REPLACEMENT HOUSING
FTW 251 AND FTW 283
FOUNDATION DESIGN ANALYSES
FORT WAINWRIGHT, ALASKA

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1.0 INTRODUCTION

1.1 Purpose and Scope

This report presents the results of our foundation engineering studies for the design and construction of Replacement Housing (FTW 251 and 283) proposed for Fort Wainwright, Alaska. The purpose of these studies was to develop foundation design recommendations based on the results of the geotechnical investigation conducted by the United States Army Corps of Engineers (Corps).

1.2 Project Understanding

The project consists of site preparation for 140 multi-family quarters for junior enlisted personnel and associated support. The units will be single-story and multi-story duplex units with integral garages. The project will be located on the Taku Gardens site, which is located in the southwestern portion of the Ft. Wainwright cantonment area. The site is located east of White Street, north of Alder Road and west of the railroad that crosses the southern part of Fort Wainwright. The area is generally flat, with a surface elevation on the order of 445 feet. The existing vegetation was stripped from the site during the early spring of 2004 while the ground was frozen.

While the majority or the site is relatively flat, there is a large mound of soil in the northwest portion of the proposed housing development. It is likely that this mound of soil is the surficial silt and silty sand that was excavated as part of the site preparation work associated with the construction of the school located just north of the FTW 283 project boundary. We anticipate that this material could be used for berms and landscaping purposes in play and park areas. No borings were drilled through this mound of soil as part of the geotechnical findings report. It is possible that the frozen near surface frozen soils are present beneath the mound.

2.0 GEOLOGIC SETTING

2.1 Geological Setting

The Fort Wainwright area is located within the Tanana Lowlands physiographic province, which forms a large arcuate band of alluvial sediments between the Alaska Range and the Yukon-Tanana Uplands. The lowlands consist of vegetated floodplains and low benches cut by the Tanana River, and sloughs and oxbow lakes representing former channel positions of the Tanana or Chena Rivers. Soils in the lowlands typically consist of interbedded alluvial sand and gravel covered by silty overbank deposits. Cobbles may be observed in alluvial sand and gravel. Wood in the form of roots, sticks, and twigs, as well as logs, is often encountered in the alluvium.

Former slough deposits are commonly filled with organic silt and peat deposits. These deposits are laterally discontinuous and vary in thickness.

The density of the alluvial soils generally ranges between loose to medium dense. The thickness of the sediments overlying bedrock in the vicinity of the project is unknown, but has been established to be as great as 400 to 500 feet in the Fairbanks area.

The portion of the Tanana Lowland in which the site is located has not been glaciated.

The Fort Wainwright area is in a subarctic zone underlain by discontinuous permafrost. Permafrost is defined as ground that has remained at a temperature of 32° Fahrenheit or less for two or more years. The maximum depth of permafrost measured in the Fairbanks area is in excess of 200 feet. The thickness of the "active layer," the portion of the ground at or near the surface that undergoes an annual freeze-thaw cycle, is largely dependent upon the type of ground cover and the snow depth, as well as other factors. Seasonal frost penetration commonly exceeds 10 feet beneath roads or parking areas kept free of snow during winter; whereas, in areas covered by thick mats of tundra or organic material, the thickness of the active zone is often 2 feet or less.

2.2 Seismological Setting

Fort Wainwright lies between two, right-lateral shear systems; the Denali Fault System approximately 60 to 80 miles to the south of Fairbanks, and the Kaltag and Tintina Fault Systems approximately 80 miles to the north. The shear along these systems is believed to be the result of crustal adjustments in the North American Plate due to the convergence with the Pacific Plate along the Gulf of Alaska.

Earthquake epicenters in the interior of Alaska recorded by the University of Alaska Geophysical Institute and the U.S. Geological Survey between 1904 and 2003, and the epicenters of large historic earthquakes, are shown on Figure 1. Seismicity in the Fort Wainwright area has historically been concentrated in clusters or bands with a northeast-southwest trend that indicates active faulting, although no faults with Holocene displacement have been recognized in the Fairbanks area (Page et al., 1991). These seismic zones include the Salcha Seismic Zone (SSZ) about 25 miles to the northwest of Fairbanks. Page and others (1995) hypothesized these bands delineate the edges of blocks rotating clockwise between two right-lateral shear systems. Outside these northeast-trending linear seismic zones, recorded seismicity appears diffuse. The earthquakes in the Fairbanks area typically occur at depths of less than 25 miles.

Within the past century, the Fort Wainwright area has been subject to three large earthquakes that occurred in the Tanana Lowlands. On July 22, 1937, a Magnitude 7.6 (M_s) event occurred in the Salcha Seismic Zone (SSZ) about 28 miles to the southeast of Fairbanks. This event, which was widely felt throughout central Alaska, produced extensive ground failures in the epicentral area (Page and others, 1995). Two other earthquakes, an October 15, 1947, M_s 7.2 event about 47 miles south-southwest of Fairbanks and an August 27, 1904, M_s 7.3 event about 17 miles southwest, are not correlated with apparent seismic zones. Data from the October 15, 1947, M_s 7.2 event suggests thrust faulting in contrast to the strike-slip faulting suggested in other events in the Fort Wainwright area. The epicenter of the 1904 earthquake, which predates the University of Alaska seismograph, is uncertain.

A recent November 3, 2002, M_s 7.9 event on the Denali Fault south of Fort Wainwright was felt widely throughout central and southern Alaska and resulted in minor liquefaction in the Fairbanks area. The peak horizontal ground acceleration of this event recorded on bedrock at the University of Alaska campus in Fairbanks was 0.09g.

2.3 Subsurface Conditions

The Taku Gardens site was explored with 65 borings which were drilled between November 14, 2003, and February 14, 2004 by the Corps Alaska District Soils and Geology Branch. These borings ranged in depth from approximately 10 to 50 feet. The results of the subsurface exploration programs are presented in Geotechnical Findings Report, Family Housing Replacement-Taku Gardens Resite, Fort Wainwright, Alaska (FTW 251) dated March 2004 and Geotechnical Findings Report, Family Housing Replacement-Taku Gardens Site, Fort Wainwright, Alaska (FTW 283) dated February 2004. These reports are attached as Appendix A.

The subsurface explorations performed by the Corps indicate that the surficial soils at the site consist of silts and silty sands that range in depth from less than 3 feet to about 13 feet. These silty soils are generally classified as being frost susceptible. The surficial, fine-grained soils are underlain by interbedded alluvial sand, sandy gravel and gravelly sand to the depth explored by the borings. Blow counts obtained during split-spoon sampling indicate that the relative density of these soils range between loose to medium dense.

Groundwater was observed during drilling at depths ranging from 7.9 to 18.7 feet below the existing ground surface. The subsurface explorations were conducted during the winter. The method of observing the groundwater during drilling is approximate, particularly in areas where the water table is within a zone of silty material. The relative groundwater table depth at this site is consistent with our knowledge of groundwater in the area. The groundwater table at this site is expected to be influenced by the Tanana and the Chena Rivers. Highest groundwater levels should be anticipated in the late spring after breakup, and during the summer when rainfall combined with melting snow in the headwaters normally results in higher groundwater levels. Groundwater levels are expected to drop throughout the late fall and winter months and should reach their lowest levels before spring breakup; higher groundwater elevations should be anticipated during the summer construction season. Based on our knowledge of the groundwater near the site, we anticipate that seasonal groundwater fluctuations may be on the order of 3 feet.

Seasonal frost penetration on the order of 6.5 feet was observed in some of the borings. Seasonal frost penetration at least this deep should be anticipated in the spring of 2005 when construction is scheduled to begin. The depth of seasonal frost penetration is highly dependent upon the thickness of insulating snow cover. It has been our experience that in areas kept clear of snow throughout the winter, such as streets and parking areas, the seasonal frost penetration can exceed 13 feet in the Fairbanks/Fort Wainwright area.

Frozen soil anticipated to be permafrost was reported within the depth explored in 4 of the 65 borings drilled at the site. Near surface permafrost was found in borings AP-8978 and AP-8979, which are located west of the electrical substation in the southern portion of the site. Permafrost was also encountered below a depth of 41 feet in AP-8977 and below 46 feet in AP-8924. These borings are located on the southern portion of the site. A review of the aerial photos suggests that the borings with near surface permafrost are located in areas that were recently vegetated with spruce. The aerial photographs indicate that a majority of the Taku Gardens site had been cleared in the past. We anticipate that the removal of the vegetative cover has resulted in the degradation of permafrost.

2.4 Seismic Ground Motion

Fort Wainwright is in a seismic locale where damage can occur in the event of a major of earthquake. Seismic ground motions for the analysis of liquefaction were developed in general accordance with the requirements of Ground Motion A in TI 809-04 (Seismic Design for Buildings, U.S. Army Corps of Engineers, 1998) for a stiff soil site. A peak ground acceleration (PGA) of 0.30-g was used to evaluate earthquake-induced hazards at the site.

2.5 Seismic Hazards

Earthquake-induced geologic hazards include landsliding, fault rupture, settlement, and liquefaction and associated effects (e.g., loss of shear strength, bearing capacity failures, loss of lateral support, ground oscillation, lateral spreading). Because of the flat topography at the site, the risk of landsliding and lateral spreading is considered to be low. An assessment of geologic mapping reveals no conclusive evidence of faulting or fault-related geomorphic structures with Holocene displacements in the area. The absence of obvious fault-related geomorphic structures does not preclude the possibility of active faults in the area. However, the potential for fault rupture is also considered to be relatively low.

2.6 Soil Liquefaction

We evaluated the liquefaction hazard at the site based on the data obtained from drilling using a method known as "the simplified procedure," originally developed by Seed and Idress (1971) and modified over the years. The procedure uses blow counts (N) from the Standard Penetration Test (SPT) to assess liquefaction potential.

The seismic load or demand placed on the soils required to cause liquefaction is a function of the intensity and duration of ground shaking. The duration of ground shaking is related to the earthquake magnitude, distance from the earthquake, and site response characteristics. Generally, the shear stress and cyclic stress ratio (CSR) are estimated as a function of the peak horizontal ground acceleration (a_{max}), overburden stress, and a stress reduction coefficient, which accounts for a variation in the stress level or acceleration with depth.

As presented in Section 2.4, the ground acceleration (0.3g) was developed using the procedures of TI 809-04. Overburden stress was estimated based on the Corps boring logs and our

experience in the area. The stress reduction coefficient was determined in accordance with equations identified by Harder and Seed (1990).

The capacity of granular soil to resist liquefaction is defined by the cyclic resistance ratio (CRR), which is the threshold CSR required for liquefaction initiation. Based on case history studies of liquefied and nonliquefied sites from numerous earthquakes, empirical relationships have been developed the correlate the CRR for a magnitude 7.5 earthquake with normalized/corrected values of SPT blow counts (N), identified as $(N_1)_{60cs}$. $(N_1)_{60cs}$ is the SPT blow count normalized to an overburden stress of 2000 psf, a hammer efficiency of 60 percent, and adjusted for fines content. Blow counts are also corrected for other factors, such as borehole size, sample rod length, and whether or not a sample liner is used.

We note that blow count data were not obtained in accordance with the SPT that is used in the analysis. The SPT uses a 140-pound hammer to drive a 1.5-inch split-spoon sampler rather than a larger hammer with a 2.5-inch I.D., split spoon sampler. The larger sampler is typically used to obtain better samples and reduce the potential of artificially high blow counts in gravelly soils. Based on correlations in the *Foundation Engineering Handbook* (Fang, 1991), the blow count obtained using the larger hammer and sampler combination is approximately equivalent to the SPT blow count in cohesionless soils. Even though a larger sampler was used, we anticipate some of the blow counts for this study may have been artificially high because of gravel.

A magnitude scaling factor is used to adjust the CRR for earthquake magnitudes larger or smaller than 7.5. A magnitude 7.5 earthquake was assumed for this analysis, consistent with the site seismicity, and therefore a CRR scaling factor of one was used for the analysis.

The CRR correlations were developed for a data set with depths less than 40 feet for the N-based procedure. High overburden stress correction factories were developed by Seed to extrapolate the N-based analysis to greater depths. In our opinion, evaluation of liquefaction potential at depths greater than those in the data sets, although theoretically possible, is uncertain.

The soils are potentially liquefiable when the seismic load (CSR) is greater than the resistance to liquefaction (CRR). The potential for liquefaction can be expressed in terms of a factor of safety against liquefaction defined by:

$$FS = CRR/CSR$$

Liquefaction is predicted at those depths where FS is less than 1.

At this site we believe that the primary effect of liquefaction would be a reduction in soil shear strength, resulting in reduced foundation support as well as dynamic densification or settlement of the liquefied zones. In both the FTW 251 and FTW 2833 investigations, many of the samples from below the water table had uncorrected penetration resistance values (blow counts) of less than 20 and several had blow counts of 10 or less. These soils are, in our opinion, susceptible to liquefaction and dynamically induced compaction if they are subjected to a strong magnitude earthquake. Densification of the granular soils above and below the water table may occur when subject to earthquake shaking, resulting in potential ground settlement at the site. We reevaluated our estimate of potential earthquake-induced ground settlement at each boring location using a relationship by Tokimatsu and Seed (1987) that correlates earthquake ground motion and penetration resistance with volumetric strain. For the design earthquake (magnitude 7.5, peak ground acceleration 0.30), total free-field ground surface settlements were estimated to exceed 6 inches at several locations.

3.0 FOUNDATION ENGINEERING RECOMMENDATIONS

3.1 Discussion

The investigations conducted by the Corps indicate that the soils at the site generally consist of approximately 3 to 13 feet of silty soils overlying "clean" alluvial sand and gravel. The relative density of the sand and gravel was reported to be medium dense with some areas of loose soils. In addition, near-surface, perennially frozen soils were reported in two of the borings near the southern boundary of the project.

3.2 Foundation Recommendations

We recommend that the duplex housing units be founded on a thickened edge slab foundation bearing in a replacement, compacted structural fill. We have evaluated the soil system in both static and under earthquake conditions. Based on the results of our analysis, the thickened portion of the slab should be sized for a maximum allowable bearing capacity of 3000 psf. Our recommended width for the thickened portions of the slab, depth of foundation, and the minimum recommended thickness of compacted fill are shown on Figure 2.

To minimize the potential for a punching-type failure during the design earthquake, the thickened bearing portion of the slab should be underlain with compacted, select granular fill, at least twice as deep as the width of the thickened portion.

Estimated settlement of the thickened slab footings under static loading conditions is estimated to be less than ¾ inch.

Frost protection for thickened slab foundation should be provided by having non-frost-susceptible fill beneath the perimeter portion of the slab down to the underlying NFS granular soils. In addition, the foundation should have 2 inches of rigid board insulation suitable for direct burial against the vertical portion of the thickened slab edge and 2 inches of insulation extending horizontally 48 inches from the thickened slab.

3.3 Excavation and Site Preparation

Based on the depth of silty soils reported in the Corps boring logs, we anticipate that the depth to nonfrost-susceptible soils is approximately 3 to 13 feet below the existing grade. Site preparation for the building footprints should include the removal of silty, frost susceptible soils and organics from the base of the excavation to nonfrost-susceptible soils, and the subsequent compaction of the subgrade. We define nonfrost-susceptible soils to be sand and gravel with less than 5 percent of the material finer than the No. 200 sieve, based on the ¾-inch minus material. We recommend the base of the excavation extend laterally a minimum of 2 feet for every 3 feet of depth between the base of the excavation and the base of the thickened portion of the slab.

Our recommendations for foundation design are based on suitable soils at the base of the excavation. We should be retained to the base of the excavation to identify areas of unsuitable soils that may be required to be removed. Localized areas of deeper-than-anticipated deposits of silty soils or organics are sometimes encountered that may require additional excavation. Recent excavations for building foundations in the flood plain deposits between Fairbanks and Eielson Air Force Base have encountered numerous logs that were not encountered in the subsurface explorations.

After all unsuitable soils, organics, and buried logs have been removed and before placement of the structural fill, the base of the excavation should be uniformly and systematically compacted Following compaction of the base, the excavation should be backfilled with structural fill.

Structural fill should not be placed over seasonally frozen ground.

Near-surface permafrost was reported in two borings located west of the GVEA Substation. Air photos suggest that this area was recently cleared. We identified three duplex units that may bee located in the area near surface permafrost. Where encountered, the frozen soils beneath the proposed structure and extending laterally 10 feet beyond the footprint of these units should be

excavated in the spring of 2005 to a depth of at least 13 feet below existing ground surface. The base of these excavations should be allowed to thaw before they are compacted and backfilled in late summer of 2005. The borings logs indicate that the granular soils below a depth of about 20 feet are relatively thaw stable. The thick layer of compacted fill beneath these units will tend to reduce the impact of areas of localized settlement and minimize the differential settlement of these units. It is our opinion that permafrost below a depth of 30 feet is likely to be thaw stable. The housing units in areas of near surface permafrost can then constructed on thickened edge slab foundations.

It is possible that near surface frozen soils are present beneath the mound of soil in the northwest portion of the project. This area should be investigated with test pits once the mound of silt has been removed. Special foundations and /or site preparation methods may be required, depending upon the results of the test pitting.

Groundwater is expected to be approximately 3 feet higher during the summer construction than it was during the winter when the exploratory borings for this project were drilled. If silty soils are encountered below the water table in building excavations, these soils should be removed in the wet under the observation of the geotechnical engineer. The initial lift of granular fill will be placed in the water to a sufficient thickness to bring the surface of the fill approximately 12 inches above water level prior to fill placement. As this initial lift is being placed, the groundwater table is anticipated to rise as sand and gravel displaces the water. The contractor may be required to allow the water level to return to near pre-backfill levels prior to compaction. During compaction of this initial lift, additional material may be required to be added to maintain the grade of the initial lift.

3.4 Structural Backfill Recommendations

The structural backfill should consist of unfrozen, gravelly sand or sandy gravel that meets the following gradation limits after compaction. Soils meeting this gradation criterion are commonly available from local sources as pit-run sand and gravel.

Size	Percentage Passing
3-inch	100
¾-inch	More than 70
No. 4 sieve	30 – 60
No. 200 sieve	Less than 5 (Based on the ¾-inch minus fraction

The borings drilled for the project suggest that the granular soils beneath the play lots and play fields on the northwest and southeast portions of the proposed housing development are a

potential source for non frost-susceptible granular fills. The geophysical survey suggests that these areas are relatively free of buried metallic debris. If these areas are mined for granular borrow they may be backfilled with silt and silty sands obtained from the building excavations and the mound of silt that is south of Tanana School.

In general, the structural fill should be placed in layers not exceeding 8 inches in height after compaction (or about 10 inches loose height). This may have to be reduced if the contractor methods and means do not adequately compact the entire thickness of the layer. The material in each layer should be compacted to achieve a density of at least 95 percent (or higher, as recommended) of the maximum dry density, based on the Modified Proctor moisture-density relationship (ASTM D1557). Please note that ASTM D1557 is only valid for soils that have 30 percent or less by mass of their particles retained on the ¾-inch sieve. ASTM D2922 and ASTM D3017 should be used to determine in-place densities. The water content of the fill should be altered by wetting or drying as necessary to achieve the desired compaction.

The fill should consist of unfrozen materials and be placed at above freezing air temperatures. If previously placed fill freezes, for instance overnight, the frozen material should be excavated and wasted or allowed to thaw and be recompacted prior to the placement of additional fill.

The structural backfill should be brought up at the same rate on both sides of foundation walls or other underground structures. We further recommend that fill within 5 feet of structures be compacted with hand-operated compactors rather than self-propelled compaction equipment, to avoid damage or movement of the structures.

Any virgin ground-receiving fill should be cleared and grubbed.

3.5 Nonstructural Backfill Recommendations

Nonstructural fills may be used to fill or shape unpaved areas for landscaping or backfill utility trenches outside of the pavement areas. Nonstructural fills may consist of silt or silty soils from the excavation; however, the fill should not contain topsoil or organics. Maximum loose lift height for nonstructural fill should not exceed 12 inches. This material should be compacted to at least 90 percent of the maximum density obtained from the Modified Proctor compaction test (ASTM D 1557). Drying or wetting of the soil may be necessary to obtain compaction.

3.6 Excavation Slopes

All excavations should be sufficiently sloped or shored to provide a stable bank. We recommend that the stability of the excavated slopes be made the responsibility of the earthwork subcontractor, as they will be most familiar with the conditions encountered in the excavations and have direct control of working conditions in the field. The work should be accomplished in general accordance with the applicable local, state, and federal standards. For planning purposes, we recommend that you assume unsupported excavation slopes will be no steeper than one vertical to one horizontal. It is also important to note that temporary excavation slopes may initially stand steep but slough and cave as they dry out, particularly when equipment is operated nearby. Similarly, steep cuts made in seasonally frozen ground can become unstable upon thawing.

3.7 Utilidors

We recommend the base of the utildors be founded on a minimum of 1 foot of compacted structural fill. The fill should be placed and compacted according to our recommendations for structural fill. Prior to the placement of fill, the base of the trench should be adequately compacted to provide a firm base for the first lift of compacted structural fill. If the subgrade is not adequately compacted, the contractor will have a difficult time achieving the required density in the initial lift of structural fill. The base of the trench should extend a minimum of 2 feet laterally beyond the sides of the utilidor.

We recommend the trench be backfilled with compacted structural fill to a minimum elevation of 1 foot above the top of the utilidor. Under paved areas, the structural fill should extend to the pavement section.

Abrupt changes in soil conditions should be avoided beneath paved areas. Structural fills beneath pavement areas, such as around utilidors or culverts, should be tapered and placed on subgrade slopes no steeper than 10H:1V.

3.8 Lateral Earth Pressures and Frictional Resistance

Lateral movement of the structure can be resisted by passive pressures developed along the buried portions of the structure perpendicular to the direction of movement, and by friction along the buried portions of the structure parallel to the direction of movement. We recommend that the ultimate passive pressure be estimated assuming a fluid pressure developed by a fluid with a weight of 440 pounds per cubic foot (pcf). The ultimate frictional resistance against sliding

along the base of foundations may be computed using a coefficient of friction of 0.67 between cast-in-place concrete and structural fill. These values do not include a factor of safety.

In addition to the resisting forces, the soil will exert a driving force. This driving force may be estimated as the static active earth pressure or as a dynamic earth pressure which includes static pressure plus a dynamic increment distributed uniformly over the height of the buried portion of the structure. The static active earth pressure should be estimated assuming a fluid pressure and a fluid weight of 38 pounds per cubic foot. For the PGA assumed in our analyses, we recommend that the dynamic increment be 30 percent of the static component. These values do not include a factor of safety.

4.0 PAVEMENT, SIDEWALK, AND TRAIL STRUCTURAL SECTIONS

4.1 Recommended Pavement Section

Our recommended design pavement section was developed using the techniques contained in the reduced subgrade strength method of the Department of the Army and Air Force's *Pavement Design for Roads, Streets, Walks, and Open Storage Areas* (TM 5-822-5/AFM 88-7, Chapter 1), and our experience with pavement section in the Fairbanks area. In general, the soils underlying the parking and driving areas are assumed to be silty sand. The use of the reduced subgrade strength method was selected due to the deep, seasonal, frost penetration anticipated for the site.

The following parameters were assumed in this analysis.

Traffic Category:	IV	(Page 3-1, TM 5-822-5)
Road/Traffic Classification:	C	(Page 3-3, TM 5-822-5)
Pavement Design Index:	5	(Page 3-2, TM 5-822-5)
Base Course CBR:	100	(Page 6-1, TM 5-822-5)
Subbase CBR:	50	(Page 5-1, TM 5-822-5)
Frost Group of Subgrade Soil:	F3 to F4	(Page 18-5, TM 8-822-5)
Frost-area Soil Support Index:	3.5	(Table 18-3, TM 5-822-5)

The analysis shows that the total minimum thickness required for the subbase, base, and pavement surface is 23 inches (Figure 8-1, TM 5-822-5). The minimum base and asphalt concrete thicknesses are 4 inches and 2 inches (Table 6-1, TM 5-822-5), respectively. The recommended minimum pavement section is presented on the following page.

Course	Minimum Thickness (in)	Material Recommendation
Surface	2	Asphalt concrete
Base	4	Aggregate base course meeting all the requirements for ADOT&PF base course, grading D-1, compacted to 98% of the maximum dry density determined by ASTM D1557.
Subbase	17	Nonfrost-susceptible material meeting the structural fill requirements of this report, compacted to 95% of the maximum dry density determined by ASTM D1557.

4.2 Sidewalk Design

We recommend the base of the roadway excavation be extended laterally such that the base of the excavation extends to the outer edge of proposed concrete sidewalks. The excavation under concrete sidewalks should be backfilled and compacted in accordance with the requirements of structural fill presented in Section 3.4 of this report. We do not recommend a base course under the sidewalk section. In accordance with project bid specifications, the minimum thickness of concrete for the sidewalk should be 4 inches.

4.3 Greenway Trail System

We recommend a pavement section for the Greenway Trail System to consist of the following: 12 inches of compacted structural fill underlying 2 inches of asphalt concrete and 2 inches of compacted base course. The base course should conform to the requirements of ADOT&PF Standard Specifications for Highway Construction base course meeting the grading requirements of D-1. The base course should be compacted to a minimum of 98 percent of the maximum dry density as determined by ASTM D1557.

We recommend a surfacing consisting of a 2-inch-thick layer of compacted asphalt concrete. The placement of asphalt concrete should be in accordance with ADOT&PF Standard Specifications for Highway Construction.

4.4 Subgrade Preparation

At a minimum, the soils underlying roadways, parking areas, sidewalks and paths should be cleared and grubbed. We recommend that preparation of the subgrade consist of the removal of all organic material from the base of the excavation and the additional removal of soils to allow for the placement of the structural section. Please note that organics soils were reported near the surface in several boring logs and additional excavation will be required to remove this material, if encountered. The width of the excavation in roadway areas should extend to the outer edge of the sidewalks.

In general, the base of the excavation should be compacted with a minimum of four passes of a heavy, self-propelled vibratory compactor. Additional compaction may be required depending on local soil conditions and the moisture content of subgrade soils. Compaction of the subgrade should be continued until the contractor achieves a suitable base to allow for the placement and compaction of the first lift of structural fill. If the subgrade soils are not adequately compacted, the effort required to compact the first lift of material will be dramatically increased.

Frozen soils or high moisture subgrade soils may be encountered during excavation activities. These conditions may require modification of the recommendations in this subsection and are discussed in the following subsections.

4.4.1 Permafrost and Frozen Soils

Depending on the time of site preparation, seasonally frozen soils may be encountered at the base of the roadway/sidewalk or trail excavations. The depth of the seasonally frozen soils may be in excess of 6 feet. If encountered, seasonally frozen soils should be either removed or allowed to thaw prior to subgrade preparation. If the contractor allows the material to thaw, the soils should be allowed to thaw a minimum of 2 feet below the top of the subgrade prior to subgrade preparation.

During review of the boring logs, two borings (AP-8978 and AP-8979, located near buildings 63 to 65) reported that there was deep frozen soils consistent with near-surface permafrost. The contractor should be aware that permafrost may be encountered under roadway, sidewalk, and trail sections, particularly in the southeast portion of the project. If permafrost is encountered, we recommend that the soil be allowed to thaw a minimum of 2 feet below the top of subgrade prior to subgrade preparation. As an alternative, the contractor can remove an additional 2 feet

of frozen soils and replace the material with compacted structural fill. The thickness of the first lift of this replacement fill may be increased to 1 foot prior to compaction.

4.4.2 Use of Geofabric Separator Material

We have reviewed the boring logs provided by the Corps of Engineers and the reported moisture content of the near surface soils anticipated to be at the base of the excavation in roadway, sidewalks and pathways is generally low. Based on the reported moisture contents, we do not anticipate that a geofabric separator will be required. However, the moisture content of soil observed in the field may be significantly different than those reported in the logs due to changed seasonal conditions or recent thawing.

If subgrade soils are too wet to compact, we recommend that geotechnical separator be placed at the base of the excavation. We recommend that the separator and the installation of the separator conform to the requirements of the American Association for Highway and Transportation Officials (AASHTO) M 288 for a Class 2 geotextile with an elongation of greater than or equal to 50 percent. The Class 2 geotextile should conform to the requirements of Table 3 *Separation Geotextile Property Requirements* in AASHTO M 288, except the minimum permittivity of the fabric should be 0.05 cm per second. The geotextile separator should also have an apparent opening size (AOS) equal to or between the No. 70 and No. 100 U.S. Standard Sieve as determined by ASTM D4751. Class 2 geotextiles may be joined either by sewing or overlapping. If the material is joined by lapping, we recommend a minimum overlap of 3 feet.

The thickness of the first lift of structural fill overlying the fabric may be increased to 12 inches prior to compaction.

As an alternative to placement of the separator fabric, the contractor may allow the material to dry out to a point that effective compaction can occur. However, the contractor should be cautioned that, depending on climate conditions, this may take a significant period of time.

5.0 LIMITATIONS

Subsurface explorations and testing identify actual subsurface conditions only at those points where samples are taken, and at the time they are taken. Actual conditions at other locations of the project site, including those inferred to exist between the sample points, may differ significantly from conditions that exist at the sampling locations. The passage of time or intervening causes may change the actual conditions at the sampling locations as well.

Interpretations and recommendations made by Shannon & Wilson are based solely upon information available to Shannon & Wilson at the time the interpretations and recommendations are made.

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Shannon & Wilson, Inc., has prepared the attachment *Important Information About Your Geotechnical/Environmental Report* in Appendix B to assist you and others in understanding the uses and limitations of our reports.

We trust that this information is sufficient for your needs at the present time. If you have any questions, please do not hesitate to call.

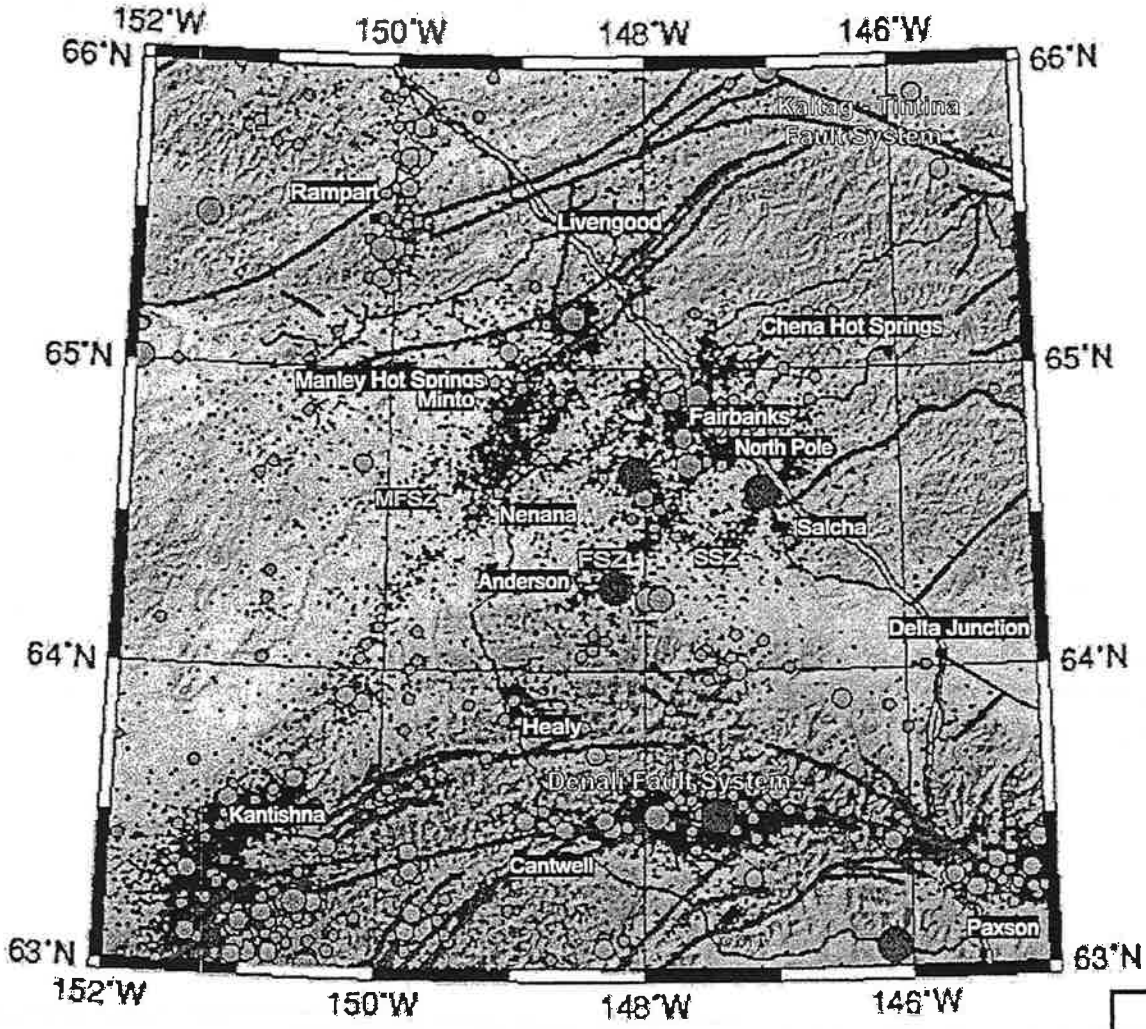
Sincerely,

SHANNON & WILSON, INC.

Rohn D. Abbott, P.E.
Senior Vice President

Reviewed by:

Steve Adamczak, P.E.
Vice President



Depth
Background Seismicity
- 0-33 km
- 33-75 km
- 75-125 km
- 125+ km

Magnitude
Significant Earthquakes
- 4.0+
- 5.0+
- 6.0+
- 7.0+

Seismic Zones
MFSZ: Minto Flats
FSZ: Fairbanks
SSZ: Salcha

- Faults
- Roads
- Rivers
- Oil Pipeline

Figure 1

Map Source: Alaska Earthquake Information Center---University of Alaska Geophysical Institute and U.S. Geological Survey

http://www.giseis.alaska.edu/Seis/html_docs/interior_seismicity_map.html

INTERIOR ALASKA SEISMICITY
1904 TO 2003

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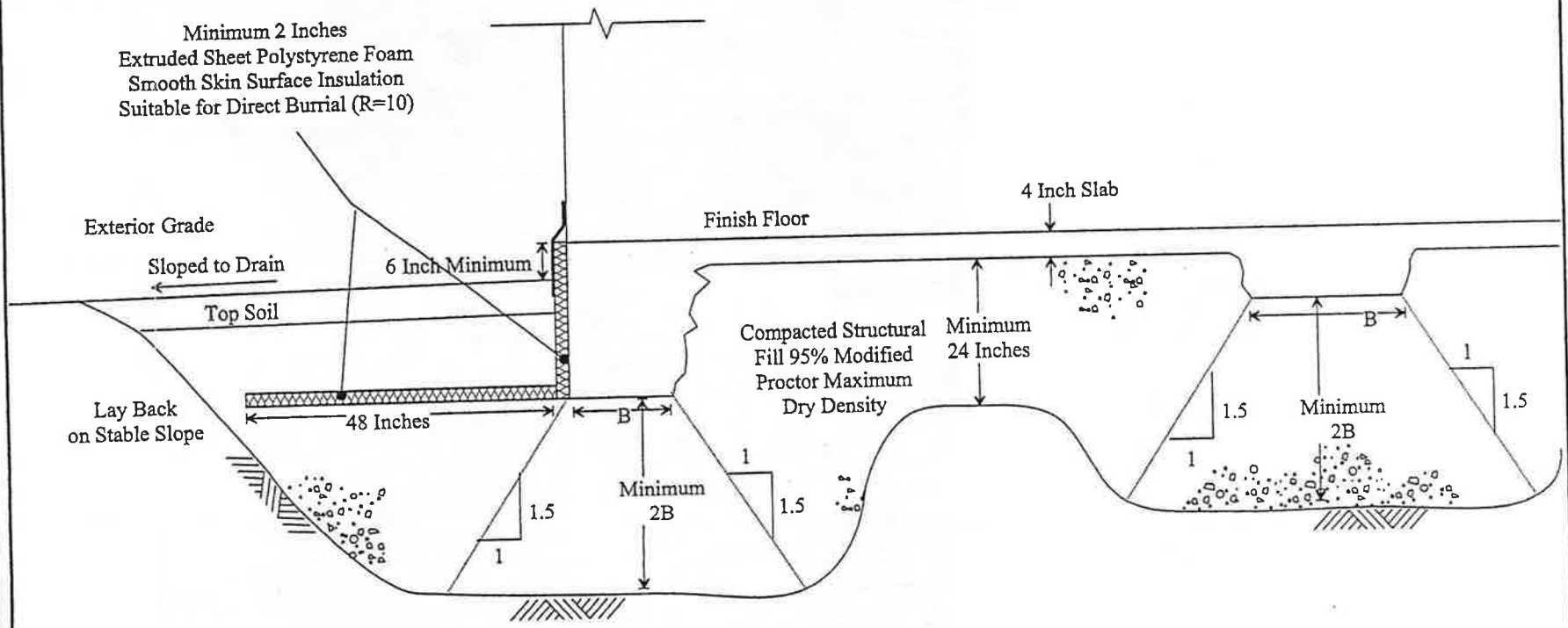
Figure 1



B = Footing Width
Minimum Footing Width, Exterior, 16 Inches
Minimum Footing Width, Interior, ~~24~~ 16 Inches

No Compacted Fill Placed over Seasonally Frozen Ground

Not to Scale

2

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Date: November 2004	Project: 31-1-01869-001
Drawn: ea	File: thickened edgeii.dsf
Checked: rda	Scale: nts

Title: Summary of Thickened Edge Foundation Recommendations

Project: Replacement Housing FTW 251 and FTW 283
Fort Wainwright, Alaska

NO.	DATE:	REVISION:	BY:

Appendix A

U.S. Army Corps of Engineers, Alaska District, Soils and Geology Section
Geotechnical Findings Report
Family Housing Replacement – Taku Gardens Resite
Fort Wainwright, Alaska
(FTW251)

U.S. Army Corps of Engineers, Alaska District, Soils and Geology Section
Geotechnical Findings Report
Family Housing Replacement – Taku Gardens Site
Fort Wainwright, Alaska
(FTW283)

Appendix B

Important Information Regarding Your Geotechnical/Environmental Report

GEOTECHNICAL FINDINGS REPORT
REPLACEMENT FAMILY HOUSING – TAKU GARDENS RESITE (FTW251)
FORT WAINWRIGHT, ALASKA

March 2004

1. Introduction

The results of a geotechnical investigation performed for the Replacement Family Housing - Taku Gardens Resite at Fort Wainwright, Alaska are presented in this report.

The purpose of the investigation was to identify surface and subsurface conditions to address geotechnical and environmental concerns. This report presents a summary of the findings based on site observations and results of the field explorations and laboratory testing program.

2. Location and Project Description

The project site is located southeast of the intersection of 9th Street and Neely Road. The project boundary is shown on the enclosed Project Location and Vicinity Map, Figure 1.

The project scope is to construct 100 junior enlisted family housing quarters consisting of single-story and two-story multi-family units with integral garages. Supporting amenities include landscaping, playgrounds, driveways, parking areas, streets, lighting, and below ground utilities.

3. Field Exploration

The subsurface exploration for the project was conducted on 14 November 2003 and 23 January to 14 February 2004. Initially, one boring was drilled in November to obtain preliminary site data, primarily the potential presence of permafrost. This initial boring was drilled to a depth of 15.2 meters. To complete the exploration, 38 borings were drilled in January and February to depths ranging from 4.6 to 15.2 meters. The 39 test borings have been designated AP-8910 and AP-8943 through AP-8980.

One boring (AP-8910 drilled in November) was drilled by the Alaska District's CME 850 drill crew. The remainder of the borings were drilled with a track mounted, Mobile B61 HDX drill rig owned and operated by Tester Drilling Services under contract with the U.S. Army Corps of Engineers, Alaska District (USACE-AD). The drill rigs were fitted with continuous flight, 203-millimeter diameter, hollow-stem auger. Engineers with the Corps supervised the drilling

and logged the test borings in accordance with ASTM D-2488-93, "Description and Identification of Soils (Visual - Manual Procedure)."

The test boring locations were determined using standard survey techniques. DOWL Engineers, under contract with USACE-AD, performed the survey. Horizontal coordinates are based on Alaska State Plane Zone 3, NAD83 (metric). The horizontal control point is USACE Monument "W-3", having a value of Northing 1,206,895.534, and Easting 420,550.111. Elevations are based on NAVD88 datum referencing U.S. Coast and Geodetic Survey monument "W-2" having an elevation of 136.763 meters, Mean Sea Level. The boring locations are shown on the enclosed Test Boring Location Map, Figure 2. This map overlays a recent aerial photograph.

Soil samples generally were procured near the surface, at 0.75 and 1.5 meters below the ground surface, and at 1.5-meter intervals thereafter. Grab samples were taken at the surface with subsequent samples being taken with a 63.5-millimeter inside diameter, split spoon sampler driven with a 154-kilogram hammer falling 760 millimeters operated with a cathead and rope system. The sampler was driven 450 millimeters ahead of the auger. The number of blows required to drive each 150-millimeter increment is recorded on the exploration logs. The blow count is an indication of the relative density or consistency of the soil.

Many of the recovered samples were scanned for volatile organic compounds (VOCs) with a photo ionization detector (PID). The PID readings, in parts per million (ppm), were recorded by a chemist with the Corps and are shown on the exploration logs.

4. Laboratory Testing and Soils Classification

A laboratory testing program was established to classify and determine physical properties of the soils encountered. The testing program consisted of a total of 50 moisture content tests, 95 sieve analyses, and 40 frost classification tests. The tests were performed in accordance with the latest edition of the following methods.

- ASTM D 422, "Standard Test Method for Particle Size Analysis of Soils".
- ASTM D 2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass".
- ASTM D 2487, "Standard Practice for Classification of Soils for Engineering Purposes (Uniform Soil Classification System)".

- TM 5-822-5, "Pavement Design for Roads Streets, Walks, and Open Storage Areas" (frost classification).

The soil descriptions and classifications contained in this report and presented on the final exploration logs are the project engineer's interpretation of the field logs and results of the laboratory testing program. The stratification lines represent approximate boundaries between soil types; the transitions are often gradual or not discernible by drill action. The exploration logs are enclosed as Appendix A and grain-size distribution curves and laboratory test results are enclosed as Appendix B.

In addition to field screening of the soils with a PID, soil from the samples was also collected for further environmental contamination testing. The results of the environmental testing are presented separately in a chemical data report prepared by the Alaska District's Materials Section.

5. Regional Geology

General: Fort Wainwright is located adjacent to Fairbanks, to the south and east, in the Tanana-Kuskokwim Lowland section of the Western Alaska province of the Intermontane Plateaus. The post is situated in the Tanana River valley on the broad essentially level flood plain of the Tanana and Chena Rivers. The Tanana River valley is a large structural basin bordered by the Yukon-Tanana Upland (Birch Hills locally) on the north and the rugged Alaska Range on the south.

Throughout Quaternary time (Pleistocene and Holocene), cycles of deposition and erosion occurred in the Tanana basin as a result of climatic changes. Deposition occurred during times of glacial advance and erosion during times of glacial recession. As a result, the basin aggraded with alluvial deposits (fluvial and glaciofluvial) of gravel, sand and silt. These deposits extend to a rugged bedrock floor and range from a few millimeters in thickness near Birch Hills to in excess of 180 meters near the Tanana River. The near-surface alluvial deposits are probably of Holocene age while the deeper deposits are primarily of Pleistocene age. These deposits were formed during the aggradation of the basin by the Tanana River and its southern, glacier-fed tributaries from the Alaska Range. This aggradation, migrating northward, effectively pushed the Tanana River against and near the Yukon-Tanana Upland. Consequently, the aggradation toward the north side of the Tanana River basin forced the streams draining the uplands north of the Chena River to aggrade their lower valleys. As this aggradation continued, the upland streams formed coalescing alluvial fans that overlapped and inter-bedded the Tanana alluvium with silt and organic-rich sediments.

During the periods of glacial advance, vast amounts of silt and silty fine sand were wind borne from the flood plain and deposited as a blanket of loess on

the upland ridges. This blanket ranges from a few millimeters in thickness on ridge summits to more than 45 meters on lower and mid slopes. Some of these fines have since been re-transported both by wind and fluvial processes to the creek bottoms and the basin floor. Currently, in areas not subject to erosion, a mantle of silt or silty sand overlies the alluvial deposits of the basin to depths ranging from about one to five meters in the Fort Wainwright area.

The Fairbanks and Fort Wainwright area is in the discontinuous permafrost zone of Alaska. The presence of permafrost is widespread throughout this area although its nature and occurrence varies. Where present, it is frequently encountered well below the seasonal thaw zone to depths reported to 75 meters in the Fairbanks area. It also frequently occurs in multiple layers of varying thickness separated by unfrozen zones known as taliks. Ice content varies little in the alluvial sands and gravels. It generally exists as inclusions in the interstitial soil voids and cements the soil particles to one another. Large ice masses are uncommon in these coarse alluvial sediments. The ice content in the surficial silts and silty sands is generally much higher than that of the alluvium and frequently forms into ice lenses that can grow to tens of millimeters in thickness. Since the early 1900's, degradation of permafrost in the area has occurred as a result of removing the vegetative cover generally by land development and fire. Pewe and Reger report these disturbances have increased the depth to permafrost by seven to 12 meters.

Area Hydrogeology: Groundwater generally flows in a west-northwestward direction in the Fairbanks and Fort Wainwright area, similar to the flow direction of the Chena and Tanana Rivers. However, permafrost bodies and streams do influence flow direction on a local basis. The groundwater table is generally encountered by a depth of three to six meters below the ground surface. The Tanana basin alluvium is the aquifer of the area and it is considered to be unconfined in permafrost-free areas. Groundwater in wells drilled through permafrost typically exhibit, by definition, the characteristic of a confined aquifer in that it rises to levels above the bottom of the confining layer (permafrost). These levels are similar to those of wells drilled in unfrozen alluvium that suggests the basin alluvium is a single unit aquifer. As discussed above, the extent of the alluvium deposit is vast. This results in enormous water storage capacity. Cederstrom, through well tests, showed that transmissivity of the alluvium to be several hundred thousand liters per day per meter.

Seismicity: Fort Wainwright is located in a seismic locale where great damage can occur in the event of a major earthquake. These structures should be designed according to the International Building Code (IBC) 2000.

As a minimum, the in-situ mineral soils at the planned site and compacted, classified material used for engineered fills both have the characteristics of Site Class D soils as defined in the IBC. It would be appropriate to develop the

response spectra for seismic analysis of the proposed structures using Site Class D. However, it will also be necessary to evaluate the liquefaction potential of the site and address the potential for settlement and/or loss of bearing capacity during a seismic event as part of the foundation design for structures. More detailed seismic information for conditions at Fort Wainwright can be obtained in "Final Report – Geologic Evaluation of Fort Wainwright, Alaska" prepared by Geomatrix Consultants dated June 1997.

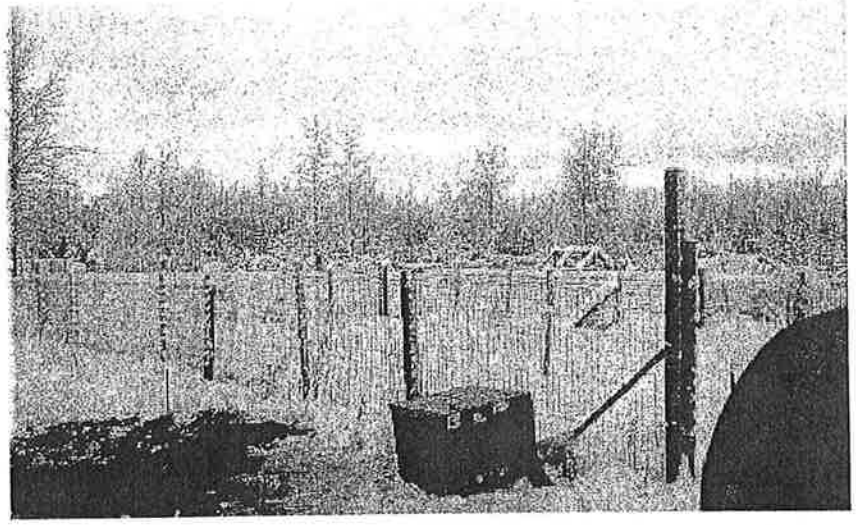
6. Site Conditions

Surface:

The site is generally flat with little vertical relief. Ground elevations are generally near 136 meters. An east-west oriented, overhead power line and a parallel underground communication line bisect the site. There are several trails that pass through the site. The north portion of the site is cleared and used as a snow storage area. The southwest corner has been used as a community garden and is traversed with numerous fences. The community garden is shown on photograph 1 below. An electrical substation owned by Golden Valley Electric Association extends into the southeast corner of the site. The remainder of the site is vegetated with a dense cover of second or third growth alder, aspen, scattered spruce and birch to about 150 millimeters in diameter. Some individual trees, however, have diameters to 500 millimeters. Photograph 2 below shows the dense, wooded area.

Subsurface:

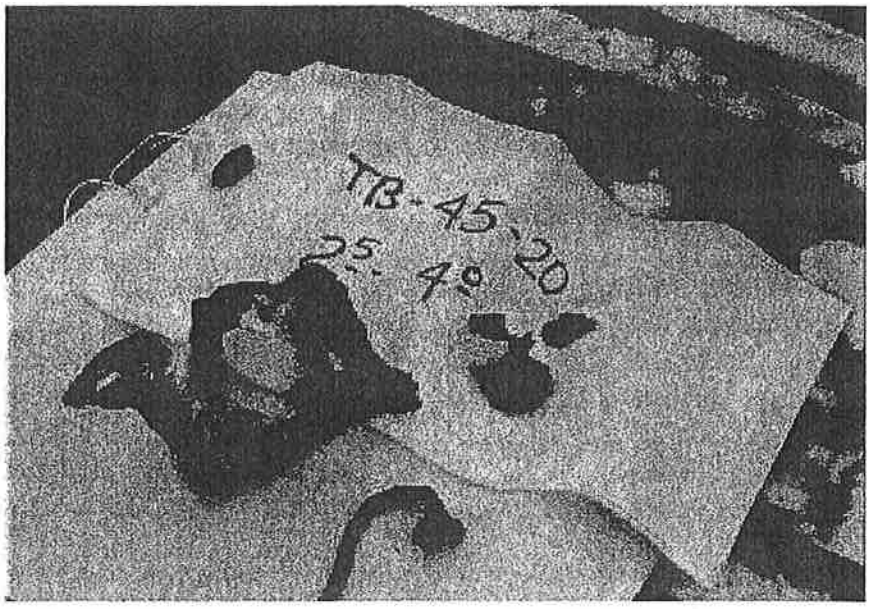
This site has a history of past activities that include the presence of buildings, parking areas, and military equipment storage. An overlay of the site with the test boring locations on a 1956 aerial photograph is included as Figure 3. As expected from past land use and construction activities, the test borings indicate the presence of fill, backfill, and disturbed native soils. Where such soils are suspected they have been annotated on the exploration logs as fill. It was not always possible to differentiate between disturbed soils and native in-situ material due to similarity. Consequently, fill, backfill, and disturbed soils may have been encountered in a boring, but not annotated. It should be noted that AP-8960 encountered fill with metal debris to a depth of about 2.5 meters. Photograph 3 shows some of the debris removed from the cuttings of that boring. Other borings where fill was identified include AP-8943, AP-8950, AP-8951, AP-8969, AP-8971, AP-8976 and AP-8980



Photograph 1 - Northwestward view across the community garden area located in the southwest corner of the site.

Photograph 2 - Drilling operation in the dense, wooded portion of the site.

Other areas with buried debris could be present on the site. When the drilling was performed the site was snow covered and surficial debris generally was not visible. A 55-gallon drum was observed near the northwest corner of the substation. As a precaution, one boring (AP-8980) to a depth of 4.6 meters was drilled at the drum location and chemical sampling was performed. The results of the additional chemical testing will be included in the Chemical Data Report.



Photograph 3 - Debris recovered in cuttings from AP-8960.

These surficial soils generally consist of silt (ML) and silty sand (SM) with some occurrences of silty gravel (GM). These soils were present from the surface to a depth up to four meters. These soils predominately classify as frost susceptible (F4 to F1). Blow counts indicate the fine-grain soils have a very soft to stiff consistency and the granular soils to be loose to medium dense.

The soils beneath the surficial soils generally consist of brown to gray, moist to wet, poorly and well-graded alluvial sands and gravels (SP, SW, GP, GW). These soils predominantly classify as possibly frost susceptible (PFS) to non-frost susceptible (NFS) to the depth of exploration. At some boring locations a transitional layer of poorly graded sand with silt (SP-SM) separates the two soil zones. Boring AP-8948 encountered a stratum of poorly graded sand (SP) from 3.7 to 6.7 meters depth that contained substantial amounts of tree fragments and wood. Tree fragments and wood are often encountered in these alluvial deposits, but the volume recovered in these samples was unusually high. Although no cobbles were encountered, the presence of cobbles is possible based on the geological origins of the site material. Blow counts indicate these soils be in a loose to medium dense state both above and below the groundwater water table.

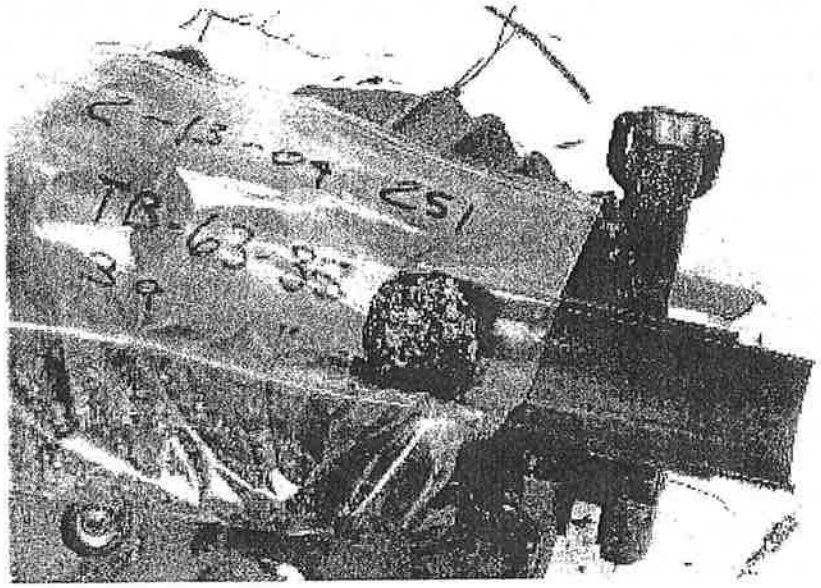
Groundwater was encountered in all test borings except where permafrost was encountered at a shallow depth. The groundwater table was encountered at depths ranging from 3.5 to 5.7 meters while drilling. These while drilling levels are recorded on the exploration logs. Piezometers were installed in five test

borings. The piezometers allow the groundwater levels to stabilize after drilling so that relatively accurate measurements may be obtained at later dates. The observations made to date are presented in Table 1. The groundwater levels fluctuate seasonally and with changes in precipitation and run-off conditions. The groundwater elevation may be at an annual low during the period when these water level measurements were taken.

TABLE 1 - GROUNDWATER LEVELS

Test Boring	While Drilling Elevation (meters)	Piezometric Elevation (meters)	Date
AP-8955-P	131.84	132.20	16 February 2004
AP-8957-P	132.38	132.38	16 February 2004
AP-8963-P	131.45	132.19	16 February 2004
AP-8967-P	132.55	132.52	16 February 2004
AP-8976-P	132.52	132.58	16 February 2004

Seasonal frost was encountered up to a depth of two meters at the time of the exploration. Well-bonded permafrost with no excess moisture (Nbn) and some small visible ice crystals (Vx) was encountered from near the ground surface to the depth of exploration in AP-8978 and AP-8979 and at depth in AP-8977. Permafrost was not encountered in any of the other borings drilled at the site.



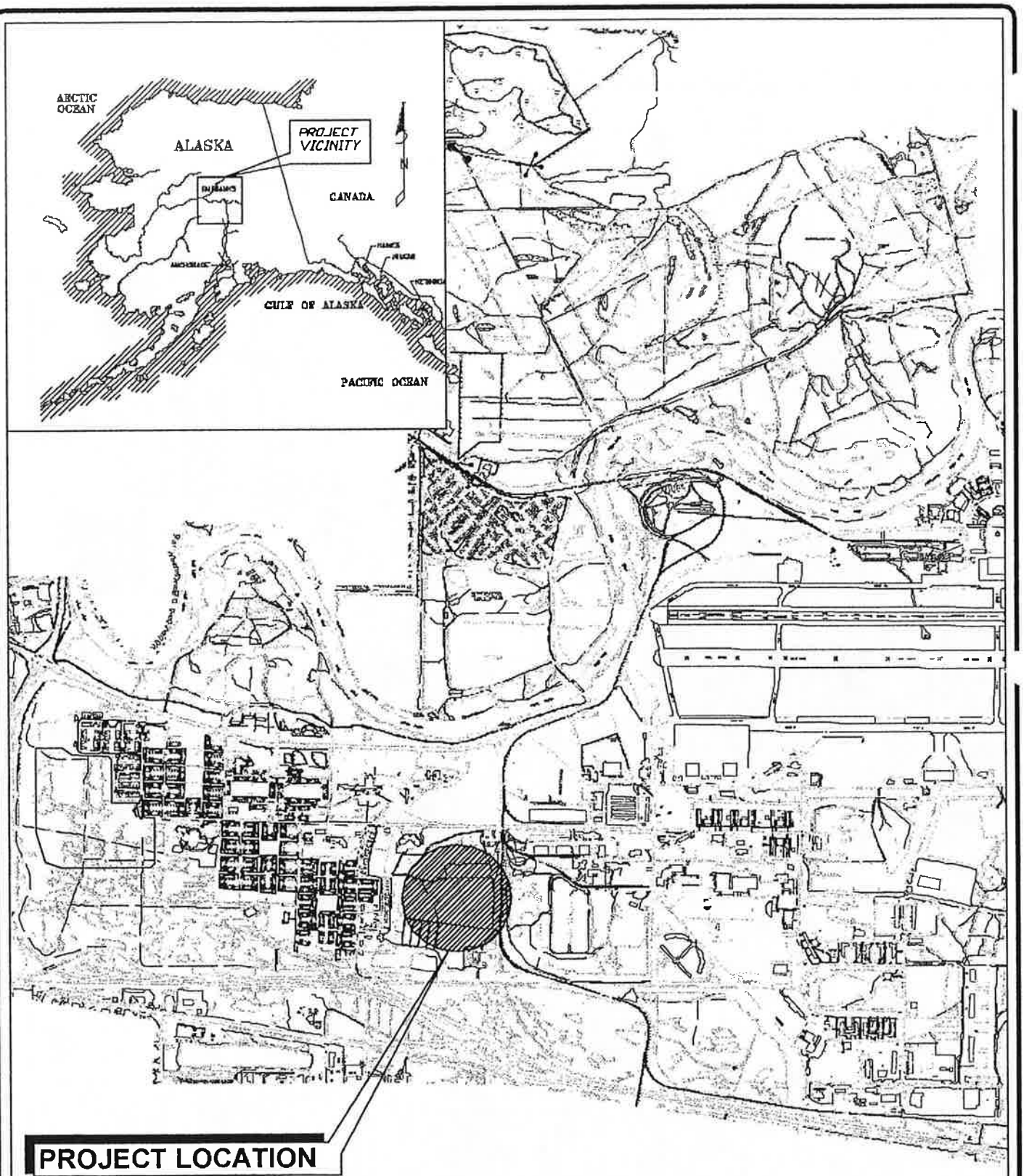
Photograph 4 - Ice crystals as seen in permafrost samples from AP-8978 at a depth of 11.9 meters.

The recorded PID readings were all less than six ppm. These readings are recorded on the exploration logs. However, not all samples were screened with

the PID due to short-term equipment problems.

Enclosures:

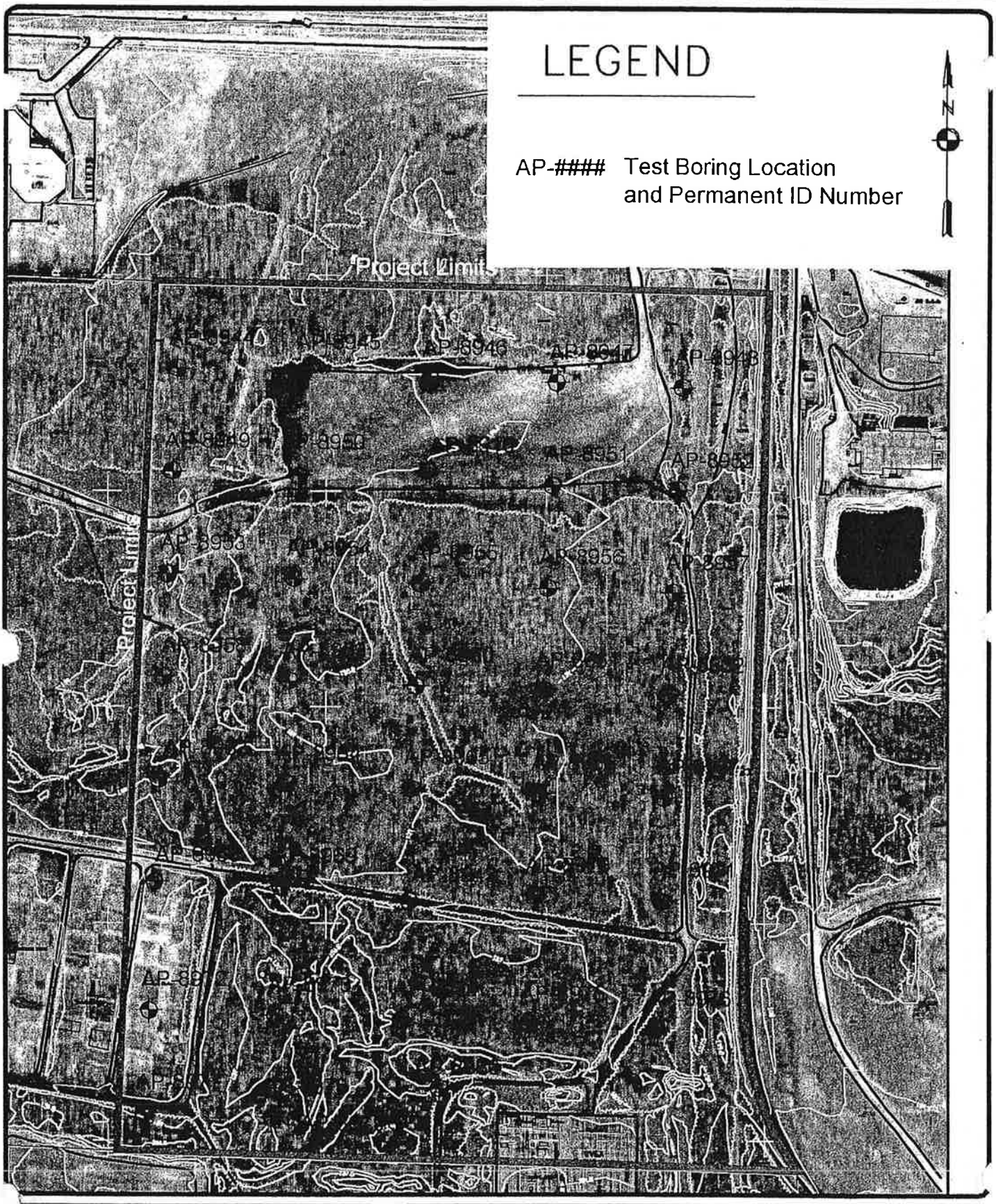
1. Figure 1 - Project Location and Vicinity Map
2. Figure 2 - Test Boring Location Map (Recent Aerial Photograph)
3. Figure 3 - Test Boring Location Map (1956 Aerial Photograph)
4. Appendix A - Test Boring Logs
5. Appendix B - Laboratory Results for Selected Soil Samples



ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

PROJECT LOCATION AND VICINITY MAP
FAMILY HOUSING REPLACEMENT
TAKU GARDENS RESITE (FTW251)
FORT WAINWRIGHT, ALASKA

SCALE: NTS
DATE: March 2004
DRAWN/RVW: MDP/CRW
FIGURE 1

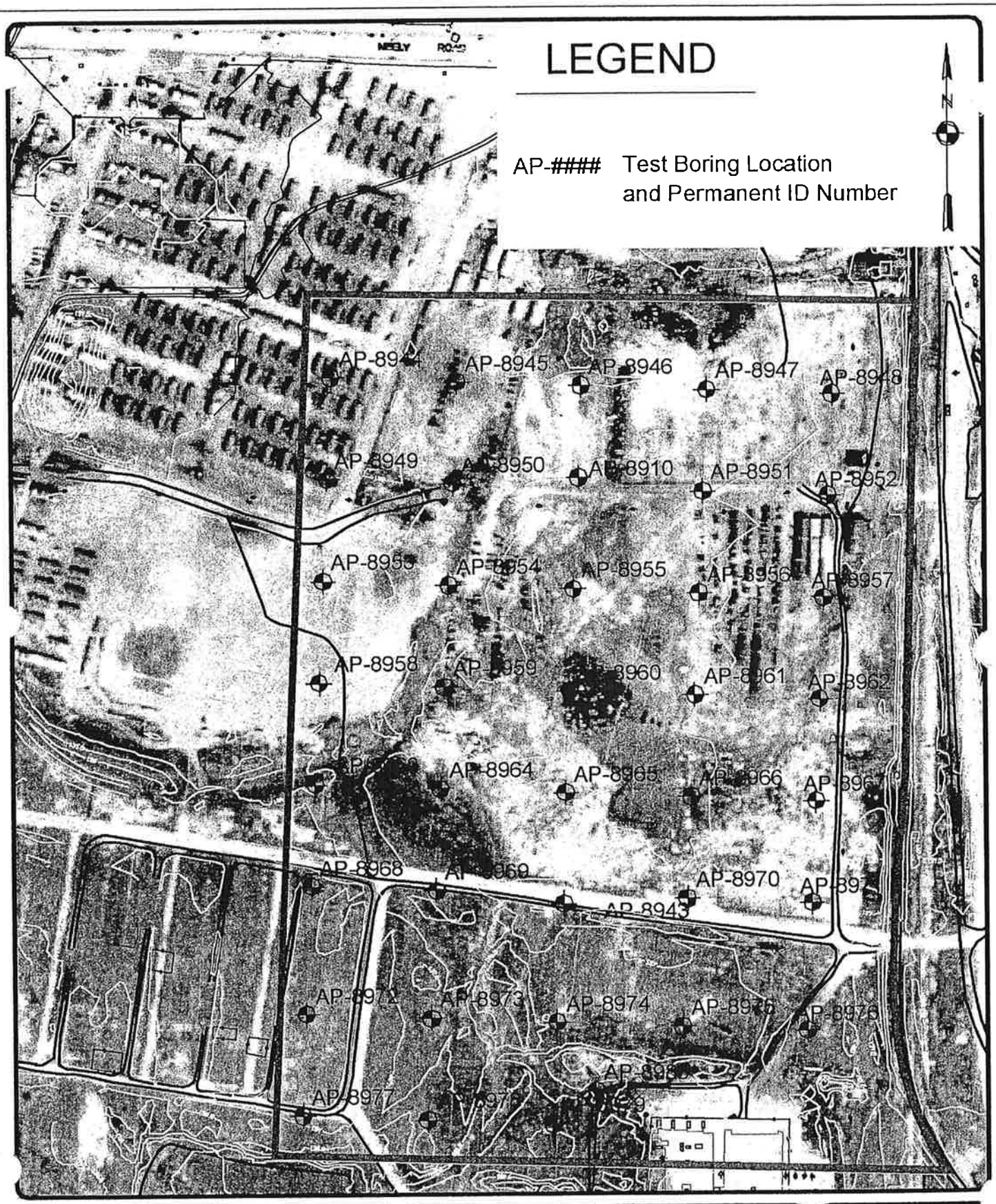


ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

TEST BORING LOCATION MAP
FAMILY HOUSING REPLACEMENT
TAKU GARDENS RESITE (FTW251)
FORT WAINWRIGHT, ALASKA

SCALE:	1 : 3000
DATE:	March 2004
DRAWN/RVW:	RTW/CRW

FIGURE 2



ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

TEST BORING LOCATION MAP
FAMILY HOUSING REPLACEMENT
TAKU GARDENS RESITE (FTW251)
1956 AERIAL PHOTOGRAPH
FORT WAINWRIGHT, ALASKA

SCALE: 1 : 3000
DATE: March 2004
DRAWN/RVW: RTW/CRW
FIGURE 3

Appendix A

Test Boring Logs

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 14 Nov 2003

Drilling Agency: ☐ Alaska District ☒ Other USACE

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 367,851 m Easting: 128,340 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-19 Permanent: AP-8910

Operator: Ronnie Ngirailild

Inspector: Robert Weakland, Cynthia Turenne

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.7 m WD

Depth Drilled: 15.2 m

Total Depth: 15.2 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: CME 850 w/ Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1		F3		SM	Silty SAND					-/ 1.2		Surface: Spruce, Aspen, and Birch (up to 100 millimeters in diameter), 150 millimeters of snow Brown, frozen, fine sand, nonplastic (NP) fines
1		2		NFS	4 5 4	SP	Poorly graded SAND					-/ 1.7		Brown to tan, moist, fine to medium sand
		3		NFS	3 3 3	SP	Poorly graded SAND					-/ 1.0		Brown to tan, moist, fine to medium sand
2														
3		4		NFS	3 3 4	SP	Poorly graded SAND				38	-/ 0.9		Brown to tan, moist, angular to subangular gravel, fine to coarse sand
4														
		5		NFS	6 6 7	SW	Well-graded SAND with Gravel				>76	-/ 0.8		Brown, wet, angular gravel, fine to coarse sand, gravel and cobble fractured while driving
5														
6		6			12 12 11	GW	Well-graded GRAVEL with Sand				64	-/ 0.5		Brown, wet, angular to subangular gravel, fine to coarse sand
7														
		7			6 8 6	GW	Well-graded GRAVEL with Sand				51	-/ 1.1		Gray, wet, subangular to subrounded gravel, fine to coarse sand, NP fines, 6 meters of heaving sand
8														
9		8			8 14 13	GW-GM	Well-graded GRAVEL with Silt and Sand				64	-/ 1.1		Gray, wet, angular to subrounded gravel, fine to coarse sand
10														

EXPLORATION LOG FTW25 ...\U RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 14 Nov 2003

Drilling Agency: ☐ Alaska District ☒ Other USACE

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 367,851 m Easting: 128,340 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-19 Permanent: AP-8910

Operator: Ronnie Ngirailild

Inspector: Robert Weakland, Cynthia Turenne

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.7 m WD

Depth Drilled: 15.2 m

Total Depth: 15.2 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: CME 850 w/ Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Spruce, Aspen, and Birch (up to 100 millimeters in diameter), 150 millimeters of snow
														2.5 meters of heaving sand
11		9			10 13 11	NR	No Recovery							75 millimeters of heave in sampler
12		10			13 24 21	NR	No Recovery							100 millimeters of heave in sampler
13														
14														
15														
														Bottom of Hole 15.2 m Elevation 121.5 m Groundwater Encountered While Drilling: at an elevation of 133.0 m PID = (Cold Hot) Photo Ionization Detector
16														
17														
18														
19														
20														

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 8 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,636 m Easting: 421,047 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-20

Permanent: AP-8943

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Second growth trees to 150 millimeters, 480 millimeters of snow)
0		1	Non	F2	Grab	SM	Silty SAND with Gravel				13	-/ 0.9		Brown, frozen, rounded gravel, fine to medium sand, nonplastic (NP) fines, FILL.
1		2	Non	F3	19 19 15	SM	Silty SAND					-/ 0.5		Tan, frozen, fine sand, NP fines, FILL.
		3	Non	F4	10 10 7	ML	Sandy SILT		38	62		-/ 0.4	11	Tan, frozen, fine sand, NP fines, FILL.
2														
3		4a		F4	2	ML	SILT with Sand	12	16	72	25	-/ 0.4		Dark brown, moist, fine sand, NP fines
		4b		NFS	7 8	SP	Poorly graded SAND with Gravel							Gray, moist, rounded gravel, fine to medium sand
4														
		5		PFS	3 8 9	GP	Poorly graded GRAVEL with Sand				25			Brown, moist, rounded gravel, fine to medium sand
5														
6		6			4 6 9	SP	Poorly graded SAND with Gravel				32			Gray, wet, subrounded to rounded gravel, fine to medium sand
7		7			2 6 7	SP	Poorly graded SAND				13			Gray, wet, rounded gravel, fine to medium sand
8														
9		8			5 5 3	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
10														

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Project: Family Housing Replacement, Taku Gardens Resite

Hole Number: AP-8943

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 8 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,636 m Easting: 421,047 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-20

Permanent: AP-8943

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth trees to 150 millimeters, 480 millimeters of snow
11														
12		9			3 8 8	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, rounded gravel, medium to coarse sand
13														
14														
15		10			35 5020 mm	GP	Poorly graded GRAVEL with Sand				>76			Gray, wet, subrounded to rounded gravel, medium to coarse sand
16														Bottom of Hole 15.4 m Elevation 121.5 m Groundwater Encountered While Drilling: at an elevation of 132.2 m PID = (ColdHot) Photo Ionization Detector
17														
18														
19														
20														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 27 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,956 m Easting: 420,917 m

Top of Hole Elevation: 136.1 m

Hole Number, Field: TB-29

Permanent: AP-8944

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.4 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Aspen to 100 millimeters)
0		1	Non	F4	Grab	ML	SILT					-/ 0.9		Dark brown, frozen, fine sand (micaceous), nonplastic (NP) fines, TOPSOIL
1		2		F4	3 5 7	ML	SILT with Sand		25	75		-/ 0.3	8	Yellowish-tan, moist, fine sand, NP fines
2		3		F4	3 4 4	ML	SILT					-/ 0.3		Tan and gray, moist, fine sand, NP fines
3		4		NFS	2 2 2	SP	Poorly graded SAND		97	3		-/ 0.2	4	Tan, moist, fine to medium sand
4		5			6 7 11	SP	Poorly graded SAND with Gravel	45	52	3	25		12	Gray, wet, subrounded gravel, fine to medium sand
5														
6		6			3 6 9	GW	Well-graded GRAVEL				51			Dark gray, wet, subrounded gravel, fine to coarse sand
7		7			12 7 4	GP	Poorly graded GRAVEL				38			Dark gray, wet, subrounded gravel, fine to medium sand
8														Bottom of Hole 7.9 m Elevation 128.2 m Groundwater Encountered While Drilling: at an elevation of 131.7 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 27 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,954 m Easting: 420,990 m

Top of Hole Elevation: 135.8 m

Hole Number, Field: TB-30 Permanent: AP-8945

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.7 m WD

Depth Drilled: 10.7 m

Total Depth: 10.7 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Aspen to 100 millimeters, snow
		1		F4	Grab	ML	SILT				6	-/ 0.5		Tan, frozen, subangular gravel, fine to coarse sand, nonplastic (NP) fines
1		2		F4	2 2 2	ML	SILT	0	34	66		-/ 0.4	12	Tan, frozen, fine sand, NP fines, interbedded layers 75 millimeters
		3		S2	2 3 2	SM	Silty SAND	0	84	16		-/ 0.3	5	Tan, frozen, fine to medium sand
2														
3		4		NFS	1 3 3	SP	Poorly graded SAND	0	95	5		-/ 0.5	8	Light brown, moist, medium sand
4														
		5		NFS	8 11 8	SW	Well-graded SAND				57			Gray, wet, rounded gravel, fine to coarse sand
5														
6		6			5 8 8	GP	Poorly graded GRAVEL				51			Gray, wet, fine to coarse sand
7														
		7			3 5 6	GW	Well-graded GRAVEL				51			Dark gray, wet, rounded gravel, fine to coarse sand
8														
9		8			3 4 5	SW	Well-graded SAND				25			Dark gray, wet, rounded gravel, fine to coarse sand
10														

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EXPLORATION LOG

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 27 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,954 m Easting: 420,990 m

Top of Hole Elevation: 135.8 m

Hole Number, Field: TB-30 Permanent: AP-8945

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.7 m WD

Depth Drilled: 10.7 m

Total Depth: 10.7 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Aspen to 100 millimeters, snow
11														Augers plugged, unable to lower spoon Bottom of Hole 10.7 m Elevation 125.2 m Groundwater Encountered While Drilling: at an elevation of 132.1 m PID = (Cold/Hot) Photo Ionization Detector
12														
13														
14														
15														
16														
17														
18														
19														
20														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 25 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,952 m Easting: 421,061 m

Top of Hole Elevation: 136.5 m

Hole Number, Field: TB-31

Permanent: AP-8946

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.3 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Open area for snow disposal
0		1	Non	F4		ML	Sandy SILT							Dark brown, frozen, fine sand (micaceous), moderately plastic fines
1		2	Non	F4	15 23 21	ML	SILT with Sand		20	80		-/ 0.7	11	Tan, frozen, fine sand, nonplastic (NP) fines (micaceous) interbedded
		3		F4	6 7 4	ML	Sandy SILT		40	60		-/ 1.2	6	Yellowish tan, frozen (?), loose, fine sand, NP fines
2														
3		4			2 3 3	SM	Silty SAND		84	16		-/ 0.3	9	Yellowish tan, moist, fine sand
4														▼
5		5			1 3 2	SP-SM	Poorly graded SAND with Silt							Dark gray, wet at 4.65 meters, fine sand (micaceous), NP fines
6		6			5 9 6	GW	Well-graded GRAVEL with Sand				70			Gray, wet, subrounded gravel, fine to coarse sand
7														
		7			3 7 13	GW	Well-graded GRAVEL with Sand				44			Gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 128.5 m Groundwater Encountered While Drilling: at an elevation of 132.2 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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Project: Family Housing Replacement, Taku Gardens Resite

Hole Number: AP-8946

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 26 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,953 m Easting: 421,138 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-32

Permanent: AP-8947

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Open area for snow dumping
0		1	Non	F4		SM	Silty SAND					-/ 1.3		Brown, frozen, fine sand, nonplastic (NP) fines
1		2	Non	F4	24 22 16	ML	SILT with Sand					-/ 0.5		Gray and orange, frozen, fine sand, NP fines
		3		F4	4 3 3	ML	Sandy SILT		41	59		-/ 0.1	9	Tan, frozen, fine sand, NP fines
2														
3		4		F4	2 1 1	ML	SILT			100		-/ 0.1	40	Greenish gray, moist, plastic fines
4														
		5			1 4 4	SP-SM	Poorly graded SAND with Silt							Black, moist, fine sand, NP fines, 50 mm coarse wood
5														
6		6			3 6 9	SP	Poorly graded SAND with Gravel							Black, wet, subrounded gravel, fine to medium sand
7		7			11 14 12	GW	Well-graded GRAVEL with Sand							Dark gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 128.8 m Groundwater Encountered While Drilling: at an elevation of 132.0 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 5 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,939 m Easting: 421,200 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-33

Permanent: AP-8948

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth trees to 300 millimeters, 480 millimeters of snow
0	1	Non	F4	Grab	ML	SILT with Sand					-/ 0.6		Brown, frozen, fine sand, nonplastic (NP) fines
1	2	Non	F4	12 10 6	ML	SILT with Sand	1	21	78		-/ 0.8	7	Brown, frozen, fine sand, NP fines
	3		NFS	2 3 3	SP	Poorly graded SAND					-/ 0.4		Brown, moist, fine to medium sand, NP fines
2													
3	4		F4	1 3 3	ML	Sandy SILT		47	53		-/ 1.4	16	Brown, moist, fine to medium sand
4	5		NFS	2 4 3	SP	Poorly graded SAND							Brown, moist, fine to medium sand, estimate 50% organics by volume
5													
6	6			4 4 6	SP	Poorly graded SAND							Gray, wet, fine to medium sand, estimate 25% organics
7	7			3 5 5	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, rounded gravel, fine to coarse sand
8													
9	8			4 6 10	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine to coarse sand
10													

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 5 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,939 m Easting: 421,200 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-33 Permanent: AP-8948

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth trees to 300 millimeters, 480 millimeters of snow
11														
12		9			7 9 7	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to coarse sand
13														
14														
15		10			4 9 12	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to coarse sand
16														Bottom of Hole 15.4 m Elevation 121.6 m Groundwater Encountered While Drilling: at an elevation of 131.3 m PID = (Cold-Hot) Photo Ionization Detector
17														
18														
19														
20														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 24 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,887 m Easting: 420,912 m

Top of Hole Elevation: 136.0 m

Hole Number, Field: TB-34

Permanent: AP-8949

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.4 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4		ML	Sandy SILT					-/ 3.3		Second growth Aspens to 75 millimeters, snow Yellowish tan, frozen, subrounded gravel, fine sand, nonplastic (NP) fines
1		2	Non	PFS	17 17 15	GP-GM	Poorly graded GRAVEL with Silt and Sand				25	-/ 3.2		Tan, frozen (loose), subrounded gravel, fine to coarse sand
		3		PFS	8 7 6	GP-GM	Poorly graded GRAVEL with Silt and Sand	59	34	7	38	-/ 3.3	3	Tan, frozen (loose), subrounded gravel, fine to coarse sand
2														
3		4		NFS	2 4 8	SP	Poorly graded SAND with Gravel	28	69	3	38		6	Gray, moist, subrounded gravel, medium sand
4														
		5		NFS	8 16 12	SP	Poorly graded SAND with Gravel	44	52	4	8		12	Gray, wet, subrounded gravel, medium sand
5														
6		6			2 1 2	SP	Poorly graded SAND				6			Gray, wet, medium sand
7														
		7			2 2 2	SP	Poorly graded SAND							Gray, wet, medium sand
8														Bottom of Hole 7.9 m Elevation 128.1 m Groundwater Encountered While Drilling: at an elevation of 131.7 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 23 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,884 m Easting: 420,979 m

Top of Hole Elevation: 135.9 m

Hole Number, Field: TB-35

Permanent: AP-8950

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NR

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F2		SM	Silty SAND							Second growth Aspen, snow Brown, frozen, fine to medium sand, nonplastic (NP) fines, possibly FILL
1		2	Non	F4	14 15 14	ML	Sandy SILT	0	32	68			14	Yellowish tan, frozen, fine sand (and silty sand interbedded) NP fines
		3	Non	F4	3 2 2	ML	Sandy SILT							Yellowish tan, frozen, fine sand, NP fines
2														
3		4		F4	1 2 1	ML	Sandy SILT							Brownish orange, moist, fine sand, NP fines
4														
5		5		PFS	3 4 3	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine to coarse sand
6		6			2 3 4	SW	Well-graded SAND with Gravel				6			Gray, wet, rounded gravel, fine to coarse sand
7		7			3 12 8	SW	Well-graded SAND with Gravel				51			Gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 128.0 m Groundwater Not Recorded PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 26 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,862 m Easting: 421,156 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-36

Permanent: AP-8951

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.5 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F1		GM	Silty GRAVEL with Sand				9	-/ 1.2		Brown, frozen, subrounded gravel, fine to coarse sand, nonplastic (NP) fines, possibly FILL
1		2	Non	F2	4 3 3	SM	Silty SAND					-/ 1.2		Tan, frozen (loose), fine to medium sand, NP fines, possibly FILL
		3		F4	3 2 3	ML	Sandy SILT					-/ 0.6		Yellowish tan, frozen, fine sand, NP fines
2														
3		4			3 5 10	SP	Poorly graded SAND	2	95	3		-/ 1.3	3	Gray, moist, medium sand
4														
		5			5 5 8	SW	Well-graded SAND with Gravel				51			Gray, moist to wet at 4.65 meters, rounded gravel, fine to coarse sand
5														
6		6			8 5 7	SP	Poorly graded SAND with Gravel	46	52	2	57		11	Gray, wet, subrounded gravel, fine to coarse sand
7		7			7 11 11	GW	Well-graded GRAVEL with Sand				64			Gray, wet, rounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 128.8 m Groundwater Encountered While Drilling: at an elevation of 132.3 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 26 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,878 m Easting: 421,201 m

Top of Hole Elevation: 137.3 m

Hole Number, Field: TB-37

Permanent: AP-8952

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.2 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Second growth Aspen to 150 millimeters)
0		1	Non	F2		SM	Silty SAND				6	-/ 0.2		Yellowish tan, frozen, subrounded gravel, fine to coarse sand, nonplastic (NP) fines
1		2	Non	F4	3 6 8	SM	Silty SAND					-/ 0.1		Yellow, frozen, fine sand, NP fines
		3		F4	4 4 6	ML	SILT with Sand		27	73		-/ 0.2	14	Yellowish tan, moist, fine sand, NP fines
2														
3		4			5 9 14	GW	Well-graded GRAVEL with Sand	60	38	2	25	-/ 0.3	1	Tan, moist, rounded gravel, fine to coarse sand
4														
5		5			4 7 7	SP-SM	Poorly graded SAND with Silt and Gravel	40	55	5	25	-/ 0.7	5	Tan, moist, rounded gravel, fine to coarse sand
6		6			14 10 9	GW	Well-graded GRAVEL with Sand				57	-/ 1.1		Brown, wet, rounded gravel, fine to coarse sand
7		7		PFS	9 9 9	GW	Well-graded GRAVEL with Sand				64	-/ 2.3		Dark gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 129.4 m Groundwater Encountered While Drilling: at an elevation of 132.1 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW251 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 25 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,831 m Easting: 420,910 m

Top of Hole Elevation: 135.8 m

Hole Number, Field: TB-38

Permanent: AP-8953

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.5 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth Aspen to 75 millimeters, snow
0		1	Non	F4		ML	SILT					-/ 1.2		Tan, frozen, moderately plastic fines
1		2	Non	F2	3 6 9	SM	Silty SAND	11	48	41	13	-/ 1.1	11	Tan, frozen, subrounded gravel, fine to coarse sand, nonplastic (NP) fines
2		3		NFS	9 12 12	GP-GM	Poorly graded GRAVEL with Silt and Sand	62	33	5	64	-/ 0.3	1	Tan, frozen (loose), subrounded gravel, fine to coarse sand
3		4		NFS	9 14 16	GW	Well-graded GRAVEL with Sand	65	33	2	44	-/ 0.4	2	Tan, moist, subrounded gravel, fine to coarse sand
5		5		NFS	3 6 4	GW	Well-graded GRAVEL with Sand				8			Tan, wet, subrounded gravel, fine to coarse sand
6		6			9 9 10	SP	Poorly graded SAND with Gravel	46	51	3	13		7	Gray, wet, subrounded gravel, fine to coarse sand
7		7			9 11 8	SW	Well-graded SAND with Gravel				8			Gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.9 m Elevation 127.9 m Groundwater Encountered While Drilling: at an elevation of 132.3 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 9 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,825 m Easting: 420,982 m

Top of Hole Elevation: 136.0 m

Hole Number, Field:	Permanent:	Operator:	Inspector:
TB-39	AP-8954	Lincoln Trigg	Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.0 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight:	Split Spoon I.D.:	Size and Type of Bit:	Type of Equipment:	Type of Samples:
154 kg	64 mm	203 mm HSA	Mobile B61 HDX w/Cathead & Rope	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Second growth trees to 200 millimeters, 480 millimeters of snow cover
0		1	Non	F4	Grab	ML	SILT					-/ 0.6		Brown, frozen, nonplastic (NP) fines
1		2		NFS	5 3 3	SP	Poorly graded SAND					-/ 0.4		Tan, moist, fine sand
		3		F4	2 4 3	ML	Sandy SILT		42	58		-/ 0.5	4	Brown, moist, fine sand
2														
3		4a		S2	3 6	SM	Silty SAND	1	72	27		-/ 0.4	28	Brown, moist, fine sand, NP fines
		4b		NFS	5	GP	Poorly graded GRAVEL with Sand	49	48	3	13		8	Red, moist, rounded gravel, medium to coarse sand
4													▼	
		5		NFS	2 6 6	SP	Poorly graded SAND with Gravel	35	62	3	25		16	Gray, wet, rounded gravel, fine sand
5														
6		6			2 2 3	GP	Poorly graded GRAVEL with Sand	52	47	1	19		13	Gray, wet, rounded gravel, fine to medium sand
7		7			4 3 4	SP	Poorly graded SAND with Gravel				25			Gray, wet, rounded gravel, fine to medium sand
8														Bottom of Hole 7.9 m Elevation 128.1 m Groundwater Encountered While Drilling: at an elevation of 132.0 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW251 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 9 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,825 m Easting: 421,054 m

Top of Hole Elevation: 136.5 m

Hole Number, Field: TB-40

Permanent: AP-8955P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Nfrn	F2	Grab	SM	Silty SAND					-/ 0.2		Brown, frozen, fine sand, nonplastic (NP) fines; Second growth trees to 180 millimeters, 510 millimeters of snow cover
1		2		NFS	4 2 2	SP-SM	Poorly graded SAND with Silt	1	94	5		-/ 0.2	2	Tan, moist, fine to medium sand
		3		NFS	2 2 2	SP	Poorly graded SAND					-/ 0.5		Tan, moist, fine to medium sand
3		4		NFS	3 2 2	SP	Poorly graded SAND					-/ 0.7		Tan, moist, fine to medium sand
4		5		NFS	1 5 3	SP	Poorly graded SAND with Gravel				25			Gray, wet, rounded gravel, fine to coarse sand
6		6			2 4 4	GP	Poorly graded GRAVEL with Sand				19			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			2 4 6	GP	Poorly graded GRAVEL with Sand				51			Gray, wet, subrounded to rounded gravel, coarse sand
8														Bottom of Hole 7.8 m Elevation 128.8 m Groundwater Encountered While Drilling: at an elevation of 131.8 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 11 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,822 m Easting: 421,124 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-41

Permanent: AP-8956

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 0.3		Second growth trees to 150 millimeters, 480 millimeters of snow cover Black to brown, frozen, fine sand, nonplastic (NP) fines, estimate 10% organics by volume
1		2		NFS	3 4 3	SP	Poorly graded SAND					-/ 0.5		Tan, moist, fine sand
		3		NFS	2 2 2	SP	Poorly graded SAND					-/ 0.4		Tan, moist, fine sand, 50 millimeters of silty sand at 1.5 meters
2														
3		4		NFS	3 4 5	SP	Poorly graded SAND with Gravel	41	56	3		-/ 0.8	2	Brown, moist, rounded gravel, fine to medium sand
4														
		5			3 4 5	SP	Poorly graded SAND with Gravel							Brown, wet, rounded gravel, fine to medium sand
5														
6		6			3 4 3	GP	Poorly graded GRAVEL with Sand	65	33	2	25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			11 15 10	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 129.0 m Groundwater Encountered While Drilling: at an elevation of 132.1 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW251 TAKU RESITE.GPJ ACE ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 2 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,820 m Easting: 421,194 m

Top of Hole Elevation: 137.2 m

Hole Number, Field: TB-42

Permanent: AP-8957P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.8 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 2.5		Brown, frozen, fine sand, nonplastic (NP) fines; Second growth trees to 75 millimeters, 500 millimeters of snow cover
1		2		F4	3 5 6	ML	Sandy SILT	1	33	66		-/ 0.6	11	Brown, moist, fine sand, NP fines
		3a		F4	4 6 6	ML	Sandy SILT	1	46	53		-/ 0.9	12	Brown, moist, fine sand, NP fines
		3b		NFS	6	SP	Poorly graded SAND							Tan, moist, fine to medium sand
2														
3		4		NFS	6 12 12	GW	Well-graded GRAVEL with Sand	60	37	3	51		4	Brown, moist, subrounded to rounded gravel, fine to medium sand
4														
5		5		NFS	3 3 3	SP	Poorly graded SAND					-/ 0.8		Brown, moist, fine to medium sand
6		6			6 11 10	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to medium sand
7		7			12 6 4	GP	Poorly graded GRAVEL with Sand				44			Gray, wet, subrounded to rounded gravel, fine to medium sand
8														Bottom of Hole 7.9 m Elevation 129.2 m Groundwater Encountered While Drilling: at an elevation of 132.4 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

NPA Form 19-E
May 94 Prev. Ed. Obsolete

Project: Family Housing Replacement, Taku Gardens Resite

Hole Number: AP-8957P

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 25 Jan 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,772 m Easting: 420,908 m

Top of Hole Elevation: 135.9 m

Hole Number, Field: TB-43

Permanent: AP-8958

Operator: Lincoln Trigg

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 3.9 m WD

Depth Drilled: 7.5 m

Total Depth: 7.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0	1	Non	F4		ML	Sandy SILT					-/ 0.1		Brown, frozen, fine sand, moderately plastic fines
1	2	Non	F2	9 7 3	SM	Silty SAND	0	74	26		-/ 0.1	11	Tan, frozen, fine sand, nonplastic (NP) fines (interbedded)
	3		NFS	2 2 2	SP	Poorly graded SAND	0	95	5		-/ 0.3	4	Gray, moist to frozen, medium sand
2													
3	4		NFS	4 8 9	GP	Poorly graded GRAVEL with Sand	52	45	3	32	-/ 1.3	2	Tan, moist, subrounded gravel, fine to coarse sand
4													
	5		NFS	3 5 15	SP	Poorly graded SAND with Gravel				32			Gray, wet, subrounded gravel, fine to medium sand
5													
6	6			11 9 7	SP	Poorly graded SAND with Gravel				38			Gray, wet, subrounded gravel, fine to medium sand
7	7			2 5 6	SP	Poorly graded SAND							Gray, wet, fine to medium sand
8													Bottom of Hole 7.9 m Elevation 127.9 m Groundwater Encountered While Drilling: at an elevation of 131.9 m PID = (Cold/Hot) Photo Ionization Detector
9													
10													

EXPLORATION LOG FTW251 TA-KU RESITE.GPJ ACE_ANC.GDT 3/18/04

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 14 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,765 m Easting: 420,979 m

Top of Hole Elevation: 136.5 m

Hole Number, Field:	Permanent:	Operator:	Inspector:
TB-44	AP-8959	Lincoln Trigg	Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight:	Split Spoon I.D.:	Size and Type of Bit:	Type of Equipment:	Type of Samples:
154 kg	64 mm	203 mm HSA	Mobile B61 HDX w/Cathead & Rope	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4	Grab	ML	SILT with Sand		15	85		-/ 0.3	15	Second growth trees to 150 millimeters, 410 millimeters of snow cover Brown, frozen, fine sand, nonplastic (NP) fines
1		2	Non	F4	8 6 4	ML	SILT with Sand		7	93		-/ 0.3	9	Brown, frozen, fine sand, NP fines
		3		F3	2 3 2	SM	Silty SAND					-/ 0.6		Brown with gray inclusions, moist, fine sand, NP fines
2														
3		4		NFS	2 2 2	SP	Poorly graded SAND					-/ 0.7		Brown, moist, fine to medium sand
4														
		5		S2	2 3 2	SM	Silty SAND		84	16	19			Gray, wet, fine to coarse sand, NP fines
5														
6		6			3 5 10	GP	Poorly graded GRAVEL with Sand	53	43	4	25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			2 6 5	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation: 128.8 m Groundwater Encountered While Drilling: at an elevation of 131.8 m PID = (Cold Hot) Photo Ionization Detector
9														
10														

AKU RESITE.GPJ ACE_ANC.GDT 3/18/04

EXPLORATION LOG

ALASKA DISTRICT
CORPS OF ENGINEERS
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 5 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,765 m Easting: 421,049 m

Top of Hole Elevation: 136.4 m

Hole Number, Field: TB-45

Permanent: AP-8960

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.4 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	Sandy SILT					-/ 0.4		Brown, frozen fine to medium sand, nonplastic (NP) fines, FILL.
1		2		F4	7 9 8	ML	SILT with Sand	3	29	68		-/ 0.4	13	Brown, frozen to moist, fine to medium sand, NP fines, estimate 10% organics by volume, metal debris in sampler and cuttings, FILL.
		3		F4	6 7 5.5	ML	Sandy SILT					-/ 0.5		Brown, moist, fine to medium sand, NP fines, metal debris in sampler and cuttings, FILL.
2														
3		4		NFS	2 3 4	SP-SM	Poorly graded SAND with Silt		91	9		-/ 0.4	4	Brown, moist, fine to medium sand, NP fines
4														
		5		NFS	3 3 3	GP	Poorly graded GRAVEL with Sand	64	34	2	38		8	Gray, wet, subrounded to rounded gravel, fine to coarse sand
5														
6		6			4 9 9	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			6 14 12	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 128.6 m Groundwater Encountered While Drilling: at an elevation of 132.0 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW251 TAKU RESITE.GPJ ACE ANC.GDT 3/18/04

ALASKA DISTRICT
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ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1
Date: 6 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,763 m Easting: 421,122 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-46
Permanent: AP-8961

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.3 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth trees to 150 millimeters, 480 millimeters of snow
0		1	Nbe	F4	Grab	ML	SILT with Sand		17	83		-/ 3.2	22	Brown, frozen to moist, fine sand, NP fines
1		2		NFS	2 2 1	SP	Poorly graded SAND					-/ 2.4		Brown, moist, fine to medium sand
		3		NFS	1 2 2	SP	Poorly graded SAND					-/ 2.8		Brown, moist, fine to coarse sand
2														
3		4		NFS	2 7 9	SP	Poorly graded SAND with Gravel	4	91	5		-/ 3.6	3	Brown, moist, fine to coarse sand
4														
5		5		NFS	6 6 8	GW	Well graded GRAVEL with Sand	64	34	2	25		6	Brown with mottling, wet, subrounded to rounded gravel, fine to coarse sand
6		6			3 3 5	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine and coarse sand
7		7			2 1 5	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine to medium sand
8														Bottom of Hole 7.8 m Elevation 129.1 m Groundwater Encountered While Drilling: at an elevation of 131.5 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 2 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,760 m Easting: 421,192 m

Top of Hole Elevation: 137.0 m

Hole Number, Field: TB-47

Permanent: AP-8962

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Second growth trees to 150 millimeters, 500 millimeters of snow cover)
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 0.9		Brown, frozen, fine sand, nonplastic (NP) fines
1		2		F4	4 5 5	ML	SILT with Sand		26	74		-/ 0.7	16	Brown, moist, fine sand, NP fines
		3a		F3	6	SM	Silty SAND					-/ 0.9		Brown, moist, fine sand, NP fines
		3b		NFS	6	SP	Poorly graded SAND							Brown, moist, fine to medium sand
2														
3		4		NFS	1 1 2	SP-SM	Poorly graded SAND with Silt	1	92	7		-/ 0.3	5	Brown, moist, fine to medium sand
4														
5		5		NFS	7 14 13	GP	Poorly graded GRAVEL with Sand				51	-/ 0.2		Gray with some mottling, wet, rounded gravel, medium to coarse sand
6		6			4 10 13	GP	Poorly graded GRAVEL with Sand	58	39	3	51		9	Gray, wet, rounded gravel, fine to coarse sand
7		7			3 5 8	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine to coarse sand
8														
9		8			2 4 6	GP	Poorly graded GRAVEL with Sand				25			1.5 meters of heaving sand Gray, wet, rounded gravel, medium to coarse sand
10														

EXPLORATION LOG FTW25...\KU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 2 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,760 m Easting: 421,192 m

Top of Hole Elevation: 137.0 m

Hole Number, Field: TB-47

Permanent: AP-8962

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
11														Second growth trees to 150 millimeters, 500 millimeters of snow cover
12		9			5 6 9	GP	Poorly graded GRAVEL with Sand				25			1.8 meters of heaving sand Gray, wet, rounded gravel, medium to coarse sand
13														
14														
15		10			6 8 8	GP	Poorly graded GRAVEL with Sand				32			2.4 meters of heaving sand Gray, wet, rounded gravel, fine to coarse sand
16														Bottom of Hole 15.4 m Elevation 121.6 m Groundwater Encountered While Drilling: at an elevation of 132.3 m PID = (Cold-Hot) Photo Ionization Detector
17														
18														
19														
20														

EXPLORATION LOG /51 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 9 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,710 m Easting: 420,905 m

Top of Hole Elevation: 135.7 m

Hole Number, Field: TB-48

Permanent: AP-8963P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.2 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4	Grab	ML	SILT					-/ 0.5		Second growth trees to 330 millimeters, 510 millimeters of snow cover Dark brown, frozen, nonplastic (NP) fines
1		2	Non	F2	10 5 2	SM	Silty SAND	1	49	50		-/ 0.4	18	Brown, frozen, fine sand, NP fines
		3		F2	2 2 3 2	SM	Silty SAND		56	44		-/ 0.5	8	Brown, moist, fine sand
2														
3		4		NFS	3 4 5	SP	Poorly graded SAND					-/ 0.4		Brown, moist, fine sand Gravel layer indicated by chill action
4		5		NFS	1 4 2	SP	Poorly graded SAND							Gray, wet, fine to medium sand, 50 millimeter layer of silt at 4.32 meters
5														
6		6			5 9 12	SP	Poorly graded SAND with Gravel				19			Gray, wet, rounded gravel, fine to medium sand
7		7			6 9 12	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, medium to coarse sand
8														Bottom of Hole 7.8 m Elevation 127.9 m Groundwater Encountered While Drilling: at an elevation of 131.5 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW25...AKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 14 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,705 m Easting: 420,977 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-49

Permanent: AP-8964

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.8 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	Sandy SILT		49	51		-/0.5	38	Brown, frozen, fine sand, nonplastic (NP) fines
1		2		F4	3 3 3	ML	SILT with Sand		20	80		-/0.4	12	Brown, moist, fine sand, NP fines
		3		NFS	2 3 2	SP	Poorly graded SAND					-/0.2		Brown, moist, fine sand
2														
3		4		NFS	2 3 2	SP	Poorly graded SAND					-/0.2		Brown, moist, fine sand
4														
		5		NFS	1 2 4	SP	Poorly graded SAND							Brown, wet, coarse sand
5														
6		6			7 8 8	GP	Poorly graded GRAVEL with Sand				19			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			3 5 5	GP	Poorly graded GRAVEL with Sand	63	35	2	25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 128.9 m Groundwater Encountered While Drilling: at an elevation of 131.9 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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EXPLORATION LOG

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 7 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,706 m Easting: 421,049 m

Top of Hole Elevation: 136.9 m

Hole Number, Field: TB-50 Permanent: AP-8965

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.4 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Second growth trees to 300 millimeters, 480 millimeters of snow)
0		1	Non	F4	Grab	ML	SILT					-/ 0.7		Dark brown, frozen to moist, nonplastic (NP) fines
1		2		S2	5 6 5	SM	Silty SAND		68	32		-/ 0.4	5	Brown, moist, fine sand, NP fines
		3		NFS	3 4 2	GW	Well graded GRAVEL with Sand	61	36	3	19	-/ 0.4	2	Brown, moist, rounded gravel, fine to medium sand
2														
3		4		NFS	2 3 2	SP	Poorly graded SAND	13	83	4	13	-/ 0.4	4	Brown, moist, fine to medium sand
4														
		5		PFS	4 5 7	GP	Poorly graded GRAVEL with Sand				32			Gray to brown, wet, subrounded to rounded gravel, medium sand
5														
6		6			4 4 4	GP	Poorly graded GRAVEL with Sand				44			Gray, wet, subrounded to rounded gravel, coarse sand
7														
		7			4 4 4	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, medium to coarse sand
8														Bottom of Hole 7.8 m Elevation 129.1 m Groundwater Encountered While Drilling: at an elevation of 132.5 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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Project: Family Housing Replacement, Taku Gardens Resite

Hole Number: AP-8965

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 7 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,704 m Easting: 421,118 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-51

Permanent: AP-8966

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.1 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	SILT					-/ 0.9		Brown, frozen to moist, fine sand, nonplastic (NP) fines
1		2a		F4	2 3	ML	SILT		8	92		-/ 0.7	14	Brown and gray, moist, fine sand, NP fines
		2b		NFS	4	SP	Poorly graded SAND							Brown, moist, fine sand
		3		NFS	2 3 4	SP	Poorly graded SAND					-/ 0.4		Brown, moist, fine sand
3		4		NFS	3 8 9	GP	Poorly graded GRAVEL with Sand	60	38	2	19	-/ 0.6	1	Brown, moist, rounded gravel, fine to medium sand
5		5		NFS	4 4 7	GP	Poorly graded GRAVEL with Sand				32			Gray with mottling, moist to wet, subrounded to rounded gravel, fine to medium sand
6		6			3 8 10	GW	Well-graded GRAVEL with Sand	62	36	2	32			Gray, wet, subrounded to rounded gravel, fine to medium sand
7		7			1 1 7	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, fine to medium sand
8														Bottom of Hole 7.8 m Elevation 128.9 m Groundwater Encountered While Drilling: at an elevation of 131.6 m PID = (Cold-Hot) Photo Ionization Detector

ALASKA DISTRICT
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Soils and Geology Section
EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 3 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,702 m Easting: 421,190 m

Top of Hole Elevation: 137.1 m

Hole Number, Field: TB-52
Permanent: AP-8967P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.6 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Second growth trees to 230 millimeters, snow to 410 millimeters cover)
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 5.8		Brown, frozen, fine sand, nonplastic (NP) fines, FILL
1		2a	Non	F4	4 4	OL	Organic SILT					-/ 2.9		Black, frozen, NP fines, 85% organics by volume
		2b		F4	4 3	SM	Silty SAND							Brown, moist, fine sand, NP fines
		3		S2	3 3 1	SP-SM	Poorly graded SAND with Silt				6	-/ 3.2		Brown, moist, fine to medium sand, NP fines
2														
3		4		NFS	2 1 3	SP	Poorly graded SAND with Gravel	20	78	2		-/ 4.5	2	Tan, moist, medium sand
4		5a		NFS	4 7	SP	Poorly graded SAND					-/ 3.8		Brown, moist, medium sand
		5b		NFS	11	GP	Poorly graded GRAVEL with Sand				38			Gray with mottling, wet, rounded gravel, medium to coarse sand
5														
6		6			2 2 4	GP	Poorly graded GRAVEL with Sand				25			Brown, wet, rounded gravel, fine to coarse sand
7		7			3 9 7	GP	Poorly graded GRAVEL with Sand				19			Brown, wet, subrounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 129.4 m Groundwater Encountered While Drilling: at an elevation of 132.5 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

ALASKA DISTRICT
CORPS OF ENGINEERS
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 4 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,650 m Easting: 420,902 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-53 Permanent: AP-8968

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.6 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 0.6		Garden plots, 470 millimeters of snow Brown, frozen, fine sand, nonplastic (NP) fines
1		2	Non	F4	4 3 4	ML	SILT with Sand		25	75		-/ 0.6	8	Brown, frozen to moist, fine sand, NP fines
		3		F4	2 3 3	ML	SILT		10	90		-/ 0.8	15	Brown, moist, fine sand, NP fines
2														
3		4		NFS	7 10 11	SP-SM	Poorly graded SAND with Silt and Gravel	29	60	11	25	-/ 0.6	11	Brown, moist, subrounded to rounded gravel, medium to coarse sand
4														
		5		NFS	4 11 12	GP	Poorly graded GRAVEL with Sand				32			Brown with mottling, moist to wet, rounded gravel, medium to coarse sand
5														
6		6			4 8 10	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, rounded gravel, medium to coarse sand
7		7			7 8 10	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, rounded gravel, medium to coarse sand
8														Bottom of Hole 7.8 m Elevation 128.9 m Groundwater Encountered While Drilling: at an elevation of 132.1 m PID = (Cobl-Hof) Photo Ionization Detector
9														
10														

EXPLORATION LOG: 51 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 4 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,646 m Easting: 420,974 m

Top of Hole Elevation: 136.7 m

Hole Number, Field: TB-54

Permanent: AP-8969

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.0 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
0		1	Non	S2	Grab	SP-SM	Poorly graded SAND with Silt and Gravel				19	-/ 0.4		Shoulder of dirt road, 460 millimeters of snow Brown, frozen, subangular to rounded gravel, fine to medium sand, nonplastic (NP) fines, FILL
1		2	Noe	F4	30 25 27	ML	SILT		12	88		-/ 0.4		Brown, frozen, fine sand, NP fines
		3	Non	F4	7	ML	SILT					-/ 0.3	19	Brown, frozen, fine sand, NP fines
2				F2	15 9	SM	Silty SAND							Brown, moist, fine sand, NP fines
3		4		NFS	2 2 2	SP	Poorly graded SAND		96	4		-/ 0.7	4	Brown, moist, fine to medium sand Gravel layer indicated by drill action
4				NFS	5	SP	Poorly graded SAND							Brown, moist, fine to medium sand
		5		NFS	5 9	SP	Poorly graded SAND with Gravel				25			Gray, wet, rounded gravel, fine to coarse sand
5														
6		6			4 5 6	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			3 3 13	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 128.9 m Groundwater Encountered While Drilling: at an elevation of 131.7 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW2...KU RESITE.GPJ ACE_ANC.GDT 3/18/04

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Project: Family Housing Replacement, Taku Gardens Resite

Hole Number: AP-8969

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 7 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,639 m Easting: 421,119 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-55 Permanent: AP-8970

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.6 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Gain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4	Grab	ML	Sandy SILT with Gravel				13	-/ 0.6		Brown, frozen to moist, rounded gravel, fine sand, nonplastic (NP) fines
1		2		F4	5 4 4	ML	Sandy SILT		32	68		-/ 0.3	3	Brown, moist, fine sand, NP fines
		3		F3	2 3 4	SM	Silty SAND					-/ 0.3		Brown, moist, fine sand, NP fines
2														
3		4		NFS	5 11 14	GW	Well-graded GRAVEL with Sand	58	40	2	19	-/ 0.3	1	Brown, moist, rounded gravel, fine to medium sand
4														
		5		NFS	4 8 10	GP	Poorly graded GRAVEL with Sand				64			Brown with motting, moist to wet, subrounded to rounded gravel, fine to medium sand
5														
6		6			3 10 9	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, fine to medium sand
		7			3 6 4	GP	Poorly graded GRAVEL with Sand				13			Gray, wet, subrounded to rounded gravel, fine to medium sand
7														
8														Bottom of Hole 7.8 m Elevation 129.0 m Groundwater Encountered While Drilling: at an elevation of 132.2 m PID = (ColdHot) Photo Ionization Detector
9														
10														

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Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

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Date: 3 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,642 m Easting: 421,192 m

Top of Hole Elevation: 137.2 m

Hole Number, Field: TB-56

Permanent: AP-8971

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.7 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second trees to 300 millimeters, 440 millimeters of snow cover
0		1	Nm	F3	Grab	SM	Silty SAND					-/ 1.4		Brown, frozen, fine sand, nonplastic (NP) fines, FILL
1		2a		F4	1	ML	SILT					-/		Brown, moist, fine sand, NP fines, FILL
		2b		F4	2	OL	Organic SILT					4.7		Brown, moist, NP fines, estimate 70% organics by volume
		3		F4	2	ML	SILT					-/ 2.9		Tan, moist, fine sand, NP fines
2					1									
					4									
3		4a		F4	1	ML	SILT with Sand					-/		Brown, moist, fine sand, NP fines
		4b		PFS	1	SM	Silty SAND		83	17		3.0	9	Brown, moist, fine to medium sand, NP fines
4					1									
		5		NFS	5	GW	Well-graded GRAVEL with Sand	63	34	3	32		7	Brown with mottling, moist, subrounded to rounded gravel, fine to coarse sand
5					10									
					9									
6		6			4	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
					4									
7					3									
		7			4	SW	Well-graded SAND with Gravel				19			Gray, wet, subrounded to rounded gravel, fine to coarse sand
					7									
8														Bottom of Hole 7.8 m Elevation 129.5 m Groundwater Encountered While Drilling: at an elevation of 132.5 m PID = (Cold/Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW25 ...KU RESITE.GPJ ACE ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 4 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,575 m Easting: 420,899 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-57 Permanent: AP-8972

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 5.0 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Garden plots, 470 millimeters of snow
0		1	Non	F4	Grab	ML	SILT with Sand					-/ 0.7		Brown, frozen, fine sand, nonplastic (NP) fines, estimate 10% organics by volume
1		2		FFS	10 10 5	GM	Silty GRAVEL with Sand	46	40	14	25	-/ 0.8	1	Brown, moist, rounded gravel, fine to coarse sand
		3		FFS	3 3 5	SM	Silty SAND		87	13		-/ 0.6	5	Brown, moist, fine to medium sand
2														
3		4		NFS NFS	2 7 12	SP GP	Poorly graded SAND Poorly graded GRAVEL with Sand				32	-/ 0.6		Brown, moist, fine to medium sand Brown with mottling, moist, subrounded to rounded gravel, fine to coarse sand
4														
		5		NFS	8 11 8	GP	Poorly graded GRAVEL with Sand	67	31	2	44		7	Brown with mottling, moist to wet, rounded gravel, fine to coarse sand
5														
6		6			7 14 14	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, rounded gravel, fine to coarse sand
7		7			3 7 6	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 129.1 m Groundwater Encountered While Drilling: at an elevation of 131.8 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1
Date: 13 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,572 m Easting: 420,971 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-58 Permanent: AP-8973

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NR

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Second growth trees to 200 millimeters, 410 millimeters of snow
0		1	Non	F4	Grab	ML	SILT					-/ 0.4		Brown, frozen, fine sand, nonplastic (NP) fines
1		2	Non	F4	4 6 6	ML	SILT		8	92		-/ 0.3	6	Brown, frozen, fine sand, NP fines
		3		F4	4 3 3	ML	SILT		10	90		-/ 0.3	7	Brown, moist, fine sand, NP fines
2														
3		4		NFS	3 4 4	SP	Poorly graded SAND with Gravel	41	56	3	13	-/ 0.2	2	Brown, moist, rounded gravel, medium sand
4														
5		5		NFS	8 11 8	GP	Poorly graded GRAVEL with Sand				51			Brown with mottling, wet, rounded gravel, medium to coarse sand
6		6			2 3 4	SP	Poorly graded SAND							Gray, wet, fine to medium sand
7		7			4 7 6	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, medium to coarse sand
8														Bottom of Hole 7.8 m Elevation 129.1 m Groundwater Not Recorded PID = (Cold/Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG FTW2x_KU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 13 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,571 m Easting: 421,043 m

Top of Hole Elevation: 136.6 m

Hole Number, Field: TB-59

Permanent: AP-8974

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.1 m WD

Depth Drilled: 7.3 m

Total Depth: 7.8 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4	Grab	ML	SILT					-/ 1.1		Second growth trees to 200 millimeters, 480 millimeters of snow cover Brown, frozen to moist, nonplastic (NP) fines
1		2		S2	4 4 3	SM	Silty SAND		73	27		-/ 0.7	2	Brown, moist, fine sand, NP fines
		3		NFS	5 4 4	SP	Poorly graded SAND with Gravel	35	63	2		-/ 0.9	1	Brown, moist, rounded gravel, fine to medium sand
2														
3		4		NFS	2 3 3	SP	Poorly graded SAND					-/ 1.1		Brown, moist, fine sand
4													▼	
		5			3 4 7	SP	Poorly graded SAND							Gray, wet, fine to medium sand
5														
6		6			2 5 5	GP	Poorly graded GRAVEL with Sand							Gray, wet, rounded gravel, fine to medium sand
7														
		7			5 8 12	SP	Poorly graded SAND with Gravel	44	53	3				Gray, wet, rounded gravel, fine to coarse sand
8														Bottom of Hole 7.8 m Elevation 128.9 m Groundwater Encountered While Drilling: at an elevation of 132.6 m PID = (Cold-Hot) Photo Ionization Detector
9														
10														

EXPLORATION LOG -51 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 11 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,570 m Easting: 421,115 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-60

Permanent: AP-8975

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.3 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
			Non	F4		CL	Organic SILT					-/ 0.4		Black, frozen, nonplastic (NP) fines, estimate 30% organics by volume
		1	Non	F4	Grab	ML	SILT		2	98			25	Brown, frozen, NP fines
1		2		NFS	4 4 6	SP	Poorly graded SAND					-/ 0.3		Brown, moist, fine sand
		3		NFS	6 8 6	GP	Poorly graded GRAVEL with Sand				32	-/ 0.4		Tan, moist, rounded gravel, fine to medium sand
2														
3		4		NFS	5 9 8	GP	Poorly graded GRAVEL with Sand				25	-/ 0.5		Brown, moist, subrounded to rounded gravel, fine to medium
4														
		5		PFS	3 6 10	SM	Silty SAND	6	79	15	13		16	Gray, wet, rounded gravel, fine to medium sand
5														
6		6			3 6 6	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			2 4 5	GP	Poorly graded GRAVEL with Sand				25			Gray, wet, subrounded to rounded gravel, fine to coarse sand
8														
9		8			3 5 6	GP	Poorly graded GRAVEL with Sand				32			Gray, wet, subrounded to rounded gravel, medium to coarse sand
10														

EXPLORATION LOG FTW2-KU RESITE.GPJ ACE_ANC.GDT 3/18/04

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 11 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,570 m Easting: 421,115 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-60 Permanent: AP-8975

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 4.3 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
11														
12		9			5 8 7	GP	Poorly graded GRAVEL with Sand				19			1.5 meters of heaving sand Gray, wet, rounded gravel, fine to medium sand
13														
14														
15		10			5 18 28	GP	Poorly graded GRAVEL with Sand				51			Gray, wet, subangular to rounded gravel, fine to coarse sand
														Bottom of Hole 15.4 m Elevation 121.4 m Groundwater Encountered While Drilling at an elevation of 132.6 m PID = (Cold-Hot) Photo Ionization Detector
16														
17														
18														
19														
20														

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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 3 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,568 m Easting: 421,189 m

Top of Hole Elevation: 137.0 m

Hole Number, Field: TB-61 Permanent: AP-8976P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.5 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F2	Grab	SM	Silty SAND					-/ 4.3		Second growth trees to 250 millimeters, 410 millimeters of snow cover Brown, frozen, fine to medium sand, nonplastic (NP) fines, FILL
1		2	Non	F4	16 20 18	ML	SILT					-/ 3.6		Tan to brown, frozen, fine sand, NP fines
		3		F4	6 5 4	ML	Sandy SILT		47	53		-/ 3.1	3	Brown, moist, fine sand, NP fines
2														
3		4		NFS	5 9 12	GP	Poorly graded GRAVEL with Sand	70	25	5	38	-/ 4.7	6	Brown with mottling, moist, subrounded to rounded gravel, medium to coarse sand
4														
		5		NFS	2 12 12	GP	Poorly graded GRAVEL with Sand	62	36	2	32	-/ 4.2	8	Brown with mottling, wet, subrounded to rounded gravel, medium to coarse sand
5														
6		6			7 3 3	SP	Poorly graded SAND with Gravel				19			Gray, wet, rounded gravel, medium sand
7		7			1 7 8	GP	Poorly graded GRAVEL with Sand				19			Gray, wet, rounded gravel, medium to coarse sand
8														
9		8			1 8 8	GP	Poorly graded GRAVEL with Sand	65	34	1	32		7	Gray, wet, rounded gravel, medium to coarse sand
10														

EXPLORATION LOG FTW2 KU RESITE.GPJ ACE ANC.GDT 3/18/04

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Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 3 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,568 m Easting: 421,189 m

Top of Hole Elevation: 137.0 m

Hole Number, Field: TB-61 Permanent: AP-8976P

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☐ Auger Hole ☐ Monitoring Well ☒ Piezometer

Depth to Groundwater: 4.5 m WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
11														Second growth trees to 250 millimeters, 410 millimeters of snow cover
12		9			2 7 7	GP	Poorly graded GRAVEL with Sand				44			Gray, wet, rounded gravel, medium to coarse sand
13														
14														
15		10			5 7 14	GP	Poorly graded GRAVEL with Sand				51			Gray, wet, rounded gravel, medium to coarse sand
16														Bottom of Hole 15.4 m Elevation 121.6 m Groundwater Encountered While Drilling: at an elevation of 132.5 m PID = (Cold/Hot) Photo Ionization Detector
17														
18														
19														
20														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 6 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,516 m Easting: 420,895 m

Top of Hole Elevation: 136.6 m

Hole Number, Field: TB-62 Permanent: AP-8977

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	F4	Grab	ML	SILT with Sand					-/ 3.3		Brown, frozen, fine sand, nonplastic (NP) fines
1		2		F4	7 7 4	ML	SILT with Sand		21	79		-/ 2.5	13	Brown, moist, fine to medium sand, NP fines
		3		F4	2 2 2	ML	SILT with Sand		19	81		-/ 2.5	16	Brown, moist, fine to medium sand, NP fines
2														
		4		NFS	1 2 1	SP	Poorly graded SAND					-/ 2.6		Brown to gray, moist, fine to medium sand
3														
4		5		NFS	3 9 9	GP	Poorly graded GRAVEL with Sand				32			Brown, wet, subrounded to rounded gravel, fine to coarse sand
5														
6		6			9 10 9	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to coarse sand
7		7			5 14 12	GP	Poorly graded GRAVEL with Sand				44			Gray, wet, subrounded to rounded gravel, fine to coarse sand
8														
9		8			4 5 8	GP	Poorly graded GRAVEL with Sand				51			Gray, wet, subrounded to rounded gravel, fine to coarse sand
10														

EXPLORATION LOG FTW_4KU RESITE.GPJ ACE_ANC.GDT 3/18/04

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 6 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,516 m Easting: 420,895 m

Top of Hole Elevation: 136.6 m

Hole Number, Field: TB-62

Permanent: AP-8977

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: WD

Depth Drilled: 14.9 m

Total Depth: 15.4 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
11														Shoulder of dirt road, 460 millimeters of snow
12		9			8 14 16	GP	Poorly graded GRAVEL with Sand				38			Gray, wet, subrounded to rounded gravel, fine to coarse sand
13														
14														
15		10	Non		16 37 32	SP	Poorly graded SAND		97	3	25		26	Gray, frozen, rounded gravel, fine to coarse sand
16														Bottom of Hole 15.4 m Elevation 121.3 m Groundwater Encountered While Drilling PID = (Cold-Hot) Photo Ionization Detector
17														
18														
19														
20														

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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 13 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,513 m Easting: 420,968 m

Top of Hole Elevation: 136.5 m

Hole Number, Field: TB-63 Permanent: AP-8978

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NE

Depth Drilled: 14.9 m

Total Depth: 15.2 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Spruce trees to 330 millimeters, 460 millimeters of snow cover)
0		1	Non	F4	Grab	CL	Organic SILT		36	64		-/ 1.3	89	Black, frozen, nonplastic (NP) fines, estimate 50% organics by volume
1		2	Non	F4	4 10 9	ML	SILT with Sand		11	89		-/ 0.5	37	Brown, frozen, fine sand, NP fines
		3	Non	F4	8 10 10	ML	SILT		18	82		-/ 0.7	37	Brown, frozen, NP fines
2														
3		4	Noe	F3	11 20 18	SM	Silty SAND		59	41		-/ 0.3	37	Gray, frozen, fine sand, NP fines
4		5	Non	PFS	50/125mm	SM	Silty SAND with Gravel	42	44	14	13		10	Gray, frozen, rounded gravel, fine to coarse sand
5														
6		6	Non		50	SM	Silty SAND with Gravel	34	53	13	19		12	Gray, frozen, rounded gravel, fine to medium sand
7		7	Non		50/125mm	SM	Silty SAND with Gravel	42	45	13	19		10	Gray, frozen, rounded gravel, fine to medium sand
8														
9		8a	Non		25	SP-SM	Poorly graded SAND with Silt	1	89	10			28	Gray, frozen, fine to medium sand
		8b	Noe		50/100mm	GP	Poorly graded GRAVEL with Sand	58	38	4	19		10	Gray, frozen, rounded gravel, fine to coarse sand
10														

ALASKA DISTRICT
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EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 13 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,513 m Easting: 420,968 m

Top of Hole Elevation: 136.5 m

Hole Number, Field: TB-63 Permanent: AP-8978

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NE

Depth Drilled: 14.9 m

Total Depth: 15.2 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Spruce trees to 330 millimeters, 460 millimeters of snow cover)
12		9	Vx		32 50/75mm	GP	Poorly graded GRAVEL with Sand	55	42	3	13		6	Gray, frozen, rounded gravel, fine coarse sand, ice crystals to 5 mm, voids filled with ice
15		10	Nbe		50 50/125mm	SP-SM	Poorly graded SAND with Silt and Gravel	26	68	6	25		18	Gray, frozen, subrounded to rounded gravel, fine to medium sand

Bottom of Hole 15.2 m
Elevation 121.3 m
Groundwater Not Encountered
PID = (Cold-Hot) Photo Ionization Detector

EXPLORATION LOG -51 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 12 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,510 m Easting: 421,040 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-64

Permanent: AP-8979

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NE

Depth Drilled: 14.8 m

Total Depth: 14.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Nbe	F4	Grab	ML	SILT					-/ 0.3		Dark brown, frozen, nonplastic (NP) fines
1		2		F2	3 5 5	SM	Silty SAND					-/ 0.4		Brown, moist, fine sand, NP fines
		3		F4	7 7	ML	SILT with Sand		16	84		-/ 0.4	34	Brown, moist, fine sand, NP fines
2														
		4		NFS	4 5 3	SP	Poorly graded SAND				13	-/ 1.0		Brown, moist, rounded gravel, fine to medium sand
3														
4		5	Vx	NFS	14 29 28	SP-SM	Poorly graded SAND with Silt	7	88	5	6		30	Gray, frozen, fine to medium sand, ice crystals faintly visible (<1 mm)
5														
6		6	Vx		21 27 50/125mm	SP	Poorly graded SAND		95	5	6		26	Gray, frozen, fine to medium sand, ice crystals faintly visible (<1 mm)
7		7	Nbn		50/125mm	SM	Silty SAND with Gravel	33	51	16	19		9	Gray, frozen, rounded gravel, fine to medium sand
8														
9		8	Nbn		50/100mm	SM	Silty SAND with Gravel	27	55	18	6		8	Gray, frozen, rounded gravel, fine to medium sand
10														

EXPLORATION LOG FTW251 TAKU RESITE.GPJ ACE_ANC.GDT 3/18/04

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Date: 12 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,510 m Easting: 421,040 m

Top of Hole Elevation: 136.8 m

Hole Number, Field: TB-64 Permanent: AP-8979

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NE

Depth Drilled: 14.8 m

Total Depth: 14.9 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Spruce trees to 200 millimeters, 350 millimeters of snow cover
11														
12		9	Vx		40 50/100mm	SP	Poorly graded SAND	3	93	4			24	Gray, frozen, fine to medium sand, ice crystals fairly visible (<1 mm)
13														
14														
15		10	Nbn		50/100mm	SM	Silty SAND with Gravel	28	56	16	25		10	Gray, frozen, fine to medium sand, NP fines
16														Bottom of Hole 14.9 m
17														Elevation 121.9 m
18														Groundwater Not Encountered
19														PID = (Cold-Hot) Photo Ionization Detector
20														

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section

EXPLORATION LOG

Project: Family Housing Replacement, Taku Gardens Resite
Fort Wainwright, Alaska (FTW251)

Page 1 of 1

Date: 12 Feb 2004

Drilling Agency: ☐ Alaska District ☒ Other Tester Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 1,206,530 m ± Easting: 421,064 m ±

Top of Hole Elevation: ±

Hole Number, Field: TB-65

Permanent: AP-8980

Operator: Lincoln Trigg

Inspector: Steven Henslee

Type of Hole: ☐ other _____
☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NE

Depth Drilled: 4.1 m

Total Depth: 4.6 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 203 mm HSA

Type of Equipment: Mobile B61 HDX w/Cathead & Rope

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1	Non	S2	10 14 26	GP	Poorly graded GRAVEL with Sand				51	-/ 0.4		Brown, frozen, subangular to rounded gravel, fine to medium sand, FILL
			Non	F4		CL	Organic SILT							Black to brown, frozen, nonplastic (NP) fines
1		2		F4	5 5 5	SM	Silty SAND					-/ 0.4		Brown, moist, fine sand, NP fines
2		3		NFS	3 4 4	SP	Poorly graded SAND					-/ 0.5		Brown, moist, fine to medium sand
3		4			2 2 2	SP	Poorly graded SAND					-/ 0.6		Brown, moist to wet, fine to medium sand
4														Bottom of Hole 4.6 m ± Groundwater Not Encountered PID = (Cold/Hot) Photo Ionization Detector
5														
6														
7														
8														
9														
10														

EXPLORATION LOG FTW2... AKU RESITE.GPJ ACE ANC.GDT 3/18/04

Revised
Design Analyses and Technical Solution
Soils and Foundations

The housing units will be founded on thickened slab foundations. The thickened slab foundations will bear in a select, compacted, granular structure fill. The thickened slab will be sized to limit settlement under static loading conditions to less than ¾ inch. To minimize the potential for a punching-type failure during the design earthquake, the footings will be underlain by a layer of compacted, select granular fill, which will be at least twice as deep as the thickened portion of the slab is wide. The select granular fill will not be placed over seasonally frozen ground

The near surface, soils beneath the perimeter-footings and/or the perimeter portion of the thickened edge-slab foundation will be removed to a depth of at least 32 inches below the elevation of the thickened edge. The base of the excavation will be proof rolled and uniformly and systematically compacted prior to placing the select granular fill. The select granular fill will be placed in lifts not exceeding 12-inches loose height and each lift will be compacted to at least 95 percent of the Modified Proctor Maximum Dry Density. We understand that the anticipated maximum loads on the thickened edge perimeter foundations will be 1650 pounds per lineal foot. Interior column loads will be carried on 4-foot long sections of thickened slab. The minimum recommended width of the thickened portion of the slab is 16-inches. The thickened slab underlain by at least 32-inched of densely compacted select granular fill will have a factor of safety against bearing capacity failure in excess of 4. Anticipated settlements are expected to be less than ¾ inch. A geotechnical engineer from our office will observe the base of the excavation prior to the placing of and compacting of the select granular fill. Fill will not be placed over compressible organics or seasonally frozen ground. At some building locations the thickness of select granular fill beneath the thickened edge slab foundation will exceed the minimum recommended 32-inches.

Frost Protection

Frost protection for thickened slab foundation will be provided by providing 2 inches of rigid board insulation suitable for direct burial against the vertical portion of the thickened slab edge and 2 inches of insulation extending horizontally 48 inches from the thickened slab.

Construction will be scheduled so that the thickened edge slab foundation will be contimuously heated throughout the winter. It is our understanding that the housing units will be continuously heated throughout the life of the facility. ASCE 32-01 provides guidance for the design and construction of frost-protected foundation in areas with a design air-freezing index (F_{100}) of less than 4,500 °F-days and a mean annual air temperature ($MAAT$) of less than 32°F. The design-air freezing index is based on a 1 percent probability of exceedence annually.

The Fairbanks and Fort Wainwright areas have an F_{100} on the order of 7,030 °F-days and the $MAAT$ of less than 32°F, and therefore the standard does not apply. To assist us in selecting insulation requirements for the project we performed thermal analyses using Temp/W, a finite element simulation package developed and sold by Geoslope International Inc., Calgary, Alberta. The simulation program was written to solve two-dimensional, nonsteady-state, heat transfer problems with phase change. An apparent heat capacity method is used to treat latent heat, which requires unfrozen moisture content curves for materials undergoing phase change. Iteration is performed at every time-step to improve accuracy in establishing the phase change boundary.

A rectangular, finite-element mesh was developed having a width of 36 feet. The bottom boundary was set at a depth of 36 feet from the ground surface. The sides of the mesh were assumed to be no-heat-flow boundaries. The interior floor temperature was assumed to be a constant 68°F. The bottom edge of the mesh was set at a constant 35°F throughout the simulation.

Exterior ground surface temperatures used in the simulation were developed by modifying air temperatures. The Western Regional Climate Center databases were used as a source of air temperatures for the Fort Wainwright area. The mean daily air temperatures were determined from these records by averaging the average high and low daily temperatures for the period from 1949 to 2004 (Station 502968, Fairbanks WSO Airport). From the computed daily means, the mean annual air temperature was computed to be 27.0°F, and the mean air freezing and thawing indices were computed to be approximately 5,352 °F-days and 3,535°F-days, respectively. This computed thawing index along with the design air-freezing index (F_{100}) were entered into the ADOT&PF Berg2 computer program, along with surface n-factors for freezing and thawing (n_f and n_t) of 0.90 and 1.0 respectively, to calculate surface freezing and thawing indicies, mean

annual surface temperatures ($MAST$), and amplitude of the annual sinusoidal temperature cycle (A_0). The results were used to describe the annual ground surface temperature as

$$T_S = MAST - A_0 \cos\left(\frac{2\pi t}{365}\right)$$

where "t" is in days, $MAST = 24.4\,°F$ and $A_0 = 41.7\,°F$. The length of the freezing season described by this relationship is 203 days. The length of the mean air-freezing season based on the climatic data is 190 days.

The following two soil profiles were considered in the analysis. In the first profile the majority of the potentially frost susceptible silt has been replaced with a nonfrost-susceptible structural fill across the mesh, and in the second profile the upper two feet of the silt has been replaced with a nonfrost-susceptible structural fill.

SOIL PROFILES

Depth (feet)	Profile 1	Profile 2
0 to 2	Structural Fill	Structural Fill
2 to 8	Structural Fill	Silt
8 to 12	Moist Sand and Gravel	Moist Sand and Gravel
>12	Saturated Sand and Gravel	Saturated Sand and Gravel

Material properties selected for use in the simulations are presented below. Thermal conductivities for soils were determined by a method after Johansen (1975).

SUMMARY OF MATERIAL PROPERTIES

Material	Dry Unit Weight (lb/ft^3)	Moisture Content (%)	Thermal Conductivity (unfrozen) (Btu/h-ft-°F)	Thermal Conductivity (frozen) (Btu/h-ft-°F)	Heat Capacity (unfrozen) (Btu/ft^3-°F)	Heat Capacity (frozen) (Btu/ft^3-°F)
Structural Fill	135	3	1.13	0.89	27.0	25.0
Silt	85	25	0.74	1.19	35.7	25.1
Moist Sand and Gravel	120	4	0.86	0.67	25.2	22.8
Saturated Sand and Gravel	120	14	1.27	1.84	37.4	28.9
Concrete	-	0	1.00	1.00	24.0	24.0
Insulation	-	0	0.02	0.02	0.6	0.6

The phase change and change in thermal conductivity were spread over a temperature range of 0.5°F, from 31.5°F to 32°F.

The model was run for one freezing season (203 days) with the following initial temperatures.

INTIAL TEMPERATURE

Depth (feet)	Temperature (°F)
0 to 5	45
5 to 10	40
>10	35

The simulations show that the frost penetration is greater for Profile 1 than Profile 2, primarily due greater capacity of the higher moisture content silt to resist freezing. Conservatively, we continued our analyses and developed our recommendations based on simulations using Profile 1.

The simulations indicate that that 2 inches of insulation placed vertically on the exterior foundation wall and a 2-inch-thick wing of insulation 4 feet wide extending out horizontally from the base of the foundation is sufficient to prevent the seasonal from penetrating the soils beneath the foundation. The analyses also indicate that within 2 feet of building corners 2 inches of insulation will prevent frost penetration beneath the foundation.

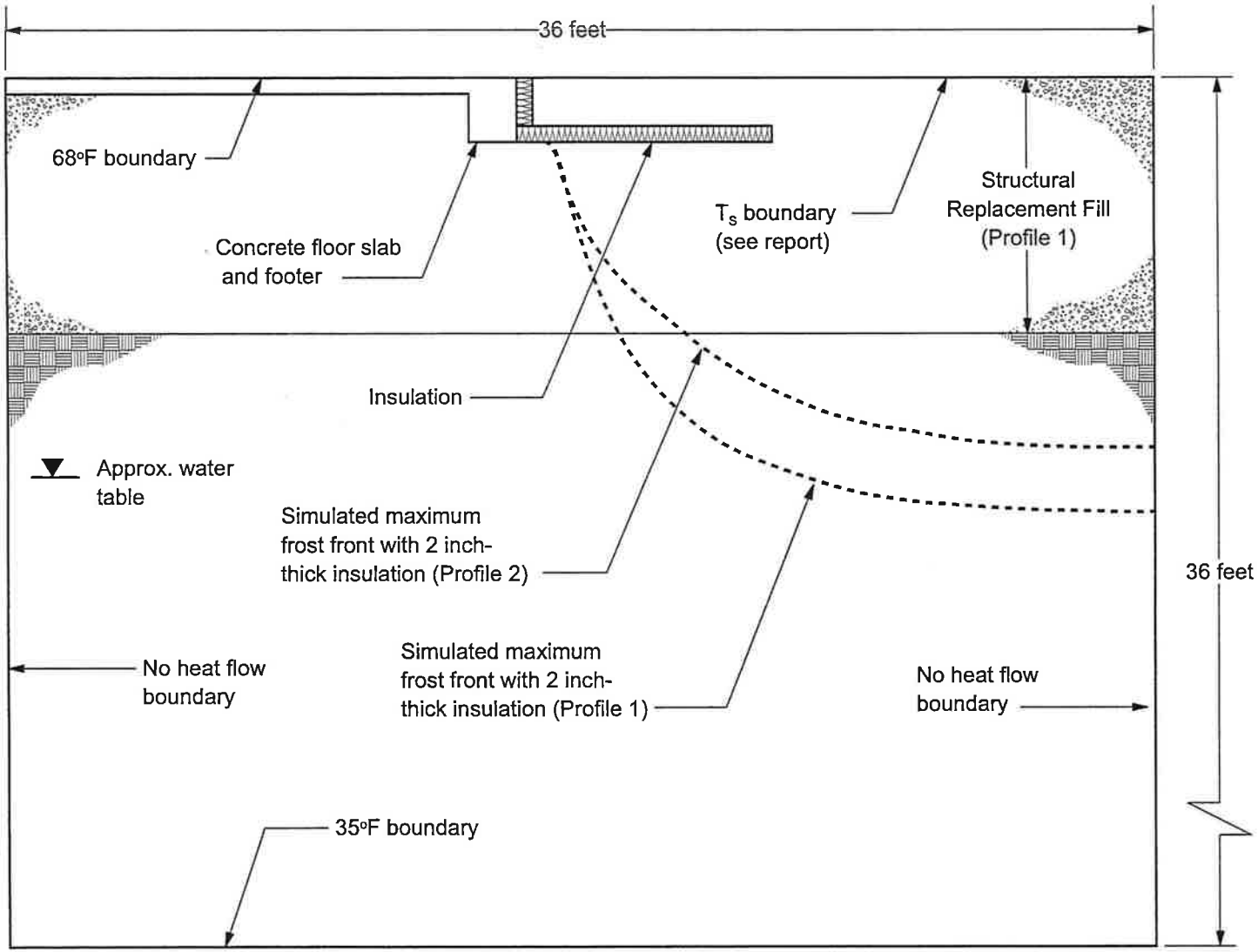
Based on our analyses we recommend placing 2 inches of insulation placed vertically on the exterior foundation wall and a 2-inch-thick wing of insulation 4 feet wide extending out horizontally from the base of the foundation. Note that below the insulation the freezing front is near vertical. Ice formed in this area would be nearly vertical resulting in minimum jacking forces on the thickened edge foundation. Therefore removal of all frost soils beneath the thickened edge foundation down to NFS sand and gravel will not be necessary.

Permafrost

Near-surface permafrost was encountered in two borings located west of the GVEA Substation. Air photos suggest that this area was recently cleared. Three duplex units appear to be located in the area of near surface permafrost. The frozen soils beneath and 10 feet beyond the footprint of these units will be excavated in the Spring of 2005 to a depth of at least 13 feet, and allowed to thaw before the base of the excavation is compacted and backfilled in late summer of 2005. The borings indicate that the granular soils from about 20 to 30 feet have a potential for a slight amount of thaw settlement. The thick layer of compacted fill beneath these units will tend to bridge and minimize the differential thaw related settlement of these units. Permafrost below 30 feet is assumed to be thaw stable

Paved streets and sidewalks will be designed using techniques contained in the reduced subgrade strength method of TM-822.

Groundwater is expected to be up to a meter higher during the summer construction than it was during the winter when the exploratory borings for this project were drilled. If silty soils are encountered below the water table in building excavations, these soils will be removed in the wet under the direction of the geotechnical engineer. The initial lift of granular fill will be placed in the water to a sufficient depth to bring the surface of the fill above water level before the lift and subsequent lifts of fill are compacted.



Note: This is not a design recommendation drawing

REPLACEMENT HOUSING
FTW 251 AND 283
FORT WAINWRIGHT, ALASKA

Thermal Simulation

March 2005 31-1-01869-002

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Figure 1

Checked 1/26/01

Bearing Capacity of Soils (Single Layer System)
For round, square, or strip footings (Terzaghi)

Input

γ_w =	135	Unit Weight of Soil (pcf)
D =	2	Depth of Embedment (ft)
B =	1.33	Width of Strip Footing (ft)
B =	1.33	Width of Square/Circular Footing (ft)
FS =	3	Factor of Safety
c =	0	Cohesion (psf)
d =	8	Depth to Water Table (ft)

ϕ = 35 ϕ' = 23

$N_{(60)}$ = 35 <<Corrected blow count within 2B

Calculated Bearing Capacity Factors:

N_q = 41	N'_q = 13
N_c = 58	N'_c = 25
N_γ = 47	N'_γ = 25

BEARING CAPACITY (General Shear) $q_{ult} = cN_cs_c + qNq + 0.5\gamma BN_\gamma s_\gamma$

Strip Footings	q_{ult} = 15,380	q_{all} = 5,100
Square Footings	q_{ult} = 12,992	q_{all} = 4,300
Circular Footings	q_{ult} = 12,541	q_{all} = 4,100

BEARING CAPACITY (Local Shear) $q_{ult} = (^2/_3c)N_cs_c + qNq + 0.5\gamma BN_\gamma s_\gamma$

Strip Footings	q_{ult} = 5,723	q_{all} = 1,900
Square Footings	q_{ult} = 4,424	q_{all} = 1,400
Circular Footings	q_{ult} = 4,179	q_{all} = 1,300

Maximum Bearing Capacity (psf)

Note: - Local shear will generally control if bearing in loose or soft soils

- General shear will control if bearing in compacted, dense or hard soils

	General	Local	
	5,100	1,900	Strip
	4,300	1,400	Square
	4,100	1,300	Circular
Bearing Capacity based on Limiting Settlement to 1-inch (Terzaghi charts)	6,600		Square

Calculated 2/18/05 2:50 PM