FINAL REPORT ON

GEOTECHNICAL INVESTIGATION
WHITCOMB HEIGHTS SUBDIVISION
SITKA, ALASKA

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1.0 INTRODUCTION

The City and Borough of Sitka, AK intends to develop the Whitcomb Heights Subdivision on the western flank of Harbor Mountain along Halibut Point Road in Sitka, AK (Figure 1). Development of the subdivision requires completion of a previously existing network of temporary gravel roads, construction of a new water storage tank upslope of the subdivision, and development of related utilities. The City and Borough of Sitka (CBS) has hired USKH Inc. (USKH) to provide road, water, sewer and storm drain design services. USKH has in turn subcontracted Golder Associates Inc. (Golder) to conduct a geotechnical investigation and evaluation of the subsurface conditions in the proposed subdivision. This work is being carried out under USKH Project No. 1024000.

1.1 Purpose

The purpose of this study is to assist USKH with the selection of the prospective water tank foundation sites and provide geotechnical recommendations for the water tank foundation, water tank access road, and subdivision road upgrades. Most roads in the subdivision are already established and the preferred water tank location is Option #6.

1.2 Scope of Work

The scope of work for this project included:

- Acquisition and review of existing information relating to the geology and geotechnical conditions pertinent to the site, including geologic maps, stereo-paired air photos, reports by government agencies, and previous technical work in or near the subdivision.
- A field reconnaissance to inspect the existing roadway, probe to determine depth of organic or soft soils, inspection and probing at the prospective tank site location(s), geologic mapping, and identification of prospective test pit locations.
- A subsurface investigation that included up to 15 test pits along the existing road network, three test pits on proposed roads accessing the water tank site, and five test pits excavated at the proposed tank site.
- Soil sampling at representative depths in test pits including field measurement of geotechnical properties using a torvane and pocket penetrometer where appropriate.
- Lab analysis of appropriate samples for geotechnical properties including soil moisture, grain size, organic content, and Atterberg limits.
- Geotechnical analysis to assess the bearing capacity, lateral resistance and settlement of the water tank foundation, as well as address foundation settlement, grading at the tank site, existing road subbase stability, the tank access road, utility piping, and seismic concerns.

Prior to this geotechnical investigation, five tank locations were proposed by USKH, as shown in Figure 2. Of these five proposed tank sites, USKH originally identified Sites #1 and #2 to Golder as preferred locations and requested a geotechnical investigation to assist in final site selection. As Golder’s investigation progressed, USKH requested that Golder broaden the investigation to identify other suitable tank locations; therefore, Golder also performed a geotechnical investigation near Site #6, which has been chosen as the preferred tank location.
2.0 BACKGROUND

Development of the Whitcomb Heights Subdivision began in 1981 when the CBS awarded two contracts to begin construction of proposed roads in the subdivision. Temporary roads were constructed to grade, capped with crushed gravel and cobble fill, and generally remain in good condition at present day.

Future development of the Whitcomb Heights Subdivision requires the construction of a new water tank to provide the subdivision with adequate water supply and pressure. The great majority of the 143 lots in the subdivision are above the 150 ft elevation, the approximate maximum elevation at which Sitka’s water system can provide adequate water flow and pressure for fire suppression. To accommodate fire suppression in the subdivision, the tank must be founded at or above the 340 ft elevation, which is about 130 ft higher than the City’s existing water tanks. This higher water tank elevation will resolve broader issues of inadequate water supply and pressure throughout the Sitka water system. An 80 ft diameter (about 1,000,000 gallon) water tank has been proposed for these purposes.

2.1 Sitka Area Geologic Conditions

The Sitka area is characterized by rugged coastal mountains that typically range from 2,000 ft to 4,000 ft in elevation. The Whitcomb Heights Subdivision lies in the elevation range of 150 ft to 300 ft on the southwest flank of Harbor Mountain, which is approximately 2,400 ft high. The region is underlain primarily by coarse-grained graywacke sandstone that has been slightly metamorphosed. Argillite is also known to occur in the area (Yehle, 1974). In samples taken from Harbor Mountain for uniaxial compression tests, Golder measured the compressive strength of local graywacke to be 11,450 to 14,650 psi (Golder, 2001).

Pleistocene ice sheets covered the region until the last glacial maximum approximately 10,000 years ago. Local topography has been dominantly formed by glacial erosion, producing U-shaped valleys, rounded knobs, hanging valleys and fjords typical of glaciated mountainous terrain. Following the last glacial maximum, glacial retreat left widespread glacial drift deposits (till, moraine, and outwash sediments) atop the bare bedrock (Golder, 2001). The glacial drift is typically a compact, poorly graded, sub-rounded, gravel and cobble mixture in a sand matrix with some boulders, silt and clay present. Localized variation in the deposit thickness and grain size content of glacial drift is common,
depending on the depositional conditions. Glacial drift deposits are estimated to have a shear wave velocity of 2,300 ft/sec (Yehle, 1974).

Following the last glacial maximum, multiple eruptions of Mt. Edgecombe and its adjacent volcanic vents deposited large volumes of volcanic ash atop glacial drift deposits. The ash consists primarily of reddish-brown silt and sand size grains and may include both clay and/or fine gravel components. Its estimated shear wave velocity is 590 ft/sec. The ash has an undisturbed, undrained shear strength of approximately 20 psi. When disturbed, the ash is known to liquefy (Yehle, 1974). A heavy vegetative mat of moss and a variety of low plants and bushes overlie the mineral soils. The terrain is heavily forested with spruce, hemlock, alder and occasional cedar.

Glacial retreat removed a large regional mass of water from the Earth’s crust, resulting in isostatic rebound. The current rate of buoyant uplift of the crust is 0.08 in. per year. Consequently, the local coastline is emergent and ancient beach deposits of rounded gravel and cobble occur at elevations between 0 ft and 35 ft, and as high as 250 ft (R&M, 1978).

The probability of a destructive earthquake in the Sitka area is unknown. There are two major fault zones in the area that includes the inactive Chichagof fault, which is 2.5 miles northeast of Sitka, and the Fairweather-Queen Charlotte Island fault, which is 800 miles long, passing 30 miles southwest of Sitka. Both faults trend roughly southeast to northwest, parallel to the coastline. Several earthquakes have been felt in Sitka since 1983, but none have caused damage. It is expected that liquefaction is possible in large volumes of volcanic ash that have been excavated and reused as fill (Yehle, 1974).
3.0 METHODS OF INVESTIGATION

3.1 Data Review

A review of existing reports, geologic maps and air photos was conducted to develop a cursory understanding of the local geology and subsurface conditions. Stereo pairs of aerial photos of the Whitcomb Heights Subdivision were examined to identify potential landslide paths and deposits, as well as examine potential development sites. Topographic maps produced from Light Detection and Ranging (LIDAR) data were examined and utilized for mapping and navigation in the field.

3.2 Geologic Reconnaissance

An initial geologic reconnaissance was conducted by a Golder engineering geologist from September 10 to 12, 2007, to characterize the general surface conditions. A hand driven 3/8-in. diameter steel probe was used to estimate depths of soft soils with the goal of approximating the depth to either bedrock or compact glacial drift. Surface soils and topography were examined and photographed to identify potential areas of either ancient or currently active landslides. No suitable bedrock outcrops were encountered for structural mapping.

Both proposed water tank locations identified by USKH (Sites #1 and 2, Figure 2) were visited, as well as their proposed access road alignments. Locations were selected for test pit excavation both along the existing roadway and at the proposed tank locations. Local Sitka contractors were brought to the project area to assess the feasibility and expense of pioneering access roads to proposed Tank Sites #1 and #2, as well as excavating the planned test pits on the existing road system.

3.3 Subsurface Investigation

A total of 21 test pits were excavated throughout the subdivision between September 13 and 20, 2007, using a Hitachi 160 excavator that was operated by Twaddle’s Excavation of Sitka. Thirteen of these test pits (TP-02 to TP-14) were excavated within or adjacent to the existing road and seven test pits were excavated at three of the proposed water tank locations. These test pit locations were generally identified using GPS and are shown in Figures 2 and 3.
A detailed record of the soil stratigraphy was logged at each test pit by a Golder engineering geologist who classified the soils according to the USCS soil classification system. Test pit logs are included in Appendix A. Soil samples were collected from test pits at depths that were representative of the materials present. Relative consistency was estimated based on the excavation effort and hand probes with a pocket penetrometer.

3.4 Laboratory Testing

In Golder’s Anchorage laboratory, the majority of samples were analyzed for soil moisture content. Select samples from representative locations throughout the subdivision were analyzed for grain size distribution and detailed USCS classification. Where appropriate, Atterberg limits were determined, as well as measuring organic material content. All laboratory testing was performed in general accordance with ASTM test methods. A summary of the laboratory test results is shown in Table 1.
4.0 FIELD INVESTIGATION RESULTS

4.1 General Subsurface Conditions

Five distinct soil units that were identified in the subdivision area are summarized below. Not all units were present in each test pit and the stratigraphic order of these units varied with location. Detailed soil descriptions and test pit logs are presented in Appendix A.

- **Peat and Forest Organics.** This unit consists of moist to wet forest hummus that typically blankets the site, including moss, roots, and decaying organic materials. Layer thickness varies from 0.5 ft to 2 ft. Composition varies greatly, dependent on local topography, soil drainage, soil type, and local vegetation. These organic deposits are highly compressible, will degrade, and are unsuitable as a bearing surface or fill material.

- **Volcanic Ash.** This unit is primarily composed of reddish brown, silty sand that is typically moist to wet, compact, and locally includes a clayey component, but fine gravel and/or coarse sand may be present as well. Thickness of the ash encountered varied from 4 ft to 15 ft. Deposits are often stratified with 3 in. to 24 in. layers, possibly representing discrete eruptions. Laboratory moisture content values ranged from 42% to 165%. The volcanic ash typically loses considerable strength when disturbed; therefore, this unit is generally unsuitable as a bearing surface or as fill material.

- **Glacial Drift.** The glacial drift encountered was primarily greenish gray, dense to very dense, moist to wet, poorly graded gravel with sand and included some sub-rounded cobbles and boulders. Silt and/or clay are also occasionally present in the soil matrix. This glacial drift is typically well drained, but may be less permeable where it has increased fine-grained content. The average moisture content measured was 8%. This unit is generally suitable as a bearing surface or as fill material.

- **Ancient Landslide.** This unit is composed of varying mixtures of volcanic ash, glacial drift, and organic materials. These deposits are typically reddish brown, moist to wet, compact to dense, and vary in thickness from 1.5 ft to 18.5 ft. The average moisture content was 27%. Landslide deposits commonly exhibit characteristics of disturbed volcanic ash and are generally unsuitable as a bearing surface or as fill material.

- **Fill Materials.** Existing road grades are generally capped with angular, gravelly to cobble fill that is dry to moist, poorly graded, and derived from crushed rock. The average fill depth is about 3 ft and varied from 1.5 ft to over 12 ft thick. Fill is typically composed of crushed rock, although organics and disturbed volcanic ash were observed incorporated into fill material in one location at Test Pit TP-04
(see Appendix A). The average moisture content was 3%. Except for the poorly graded material and the organics and volcanic ash observed in Test Pit TP-14, the fill materials generally appear to meet the Type A material designation specified in the 2002 CBS Standard Specifications.

4.2 Bedrock

Bedrock was encountered in only Test Pit TP-11, located on Brightman Street, at a 13.5 ft depth where the excavator met refusal. No sample could be collected, but the rock is believed to be argillite, as some argillite cobbles and boulders were found in Test Pit TP-11 and in the local vicinity. No surface bedrock outcrops were found throughout the subdivision area.

4.3 Groundwater and Perched Water Tables

Groundwater was encountered in all of the test pits except for Test Pits TP-02 and TP-08. The average depth to groundwater was 7 ft, with a depth range of 2 ft to 15 ft. Areas of glacial drift and fill material were commonly well drained. Undisturbed volcanic ash deposits were moderately drained. Disturbed volcanic ash and ancient landslide deposits tended to be poorly drained, as well as glacial drift with greater silt and/or clay content.

Perched water tables were found in at least five test pits (TP-14 through TP-16 and TP-21) at an average depth of 3 ft, ranging from 1.5 ft to 4 ft depth. This perched water is believed to be caused by infiltrating surface water (rain or stream water) that is impeded by, and flows on top of a low permeability strata. The impermeable layer is commonly an ancient landslide that contains either disturbed volcanic ash with clay characteristics, or clay-rich glacial drift. Where perched water tables were observed, soils below the impermeable layer are often moist, unsaturated and exhibit good drainage.

4.4 Stratigraphy at Existing Roads

The existing roads in the subdivision are capped with fill and unpaved, as shown in Figure 4. To achieve an even grade, previous contractors employed a series of moderate cuts where the road intersects local ridges and fill areas where the road crosses drainages.
Test pits excavated within and adjacent to the road generally encountered coarse fill materials 1.5 ft to over 12 ft thick overlying landslide, ash, or glacial drift deposits. An example of the typical stratigraphy along the existing roads is shown in Photo 2, Figure 4. Except for Test Pits TP-04 and TP-14, where the fill was 6 ft and over 12 ft thick, respectively, the average fill thickness was about 2 ft. As described in Section 4.1, the fill materials were generally composed of angular crushed rock in the form of poorly to well-graded gravel with sand (GP, GW) including cobble-sized materials. Fines content of these fill materials appeared to be less than 6%; therefore, this material appears to have a low frost susceptibility and may be non-frost susceptible (NFS).

4.5 Stratigraphy of Proposed Tank Site 1

Proposed Tank Site #1 is located on a prominent ridge at a 400 ft elevation. The local ridge is heavily forested with healthy hemlock and spruce trees ranging in diameter from 3 to 36 in. (Photo 1, Figure 5). Extensive soil probing in the area with the steel rod met refusal in cobbles, boulders, or bedrock at an average depth of 5.5 ft and varied between 2 ft and 8.5 ft.

Due to the rugged terrain, the excavator could not access the site. However, Test pit TP-01 was dug manually at this site to a depth of 7 ft and generally encountered volcanic ash overlying sub-angular cobbles and boulders. Bedrock may lie at a shallow distance below the cobbles and boulders, but could not be verified. Detailed stratigraphy of Test Pit TP-01 is presented in Appendix A, but can be summarized as:

- 0 ft – 2 ft: Forest floor organics (peat)
- 2 ft – 6.5 ft: Volcanic ash
- 6.5 ft and deeper: Glacial drift

4.6 Stratigraphy at Proposed Tank Site 2

Proposed Tank Site #2 is at an elevation of about 240 ft and was the lowest of the three potential tank sites investigated. The subsurface materials at the site are dominated by ancient landslide deposits that are interpreted to have descended from the drainages and gullies immediately upslope. The site is currently well forested with healthy hemlock and spruce trees ranging in diameter from 3 in. to 30
in. (see Photo 1, Figure 6). Based on surface observations, the landslide deposits did not appear to be presently active or mobile.

Four test pits (TP-17 through TP-20) were excavated at Tank Site #2 (Figure 2), revealing large volumes of ancient landslide and volcanic ash deposits. Glacial drift materials at this site were encountered at an average depth of about 17 ft below the ground surface, ranging in depth from about 7 ft to 23 ft. Based on the subsurface conditions observed in the four test pits, the stratigraphy at Tank Site #2 can be generalized as:

- 0 ft – 0.5 ft: Forest floor organics (peat)
- 0.5 ft – 11.5 ft: Ancient landslide, rich in volcanic ash
- 11.5 ft – 17 ft: Volcanic ash
- 17 ft and deeper: Glacial drift

4.7 Stratigraphy of Proposed Tank Site 6

At the request of USKH, exploration for suitable tank locations other than Site #1 and #2 identified a location 200 ft. south of the proposed Tank Site #4 (Figure 2). USKH has identified this as Tank Site #6 and CBS has selected this site as the preferred tank location.

Three test pits (TP-15, TP-16 and TP-21) were excavated in the vicinity of Site #6. Test Pit TP-16 (Photo 2, Figure 7) is considered most representative of the site and revealed 11 ft of overburden above the glacial drift with the following stratigraphy:

- 0 ft - 2 ft: Forest peat and organics
- 2 ft - 4 ft: Ancient landslide
- 4 ft - 11 ft: Volcanic Ash
- 11 ft and deeper: Glacial Drift
The volcanic ash encountered in Test Pit TP-16 was composed of three distinct strata that appeared significantly coarser than ash observed in other test pits during our investigation. In field examination, these strata do not exhibit the clayey character typical of the ash in other test pits.

Test Pit TP-21 was excavated approximately 60 ft south of Test Pit TP-16 to verify the depth to glacial drift. Subsurface materials and stratigraphy in these two test pits were similar, but the glacial drift in Test Pit TP-21 was encountered at a shallower depth of 7 ft. Glacial drift materials were also encountered at a depth of 7 ft in Test Pit TP-15, which was excavated about 300 ft downslope.

4.8 Culverts and Surface Drainage

No notable points of mass erosion were observed due to water drainage or slope instability during our investigation. However, mild erosion of road surface material was noted due to hillside drainage flowing atop the road at two locations: the first location is 50 ft. NW of Test Pit TP-08 at the intersection of Kramer Avenue and Hope Street and the second location is 100 ft southeast of the intersection of Kramer Avenue and Brightman Street at the base of a small drainage that descends westward and crosses Kramer Avenue. Culverts should be considered at these two locations as part of the future road upgrades.
5.0 RECOMMENDATIONS

5.1 Water Tank Location

Based on the field investigation, Tank Site #6 appears to be the most favorable location for the proposed water tank due to the site elevation, which is about 370 ft, and relative shallow depth of glacial drift materials. Since the CBS has selected Tank Site #6 as their preferred option, additional investigation in this area is not necessary except to establish better accuracy for estimating material quantities.

5.2 Water Tank Foundation

The design of any structure’s foundation must consider the bearing support capacities of the underlying soils as well as the expected settlements and the effects of seasonal frost action. Due to the unsuitable nature of the overburden materials above the glacial drift (organics, volcanic ash, and landslide materials), we recommend constructing the water tank foundation over the denser and more stable glacial drift.

Preparation of the site would consist of excavating the overburden materials to expose the glacial drift layer. To construct a level foundation, a combination of cut (upslope) and fill (downslope) will be required, as shown in Figure 8. Since the glacial drift materials appear to be generally adequate for use as structural fill, the section should consider balancing the cut and fill quantities to limit use of imported materials. Bench cuts into the glacial drift will be necessary across the downslope fill section to provide a level fill surface. Long term cut slopes should be a minimum of $2H:1V$ (horizontal to vertical) in the overburden materials above the glacial drift and $1.5H:1V$ in the glacial drift. Minimum $1H:1V$ slopes can be used for the short term during construction; however, cut slopes used during construction should be done according to OSHA and should be the responsibility of the contractor.

The structural fill should be composed of granular mineral soil that is not gap-graded with a maximum 10% passing the No. 200 sieve and a maximum 6 in. particle size. The structural fill should be placed and compacted in lifts not to exceed 12 in. loose thickness and compacted to 95% of the optimum dry density as determined by the Modified Proctor test (ASTM D1557). The glacial drift materials should be adequate for use as structural fill; however, the materials may require drying
prior to placement to reduce the relatively high natural moisture content to near optimum moisture content, which is expected to be about 8%. Segregation of cobbles and boulders should also be anticipated. Prior to backfilling, the excavated area should be proof-rolled and inspected to assure that all soft, frozen, ash deposits, or organic materials have been removed and the surface prepared to provide a firm, stable base.

Final grades have not been established at this time, but we recommend a minimum 18 in. of well-graded sand and/or gravel, non-frost susceptible (NFS) (maximum 6% passing the No. 200 sieve) structural fill be placed and compacted underneath and a minimum 18 in. outside of the water tank perimeter. NFS structural fill should also be placed and compacted in lifts not to exceed 12 in. loose thickness and compacted to 95% of the optimum dry density as determined by the Modified Proctor test (ASTM D1557).

Positive drainage should be provided for the final grades so that runoff will quickly flow away from the structure. Care should be taken in the site layout to avoid ponding of water adjacent to the structure.

Exposed overburden soil consisting of ash, landslide, or organic deposits, can be stabilized locally on 2H:1V cut slopes by revegetating the area using an erosion control blanket or flexible growth membrane.

5.2.1  Footing Design Parameters

Perimeter ring-wall footings should be designed according to the following criteria:

- Min 36 in. embedment depth
- Min. 16 in. footing width
- Max. allowable bearing capacity of 4,000 psf for static loadings (dead and live)

Allowable bearing capacities can be multiplied by 1.33 for short term wind and seismic loads. These allowable bearing pressures assume that the footing bears on compacted materials prepared according to our recommendations. The recommended footing depth is in compliance with local building codes to resist the possible effects from seasonal frost.
5.2.2 Settlements

The amount of settlements that will occur at the site will depend upon the applied loads, the subgrade reaction of the support soils, and the care that structural fill are placed and compacted. For the loadings anticipated for this structure, the total estimated maximum settlement will be about 1 in. with a differential settlement of about 1/2 of the total settlements. These total and differential settlements could increase considerably if the unsuitable soils are not removed and/or structural fills placed under the structure are not properly compacted. The greatest amount of settlement will occur after filling the tank. Some rebound should also be expected after the tank has been drained.

5.2.3 Seismic

Based on our observations during the excavation and hand probes, and in accordance with the 2000 International Building Code (IBC), we recommend using a classification of D (stiff soil profile) for the site. Based on the local structural design criteria, spectral response accelerations (maximum considered ground motions) for the site should be $S_s = 0.97g$ and $S_l = 0.50g$ for the short and long periods, respectively. According to the IBC, the Seismic Design Category is D; therefore, the geotechnical study should address slope stability, liquefaction, surface rupture, and lateral pressures. Our foundation design recommendations, as described in previous sections, are intended to mitigate these potential hazards such that the structure and cut/fill slopes do not experience loss of support during a seismic event. It is possible that some slope failure may occur as a result of liquefaction and/or lateral spreading of the loose ash, landslide, or organic deposits in the cut slope; however, it is not unreasonable in terms design of the water tank.

5.3 Roads

Based on the 12 test pits that were excavated in the existing roads as part of our investigation, the fill materials we encountered appear satisfactory for use as a subgrade for the existing road construction. Considering there is about 13,400 lf of roadway proposed for the subdivision, additional investigation may be warranted to verify subsurface conditions are as expected. The Alaska Department of Transportation and Public Facilities suggest spacing explorations at 500 ft intervals in fill sections and 300 ft intervals in cut sections.
5.3.1 Structural Section Options for Paved Roads

We considered several design methods for the proposed asphalt roads including:

- The non-frost method that prevents frost penetration into the frost susceptible subgrade materials;
- The limited subgrade frost penetration method used to control pavement distortion caused by frost heave; and,
- The reduced subgrade strength method that considers the loss in subgrade support capacity during breakup when the ground is thawing.

Taking into account the moderate frost susceptibility of the subgrade (ash and/or glacial drift) and the associated frost penetration in the winter, a fill section at least 36 in. thick is required for a non-frost design. For a limited subgrade frost penetration design, the fill section should be at least 32 in. thick. A minimum 18 in. fill section should be used for a reduced subgrade strength design. A comparison of these sections, including the standard section used by the CBS, is shown in Table 2.

Choice of the structural section is based on a number of factors including cost, desired level of service and need for continued maintenance/crack sealing. In general, roads constructed according to the non-frost design criteria perform well, but their cost is relatively high. Roads built to a lesser, minimum structural thickness need to accommodate reduced subgrade strength will have a shorter life, lower level of service (i.e., there will be more frost heaves and cracking), and ongoing maintenance will likely be required.

Given our understanding of the site conditions, we recommend the existing roads should be constructed with the Standard CBS Section listed in Table 2, which includes 24 in. of Type A selected material in the subbase and is expected to perform similarly to the non-frost section. Our investigations indicate that there is at least 1.5 ft of fill material that generally meets the Type A specification already in place; therefore, we anticipate that a limited amount of additional Type A material would be required to achieve the design section thickness. This fill section will also provide similar performance for new roads constructed beyond those already existing.
Groundwater decreases pavement life and performance; therefore, positive drainage along ditches should be established as needed. Excavations should also be graded so that they do not create depressions where shallow groundwater flow will accumulate.

5.3.2 Structural Section for Gravel Roads

Gravel surfaced roads within the subdivision under the anticipated conditions should have a minimum 10 in. structural section consisting of 4 in. of base course (CBS Grading D-1) overlying 6 in. of CBS Grading B subbase. The base course and subbase thicknesses can each be reduced by 2 in. for the water tank access road given the limited traffic that is expected. CBS Type A material should be used to fill in low areas to meet road grades.

5.3.3 Road Excavations

All organic-rich soils should be removed from the subgrade. The in-situ soil exposed at the base of the excavation should be proof rolled using a heavy, smooth drum roller prior to backfill. Pumping soil should be over-excavated 1 ft and a layer of filter fabric should be placed prior to backfilling with free-draining crushed gravel. A non-woven geotextile should be placed between new fill and silty subgrade, where applicable, to prevent silt from migrating into the new road structural section. All soil placed during construction should be protected from freezing during placement in the winter.
6.0 USE OF REPORT

This report has been prepared for the use of USKH Inc. and the City and Borough of Sitka for design of the proposed Whitcomb Heights Subdivision in Sitka, Alaska. If there are significant changes in the nature, design, or location of the facilities, we should be notified so that we may review our conclusions and recommendations in light of the proposed changes and provide a written modification or verification of the changes.

There are possible variations in subsurface conditions between explorations and also with time. Therefore, inspection and testing by a qualified geotechnical engineer should be included during construction to provide corrective recommendations adapted to the conditions revealed during the work.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by a limited number of explorations or soil samples. Such unexpected conditions frequently result in additional project costs in order to build the project as designed. Therefore, a contingency for unanticipated conditions should be included in the construction budget and schedule.

The work program followed the standard of care expected of professionals undertaking similar work in the State of Alaska under similar conditions. No warranty expressed or implied is made.
We appreciate the opportunity to assist USKH and the City and Borough of Sitka with this project. If you have questions or require additional information, please contact one of the undersigned at (907) 344-6001.

Sincerely,

GOLDER ASSOCIATES INC.

Steven L. Anderson, P.E.
Associate and Senior Geotechnical Engineer

Robert G. Dugan, R.P.G.
Principal and Office Manager

SLA/RGD/mlm
8.0 REFERENCES


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<th>Test Pit Number</th>
<th>Sample Number</th>
<th>Sample Depth (ft)</th>
<th>Moisture Content (%)</th>
<th>Grain Size Distribution (%)</th>
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<td>2</td>
<td>4.5-5.5</td>
<td>12%</td>
<td>72 26 3</td>
<td></td>
<td>GW</td>
<td></td>
</tr>
<tr>
<td>TP-04</td>
<td>1</td>
<td>2.0-2.5</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0-5.5</td>
<td>119%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-05</td>
<td>1</td>
<td>2.0-2.5</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0-5.5</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10.0-11.0</td>
<td>113%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-07</td>
<td>1</td>
<td>2.5-3.0</td>
<td>8%</td>
<td></td>
<td></td>
<td>GP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0-5.5</td>
<td>9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-08</td>
<td>1</td>
<td>2.5-3.0</td>
<td>3%</td>
<td>79 17 4</td>
<td></td>
<td>GP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.5-5.5</td>
<td>77%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10.0-11.0</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-09</td>
<td>1</td>
<td>2.5-3.0</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0-5.5</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-10</td>
<td>1</td>
<td>3.5-4.0</td>
<td>6%</td>
<td></td>
<td></td>
<td>NP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.0-8.0</td>
<td>9%</td>
<td>69 25 6</td>
<td></td>
<td>GP-GM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10.0-10.75</td>
<td>67%</td>
<td>1 84 15</td>
<td></td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>TP-11</td>
<td>1</td>
<td>2.5-3.5</td>
<td>69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.0-8.0</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-12</td>
<td>1</td>
<td>4.0-5.0</td>
<td>83%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6.0-7.0</td>
<td>59%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-13</td>
<td>1</td>
<td>2.0-2.5</td>
<td>81%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-15</td>
<td>1</td>
<td>4.5-5.0</td>
<td>17%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6.5-7.0</td>
<td>17%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-16</td>
<td>1</td>
<td>4.5-5.0</td>
<td>91%</td>
<td>1 64 34</td>
<td></td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.5-8.0</td>
<td>48%</td>
<td>15 81 4</td>
<td></td>
<td>SP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9.0-10.0</td>
<td>42%</td>
<td>14 85 1</td>
<td></td>
<td>SP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>17.0-18.0</td>
<td>10%</td>
<td>50 38 12</td>
<td></td>
<td>GM</td>
<td></td>
</tr>
<tr>
<td>TP-17</td>
<td>1</td>
<td>3.0-3.5</td>
<td>62%</td>
<td></td>
<td></td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.0-8.0</td>
<td>63%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>17.0-18.0</td>
<td>71%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-18</td>
<td>1</td>
<td>4.0-5.0</td>
<td>17%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10.0-11.0</td>
<td>165%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>18.0-19.0</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP-20</td>
<td>1</td>
<td>5.5-6.5</td>
<td>51%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES: 1) PL=Plastic Limit, LL=Liquid Limit, PI=Plastic Index.
2) USCS=Unified Soil Classification System
## Table 2
Summary of Section Thicknesses for Asphalt Pavements

<table>
<thead>
<tr>
<th>Layer</th>
<th>CBS Standard Section</th>
<th>Non-Frost Section</th>
<th>Limited Subgrade Frost Penetration Section</th>
<th>Reduced Subgrade Strength Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Pavement</td>
<td>2.25 in. (or minimum required by CBS)</td>
<td>2.25 in. (or minimum required by CBS)</td>
<td>2.25 in. (or minimum required by CBS)</td>
<td>2.25 in. (or minimum required by CBS)</td>
</tr>
<tr>
<td>Base</td>
<td>4 in Base Course, Grading D-1</td>
<td>4 in Base Course, Grading D-1</td>
<td>4 in Base Course, Grading D-1</td>
<td>4 in Base Course, Grading D-1</td>
</tr>
<tr>
<td>Subbase</td>
<td>6 in. Subbase, Grading B</td>
<td>6 in. Subbase, Grading B</td>
<td>6 in. Subbase, Grading B</td>
<td>6 in. Subbase, Grading B</td>
</tr>
<tr>
<td></td>
<td>24 in. Selected Material, Type A</td>
<td>26 in. Selected Material, Type A</td>
<td>22 in. Selected Material, Type A</td>
<td>8 in. Selected Material, Type A</td>
</tr>
</tbody>
</table>

Notes:  
2. Non-woven separation geotextile should be placed at the base of all excavations.  
3. Base of excavations should be graded so that they do not form a depression where shallow groundwater can collect.
FIGURES
PROJECT LOCATION MAP
WHITCOMB HEIGHTS GEOTECH.
SITKA, AK

SCALE AS SHOWN
CADD
DATE 10/29/07
CHECK RGD

Golder Associates
Anchorage, Alaska

FILE No. PROJLOC.CDR
PROJECT No. 073-95050

USKH / WHITCOMB HEIGHTS GEOTECH / AK
FIGURE 1
LEGEND

- TP-01  TEST PIT LOCATION

1. BASE DRAWINGS PROVIDED BY USKH.

NOTES

2. TEST PIT TP-19 (NOT SHOWN) IS LOCATED ABOUT 50 FT SOUTHEAST OF TEST PIT TP-18.
PHOTO 1: Typical view of existing subdivision road. Photograph taken looking south from Test Pit TP-14 on Cushing Street.

0 ft to 2 ft: Shot Rock Fill Materials

2 ft to 5.5 ft: Volcanic Ash

5.5 ft to 14 ft: Glacial Till

PHOTO 2: Test Pit TP-11 exhibits typical stratigraphy beneath existing road grade.
PHOTO 1: View south across slope at proposed Tank Site #1.

PHOTO 2: Test Pit TP-01 hand excavated at proposed Tank Site #1.
PHOTO 1: Proposed Tank Site #2 is located in an area dominated by thick landslide and volcanic ash deposits. Trees in background of photo are unstable due to near saturated ground conditions.

0 ft to 1 ft: Organics

1 ft to 5 ft: Ancient Landslide, rich in organics

5 ft to 11 ft: Ancient Landslide, rich in glacial till

11 ft to 19 ft: Ancient Landslide, dominantly volcanic ash

PHOTO 2: Test Pit TP-20 at proposed Tank Site #2. Three separate landslide strata are visible composed of varying materials. Glacial till encountered at 23 ft depth.
PHOTO 1: View across slope at proposed Tank Site #6 and location of Test Pit TP-16.

0 ft to 2 ft: Organics
2 ft to 4 ft: Ancient Landslide, rich in glacial till
4 ft to 6 ft: Volcanic Ash, medium sand
6 ft to 9 ft: Volcanic Ash, coarse sand
9 ft to 11 ft: Volcanic Ash, fine gravel
11 ft to 24 ft: Glacial Till

PHOTO 2: Test Pit TP-16 showing multiple layers of volcanic ash. The excavation remained well drained despite large volume of water flowing into pit from perched water table at 2 ft depth.
1. EXCAVATE OVERBURDEN MATERIALS (PEAT, VOLCANIC ASH, AND/OR LANDSLIDE DEPOSIT) TO EXPOSE GLACIAL DRIFT LAYER. MIN. 1H:1V TEMPORARY CUT SLOPES OR AS REQUIRED BY OSHA.

2. STABILIZE EXPOSED OVERBURDEN MATERIALS IN CUT SLOPES WITH REVEGETATED EROSION CONTROL BLANKET OR FLEXIBLE GROWTH MEMBRANE.

3. STRUCTURAL FILL MATERIALS TO BE CONSTRUCTED BY COMPACTING IN MAX. 12 IN. LOOSE LIFTS TO 95% RELATIVE DENSITY.

4. GRADE SURFACES TO DRAIN.

NOTES
If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

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

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

(c) Refer to text of ASTM D 1586-99 for a definition of N; in normally consolidated cohesionless soils relative density terms are based on N values corrected for overburden pressures (N_p). N_p values may be affected by a number of factors including material size, depth, drilling method, and bore-hole disturbance. N values are only an approximate guide to the consistency of cohesive and frozen soil.

(d) Undrained shear strength, s_u = 1/2 unconfined compression strength, U_c.

Component Definitions by Gradation

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

Figure A-1

SOIL CLASSIFICATION / LEGEND

Relative Density or Consistency Utilizing Standard Penetration Test Values

<table>
<thead>
<tr>
<th>Cohesionless Soils (a)</th>
<th>Cohesive Soils (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>N_5 blows (c)</td>
</tr>
<tr>
<td>Very loose</td>
<td>0 to 4</td>
</tr>
<tr>
<td>Loose</td>
<td>4 to 10</td>
</tr>
<tr>
<td>Compact</td>
<td>10 to 30</td>
</tr>
<tr>
<td>Dense</td>
<td>30 to 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>over 50</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Criteria for Describing Moisture Condition

- **Dry**: Absence of moisture, dusty, dry to the touch
- **Moist**: Damp but no visible water
- **Wet**: Visible free water, usually soil is below water table

Descriptive Terminology Denoting Component Proportions

<table>
<thead>
<tr>
<th>Trace</th>
<th>Little</th>
<th>Some</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5%</td>
<td>5 - 12%</td>
<td>12 - 30%</td>
</tr>
</tbody>
</table>

Samples

- **SS**: SPT Sampler (2 in. O.D.)
- **SSO**: Over size SPT (2.5 in. O.D.)
- **HD**: Heavy Duty Spoon (3.0 in. O.D.)
- **SH**: Shelby Tube
- **P**: Pitcher Sampler
- **B**: Auger Cuttings or Grab Sample (Bulk)
- **C**: Cored
- **RC**: Air Rotary Cuttings
- **AC**: Auger Core

1. SS drive samples advanced with 140 lb. hammer with a 30 in. Drop.
2. SSO drive samples advanced with 140 lb. hammer with a 30 in. Drop.
3. HD drive samples are advanced with 300 lb. hammer with a 30 in. drop.
Notes:
1) Groundwater encountered at 3.0 ft
2) No bedrock encountered
3) Ash appears to be on top of glacial drift boulders. Difficult to dig deeper by hand and impossible to positively identify glacial drift below.
4) Slow water flow into pit from 3 ft level. Water is coming from saturated peat layer.
5) Pt is hand-dug at site of fallen tree. Tree root-wad has pulled up the top 2.5 ft of soil.
6) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-04-42.43 N
   LONG: 135-21-45.13 W
   175 ft NW of proposed Tank Site #1

Test Pit completed at 6.5 ft.
Sample #1 Sieve Analysis Results:
74% gravel, 21% sand, 5% fines

Notes:
1) No groundwater encountered.
2) Strata thickness is variable in pit and slope according to local topography.
3) Slope 15 ft to east of pit appears to be all volcanic ash, 8-12 ft thick.
4) GPS coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-05-25.93 N
   LONG: 135-22-42.51 W

Test Pit completed at 12.0 ft.

Notes:
1) No groundwater encountered.
2) Strata thickness is variable in pit and slope according to local topography.
3) Slope 15 ft to east of pit appears to be all volcanic ash, 8-12 ft thick.
4) GPS coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-05-25.93 N
   LONG: 135-22-42.51 W
Sample #2 Sieve Analysis Results:
72% gravel, 26% sand, 3% fines

Notes:
1) Groundwater encountered at 3.5 ft. Large volume water flowing into, and filling pit at 9.5 ft.
2) Moist above 2.5 ft, wet 2.5-3.5 ft, saturated below 3.5 ft.
3) Located on Beluga Street.
4) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-05-19.07 N
   LONG: 135-22-41.88 W

Test Pit completed at 11.0 ft.
### Notes:
2. Refusal at 12 ft in large boulders 4-10 ft diameter.
3. Ash layer is disturbed, soft, with organics (roots, tree limbs), but has angular shot rock beneath. This probably occurred during fill in road construction.
4. Location is the north intersection of Kramer and Hope Street.
5. Intersection is on a large fill (3 ft deep on uphill side, 25 ft on downhill).
6. Water is draining from toe of fill downslope of pit at approx 5 cfs. No culvert or stream source presence, so water must be infiltrating through road fill.

---

### Soil Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>WATER CONTENT (%), W</th>
<th>WATER LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.5</td>
<td>Compact, gray, dry, well-graded GRAVEL fill with sand. Angular gravel, shot rock source. (GW, FILL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 - 3.0</td>
<td>Compact, gray, moist, COBBLES, some gravel and sand (30%), trace boulders (&lt;24 in.). Angular aggregate, shot rock source. (Cobbles, FILL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0 - 5.5</td>
<td>Loose, reddish brown, moist, silty SAND, some organics mixed in matrix, lenses of stiff cohesive clay present. (SM, Volcanic Ash FILL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 - 12.0</td>
<td>Loose to compact, gray, moist, COBBLES, some gravel. Angular cobbles up to 18 in. diameter, about 10% boulders (&lt;24 in.) above 8 ft depth, increasing to 10 ft diameter below 8 ft depth. (Cobbles, FILL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Test Pit completed at 12.0 ft.**
113

GRAB

15.5

9.0

7.0

3 ft

0.0 - 1.5
Loose to compact, grayish brown, moist, poorly
graded GRAVEL with sand, trace organics, cobbles (<9 in.) present. Aggregate is angular, shot rock source. (GP, Fill)

1.5 - 7.0
Loose to compact, reddish brown, moist to wet
(wet below 3 ft), poorly graded SAND with gravel,
cobbles (30%) present. Cobbles are sub-angular (<12 in.) and unsorted in sand matrix. Ancient Landslide, suggested by mixture of volcanic ash and glacial drift. (SP, Ancient Landslide)

7.0 - 9.0
Compact, black, wet, silty SAND with organics.
Undisturbed ancient organic/volcanic ash layer
covered by landslide. (SM, Peat/Volcanic Ash)

9.0 - 15.5
Dense, reddish brown, wet, silty SAND. Angular sand. (SM, Volcanic Ash)

15.5 - 16.5
Dense, gray, wet, poorly graded GRAVEL with sand, some cobbles and boulders present. Subrounded aggregate. (GP, Glacial Drift)

Test Pit completed at 16.5 ft.

Notes:
1. Groundwater encountered at 3.0 ft.
2. Pit filled with water up to 14 ft.
3. Landslide deposits like this are reported as typical for Sitka area by operator. Material on banks/side cuts of pit are similar to landslide layer in pit and common throughout subdivision.
4. Location: Near end of Witz Lane.
5. GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
LAT: 57°05′17.71″ N
LONG: 135°22′31.84″ W

Notes:
1) Groundwater encountered at 3.0 ft.
2) Pit filled with water up to 14 ft.
3) Landslide deposits like this are reported as typical for Sitka area by operator. Material on banks/side cuts of pit are similar to landslide layer in pit and common throughout subdivision.
4) Location: Near end of Witz Lane.
5) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
LAT: 57°05′17.71″ N
LONG: 135°22′31.84″ W

Notes:
1) Groundwater encountered at 3.0 ft.
2) Pit filled with water up to 14 ft.
3) Landslide deposits like this are reported as typical for Sitka area by operator. Material on banks/side cuts of pit are similar to landslide layer in pit and common throughout subdivision.
4) Location: Near end of Witz Lane.
5) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
LAT: 57°05′17.71″ N
LONG: 135°22′31.84″ W
**VEGETATION:** None

**DESCRIPTION:**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>SOIL PROFILE</th>
<th>WATER CONTENT (PERCENT)</th>
<th>NOTES AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 3.5</td>
<td>Loose to compact, gray, dry, COBBLES, some gravel and sand, trace organics, boulders (8%) present. Angular aggregate. (GP, FILL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5 - 14.5</td>
<td>Loose to dense, brown, wet, silty SAND, trace clay, cobbles (30%, &lt;12 in.) and boulders (5%, &lt;30 in.) present. Organics include tree roots/limbs. Ancient landslide mixture of volcanic ash and glacial drift. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Pit completed at 14.5 ft.

Notes:
1) Groundwater encountered at 4.0 ft, flowing into pit and filling up to 13.5 ft.
2) GPS Coordinates (NAD27, Deg-Min-Sec.decimal):
   - LAT: 57-05-12.53 N
   - LONG: 135-22-27.36 W

**EXCAVATION DATE:** 9/13/07

**EQUIPMENT:** Hitachi 160

**GS ELEVATION:** 153 ft

**DATUM:** Ground Surface

**COORDS:** n/a

**TOC ELEVATION:**

**EXCAVATION DATE:** 9/13/07

**EQUIPMENT:** Hitachi 160

**GS ELEVATION:** 153 ft

**DATUM:** Ground Surface

**COORDS:** n/a

**TOC ELEVATION:**

**TEST PIT TP-06**

**LOCATION:** Sitka, AK

**PROJECT:** Sitka Whitcomb Subdivision Geotech

**PROJECT NUMBER:** 073-95050

**CLIENT:** USKH

**CONTRACTOR:** Twaddle's Excavation

**OPERATOR:** Jeremy Twaddle

**DATE:** 11/13/2007

**LOGGED:** H Henry

**CHECKED:** SLA

**Figure:** A-7
WRITE TEXT HERE
Sample #1 Sieve Analysis Results:
79% gravel, 17% sand, 4% fines

Sample #2 Atterberg Limits Results:
PL = NP, LL = 121

Sample #3 Atterberg Limits Results:
PL = NP, LL = 15

Notes:
1) No groundwater encountered. Pit is very well drained.
2) Located at south intersection of Kramer Avenue and Hope Street.
3) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
LAT: 57.05.07.60 N
LON: 135.22.30.73 W

0.0 - 0.5
Loose, gray, dry, poorly graded GRAVEL with sand. Angular gravel and sand, shot rock source. (GP, FILL)

0.5 - 3.0
Loose to compact, gray, dry, poorly graded GRAVEL with sand, trace silt, cobbles (25%) and trace boulders (<20 in.) present. Angular aggregate, shot rock source. (GP, FILL)

Sample #1 Sieve Analysis Results:
79% gravel, 17% sand, 4% fines

3.0 - 7.0
Loose to compact, reddish brown, dry, silty SAND. Angular sand. (SM, Volcanic Ash)

7.0 - 14.0
Compact to dense, gray, dry, poorly graded GRAVEL with sand, cobbles (30%) and boulders (10%) present. Sub-rounded aggregate. (GP, Glacial Drift)

Test Pit completed at 14.0 ft.
### Characterization of Soil Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Type</th>
<th>Notes and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.5</td>
<td>Loose, gray, dry, COBBLES, some gravel (20%) and boulders (20%, &lt; 24 in.) present. Angular aggregate, shot rock source. (Cobbles, FILL)</td>
<td>Fill</td>
<td></td>
</tr>
<tr>
<td>2.5 - 16.5</td>
<td>Dense, gray, moist to wet, poorly graded GRAVEL with sand, cobbles (20%, &lt;8 in.) present. Sub-rounded aggregate, becomes moist below 9 ft. (GP, Glacial Drift)</td>
<td>GP</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes

1. Groundwater encountered at 15 ft, no ponding in well drained glacial drift.
2. Pit is dug in road, NW-SE orientation.
3. Road cut on both sides is glacial drift covered by volcanic ash. Approx. 10 ft was excavated for road grade (6 ft of glacial drift, 4 ft of ash).
4. GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57°05'02.23 N
   - LONG: 135°22'22.77 W

---

**Figure A-10**

- **DATE:** 11/13/2007
- **LOGGED:** H Henry
- **CHECKED:** SLA
- **OPERATOR:** Jeremy Twaddle
- **CONTRACTOR:** Twaddle's Excavation

---

**Participant Information**

- **DATE:** 9/14/07
- **EQUIPMENT:** Hitachi 160
- **EXCAVATION DATE:** 9/14/07
- **DATUM:** Ground Surface
- **GS ELEVATION:** 183 ft
- **COORDS:** n/a
Loose to compact, gray, moist, poorly graded GRAVEL with sand, cobbles (20%), and boulders (5%, <18 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)

Notes:
1) Groundwater encountered at 14.0 ft flowing into pit.
2) Landslide is indicated by inclusion of rounded, glacial cobbles in reddish brown matrix, inclusion of organics and fact that glacial materials overlies undisturbed volcanic ash layer.
3) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57°04'59.62 N
   LONG: 135°22'27.30 W
**RECORD OF TEST PIT TP-11**

**DESCRIPTION**

<table>
<thead>
<tr>
<th>VEGETATION: None</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>TYPE</th>
<th>NOTES AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.0</td>
<td>Fill</td>
<td>Graphic Log</td>
</tr>
</tbody>
</table>

**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.0</td>
<td>Loose to compact, gray, dry, poorly graded GRAVEL, cobbles (30%, &lt;12 in.) and boulders (15%, &lt;24 in.) present. Angular aggregate, shot rock source. (GP, Fill)</td>
</tr>
<tr>
<td>2.0 - 5.5</td>
<td>Compact, reddish brown, dry, silty SAND in horizontal bedding layers from 1 to 6 in. thick. (SM, Volcanic Ash)</td>
</tr>
<tr>
<td>5.5 - 13.5</td>
<td>Compact to dense, gray, moist to wet (below 8 ft), poorly graded GRAVEL with sand, cobbles (15%, &lt;9 in.) and boulders (5%, &lt;12 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)</td>
</tr>
<tr>
<td>13.5 - 14.0</td>
<td>Bedrock. Hard Graywacke.</td>
</tr>
</tbody>
</table>

**Notes:**
1) Groundwater encountered at 8.5 ft flowing into pit with slight ponding. Dry above 5.5 ft, moist from 5.5 to 8.5 ft.
2) Refusal at 14.0 ft is thought to be bedrock, but may be large boulder.
3) Culvert about 25 ft to NE of pit.
4) Downhill of pit, road fill is about 9 ft high.
5) Uphill of pit, slope is not cut for road grade.
6) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57°04'50.23 N
   - LONG: 135°22'22.04 W

**Figure A-12**

**Site: Sitka Subdivision Geotech**
**Project Number: 073-95050**
**Location: Sitka, AK**
**Client: USKH**

**Excavation Date:** 9/14/07
**Datum:** Ground Surface
**GS Elevation:** 109 ft
**Contractor:** Twaddle’s Excavation
**Operator:** Jeremy Twaddle
**Logged:** H Henry
**Checked:** SLA
**Date:** 11/13/2007

**Water Levels**

<table>
<thead>
<tr>
<th>ELEV. (ft)</th>
<th>WATER CONTENT (PERCENT)</th>
<th>WATER LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Log: 2.0**

**Graphic Log:**

**Logged:** H Henry
**Checked:** SLA
**Date:** 11/13/2007

**Water Contents (Percent):**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>WATER CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Soil Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Samples</th>
<th>Notes and Remarks</th>
<th>Water Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5</td>
<td>Loose, gray, dry, well-graded GRAVEL with sand. Angular, medium-grained aggregate, shot rock source. (GW, FILL)</td>
<td>Fill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 - 1.5</td>
<td>Compact, gray, poorly graded GRAVEL, cobbles (40%, &lt;10 in.) present. Angular aggregate. (GP, FILL)</td>
<td>Fill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 - 3.0</td>
<td>Loose to compact, yellowish brown, dry to moist, silty SAND, trace organics, cobbles (10%, &lt;8 in.) present. Organics mixed into matrix, aggregate is sub-rounded. (SM, Ancient Landslide)</td>
<td>SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0 - 5.0</td>
<td>Loose to compact, yellowish brown, moist, silty SAND, trace to little clay, stratified in layers 2 to 6 in. thick. (SM, Volcanic Ash)</td>
<td>SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0 - 8.0</td>
<td>Compact to dense, reddish brown, moist, poorly graded SAND. Angular sand. (SP, Volcanic Ash)</td>
<td>SP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0 - 12.0</td>
<td>Compact to dense, gray, wet, poorly graded GRAVEL with sand, cobbles (30%, &lt;10 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)</td>
<td>GP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Pit completed at 12.0 ft.

Notes:
1) Groundwater encountered at 8.0 ft filling bottom of pit.
2) Located 150 ft south of intersection of Kramer Avenue and Emmons Street.
3) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal): LAT: 57°44.4277 N
   LON: 135°22.0387 W

---

**EXCAVATION DATE:** 9/14/07  
**DATUM:** Ground Surface  
**GS ELEVATION:** 116 ft  
**PROJECT NUMBER:** 073-95050  
**LOCATION:** Sitka, AK  
**PROJECT: Sitka Whitcomb Subdivision Geotech**  
**CLIENT:** USKH  
**EQUIPMENT:** Hitachi 160  
**COORDS:** n/a  
**DATE:** 11/13/2007  
**LOGGED:** H Henry  
**CHECKED:** SLA  
**CONTRACTOR:** Twaddle's Excavation  
**OPERATOR:** Jeremy Twaddle  
**DATE:** 11/13/2007
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
<th>VEGETATION: None</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 1.5</td>
<td>Compact, gray, dry, poorly graded GRAVEL with sand, cobbles (30%, &lt;12 in) and boulders (5%, &lt;16 in.) present. Angular aggregate, shot rock source. (GP, Fill)</td>
<td></td>
</tr>
<tr>
<td>1.5 - 3.0</td>
<td>Compact, reddish brown, moist, silty SAND, trace clay in stratified layers from 1 to 6 in. thick. Angular medium to coarse-grained sand. (SM, Volcanic Ash)</td>
<td></td>
</tr>
<tr>
<td>3.0 - 14.0</td>
<td>Dense, gray, moist to wet (below 15 ft), poorly graded GRAVEL with sand, cobbles (30%, &lt;9 in.) and boulders (5%, &lt;15 in.) present. Sub-rounded aggregate, cobbles and boulder size increases with depth below 9 ft. (GP, Glacial Drift)</td>
<td></td>
</tr>
</tbody>
</table>

Test Pit completed at 14.0 ft.

Notes:
1) Groundwater encountered at 5.0 ft filling pit bottom.
2) Road has cuts on either side: 10 ft high cut to E, 4 ft high cut to W, 1:4:1 layback slope into volcanic ash and landslide deposits.
3) Natural / original land surface is approx 6 ft above current road grade. Estimated original stratigraphy above road fill grade: 0-3 ft volcanic ash (SM), 3.0 ft ancient landslide (SM, as described above). Small pit dug into slope to east of pit reveals the contact of volcanic ash and ancient landslide at 3 ft above road grade.
4) Located at intersection of Emmons Street and Humpback Street.
5) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57°04'47.58 N
   - LONG: 135°22'04.81 W

**NOTES AND REMARKS**

- WATER LEVELS
- EQUIPMENT: Hitachi 160
- GS ELEVATION: 228 ft
- CLIENT: USKH
- LOCATION: Sitka, AK
- PROJECT NUMBER: 073-95050
VEGETATION: None

0.0 - 6.0
Compact, gray, dry to moist, poorly graded GRAVEL with sand, cobbles (30%, 10 in.) and boulders (3%, <15 in.) present. Angular aggregate, shot rock source, dry to 2 ft, moist to 4 ft. (GP, FILL)

6.0 - 9.0
Compact, yellowish brown, moist to wet, silty SAND in stratified layers from 1 to 6 in. thick. (SM, Volcanic Ash)

9.0 - 13.5
Compact to dense, greenish gray, wet, poorly graded GRAVEL with sand, trace silt, cobbles (25%, <10 in.) and boulders (3%) present. Sub-rounded aggregate. (GP, Glacial Drift)

13.5 - 15.5
Compact, grayish brown, wet, poorly graded SAND with gravel, cobbles (5%) present. Angular aggregate. (SP, Glacial Drift)

Test Pit completed at 15.5 ft.

Notes:
1) Perched groundwater encountered at 4.0 ft, running into pit, filling slowly and producing pooling at 13.5 ft. Soil unsaturated/well-drained from 6 to 13.5 ft.
2) Located on Cushing Street.
3) Located on Cushing Street.
4) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-04-49.93 N
   LONG: 135-22-10.94 W

Perched W.T. at 4.0 ft

WATER CONTENT (PERCENT)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>WATER CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td></td>
</tr>
</tbody>
</table>

EXCAVATION DATE: 9/14/07
EQUIPMENT: Hitachi 160
GS ELEVATION: 220 ft

LOGGED: H Henry
CHECKED: SLA
DATE: 11/13/2007
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Notes and Remarks</th>
<th>Water Content (%)</th>
<th>Notes Water Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.0</td>
<td>Loose, black, wet, peat consisting of forest duff, moss, roots, decaying wood, and sand. (PT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0 - 5.0</td>
<td>Compact, gray, wet, silty sand with gravel, cobbles (25%, &lt;10 in.) present. Cobbles and gravel are sub-rounded. Clay lenses are present which prevent water infiltration. Ancient landslide with high glacial drift content. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0 - 7.0</td>
<td>Compact, reddish brown, moist, silty sand with gravel, trace clay, trace organics, cobbles (15%) present. Unstratified with random mixing of black organics. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.0 - 20.0</td>
<td>Dense, light brown, moist, well-graded gravel with sand, cobbles (15%, &lt;9 in.) and boulders (3%) present. Sub-rounded aggregate. (GW, Glacial Drift)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Log continued on next page
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0 - 22.0</td>
<td>Loose, light brown, moist, poorly graded SAND, trace gravel. (SP, Glacial Drift)</td>
<td>SP</td>
</tr>
</tbody>
</table>

Test Pit completed at 22.0 ft.

Notes:
1) Perched water table encountered at 2.0 ft flowing along contact of peat and ancient landslide (impermeable clay-rich boundary). Soil is unsaturated and well drained below landslide layer (5 ft).
2) Volcanic ash and glacial drift layers are very well drained, absorbing large volume of water flowing into pit from 5 ft level. Depth profile of moisture: 0-2 ft saturated, 2-5 ft wet, 5-22 ft moist.
3) Glacial drift has color more typical of volcanic ash, but is consistent with glacial drift in Test Pit TP-14 on Cushing Street.
4) Pit is located approx 225 ft W of culdesac on Emmons Street.
5) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57-04-53.70 N
   - LONG: 135-22-07.92 W
### Sample #1 Sieve Analysis Results:
1% gravel, 64% sand, 34% fines

### Sample #2 Sieve Analysis Results:
14% gravel, 85% sand, 1% fines

### Sample #3 Sieve Analysis Results:
15% gravel, 81% sand, 4% fines

### Sample #4 Sieve Analysis Results:
50% gravel, 38% sand, 12% fines

---

### Soil Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.0</td>
<td>Loose, black, wet, PEAT composed of forest duff, moss, roots, decaying wood, sand. (PT)</td>
<td>PT</td>
</tr>
<tr>
<td>2.0 - 4.0</td>
<td>Compact, yellowish brown, moist, poorly graded SAND, trace clay, cobbles (20%, &lt;8 in.) present. Cobbles are sub-angular to sub-rounded. (SP, Ancient Landslide)</td>
<td>SP</td>
</tr>
<tr>
<td>4.0 - 6.0</td>
<td>Compact, light brown, dry to moist, silty SAND, trace gravel. Medium grained sand. (SM, Volcanic Ash)</td>
<td>SM</td>
</tr>
<tr>
<td>6.0 - 9.0</td>
<td>Loose to compact, reddish brown, moist, poorly graded SAND, trace gravel. Course-grained in stratified layers from 2 to 6 in. thick, gravel is fine-grained. (SP, Volcanic Ash)</td>
<td>SP</td>
</tr>
<tr>
<td>9.0 - 11.0</td>
<td>Loose to compact, brown, moist, poorly graded SAND, little gravel, trace fines. Gravel is less than 0.5 in. (SP, Volcanic Ash)</td>
<td>SP</td>
</tr>
<tr>
<td>11.0 - 19.0</td>
<td>Dense to very dense, greenish gray, moist to wet, silty GRAVEL with sand, cobbles (25%, &lt;10 in.) present, and boulders (3%, &lt;30 in.) below 15 ft. Boulder size increases with depth. Moist above 15 ft, wet below. (GM, Glacial Drift)</td>
<td>GM</td>
</tr>
</tbody>
</table>
**RECORD OF TEST PIT TP-16**

**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
<th>ELEV. DEPTH (ft)</th>
<th>TYPE</th>
<th>WATER CONTENT (PERCENT)</th>
<th>WATER LEVELS</th>
<th>NOTES AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>19.0 - 21.0 Loose, brown, wet, poorly graded SAND. Course sand. (SP, Glacial Drift) (Continued)</td>
<td>21.0</td>
<td>SP</td>
<td></td>
<td>21.0</td>
<td>Test Pit completed at 24.0 ft.</td>
</tr>
<tr>
<td>21.0 - 24.0 Dense to very dense, greenish gray, poorly graded GRAVEL with sand, cobbles (25%, &lt;10 in.) and boulders (3%, &lt;30 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)</td>
<td></td>
<td>GP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1) Perched water table encountered at 2.0 ft. Surface water infiltrates, pools and flows along contact of Peat and ancient landslide (impermeable clay-rich boundary). Soil is unsaturated and well drained below landslide layer (5 ft).
2) Volcanic ash and glacial drift layers are very well drained, absorbing large volume of water flowing into pit from 5 ft level.
3) Three volcanic ash layers between 2 and 9 ft are each very poorly graded and may represent individual eruptions. Ash in this pit does not contain significant silt or clay and does not liquify when wetted and/or disturbed.
4) Thickness of landslide layer is variable and tapers to the south.
5) Located approx 525 ft W of Emmons Street cul-de-sac.
6) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-04-55.25 N
   LONG: 135-22-02.58 W
### Sample #1 Organic Content Results:
22% organics

<table>
<thead>
<tr>
<th>Depth Interval</th>
<th>Description</th>
<th>Samples</th>
<th>Notes and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.5</td>
<td>Loose, black, moist, PEAT composed of forest floor organics, moss, shrubs, and tree roots. (PT)</td>
<td>PT</td>
<td></td>
</tr>
<tr>
<td>0.5 - 6.0</td>
<td>Very loose, dark brown, moist, silty SAND, trace to little organics, cobbles (15%, &lt;9 in.) and boulders (2%, &lt;18 in.) present. Cobbles are sub-angular to sub-rounded, organics consist of tree roots. (SM, Ancient Landslide)</td>
<td>SM</td>
<td>1 GRAB</td>
</tr>
<tr>
<td>6.0 - 17.0</td>
<td>Compact, greenish brown, wet, poorly graded SAND with gravel, trace clay, cobbles (25%, &lt;9 in.) and boulders (8%, &lt;24 in.) present. Cobbles are sub-rounded. (SP, Ancient Landslide)</td>
<td>SP</td>
<td>2 BULK</td>
</tr>
<tr>
<td>17.0 - 19.5</td>
<td>Loose to compact, reddish brown, moist, silty SAND, little clay. Angular sand. (SM, Volcanic Ash)</td>
<td>SM</td>
<td>3 BULK</td>
</tr>
</tbody>
</table>

**Notes and Water Levels**
- Water Level: 62
- **Date**: 9/18/07
Notes:
1) Groundwater encountered at 6.0 ft.
2) Castings from pit are saturated and liquify with disturbance.
3) Material gets softer (more easily excavated) with depth.
4) Located at proposed Tank Site #2.
5) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-04-46.02 N
   LONG: 135-21-59-81 W

<table>
<thead>
<tr>
<th>VEGETATION: Dense Forest</th>
<th>WATER CONTENT (PERCENT)</th>
<th>NOTES WATER LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DEPTH SCALE: 1 in to 2.5 ft</th>
<th>LOGGED: H Henry</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td>35</td>
<td></td>
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</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PROJECT: Sitka Whitcomb Subdivision Geotech
PROJECT NUMBER: 073-95050
LOCATION: Sitka, AK
CLIENT: USKH

EXCAVATION DATE: 9/14/07
EQUIPMENT: Hitachi 160
DATUM: Ground Surface
COORDS: n/a
GS ELEVATION: 250 ft
TOC ELEVATION: 250 ft

CONTRACTOR: Twaddle's Excavation
OPERATOR: Jeremy Twaddle
DATE: 11/13/2007

Figure A-18
Pt

1.0 - 8.0
Compact, reddish brown, moist, poorly graded SAND with gravel, cobbles (25%, < 9 in.) and boulders (10%, <24 in.) present. Bands of black old, organic material mixed in a the 5-7 ft depth. Angular aggregate. (SP, Ancient Landslide)

SM

8.0 - 16.0
Compact, reddish brown, wet, silty SAND. Angular grains, stratified with layers 0.5 to 6.0 in. thick. (SM, Volcanic Ash)

GP

16.0 - 20.0
Compact to dense, greenish gray, wet, poorly graded GRAVEL with sand, cobbles and boulders (10%, <24 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
<th>USCS</th>
<th>ELEV. DEPTH (ft)</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>WATER CONTENT (PERCENT)</th>
<th>NOTES AND REMARKS</th>
<th>WATER LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 1.0</td>
<td>Loose, black, moist, PEAT composed of forest humus, moss, shrubs, tree roots, and decaying wood. (PT)</td>
<td>Pt</td>
<td>0.0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0 - 8.0</td>
<td>Compact, reddish brown, moist, poorly graded SAND with gravel, cobbles (25%, &lt; 9 in.) and boulders (10%, &lt;24 in.) present. Bands of black old, organic material mixed in a the 5-7 ft depth. Angular aggregate. (SP, Ancient Landslide)</td>
<td>SP</td>
<td>1.0</td>
<td>1</td>
<td>GRAB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0 - 16.0</td>
<td>Compact, reddish brown, wet, silty SAND. Angular grains, stratified with layers 0.5 to 6.0 in. thick. (SM, Volcanic Ash)</td>
<td>SM</td>
<td>8.0</td>
<td>2</td>
<td>BULK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.0 - 20.0</td>
<td>Compact to dense, greenish gray, wet, poorly graded GRAVEL with sand, cobbles and boulders (10%, &lt;24 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)</td>
<td>GP</td>
<td>16.0</td>
<td>3</td>
<td>BULK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Notes:**
1) Groundwater encountered at 6.0 ft.
2) Located at proposed Tank Site #2.
3) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57-04-45.30 N
   - LONG: 135-21-59.48 W

---

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>USCS</th>
<th>Elevation</th>
<th>Number</th>
<th>Type</th>
<th>Water Content (%)</th>
<th>Notes and Remarks</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>VEGETATION: Dense Forest</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

---

**Figure A-19**

---

**Ancillary Information:**
- **Project:** Sitka Whitney Subdivision Geotech
- **Project Number:** 073-95050
- **Location:** Sitka, AK
- **Client:** USKH
- **Excavation Date:** 9/14/07
- **Equipment:** Hitachi 160
- **Datum:** Ground Surface
- **Coordinates:** n/a
- **Logged:** H Henry
- **Checked:** SLA
- **Date:** 11/13/2007
- **Contractor:** Twaddle's Excavation
- **Operator:** Jeremy Twaddle
- **Depth Scale:** 1 in to 2.5 ft
- **Logged:** H Henry
- **Checked:** SLA
- **Date:** 11/13/2007

---

**Ancillary Information:**
- **Ancillary Test Pit:** SITKA_TEST_PITS.GPJ
- **Ancillary Model:** GLDR_ANC.GDT
- **Date:** 2/6/08

---

**Ancillary Information:**
- **Sitka Test Pit:** 2008
- **General:**
  - **Remark:** Twaddle's Excavation
  - **Operator:** Jeremy Twaddle
  - **Date:** 11/13/2007
  - **Project:** Sitka Whitney Subdivision Geotech
  - **Project Number:** 073-95050
  - **Location:** Sitka, AK
  - **Client:** USKH
RECORD OF TEST PIT TP-19

SOIL PROFILE

DEPTH (ft)

DESCRIPTION

0.0 - 0.5
Loose, black, moist, PEAT composed of black forest organics, moss, shrubs, tree roots, and decaying wood. (PT)

0.5 - 3.0
Compact, reddish brown, moist, poorly graded SAND with gravel, little organics, cobbles (25%, <9 in.) and boulders (10%, <24 in.) present. Bands of black, old organic material mixed in. (SP, Ancient Landslide)

3.0 - 7.0
Compact, reddish brown, wet, silty SAND stratified with 0.5 to 6.0 in. layers. Angular sand. (SM, Volcanic Ash)

7.0 - 9.0
Compact to dense, greenish gray, poorly graded GRAVEL with sand, cobbles and boulders (10%, <24 in.) present. Sub-rounded aggregate. (GP, Glacial Drift)

Test Pit completed at 9.0 ft.

Notes:
1) Groundwater encountered at 7.0 ft.
2) Pit dug quickly into hillside about 50 ft SE of Test Pit TP-18.
3) Test Pit TP-19 may be south margin of landslide that has come from drainage above. Extent unknown.
4) GPS Coordinates unknown.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Notes and Remarks</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.5</td>
<td>Loose, black, moist, PEAT composed of forest organics, moss, shrubs, roots, and decaying organics in silty sand. (PT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 - 5.0</td>
<td>Loose, dark brown, moist, silty SAND, little gravel and organics, cobbles present. Angular aggregate. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0 - 11.0</td>
<td>Compact, light brown, wet, poorly graded SAND with gravel, trace to little organics, cobbles (20%) and boulders (5%, &lt;18 in.) present. Angular aggregate. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.0 - 19.0</td>
<td>Dense, reddish brown, wet, silty SAND, little gravel. Angular aggregate. (SM, Ancient Landslide)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.0 - 23.0</td>
<td>Dense, reddish brown, wet, silty SAND. Angular sand. (SM, Volcanic Ash)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# RECORD OF TEST PIT TP-20

**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>DESCRIPTION</th>
<th>NOTES AND REMARKS</th>
<th>WATER CONTENT (%)</th>
<th>NOTES WATER LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0 - 23.0</td>
<td>Dense, reddish brown, wet, silty SAND. Angular sand. (SM, Volcanic Ash) (Continued)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.0 - 25.0</td>
<td>Dense, gray, wet, poorly graded GRAVEL with sand, cobbles (25%, &lt;9 in.) and boulders (4%, &lt;18 in.) present. Angular aggregate. (GP, Glacial Drift)</td>
<td></td>
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</tbody>
</table>

Test Pit completed at 25.0 ft.

**Notes:**
1) Groundwater encountered at 6.0 ft. Slow infiltration into pit with some filling at bottom.
2) Multiple episodes and layers of landslide deposits are visible in pit wall with varying proportions of glacial drift content.
3) Located at proposed Tank Site #2, adjacent to Test Pits TP-17, TP-18, and TP-19.
4) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   - LAT: 57-04-44.85 N
   - LONG: 135-22-01.21 W

**EXCAVATION DATE:** 9/14/07  
**EQUIPMENT:** Hitachi 160  
**DATUM:** Ground Surface  
**GS ELEVATION:** 220 ft  
**GS ELEVATION:** 220 ft  
**COORDS:** n/a  
**TOC ELEVATION:**  
**PROJECT:** Sitka Whitcomb Subdivision Geotech  
**PROJECT NUMBER:** 073-95050  
**LOCATION:** Sitka, AK  
**CLIENT:** USKH

**LOGGED:** H Henry  
**CHECKED:** SLA  
**DATE:** 11/13/2007  
**CONTRACTOR:** Twaddle's Excavation  
**OPERATOR:** Jeremy Twaddle

**Figure A-21**
Notes:
1) Perched water table encountered at 1.5 ft flowing atop boundary between saturated peat and landslide. Water entered pit but did not pond in bottom. Pit is well drained by both volcanic ash and glacial drift layers.

2) Located approximately 60 to 80 ft south of Test Pit TP-16.

3) Stratigraphy is similar to Test Pit TP-16. Volcanic ash is coarse, but multiple distinct ash layers are not prevalent.

4) GPS Coordinates (NAD 27, Deg-Min-Sec.decimal):
   LAT: 57-04-54.57 N
   LONG: 135-22-03.09 W

Test Pit completed at 14.0 ft.
APPENDIX B

GRAIN SIZE DISTRIBUTION PLOTS
<table>
<thead>
<tr>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>FINES</th>
<th>SILT OR CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COARSE</td>
<td>FINE</td>
<td>COARSE</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>TEST PIT NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH</td>
<td>DESCRIPTION</td>
<td></td>
</tr>
<tr>
<td>TP–16</td>
<td>1</td>
<td>4.5’ – 5.0’</td>
<td>silty SAND (SM)</td>
<td></td>
</tr>
<tr>
<td>TP–16</td>
<td>2</td>
<td>7.5’ – 8.0’</td>
<td>poorly graded SAND (SP)</td>
<td></td>
</tr>
<tr>
<td>TP–16</td>
<td>3</td>
<td>9.0’ – 10.0’</td>
<td>poorly graded SAND (SP)</td>
<td></td>
</tr>
<tr>
<td>TP–16</td>
<td>4</td>
<td>17.0’ – 18.0’</td>
<td>silty GRAVEL with sand (GM)</td>
<td></td>
</tr>
</tbody>
</table>