June 1, 2011

Mr. Bill Johnson, PE
CRW Engineering Group, LLC
3940 Arctic Blvd., Suite 300
Anchorage, AK 99503

RE: HISTORICAL REVIEW OF EXISTING GEOTECHNICAL DATA FOR PROPOSED CAMPBELL AIRSTRIP ROAD – MILE 0.3 TO 0.7, ANCHORAGE, AK (MOA PM&E PROJECT NO. 10-028)

Dear Bill:

Golder Associates Inc. (Golder) is pleased to present the findings of our historical review of existing geotechnical data for the proposed upgrade to Campbell Airstrip Road between mile 0.3 and 0.7 south of Tudor Road in Anchorage, AK (Figure 1). We understand that the proposed project encompasses about 2,100 lineal feet of roadway. The upgrades will occur to the roadway, parking lot and trail facilities, and matching similar road improvements at either end of the project limits.

The purpose of our review is to evaluate existing available geotechnical data and other site information, commenting on its relevancy to the proposed road upgrade project.

1.0 PROJECT OVERVIEW

Campbell Airstrip Road is owned and maintained by the Municipality of Anchorage. It serves as the primary access to Far North Bicentennial Park and the Stuckagain Heights Neighborhood. Several local plans include this project and recommended the improvement. The road and associated trail have been improved at both ends of the project limits. The project will improve the road and trail, matching the existing improvements.

2.0 SITE DESCRIPTION

The particular segment of Campbell Airstrip Road proposed for upgrading by this project is located between 0.3 miles and 0.7 miles south of Tudor Road in northeast Anchorage. Although this segment of road is asphalt paved, it is otherwise unimproved. The roadway parallels a hillside for its entire length with the road bed cut into the uphill east side and filled to the downhill west side. There are no drainage ditches. With exception to a few natural drainages on the downhill west side of the road, soil berms or embankment toes are present at the edge of the asphalt surfacing. Vegetative growth consisting of mostly birch trees sparsely intermixed with a few black spruce trees and brush extend up to the road edge.

The existing pavement surface in this segment of roadway was showing isolated areas of distress which had been patched with asphalt. Given the high percentage of silt in the makeup of the local soils, it is expected this distress is primarily a result of differential frost heaving.

A review of wetland maps in the project area indicate that the proposed alignment does not pass through a designated wetland area. However, the proposed alignment is bordered by wetlands designated as type “A”.

Campbell Airstrip Road
3.0 REVIEW OF AVAILABLE DATA

3.1 Surficial Geology

The proposed alignment passes through an area where surficial geologic mapping\(^1\) indicates the presence of two major soil deposits which are noted below and presented in Figure 2:

1. Glacial and or marine deposits (gm): These deposits generally occur in hills and consist of diamicton (poorly sorted sediments). The deposits may contain beds of fine sand and silt or thin beds of gravel and sand.

2. Marine, glacial and (or) lacustrine deposits (mg): These deposits typically occur in low areas near hills mapped as gm. These deposits may contain a variety of fine grained materials including silt and fine grained sand.

The surficial mapping also indicates that the proposed alignment is near an alluvium deposit (al) which generally consists of gravel and sand. This deposit was likely caused by the reworking of the north fork of Campbell Creek.

3.2 Historical Subsurface Data

Existing available geotechnical data consist of two separate geotechnical investigation reports performed for improvements to the road at either end of this projects limit. To the north, the mile 0.0 to 0.3 segment of Campbell Airstrip Road improvement was investigated and reported by Duane Miller & Associates (DMA). To the south, mile 0.8 to 1.4 was investigated and reported by Shannon Wilson, Inc. These investigations and reports are presented below.

3.2.1 Mile 0.0 to 0.3

A historic geotechnical investigation program and report by Duane Miller & Associates (DMA) was reviewed to determine subsurface conditions between the intersection of Campbell Airstrip Road and Tudor Road (mile 0.0) to approximately mile 0.3 of Campbell Airstrip Road. The report is presented in Appendix A.

Six geotechnical borings were advanced to depths between 5 to 16 feet for the DMA investigation. Soil samples were collected using the Standard Penetration Test (SPT) methods. Subsurface conditions encountered generally consisted of the following:

- SILT (ML) – Silt with varying amounts of sand and gravel was encountered between depths of 2 to 6 feet along the project alignment. The silt had a frost classification of F4.

- Silty Sand to Silty Gravel (SM to GM) – Silty sand and gravel was encountered below the surficial silt in all boreholes. The frost classification of the soil was mostly F3, though some F2, F1 and NFS material was present. The silty sand and gravel was generally very dense, had low moisture contents and contained numerous cobbles.

- Groundwater was not encountered while drilling in any of the borings conducted.

3.2.2 Mile 0.8 to 1.4

A second historic geotechnical investigation and report by Shannon & Wilson, Inc. was reviewed to determine subsurface conditions near the North Fork of Campbell Creek road crossing. The report is presented in Appendix B.

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Eight geotechnical boreholes were advanced to depths between 5 and 9.6 meters (16.4 and 31.5 feet). Four of the boreholes were advanced along the Campbell Airstrip Road. Two of the boreholes were advanced at the Dog Trail road crossing and the remaining two were advanced at a potential borrow site located near the North Fork Campbell Creek crossing. Subsurface conditions were generally similar in all boreholes, and consisted of the following:

- **Gravel (GP-GM to GM)** – Gravel with varying amounts of sand was encountered in each of the boreholes. The gravel extended to approximately 3 meters (9.8 feet) below ground surface (bgs) in the four borings advanced along the road. This material was considered fill material for the road. The moisture content of the gravel ranged from approximately 3 to 18 percent. The gravel was typically dense to very dense.

- **Sand (SP-SM to SM)** – Sand with varying amounts of silt and gravel was encountered in each of the boreholes. The silt contents ranged from 6 to 27 percent, with the silt content increasing with depth. The gravel contents ranged from 16 to 37 percent. Heaving sands was encountered in most borings, so accurate estimates of soil density could not be obtained. However, it was estimated that the sand was medium dense to very dense. The frost classification of the sand was F1 to F2.

- **Groundwater** – Groundwater was encountered in the boreholes advanced in the road at depths ranging from 2 to 3 meters (6.6 to 9.8 feet) bgs.

### 3.3 Existing Structural Road Section

#### 3.3.1 Mile 0.0 to 0.3

The As-Built drawings from 1989 for Campbell Airstrip Road between the intersection of Campbell Airstrip Road and Tudor Road (mile 0.0) and mile 0.3 were reviewed. The existing structural road section was designed as follows:

- 2 inches of asphalt concrete pavement, Class C
- 2 inches of leveling course compacted to 95 percent maximum density
- 2.6 feet minimum of Type II classified fill or backfill, compacted to 95 percent maximum density, with the top six inches of material to be 3 inch minus

The road sections were mostly constructed as a side cut into a hill which slopes from east to west. The widths of each road lane ranged from 26 feet to 12 feet, with the road being wider near the Tudor intersection. The road was constructed with a curb and gutter from approximately mile 0.0 to mile 0.09. Mile 0.09 to mile 0.3 was constructed with a ditch on either side of the road and no curb or gutter. The side slopes from the road were generally cut at a 3H:1V (horizontal to vertical). The side slopes of the ditches ranged from 3H:1V to 2H:1V. A pedestrian pathway was constructed along the entire project area east of the road. The structural section of the pathway was constructed similar to the roadway, but only required a minimum of 1.5 feet of Type II classified fill or backfill.

Two culverts were placed under the road between mile 0.0 and mile 0.3. They were both 16 gauge 18 inch shape II corrugated metal pipes (CMP) with an installed length of 60 feet.

#### 3.3.2 Mile 0.8 to 1.4

The As-Built drawings from 1996 for Campbell Airstrip Road between mile 0.8 and 1.4 were also reviewed. The drawings show the road was constructed with a structural section as follows:

- 50 mm (2 inches) of asphalt concrete pavement, Type II, Class B
- 100 mm (4 inches) of crushed aggregate base course
- 650 mm (2.1 feet) of selected material, Type A with a maximum particle size of 75 mm (3 inches)
- Variable amount of selected material, Type C
The road sections in this area ranged from an embankment placed over existing ground, to a side cut into an east to west sloping hill. The traveled width of the road was 7.2 meters (23.6 feet) wide, with 1.5 meter (4.9 foot) wide shoulders. A pedestrian pathway, with a structural section similar to the road, was constructed west of the road. The road was constructed with no curb or gutter. A bridge was constructed over Campbell Creek. Several culverts, ranging from 300 to 760 mm in diameter (12 to 30 inches) were placed under the road at select locations.

4.0 DISCUSSION

4.1 Anticipated Subgrade Conditions

Based on the historic geotechnical information and geology of the area, it is anticipated there may be a relatively thin layer of surficial silty sand soils overlying silty gravel materials. However, there is variability in the soil layer types and thicknesses. As noted in the geotechnical investigation reports, the silty soils encountered have a predominant frost classification of F-3. We recommend boreholes be drilled in conformance with the Municipality of Anchorage geotechnical guidelines to better define the subsurface conditions in this segment of roadway in support of the design.

4.2 Preliminary Pavement Structural Design Section

The structural section of the road between mile 0.0 to 0.3 and 0.8 to 1.4 are generally similar in design. It is our opinion that the proposed road upgrade between mile 0.3 to 0.7 could utilize a similar structural section. However, the roadway design section should be designed to assure conformance to MOA minimum design standards. We understand these road segments do not have insulated pavement sections.

5.0 USE OF REPORT

This report has been prepared for the use of CRW for the proposed upgrade to Campbell Airstrip Road. If there are significant changes in the conditions, or recommended design, we should be notified so that we may review our conclusions and recommendations in light of the proposed changes and provide a written modification or verification of the changes. The work program followed the standard of care expected of professionals undertaking similar work in Alaska under similar conditions. No warranty expressed or implied is made.

6.0 CLOSING

We appreciate the opportunity to provide this review. Please contact us at 907-344-6001 if you have questions or comments.

Sincerely,

GOLDER ASSOCIATES INC.

Brenton B. Savikko, EIT
Staff Engineer

Mark R. Musial, PE
Principal and Manager Anchorage Operations

Attachments:  Figure 1 – Site Plan
               Figure 2 – Surficial Geology Map
               Appendix A - Soil Investigation Campbell Airstrip Road – DMA Report, May 22, 1989
               Appendix B – Geotechnical Report – Far North Bicentennial Park Dog Trail Crossing,
                           Anchorage, Alaska – Shannon & Wilson, Inc.

BBS/JDU/MRM/mlp
FIGURES
REFERENCES

1.) AERIAL IMAGERY PROVIDED BY MOA. PHOTO DATE 2006.
LEGEND

gm - GLACIAL AND OR MARINE DEPOSITS. CONSISTS CHIEFLY OF DIAMICTON.

mg - MARINE, GLACIAL, AND OR LACUSTRINE DEPOSITS. CHIEFLY FINE SAND AND SILT.

al - ALLUVIUM IN ABANDONED STREAMS CHANNELS AND IN TERRACES ALONG MODERN STREAMS. GRAVEL AND SAND, GENERALLY WELL BEDDED AND WELL SORTED.

REFERENCES

1.) AERIAL IMAGERY PROVIDED BY MOA. PHOTO DATE 2006.

2.) GEOLOGIC MAPPING PROVIDED BY MOA, AND BASED ON SURFICIAL GEOLOGY BY SCHMOLL AND DOBROVOLNY (1972), WITH INPUT FROM ADGGS (R. COMBELLICK) .
A report prepared for

USKH
2515 "A" Street
Anchorage, Alaska

SOIL INVESTIGATION
Campbell Airstrip Road
Anchorage, Alaska

by

Duane L. Miller, P.E.
Civil Engineer 3696-E

DM&A Job No. 4005.32

Duane Miller & Associates
9720 Hillside Drive
Anchorage, Alaska 99516
(907) 346-1021

May 22, 1989
INTRODUCTION

This report presents the results of the soil investigation I performed for the proposed realignment of the Campbell Airstrip Road. The realignment will move the road's intersection with Tudor Road about 600 feet west of its present location so that it will align with Baxter Road to the north. Campbell Airstrip Road will merge with the existing alignment before the Dog Crossing tunnel and will have a total length of realignment of about 1200 feet.

The soil investigation was performed in accordance with my proposal to you dated October 24, 1988. The object of the soil investigation was to determine the soil and ground water conditions along the alignment and to develop conclusions and recommendations regarding excavation conditions, reuse of materials and typical roadway embankment sections.

INVESTIGATION

The geotechnical conditions along the alignment were explored by drilling borings and performing laboratory tests. Six borings were drilled to depths of 5 to 16 feet. The borings were drilled on November 4 and 7, 1988, using a truck-mounted drill rig equipped with hollow stem augers. The locations of the holes were established by measuring distances from USKH's survey control points using a cloth tape.

The soils were logged and sampled by Mr. Randolph Ross, P.E., as the borings were drilled. The soils were sampled by grabbing materials off the augers and by using a 1.5-inch inside diameter sampler advanced below the bottom of the auger by driving with a 140-pound hammer free-falling 30 inches, i.e., the Standard Penetration Test (SPT). Larger materials are not sampled by an SPT sampler; therefore, when appropriate, the presence of coarse gravel and cobbles was logged on the basis of drilling behavior.

The samples were sealed in plastic bags and returned to the laboratory. In the DM&A laboratory, the samples were reexamined to verify the field classification
and were tested for moisture content. Particle size analysis of two representative samples was performed by Harding Lawson Associates.

The logs of the borings are presented on Plates 1 through 3. The soils have been classified in accordance with the Unified Soil Classification System described on Plate 4. The frost classification, results of the SPT sampling, and moisture contents of the samples are also shown on the logs. The results of the particle size analysis are shown on Plate 5.

SITE and SOIL CONDITIONS

The area of the new roadway alignment crosses the side of a gently sloping hill. Elevations change along the new road from about 250 feet near Tudor Road to about 295 feet where the new and existing roads merge. The area is forested.

The geologic conditions in the roadway area are shown on U. S. Geologic Map 1-787-A, "Generalized Geologic Map of Anchorage and Vicinity" by Schmoll and Dobrovolny, 1985. The flatter ground near the intersection of the new alignment with Tudor Road is underlain by alluvium. The hill that the road climbs is a glacial deposit made up of a mixture of fine sand, gravel and cobbles in a silt matrix.

The soils found in the borings correlate well with the descriptions shown on the geologic map. Boring 6, which is closest to Tudor Road found 3.5 feet of silt overlying relatively clean sand and gravel. The sand and gravel has a frost classification of F2 and appears to represent the alluvial soils.

The borings drilled on the slope of the hill generally encountered a surface layer of silt over silty sand and gravel. The surface silt has a frost classification of F4. The silty sand and gravel are mostly F3 soils though some F2 soil and thin layers of F1 and NFS materials are present.

The silty sand and gravel generally is very dense, has low to moderate moisture content and contains numerous cobbles. The drilling was hard and refusal conditions were encountered in several borings. The following table summarizes the conditions found in the six borings.
<table>
<thead>
<tr>
<th>Boring Number</th>
<th>Depth of Boring</th>
<th>Surface Layer</th>
<th>Frost classification and soils beneath surface layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.5'</td>
<td>F4 to 5.5'+</td>
<td>drilled on road to refusal</td>
</tr>
<tr>
<td>2</td>
<td>16'</td>
<td>F3 to 4'</td>
<td>(SM) F3 below</td>
</tr>
<tr>
<td>3</td>
<td>10'</td>
<td>F4 to 2'</td>
<td>(SM) F3 below</td>
</tr>
<tr>
<td>4</td>
<td>14.5'</td>
<td>F4 to 4'</td>
<td>(SP) and (GM) F1 and F2 below</td>
</tr>
<tr>
<td>5</td>
<td>10'</td>
<td>F4 to 4'</td>
<td>(SP) and (GM) F1 and F3 below</td>
</tr>
<tr>
<td>6</td>
<td>10.5'</td>
<td>F4 to 3.5'</td>
<td>(GP-GM) F2 below</td>
</tr>
</tbody>
</table>

The water table was not encountered in the borings. Boring 1 was drilled at the edge of the existing Campbell Airstrip Road, and seasonal frost had penetrated the surface about six inches. The other borings were drilled at natural locations where surface forest litter was present and no frost was found.

CONCLUSIONS

The roadway can be constructed on the silty sand and gravel deposit that is present beneath the highly frost susceptible, surface, silt layer. The deeper soils are frost susceptible but if the surface silt layer is removed and a uniform condition is achieved, the design can be based on an F3 frost classification.

The section recommended in this report is based on the minimum road base depths recommended in the Municipality of Anchorage Design Criteria Manual dated March 1988, and assumes a uniform F3 subgrade. The glacial soils vary widely in silt content. Therefore, the upper portion of the soils should be scarified and mixed to provide a more uniform frost susceptibility beneath the roadway section. The silty soils will be difficult to compact if earthwork is attempted during rains.

RECOMMENDATIONS

- The surface layer containing forest litter and roots should be stripped and removed from the site.

- The surface silt should be overexcavated to expose the underlying silty sand and gravel. The silt should not be used within the roadway embankment. The material will be very difficult to properly compact if it gets wet, and it is highly frost susceptible. The excavations should be carefully inspected to
verify that silt is fully removed or removed to a depth of at least 72 inches below the finish roadway surface.

- To provide toe stability, the stripping of organics and silt should extend to the toe of the proposed embankment.

- To provide uniformity beneath the traffic way, the exposed silty subgrade should be scarified to a depth of about twelve inches and bladed to mix the materials. The scarification and mixing should not be performed during wet conditions since excess moisture will make proper compaction difficult to achieve. The scarified materials should be moisture conditioned (moistened or dried) as needed, placed in a thin lift and each lift compacted with a heavy roller to a density of at least 95 percent of the maximum density of the material as determined by the ASTM D-1557 test procedure (relative density).

- The roadway should be constructed to the thicknesses shown in the following section. The material types refer to the Municipality of Anchorage Standard Specifications.

- Materials for the road section should be placed in thin lifts, and each lift should be compacted to 95 percent relative compaction.

- Fill cut and fill slopes can be cut to an inclination of two horizontal to one vertical (2:1). Cut slopes of less than ten feet in height can be cut as steep as 1.5:1 in the silty sand gravel soils. The surface silt should be sloped at 2:1.
INSPECTION

The overexcavation of the silt, the scarification, mixing and compaction of the silty glacial soils, and the placement and compaction of the roadway section should be inspected and tested by a qualified soils engineer. Inspection will permit the detection of unanticipated conditions and allow verification that the work is done in accordance with the intent of the recommendations in this report.

ILLUSTRATIONS

Plates 1 through 3
Plate 4
Plate 5
Logs of Borings
Soil Classification Chart
Particle Size Analysis
**LOG of BORING 1**

Mobile B-50 w/ hollow stem auger
November 4, 1988
Location = 41+31, 5.0' Left
Elevation = 294' *

---

**LIGHT BROWN GRAVELLY SILT (ML) F4**

Dense, Dry to moist, Subrounded gravels to 1.5" size, Gravels and cobbles are exposed in nearby cutbank, Hard, dense drilling below seasonal frost

No free water encountered while drilling.

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**LOG of BORING 2**

November 4, 1988
Location = 43+06, 6.8' Right
Elevation = 294' *

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**RED BROWN SILTY SAND (SM) F3** Loose, Moist, w/ roots

**LIGHT BROWN GRAVELLY SILTY SAND (SM) F3** Medium dense, Moist, w/ rounded gravels to 1.5" size, Occasional subrounded cobbles easier drilling below 7'

drills cobbly below 10'

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**BROWN GRAVELLY SAND (SP) F1**

Dense, Moist

No free water encountered

* Elevations interpolated from two-foot contours on USKH map of field survey.

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Duane Miller & Associates
Arctic and Geotechnical Engineering
Job No.: 4005.32
Date: May 1989

LOGS of BORINGS 1 & 2
Campbell Airstrip Road
Anchorage, Alaska

Plate 1
LOG of BORING 3
Mobile B-50 w/ hollow stem auger
November 4, 1988
Location = 45+69, 21.4' Left
Elevation = 286'

Description
RED BROWN SILT (ML) F4 Loose, Moist, w/ organics
YELLOW BROWN GRAYELLY SILTY SAND (SM) F3 Medium dense, Moist,
Grevels rounded to 2'' size
Becomes very dense at 5', Rounded gravel to 3'' size
Hard drilling with cobbles from 6'

No free water encountered

LOG of BORING 4
November 7, 1988
Location = 47+70, 42.3' Right
Elevation = 277'

Description
RED BROWN SANDY SILT (ML) F4 Medium dense, Moist, w/ roots and organics

BROWN SAND (SP) NFS to F1 Medium dense, Moist

BROWN SILTY SANDY GRAVEL (GM) F2 Medium dense to dense, Moist

Hard drilling below 10', Many rounded gravels to 4'' size

Practical refusal at 14'
No free water encountered

Duane Miller & Associates
Arctic and Geotechnical Engineering
Job No.: 4005.32
Date: May 1989

LOGS of BORINGS 3 & 4
Campbell Airstrip Road
Anchorage, Alaska
Plate 2
LOG of BORING 5
Mobile B-50 w/ hollow stem auger
November 7, 1988
Location 49+06, 40.6' Right
Elevation = 264'

- Moisture Content (%)

<table>
<thead>
<tr>
<th>Description</th>
<th>Other Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIGHT BROWN SANDY SILT (ML) F4</td>
<td></td>
</tr>
<tr>
<td>BROWN GRAVELLY SAND (SP) F1</td>
<td></td>
</tr>
<tr>
<td>BROWN SILTY SANDY GRAVEL (GM) F3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No free water encountered</td>
</tr>
</tbody>
</table>

LOG of BORING 6
November 7, 1988
Location 50+61, 81.9' Right
Elevation = 254'

- Blows / Foot (SPT)

<table>
<thead>
<tr>
<th>Description</th>
<th>Other Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIGHT BROWN SANDY SILT (ML) F4</td>
<td></td>
</tr>
<tr>
<td>BROWN SANDY GRAVEL (GP-GM) F2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No free water encountered</td>
</tr>
</tbody>
</table>

Duane Miller & Associates
Arctic and Geotechnical Engineering
Job No.: 4005.32
Date: May 1989

LOGS of BORINGS 5 & 6
Campbell Airstrip Road
Anchorage, Alaska
Plate 3
## Coarse Grained Soils

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOL</th>
<th>TYPICAL NAMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAVELS</td>
<td>GW</td>
<td>Well graded gravels, sandy gravel</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly graded gravels, sandy gravel</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravels, silt sand gravel mixtures</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravels, clay sand gravel mixtures</td>
</tr>
<tr>
<td>SANDS</td>
<td>SW</td>
<td>Well graded sands, gravelly sand</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>Poorly graded sands, gravelly sand</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty sands, silt gravel sand mixtures</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>Clayey sands, clay gravel sand mixtures</td>
</tr>
</tbody>
</table>

## Fine Grained Soils

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOL</th>
<th>TYPICAL NAMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILTS and CLAYS</td>
<td>ML</td>
<td>Inorganic silts and very fine sand rock flour</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays, gravelly and sandy clays, silty clays</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and clays of low plasticity</td>
</tr>
<tr>
<td>SILTS and CLAYS</td>
<td>MH</td>
<td>Inorganic silts</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic clays, fat clays</td>
</tr>
<tr>
<td></td>
<td>OH</td>
<td>Organic silts and clays of high plasticity</td>
</tr>
<tr>
<td></td>
<td>Pt</td>
<td>Peat and other highly organic soils</td>
</tr>
</tbody>
</table>

## Unified Soil Classification System

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ICE VISIBILITY</th>
<th>DESCRIPTION</th>
<th>SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Segregated ice not visible by eye</td>
<td>Poorly bonded or friable</td>
<td>Nf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Well bonded</td>
<td>Nb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No excess ice</td>
<td>Nbn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excess microscopic ice</td>
<td>Nbe</td>
</tr>
<tr>
<td>Y</td>
<td>Segregated ice is visible by eye and one inch or less in thickness</td>
<td>Individual ice crystals or inclusions</td>
<td>¥x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ice coatings on particles</td>
<td>¥c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Random or irregularly oriented ice</td>
<td>¥r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stratified or distinctly oriented ice</td>
<td>¥s</td>
</tr>
<tr>
<td>ICE</td>
<td>Ice greater than one inch in thickness</td>
<td>Ice with soil inclusions</td>
<td>ICE + soil type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ice without soil inclusions</td>
<td>ICE</td>
</tr>
</tbody>
</table>

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**Duane Miller & Associates**  
Arctic and Geotechnical Engineering  
Job No.: 4005.32  
Date: April 1989  

**SOIL AND ICE CLASSIFICATION SYSTEM**  
Campbell Airstrip Road  
Anchorage, Alaska  
Plate 4
U.S. Standard Sieve Opening Sizes | U.S. Standard Sieve Numbers | Hydrometer

PERCENT FINER BY WEIGHT

GRAIN SIZE IN MILLIMETERS

GRANULARITY

- GRAVEL
- SAND
- SILT OR CLAY

- Boring 2 at 1.0', SILTY GRAVELLY SAND (SM)
- Boring 2 at 4.0', SILTY GRAVELLY SAND (SM)

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4005.32
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Particle Size Analysis
Campbell Airstrip Road
Anchorage, Alaska
APPENDIX B
GEOTECHNICAL REPORT – FAR NORTH BICENTENNIAL PARK DOG TRAIL CROSSING, ANCHORAGE, ALASKA – SHANNON & WILSON, INC.
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GEOTECHNICAL REPORT
FAR NORTH BICENTENNIAL PARK
DOG TRAIL CROSSING
ANCHORAGE, ALASKA

A. INTRODUCTION

This report presents the results of subsurface explorations, laboratory testing and geotechnical engineering studies for the proposed improvements to the dog trail crossing located at Campbell Airstrip Road in Far North Bicentennial Park, Anchorage, Alaska. The purpose of the field explorations was to define the soil and groundwater conditions for use in the design of foundations for the large diameter culvert and upgrade of the road. Also a borrow source located to the north of the crossing was evaluated for potential use for this project. To develop the criteria for use in design, 6 borings were advanced at the site and 2 borings were advanced in the proposed borrow site. Soil samples recovered from the borings were returned to our laboratory for visual classification and testing. Based on the field and laboratory results, engineering studies were conducted to develop our design recommendations. Included in this report are a description of the site and project, subsurface explorations and laboratory test procedures, interpretation of the subsurface conditions and conclusions and recommendations from our engineering studies.

Authorization to proceed with this work was received by a signed contract from Bill Smith of Tryck Nyman Hayes, Inc. All work was conducted in accordance with our proposal of June 6, 1994.

B. SITE AND PROJECT DESCRIPTION

The proposed site is located along Campbell Airstrip Road where the present dog trail crosses the road. This area is located in Far North Bicentennial Park, Anchorage, Alaska. Approximately 150 meters north of the crossing the north fork of Campbell Creek crosses the road. Directly north of the creek is a hill approximately 10 meters high that slopes down toward the north. This hill slopes steeply on the west side (road side) and to the east maintains a ridge with the creek following along the base of the ridge. It has the appearance of a glacial deposit known as a drumlin. At the time of the field studies, the area was covered with approximately 1.5 meters of snow, however creek channels could be deciphered by dips in the snow. There are several small
creeks that connect to the north fork of Campbell Creek in this area. Several parallel the road particularly on the east side of the road. The area is heavily wooded with birch and spruce. Although the road was covered with ice and snow, it appeared from drilling that at present the road is unpaved and consist of gravel. A site map is shown in Figure 1.

We understand that a large diameter (~4 meters) culvert is to be placed near the present crossing of the dog trail. This culvert would serve as the trail crossing in the future. The road will have to be replaced and we understand that it will be unpaved. The hill located directly north of Campbell Creek is considered to be a potential borrow source for this project.

C. FIELD EXPLORATIONS

Eight borings, designated B-1 through B-8, were advanced at the site on the 9th, 10th, 17th and 20th of March 1995, to define subsurface conditions. The locations of these borings are shown on Figure 1. Soils encountered were visually and later through laboratory analysis, classified according to the Unified Soils Classification System which is presented in Figure 2. Detailed logs of the borings are presented in Figures 3 through 10.

Drilling services for this project were provided by Discovery Drilling of Anchorage, Alaska using a Nodwell mounted CME 55 drill rig to advance the offroad holes and a truck mounted CME 75 drill rig to advance the road holes. The borings were advanced with a CME 20-centimeter outside diameter, 8.2 centimeter inside diameter hollow-stem auger. An experienced engineer from our firm was present continuously during drilling to locate the borings, observe drill action, collect samples, log subsurface conditions, and monitor any ground water encountered.

Borings B-1 through B-4 were advanced to a depth of 9.6 meters, while the remaining borings were advanced to a depth of 5.0 meters. As the borings were advanced, samples were recovered at 1.5 meters and at 1.5 meter invervals thereafter. Sampling with a split-spoon was conducted for all of the samples using Standard Penetration Test procedures. In this test, samples were recovered by driving a 5.1 centimeter O.D. split spoon sampler into the bottom of the advancing hole with blows of a 623 N hammer free-falling 76 centimeters onto the drill rod. The number of blows required to advance the sampler the final 31 centimeters of an 46 centimeter penetration in the standard test is termed the Penetration Resistance, which was recorded for each
sample. Due to the anticipated large particle size at the proposed borrow source, Borings B-1 and B-2 were sampled using the Modified Penetration Test procedures. This test is similar to the one described above, however a 7.6 centimeter O.D. split spoon sampler is driven into the bottom of the advancing hole with blows of a 1513 N hammer free-falling 76 centimeters onto the drill rod. The number of blows required to advance the sampler the final 31 centimeters of an 46 centimeter penetration in the modified test is termed the Modified Penetration Resistance. Both values (Penetration Resistance and Modified Penetration Resistance) are shown graphically (a black triangle) 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.

At the completion of drilling Borings B-3, B-4 and B-7 had 2.5 centimeter diameter slotted PVC tubing installed to monitor groundwater conditions. Native material was used to backfill around the tubing and to backfill the remaining borings. The locations of the borings were determined by the cloth tape measurements reference to existing structures. The hole locations, shown in Figure 1, presented on the boring logs should be considered approximate.

D. LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to verify field classifications and to determine the pertinent behavior characteristics of the typical materials encountered at the site. The laboratory testing was formulated with emphasis on determining the materials classification, moisture and frost characteristics. This data plus estimated strength and density properties from the modified penetration test provided information for evaluating foundation requirements.

A total of 33 water content tests were performed on samples from the eight borings. These tests were conducted in accordance with procedures described in ASTM D-2216. The results of the water content measurements are presented on the boring logs in Figures 3 through 10.

Grain size classification tests for this project consisted of nine mechanical sieve analyses to confirm the field classification and to estimate permeability characteristics and frost susceptibility. These tests were conducted according to procedures described in ASTM D-422. The results are presented in Figures 11 through 13.
E. SUBSURFACE CONDITIONS

The subsurface conditions at the site are depicted in detail in the boring logs, Figures 3 through 10. Two major soil types were encountered in Borings B-3 through B-8: a brown gravel and a brown sand. The brown gravel was encountered to a depth of approximately 3 meters in the borings located along the road. This material is considered fill material for the road. The brown sand was encountered in the borings along the road at depth and in Borings B-3 and B-4 throughout the borings.

The brown gravel was typically sandy and was dense to very dense. The material was frozen in the top 1 meter. Moisture contents ranged from approximately 3% to 18%.

The brown sand contained variable amounts of silt and gravel, and was poorly graded. Silt content ranged from approximately 6% to 27%, with the silty material occurring at depth in the borings. Gravel content ranged from about 16% to 37% and occurred throughout the borings. According to the Unified Soil Classification System the sand unit was classified as an SP-SM to SM depending upon the silt content. Moisture contents ranged from 3% to about 32% with the higher moisture content material occurring in samples that contained groundwater. The average moisture content was approximately 16%. In most borings, the material at depth was heaving and accurate blow counts could not be obtained. The blow counts indicate material that was medium dense to very dense.

The borrow source material is depicted in Borings B-1 and B-2 as well as the grain size classification curves in Figures 3, 4 and 11, respectively. The material that created the hill appears to be till material with variable amounts of silt and sand in a gravel matrix. At depth the gravel content diminishes yielding a sand. The material in Boring B-1 which was located on the south side of the hill crest contained more silt than the material in Boring B-2. Silt content ranged from approximately 17% to 29% in Boring B-1 and was approximately 7% to 8% in Boring B-2. Moisture contents ranged from approximately 2% to 5% with one moisture content at about 10% at depth in Boring B-1.
In the vicinity of the crossing, groundwater levels were observed at a depth of approximately 2 to 3 meters below the existing ground level during drilling. The stabilized water depth after drilling could not be obtained due to the burial of the piezometers by road grading equipment. After break-up, the piezometers can be read again. Campbell Creek as well as associated creeks occur near the site and influence the depth of the groundwater. Seasonal fluctuations in the groundwater table may occur due to variations in snowfall, rainfall, and temperature. March is typically considered a time when the groundwater table is lowest.

F. ENGINEERING RECOMMENDATIONS

1. **Pipe Support**

   We understand from the drawings that an approximately 4 meter diameter pipe will be placed approximately 1 meter below the present grade of the road. Design of the pipe must consider local support conditions along the alignment. Based on our borings the soils encountered at depth are generally dense to very dense and should provide competent bearing support for the pipe. Organic material should be excavated and area backfilled with native material or structural backfill.

2. **Estimated Settlements**

   As the pipe is lighter in weight than the soil it displaces, relatively small future displacements are expected. Total and differential settlements of the pipe are therefore controlled by the details of construction, particularly by the care the contractor to properly seat the pipe firmly in the bedding material and surround it with a compacted granular fill. Total settlement should be less than 3 centimeters.

3. **Trench Backfill**

   To minimize local stress concentration on the pipe, we recommend that the pipe be bedded on a minimum 30 centimeter layer of free draining, classified granular soils. This bedding should also be placed and compacted densely around the pipe and carried evenly on both sides of the pipe for the full width of the trench.
Bedding materials may consist of relatively clean sand or sand and gravel material which can be placed with ease in both wet and dry conditions. The bedding material classification is shown in Figure 14. Generally, a material containing less than 5 percent fines (material passing the No. 200 sieve) based on the minus 3/4 inch portion would satisfy this requirement. The maximum particle size should be 60 millimeters. This material should be placed in maximum loose lifts of 15 centimeters near it's optimum moisture content and compacted to at least 92% of the Modified Proctor maximum dry density and to at least 95% of the Modified Proctor maximum dry density in the top 0.61 meters.

4. **Trench Excavation and Shoring**

Excavations on the order of 2 meters are required to install the pipe. Due to the proximity of Campbell Creek and its tributaries and depending upon the construction schedule, groundwater elevations may be different than those recorded during our explorations. Since the native soils below a depth of approximately 1.5 meters may be relatively wet and the trench may encountered groundwater, during construction, trenches may need to be dewatered. If the contractor elects to dewater the excavation, it could be accomplished using well points that will pull the water table down on all sides and below the excavation. This system should be designed for relatively moderate pumping capacities.

State and Federal OSHA Statutes require trench safety standards for all trenches greater than 1.2 meters deep. It is the contractors responsibility to ensure that all safety measures, including, but not limited to, shoring, side slope stability, egress structures and drainage be adhered to. We recommend that the slopes and slope stability be made the responsibility of the contractor as he is present on a day to day basis and can adjust the slopes to obtain the needed stability. Deviation from the Occupational Safety and Health Administration (OSHA) stipulations requires the approval of a qualified registered engineer.

5. **Borrow Source**

The borrow source site is currently covered with heavy vegetation including spruce and birch trees. The vegetation should be stripped and discarded to an approximate depth of 1.5 meters. Typically, the on-site soils have more than 6% silt. Material required for the project includes...
bedding material for the pipe and fill material for the road. Figure 14 presents the Municipality of Anchorage requirements for bedding material and road fill material. It can be seen in Figure 15 that the material from the proposed borrow source contains variable amounts of silt which limits its use as bedding and fill material. We recommend that the material from the proposed borrow source be screened for silt content and used at various depths for the road fill. The following table illustrates the usage of the borrow source material:

<table>
<thead>
<tr>
<th>SILT CONTENT (%)</th>
<th>USAGE (meters below proposed road surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6%</td>
<td>Type I (0.0 - 0.6 meters)</td>
</tr>
<tr>
<td>6 - 10%</td>
<td>Type III (0.6 - 1.0 meters)</td>
</tr>
<tr>
<td>10 - 15% *</td>
<td>Type IV (1.0 - 2.0 meters)</td>
</tr>
<tr>
<td>&gt; 15% *</td>
<td>Below 2.0 meters</td>
</tr>
</tbody>
</table>

* may be difficult to compact to required Proctor density if moisture content is at or above optimum.

In addition to the above material being used for fill, material with less than 6% silt may also be used for bedding material for the pipe son long as the maximum particle size is less than 60 millimeters.

6. **Structural Fill and Compaction**

Structural fill placed to level the site should be granular and consist of a reasonably well graded mixture of sand and gravel. Structural fill materials should be clean granular soils to provide drainage and frost protection. These soils should also be non-frost susceptible (NFS), with less than about 6 percent (by weight, based on minus 3/4-inch portion) passing the #200 sieve.

Structural fill (bedding) materials should be placed in maximum loose lifts of 15 centimeters near it’s optimum moisture content and compacted to at least 92% of the Modified Proctor maximum dry density and to at least 95% of the Modified Proctor maximum dry density in the top 0.61 meters. Prior to placing the structural fill, the site should be cleared of organics in areas
where development is planned. During fill placement, we also recommend that large cobbles or boulders with dimensions in excess of 20 centimeters be removed from any structural fills.

When backfilling within 1/2 meter of the pipe wall, materials should be placed in layers not to exceed 15 centimeters loose thickness and densely compacted with hand operated equipment. Heavy equipment should not be used as it could cause increased lateral earth pressures and possibly damage the pipe.

7. **Road Design**

The explorations revealed that the soils along the alignment are firm for subgrade support. The soils are classified as SP to SP-SM. These soils are frost susceptible and are somewhat moisture sensitive. The sands have a low frost susceptibility and should provided suitable subbase. The frost classification for the sands is a F1 to F2 as shown in Figure 16. Design of a final grade of the road requires consideration of site drainage and grade requirements for roadways entering parking lots.

The anticipated loads are generally light. The section must consider frequency of loading, thaw weakening and subgrade support. Based on the provided soils information in the area, the following section is recommended:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centimeters</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Type I (surface)</td>
</tr>
<tr>
<td>15</td>
<td>Type IIA base course</td>
</tr>
<tr>
<td>40</td>
<td>Non-frost susceptible soil (Type II base)</td>
</tr>
</tbody>
</table>

The above materials should meet the gradation requirements shown in Figure 14 which is modelled after Section 20.00 of the Municipality of Anchorage Standard Construction Specification for Street Construction. The base course should be placed in maximum 30 centimeter loose lifts and compacted to 95 percent of the Modified Proctor maximum density (ASTM D1557 or AASHTO - T180D).
To provide further protection, we recommend that the street surface be designed to encourage surface water flow to the edges and ditches or to a collection system. To the extent possible, soil at the edges and below the road prism should be sloped and ditched to encourage drainage away from the surface.

The performance of the road is controlled by the details of construction, and, as indicated previously, by the quality (gradation characteristics) of the materials that must be selected on-site or imported to the site, placed and compacted to develop the needed structural section. Quality control inspection is strongly recommended with support soil testing at regular intervals to be sure that the intent of the specification is met.

G. **LIMITATIONS**

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist and further assume that the exploratory borings are representative of the subsurface conditions throughout the site, i.e., the subsurface conditions everywhere are not significantly different from those disclosed by the explorations.

If, during construction, subsurface conditions different from those encountered in these and prior explorations are observed or appear to be present, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. 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 and recommendations considering the changed conditions and time lapse.
Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples or making test borings, particularly when attempting to develop in or near a slide mass. 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, INC.

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Reviewed by:

Keith F. Mobley, P.E.
Associate

STATE OF ALASKA
Registered Professional Engineer

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KEITH F. MOBLEY
CE - 5066

SHANNON & WILSON, INC.
## Unified Soil Classification System

### Criteria for Assigning Group Symbols and Names

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Generalized Group Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAVELS</td>
<td>50% or more of coarse fraction retained on No. 4 sieve</td>
<td>CLEAN GRAVELS Less than 5% fines GW Well-graded Gravels</td>
</tr>
<tr>
<td>SANDS</td>
<td>More than 50% of coarse fraction passes No. 4 sieve</td>
<td>CLEAN SANDS Less than 5% fines SW Well-graded Sands</td>
</tr>
<tr>
<td>FINE-GRAINED SOILS</td>
<td>50% or more passes the No. 200 sieve</td>
<td>INORGANIC ML</td>
</tr>
<tr>
<td>FINE-GRAINED SOILS</td>
<td>Liquid limit 50% or less</td>
<td>ORGANIC CL</td>
</tr>
<tr>
<td>FINE-GRAINED SOILS</td>
<td>Liquid limit greater than 50%</td>
<td>INORGANIC CH</td>
</tr>
<tr>
<td>HIGHLY ORGANIC SOILS</td>
<td>Primarily organic matter, dark in color, and organic odor</td>
<td>ORGANIC OH</td>
</tr>
</tbody>
</table>

### Relative Density or Consistency Utilizing Standard Penetration Test Values

#### Cohesionless Soils (a)

| Density | N, blows/ft. | Relative Density (%)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very loose</td>
<td>0 to 4</td>
<td>0 - 15</td>
</tr>
<tr>
<td>Loose</td>
<td>4 to 10</td>
<td>15 - 35</td>
</tr>
<tr>
<td>Med. Dense</td>
<td>10 to 30</td>
<td>35 - 65</td>
</tr>
<tr>
<td>Dense</td>
<td>30 to 50</td>
<td>65 - 85</td>
</tr>
<tr>
<td>Very Dense</td>
<td>over 50</td>
<td>&gt; 85</td>
</tr>
</tbody>
</table>

#### Cohesive Soils (b)

<table>
<thead>
<tr>
<th>Consistency</th>
<th>N, blows/ft.</th>
<th>Undrained Shear Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>0 to 2</td>
<td>&lt;250</td>
</tr>
<tr>
<td>Soft</td>
<td>2 to 4</td>
<td>250-500</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>4 to 8</td>
<td>500-1000</td>
</tr>
<tr>
<td>Stiff</td>
<td>8 to 15</td>
<td>1000-2000</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>15 to 30</td>
<td>2000-4000</td>
</tr>
<tr>
<td>Hard</td>
<td>over 30</td>
<td>&gt;4000</td>
</tr>
</tbody>
</table>

(a) Soils consisting of gravel, sand and silt, either separately or in combination, possessing no characteristics of plasticity, and exhibiting drained behavior.

(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.

(c) Refer to test of ASTM D-1586-84 for a definition of N; in normally consolidated cohesionless soils, relative density terms are based on N values corrected for overburden pressures.

(d) Undrained shear strength = \(\frac{1}{2}\) unconfined compression strength

### Component Definitions by Gradation

<table>
<thead>
<tr>
<th>Component</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Above 12 in.</td>
</tr>
<tr>
<td>Cobbles</td>
<td>3 in. to 12 in.</td>
</tr>
<tr>
<td>Gravel</td>
<td>3 in. to No. 4 (4.76 mm)</td>
</tr>
<tr>
<td>Coarse Gravel</td>
<td>3 in. to 3/4 in.</td>
</tr>
<tr>
<td>Fine Gravel</td>
<td>3/4 in. to No. 4 (4.76 mm)</td>
</tr>
<tr>
<td>Sand</td>
<td>No. 4 (4.76 mm) to No. 200 (0.074 mm)</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>No. 4 (4.76 mm) to No. 10 (2.0 mm)</td>
</tr>
<tr>
<td>Medium sand</td>
<td>No. 10 (2.0 mm) to No. 40 (0.42 mm)</td>
</tr>
<tr>
<td>Fine sand</td>
<td>No. 40 (0.42 mm) to No. 200 (0.074 mm)</td>
</tr>
<tr>
<td>Silt and Clay</td>
<td>Smaller than No. 200 (0.074 mm)</td>
</tr>
</tbody>
</table>

### Uniformity Coefficients

- **Coefficient of Uniformity**
  \[ C_u = \frac{D_{60}}{D_{10}} \]

- **Coefficient of Concavity**
  \[ C_c = \frac{D_{60}^2}{D_{10}(D_{10} - D_{60})} \]

*Used when 10 percent or less of the soil is (-) No. 200 sieve.

### Silt and Clay Descriptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Typical Unified Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt</td>
<td>ML (non-plastic)</td>
</tr>
<tr>
<td>Clayey Silt</td>
<td>CL-ML (low plasticity)</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>CL</td>
</tr>
<tr>
<td>Clay</td>
<td>CH</td>
</tr>
<tr>
<td>Plastic Silt</td>
<td>MH</td>
</tr>
<tr>
<td>Organic Soils</td>
<td>OL, OH, Pt</td>
</tr>
</tbody>
</table>

### Descriptive Terminology Denoting Component Proportions

<table>
<thead>
<tr>
<th>Descriptive Terms</th>
<th>Range of Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>0-5%</td>
</tr>
<tr>
<td>Little or slightly</td>
<td>5-12%</td>
</tr>
<tr>
<td>Some or Adjective (a)</td>
<td>12-30%</td>
</tr>
<tr>
<td>And</td>
<td>30-50%</td>
</tr>
</tbody>
</table>

(a) Use Gravelly, Sandy or Silty as appropriate

### Plasticity Chart

The chart shows a relationship between liquid limit and plasticity index, with labels for various soil types such as CL, ML, OH, and MH.

### Dog Trail Crossing

**Anchorage, Alaska**

**SOIL CLASSIFICATION/LEGEND**

April 1995

A-633

**SHANNON & WILSON, INC.**
Geotechnical & Environmental Consultants

Fig. 2
## Soil Description

<table>
<thead>
<tr>
<th>Depth, m</th>
<th>Organic material / peat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Very dense, brown, silty, sandy GRAVEL (GM) with large diameter cobbles (TILL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth, m</th>
<th>Very dense, brown, silty, gravelly SAND (SM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td></td>
</tr>
</tbody>
</table>

**Bottom of Boring**

Boring Completed 3/9/95

Groundwater encountered at approximately 9 meters while drilling.

### Atterberg Limits & Water Content

<table>
<thead>
<tr>
<th>Plastic Limit</th>
<th>Natural Water Content %</th>
</tr>
</thead>
</table>

### Penetration Resistance

(540-lb. weight / 30 in. drop)

<table>
<thead>
<tr>
<th>Depth, m</th>
<th>penetration Resistance</th>
</tr>
</thead>
</table>

### Log of Boring B-1

**Legend**

- **3" O.D. thin-wall sample**
- **3" O.D. split-spoon sample**
- **Continuous sample**
- **Rock core sample**
- **Grain sample**

- **Impervious seal**

- **Water level at indicated**

- **11/30 Date of measurement**

- **Piezometer tip**

<table>
<thead>
<tr>
<th>Method of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Compression</td>
</tr>
<tr>
<td>Unconsolidated - Undrained triaxial compression</td>
</tr>
<tr>
<td>Torvane</td>
</tr>
<tr>
<td>Pocket Penetrometer</td>
</tr>
</tbody>
</table>

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors.
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

**Log of Boring B-1**

**SHANNON & WILSON, INC.**

**Geotechnical Consultants**

**Dog Trail Crossing**

**Anchorage, Alaska**

**A-633**

**Fig. 3**
**Soil Description**

Surface Elevation:  

<table>
<thead>
<tr>
<th>Depth</th>
<th>Dry Unit Weight</th>
<th>Sample</th>
<th>Ground Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Atterberg Limits & Water Content**

<table>
<thead>
<tr>
<th>Plastic Limit</th>
<th>Liquid Limit</th>
</tr>
</thead>
</table>

**Penetration Resistance**

(360-lb. weight / 30 in. drop)  
△Blows/foot or indicated depth

---

**Legend**

- Impervious seal
- Water level at indicated
- Continuous sample
- Rock core sample

**Method of Measurement**

- Unconfined Compression
- Unconsolidated – Undrained triaxial compression
- Torvane
- Pocket Penetrometer

---

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors  
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

---

**Log of Boring B-2**

**SHANNON & WILSON, INC.**  
Geotechnical Consultants

**Dog Trail Crossing**  
**Anchorage, Alaska**

**A-633**  
**Fig. 4**
## Soil Description

**Surface Elevation:**

- Brown, organic material / peat
- Frozen to approximately 1 meter
  - Very dense, brown, gravelly SAND
- Very dense, brown, wet, slightly silty, gravelly SAND (SP-SM), heaving at 7.62 meters.

**Bottom of Boring**

Boring Completed 3/17/95

Groundwater encountered at approximately 3 meters while drilling

---

### Legend

- **3” O.D. thin-wall sample**
- **2” O.D. split-spoon sample**
- **Rock core sample**
- **Impervious seal**
- ** underway drilling**
- **Invert of measurement**
- **Piezometer tip**

---

### Method of Measurement

- O Unconfined Compression
- △ Unconsolidated - Undrained triaxial compression
- ○ Torvane
- □ Pocket Penetrometer

---

### Atterberg Limits & Water Content

<table>
<thead>
<tr>
<th>Plastic Limit</th>
<th>Liquid Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Water Content %</td>
<td></td>
</tr>
</tbody>
</table>

### Standard Penetration Resistance

140-lb. weight / 30 in. drop

---

### Log of Boring B-3

**SHANNON & WILSON, INC.**
Geotechnical Consultants

**Dog Trail Crossing**
Anchorage, Alaska

**A-633**

**Fig. 5**
Soil Description

Surface Elevation:

Organic material / peat
Frozen to approximately 1 meter
Very dense, brown, gravelly SAND

Dense to very dense, brown, wet, silty gravelly SAND (SM), heaving at 20 feet

Bottom of Boring
Boring Completed 3/20/95
Groundwater encountered at approximately 3 meters while drilling

Log of Boring B-4

SHANNON & WILSON, INC.
Geotechnical Consultants

Dog Trail Crossing
Anchorage, Alaska

Fig. 6
**Soil Description**

### Surface Elevation:

- Frozen to approximately 1 meter
- Dense, brown, sandy GRAVEL

### Standard Penetration Resistance

- (140-lb. weight / 30 in. drop)
- ▲ Blows/foot or indicated depth

<table>
<thead>
<tr>
<th>Depth</th>
<th>Dry Unit Weight</th>
<th>Sample</th>
<th>Ground Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Bottom of Boring**
  - Boring Completed 3/17/95
  - Groundwater encountered at approximately 3 meters while drilling

### Legend

- **equivl energy: 623 N per 76.2 cm drop**

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

---

**Log of Boring B-5**

**SHANNON & WILSON, INC.**
Geotechnical Consultants

Dog Trail Crossing
Anchorage, Alaska

A-633

Fig. 7
Soil Description

Surface Elevation:

Frozen to approximately 1 meter
Very dense, brown, sandy GRAVEL.

Medium dense to dense, brown, slightly silty, gravelly SAND

Bottom of Boring
Boring Completed 3/17/95
Groundwater encountered at approximately 3 meters while drilling

Legend

equivl energy: 623 N per 76.2 cm drop

Method of Measurement

uns. Compression
Unconsolidated - Undrained triaxial compression
TerVane
Pocket Penetrometer

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

Log of Boring B-6

SHANNON & WILSON, INC.
Geotechnical Consultants

Dog Trail Crossing
Anchorage, Alaska

A-633
Fig. 8
Soil Description

Surface Elevation:

- Frozen to approximately 1 meter
  Very dense, brown, sandy GRAVEL

- Dense to very dense, brown, slightly silty, gravelly SAND (SP-SM)

Bottom of Boring
Boring Completed 3/20/95
Groundwater encountered at approximately 2 meters while drilling

Legend

- 3" O.D. thin-wall sample
- 2" O.D. split-spoon sample
- continuous sample
- Rock core sample
- Grab sample
- Impervious seal
- Water level at indicated
- 1/4-80 Date of measurement
- Piezometer tip

Method of Measurement

- Unconfined Compression
- Unconsolidated - Undrained triaxial compression
- Torvane
- Pockets Penetrometer

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

Log of Boring B-7

SHANNON & WILSON, INC.
Geotechnical Consultants

Dog Trail Crossing
Anchorage, Alaska

A-633
Fig. 9
**Soil Description**

<table>
<thead>
<tr>
<th>Depth, m</th>
<th>Surface Elevation</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Frozen to approx. 1 meter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dense, brown, sandy GRAVEL</td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td>Dense, brown, gravelly, silty SAND (SM)</td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td>Bottom of Boring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boring Completed 3/20/95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater encountered at approximately 2.4 meters while drilling</td>
</tr>
</tbody>
</table>

**Legend**

- 3" O.D. thin-wall sample
- 2" O.D. split-spoon sample
- Continuous sample
- Rock core sample
- Grab sample
- Impervious seal
- Water level at indicated 1-90 Date of measurement
- Piezometer tip

**Method of Measurement**

- ○ Unconfined Compression
- △ Unconsolidated - Undrained triaxial compression
- ○ Torvane
- □ Pocket Penetrometer

1. Groundwater levels may vary with time, precipitation, infiltration, and other factors.
2. The stratification lines represent approximate soil boundaries. Actual boundary may be transitional.

Log of Boring B-8

**Atterberg Limits & Water Content**

<table>
<thead>
<tr>
<th>Plastic Limit</th>
<th>Liquid Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Water Content %</td>
<td></td>
</tr>
</tbody>
</table>

**Standard Penetration Resistance**

(140-lb. weight / 30 in. drop)

- ▲ Blow/sq. ft. or indicated depth
## TYPE 1

<table>
<thead>
<tr>
<th>PARTICLE SIZE (mm)</th>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>2&quot;</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>3/4&quot;</td>
<td>60-100</td>
</tr>
<tr>
<td>5</td>
<td>NO. 4</td>
<td>30-65</td>
</tr>
<tr>
<td>2</td>
<td>NO. 10</td>
<td>20-50</td>
</tr>
<tr>
<td>0.45</td>
<td>NO. 40</td>
<td>10-30</td>
</tr>
<tr>
<td>0.08</td>
<td>NO. 200</td>
<td>2-6</td>
</tr>
</tbody>
</table>

Fractions passing the NO. 200 sieve shall not be greater than 15% of the fractions passing the NO. 4 sieve.

## TYPE II-A BASE

<table>
<thead>
<tr>
<th>PARTICLE SIZE (mm)</th>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>3&quot;</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>3/4&quot;</td>
<td>50-100</td>
</tr>
<tr>
<td>5</td>
<td>NO. 4</td>
<td>25-60</td>
</tr>
<tr>
<td>2</td>
<td>NO. 10</td>
<td>15-50</td>
</tr>
<tr>
<td>0.45</td>
<td>NO. 40</td>
<td>4-30</td>
</tr>
<tr>
<td>0.08</td>
<td>NO. 100</td>
<td>2-6</td>
</tr>
</tbody>
</table>

Fractions passing the NO. 200 sieve shall not be greater than 20% of the fraction passing the NO. 4 sieve.

## BEDDING B

<table>
<thead>
<tr>
<th>PARTICLE SIZE (mm)</th>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1&quot;</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>3/8&quot;</td>
<td>60-100</td>
</tr>
<tr>
<td>5</td>
<td>NO. 4</td>
<td>40-85</td>
</tr>
<tr>
<td>2</td>
<td>NO. 10</td>
<td>25-70</td>
</tr>
<tr>
<td>0.45</td>
<td>NO. 40</td>
<td>5-40</td>
</tr>
<tr>
<td>0.08</td>
<td>NO. 200</td>
<td>0-6</td>
</tr>
</tbody>
</table>

Fractions passing the NO. 200 sieve shall not be greater than 35% of the fractions passing the NO. 40 sieve.

## BEDDING C

<table>
<thead>
<tr>
<th>PARTICLE SIZE (mm)</th>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>2&quot;</td>
<td>100</td>
</tr>
<tr>
<td>1.7</td>
<td>1/2&quot;</td>
<td>40-100</td>
</tr>
<tr>
<td>5</td>
<td>NO. 4</td>
<td>20-75</td>
</tr>
<tr>
<td>2</td>
<td>NO. 10</td>
<td>12-60</td>
</tr>
<tr>
<td>0.45</td>
<td>NO. 40</td>
<td>2-30</td>
</tr>
<tr>
<td>0.08</td>
<td>NO. 200</td>
<td>0-6</td>
</tr>
</tbody>
</table>

Fractions passing the NO. 200 sieve shall not be greater than 20% of the fractions passing the NO. 4 sieve.

**Type II:** coarser material is allowed than in Type II-A.

**Type III:** An approved sand or gravel with a maximum of 10% passing the NO. 200 sieve

**Type IV:** An approved sand or gravel with a maximum of 25% passing the NO. 200 sieve.
<table>
<thead>
<tr>
<th>GROUP</th>
<th>KIND OF SOIL</th>
<th>P200</th>
<th>TYPICAL SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Sandy Soils</td>
<td>0 to 3</td>
<td>SW, SP</td>
</tr>
<tr>
<td></td>
<td>Gravelly Soils</td>
<td>0 to 6</td>
<td>GW, GP, GW-GM, GP-GM</td>
</tr>
<tr>
<td>F2</td>
<td>Sandy Soils</td>
<td>3 to 15</td>
<td>SW, SP, SW-SM, SP-SM, SM</td>
</tr>
<tr>
<td></td>
<td>Gravelly Soils</td>
<td>6 to 20</td>
<td>GM, GW-GM, GP-GW</td>
</tr>
<tr>
<td>F3</td>
<td>Sands, except very fine silty sands</td>
<td>Over 15</td>
<td>SM, SC</td>
</tr>
<tr>
<td></td>
<td>Gravelly soils</td>
<td>Over 20</td>
<td>GM, GC</td>
</tr>
<tr>
<td></td>
<td>Clays PI&gt;12</td>
<td></td>
<td>CL, CH</td>
</tr>
<tr>
<td>F4</td>
<td>All Silts</td>
<td></td>
<td>ML, MH</td>
</tr>
<tr>
<td></td>
<td>Very fine silty sands</td>
<td>Over 15</td>
<td>SM</td>
</tr>
<tr>
<td></td>
<td>Clays, PI&lt;12</td>
<td></td>
<td>CL, CL-ML</td>
</tr>
<tr>
<td></td>
<td>Varved clays and other fine grained, banded seds.</td>
<td></td>
<td>CL and ML; CL, ML, and SM; SL, SH, and ML; CL, CH, ML, and SM</td>
</tr>
</tbody>
</table>

P200 = percent passing the number 200 sieve