend of out-migration.

Significant portions of the construction work are likely to require heavy equipment operators, engineers, logistical specialists, and other-well paying positions. Long-term operation of the harbor and efforts that support maintenance and oversight of those facilities would also likely generate employment opportunities. Also, reliable, long-term operation of the harbor would be expected to reduce transportation associated costs applied to fuel and durable goods that borne by the community.

Long-term effects stemming from the implementation of Alternative N-3 may also include the stability that the harbor offers the community of St. George, fuel and durable goods could be reliably delivered, where in the past, this was not guaranteed. Indirect impacts could vary in scale or scope but could include the establishment of ecotourism, fish processing, marine repair, or similar type business based at St. George.

7.8.5 Four Accounts Evaluation Summary

Based on this analysis of the four accounts, each alternative has positive effects for the RED and OSE accounts and temporary negative effects for the EQ account. The four accounts summary for all alternatives, with the Recommended Plan highlighted in yellow, is shown in Table C-23.

Table C-23. Four Accounts Evaluation Summary

Alternative	Benefit-Cost Ratio	Average Annual Cost	EQ	RED	OSE (increased access & moorage
No Action	N/A	$0	Neutral	Neutral	0
N-1	0.06	$1,958,000	Negative	Increased employment and income for the region and state	38
N-2	0.16	$6,599,000	Negative	Increased employment and income for the region and state	149
N-3	0.16	$6,950,000	Negative	Increased employment and income for the region and state	179
N-4	0.27	$3,966,000	Negative	Increased employment and income for the region and state	127

7.8.1 Project Cost Summary

Updated costs for the recommended plan were completed using MCACES and include a Cost and Schedule Risk analysis for contingency development. This cost update would not alter the plan selection and was not performed for alternatives N-1, N-2, and N-4, therefore the Level 4 costs are carried through the economic analysis for plan evaluation and comparison. Summary of the updated project costs for the recommended plan are included below. Note that the costs presented in this cost share table are based on certified costs, which differ from the costs presented in the rest of this appendix that were used to compare and screen alternatives.

Table C-24. Cost Sharing for Recommended Plan

Cost Share (October 1, 2019 Price Levels, Program Year (FY) 2020)[1]			
Description	**Project Cost with Contingency**	**Federal Share**	**Non-Federal Share**
General Navigation Features			
Breakwater	$109,605,000	$98,644,500	$10,960,500
Navigation Ports and Harbors[2]	$31,594,000	$28,434,600	$3,159,400
Preconstruction, Engineering & Design (PED)[4]	$7,246,000	$6,521,400	$724,600
Construction Management (S&I)[3]	$11,318,000	$10,186,200	$1,131,800
Subtotal Construction of GNF	**$159,763,000**	**$143,786,700**	**$15,976,300**
Lands, Easements, Right-of-Ways, Relocations (LERR)[4- Federal]	$0	$0	$0
Lands, Easements, Right-of-Ways, Relocations (LERR)[4- Non-Federal]	$75,000	$0	$75,000
Total Project First Costs	**$159,838,000**	**$143,786,700**	**$16,051,300**
Aids to Navigation[5]	$91,000	$91,000	$0
Credit for Non-Federal LERR[6]		$75,000	($75,000)
Roads and Docks-LSF	$17,999,000		$17,999,000
Navigation Ports and Harbors-LSF	$2,994,000		$2,994,000
Preconstruction, Engineering & Design (PED)- LSF	$1,084,000		$1,084,000
Construction Management (S&I)-LSF	$1,690,000		$1,690,000
10% GNF Non-Federal[7]		($15,976,300)	$15,976,300
Total Cost Apportionment	**$183,696,000**	**$127,976,400**	**$55,719,600**

Notes:

1. Cost is based on Project First Cost (constant dollar basis) on Total Project Cost Summary Spreadsheet, at an effective price level 1 Oct 2019 (Cost Appendix). Aids to Navigation broken out and shown as a separate cost.

2. ER 1105-2-100, Appendix E, E-8, b. (6) states, "Increased depths provided in entrance channels for transit of vessels between protected interior channels and the wave action zone, e.g., across an outer bar, will be cost shared the same as the deepest protected interior channel. Breakwaters, jetties and channel width increases are cost shared in the same manner." Federal and non-Federal breakdown of costs reflect 90% Federal/10% non-Federal.

3. PED and Construction cost sharing totals are reflected as 90% Federal/10% non-Federal.

4. These are Real Estate administrative costs. There are no actual lands and damages but per USACE regulations, Real Estate administrative costs will be placed in the 01 account. Additional Real Estate costs will be

cost shared according to the GNF. Escalation from the TPCS accounts for some numerical differences.

5. Aids to Navigation are reflected as a Federal cost, but are coordinated and paid for by the U.S. Coast Guard.

6. Credit is given for the incidental costs borne by the non-Federal sponsor for lands, easements, rights of w ay and relocations (LERR) per Section 101 of WRDA 86, not to exceed 10% of the GNF

7. The non-Federal sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited tow ard the additional 10% payment except in the case of LERR for GNF.

Table C-25. Recommended Plan Project Cost Summary

Investment Costs	
Total Project Construction Costs	$200,433,000
Interest During Construction	$15,976,000
OMRR&R	$9,480,000
Total Investment Cost	$225,889,000
Average Annual Costs	
Interest and Amortization of Initial Investment	$8,016,000
OMRR&R	$351,000
Total Average Annual Costs	$8,367,000
Average Annual Benefits	$1,066,000
Net Annual Benefits	($7,301,000)
Benefit-Cost Ratio	0.13 to 1

Note: October 2019 Price level, 50-Year Period of Analysis, 2.750 Percent Discount rate. Costs and benefits in this table are based on the certified cost for the Recommended Plan and differ slightly from the costs and benefits used for plan evaluation and comparison.

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ST. GEORGE HARBOR IMPROVEMENT FEASIBILITY STUDY

APPENDIX D: COST ENGINEERING

ST. GEORGE, ALASKA

U.S. Army Corps
of Engineers
Alaska District

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1.0 INTRODUCTION

The purpose of the Cost Engineering Appendix is to discuss the cost assumptions, methodology, materials, labor, and equipment used to develop the construction cost estimates for the St. George Feasibility Study. This study is intended to evaluate Federal interest in and feasibility of providing navigation improvements at St. George, Alaska.

There were two distinct cost estimate efforts for this study that follow the Civil Works Planning Process;

- Develop construction costs for the Alternative Decision Milestones (ADM)
- Develop a cost estimate for the Recommended Plan.

The ADM estimate development is documented in Section 2 of this Appendix, and the Recommended Plan estimate is documented in Section 3 of this Appendix. The Recommended Plan cost estimate was reviewed and certified by the Cost Mandatory Center (Cost MCX) of Expertise in April 2020.

1.1. Cost Certification

The recommended plan, N3, was certified on April 21, 2020, by the Cost MCX to have an estimated FY20 Estimated Total Project Cost of $159,838,000 and a Fully Funded Amount of $204,004,000. A copy of the certification is included in this appendix.

1.2. Standards, Estimate Software and Data Sources

- ER 1110-1-1300 Cost Engineering Policy and General Regulations
- ER 1110-2-1302 Civil Works Cost Engineering
- UFC 3-740-05 Handbook: Construction Cost Estimating with Change 1
- ASTM E2515-11, Standard Classification for Cost Estimate Classification System
- MCACES 2nd Generation (MII) version 4.4
- Davis Bacon Wage Rates - Alaska
- 2016 EP1110-1-8, Equipment Region 9
- 2016 MII English Cost Book

The cost estimate level of accuracy is classified per ASTM E2515-11 as a function of the level of design development. Estimates for the ADM phase are considered Level 4 estimates, and the Recommended Plan estimate is Level 3.

2.0 ALTERNATIVE DECISION MILESTONE COST ESTIMATES

2.1. Quantities

The quantities for the initial array of alternatives (alt) were developed by the H&H Design team. Dredge and rock quantities for the breakwater construction made up the main portion of the costs developed. These quantities were checked by the cost team for reasonableness.

2.2. Unit Prices

The unit prices used in Class 4 alternative estimates developed using a combination of historical bid data, cost models used in similar types of project estimates, and current pricing for large cost items such as breakwater rock. This data was entered into MCACES for the TSP (Alternative 3B). The unit costs calculated for A-rock, B-rock, C-rock, mobe-demob, drill/blast, and the LSF work features was then used for the other Alternative cost estimates used for the economic analysis. All costs were adjusted to factor freight, and local area mark-ups and other global mark-ups typically included in a Class 4 level estimate. Some specific assumptions and methodologies used in these estimates are listed below;

1. Mobilization-Demobilization – assume full plant from West Coast CONUS. The quantity depended on the scope. For alt comparison purposes, three years was used for the different alternatives.
2. Breakwater – Standard rubble mound-breakwater construction methods were assumed, using marine-based equipment placing material from a barge until above the tideline. Special placement armor will be via equipment on the crest.
3. Quarried material costs were assumed from historical data and previous quotes from quarries. There is no operating local quarry source and little demand for local quarry materials. The rock for the project is assumed likely to be transported by barge from the quarry near Nome, Alaska. Unalaska is a possibility, but the material from that source is more suited to gravel and fill, not armor rock, from the quarry at Sand Point, Alaska, or possibly from Kodiak Island.
4. Rough Order of Magnitude (ROM) rock pricing was based on prior project low bids constructed at St. Paul Island (2016 and 2009) and Nome Harbor (2005) with escalation to the current level (2019). Although Cape Nome rock was used partially or totally for some of these projects, it was transported shorter distances.
5. Drill-Blast-Dredge – unit cost used from similar projects and normalized to current prices. Dredging unit costs assumed mechanical dredging and in-water disposal for applying similar projects.
6. All LSF features – ROM level costs developed using quantities and historical pricing from similar projects.

2.3. Contingencies

Contingencies represent allowances to cover unknowns, uncertainties, and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time the cost estimate is prepared. Still, it must be represented by a sufficient cost to cover the identified risks. An abbreviated risk analysis (ARA) has been prepared for the alternative cost estimates to calculate alternative specific contingencies. Based on this, 39% contingency was used for all the Alternative Cost Estimates for use in comparison and the Alternative Decision Milestone.

Table 1. Summary of Alternatives- Total Project Costs

No table of figures entries found.	Alternative N-1	Alternative N-2	Alternative N-3	Alternative N-4
Mobilization and Demobilization	$11,066,000	$11,066,000	$11,066,000	$7,378,000
Breakwater and Seawalls	$11,070,000	$61,097,000	$61,097,000	$28,473,000
Harbor Road	$35,000	$114,000	$114,000	$114,000
Navigation Ports & Harbors (Upland Fill)	$709,000	$1,653,000	$1,653,000	$422,000
Navigation Ports & Harbors (Dock)	$0	$17,385,000	$17,385,000	$6,861,000
Bank Stabilization (Slope Protection)	$323,000	$323,000	$323,000	$323,000
Navigation Ports & Harbors (Boat Launch)	$1,551,000	$2,326,000	$2,326,000	$2,326,000
Navigation Ports & Harbors (Nave Markers-lighted)	$14,000	$18,000	$18,000	$18,000
Navigation Ports & Harbors (Drill/Blast/Dredge) (GNF)	$406,000	$4,278,000	$10,343,000	$3,296,000
Navigation Ports & Harbors (Drill/Blast/Dredge) (LSF)	$0	$891,000	$1,293,000	$1,513,000
Lands and Damages	$20,000	$20,000	$20,000	$20,000
PED	$3,776,000	$7,000,000	$7,000,000	$7,000,000
Construction Management	$2,014,000	$10,000,000	$10,000,000	$10,000,000
Contingency (approx 39%)	$12,084,000	$45,307,000	$47,402,000	$26,184,000
Total	**$43,068,000**	**$161,478,000**	**$170,040,000**	**$93,926,000**

Table 2. Abbreviated Cost Risk Analysis Calculated Contingency

Abbreviated Cost Risk Analysis

Project (less than $40M): **St George Harbor Improvements**
Project Development Stage/Alternative: **Feasibility (Alternatives)**
Risk Category: **Moderate Risk: Typical Project Construction Type**
Alternative: **Alt N3 - Crabber Fleet Hbr**
Meeting Date: **7/19/2018**

Total Estimated Construction Contract Cost = **$ 105,618,008**

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	**$ 20,000**		**20.00%**	$ 4,000	$ 24,000
1	**32 01 MOB, DEMOB & PREPARATORY WORK**	**Mobilization - Demobilization**	**$ 11,066,266**		22.23%	$ 2,460,307	$ 13,526,574
2	**12 NAVIGATION, PORTS AND HARBORS**	**Drill blast dredge**	**$ 11,928,451**		56.42%	$ 6,729,698	$ 18,658,150
3			**$ -**		0.00%	$ -	$ -
4	**12 NAVIGATION, PORTS AND HARBORS**	**Navigation Markers**	**$ 17,500**		11.01%	$ 1,927	$ 19,427
5	**16 BANK STABILIZATION**	**Slope Protection**	**$ 323,280**		15.42%	$ 49,853	$ 373,133
6	**10 BREAKWATERS AND SEAWALLS**	**Rubblemound Breakwater (Attached)**	**$ 61,389,049**		34.08%	$ 20,924,041	$ 82,313,090
7	**12 NAVIGATION, PORTS AND HARBORS**	**Boat Launch Ramp**	**$ 2,326,210**		23.71%	$ 551,624	$ 2,877,833.46
8	**02 01 ROADS, Construction Activities**	**Uplands Fill & Road Improvements**	**$ 1,766,616**		25.67%	$ 453,436	$ 2,220,052.47
9	**12 NAVIGATION, PORTS AND HARBORS**	**Dock**	**$ 17,384,920**		60.92%	$ 10,590,044	$ 27,974,963.78
10	**12 NAVIGATION, PORTS AND HARBORS**		**$ -**		0.00%	$ -	$ -
11	**12 NAVIGATION, PORTS AND HARBORS**		**$ -**		0.00%	$ -	$ -
12	All Other	**Remaining Construction Items**	**$ (584,285)**	*0.0%*	0.00%	$ (317,887)	$ (902,172)
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	**$ 7,000,000**		40.35%	$ 2,824,668	$ 9,824,668
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	**$ 10,000,000**		35.52%	$ 3,551,560	$ 13,551,560
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					**$ -**	

Totals				
Real Estate	$ 20,000	20.00%	$ 4,000	$ 24,000.00
Total Construction Estimate	$ 105,618,008	39.24%	$ 41,443,044	$ 147,061,052
Total Planning, Engineering & Design	$ 7,000,000	40.35%	$ 2,824,668	$ 9,824,668
Total Construction Management	$ 10,000,000	35.52%	$ 3,551,560	$ 13,551,560
Total Excluding Real Estate	**$ 122,618,008**	**39%**	**$ 47,819,272**	**$ 170,437,280**

	Base	**50%**	**80%**
Confidence Level Range Estimate ($000's)	$122,618k	$151,309k	$170,437k

CONTINGENCY USED FOR ALL ALTERNATIVE ESTIMATES

3.0 RECOMMENDED PLAN COST ESTIMATE

This section documents the development of the recommended plan cost estimate, which was completed using MCACES and included a Cost and Schedule Risk Analysis (CSRA) for contingency development. Alternative N-3 from the final array of alternatives was selected as the recommended plan.

3.1. Basis of Estimate

Documents Referenced for Scope of Work: Alternatives Sketches, Geotechnical Survey Drawings, Quantities from Designers, and the Feasibility Report dated February 2020. Quantities and dimensions were provided by the project designers. Project conditions and construction costing were based upon the alternatives presented. Lands and Damages costs were provided by the Real Estate Branch of The Corps' Alaska District (POA). The PED, supervision inspection, and overhead (SIOH) were calculated via a percentage of the Estimated Construction Cost.

3.2. Acquisition Plan

The estimate assumes one contract being awarded for the total project. It is assumed that the bidding process would be unrestricted. All contractor and project mark-ups have been adjusted accordingly in the cost estimate. The estimate also assumes that the Prime Contractor would be a marine/heavy civil contractor capable of completing all the rock placement and dredging. The drilling and blasting would be subcontracted. Some other small features of work would be subcontracted as well.

3.3. Project Schedule

It is estimated that the overall construction duration from construction notice-to-proceed to completion would take approximately 68 months. The volume, rock, mobilization, demobilization, and distance, are critical factors in why this project is estimated to need this duration.

There are a few key constraints that create additional challenges. These introduce risk and complex factors a contractor would have to endure to construct this project.

1. Harsh Weather - The Island is located in the Bering Sea, which is subject to very harsh weather. Harsh weather limits the available days the contractor will be allowed to work. The Island and surrounding area are, for the most part, ice-free.
2. Limited Shelter - The Island of St George has few if any suitable locations for marine-based equipment (barges, tugs, etc.) to shelter in bad weather until the breakwater is constructed.
3. Hard Rock Bottom for Harbor – All of the new basins are assumed to require drilling and blasting to loosen and break up the material for harbor deepening
4. In-Water Work Restrictions – The contractor will not be able to do any blasting or pile driving between April 1 and October 31 of any calendar year. A large portion

of the complex and challenging work will have to be done during the winter months, which are susceptible to harsh storms, rough seas, and limited daylight.

5. Far From Viable Rock Sources – the size of rock needed for the breakwater limits the known sources of armor rock. Cape Nome and Kodiak Island are currently the nearest known sources.

As a result of these challenges and constraints, the project schedule was developed using fairly conservative production rates, work windows, and assumptions. Still, the Cost and Schedule Risk Analysis (CSRA) indicated that this project could quite possibly extend to 82 months to complete. The critical path for the schedule appears to be the delivery of the rock to the placement crew.

3.4. Project Construction

3.4.1. Sequencing and Work Windows

The breakwater would most likely need to be the first major feature built because it would provide some minimal shelter for equipment and possibly a load out area for staging. Since most of the material needs to be towed from Cape Nome or Kodiak, this would have to happen during the summer months to mitigate the risk of hauling large cargo loads during fall and winter storm seasons where ocean conditions won’t allow that.

The dredging would also happen during the summer months; this is because the equipment plant for dredging is similar to that used to construct the breakwater. The disposal of dredged material is in open water, thus making it risky to plan work during the winter months while D-B is occurring.

The drill and blast have to happen during November-April (referred to as the D-B work window). Since it would be best to start that work after some of the breakwaters are built, the start time for this work would lag behind breakwater construction.

As the breakwater is completed and the basins are deepened, the contractor could work on the local sponsored features (dock, uplands, and boat launch).

3.4.2. Staging and Site Access

The work would start with limited staging areas. Site access could be gained from Zapadni Bay, and once the new harbor is substantially complete, the contractor could use that area for access.

3.4.3. Construction Methodology

The estimate assumes breakwater placement would likely be via standard rubble mound construction methods using both land and marine-based equipment. The material would be placed from a barge until above the tideline. Then special placement armor will be via equipment on the crest.

Barges with core and B-rock could either be open water dumped or loaded into skip boxes, then lifted into place with a crane and placed in the water.

It's assumed the drill and blast contractor would have drills (2 to 4 each) mounted on a barge. Casement would be installed as holes were drilled and the charges placed from the barge, therefore it assumes no diving would be required. Without better geotechnical data for the material, the estimate assumes there will be areas of the basin that will require two separate drill/blast holes to break the material loose completely. It's assumed roughly 33% of the total area will need two drilled holes and blasts.

After the material was loosened, the dredging would take place. Dredging would be via mechanical clamshell dredge loaded onto a split scow barge, then towed to disposal site offshore. The disposal site is approximately 1 mile offshore from the project area.

The dock would require predrilled piling with a concrete deck. Uplands would be placed via barge delivered material unloaded and placed.

3.4.4. Equipment/Labor Availability and Distance Traveled

All equipment and labor are likely to be available in Alaska, but the estimate assumes the majority of the equipment will originate from the West Coast of Continental U.S.

3.5. Effective Dates for Labor, Equipment and Material Pricing

The labor, equipment, and material pricing were developed using the MCACES 2016 English Unit Cost Library, 2018 Alaska Statewide Labor Library, and the 2016 Equipment Library (Region 9) for the base cost estimates. The index pricing data has been prepared in October 2019 dollars.

The base cost estimates have been updated with current quoted fuel prices of $3.50/gal for off-road diesel, $3.50/gal for on-road diesel, and $3.50 /gal for gasoline in the state of Alaska.

3.6. Estimated Production Rates

Most of the production rates used were based on historical pricing (user-defined crews and production rates).

3.7. Project Mark-Ups

3.7.1. Escalation

Price levels have been escalated from effective price levels of the construction cost estimate for October 2019 (1Q20) to the mid-points of construction for the project. The appropriate escalation cost factors for each date and for each feature account have been calculated within the Total Project Cost Summary (TPCS).

3.7.2. Contingency

A Cost and Schedule Risk Analysis (CSRA) was completed to develop the contingency for the Recommended Plan. The CSRA report, documenting the development of the risk-based contingency, is included.

3.7.3. Overtime

The estimate assumes 6-day work weeks, 12 hours per day.

3.7.4. MCACES

The construction cost estimate was developed using MCACES 2nd Generation (MII) estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. See Attachment 10 for the MII output report.

3.7.5. Total Project Cost Summary Sheet (TPCS)

The TPCS was prepared using the latest TPCS Excel spreadsheet provided by USACE Cost CX. The TPCS incorporates the construction costs developed in MCACES, the project mark-ups, and functional costs referenced previously. The local sponsor facility (LSF), which are the road access sites, are included on the third page of the TPCS for reference. See Attachment 11 for the TPCS spreadsheet.

St George SBH
NORTH ALTERNATIVE 1 Subsistence Fleet Hbr

GNF

Item	Quantity	Units	Description	2020Q1 Unit Cost ($)	Cost ($)	
Mob/Demob - Fltg Drill & Dredge Plants	3	Yr		$ 3,688,755.47	$ 11,066,266.42	
Drill/Blast/Dredge	10,015	CY	Rocks and sand overburden over bedrock. Depth to bedrock unknown. Assume 100% of quantity requires blasting.	$ 40.57	$ 406,295.06	
A Rock	19,488	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 6,382,125.12	
B Rock	16,261	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 2,628,428.04	
C Rock	17,222	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 2,059,062.32	
				TOTAL GNF =	**$ 22,542,176.96**	90%

LSF

Item	Quantity		Description			
Road Improvements	1	LS		$ 35,000.00	$ 35,000.00	
Upland Fill	21,915	CY	Minus 12 inch, Max 5% passing #200; local source	$ 32.33	$ 708,613.32	
Slope Protection Rock	2,000	CY	500 lb rock	$ 161.64	$ 323,280.00	
Boat Launch	2080	SF	16' wide Concrete Plank ramp, 13% slope from +10' to -5' MLLW, approx 130' long	$ 745.58	$ 1,550,806.40	
Nav Markers - Lighted	4	EA	1 @ end of BW, 2 @ channel entrance, 1 @ channel bend	$ 3,500.00	$ 14,000.00	
				TOTAL LSF =	**$ 2,631,699.72**	10%
				TOTAL CONTRACT 2019 =	**$ 25,173,876.68**	
			Assume PED start Oct 2020	PED <= $10m	$ 3,776,081.50	15%
				SIOH <= $15m	$ 2,013,910.13	8%
				Real Estate	$ 20,000.00	
				TOTAL PROJECT =	**$ 30,983,868.32**	
				Contingency	$ 12,083,708.64	39%
				Total =	**$ 43,067,576.96**	

St George SBH

NORTH ALTERNATIVE 2b — Fuel and Supply Barge Harbor

GNF

				2020Q1		
Item	Quantity	Units	Description	Unit Cost ($)	Cost ($)	
North Breakwater	1800	LF		$ 31,890.54		
A Rock	100,423	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 32,887,528.27	
B Rock	63,068	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 10,194,311.52	
C Rock	119,782	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 14,321,135.92	
Spur Breakwater	225	LF		$ 16,417.47		
A Rock	7,445	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 2,438,163.05	
B Rock	5,007	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 809,331.48	
C Rock	3,734	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 446,437.04	
Drill/Blast/Dredge	127,427	CY	Rocks and sand overburden over bedrock. Depth to bedrock unknown. Assume 100% of quantity requires blasting.	$ 40.57	$ 5,169,541.77	
Mob/Demob - Fltg Drill & Dredge Plants	3	Yr		$ 3,688,755.47	$ 11,066,266.42	
				TOTAL GNF =	**$ 77,332,715.46**	78%

LSF

Item	Quantity		Description			
Harbor Road (LSF)	800	LF	Very Low traffic volume, two 12 ft lanes, 2 ft shoulders, gravel surface	$ 98.15	$ 78,520.00	
Surface Course (F1)	355	CY	Minus 1 inch, Max 20% passing #200; local source	$ 23.05	$ 8,182.75	0.5 ft
Base Course (D1)	446	CY	Minus 1 inch, Max 5% passing #200; local source	$ 35.50	$ 15,833.00	0.5 ft
Excavation	672	CY		$ 16.76	$ 11,263.78	0.84 ft
Road Improvements	1	LS		$ -	$ -	
Upland Fill	51,116	CY	Minus 12 inch, Max 5% passing #200; local source	$ 32.33	$ 1,652,816.72	
Slope Protection Rock	2,000	CY	500 lb rock	$ 161.64	$ 323,280.00	
Dock	28,000	Sf	Precast Concrete Deck on Steel Piles - 28,000 SF	$ 620.89	$ 17,384,920.00	
Boat Launch	3120	SF	24' wide Concrete Plank ramp, 13% slope from +10' to -5' MLLW, approx 130' long. (65) 8 in x 24 in x 24 ft planks on three 6x6 pressure treated lumber sleepers.	$ 745.58	$ 2,326,209.60	
Nav Markers - Lighted	5	EA	2 @ ends of BWs, 2 @ channel entrance, 1 @ channel bend	$ 3,500.00	$ 17,500.00	
				TOTAL LSF =	**$ 21,818,525.86**	22%
				TOTAL CONTRACT =	**$ 99,151,241.32**	
				PED <= $10m	$ 7,000,000.00	7%
				SIOH <= $15m	$ 10,000,000.00	10%
				Real Estate	$ 20,000.00	
				TOTAL PROJECT =	**$ 116,171,241.32**	
				Contingency	$ 45,306,784.12	39%
				Total =	**$ 161,478,025.44**	

St George SBH

NORTH ALTERNATIVE 3

Crabber Fleet Harbor - TSP

GNF

Item	Quantity	Units	Description	2020Q1 Unit Cost ($)	Cost ($)	
North Breakwater	1800	LF		$ 31,890.54		
A Rock	100,423	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 32,887,528.27	
B Rock	63,068	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 10,194,311.52	
C Rock	119,782	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 14,321,135.92	
Spur Breakwater	225	LF		$ 16,417.47		
A Rock	7,445	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 2,438,163.05	
B Rock	5,007	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 809,331.48	
C Rock	3,734	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 446,437.04	
Drill/Blast/Dredge	286,838	CY	Rocks and sand overburden over bedrock. Depth to bedrock unknown. Assume 100% of quantity requires blasting.	$ 40.57	$ 11,636,631.34	
Mob/Demob - Fltg Drill & Dredge Plants	3	Yr		$ 3,688,755.47	$ 11,066,266.42	
				TOTAL GNF =	**$ 83,799,805.03**	79%

LSF

Item	Quantity		Description			
Harbor Road (LSF)	800	LF	Very Low traffic volume, two 12 ft lanes, 2 ft shoulders, gravel surface	$ 98.15	$ 78,520.00	
Surface Course (F1)	355	CY	Minus 1 inch, Max 20% passing #200; local source	$ 23.05	$ 8,182.75	0.5 ft
Base Course (D1)	446	CY	Minus 1 inch, Max 5% passing #200; local source	$ 35.50	$ 15,833.00	0.5 ft
Excavation	672	CY		$ 16.76	$ 11,263.78	0.84 ft
Road Improvements	1	LS		$ -	$ -	
Upland Fill	51,116	CY	Minus 12 inch, Max 5% passing #200; local source	$ 32.33	$ 1,652,816.72	
Slope Protection Rock	2,000	CY	500 lb rock	$ 161.64	$ 323,280.00	
Dock	28,000	Sf	Precast Concrete Deck on Steel Piles - 28,000 SF	$ 620.89	$ 17,384,920.00	
Boat Launch	3120	SF	24' wide Concrete Plank ramp, 13% slope from +10' to -5' MLLW, approx 130' long. (65) 8 in x 24 in x 24 ft planks on three 6x6 pressure treated lumber sleepers.	$ 745.58	$ 2,326,209.60	
Nav Markers - Lighted	5	EA	2 @ ends of BWs, 2 @ channel entrance, 1 @ channel bend	$ 3,500.00	$ 17,500.00	
				TOTAL LSF =	**$ 21,818,525.86**	21%
				TOTAL CONTRACT =	**$ 105,618,330.89**	
				PED <= $10m	$ 7,000,000.00	7%
				SIOH <= $15m	$ 10,000,000.00	9%
				Real Estate	$ 20,000.00	
				TOTAL PROJECT =	**$ 122,638,330.89**	
				Contingency	$ 47,401,693.40	39%
				Total =	**$ 170,040,024.29**	

St George SBH

NORTH ALTERNATIVE 4 Crabber Fleet Harbor - TSP

GNF

Item	Quantity	Units	Description	2020Q1 Unit Cost ($)	Cost ($)	
North Breakwater	1100	LF		$ 25,884.56		
A Rock	53,099	CY	25,000 - 15,000 lb rock, 20,000 lb median weight, off-site quarry	$ 327.49	$ 17,389,391.51	
B Rock	34,335	CY	3000 lb - 1200 lb rock, 2000 lb median weight, off-site quarry	$ 161.64	$ 5,549,909.40	
C Rock	46,284	CY	1400 lb to 1 lb rock, 50 lb median weight (9 inch), off-site quarry	$ 119.56	$ 5,533,715.04	
Drill/Blast/Dredge	118,525	CY	Rocks and sand overburden over bedrock. Depth to bedrock unknown. Assume 100% of quantity requires blasting.	$ 40.57	$ 4,808,399.62	
Mob/Demob - Fltg Drill & Dredge Plants	2	Yr		$ 3,688,755.47	$ 7,377,510.95	
				TOTAL GNF =	**$ 40,658,926.51**	80%

LSF

Item	Quantity		Description			
Harbor Road (LSF)	800	LF	Very Low traffic volume, two 12 ft lanes, 2 ft shoulders, gravel surface	$ 98.15	$ 78,520.00	
Surface Course (F1)	355	CY	Minus 1 inch, Max 20% passing #200; local source	$ 23.05	$ 8,182.75	0.5 ft
Base Course (D1)	446	CY	Minus 1 inch, Max 5% passing #200; local source	$ 35.50	$ 15,833.00	0.5 ft
Excavation	672	CY		$ 16.76	$ 11,263.78	0.84 ft
Road Improvements	1	LS		$ -	$ -	
Upland Fill	13,053	CY	Minus 12 inch, Max 5% passing #200; local source	$ 32.33	$ 422,063.87	
Slope Protection Rock	2,000	CY	500 lb rock	$ 161.64	$ 323,280.00	
Dock	11,050	Sf	Precast Concrete Deck on Steel Piles	$ 620.89	$ 6,860,834.50	
Boat Launch	3120	SF	24' wide Concrete Plank ramp, 13% slope from +10' to -5' MLLW, approx 130' long. (65) 8 in x 24 in x 24 ft planks on three 6x6 pressure treated lumber sleepers.	$ 745.58	$ 2,326,209.60	
Nav Markers - Lighted	5	EA	2 @ ends of BWs, 2 @ channel entrance, 1 @ channel bend	$ 3,500.00	$ 17,500.00	
				TOTAL LSF =	**$ 10,063,687.50**	20%
				TOTAL CONTRACT =	**$ 50,722,614.01**	
				PED <= $10m	$ 7,000,000.00	14%
				SIOH <= $15m	$ 10,000,000.00	20%
				Real Estate	$ 20,000.00	
				TOTAL PROJECT =	**$ 67,742,614.01**	
				Contingency	$ 26,183,613.20	39%
				Total =	**$ 93,926,227.21**	

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 102847

POA – St George Harbor Improvements

The St George Harbor Improvements, as presented by Anchorage District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of April 21, 2020, the Cost MCX certifies the estimated total project cost:

FY20 Project First Cost:	$159,838,000
Fully Funded Amount:	$204,004,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management through the period of Federal Participation.

JACOBS.MICHAEL.PIERRE.1160569537

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Date: 2020.04.21 11:30:40 -07'00'

Michael P. Jacobs, PE, CCE
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **St George Navigation Improvements**
PROJECT NO: P2 102847
LOCATION: St. George Island, Alaska

DISTRICT: Alaska District-POA **PREPARED: 4/20/2020**
POC: CHIEF, COST ENGINEERING, Karl Harvey

This Estimate reflects the scope and schedule in report; February 2020 Int Feasibility Study

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-18** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
10	Breakwater - GNF	$85,691	$21,423	25.0%	$107,114	2.3%	$87,684	$21,921	$109,605	$0	$109,605	24.0%	$108,733	$27,183	$135,916
12	Navigation Ports and Harbors - GNF	$24,379	$6,095	25.0%	$30,474	3.7%	$25,275	$6,319	$31,594	$0	$31,594	36.1%	$34,402	$8,600	$43,002
08	Roads, Docks - LSF	$14,132	$3,533	25.0%	$17,665	1.9%	$14,399	$3,600	$17,999	$0		not included in the Total Project Cost - LSF			
12	Navigation Ports and Harbors - LSF	$2,310	$578	25.0%	$2,888	3.7%	$2,395	$599	$2,994	$0		not included in the Total Project Cost - LSF			
12	ATON	$70	$18	25.0%	$88	3.7%	$73	$18	$91	$0		not included in the Total Project Cost - LSF			
08	ROADS, RAILROADS & BRIDGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$126,582	$31,646		$158,228	2.6%	$129,826	$32,456	$162,282	$0	$141,199	10.3%	$143,135	$35,784	$178,918
01	LANDS AND DAMAGES	$59	$15	25.0%	$74	1.9%	$60	$15	$75	$0	$75	7.0%	$64	$16	$80
30	PLANNING, ENGINEERING & DESIGN	$5,606	$1,402	25.0%	$7,008	3.4%	$5,797	$1,449	$7,246	$0	$7,246	9.4%	$6,339	$1,585	$7,924
31	CONSTRUCTION MANAGEMENT	$8,756	$2,189	25.0%	$10,945	3.4%	$9,054	$2,264	$11,318	$0	$11,318	50.9%	$13,665	$3,416	$17,081
	PROJECT COST TOTALS:	$141,003	$35,251	25.0%	$176,254		$144,737	$36,184	**$180,922**	$0	**$159,838**	12.8%	$163,203	$40,801	$204,004

_______________ **CHIEF, COST ENGINEERING, Karl Harvey**

_______________ **PROJECT MANAGER, Brand Phillips**

_______________ **CHIEF, REAL ESTATE, Vacant**

_______________ **CHIEF, PLANNING, Cindy Upah**

_______________ **CHIEF, ENGINEERING, Mark Derocchi**

_______________ **CHIEF, OPERATIONS, Julie Anderson**

_______________ **CHIEF, CONSTRUCTION, Mark Derocchi**

_______________ **CHIEF, CONTRACTING,Chris Tew**

_______________ **CHIEF, PM-CW, Bruce Sexauer**

_______________ **CHIEF, DPM, Randy Bowker**

ESTIMATED TOTAL PROJECT COST:	**$204,004**
GENERAL NAVIGATION FEATURES:	*$178,918*
PROJECT FIRST COST:	**$159,838**
LOCAL SERVICES FACILITIES COST:	*$20,993*
LERR:	*$75*

Filename: 04 STG_TPCS_Draft04_042020.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: St George Navigation Improvements
LOCATION: St. George Island, Alaska
This Estimate reflects the scope and schedule in report; February 2020 Int Feasibility Study

DISTRICT: Alaska District-POA
POC: CHIEF, COST ENGINEERING, Karl Harvey
PREPARED: 4/20/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			20-Apr-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	RISK BASED CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	GNF													
10	Mob-Demobe, BW	$85,691	$21,423	25.0%	$107,114	2.3%	$87,684	$21,921	$109,605	2027Q2	24.0%	$108,733	$27,183	$135,916
12	M-D, DB and Dredge Basin	$24,379	$6,095	25.0%	$30,474	3.7%	$25,275	$6,319	$31,594	2027Q2	24.0%	$31,342	$7,836	$39,178
12	Nav Aids	$70	$18	25.0%	$88	3.7%	$73	$18	$91	2027Q2	24.0%	$90	$22	$112
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$110,140	$27,535	25.0%	**$137,675**		$113,032	$28,258	$141,289			$140,165	$35,041	$175,206
01	LANDS AND DAMAGES	$0	$0	25.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.1%	Project Management	$66	$17	25.0%	$83	3.4%	$68	$17	$85	2022Q2	8.9%	$74	$19	$93
1.0%	Planning & Environmental Compliance	$1,101	$275	25.0%	$1,377	3.4%	$1,139	$285	$1,424	2022Q2	8.9%	$1,240	$310	$1,550
3.1%	Engineering & Design	$3,414	$854	25.0%	$4,268	3.4%	$3,531	$883	$4,413	2022Q2	8.9%	$3,844	$961	$4,805
0.1%	Reviews, ATRs, IEPRs, VE	$77	$19	25.0%	$96	3.4%	$80	$20	$100	2022Q2	8.9%	$87	$22	$108
0.1%	Life Cycle Updates (cost, schedule, risks)	$88	$22	25.0%	$110	3.4%	$91	$23	$114	2022Q2	8.9%	$99	$25	$124
0.6%	Contracting & Reprographics	$661	$165	25.0%	$826	3.4%	$683	$171	$854	2022Q2	8.9%	$744	$186	$930
0.1%	Engineering During Construction	$66	$17	25.0%	$83	3.4%	$68	$17	$85	2027Q2	31.3%	$90	$22	$112
0.1%	Planning During Construction	$55	$14	25.0%	$69	3.4%	$57	$14	$71	2027Q2	31.3%	$75	$19	$93
0.0%	Adaptive Management & Monitoring	$0	$0	25.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.1%	Project Operations	$77	$19	25.0%	$96	3.4%	$80	$20	$100	2022Q2	8.9%	$87	$22	$108
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$7,710	$1,927	25.0%	$9,637	3.4%	$7,972	$1,993	$9,966	2027Q2	31.3%	$10,469	$2,617	$13,086
0.7%	Project Operation:	$771	$193	25.0%	$964	3.4%	$797	$199	$997	2027Q2	31.3%	$1,047	$262	$1,309
0.3%	Project Management	$275	$69	25.0%	$344	3.4%	$285	$71	$356	2027Q2	31.3%	$374	$93	$467
	CONTRACT COST TOTALS:	$124,502	$31,126		$155,628		$127,883	$31,971	**$159,854**			$158,394	$39,599	**$197,993**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: St George Navigation Improvements
LOCATION: St. George Island, Alaska
This Estimate reflects the scope and schedule in report; February 2020 Int Feasibility Study

DISTRICT: Alaska District-POA
POC: CHIEF, COST ENGINEERING, Karl Harvey
PREPARED: 4/20/2020

ESTIMATED COST: Estimate Prepared: **20-Apr-20**; Effective Price Level: 1-Oct-18

PROJECT FIRST COST (Constant Dollar Basis): Program Year (Budget EC): 2020; Effective Price Level Date: 1 OCT 19

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	Associated Costs													
10	BREAKWATER & SEAWALLS	$0	$0	26.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
12	Drill/Blast,Dredge Basin	$1,765	$441	25.0%	$2,206	3.7%	$1,830	$457	$2,287	2027Q2	24.0%	$2,269	$567	$2,836
08	Dock Uplands, Boat Launch Road	$14,132	$3,533	25.0%	$17,665	1.9%	$14,399	$3,600	$17,999	2027Q2	24.0%	$17,856	$4,464	$22,320
12	Slope Protection	$545	$136	25.0%	$681	3.7%	$565	$141	$706	2027Q2	24.0%	$701	$175	$876
12		$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$16,442	$4,111	25.0%	**$20,553**		$16,794	$4,199	$20,993			$20,826	$5,206	$26,032
01	LANDS AND DAMAGES	$59	$15	25.0%	$74	1.9%	$60	$15	$75	2022Q2	7.0%	$64	$16	$80
30	PLANNING, ENGINEERING & DESIGN													
0.1%	Project Management	$10	$2	25.0%	$12	3.4%	$10	$3	$13	2022Q2	8.9%	$11	$3	$14
1.0%	Planning & Environmental Compliance	$164	$41	25.0%	$206	3.4%	$170	$43	$213	2022Q2	8.9%	$185	$46	$231
3.1%	Engineering & Design	$510	$127	25.0%	$637	3.4%	$527	$132	$659	2022Q2	8.9%	$574	$143	$717
0.1%	Reviews, ATRs, IEPRs, VE	$12	$3	25.0%	$14	3.4%	$12	$3	$15	2022Q2	8.9%	$13	$3	$16
0.1%	Life Cycle Updates (cost, schedule, risks)	$13	$3	25.0%	$16	3.4%	$14	$3	$17	2022Q2	8.9%	$15	$4	$19
0.6%	Contracting & Reprographics	$99	$25	25.0%	$123	3.4%	$102	$26	$128	2022Q2	8.9%	$111	$28	$139
0.1%	Engineering During Construction	$10	$2	25.0%	$12	3.4%	$10	$3	$13	2027Q2	31.3%	$13	$3	$17
0.1%	Planning During Construction	$8	$2	25.0%	$10	3.4%	$9	$2	$11	2027Q2	31.3%	$11	$3	$14
0.0%	Adaptive Management & Monitoring	$0	$0	25.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.1%	Project Operations	$12	$3	25.0%	$14	3.4%	$12	$3	$15	2022Q2	8.9%	$13	$3	$16
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$1,151	$288	25.0%	$1,439	3.4%	$1,190	$298	$1,488	2027Q2	31.3%	$1,563	$391	$1,954
0.7%	Project Operation:	$115	$29	25.0%	$144	3.4%	$119	$30	$149	2027Q2	31.3%	$156	$39	$195
0.3%	Project Management	$41	$10	25.0%	$51	3.4%	$43	$11	$53	2027Q2	31.3%	$56	$14	$70
	CONTRACT COST TOTALS:	$18,645	$4,661		$23,306		$19,071	$4,768	**$23,839**			$23,611	$5,903	**$29,514**

St George Harbor, Alaska, N3 - Recommended Plan

This alternative includes constructing protected boat launch and recovery area for the local crabber vessel fleet. A new 1,800 foot long North Breakwater with 10 ton armor stone and a crest elevation of +25 feet MLLW would protect a new 550 foot by 450 foot maneuvering basin, a 300 foot dock and concrete launch ramp. A Spur Breakwater with 10 ton armor stone and a crest height of +20 feet would be constructed inside the North Breakwater from the base of the cliffs along the south edge of the harbor to filter waves diffracted around the nose of the North Breakwater. The maneuvering basin would be dredged to -16 feet MLLW with a transition zone and an entrance channel dredged to -18 feet MLLW. The entrance channel maintains a 300 foot width from deep water to the end of the breakwater and includes widened turning section outside the breakwater nose. The channel narrows to 250 feet wide at the breakwater nose.

Estimated by	POA-ECO-DB-C
Designed by	POA-EC-CW-HH
Prepared by	Karl Harvey
Preparation Date	3/7/2020
Effective Date of Pricing	10/1/2019
Estimated Construction Time	1,470 Days

Description	UOM	Quantity	ContractCost
Total Project Cost - Summary			**126,579,817**
GNF with Some LSF Cost Sharing	**EA**	**1**	**110,137,241**
Mobe - Demobe	**EA**	**1**	**9,735,575**
Mobilization and Demobilization Drill & Blast	**EA**	**5**	**4,506,981**
Mobilization and Demobilization Breakwater and Dredging	**EA**	**5**	**5,228,593**
Build Breakwaters	**EA**	**1**	**80,461,385**
North Breakwater	**LF**	**1,800**	**75,892,759**
Spur Breakwater	**LF**	**1,800**	**4,568,625**
Drill and Blast Basins	**EA**	**1**	**11,934,993**
Drill & Blast - Basin OG to -20	**CY**	**108,270**	**3,425,948**
Drill & Blast Basins to -27'	**CY**	**207,635**	**8,509,045**
Dredge Basins	**EA**	**1**	**7,936,234**
Manever Basin OG to -20' MLLW : Dredge Only	**EA**	**1**	**2,650,845**
Entrance Channel OG to -20 : Dredge Only	**EA**	**1**	**2,141,713**
Entrance Channel -20' to -25' + 2' Over Depth : Dredge Only	**EA**	**1**	**3,143,676**
Nav Aid Marker Bases	**EA**	**2**	**69,055**
100 % LSF Featured	**EA**	**1**	**16,442,576**
Drill/Blast/Dredge 2-beam Widths off of Dock Face	**EA**	**1**	**1,765,038**
Drill & Blast - Basin OG to -20	**CY**	**37,058**	**991,423**
Dredge and Dispose	**LCY**	**37,058**	**773,615**
All Other LSF Features	**EA**	**1**	**14,677,538**
Dock	**LF**	**300**	**10,415,841**
Upland, Boat Launch and Roads	**EA**	**1**	**3,716,418**
Slope Protection	**CY**	**2,000**	**545,280**

Project Development Stage/Alternative: Feasibility Milestone #4 - CWRB

Risk Category: Moderate Risk: Typical Project or Possible Life Safety **Meeting Date:** 1/26/2020

Schedule Duration	Apr-2024	Nov-2029	Schedule Duration:	67.1 Months	22%
	From (Month/Year)	From (Month/Year)			Schedule Contingency
			80% Finish Date		Jan-2031

	WBS	Feature of Work	Contract Cost	% Contingency	$ Contingency	Total
	Risk Not included within CSRA Model					
	01 LANDS AND DAMAGES	Real Estate	$ 5	20%	$ 1	$ 6
	Risk included within CSRA Model					
1	A Substructure	GNF- estimated construciton cost (ECC)	$ 110,137,526	25%	$ 27,534,382	$ 137,671,908
2	B Shell	Mob/ Demob Dredge and Breakwater- GNF	$ 5,228,609	25%	$ 1,307,152	$ 6,535,761
3	C Interiors	Build Breakwaters - GNF	$ 80,461,618	25%	$ 20,115,405	$ 100,577,023
4	D Services	Dredge Basins	$ 7,936,257	25%	$ 1,984,064	$ 9,920,321
5	E Equipment and Furnishings	Mobilization Demobilization Drill/Blast - GNF	$ 4,506,994	25%	$ 1,126,749	$ 5,633,743
6	F Special Construction and Demolition	Drill/Blast Basins-GNF	$ 11,934,993	25%	$ 2,983,748	$ 14,918,741
7	G Sitework	Aids to Navigation-GNF	$ 69,055	25%	$ 17,264	$ 86,319
8				0%	$ -	$ -
9		Associated Costs - LSF estimated construction cost (ECC)	$ 16,442,619	25%	$ 4,110,655	$ 20,553,274
10		Dril,Blast & Dredge LSF Part of Man Basin	$ 1,765,038	25%	$ 441,259	$ 2,206,297
11		Dock	$ 10,415,871	25%	$ 2,603,968	$ 13,019,839
12		Upland, Boat Launch and Roads	$ 3,716,429	25%	$ 929,107	$ 4,645,536
13		Slope Protection	$ 545,281	25%	$ 136,320	$ 681,601
14			$ -	0%	$ -	$ -
15			$ -	0%	$ -	$ -
16			$ -	0%	$ -	$ -
17			$ -	0%	$ -	$ -
18			$ -	0%	$ -	$ -
19			$ -	0%	$ -	$ -
20			$ -	0%	$ -	$ -
21			$ -	0%	$ -	$ -
22			$ -	0%	$ -	$ -
23	DDC Costs	**Planning, Engineering, & Design**	$ 7,594,808.70	25%	$ 1,898,702	$ 9,493,511
24	S&A	**Construction Management**	$ 14,578,970	25%	$ 3,644,743	$ 18,223,713
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)				$ -	

Totals				
Real Estate	$ 5	20%	$ 1	$ 6.00
Total Construction Estimate	$ 126,580,145	25%	$ 31,645,036	$ 158,225,181
Total Planning, Engineering & Design	$ 7,594,809	25%	$ 1,898,703	$ 9,493,512
Total Construction Management	$ 14,578,970	25%	$ 3,644,743	$ 18,223,713
Fixed Dollar Risk Equally Distributed	$ -	0%	$ -	$ -
Total	**$ 148,753,929**	**0%**	**$ 37,188,483**	**$ 185,942,412**

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	**$126,580,145**	**25%**
Baseline Estimate Cost Contingency Amount ->	$31,645,036	
Baseline Estimate Construction Cost (80% Confidence) ->	**$158,225,181**	

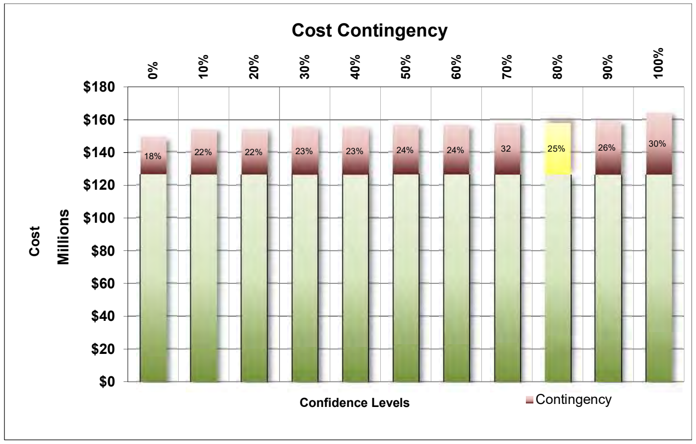
Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	**67.1 Months**	22%
Schedule Contingency Duration ->	14.8 Months	
Project Schedule Duration (80% Confidence) ->	**81.8 Months**	

St George Harbor Improvements
1-Feb-20

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION
Contingency Analysis

Base Case Estimate (Excluding 01)	**$126,580,145**	
Confidence Level	**Contingency Value**	**Contingency**
0%	**22,784,426**	**18%**
10%	**27,847,632**	**22%**
20%	**27,847,632**	**22%**
30%	**29,113,433**	**23%**
40%	**29,113,433**	**23%**
50%	**30,379,235**	**24%**
60%	**30,379,235**	**24%**
70%	**31,645,036**	**25%**
80%	**31,645,036**	**25%**
90%	**32,910,838**	**26%**
100%	**37,974,044**	**30%**

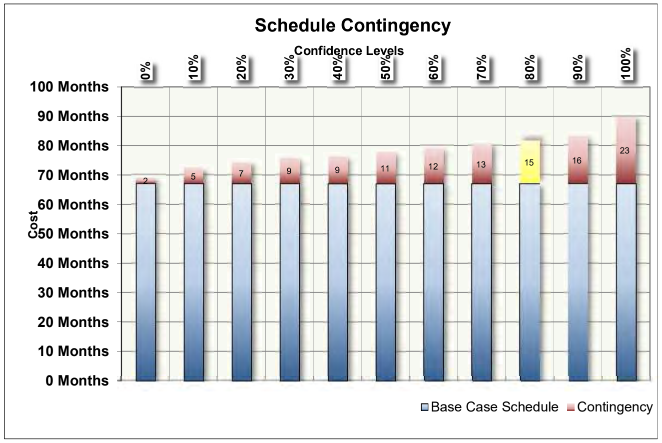


St George Harbor Improvements
1-Feb-20

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	**67.1 Months**	
Confidence Level	**Contingency Value**	**Contingency**
0%	**2 Months**	**3%**
10%	**5 Months**	**8%**
20%	**7 Months**	**11%**
30%	**9 Months**	**13%**
40%	**9 Months**	**14%**
50%	**11 Months**	**16%**
60%	**12 Months**	**18%**
70%	**13 Months**	**20%**
80%	**15 Months**	**22%**
90%	**16 Months**	**24%**
100%	**23 Months**	**34%**



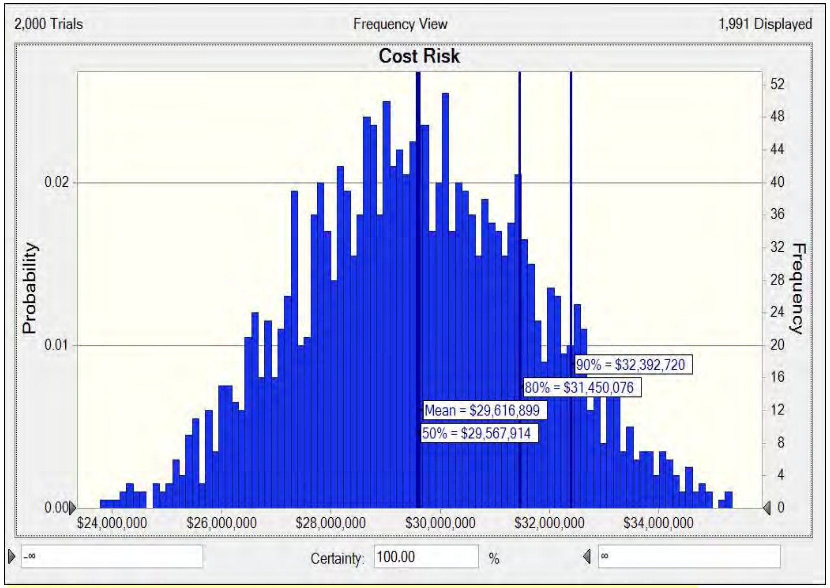
Contingency on Base Estimate		
Base Construction Estimate	**$126,580,145**	**25%**
Baseline Estimate Cost Contingency Amount ->	$31,645,036	
Baseline Estimate Construction Cost (80% Confidence) ->	**$158,225,181**	

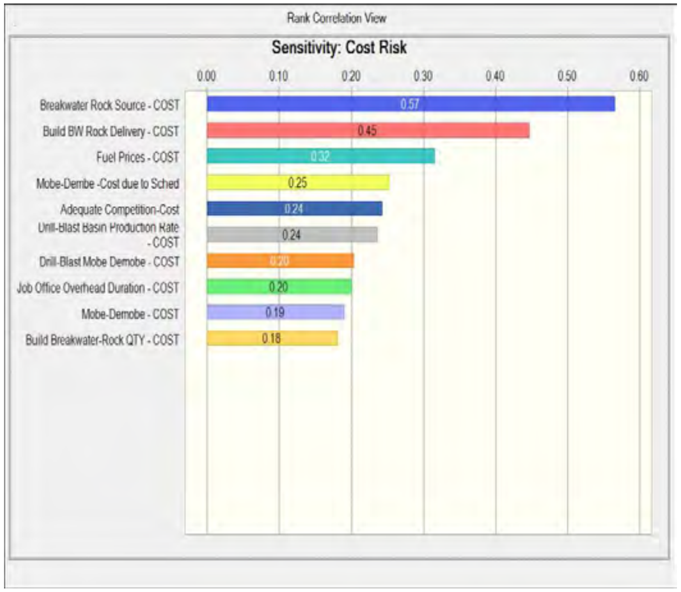
Contingency on Schedule		
Project Base Schedule Duration ->	**67.1 Months**	21%
Schedule Contingency Duration ->	14.1 Months	
Project Schedule Duration (80% Confidence) ->	**81.2 Months**	

#REF!

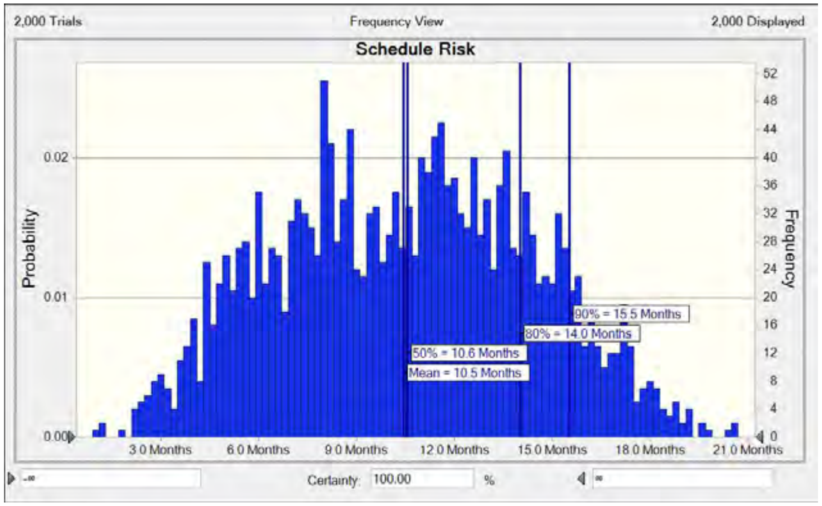
#REF!

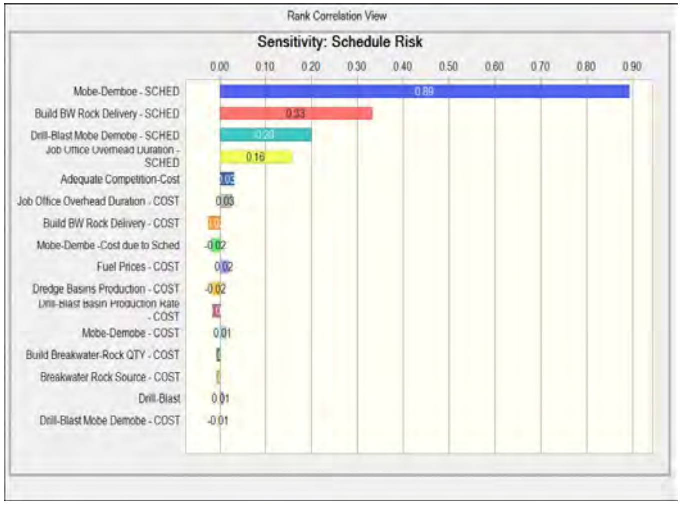
- Cost Outputs Distribution and Sensitivity -





- Schedule Outputs Distribution and Sensitivity -





ST. GEORGE HARBOR IMPROVEMENT FEASIBILITY STUDY

APPENDIX E: WAIVERS AND CORRESPONDENCE

ST. GEORGE, ALASKA

U.S. Army Corps
of Engineers
Alaska District

Table of Contents

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

FEB - 7 2019

MEMORANDUM FOR THE DEPUTY COMMANDING GENERAL FOR CIVIL AND EMERGENCY OPERATIONS

SUBJECT Saint George Small Boat Harbor Navigation Improvements Feasibility Study, Saint George, Alaska, 3x3x3 Rule Exemption

1. Reference memorandum, CECW-POD, 20 December 2018, subject: Saint George Small Boat Harbor Navigation Improvements Feasibility Study, St. George, Alaska, 3x3x3 Rule Exemption.

2. I am responding to your request that an exemption to the requirement identified in Section 1001(a) of the Water Resources Reform and Development Act of 2014 that feasibility reports are, to the extent practicable, to be completed in three years and have a maximum Federal cost of $3 million.

3. My staff has reviewed the memorandum and the background information. We have found that the analysis supports an increase in the total study time. The seven-month delay in receiving the non-Federal cost-share postponed initiation of the study. Additionally, the change in the study area to the north of the island and uncertainties on collection of new bathymetric data due to likely inclement weather added to the delays. I hereby approve the requested exemption to increase the total study time for the Saint George Small Boat Harbor Navigation Improvements Feasibility Study by 22 months for a total of 58 months. The feasibility study shall be completed by August 15, 2020.

4. I request your diligent attention on actively managing the study cost and schedule. If there are any questions, please contact Mr. Mark Kramer, Project Planning and Review at (202) 761-0041.

James

R.D. JAMES
Assistant Secretary of the Army
(Civil Works)

From: Phillips, Reese B (Brand) CIV (US)
To: Metallo, Amber C CIV USARMY CEPOA (US)
Subject: FW: Discussion of Proposed St. George Navigation Improvements with Coast Guard (UNCLASSIFIED)
Date: Wednesday, July 31, 2019 1:41:49 PM

CLASSIFICATION: UNCLASSIFIED

Here's the info we received from USCG.

-----Original Message-----
From: Phillips, Reese B (Brand) CIV (US)
Sent: Wednesday, April 10, 2019 10:25 AM
To: 'Seris, David M CIV' <David.M.Seris@uscg.mil>
Cc: Andrews, Brent J CIV USARMY CEPOA (US) <Brent.J.Andrews@usace.army.mil>; Epps, Lewis N CIV USARMY CEPOA (US) <Lewis.N.Epps@usace.army.mil>
Subject: RE: Discussion of Proposed St. George Navigation Improvements with Coast Guard (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Dave,

Thank you for the detailed input. This information should be very helpful to our economist.

Best regards,

Brand

-----Original Message-----
From: Seris, David M CIV [mailto:David.M.Seris@uscg.mil]
Sent: Tuesday, April 9, 2019 4:25 PM
To: Phillips, Reese B (Brand) CIV (US) <Reese.B.Phillips@usace.army.mil>
Cc: Andrews, Brent J CIV USARMY CEPOA (US) <Brent.J.Andrews@usace.army.mil>
Subject: RE: Discussion of Proposed St. George Navigation Improvements with Coast Guard (UNCLASSIFIED)

Hello Brand:

Thanks for reaching out. We do still owe you something on this. I'll break this into three categories, White hull (law enforcement), Red Hull (Icebreakers) and Black Hull (buoytenders).

I've circulated that proposed design to the other offices that manage CG ships that operate in the Bering on routine law enforcement patrols. So let's start with those.

This includes ships: 378' WHEC's (Hamilton class) and 418' WMSL (Legend class) currently. In the future there will also be 350' Offshore Patrol Cutters (Heritage Class) but these haven't been built yet. These all will be operating with a navigational draft of around 30 feet, so they will not moor inside of the breakwater, but rather would have to anchor out and move equipment, supplies, or people via small boat. The Coast Guard keeps at least one of these ships on patrol every day of the year, and will likely continue to do so. Other places they will stop include Dutch Harbor (frequently) Adak , St. Paul and Nome (rarely). Individual patrols usually run 2-3 months, with the ships calling to a port approximately every 2 weeks. This is a ballpark figure, but the crew is usually granted liberty in a port for 1 day out of every 10 days the ship spends on patrol, so there's a ballpark figure you could come up with of about 36 days/year where the ship will be using one of these port facilities. It's reasonable to expect that you'd have one of these ships calling on St. George at least annually for s 2 day stop.

Icebreakers: Same story, they would have to anchor out, although much less likely to call on St. George.

Buoytenders: These are 225' seagoing buoytenders. There are 4 of them in Alaska. They should be able to moor inside of the proposed St. George Harbor. You can expect one of them to visit at least annually for a 1-2 day visit to service whatever aids to navigation are going to be needed.

The Coast Guard presence will scale up if the new St. George Harbor draws additional fishing activity. If the harbor winds up boosting onshore processing and commercial fishing vessels come in increasing numbers, the Coast Guard will wind up conducting more operations in that area as we have at-sea boarding goals to reach a certain percentage of each fishing fleet, so if that is where the fishing vessels are, that is where we will be. If you wanted to estimate this, I'd take the total number of commercial fishing vessels using St. George, multiply by 10%, which is the rough number of fishing vessels we would be trying to board over the course of a year. Each boarding takes about 4 hours, so you can figure out roughly how many days of CG cutter operations you would see in that area over the course of a year.

The last thing that you will probably see is periodic use of both St. Paul and St. George for short fuse personnel movements or critical repair parts. That seems to happen about 2-3 times each year and if the ship is already near the Pribilof islands we sometimes fly in people or parts instead of having the ship transit to Dutch Harbor.

You can find information on operating costs for all of these cutters online if you look for something called "Coast Guard Reimbursable Standard Rates"

I hope this helps, give me a call if you need some more information.

Dave Seris
17th Coast Guard District
Waterways Management Branch
(907) 463-2267

-----Original Message-----
From: Phillips, Reese B (Brand) CIV (US) <Reese.B.Phillips@usace.army.mil>
Sent: Tuesday, April 9, 2019 2:05 PM
To: Seris, David M CIV <David.M.Seris@uscg.mil>
Cc: Andrews, Brent J CIV USARMY CEPOA (US) <Brent.J.Andrews@usace.army.mil>
Subject: RE: Discussion of Proposed St. George Navigation Improvements with Coast Guard (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Hello David,

George Kalli has left the Alaska District. I'm the Project Manager on the study and taking over some the things George was handling.

During our phone call in February, you mentioned you would be able to write up a short synopsis of the potential USCG use of our proposed navigation improvements at St. George. It would be greatly appreciated if you could provide that.

Thanks,

Brand

-----Original Message-----
From: Kalli, George A III CIV USARMY CEPOA (USA)
Sent: Monday, March 11, 2019 3:49 PM
To: 'Seris, David M CIV' <David.M.Seris@uscg.mil>
Cc: Phillips, Reese B (Brand) CIV (US) <Reese.B.Phillips@usace.army.mil>; Andrews, Brent J CIV USARMY CEPOA (US) <Brent.J.Andrews@usace.army.mil>; Kalli, George A III CIV USARMY CEPOA (USA) <George.A.Kalli@usace.army.mil>
Subject: RE: Discussion of Proposed St. George Navigation Improvements with Coast Guard

Hey there David.

Any chance you could provide us with a short synopsis of the potential USCG use of our proposed navigation improvements at St. George, as we discussed last month?

Thanks a bunch!

George Kalli, P.E., PMP
Alaska Silver Jackets Coordinator
US Army Corps of Engineers, Alaska District Project Management, Civil Planning (CEPOA-PM-C-PL) george.a.kalli@usace.army.mil
(907) 753-2594

-----Original Message-----
From: Kalli, George A III CIV USARMY CEPOA (USA)
Sent: Monday, February 04, 2019 10:46 AM
To: 'Seris, David M CIV' <David.M.Seris@uscg.mil>
Cc: Phillips, Reese B (Brand) CIV (US) <Reese.B.Phillips@usace.army.mil>; Andrews, Brent J CIV USARMY CEPOA (US) <Brent.J.Andrews@usace.army.mil>; Kalli, George A III CIV USARMY CEPOA (USA) <George.A.Kalli@usace.army.mil>
Subject: Discussion of Proposed St. George Navigation Improvements with Coast Guard

Dave, thanks for sharing your insights regarding potential benefits of a new harbor facility to the USCG.

As discussed, following is a more complete description of our currently proposed plan for a harbor on the north side of the island (schematic attached).

"This alternative consists of a 450-foot wide by 550-foot-long mooring basin dredged to -20 feet MLLW protected by a 1,731-foot-long north breakwater and a 250-foot-long stub breakwater at the west edge of the basin. Primary armor stone on the north breakwater has a median weight of 10 tons. The basin connects to the Bering Sea with a 250-foot wide navigation channel dredged to -25 feet MLLW. Inner harbor facilities include 2.6 acres of uplands area filled to +10 feet MLLW with a 300-foot-long pile supported dock and a concrete boat launch ramp to -5 feet MLLW for full tide launching access."

Let us know if we can provide you with any additional information.

Thanks again!

George Kalli, P.E., PMP
Alaska Silver Jackets Coordinator
US Army Corps of Engineers, Alaska District Project Management, Civil Planning (CEPOA-PM-C-PL) george.a.kalli@usace.army.mil
(907) 753-2594

11/8/2019

Dear Eva:

We appreciate you reaching out to APICDA in the development of your economic analysis for the St. George harbor project. Below you will find APICDA's response to your request for a written statement describing our intentions to support future crab processing in St. George.

The Western Alaska Community Development Program (CDQ) program was created under section 305(i)(1) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and amended and reauthorized under Section 416(a) of the 2006 Coast Guard and Maritime Transportation Act. The program was established to: 1) provide eligible Western Alaska villages the opportunity to participate and invest in fisheries in the Bering Sea and Aleutian Islands Management Area 2) support economic development in Western Alaska 3) alleviate poverty and provide economic and social benefits for residents of Western Alaska 4) achieve sustainable and diversified local economies in Western Alaska.

APICDA is structured as a 501 c (3) organization and generates revenue through management of CDQ quota as well as investments in shore-based processing operations, harvesting and processing rights, at-sea catcher processors in the BSAI, fuel operations and tourism operations.

In carrying out the directives of the program, APICDA has invested significantly in shoreside processing and support infrastructure in our six communities. These investments have included matching or full contributions for the development of dock and harbors, seafood plants, fuel farms and roads. In making these investments, APICDA's board balances its organizational resources amongst its communities to support priority initiatives and promote meaningful economic development.

The proposed harbor project in St. George has been a long-standing priority of the community and one that APICDA continues to fully support. In order to preserve crab processing opportunity for St. George, in 2008 APICDA purchased a significant amount of individual processing quota shares (IPQ), a majority of which encompass Opilio. These IPQ shares had been earned in the community and historically processed with a floating operation in St. George but moved to St. Paul due to damage to the harbor's breakwater in early 2006 that made deliveries to St. George unsafe. APICDA's purchase of these IPQ shares was done with the intention of reinitiating crab processing in St. George for when there is a safe and functioning harbor at St. George. Since the time of the IPQ purchase, many crab fisheries in the BSAI have witnessed declines. While the Opilio fishery has shown promising recovery in the past two years, which may be a signal of returns to historical high levels, quotas are still 50% below what they were when APICDA purchased the shares in 2008. Fluctuations in harvest quotas have been persistent historically but will require APICDA to evaluate the appropriate level of processing investment to make at the time the harbor development is imminent.

The harbor is critical to reinitiating crab processing in St. George. In fact, the harbor is critical to the survival of St. George as a community. We understand that this project will take a significant amount of time to design and construct and during this time there will likely continue to be shifting resource regimes in the crab and groundfish fisheries. APICDA remains committed to providing the appropriate scale of processing operations in the context these fisheries changes, once the timeline for the harbor becomes clear, to ensure that the community is realizing the intended benefits of these operations through job opportunities and tax revenue to the City.

Please let me know if you have any additional questions.

Thank you,
Angel Drobnica
APICDA
Director of Fisheries and Government Affairs

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON, DC 20310-0108

MAR 0 3 2020

MEMORANDUM FOR THE COMMANDING GENERAL, U.S. ARMY CORPS OF ENGINEERS

SUBJECT: St. George Feasibility Study/Environmental Assessment, Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) Policy Exception Request

1. Reference memorandum, CECW-POD, 05 February 2020, subject: Policy Waiver Request for St. George, Alaska, Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) Compliance.

2. I am responding to your memorandum requesting a waiver to the policy requirement to complete ESA Section 7 consultation prior to completion of the feasibility study for the St. George, Alaska project and defer completion until the Preconstruction Engineering and Design (PED) Phase.

3. My staff has reviewed the memorandum and recommendations by the Alaska District and Pacific Ocean Division, and the assessment by Corps Headquarters. Completing the St. George ESA consultation in PED will allow the Corps to develop the necessary information to inform the services of impacts to marine mammals, while avoiding unnecessary costs and time during the feasibility study. I approve the requested policy waiver for St. George.

4. If there are any questions, your staff may contact Mr. Douglas Gorecki, Project Planning and Review at (202) 761-0028.

R James

R.D. JAMES
Assistant Secretary of the Army
(Civil Works)

CF:
CECW-ZA
CECW-ZB

St. George Office:

P.O. Box 929
St. George, Alaska 99591-0929
Tel: (907) 859-2263
Fax: (907) 859-2212

Date: April 22, 2020

Reese Brand Phillips, PhD
Biologist / Project Manager
Civil Project Management Branch
USAGE Alaska District

Mr. Reese Brand Phillips:

As the Non-Federal co-sponsor for the project at St. George, we offer the following. Our municipal government is in full support to seeing the work and project completed. This project is critical to the health and survival of our community. Therefore, we will meet our obligations to make certain the project's success. Thank you for seeking clarification.

Sincerely,

Patrick Pletnikoff

Patrick Pletnikoff

Mayor

NON-FEDERAL SPONSOR'S
SELF-CERTIFICATION OF FINANCIAL CAPABILITY
FOR AGREEMENTS

I, Diane Olsen, do hereby certify that I am the Chief Financial Officer [OR TITLE OF EQUIVALENT OFFICIAL] of the City of St. George; that I am aware of the financial obligations of the Non-Federal Sponsor for the St. George Harbor Improvement Feasibility Study St. George, Alaska; and that the Non-Federal Sponsor has the financial capability to satisfy the Non-Federal Sponsor's obligations under the St. George Harbor Improvement Feasibility Study.

IN WITNESS WHEREOF, I have made and executed this certification this 24th day of April, 2020.

BY: Diane Olsen

TITLE: City of St. George CFO

DATE: 4/24/20

Aleutian Pribilof Island Community Development Association
302 Gold Street, Suite 202 | Juneau, Alaska 99801 | Phone: (907) 586-0161 | Fax: (907) 586-0165
717 K Street | Anchorage, Alaska 99501 | (907) 929-5273 | Fax: (907) 929-5275 | www.apicda.com

April 16, 2020

Reese Brand Phillips, PhD
Biologist / Project Manager
Civil Project Management Branch
USACE Alaska District

Dear Brand:

APICDA is writing this letter in response to the Army Corps of Engineers' (ACE) request for a statement of financial commitment to supplement the self-certification statement that will be provided by the City of St. George, as required to complete the draft Chief's report for the St. George harbor project. The harbor project is a very important initiative for St. George and we appreciate the effort that the ACE and stakeholders have expended over numerous years to get to this stage.

APICDA's board and staff have discussed our organizational capacity to help support the non-federal match for the harbor project. If the project is authorized under the next Water Resources Development Act (WRDA), which is expected to be in 2020, and receives subsequent federal funding for construction, APICDA anticipates being able to offer some level of financial contribution to assist the sponsor with the match requirement.

As part of our commitment, we would require the City to utilize our existing Community Development Grant Fund and Infrastructure Grant programs, which will be counted towards APICDA's contribution. Our commitment of funds will only be applicable to this project and only through the next WRDA bill, after which time, we will need to reassess our financial capability to contribute to a non-federal match. We also anticipate that the City will be seeking funding sources from multiple entities to assist with the match requirement.

Finally, we acknowledge that neither APICDA's statement of financial support or the self-certification statement obligates the agency or the sponsor to carry through implementation of the project.

Please feel free to contact us with any questions or additional information needs.

Best,

Luke Fanning
Chief Executive Officer, APICDA