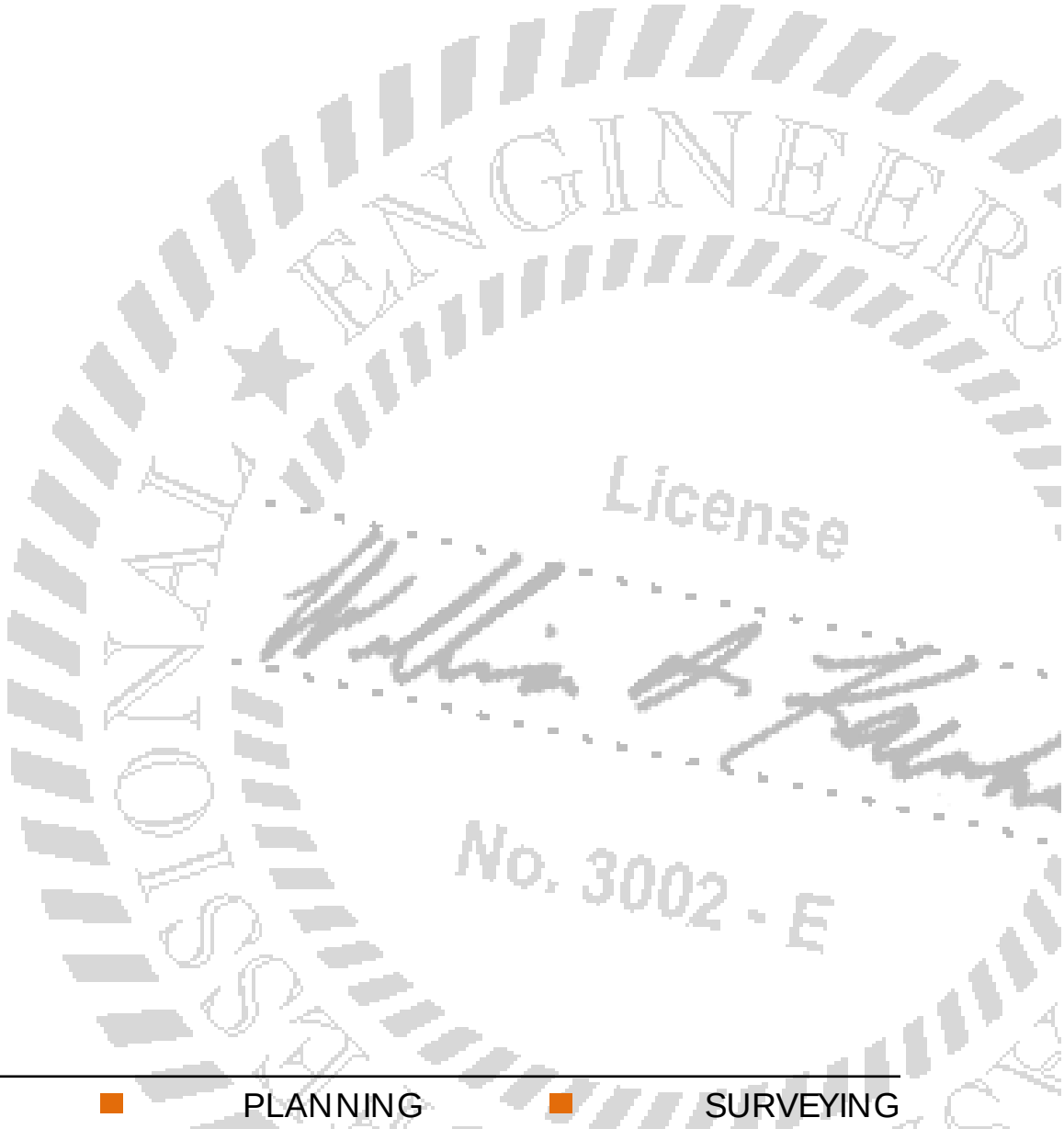
DOWL HKM

GEOTECHNICAL/GEOLOGICAL RECONNAISSANCE STUDY REPORT

CHIGNIK LAGOON ROAD

CHIGNIK LAGOON, ALASKA



DOWL HKM

January 27, 2012
W.O. 60936
Report No. 5288
Area 3

Ms. Angela Gregorio
Chignik Lagoon Tribal Council
P.O. Box 9
Chignik Lagoon, Alaska 99565

Subject: Chignik Lagoon Road Geotechnical/Geological Reconnaissance Study Report
Chignik Lagoon, Alaska

Dear Ms. Gregorio:

DOWL HKM has completed the Geotechnical/Geological Reconnaissance Study of an approximate 1.3-mile portion of the proposed Chignik Lagoon Road alignment which is to be located along steep hillside areas above and to the south of the Village of Chignik Lagoon, Alaska. The study also included assessment of the existing landfill access route that is located along the shoreline below the hillside route.

The purpose of the study was to perform an initial reconnaissance level assessment of slope stability concerns with the proposed hillside route and the feasibility of upgrading the existing landfill access road as an alternate route to the hillside alignment. Additionally, the reconnaissance level study was to allow scoping of more in depth geotechnical investigations. The study included review of existing feasibility studies and geologic literature, a site visit, informal interviews with Chignik Lagoon Public Works personnel and other tribal members of the Village of Chignik Lagoon, and sampling of potential borrow materials. The results of the study are presented in detail in the attached report. Our initial findings are summarized briefly in the following paragraphs.

In summary, construction on the steep side hill areas along the proposed hillside route will be challenging. Cut slope stability is a concern in regard to the steep backslope angles (0.75H:1V [Horizontal: Vertical] or 0.5H:1V) which will be required in order to achieve excavation catch points that are not at excessive elevations above the roadbed. There is also concern that large scale slope instability could occur if proper drainage and backslope stabilizations are not achieved. Based on the visual reconnaissance investigation, which was somewhat limited by the dense vegetation and steep terrain, there did not appear to be any blatant indications of active slope instability along the hillside route. However, the geologic conditions must be further confirmed along the steep side hill locations in order to assess the effect construction of the road will have on global slope stability. It must be determined if the roadbed will be within bedrock or colluvial (surface) soils and the engineering characteristics of the colluvial soil veneer must also be defined.

It is DOWL HKM's opinion that the landfill access route may be a feasible alternative to the hillside route. This is provided that permitting can be obtained to allow fill placement along the shoreline and ample borrow material can be obtained to allow construction of an approximate eight-foot fill along the access route. Additionally, in depth geotechnical investigations will also be required to further determine feasibility. The geotechnical investigation will allow confirmation of subgrade conditions and availability of borrow and riprap.

DOWL HKM is pleased to provide this service to the Chignik Lagoon Tribal Council. Please call if you have any questions regarding this report.

Sincerely,
DOWL HKM

Gregory Underhill, P.E.
Senior Geotechnical Engineer

Reviewed by:
DOWL HKM

Howard K. Weston, P.E.
Manager, Geotechnical Engineering

Attachment: As stated

D60936.Geotechnical Recon.HKW.KAN.0112.tla

GEOTECHNICAL/GEOLOGICAL RECONNAISSANCE REPORT
CHIGNIK LAGOON ROAD
CHIGNIK LAGOON, ALASKA

Prepared for:

Chignik Lagoon Tribal Council
P.O. Box 9
Chignik Lagoon, Alaska 99565

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Report No. 5288
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January 2012

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1.0 INTRODUCTION

Western Federal Lands is evaluating the feasibility of constructing an approximate 14-mile road between Chignik Lagoon and Chignik Lake. This report presents the results of a Geotechnical/Geological Reconnaissance Study of an approximate 1.3-mile portion of the proposed roadway that runs along steep hillside areas from Chignik Lagoon south to the existing Chignik Lagoon landfill. This study also includes an assessment of the current landfill access route that runs along the shoreline immediately below the proposed hillside route. A site vicinity map showing the study area is presented in Figure 1. Site mapping is also provided on Figures A-1 through A-3 of Appendix A.

The purpose of the study was to perform an initial reconnaissance level assessment of slope stability concerns with the proposed hillside route and the feasibility of upgrading the existing landfill access road as an alternate route to the hillside alignment. Additionally, the reconnaissance level study was to allow scoping of more in depth geotechnical investigations. The study included review of existing feasibility studies and geologic literature, a site visit, informal interviews with Chignik Lagoon Public Works personnel and other tribal members of the Village of Chignik Lagoon, and sampling of potential borrow materials. The results of the study are presented in detail in this report.

1.1 Planned Development

The Chignik Lagoon Road project is part of a planned development by Western Federal Lands and the Denali Commission to construct a link between the communities of Chignik Lake and Chignik Lagoon, and possibly provide future staging and access for commercial development in the area, such as oil, gas, and geothermal.

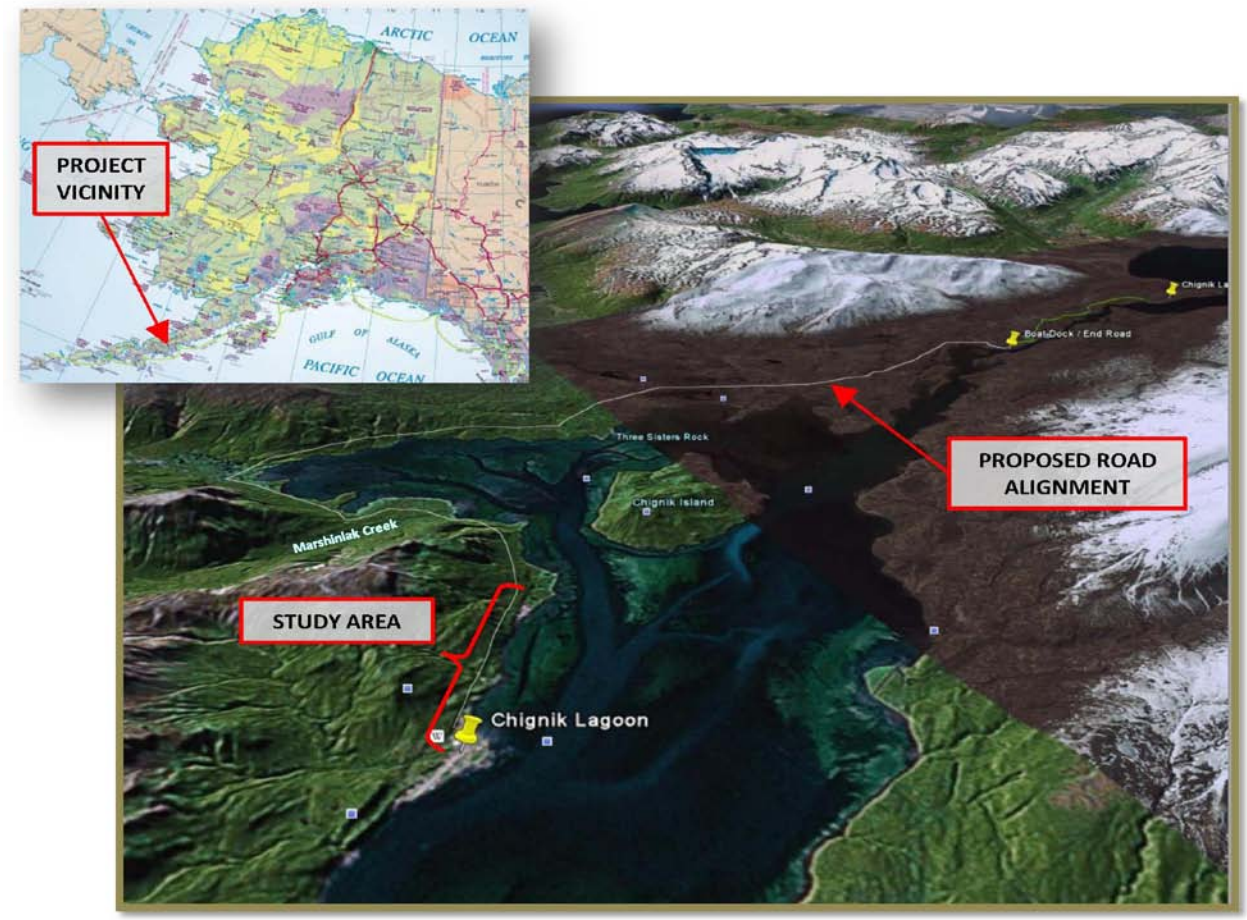

Figure 1: Vicinity Map

1.2 Purpose of Investigation

The Feasibility Study Report completed by Western Federal Lands in March 2011 did not include any geological or geotechnical studies of the proposed hillside route. The purpose of this study is to conduct a preliminary evaluation of the geotechnical feasibility of constructing a new road along the existing concrete plank shoreline road, evaluate the potential affect of construction of the proposed hillside route on the slope stability of the hillside, and identify potential material sites for use during construction. The specific project objectives are as follows:

- Evaluation of the existing shoreline road and geotechnical feasibility study to rehabilitate/reconstruct as an alternative to the hillside road,
- Slope stability of the proposed hillside route/geotechnical feasibility study of construction, and

- Identification of material sites along the proposed Chignik connection road, specifically near the head of Mallard Duck Bay and Marshinlak Creek Valley.

1.3 Scope of Work

On August 11, 2011, DOWL HKM submitted a proposal for geotechnical engineering services for the Chignik Lagoon Road project. Numerous levels of investigative scopes of work were presented and discussed. Because of the densely vegetated and steep, limited access terrain, a phased investigative approach has been agreed upon. This initial scope of work consists of a Geotechnical/Geological Reconnaissance Study. The purpose of this initial study is to allow determination of the extent of additional investigative work (test pits or borings) required to more accurately define the surface and subsurface conditions along the subject alignments and further assess the feasibility of construction along the steep hillside and shoreline alignments. The scope of this initial study is defined as the Alternative Scope of Work (Geotechnical/Geological Reconnaissance) on page three of our proposal dated August 11, 2011, and includes the following tasks.

- Conduct a four- to five-day site visit
- Complete geologic mapping along both the proposed shoreline and hillside routes, looking specifically for evidence of slope instability, potential drainage issues, and erosion due to wave action along the shoreline.
- Visit potential material sites along the proposed hillside route, near Marshinlak Creek, and obtain grab samples of potential borrow material.
- Determine the availability of local equipment and the ability to access areas of interest for the subsurface exploration.
- Conduct informal discussions with locals regarding the condition of the shoreline road and area of the proposed hillside road during various times of year - information such as areas of slumping/landslides, unstable ground, or drainage issues.
- Evaluate the feasibility of drill equipment accessibility to perform test borings in the future.

2.0 PHYSICAL SETTING

The Chignik communities are located on the south shore of the Alaska Peninsula, approximately 450 miles southwest of Anchorage. Chignik Lagoon lies 180 air miles south of King Salmon, 8.5 miles west of Chignik, and 16 miles east of Chignik Lake. The primary year-round employers are the Village of Chignik Lagoon Council, Chignik electric plant, and Chignik school. Subsistence activities significantly contribute to food sources. Chignik Lake lies 13 miles from Chignik and 265 miles southwest of Kodiak. The people of Chignik Lake depend heavily on subsistence hunting and fishing, and utilize salmon, other fish, caribou, moose and seal.

2.1 Regional Geology

The Alaska Peninsula is divided into two major and one minor physiographic sub-provinces. The major divisions are the Aleutian Mountain Range and the Bering Sea lowlands. The narrow lowlands adjacent to the Pacific Ocean constitute the minor division. Within the study area the lowlands are extremely narrow and limited, with mountains rising directly from the ocean in many places.

Geologically, sedimentary rocks (mid-Jurassic to late Cretaceous shale, sandstone, and conglomerate) compose the base of the northeast headlands of the Chignik Peninsula. Tertiary formations of sedimentary rocks, especially sandstones, siltstones and interbedded volcanic lavas, are found to the southwest of the older headland formations. This area is on the Pacific "ring of fire" of seismically active areas, but has been generally free of earthquakes of more than five on the Richter scale. Mt. Veniaminof (8,450 feet) is located about 25 miles west of Chignik Lagoon; it last erupted in June 1983 (U.S. Army Corps of Engineers 1984).

2.2 Climate

The village of Chignik Lagoon is partially protected from the most severe southerly Pacific storms by a ridge of mountains rising to 3,000 feet. Frequent cyclonic storms crossing the Northern Pacific and the Bering Sea are the predominant weather factors. These storms account for the frequent high winds and the common occurrence of fog and low visibility. Fog occurs most often from mid-July to mid-September.

The climate at Chignik Lagoon is basically maritime due to the nearness of the open ocean. Temperature extremes, both seasonal and diurnal, are generally confined to fairly narrow limits, with differences between maximum and minimum temperatures for all individual months averaging less than 15 degrees Fahrenheit. Temperatures below zero degrees Fahrenheit occur in occasional years when the Bering Sea freezes and allows the influx of cold continental air.

3.0 RESEARCH AND FIELD WORK

3.1 Research

Numerous reports and geologic maps were reviewed during the reconnaissance study. Following are the more significant publications reviewed:

- Feasibility Report Chignik Lake to Lagoon Road; Federal Highway Administration Western Federal Lands Highway Division, March 2011.
- Roadway Plan and Profile Sheets, Chignik Lagoon Road; January 2010.
- Draft Small Hydropower Interim Feasibility Report and Draft Environmental Impact Statement, Chignik Alaska; Department of The Army Alaska District, Corps of Engineers, July 1984.
- Detterman, R.L. Miller , T.P., Yount, M.E. and Wilson, F.H. , 1981a Geologic Map of the Chignik and Sutwik Island Quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-229, Scale 1:250,000, 1 sheet.
- Reger and Others 2003, Geologic Map of Proposed Transportation Corridors. In The Chignik Quadrangle, Alaska: Miscellaneous Publications 61a and 61d.

Other research literature used is detailed in the Reference Section of this report.

3.2 Field Work

Field work consisted of a site visit, field reconnaissance of the shoreline and hillside routes, and sampling of potential road surfacing/fill materials at Marshinlak Creek. The field work consisted of a walkover of the shoreline (current landfill access route) and hillside routes between stations 640+00 and 712+70, mapping of geological features, and discussions with Chignik Lagoon Public Works personnel and other residents. Photographs were taken of the project features. A geologic mapping of the project area between the landfill and Chignik Lagoon has been developed and is included in Figures A-1, A-2 and A-3 of Appendix A. Plan and profile sheets (produced by Western Federal Lands) have been used as the map base which includes hillside route stationing for reference. Photograph locations are also indicated on the maps. Photographs

are included in Appendix B. Select typical cross sections taken along the hillside alignment are presented in Appendix C. Laboratory test results from the field samples are included in Appendix D. Access and visual assessment of the surficial geologic conditions along the hillside route was challenging due the extensive, dense vegetation and steep topography (See photograph P-18, Appendix B)

4.0 FINDINGS

4.1 Site Geology

Geologic mapping is presented in Appendix A on plan and profile sheets of the alignment (Figures A-1, A-2 and A-3) for both the hillside and shoreline routes. The plan and profile sheets used for base mapping were produced by Western Federal Lands during the Feasibility Study for the project. In general, the geology along the hillside route consists predominately of a veneer of colluvium overlying either volcanic rock or sedimentary rock (photographs P- 8 and P-17). The hillside alignment crosses a large ancient landslide between approximate stations 690+00 and 700+50. No indications of active moment were observed within the landslide feature; however, considerable seepage was emerging from the toe area. Based on observations of road cuts and along the toe of the landslide, the landslide material consists of angular cobbles and boulders within a predominantly sand and silt matrix with some clay. It is likely the initial movement occurred tens of thousands of years ago during periods of glacial melting.

The hillside alignment crosses numerous small drainages and one relatively large drainage at station 681+30 (named Jerrys Point Creek in the Feasibility Study Report). The smaller drainages contain predominately colluvial soils consisting of angular volcanic and sedimentary rock fragments, sand and silt, and some clay. The larger drainage consists of more intensely worked alluvial soils consisting of subrounded to round sedimentary and volcanic rock fragments with sand and silt. The shoreline alignment is situated on marine sediments and slope wash colluvium which generally consist of subrounded cobbles, gravel, sand and silt with clayey zones.

Extensive geologic mapping has not been conducted by the United States Geological Survey within the Chignik Lagoon area. Based on generalized geologic mapping (R.D. Reger, et. al. 2003), the predominate bedrock geology consists of undifferentiated sedimentary rocks along the majority of the hillside alignment area between Chignik Lagoon and the landfill. These deposits consist of sandstone, siltstone and volcanic layers. The majority of the exposed bedrock outcrops along the shoreline and exposed in the hill slopes appear to be fairly competent and weather resistant (photographs 4 and 10). Some relatively weak shale zones were observed along the shoreline alignment below approximate station 665+00 (photograph 8). Quaternary alluvial deposits consisting primarily of cobbles, gravel, and course sand with silt underlay the

Village of Chignik Lagoon area. These deposits are derived from relatively extensive deposition by Packer Creek.

4.2 Landfill Access Route along Shoreline

The current landfill and sewage lagoon access route follows along the shoreline. Access along this alignment is controlled by tidal events. The landfill or sewage lagoon can only be accessed during low tide events. The length of the current access route from the village to the landfill is approximately 5,130 feet. Photographs have been taken along the alignment, the locations of which are shown on Figures A-1, A-2 and A-3 (see photographs 2 through 10 and 13 through 14). The alignment subgrade is comprised of marine sediments and colluvial slope-wash materials which consist predominately of fine gravel with cobble zones, sand, silt, and at some locations, clay. Portions of the alignment subgrade have been stabilized by concrete planks (photographs 6, 7 and 14). The shoreline adjacent to the beach (alignment subgrade) consists of either relatively steep colluvial soil slopes or bedrock outcrops. The outcrops form small to large cliffs dependent upon location, and the majority of the rock outcrops appear to be relatively weather resistant. In general the shoreline along the landfill access route is stable with no indication of excessive wave action erosional areas. Based on conversations with the landfill operator, Mr. Larry McCormick, the access route subgrade is generally stable and has held up well over the years. There is a clayey subgrade area between the last rock point (+/- station 658+00 of the hillside route) and the landfill that occasionally requires maintenance (photograph 14) consisting of the placement of gravel or rock fill on the unstable subgrade areas. The concrete pads have held up well over the years with exception of the pads closest to the landfill, which have experienced some settlement (photograph 14). At the time of the site visit there was no indication of active landslides or unstable areas on the hillside immediately adjacent to the beach along the alignment. Mr. McCormick also stated that he has not observed any landslides or excessive rock fall over the years along the landfill access route. Mr. McCormick indicated that the most significant problem with the access route is during the winter when clearing of ice buildup deposited by wave and wind action is required. It can take up to two to three days to clear the intermittent ice deposition because of scheduling work between tidal events.

4.3 Hillside Route Alignment

The portion of the proposed hillside route investigated is located along the hillside above the shoreline route and extends for approximately 6,900 feet from the Village of Chignik Lagoon to the drainage immediately above the landfill (station 645+00) which is named Landfill Creek in the Feasibility Study Report. Photographs have been taken along the alignment, the locations of which are shown on Figures A-1, A-2 and A-3 (see photographs 1, 2, 4, 5, 11, 11A, and 12 through 16). Additionally, three cross sections were taken at select locations along the proposed route and are presented as Figures XS-1, XS-2 and XS-3 in Appendix C.

The alignment "side hills" across very steep terrain between stations 645+00 (photographs P-12 and P-14) and 675+00 (photograph P-11A). Cross sections XS-1 (+/-station 655+00) and XS-2 (+/- station 665+25) indicate steep side slope angles of 1H:1V (horizontal to vertical) along these alignment areas. The alignment also crosses some smaller incised drainages between these stations. The alignment crosses the relatively large Jerrys Point Creek drainage at station 681+30. Between approximate stations 690+00 and 700+50 the alignment crosses an ancient landslide (photographs P-2, P-3 and P-4). Cross section XS-3 (photograph 2) indicates an existing ground slope angle of approximately 1H:1V. From station 700+50 to 707+00 the alignment crosses a structural bench. Natural slope angles along this bench are relatively low angle. As stated previously, the geology along the alignment, with the exception of drainage crossings and the landslide locations, consists predominately of colluvial soils overlaying bedrock at varying depths. It was not possible to determine depth to bedrock by visual inspections. Test pits or drilling will be required to accurately determine the thickness of the colluvial soil cover at specific locations. With the exception of the ancient landslide area, there were no blatant indications of active landslide zones along the hillside alignment. However, the extensive vegetation and difficult access due to the very steep terrain made it very difficult to visually identify subtle indications of potentially unstable areas.

4.4 Potential Borrow Marshinlak Creek Area

Sampling of potential borrow materials was performed from delta deposits at the mouth of Marshinlak Creek. Photographs were taken of the delta deposits and locations (see photographs P-22 through P-25). Weather conditions limited access to the alignment area further up the creek. However, the materials deposited within the deltaic deposit at the mouth of the creek are

representative of parent rock and soils further up the drainage in the vicinity of the road alignment crossing area.

Marshinlak Creek outlet has formed a fairly significant deltaic deposit. Three bulk samples were taken from the delta deposits and submitted to DOWL HKM's Anchorage laboratory for testing to determine physical and engineering characteristics. The following testing was conducted:

- Particle size distribution (ASTM D422);
- LA Abrasion (ASTM C131);
- Soundness (ASTM C88);
- Resistivity (ASTM G57); and
- Percent Soluble Sulfates.

5.0 CONCLUSIONS/RECOMMENDATIONS

5.1 Landfill Access Route along Shoreline

Based on DOWL HKM's site inspection and conversations with the landfill operator, the current landfill access route appears to be relatively stable and reliable. There is some periodic maintenance required in regard to subgrade stabilization in the area immediately northeast of the landfill, but according to the operator this is not excessive. The only significant limitation is working around high tide events and having to clear windblown ice from the alignment during the winter. These problems could be remedied by building the access roadbed up to a certain elevation above a selected design high tide elevation. The road bed could be built up by using a combination of benching into the shoreline colluvial soils or rock outcrops, and possibly borrowing materials from adjacent drainages. There could be considerable borrow material within the southern side slopes of Jerrys Point Creek (within the location of station 680+00 of the hillside route). There appears to be ample rock outcrops along the shoreline immediately adjacent to the alignment that could be utilized for riprap wave protection and/or rock fills for the roadbed. Borrow material could also possibly be obtained from the area immediately to the southwest of the current active landfill cell.

In considering tidal elevations to determine a design roadbed elevation, DOWL HKM has taken a quick look at the 2012 tides for Chignik, the mean higher high water (MHHW) elevation is 9.1 feet. The mean high water (MHW) elevation is 8.2 feet. Every day there are two high tides, one of which is larger than the other; the MHHW is the average of the higher of the two high tides for each cycle. The exceedance probability for the 9.1-foot MHHW is approximately 13%, while the exceedance probability for the 8.2-foot MHW is approximately 25%. Exceedance probabilities for the range of tides are summarized in Table 1.

Table 1: Chignik Lagoon Tide Elevations and Exceedance Probabilities

Tide Elevation	Exceedance Probability
(FT)	(%)
11.8	0.2
11.0	1.0
10.0	5.0
9.4	10.0
8.7	20.0
7.9	30.0
7.0	40.0
5.1	50.0
3.2	60.0
2.0	70.0
0.9	80.0
-0.4	90.0

In summary, if it is desired to have the landfill access road open about 75 percent of the time during high tide events, then the roadway elevation should be approximately eight feet above the existing beach elevation. These elevations should be considered preliminary at this time.

It would be relatively easy to connect the shoreline alignment to the southern portion of the proposed Chignik Lagoon Road at approximate station 640+00 by excavating into the southern side of the Landfill Creek drainage which the current hillside route crosses at station 643+50.

Appropriate permitting would be required to allow placement of fill along the shoreline. The extent of permitting required has not been determined at this time. Geotechnical investigations should be conducted to further define subgrade conditions along the landfill access roadway and further define borrow material and riprap availability. The results of the investigation will allow a more informed determination of the feasibility of using the landfill access alignment as an alternative to the hillside route.

5.2 Hillside Route Alignment

Based on the visual reconnaissance investigation, which was limited by the dense vegetation and steep terrain, there does not appear to be any blatant indications of active slope instability along the hillside route. However, there are some significant construction considerations associated

with locating the roadbed along the hillside. The predominate considerations are cut slope stability and roadbed drainage. Other considerations are safety measures (guardrails) during road use.

Cut slope stability. The alignment side hills very steep terrain for the majority of the distance between the landfill and Village of Chignik Lagoon. The existing ground slope angles approach 1H:1V (horizontal to vertical) at the steepest areas. Typical cross sections shown in Figures XS-1, XS-2 and XS-3 indicate that, in order to catch the existing ground at reasonable distances from the roadbed, the backslope angles would have to be at 0.75H:1V or 0.5H:1V. These angles would still intersect the existing ground at heights equal to or greater than 25 feet above the roadbed.

Colluvial soils would not remain stable at 0.75H:1V cut slope angles and raveling would likely be excessive. There is also the potential that more significant global instability could occur further upslope as a result of the excavations. At a minimum, soil nailing or other stabilization methodologies likely would be required to maintain long-term stability for cut slopes at these angles within the colluvial soils.

Geotechnical investigations will be required to define subgrade conditions and to determine if the cut slope excavations would extend into competent bedrock or colluvial soils along these alignments and if the excavations would maintain adequate stability.

Roadbed Drainage. The alignment immediately above the village between stations 692+50 to 710+00 crosses numerous small drainages. These drainages flow directly through town. Road ditch drainage will concentrate up gradient runoff flows into the existing drainages, thus increasing historic flows down gradient. As these drainages flow directly through town, increased flows could cause localized flooding. Particular attention must be given to drainage design along this section of the roadway. Upgrading of drainage infrastructure through the town will be required. Additionally, roadbed drainage is critical along portions of the roadway sited on the steep hillsides. Routing of drainage is critical so runoff does not “pool” and saturate the roadway subgrade or cut/fill toe areas. Dependent upon geologic conditions, saturation of these zones could initiate large scale instability along the alignment.

Roadway Safety Considerations. Another consideration is safety during use of the roadway. The alignment side hills very steep terrain for the majority of the alignment between the landfill and Village of Chignik Lagoon. The existing ground slope angles approach 1H:1V at the steepest alignment areas. These angles approach cliff-like exposures, and with the proposed narrow road widths, guardrails should be utilized along these steep foreslope areas. The current proposed road templates are narrow and consideration should be given to allow adequate width for placement of a guardrail.

5.3 Potential Borrow Marshinlak Creek Area

Results of the sampling indicate that deltaic soil materials consist of well graded to poorly graded gravels. Additionally, based on the samples taken, gravels exhibit relatively high resistance to weathering; however, the samples taken slightly exceed the State of Alaska Department of Transportation and Public Facilities' Standard Specifications for sodium sulfate soundness for gravel road surfacing. If the gravel source were quarried and crushed the material may pass specification. It is recommended that additional sampling and testing be performed for this potential source area aggregate.

Weather conditions during the site reconnaissance, coupled with the challenging topographic conditions, limited access to the actual alignment area further up Marshinlak Creek Drainage. However, the gravel soils sampled are representative of parent rock materials which would be located up drainage.

It is recommended that further borrow investigations be conducted for the Marshinlak Creek and Duck Creek crossing areas. Access is challenging due to variable often extreme weather conditions and shallow, narrow creek channels coupled with dense vegetation. Proper pre-planning and coordination with Tribal personnel will be required with regard to access to potential borrow areas.

5.4 Summary Conclusions

In summary, construction on the steep side hill areas along the proposed hillside route will be challenging. Cut slope stability is a concern in regard to the steep backslope angles (0.75H:1V or 0.5H:1V), which will be required in order to achieve excavation catch points that are not at excessive distances and elevations above the roadbed. There is also concern that larger scale

slope instability could occur if proper drainage and backslope stabilizations are not achieved. The geologic conditions must be further confirmed along the steep side hill locations in order to assess to affect construction of the road will have on the global slope stability. It must be determined if the roadbed will be within bedrock or colluvial soils and the engineering characteristics of the colluvial soil veneer must also be defined.

It is DOWL HKM's opinion that the landfill access route may be a feasible alternative to the hillside route, provided permitting can be obtained to allow fill placement along the shoreline and ample borrow material can be obtained to allow construction of an approximately eight-foot fill along the shoreline route. Additionally, in depth geotechnical investigations will also be required to further determine feasibility. The geotechnical investigations will allow confirmation of subgrade conditions and availability of borrow and riprap.

6.0 ADDITIONAL INVESTIGATIONS

In depth geotechnical investigations should be conducted for both the landfill access and hillside routes. At this time, DOWL HKM proposes to utilize a local contractor and tracked excavator to dig test pits at select locations along both alignments. The soil and groundwater characteristics will be recorded for each excavation and soil and rock samples will be obtained and submitted to our Anchorage laboratory for testing to define physical and engineering characteristics.

6.1 Landfill Access

Geotechnical investigations should be conducted along the existing landfill access route to further define subgrade stability and availability of borrow material and riprap. Investigation along the existing alignment will be relatively easy as access is straightforward with open country along the shoreline.

6.2 Hillside Route

Geotechnical investigations should be conducted along the proposed hillside alignment. As discussed in the report, access to portions of the alignment area is challenging due to the extensive vegetation and steep topography. It will be required to pioneer temporary roadways to allow excavator access at locations adjacent to the steep hillside areas. It is mandatory that at a minimum, test pits be excavated at representative locations along the steep hill sides in order to obtain suitable information for stability assessments. It is our understanding that there are earthwork contractors in Chignik Lagoon that have the capabilities and operator expertise to access the steep hillside areas utilizing excavators to construct temporary pads and access roadways. It is anticipated that portions of the steep hill slope areas can be accessed from the south side of Jerrys Point Creek and north side of Landfill Creek.

7.0 LIMITATIONS

This report was prepared for the use of the Owner and Engineer in the preliminary planning of the development. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions.

Any conclusions by a construction contractor or bidder relating to construction means, methods, techniques, sequences, or costs based upon the information provided in this report are not the responsibility of the Owner or DOWL HKM. The contractors and bidders are encouraged to perform additional investigations necessary to develop subsurface data for construction purposes.

8.0 REFERENCES

Detterman, R.L. Miller , T.P., Yount, M.E. and Wilson, F.H. , 1981a Geologic Map of the Chignik and Sutwik Island Quadrangles, Alaska : U.S. Geological Survey Miscellaneous Investigations Map I-229, Scale 1:250,000, 1 sheet.

Draft Small Hydropower Interim Feasibility Report and Draft Environmental Impact Statement, Chignik Alaska; Department of The Army Alaska District , Corps of Engineers , July 1984

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Reger and Others 2003, Geologic Map of Proposed Transportation Corridors In The Chignik Quadrangle, Alaska: Miscellaneous Publications 61a and 61d

Roadway Plan and Profile Sheets, Chignik Lagoon Road; January 2010

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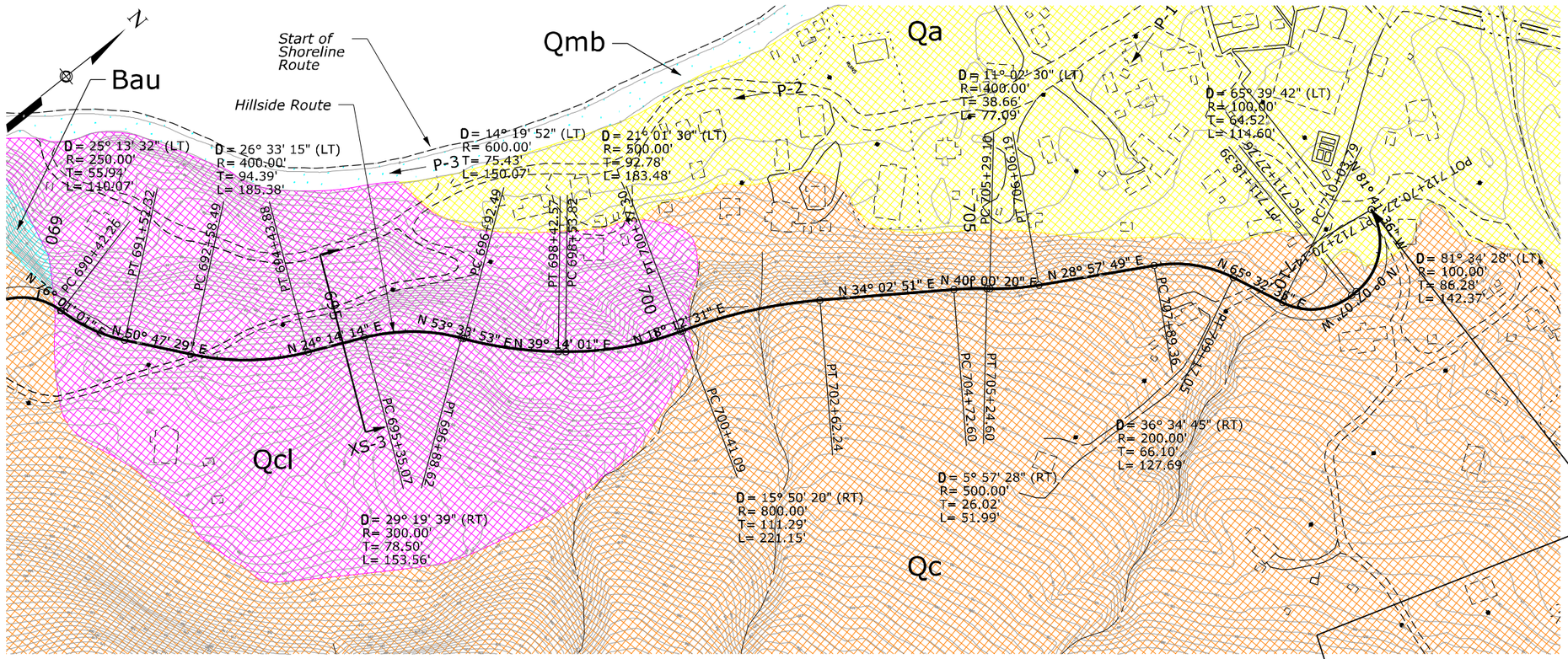
APPENDIX A

GEOLOGIC MAPPING
(Plan and Profile Sheets)

STATE	PROJECT	SHEET NUMBER
AK	DEN 2009(3)	D.25

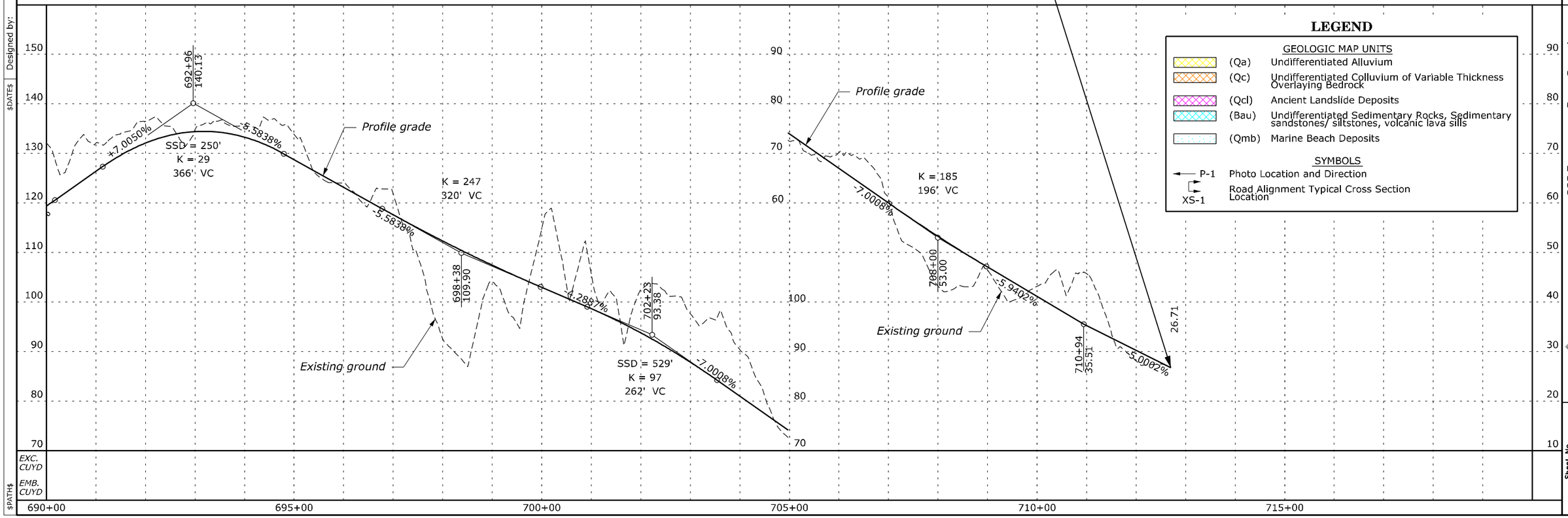
NOTE:

BASE MAPPING AND PLAN & PROFILE ALIGNMENT PROVIDED BY WESTERN FEDERAL LANDS.



HILLSIDE ROUTE END PROJECT

BEGIN NEW CONSTRUCTION
712+70.27
CHIGNIK LAGOON



LEGEND

GEOLOGIC MAP UNITS

(Qa)	Undifferentiated Alluvium
(Qc)	Undifferentiated Colluvium of Variable Thickness Overlaying Bedrock
(Qcl)	Ancient Landslide Deposits
(Bau)	Undifferentiated Sedimentary Rocks, Sedimentary sandstones/ siltstones, volcanic lava sills
(Qmb)	Marine Beach Deposits

SYMBOLS

P-1	Photo Location and Direction
XS-1	Road Alignment Typical Cross Section Location

EXC. CUYD

EMB. CUYD

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CHIGNIK LAGOON ROAD PROJECT

SITE GEOLOGIC MAPPING

Project No.: 1131.60936.01
FILE: dc09031y.dgn
Date: JANUARY 2012

Sheet No.
FIG A-1

Designed by:
Checked by:
$DATE$
$PATH$

STATE	PROJECT	SHEET NUMBER
AK	DEN 2009(3)	D.24

NOTE:

BASE MAPPING AND PLAN & PROFILE ALIGNMENT PROVIDED BY WESTERN FEDERAL LANDS.

Project No.: 1131.60936.01
FILE: dc09035x.dgn
Date: JANUARY 2012

CHIGNIK LAGOON ROAD PROJECT

SITE GEOLOGIC MAPPING

Shoreline Route

Hillside Route

Profile grade

Existing ground

Qmb

Qa

Qc

Bau

Qcl

Jerry's Point Creek

XS-2

P-4 P-5 P-6 P-6a P-7 P-8 P-11a P-11

Δ= 41° 23' 21" (LT)
R= 120.00'
T= 45.33'
L= 86.69'

Δ= 22° 05' 46" (LT)
R= 400.00'
T= 78.10'
L= 154.26'

Δ= 26° 33' 42" (LT)
R= 300.00'
T= 70.81'
L= 139.08'

Δ= 43° 23' 17" (RT)
R= 150.00'
T= 59.67'
L= 113.59'

Δ= 15° 21' 18" (RT)
R= 400.00'
T= 53.92'
L= 107.20'

Δ= 22° 12' 18" (RT)
R= 350.00'
T= 68.68'
L= 135.64'

Δ= 25° 04' 29" (RT)
R= 400.00'
T= 88.95'
L= 175.05'

Δ= 11° 16' 27" (LT)
R= 500.00'
T= 49.35'
L= 98.39'

Δ= 43° 30' 28" (LT)
R= 300.00'
T= 119.71'
L= 227.81'

Δ= 69° 38' 40" (RT)
R= 100.00'
T= 69.56'
L= 121.55'

660+55 106.86
SSD = 640'
K = 151
350' VC
-0.9568%
667+57 100.13
K = 136
198' VC
-0.9568%
+0.5008%
671+04 101.87
SSD = 1002'
K = 184
223' VC
-0.7112%
674+79 99.21
SSD = 556'
K = 133
405' VC
-3.7636%
680+51 77.65
K = 36
392' VC
-3.7636%
+7.0000%
685+04 109.39
SSD = 253'
K = 29
218' VC
+7.0000%
-0.5005%
688+33 107.68
K = 49
368' VC
+7.0050%

120 110 100 90 80 70 60 50 40

660+00 665+00 670+00 675+00 680+00 685+00 690+00

EXC. CUYD
EMB. CUYD

LEGEND

GEOLOGIC MAP UNITS

(Qa)	Undifferentiated Alluvium
(Qc)	Undifferentiated Colluvium of Variable Thickness Overlaying Bedrock
(Qcl)	Ancient Landslide Deposits
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SYMBOLS

P-1 Photo Location and Direction

XS-1 Road Alignment Typical Cross Section Location

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Sheet No.
FIG A-2

Designed by: $DATE$ Checked by: $PATH$

STATE	PROJECT	SHEET NUMBER
AK	DEN 2009(3)	D.23

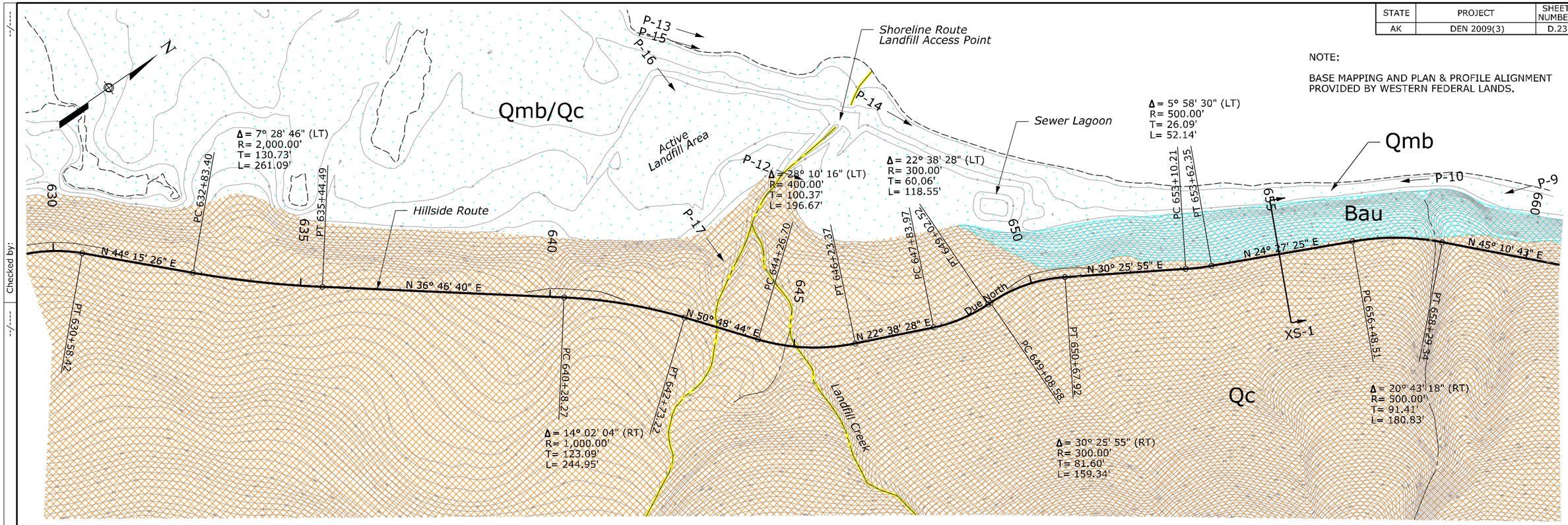
NOTE:

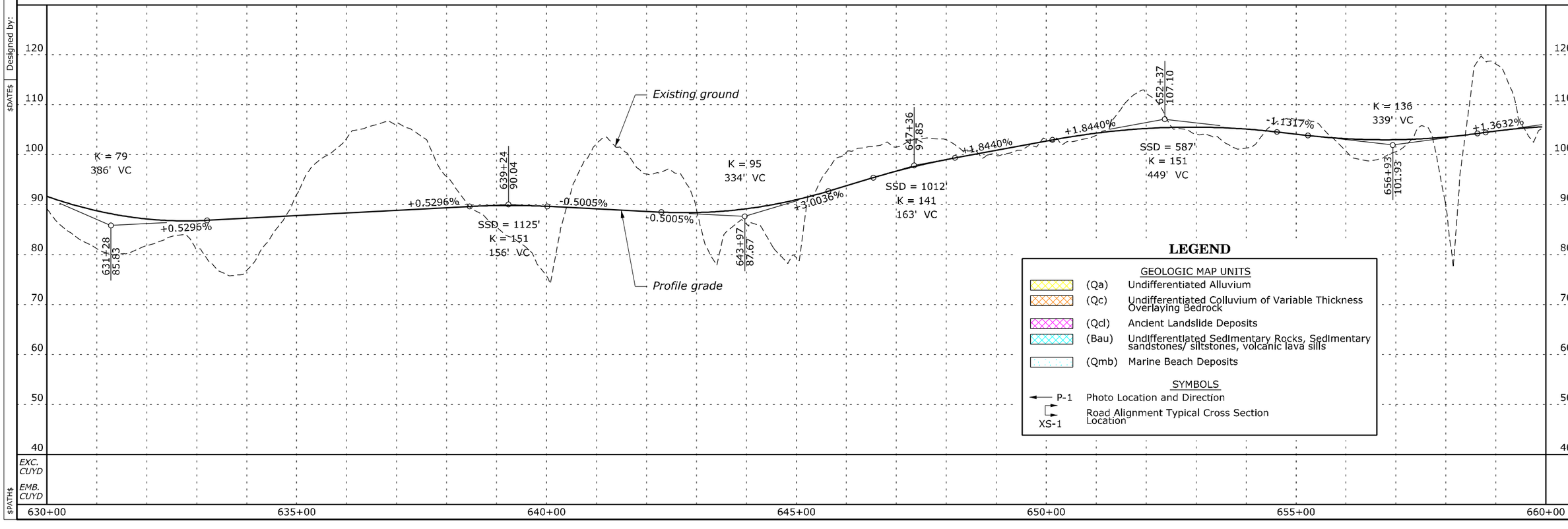
BASE MAPPING AND PLAN & PROFILE ALIGNMENT PROVIDED BY WESTERN FEDERAL LANDS.

- Project No.: 1131.60936.01
- FILE: dc09031w.dgn
- Date: JANUARY 2012

CHIGNIK LAGOON ROAD PROJECT

SITE GEOLOGIC MAPPING





LEGEND

GEOLOGIC MAP UNITS

(Qa)	Undifferentiated Alluvium
(Qc)	Undifferentiated Colluvium of Variable Thickness Overlaying Bedrock
(Qcl)	Ancient Landslide Deposits
(Bau)	Undifferentiated Sedimentary Rocks, Sedimentary sandstones/ siltstones, volcanic lava sills
(Qmb)	Marine Beach Deposits

SYMBOLS

P-1	Photo Location and Direction
XS-1	Road Alignment Typical Cross Section Location

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Sheet No.

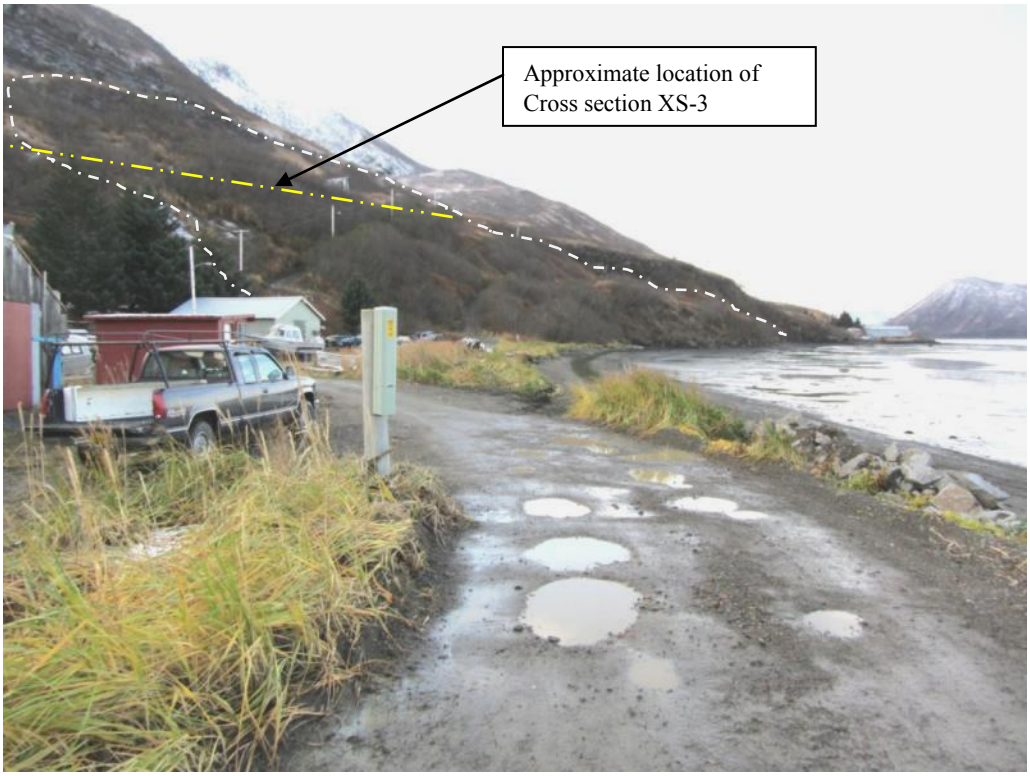
FIG A-3

Designed by: $DATE$ Checked by: --/---- --/---- $PATH$

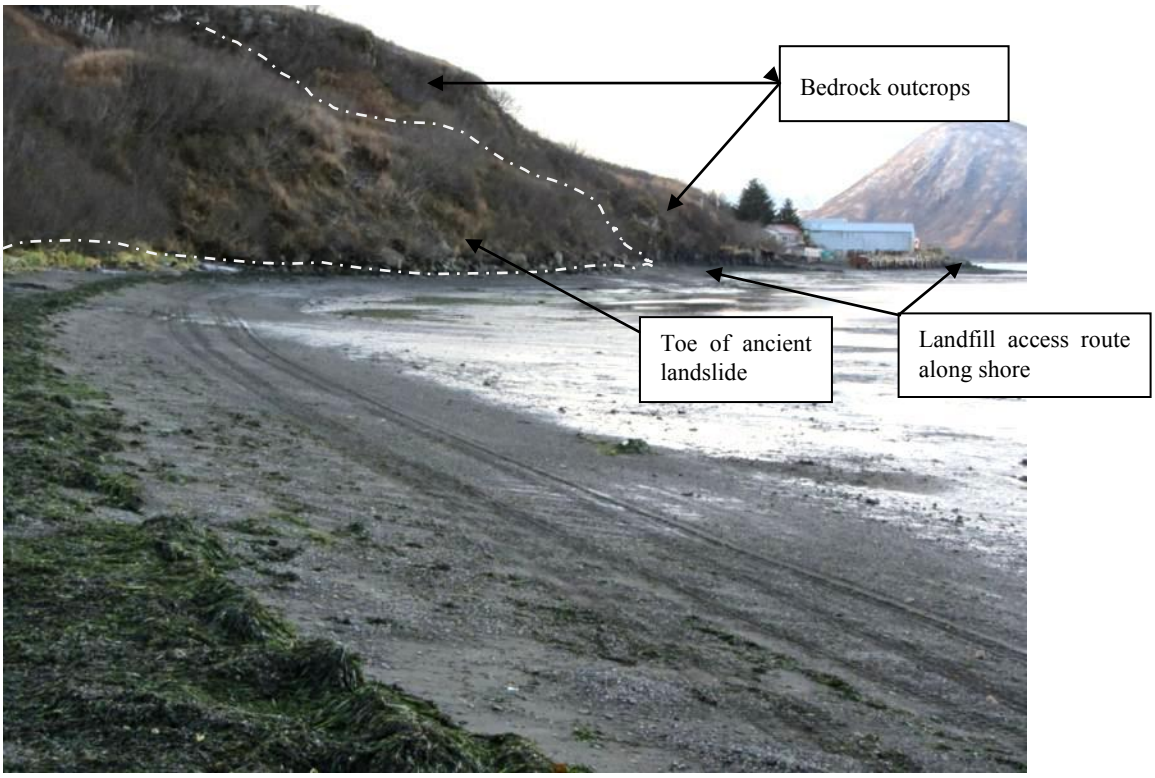
APPENDIX B

PHOTOGRAPH LOG

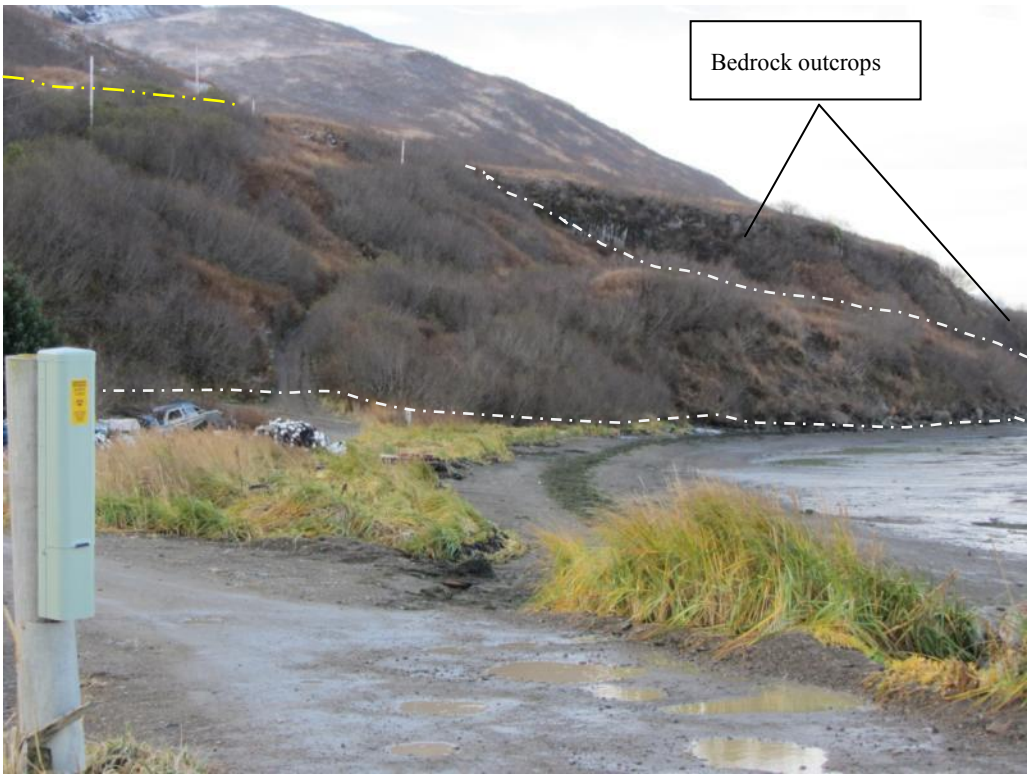
Photograph 1: Looking south east showing road alignment along structural bench above village



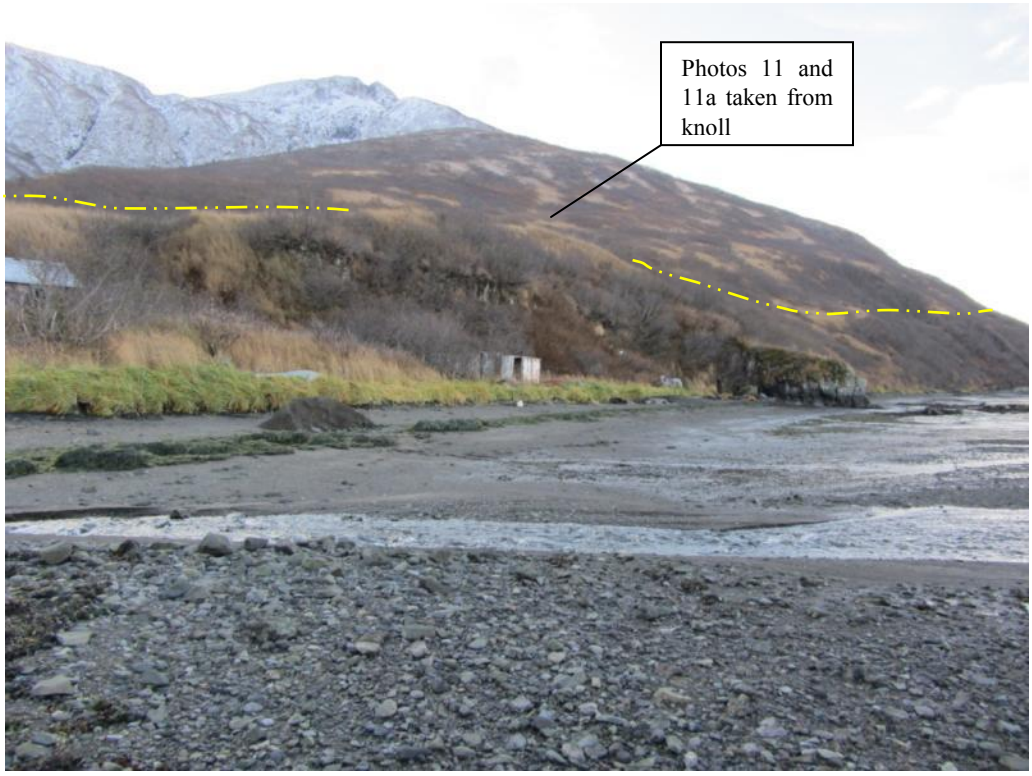
Photograph 2: Looking SE at road alignment (yellow line) and ancient landslide area (white line).



Photoraph 3: Looking SW at landfill access road along shoreline and toe of ancient landslide. Bedrock exposed in cliffs above landslide.



Photograph 4: Close up of toe of ancient landslide. Proposed road alignment shown by yellow line.



Photograph 5: Looking south at landfill access along shore from drainage outlet adjacent to Tract U. Proposed road alignment shown along hillside (yellow line).

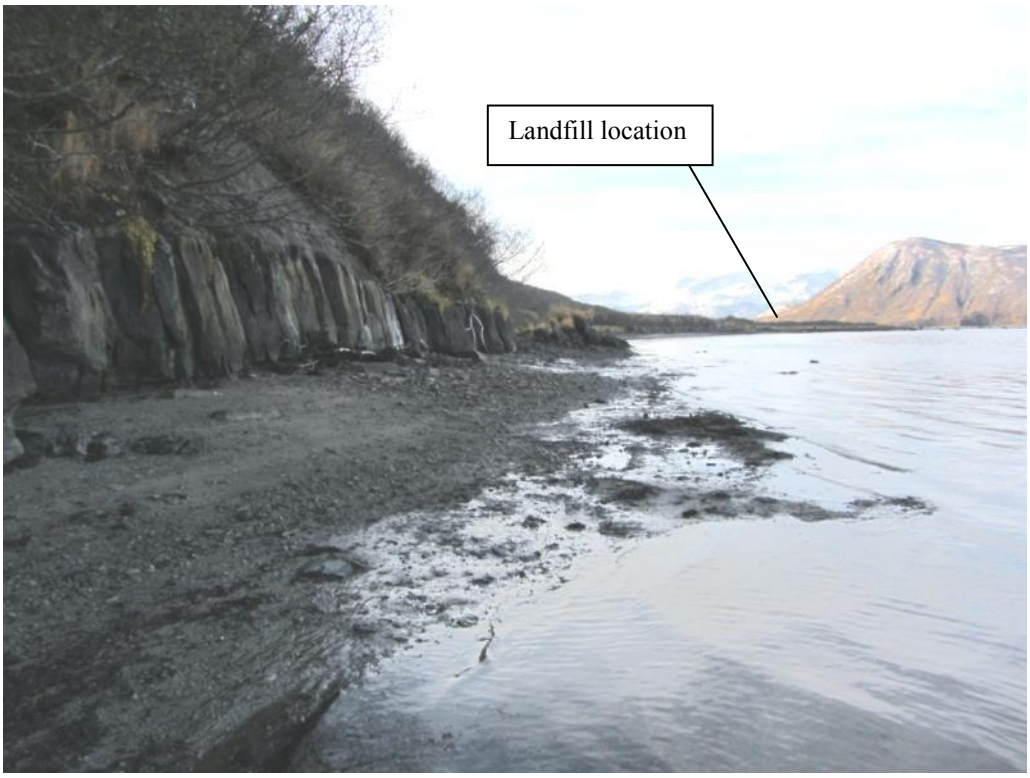
Photograph 6: Looking SSW along landfill access. Concrete road pads in foreground. Colluvium soil veneer overlaying bedrock is visible on hillside adjacent to shoreline.

Photograph 6a: Looking NNE along landfill access.

Photograph 7: Looking SSW along landfill access. Sedimentary bedrock exposed at toe of hillside. Bedrock exposed in cliffs in background.

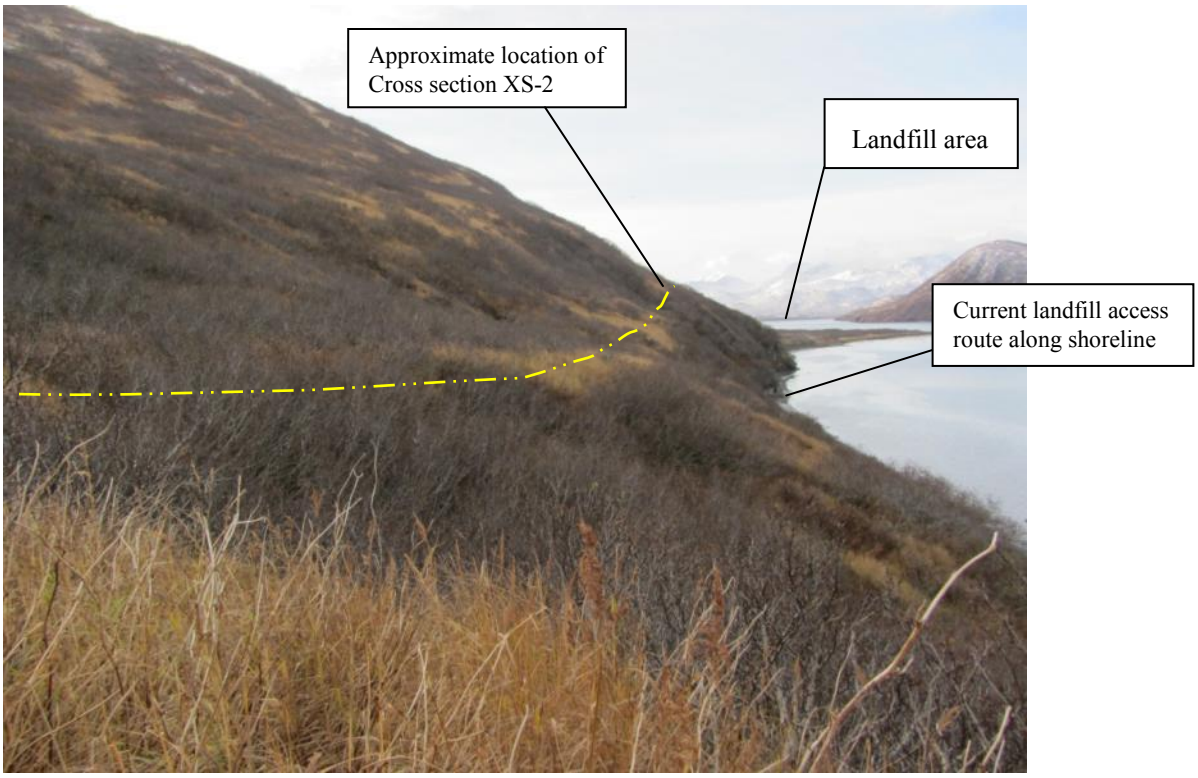
Photograph 8: Sedimentary rock outcrop with colluvial soil veneer along landfill access roadway (near station 664+00).

Photograph 9: Landfill access looking SSW at rocks forming cliffs along shoreline.

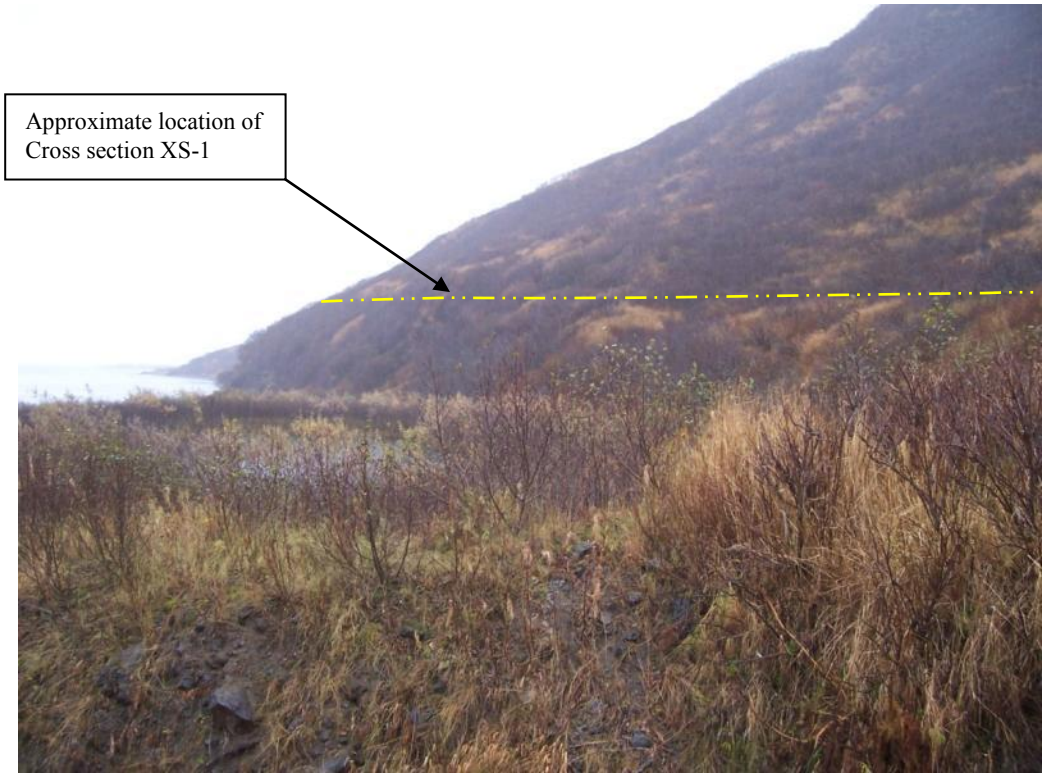


Photograph 10: Landfill access looking SW. Sewage lagoons and landfill area in background.

Photograph 11: Proposed road alignment looking NE from station 675+50.

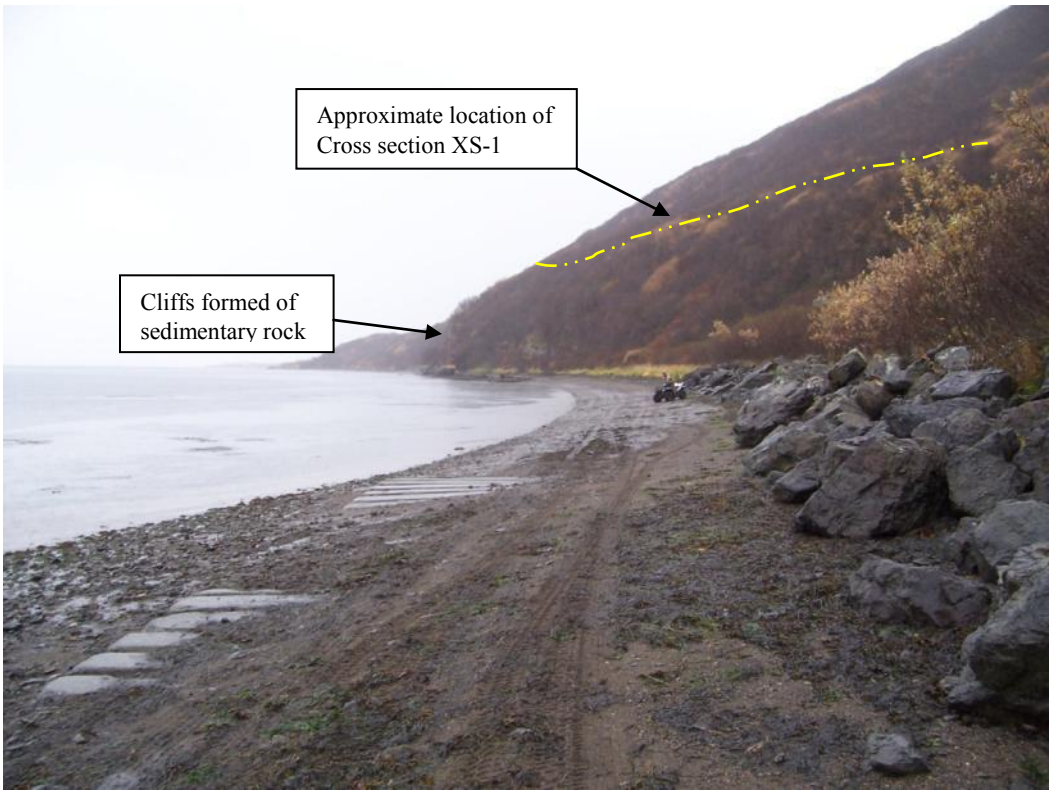


Photograph 11A: Proposed road alignment from station 675+50 looking SSW. Landfill area in background.



Photograph 12: Looking NE from berm between landfill and lagoon at alignment on hillside.

Photograph 13: From shoreline by landfill looking NE at hillside alignment.



Photograph 14: From shoreline by landfill looking NE along landfill access and hillside route alignment (yellow line).

Photograph 15: From shoreline by landfill looking NE at hillside alignment.

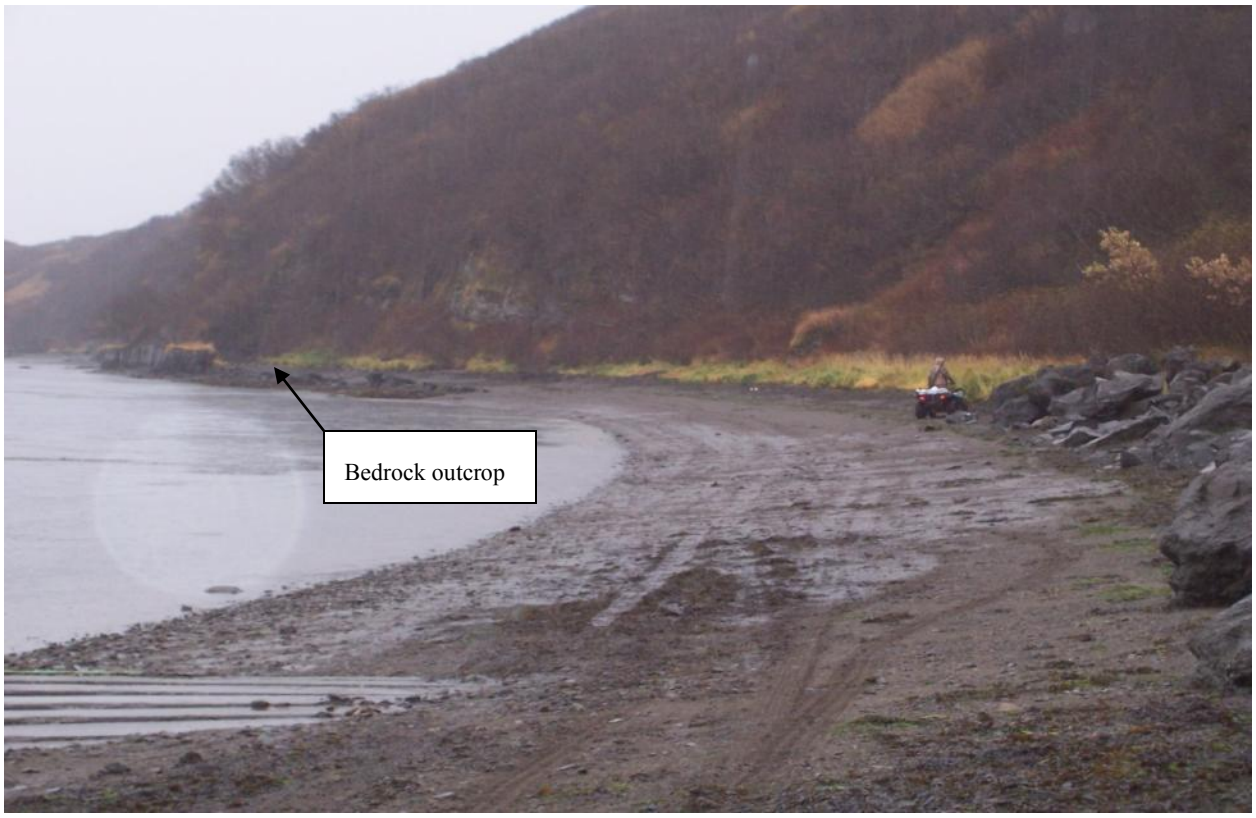
Photograph 16: From shoreline by landfill looking east at hillside alignment.

Photograph 17: Test pit excavation by landfill showing silty gravel colluvium and large blocks of volcanic rock.

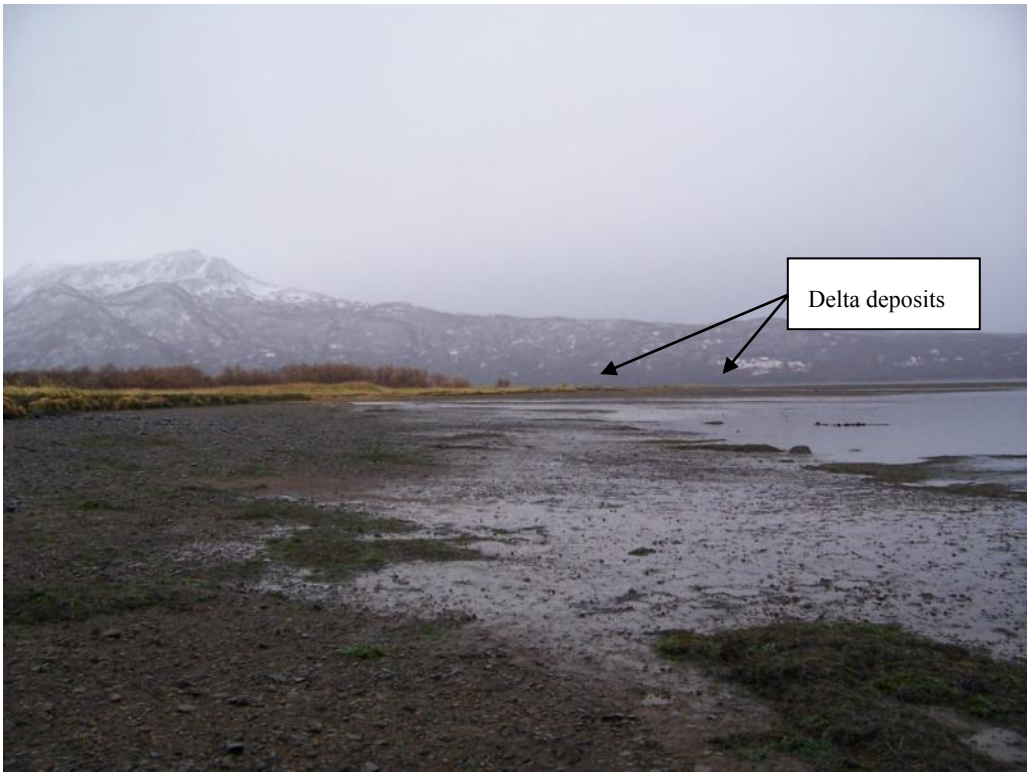
Photograph 18: Typical dense vegetation encountered along alignment (8- to 12-foot alders with salmon berry bush and mixed grasses).

Photograph 19: Showing colluvial slope / marine sediment interface along landfill access route. Colluvium consists of angular cobble and boulder size sedimentary and volcanic rocks in sand, silt and clay matrix. Large boulder "rockfall is infrequent.

Photograph 20: Showing colluvial slope / marine sediment interface along landfill access route.



Photograph 21: Showing bedrock subgrade area just northeast of sewer lagoon and landfill. Landfill access road concrete pads in foreground.



Photograph 22: Marshanlak Creek Delta.

Photograph 23: Marshanlak Creek delta deposits.

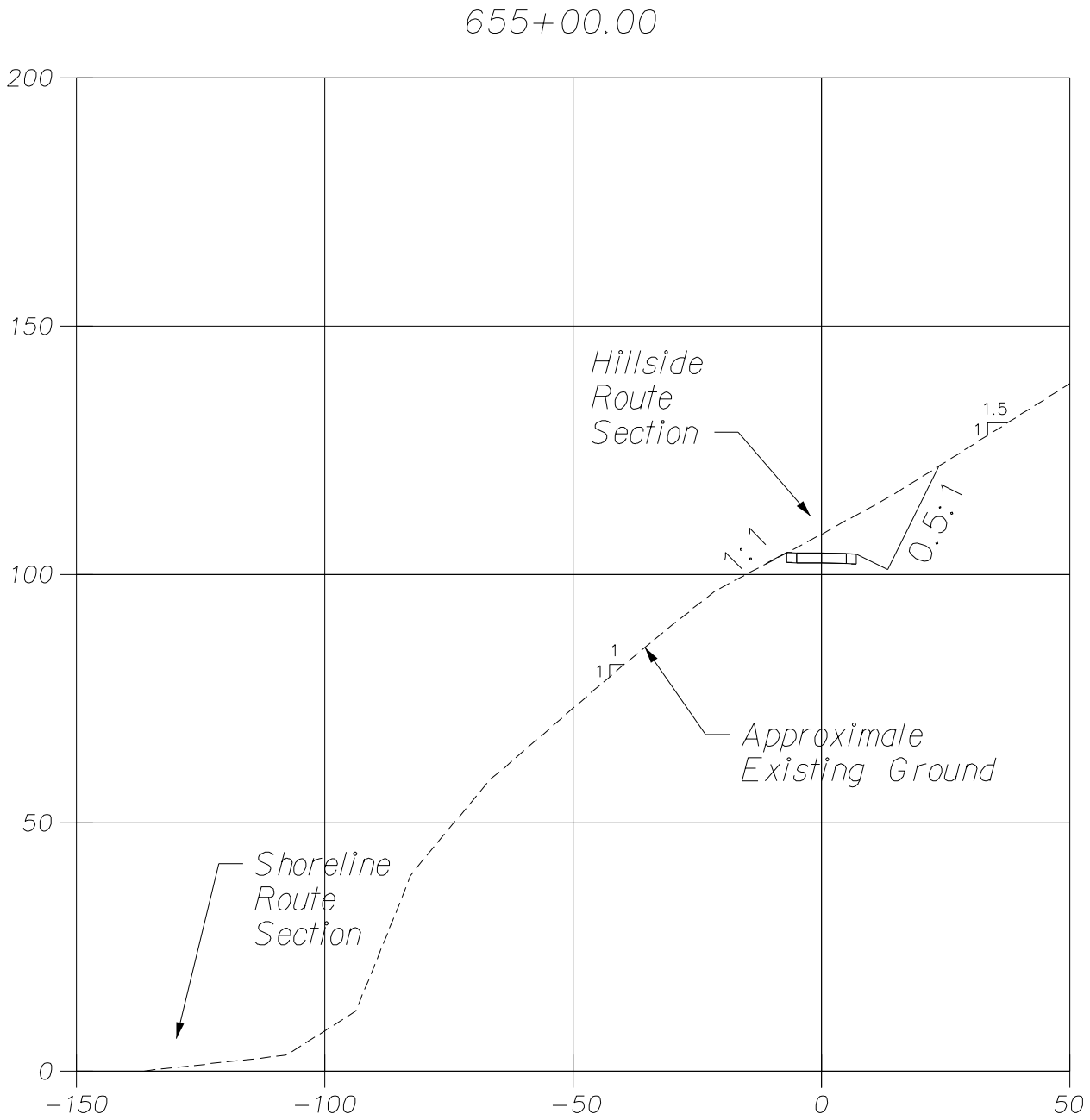
Photograph 24: Marshanlak sample sites.

Photograph 25: Marshanlak Creek sample site No. 1.

Photograph 26: Typical excavator available at Chignik Lagoon.

APPENDIX C

TYPICAL CROSS SECTIONS



NOTE:

PRELIMINARY DESIGN TYPICAL SECTION #1 (14' TRAVEL WAY WITH DITCH) USED IN CROSS SECTION.

CHIGNIK LAGOON ROAD PROJECT

CROSS SECTION XS-1 AT STA 655+00.00

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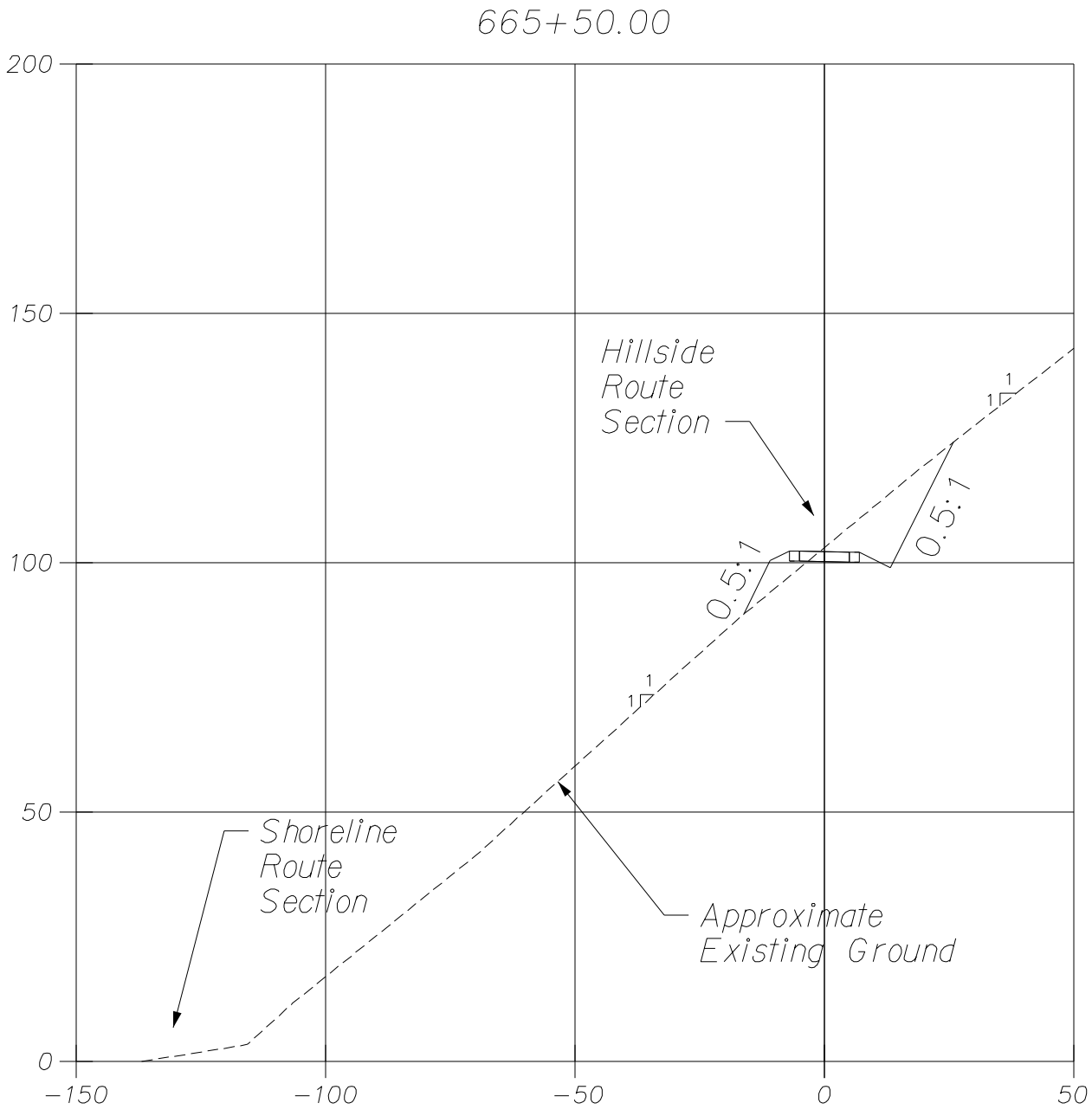
XS-1



NOTE:

PRELIMINARY DESIGN TYPICAL SECTION #1 (14' TRAVEL WAY WITH DITCH) USED IN CROSS SECTION.

CHIGNIK LAGOON ROAD PROJECT

CROSS SECTION XS-2 AT STA 665+50.00

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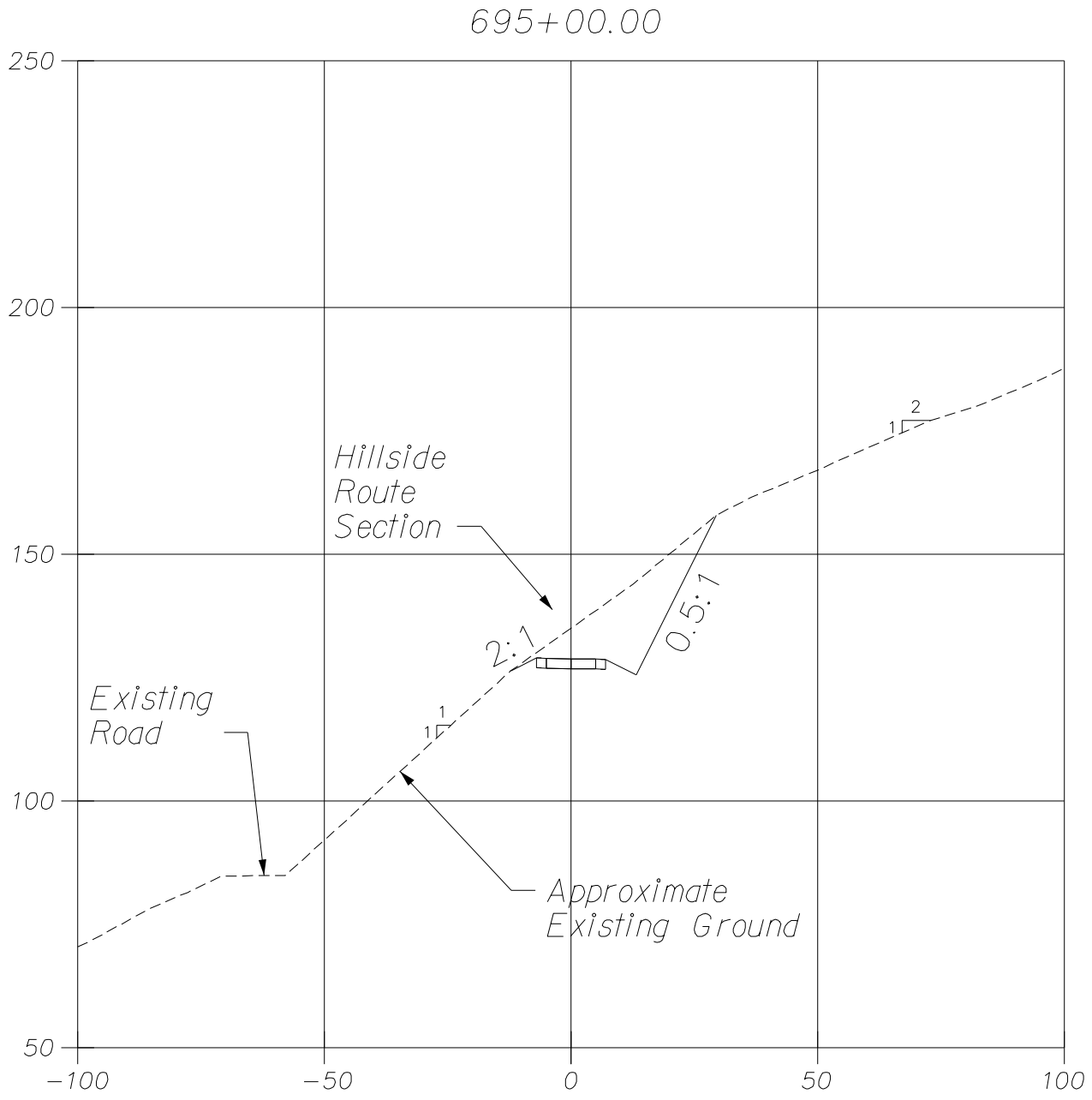
XS-2



NOTE:

PRELIMINARY DESIGN TYPICAL SECTION #1 (14' TRAVEL WAY WITH DITCH) USED IN CROSS SECTION.

CHIGNIK LAGOON ROAD PROJECT

CROSS SECTION XS-3 AT STA 695+00.00

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Sheet No.

XS-3

APPENDIX D

LABORATORY TEST RESULTS

DOWL HKM

Client: Chignik Lagoon Tribal Council
Project: Chignik Lagoon Road
Work Order: D60936

Particle Size Distribution

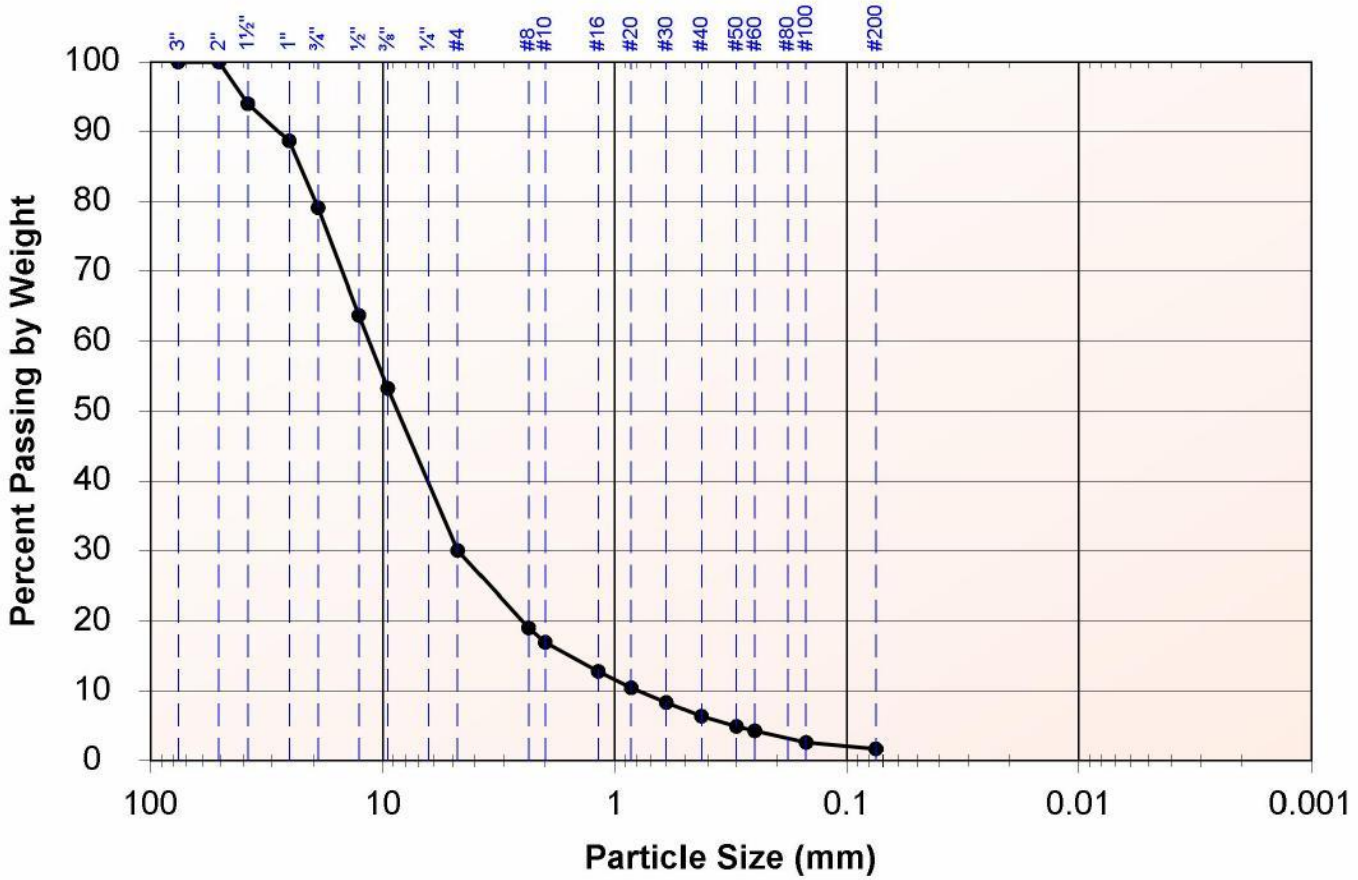
ASTM D422

Location: Sample 3
Depth 0'-1'

Lab Number	2011-1763
Received	11/8/2011
Reported	12/8/2011

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	94%	
1"	89%	
¾"	79%	
½"	64%	
⅜"	53%	
#4	30%	
Total Weight of Coarse Fraction: 4420g		
#8	19%	
#10	17%	
#16	13%	
#20	10%	
#30	8%	
#40	6%	
#50	5%	
#60	4%	
#100	3%	
#200	1.7%	
Total Weight of Fine Fraction: 327.5g		

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DOWL HKM

Client: Chignik Lagoon Tribal Council
Project: Chignik Lagoon Road
Work Order: D60936

Particle Size Distribution

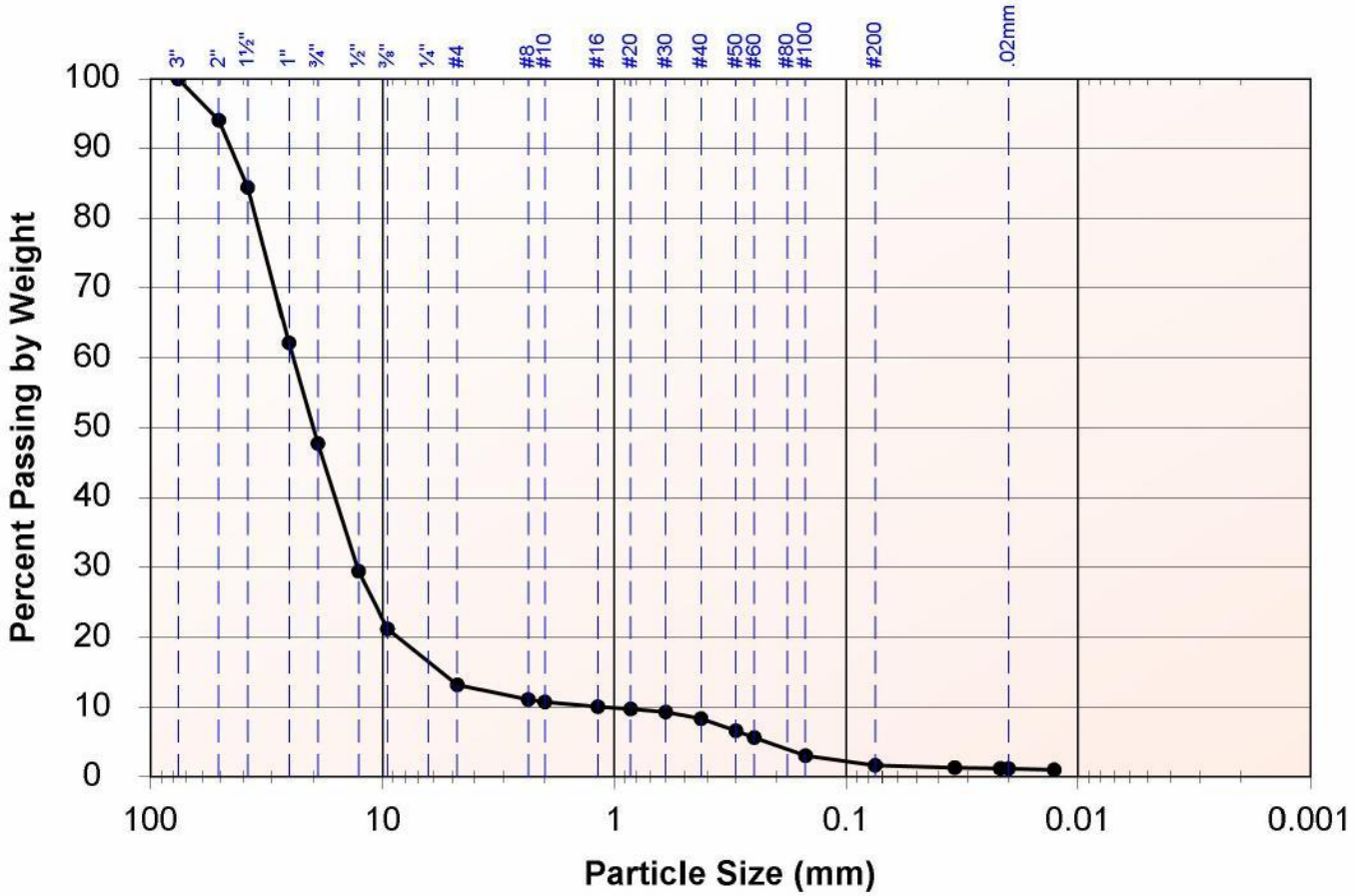
ASTM D422

Location: Sample 1
Depth 0'-1'

Lab Number	2011-1761
Received	11/8/2011
Reported	12/8/2011

Engineering Classification: **Poorly Graded Gravel, GP**

Frost Classification: **NFS MOA**



Size	Passing	Specification
3"	100%	
2"	94%	
1½"	84%	
1"	62%	
¾"	48%	
½"	29%	
⅜"	21%	
#4	13%	
Total Weight of Coarse Fraction: 26197g		
#8	11%	
#10	11%	
#16	10%	
#20	10%	
#30	9%	
#40	8%	
#50	7%	
#60	6%	
#100	3%	
#200	1.7%	
Total Weight of Fine Fraction: 415.8g		
0.02 mm	1%	

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DOWL HKM

Client: Chignik Lagoon Tribal Council
Project: Chignik Lagoon Road
Work Order: D60936

Particle Size Distribution

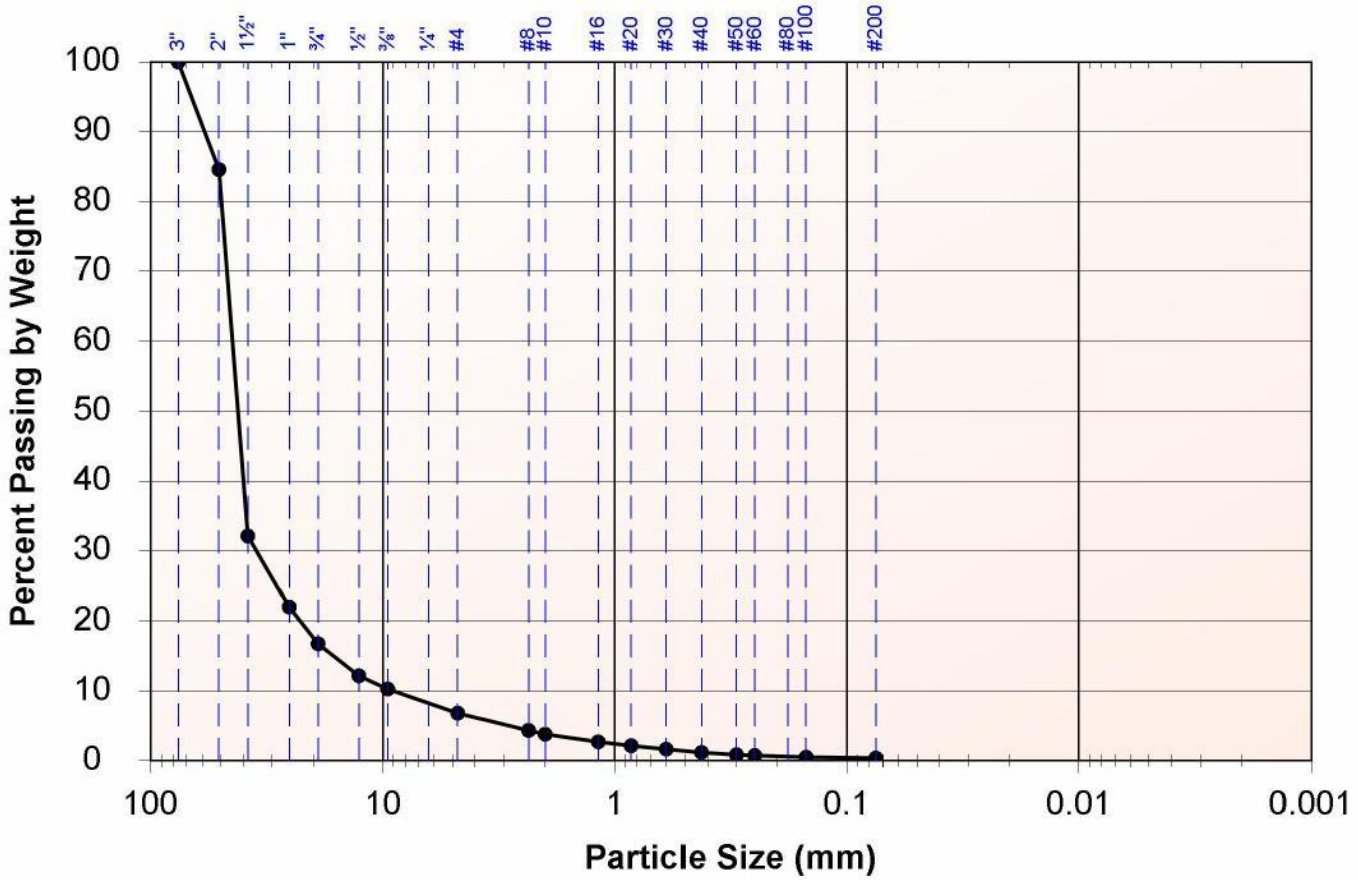
ASTM D422

Location: Sample 2
Depth 0'-1'

Lab Number	2011-1762
Received	11/8/2011
Reported	12/8/2011

Engineering Classification: **Poorly Graded Gravel, GP**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	85%	
1½"	32%	
1"	22%	
¾"	17%	
½"	12%	
⅜"	10%	
#4	7%	
Total Weight of Coarse Fraction: 16658g		
#8	4%	
#10	4%	
#16	3%	
#20	2%	
#30	2%	
#40	1%	
#50	1%	
#60	1%	
#100	1%	
#200	.4%	
Total Weight of Fine Fraction: 327g		

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DOWL HKM

Testing Report Summary

		Date Sample Recv'd	11/8/2011
Client	Chignik Lagoon Tribal Council	W.O.	D60936
Project	Chignik Lagoon Road	Lab #	See Below
Location	See Below		

All results will be posted to the website for your access and convenience. Samples will be kept for 30 days before being disposed. Please contact us if you would like the remaining material returned.

Sample ID	Test Performed	Test Method	Type	Revolutions	% Loss
1761 Sample 1	LA Abrasion	ASTM C131	B	500	26
1762 Sample 2	LA Abrasion	ASTM C131	A	500	18

Sample ID	Test Performed	Test Method	Results (ohm-cm)
1763	Soil Resistivity	ASTM G57	Resistivity Saturated = 2000

If you have questions regarding this summary report or the test procedures, please contact us.

Maria E. Kampsen, P.E.
Laboratory Supervisor

DOWL HKM

Testing Report Summary

		Date Sample Recv'd	11/8/2011
Client	Chignik Lagoon Tribal Council	W.O.	D60936
Project	Chignik Lagoon Road	Lab #	1761
Location	Sample 1, 0-1		

All results will be posted to the website for your access and convenience. Samples will be kept for 30 days before being disposed. Please contact us if you would like the remaining material returned.

Soundness of Fine Aggregate - ASTM C88

5 cycles / Sodium Sulfate

Retained On Sieve #	*Original Gradation*	*Before Test Weight*	*After Test Weight*	*After Test Percentage*	*Weighted Percentage Loss*	
-200						
200	0					
100	9					
50	36	0.0	0.0	0.0	0.00	
30	18	100.1	84.9	15.2	2.76	
16	9	100.1	74.9	25.2	2.29	
8	9	100.1	68.7	31.4	2.85	
4	18	100.0	68.2	31.8	5.78	
Total	100			**Total**	**13.7**	← **Weighted Percentage**

Soundness of Coarse Aggregate - ASTM C88

5 cycles / Sodium Sulfate

Retained On Sieve #	*Original Gradation*	*Before Test Weight*	*After Test Weight*	*After Test Percentage*	*Weighted Percentage Loss*	
3/8-no4	9	300.5	178.1	40.7	3.75	
3/8		331.2				
1/2		673.7				
3/4-3/8	31	1004.9	835.7	16.8	5.23	
3/4		506.3				
1		1014.9				
1 1/2-3/4	41	1521.2	1459.5	4.1	1.68	
1 1/2		2012.1				
2		3003.1				
2 1/2-1 1/2	18	5015.2	4929.0	1.7	0.31	
Total	100				**11.0**	← **Weighted Percentage**

If you have questions regarding this summary report or the test procedures, please contact us.

Maria E. Kampsen, P.E.
Laboratory Supervisor

(Rev 1, 12/09)