GEOTECHNICAL INVESTIGATION FOR NENANA PORT

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A. PROJECT INFORMATION

The city of Nenana has a plan for new development on the west side of the Nenana River. This necessitates an improved barge and ferry landing near the current City of Nenana boat landing, about ¼ mile upstream from the existing barge dock. Figure 1 shows the site location. The barge dock is at the confluence of the Tanana and Nenana Rivers. A geotechnical investigation was performed on August 16, 2010 in the area behind the future retaining wall, which included geotechnical drilling, in-situ field testing, and soil sampling. Laboratory soils tests were also performed to analysis gradations of obtained soil specimens.

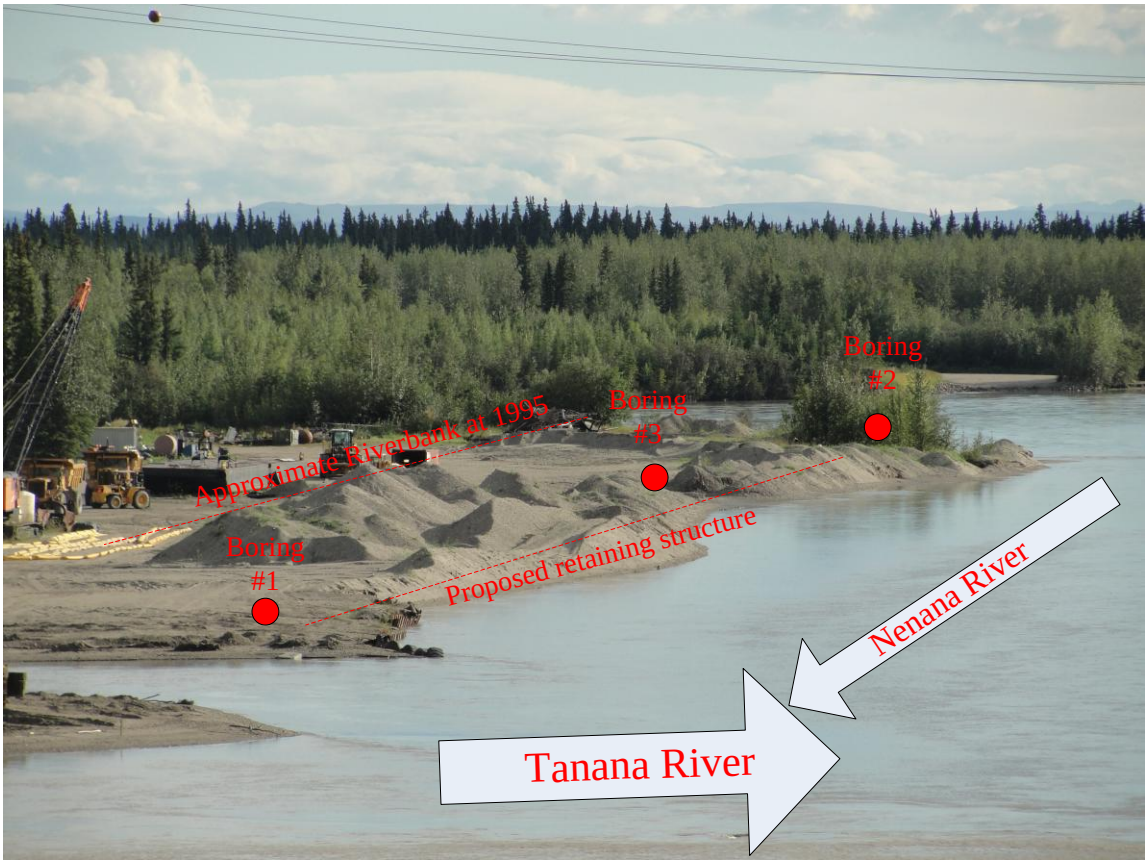

Figure 1 Picture of the planned site and approximate locations of borings

B. SCOPE OF INVESTIGATION

The purposes of the study are to: 1) explore the general subsurface conditions at the site, 2) evaluate the pertinent engineering properties of the subsurface materials, and 3) provide recommendations and design parameters concerning suitable types of retaining wall systems.

C. FIELD OPERATIONS

The field work conducted for this project involved drilling three exploratory borings. The approximate locations of the three boring holes are shown on Figure 1 and designated Borings #1 through #3, to depths of 47, 47 and 42 feet, respectively. Drilling operations were performed on August 16, 2010 by Homestead Drilling, and were supervised and logged by Tonya Bear, Civil Engineer with Sherman engineering, and Dr. Xiong Zhang.

A continuous flight auger drilling rig was used to advance the borings. Bentonite slurry was used to prevent possible heaving during the drilling. Standard penetration tests (SPT) were performed every five feet to evaluate the soil properties. Split-spoon sampling was accomplished by driving a 3.0-inch O.D. by 2.5-inch I.D. split-spoon sampler into the soil at the base of the hollow stem auger with a 340-pound drop hammer falling 30 inches onto the drill rods. For each sample, traditionally the number of blows required to advance the sampler the final 12 inches of an 18 inch sample is termed the penetration resistance and measures the relative and the relative density of unfrozen granular soils. In this site investigation, a total of 24 inches penetration was reached in each SPT and the blow counts for every 6 inches of penetration were recorded. Geotechnical soil samples recovered were visually classified in the field, sealed in airtight containers, and returned to Sherman engineering in Fairbanks for laboratory testing. Logs of the sampled exploratory borings, including sample descriptions and penetration resistance values, are presented in the attachments as well as table 1.

D. LABORATORY TESTING

Samples were examined by the project geotechnical engineer. It was found that the soils at the site vary from sand to gravel. As a result, undisturbed soil specimens could not be obtained. For available disturbed soil specimens, soil structures was changed during the

sampling process and field void ratio and water content could not be determined. For this reason, only four sieve analyses were performed by Shannon &Wilson Inc., based upon the visual classification of soil and the SPT results. Attachment 2 shows the sieve analysis results.

E. EVALUATION OF SITE INFORMATION

Topography

The site is located between the Tanana River and the Nanana River. The site is relatively flat near the intersection of the two rivers, with local differences in elevation limited to a foot or two. Along the upstream direction, there are several sand and gravel piles along the embankment with a height of 5 to 6 feet (Please see figure 1).

The results of the exploratory drillings and samplings indicated relatively uniform soils at the site. Generally, the soils encountered consisted of 20 to 25 feet of poorly graded gravel (GP) or poorly graded gravel with silts (GP-GM) overlying a layer of poorly graded sand (SP). At the upstream direction of Nenana River near boring 2, the top several feet of boring 2 is covered by sandy silts (ML) with organics and wood pieces. Due the survey data is not available at this time, figure 2 shows the approximate stratigraphy of the site only.

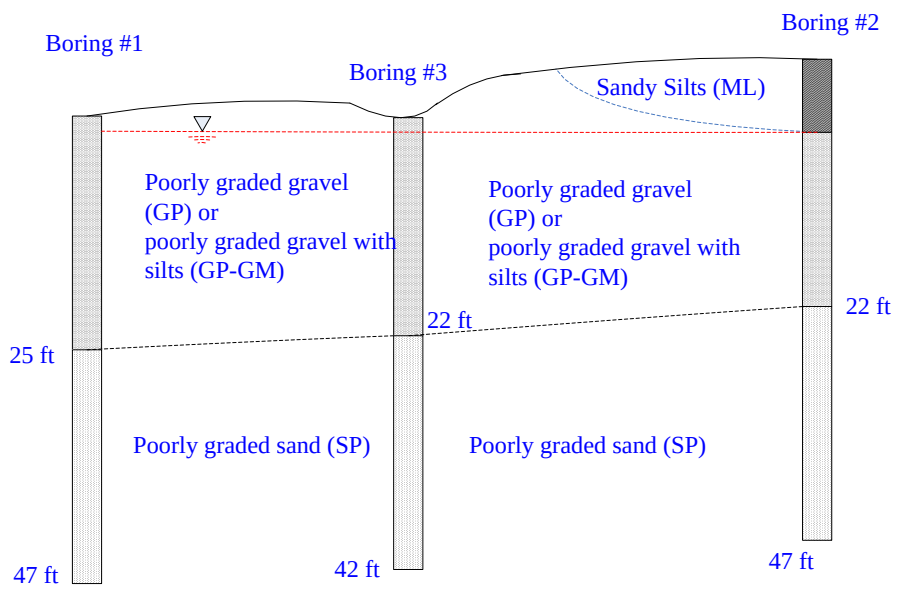

Figure 2 shows the approximate stratigraphy of the site only

Soil Properties

Table 1. Blow counts for the three borings and calculated soil strength parameter

Boring	Depth (feet)	σ' (psf)	C_N	Blows/6inches 1st	2nd	3rd	4th	N_{60}	N_{60}'	$(N_1)_{60}$	$(N_1)_{60}'^{*}$	ϕ' (degree)	$(\phi')'^{**}$ (degree)
Boring 1	5	288	2.635	4	5	11	9	16	20	42	52.7	39	41
	10	576	1.863	8	6	7	9	13	16	24	29.8	34	36
	15	864	1.521	6	4	3	3	7	6	11	9.1	30	30
	20	1152	1.318	3	4	4	4	8	8	11	10.5	30	30
	25	1440	1.179	4	3	7	8	10	15	12	17.7	31	32
	30	1728	1.076	10	13	12	12	25	24	27	25.8	35	34
	35	2016	0.996	8	7	6	6	13	12	13	12.0	31	31
	40	2304	0.932	15	12	15	20	27	35	25	32.6	34	36
	45	2592	0.878	13	13	14	16	27	30	24	26.4	34	35
Boring 2	5	288	2.635	2	2	1	1	3	2	8	5.3	29	29
	10	576	1.863	4	6	5	5	11	10	20	18.6	33	33
	15	864	1.521	6	8	7	6	15	13	23	19.8	34	33
	20	1152	1.318	3	3	6	8	9	14	12	18.4	31	32
	25	1440	1.179	6	5	9	10	14	19	16	22.4	32	34
	30	1728	1.076	7	9	9	9	18	18	19	19.4	33	33
	35	2016	0.996	9	9	10	8	19	18	19	17.9	33	32
	40	2304	0.932	11	5	6	10	11	16	10	14.9	30	31
	45	2592	0.878	8	11	13	13	24	26	21	22.8	33	34
Boring 3	5	288	2.635	4	6	5	7	11	12	29	31.6	35	36
	10	576	1.863	17	7	5	4	12	9	22	16.8	34	32
	15	864	1.521	5	6	4	3	10	7	15	10.7	32	30
	20	1152	1.318	8	7	12	10	19	22	25	29.0	34	35
	25	1440	1.179	13	12	17	11	29	28	34	33.0	37	36
	30	1728	1.076	21	18	19	19	37	38	40	40.9	38	38
	35	2016	0.996	20	14	8	11	22	19	22	18.9	33	33
	40	2304	0.932	17	18	13	12	31	25	29	23.3	35	34

$(N_1)_{60}'^{*}$ Calculated by summing the blow counts from the third and forth 6 inches

$(\phi')'^{**}$ Calculated based upon $(N_1)_{60}'^{*}$ and Peck et al. (1974) and Wolff (1989)'s equation

Table 1 shows the soil properties estimated from the SPT results. The bulk unit weight was assumed to be 120 lb/ft^3. The corrected N_{60} values vary from 11 to 29 blows/ft, indicating that the relative densities of the soils were low. According to Das (2006), the relative density of the soil varies from 30-60%. The frictional angles of the soil were estimated using Peck et al. (1974) and Wolff (1989)'s equation. The obtained values vary from 30^0 to 35^0, with an average value of 32^0. For granular materials, the cohesion is generally taken as 0. It is therefore recommended that the following material parameters be used for preliminary design purposes: **C = 0 kPa and $\phi'=30^0$**

Groundwater

Groundwater was encountered during drilling in all three borings between 0.5 (boring 3) and 4 feet (boring 2) below grade, and was consistent with observed Nenana river water level. No frozen soils were encountered in all three borings.

Erosion

Based upon conversations with personnel working at the Nenana Port for more than 15 years, it seemed that erosion was not a problem with existing erosion protection structure; at least it is true for the potion near the confluence of the two rivers. We were told that every year in the past several years there were needs for dredging the Nenana riverbed. In the past 15 years, the edge of the embankment has moved about 20 feet toward the other side of the Nenana River (Please see Figure 1). However, if future development, dredging, or floods changes the water flow conditions, erosion could be a concern. In addition, dredging operation should be done very carefully to avoid any possible damage to the retaining system.

Earthquake Consideration

From the SPT and drilling results, it was found that the soils in the site are poorly graded sand or gravels with low relative density. Also the ground water table is shallow and soils are saturated under most situations. As a result, the soils have high liquefaction potential. Since the site is in an earthquake active zone, liquefaction of soils should be a concern for future design.

RECOMMENDATIONS FOR RETAINING WALL AND BULKHEAD STRUCTURES

The SPT blow counts of the soils at the site were low, which is reflected by the low recommended soil strength parameter. In addition, the site is in an earthquake active zone, liquefaction of soils should be a concern for future design. However, the ground water table is very shallow. As a result, the active earth pressure applied on a retaining structure will be significantly reduced due to the corresponding low effective stress. That is, about half of the active earth pressure will be counterbalanced by the water pressure in

the river. Consequently, for a retaining structure which is no higher than 15 feet and shallow ground water table (depth less than 3 feet), the active earth pressure acting on the retaining structure is relatively low and horizontal anchors might not be needed.