Invitation to Bid (ITB)
ITB # VSW-TNK-2019-23

Department of Environmental Conservation
Village Safe Water Program

Addendum One

Construction of 6-Inch Diameter
Water Supply Well, Tununak, Alaska

Date of Issue: February 19, 2019

The ITB Package is hereby clarified or changed as follows:

1. Submittal deadline is changed to: March 4, 2019 at 3:00 PM.
2. Questions and Answers
3. Pre-Bid Meeting Comments and Concerns
4. Attachments

The Questions and Answers, Pre-Bid Meeting Comments and Concerns, and Attachments begin on page 2. This Addendum is hereby made part of the ITB and is a total of 5 pages (not including attachments).

All other terms and conditions for this ITB remain unchanged.

Issued by: Christine Mash
Procurement Officer
(907) 269-0291

2. Questions and Answers

Question 1: Are there any existing wells in the area and what are their depths?

Answer 1: Yes – reference Attachment 1, Attachment 2, and Attachment 4.

Question 2: What is available for fuel and crew accommodations? Any contact phone numbers?

Answer 2: Contact Tununak Tribal Administrator Mr. James James and assistant administrator Xavier Post at office phone number (907) 652-6527 and/or email triber2work@yahoo.com.

Question 3: Is there any information documenting the depth to bedrock?

Answer 3: Reference Attachment 1, 95% Draft Technical Memorandum #4 and Attachment 4, geotechnical investigations completed by R&M Engineering for Tununak high school and US PHS for Tununak water storage tank.

Question 4: How far are the sites from the road?

Answer 4: Approximately 50 to 60 feet from existing airport material haul road that lies on Tununak Tribal land.

Question 5: Will the area be wet?

Answer 5: The preference well could possibly be wet, it's not wetland or bog. The second location is more upland, it should be dryer.

Question 6: Is there a local contact to speak with for lodging, fuel and food?

Answer 6: Mr. James James is the Tununak Tribal Administrator and assistant administrator Mr. Xavier Post at office phone number (907) 652-6527 and/or email triber2work@yahoo.com. Recommend contacting LKSD in Bethel office to check on lodging at the Tununak school.

Question 7: How specific are the requirements for Erosion Control?

Answer 7: The successful Bidder shall prevent erosion in the course of the well testing discharge, which is up to 50 gpm.

Question 8: What were the conditions for staying at the school?

Answer 8: On the floor, in classrooms. The school has running water, a kitchen, and showers. Recommend contact LKSD in Bethel for lodging at school.

Question 9: If sandstone is encountered, will the well have to be encased with PVC?

Answer 9: DEC currently plans to stay with the specifications, which call for steel casing.

Question 10: Were the foundation drilling logs reviewed when the desktop study was conducted?

Answer 10: Yes, however they only went to 20 feet. Reference Attachment 1.

Question 11: Did they look at the Toksook well during the desktop study?

Answer 11: Yes.

Question 12: Has anyone looked at outcrops above Tununak?

Answer 12: There are exposed sandstone/siltstone formations along the northern beach bluffs. GCI installed a tower overlooking Tununak at the top of Ugchirnak Mountain that is located north of the village.

Question 13: Is information pertaining to the rock located at the school available?

Answer 13: Reference Attachment 4, geotechnical investigations completed nearly 40 years ago at the Tununak Washeteria water storage tank and the high school (located adjacent to the school.

Question 14: What is the elevation difference between the new well location and the old well(s) location?

Answer 14: Approximately 20 to 30 feet between the school's well and drill site location. A copy of school well is attached (Attachment 2). The school well (originally referred to as the BIA well) is located on the spit. That's why the proposed 6-inch production well is considered to be an exploratory drill due to lack of hydrogeological data below a depth of approximately 30-feet. The hydrogeological conditions in Toksook Bay (approximately 6 miles from Tununak) were evaluated in the attached desktop study completed by Stantec provided indication of potential for a deeper groundwater aquifer in the Tununak area.

Question 15: Were the previous well(s) completed in sandstone?

Answer 15: Yes.

Question 16: NSF 61 Wells are produced by well casing manufacturers. What will be required for casing?

Answer 16: DEC is staying with the 6-inch steel casing ASTM-A53 per the part 2.1.2 specifications but are deleting the requirement for ANSI/NSF 61 compliant well casing. Accordingly casing need not include any "certification mark" indicating ANSI/NSF 61 compliant casing.

Question 17: Are funds available for this project?

Answer 17: Yes, funds are available for the project.

Question 18: Is this a US Department of Agriculture Grant?

Answer 18: Yes.

Question 19: Will PVC 4 ½" casing be acceptable for sandstone or does it have to be steel?

Answer 19: No, reference Section 5, Technical Specifications

Question 20: Is there a well log for the 30' well?

Answer 20: Yes, reference Attachment 2 and Attachment 4. US PHS geotechnical investigation found evidence 40 years ago that permafrost existed near the existing Tununak washeteria.

Question 21: Do you have a particular bid bond form that you would like to see used on the Tununak Project?

Answer 21: No, we do not have a particular bid bond form.

3. Pre-Bid Meeting Comments and Concerns

1. The Community gets water from Unnamed Creek. The school gets their water from a well that's approximately 30 feet deep. The well is approximately 40 years old. There is potential for saltwater intrusion if over pumped.

2. DEC is attempting to tap the sandstone aquafer.

3. If there is unconsolidated water above 50 feet, DEC will have to assess the situation. It cannot be surface water, must be true ground water supply well.

4. Attachments

The following attachments are now added to the ITB:

1. 95% Draft TM 4 Task 2 Tununak Hydrogeology Desktop Study. (13 Pages)
2. Tununak BIA Well Log. (7 Pages)
3. Tununak PHS 1978 Geotech Soil Borings. (1 Page)
4. 1979 – Geotechnical Investigation for School – RM 1979 (40 Pages)
5. Toksook Bay Well 3B22663. (6 Pages)

Bidders must acknowledge receipt of this Addendum on Section 4, Bid Form, prior to the hour and date set for bid opening.

The bid documents require acknowledgment individually of all addenda to the drawings and/or specifications. This is a **mandatory requirement** and any bid received without acknowledgment of receipt of addenda may be classified as not being a responsive bid.

End of Addendum

95% Draft Technical Memorandum #4 – Task 2

To:	Native Village of Tununak IRA Council Tununak, Alaska	From:	Collin Macheel, CPG Victor Harris, CPG Bob Gilfilian, PE Stantec Consulting Services Inc.
File:	**Technical Memorandum 4, Task 2 – Tununak Water Source Assessment Deep Water Supply Well**	Date:	August 6, 2018

Section 1.0 Purpose

The Native Village of Tununak a.k.a. Tununak IRA Council (herein referred to as Tununak), in cooperation with the Alaska Department of Environmental Conservation (ADEC) Village Safe Water (VSW) has retained Stantec Consulting Services Inc. (Stantec) to prepare this Technical Memorandum (Tech Memo) with funding from the U.S. Department of Agriculture Rural Development (USDA-RD). The purpose of this Tech Memo is to provide a summary of the results of a desktop study to assess the feasibility of constructing a new deep (greater than 50 feet) groundwater well in Tununak. This Tech Memo provides a qualitative assessment which may or may not support further field investigation to evaluate the development of a deep groundwater source to serve as a production well that will meet the long-term water supply needs of Tununak, including a piped water system for the entire community, and provide a minimum yield of 50 gallons per day per resident.

Section 2.0 Scope and Data Sources

The scope of this study included the compilation of published water resource and subsurface hydrogeologic data. Data sources included the following:

- Alaska Department of Natural Resources
- Alaska Department of Environmental Conservation
- Alaska Department of Transportation & Public Facilities
- VSW
- U.S. Geologic Survey
- Alaska Native Tribal Health Consortium, including consultants.

The data compiled from these sources are referenced throughout this document and summarized in Attachment 1.

To evaluate the possibility of a developing a deep-water supply well in the Tununak, several features were investigated as influencing the likelihood of a developable water well and are discussed in Sections 3 through 6. These features include:

- Local and regional geologic setting.
- Local and regional developed water sources and associated water quality.

- Distribution of permafrost.
- Land accessibility including drill rig access, land ownership, and reasonable conveyance distances to Tununak.

Section 3.0 Local and Regional Geologic Setting of the Village of Tununak

Tununak is located on Nelson Island in Southwestern Alaska along the coast of the Bering Sea. Tununak is one of two communities located on Nelson Island. Tununak is separated by approximately 6 miles from the City of Toksook Bay (Figure 1). Tununak lies partially over Quaternary unconsolidated surficial deposits and folded Cretaceous sandstone and shale sedimentary rock. The Cretaceous sandstone and shale sedimentary rock underlie both Tununak and Toksook Bay along the western extent of Nelson Island as shown on Figure 2. Young (Quaternary or Tertiary) basaltic flows cap the Cretaceous folded sedimentary rock on Nelson Island, found on several hill tops around Tununak (Wilson et al., 2015; Coonrad, 1957).

The distribution, occurrence, and nature of sedimentary rock units have been described by coastal outcrops and surficial geologic investigations in and around Tununak (Coonrad, 1957; AKDOT, 1995). Further relevant descriptions of the sedimentary rock were made in the City of Toksook Bay between 1993 and 1994, indicating the occurrence of Cretaceous sedimentary rock in orientation and nature described similar to that observed by surficial and coastal outcrop descriptions in Tununak (HDR, 2005).

The nature and distribution of the Quaternary unconsolidated surficial deposits has been widely investigated in geotechnical evaluations, including those conducted for the: Tununak High School Site; Tununak Airport relocation; Tununak Water Storage Tank Site Geotechnical Investigation; and, to a lesser degree, the Nelson Island Highway Geology Reconnaissance. Geotechnical investigations identified silt rich organic soil in most of the areas, with the occurrence of ice-rich soils. Drilling and geotechnical logs rarely describe bedrock or suspected bedrock assumed by refusal of the drilling rig.

The Tununak High School geotechnical investigation found bedrock at a depth of 16.5 feet below ground surface (bgs), described as siltstone in the location of the current school (RMC, 1979). The Tununak Airport Relocation Geophysical Investigation confirmed the occurrence of sandstone and siltstone in several borings, ranging in depth from 8 to 30 feet bgs in locations south of the Tununak River (AKDOT&PF, 2005a). The geotechnical investigation conducted at the Tununak Water Storage Tank Site found undescribed bedrock at 4.3 feet bgs near the 50,000-gallon water tank and no indication of bedrock in two other borings further to the southwest (USPHS, 1977). The Nelson Island Highway Geology Reconnaissance found sandstone and silt stone at variable depths along the proposed highway corridor between Tununak and Toksook Bay, ranging in depth from 4 feet bgs to greater than 12 feet bgs (AKDOT&PF, 2005b). Because of the relatively thin nature of the unconsolidated surficial deposits, in this context, a new “deep” well means a water supply well screened in the Cretaceous sedimentary rocks.

Section 4.0 Local and Regional Developed Water Sources and Associated Water Quality

Water sources for Tununak have been primarily surface water and shallow groundwater wells. Tununak's washeteria and water treatment plant is served by an infiltration gallery as is recorded in the ADEC public water supply database (Palmer, 2018). Records were located for two shallow groundwater wells installed within the Quaternary unconsolidated surficial deposits. The Bureau of Indian Affairs (BIA) groundwater well adjacent to the Tununak School was installed to a depth of 36.5 feet bgs (ADNR, 1964). The well log identifies a limited production rate of 6 gallons per minute (gpm) during the initial well test. The well depth is shallow and vulnerable to contamination, including saltwater intrusion.

The second shallow well was installed approximately 30 feet southeast of the Alaska Village Electric Cooperative (AVEC) power generation building. The well was installed to a depth of 30 feet bgs (USGS, 1978). The AVEC well log indicates bedrock was present at bottom of the boring, and the well was pumped at 40 gpm for 6 hours, with a resultant drawdown of 16+ feet. U.S. Geologic Survey (USGS) documentation of the well indicates that the well was grouted with bentonite and constructed with a 6-foot of casing stickup. No other documentation was found regarding the AVEC well. The location of the well would indicate that it was likely installed near the Tununak River and, therefore, is likely under the influence of surface water.

Water produced from the Tununak School well has be reported to be of good quality; however, the shallow setting and vulnerability to contamination, and low production rates limit the water source. Total coliform results collected between 2002 and 2018 have all been negative (ADEC, 2018). In 1968, iron was detected at 0.05 milligrams per liter (mg/L), manganese at 0.05 mg/L, and nitrates at 0.3 mg/L (ADNR, 1964).

The water level elevation in the Tununak School well (reported at approximately 11.8 feet bgs during pumping) is near average sea level, indicating the salt water intrusion is a potential issue if a well at the location were installed with capability of producing higher flow rates. Conservatively, the Ghyben-Herzberg relates depth to the salt water interface at approximately 40 times greater below sea level for every foot of freshwater elevation head above sea level, by difference in density alone under static conditions (e.g., Freeze and Cherry 1979). The elevation of the ground surface at the Tununak School well is approximately 12 feet above sea level, based on 2015 Alaska Department of Transportation and Public Utilities (ADOT&PF) lidar elevation data. Water level in the well was measured at approximately 11.8 feet bgs during the original pump test for the well (ADNR, 1964). By the Ghyben-Herzberg relation, the salt water interface is a concern at the location. In this regard, it is interesting to note that a study of water quality in Toksook Bay indicated that, as a means to avoid seawater intrusion, a well site should be located at least 1,000 feet away from the coast (HDR, 2005).

The primary water source in Tununak is an infiltration gallery located on Unnamed Creek. Water sourced from the infiltration gallery of Unnamed Creek have been reported to have seasonal color variation (USPHS, 1977). Positive total coliform tests were recorded in August, September, and October 2009 (YKHC, 2010). No significant changes to the system have been made since the positive total coliform results. Analytical compliance testing of the Tununak water source has been inadequate and inconsistent.

Exploratory drilling at Toksook Bay, 6 miles to the southeast of Tununak, provides insight into the water-producing capabilities of the Cretaceous sedimentary rocks (sandstone units) which are expected to underlie Tununak. At least 13 groundwater wells were installed at Toksook Bay from 1976 to 1994. Toksook Bay's primary production wells used prior to 1994 were found to be effected by salt water intrusion or fuel contamination and spurred new efforts to develop a deep groundwater well source in 1993-1994. Geologic mapping of coastal outcrops and river cuts was conducted, along with surface geophysics (very-low-frequency electromagnetic survey methods), to site locations for new wells. In 1994, seven wells were installed by air rotary drilling methods. Of the seven wells installed, three provided adequate quantity and treatable quality water for supplying water to the city. The wells were screened in the Cretaceous sandstone and production rates of 20 to 50+ gpm were reported (HDR, 2005). A generalized conceptual model of the hydrogeology of the Cretaceous bedrock was provided in the City of Toksook Bay Sanitation Facilities Master Plan, as shown on Figure 3, indicating recharge in the folded Cretaceous sandstone is provided primarily by surface water.

Water quality in the three production wells currently used in Toksook Bay exceeded the secondary maximum contaminant levels (SMCLs) for iron and manganese in all three wells, with concentrations ranging from 0.69 to 1.4 mg/L iron and 0.067 to 0.13 mg/L manganese. The SMCLs for iron and manganese are 0.3 and 0.05 mg/L, respectively. No other constituents were detected above maximum contaminant levels (MCLs) or SMCLs in any of the wells. Total Organic Carbon analytical samples resulted in concentrations below laboratory detection limits (HDR 2005).

Section 5.0 Distribution of Permafrost

The regions surrounding Tununak and Toksook Bay are characterized as having a sporadic distribution of permafrost (10 to 50 percent spatial coverage). Although specific permafrost depth and spatial occurrence data is not available for Nelson Island, permafrost thickness measurements from southwestern Alaska include depths ranging from 40 to 604 feet inland near Bethel. Permafrost thickness measurements from coastal communities of Quinhagak and Goodnews Bay have been published in the range of 20 to 75 feet (Jorgenson, T. et al. 2008). The deepest borings on Nelson Island occurred in 1994 during the water well installations in Toksook Bay. The consultant who performed the geologic logging of the wells did not document the presence of permafrost. It should be noted that permafrost or suspected permafrost, as well as ice-rich soils, in Tununak have been identified in the three geotechnical investigations referenced above but, as noted, have been limited in depth to the surficial Quaternary unconsolidated soil.

Section 6.0 Land Accessibility Including Drill Rig Access, Land Ownership, and Conveyance Distance to the Community

Land accessibility has greatly improved since the recent construction of the new, relocated Tununak Airport. The new airport facility included the construction of a new road, with road maintenance located along the east and north periphery of the village, that included new road access to an upland material borrow site. The road system in Tununak now allows for greater accessibility by a truck-mounted drilling rig (e.g., air rotary).

An updated aerial photography from 2015 is shown on Figure 4, along with general land ownership status and ADOT&PF right-of-way's. Land ownership data was obtained from the Alaska Department of Natural Resources (ADNR) Recorders Office, and needs to be evaluated by a formal title search prior to siting a new well location. Potential areas of further investigation for the drilling of deep water supply wells are depicted on Figure 4. These areas appear to be accessible for drilling a well with a truck-mounted drill rig, and are located within a reasonable conveyance distance to the washeteria and water treatment plant in Tununak, while also maintaining separation distance from surface water bodies.

Section 7.0 Conclusions

Limited deep subsurface data are available in the Tununak community boundary. However, the following summarize pertinent observations of available information.

- Regional geologic mapping efforts between Tununak and Toksook Bay indicate similar folded Cretaceous sedimentary rock at both communities, including sandstone and shale.
- The sedimentary rock has been investigated in greater detail in Toksook Bay, where several deep wells were installed and produced adequate quantities of drinking water from Cretaceous sandstone units.
- The quality of groundwater developed in Toksook Bay from the Cretaceous sandstone was acceptable for the community, although iron and manganese were measured above the SMCL.
- Deep borings in Toksook Bay also described permafrost in shallow unconsolidated sediment, but no evidence of permafrost was found in deep well borings.
- Improved roads relating to the relocation of the Tununak Airport have resulted in greater accessibility for a truck-mounted drill rig capable of advancing deep soil borings (for example, depths of 160 to 170 feet bgs were obtained at Toksook Bay with a similar drill rig).

In regard to the observations and findings summarized above, we conclude the following:

- Completion of a water production well in the shallow surficial deposits in Tununak is not recommended, because of anticipated poor production, susceptibility to surface water contamination, and potential for sea water intrusion.
- Based on exploratory drilling at Toksook Bay, completion of a deep well in the Cretaceous sandstone at Tununak has a reasonable probability of producing well flows greater than 20 gpm.
- A deep well in the Cretaceous bedrock has a probability of encountering a water production aquifer with naturally occurring levels of iron and manganese that may exceed the drinking water SMCLs associated with aesthetics (taste and appearance). Water treatment, in addition to disinfection, may be necessary subject to the water quality levels encountered.
- The location of exploratory drilling for a new production well in the Cretaceous bedrock should be based on the anticipated location and depth of relatively permeable sandstone layers (site-specific conceptual hydrogeologic model) similar to that shown on Figure 3, which would benefit from additional field studies of the geology at Tununak.

Section 8.0 Recommendations

Based on the findings of this desktop study, it is recommended the following tasks be considered to further evaluate the possibility of developing a deep groundwater production well to serve the future water needs of Tununak:

- Title search to determine current landownership of potential drilling sites as shown on Figure 4. These drilling sites are shown on the figure in two shaded red areas labeled as “Proposed Deep Water Supply Investigation Areas”. The proposed drilling sites are located along the new airport road that was used to haul material for construction of the Tununak Airport. Although the two drill sites are shown on land owned by Tununrmiut Rinit Corporation, the boundaries of the proposed sites are relatively general and could be adjusted to include the adjoining land that is owned by the Village of Tununak.
- Prepare geologic mapping of the Cretaceous sedimentary bedrock at outcrops along the coast, rivers, and areas of any road cuts or borrow pits. The purpose of this mapping would be to identify the location and orientation of permeable sandstone layers within the bedrock. Geologic mapping of these units could be aided by surface geophysical techniques similar to those used in Toksook Bay to determine favorable/recommended site(s) for drilling of a deep well(s).
- Evaluate the implementation of an exploratory well drilling program to determine the feasibility of drilling a large diameter (6-inch) water supply production well. The exploratory well drilling work would involve the mobilization of a small drilling rig to drill small diameter (2- to 3-inch) soil boring holes to obtain samples of the geologic formations and install a 2-inch diameter well that could be used for water quality sampling and flow measurements of the aquifer.

Section 9.0 References

Alaska Department of Environmental Conservation (ADEC). 2018. Drinking Water Watch Coliform/Microbial Sample Results, Lower Kuskokwim School District Tununak Paul Albert High School, website accessed 3/19/2018: https://dec.alaska.gov/DWW/JSP/TcrSampleResults.jsp?tinwsys_is_number=334&tinwsys_st_code=AK&counter=1 ,.

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Alaska Department of Transportation & Public Facilities (ADOT&PF). 2005a. Geotechnical Data Report, Tununak Airport Improvements, AKSAS #51791.

AKDOT&PF. 2005b. Reconnaissance Geology Report Nelson Island Roads, AKSAS #57176.

Coonrad, W.L. 1957. Geologic Reconnaissance in the Yukon-Kuskokwim Delta Region, Alaska. Miscellaneous Geologic Investigations MAP I-223. U.S. Geologic Survey.

Freeze, R. and Cherry, J. 1979. Groundwater. Prentice-Hall Inc. Englewood Cliffs, N.J.

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Jorgenson, T. et al. 2008. Permafrost Characteristics of Alaska. Institute of Northern Engineering, University of Alaska Fairbanks, Ninth International Conference on Permafrost. July.

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R&M Consultants Inc. (RMC). 1979. Geotechnical Investigation and Foundation Recommendations for High School Site, Tununak, Alaska. April.

U.S. Department of Health, Education, and Welfare Public Health Service (USPHS). 1977. Final Report Sanitation Facilities Construction for Tununak, Alaska, Project AN-77-6313.

USPHS. 1978. Construction Plans Sanitation Facilities, Tununak, Alaska. Project AN-77-631.

U.S. Geological Survey (USGS). 1978. Tununak Well Log. Anderson-Appleton. U.S. Public Health Service. May 1. Site ID SB-6-91-28AACC1-2.

Wilson, F.H. et al. 2015. Geologic Map of Alaska. Scientific Investigations Map 3340. U.S. Geologic Survey.

Yukon-Kuskokwim Health Corporation (YJGC). 2010. Sanitary Survey of the Tununak Water System. September.

Reference: **Technical Memorandum 4,**
Task 2 – Tununak Water Source Assessment Deep Water Supply Well

Section 10.0 Limitations

This Tech Memo was prepared by Stantec for the Native Village of Tununak IRA Council at the request of the VSW Program. The findings and recommendations presented herein reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in this document and in the contract between Stantec and the Client. The opinions in this document are based on conditions and information existing at the time the document was prepared and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party.

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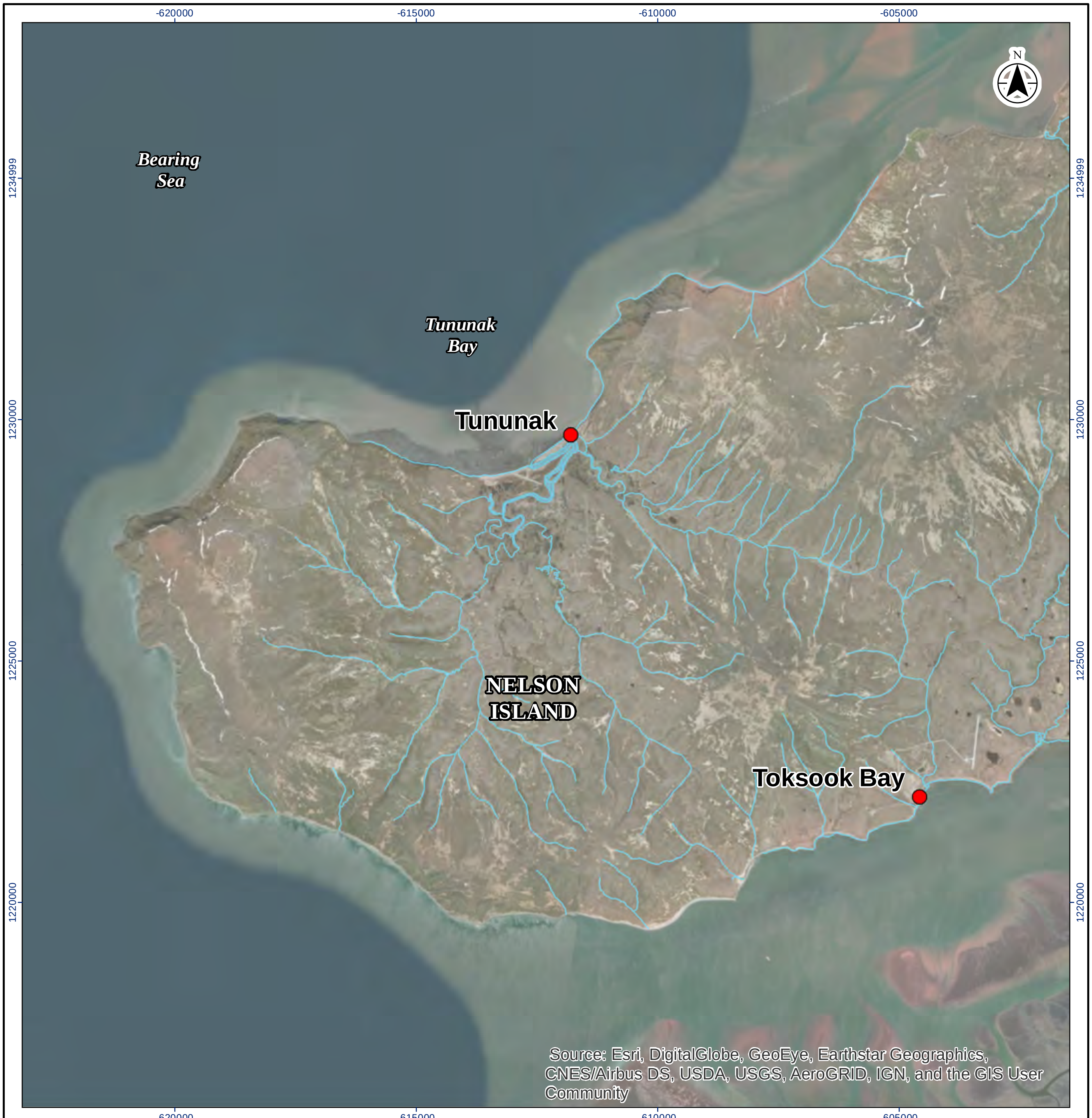
Attachments: Figure 1 – Village of Tununak Location and Vicinity Map

Figure 2 – Village of Tununak Regional Geologic Setting

Figure 3 – Conceptual Groundwater Model of Cretaceous Sandstone in Toksook Bay

Figure 4 – Village of Tununak Site Overview with Proposed Deep Water Supply Investigation Areas

Attachment 1 – Reference Table



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Legend

Hydrography 1:63360

Stantec

Project Location
T6N, R91W, S28
Village of Tununak, AK

XXXXXXXXX-XXXX REVA
Prepared by CDP on 2018-03-13
Technical Review by ABC on 2018-XX-XX
Independent Review by ABC on 2018-XX-XX

Client/Project
Technical Memorandum 4 - Water Source Assessment
Task 2 Hydrogeologic Desktop Study
Evaluation for Potential Deep Groundwater Supply Well

Figure No.
1

Title
Village of Tununak
Location & Vicinity Map

Notes
1. Coordinate System: NAD 1983 Alaska Albers
2. Hydrography and parcel features acquired from Alaska State Geo-Spatioal Clearing House, Originator:Alaska Department of Natural Resources - Information Resource Management;
3. Orthoimagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure X-X.X

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Notes
1. Coordinate System: NAD 1983 Alaska Albers
2. Hydrography and parcel features acquired from Alaska State Geo-Spatioal Clearing House, Originator:Alaska Department of Natural Resources - Information Resource Management;
3. Geologic Base Map Adapted From Wilson, F.H., Hults, C.P., Mull, C.G, and Karl, S.M, comps., 2015, Geologic map of Alaska: U.S. Geological Survey Scientific Investigations Map 3340,

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Legend

Hydrography 1:63360

Geologic Data

- Water
- Qs - Quaternary Unconsoolidated Surfical Deposits
- Ksd - Cretaceous Sandstone, Shale
- QTv - Young Volcanic Rocks, Undifferentiated

Stantec

Project Location
T6N, R91W, S28
Village of Tununak, AK

XXXXXXXXX-XXXX REVA
Prepared by CDP on 2018-03-13
Technical Review by ABC on 2018-XX-XX
Independent Review by ABC on 2018-XX-XX

Client/Project
Technical Memorandum 4 - Water Source Assessment
Task 2 Hydrogeologic Desktop Study
Evaluation for Potential Deep Groundwater Supply Well

Figure No.
2

Title
Regional Geologic Setting of Tununak and Toksook Bay

Figure X-X.X

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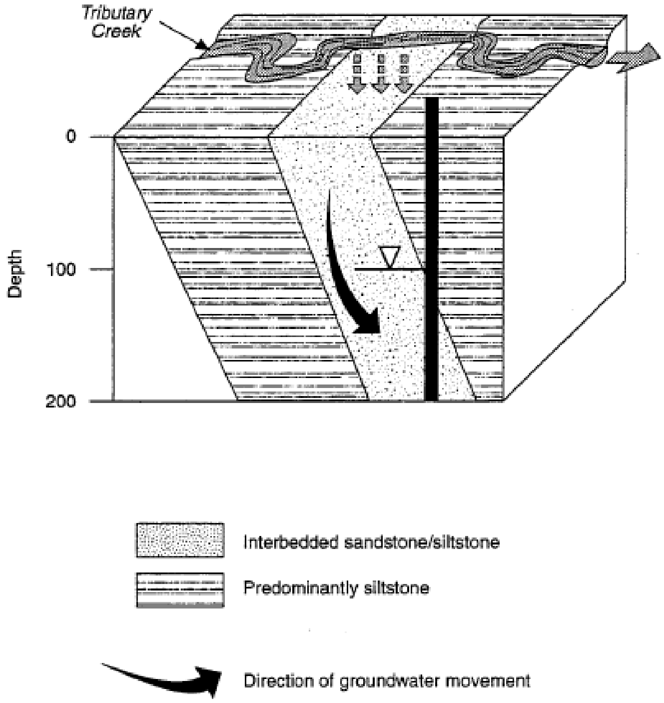
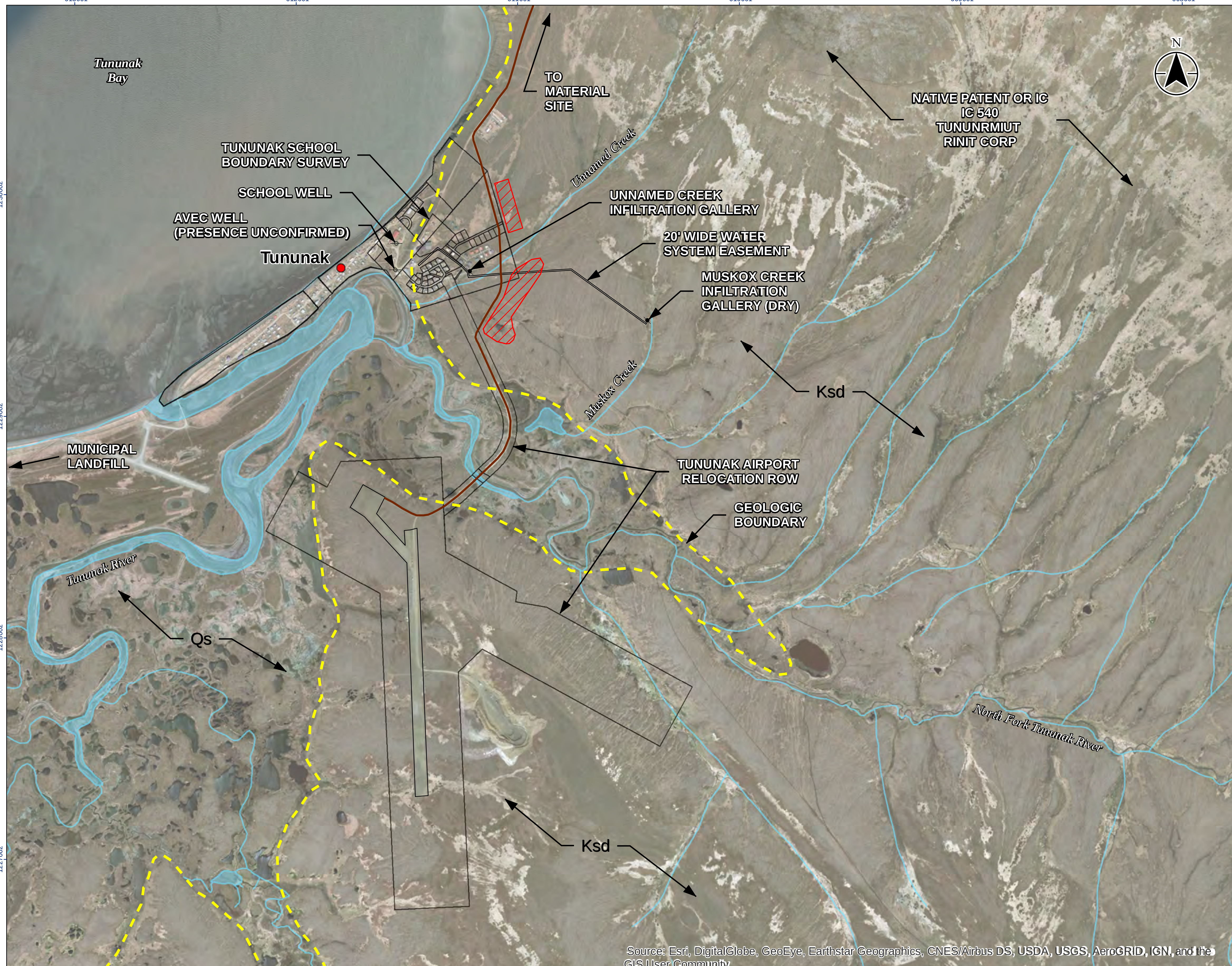


Figure 3- Conceptual groundwater model for deep water production wells in Toksook Bay (adapted from HDR Alaska Inc. 2005. City of Toksook Bay Sanitation Facilities Master Plan, Prepared for City of Toksook Bay.)



Stantec

Legend

- Groundwater Well
- Infiltration Gallery
- Proposed Deep Water Supply Investigation Areas
- Road
- Hydrography 1:63360
- Approximate Geologic Boundary

Qs - Quaternary Unconsolidated Surficial Deposits

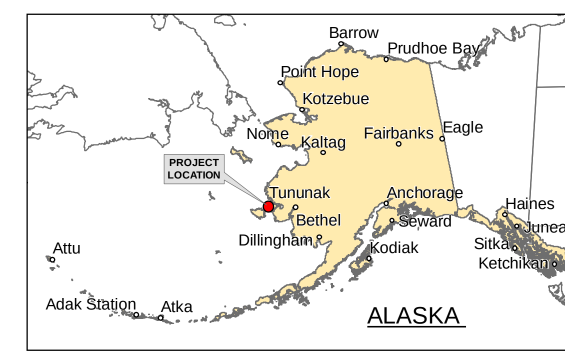
Ksd - Cretaceous Sandstone, Shale

0 1,250 2,500 Feet

1:18,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 Alaska Albers
2. Hydrography and parcel features acquired from Alaska State Geo-Spatioal Clearing House, Originator:Alaska Department of Natural Resources - Information Resource Management;
3. Orthoimagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Approximate Geologic Boundary Adapted from Wilson et al. (2015), Geologic map of Alaska, Sim 3340



Project Location

T6N, R91W, S28
Village of Tununak, AK

XXXXXXXXX-XXXX REVA

Prepared by CDP on 2018-03-13
Technical Review by ABC on 2018-XX-XX
Independent Review by ABC on 2018-XX-XX

Client/Project

Technical Memorandum 4 - Water Source Assessment
Task 2 Hydrogeologic Desktop Study
Evaluation for Potential Deep Groundwater Supply Well

Figure No.

4

Title

Village of Tununak
Site Overview

Figure X-X.X

Attachment 1 - Reference Table

Source	Reference	Description	Importance
U.S. Geologic Survey	Coonrad, W.L., 1957. Geologic Reconnaissance in the Yukon-Kuskokwim Delta Region, Alaska. Miscellaneous Geologic Investigations MAP I-223. U.S. Geologic Survey.	Group conducted a 10-day reconnaissance of Nelson Island, including interpretation of aerial imagery and foot traverses along most of the coast along and also included helicopter aerial surveys. The publication described Cretaceous age sandstone-siltstone sequences which spanned the majority of the geographic extent of the island. In addition, he described the distribution of basaltic flow rock cap sequence with an aggregate thickness of 200 feet or more indicated by benches in numerous places. The bottom of the basaltic flow rock cap sequence is marked by an angular unconformity where the basaltic flow rock cap meets underlying folded Cretaceous sedimentary unit. Folded sedimentary bedrock is generally folded with a N70°W orientation	Describes the distribution, regional orientation, and character of sedimentary cretaceous bedrock of Nelson Island. Report indicates similar bedrock from the Village of Tununak to Toksook Bay.
	Wilson, F.H. et al., 2015. Geologic Map of Alaska. Scientific Investigations Map 3340. U.S. Geologic Survey.	Most recent review and update of geologic maps state-wide. Revised descriptions of lithology and geographic extents based on synthesizing regional information, new data sets, and updated imagery.	Reaffirms the findings of Coonrad, W.L., 1957 with minimal updates.
	U.S. Geological Survey. 1955. Tununak School Water Well Water Quality Field Sample. R.M. Waller. June 13. Site ID SB-6—91-28AACB1-1. Note, Page 1.	Water quality analyses and static water level measurements collected in 1955.	Provides additional record of water quality and history of construction at the BIA School Drinking Water Well.
	U.S. Geological Survey. 1978. Tununak Well Log. Anderson-Appleton. U.S. Public Health Service. May 1. Site ID SB-6-91-28AACC1-2.	Well log for water well installed and developed in 1978 south east of the AVEC power generation building.	Provides additional record of a drinking water well in Tununak, not present in the Department of Natural Resources database.
	U.S. Geological Survey. 1955. Groundwater Reconnaissance in Five Eskimo Villages in the Lower Kuskokwim-Yukon River Area, Alaska.	Described two wells installed at the time in Tununak, primarily a 14 foot well located in the School of the time. Provides general description of surficial geology and exsisting water sources. Provides general recommendations on avoiding permafrost and salt water intrusion in the town site in the unconsolidated sediment.	
Alaska Department of Natural Resources	AK DNR. 1964. Tununak Water Well PD&C. Ralph Donelson. Bureau of Indian Affairs. February 7.	Well log for the BIA School Well.	Provides most recent information on the construction of the BIA School Well including documented production rates.
Alaska Department of Transportation	Alaska DOT & PF, 2005. Geotechnical Data Report, Tununak Airport Improvements, AKSAS #51791.	Geotechnical data collected in several proposed locations for the new runway, as well as material mining sites.	Limited to quaternary unconsolidated soil south of the Tununak River. Limited information on the nature of permafrost distribution and bedrock encountered.
	Alaska DOT & PF, 2005. Reconnaissance Geology Report Nelson Island Roads, AKSAS #57176.	Geotechnical data collected along the proposed Nelson Highway cooridor, between Villages of Tununak and Toksook Bay.	Describes depth to and types of bedrock encountered in the area between Tunuak and Toksook Bay.
Lower Kuskokwim School District	R&M Consultants, Inc. 1979. Geotechnical Investigation and Foundation Recommendations for High School Site Tununak, Alaska, Prepared for Lower Kuskokwim School District, Bethel, Alaska.	Geotechnical data collected at the Tununak School Site.	Describes shallow soils, permafrost distribution, and depth to bedrock.
City of Toksook Bay	HDR Alaska Inc. 2005. City of Toksook Bay Sanitation Facilities Master Plan, Prepared for City of Toksook Bay.	Sanitation Facilities Master Plan covers revisions to drinking and waste water systems in the nearby Village of Toksook Bay.	Describes groundwater well history, the finding of recent geologic mapping, geophysical investigations for the Village of Toksook Bay. The report also provides water quality data and production rates of the deep wells in the village.
Institute of Northern Engineering, University of Alaska Fairbanks	Jorgenson, Torre. 2008. Permafrost Characteristics of Alaska. Presented at the Ninth Internation Conference on Permafrost, Institute of Northern Engineering, Geophysical Institute.	Describes the updated understanding of permafrost distribution in Alaska, including all available depth information, and regional classifications.	Describes the general distribution of permafrost in southwest Alaska including all nearby thickness measuremnets.
Alaska Department of Environmental Conservation - Drinking Water Protection	Palmer, Charlie. 2018. Email communication March 02, 2018.	Provided current status of drinking water source classification for the Village of Tununak, well logs source from the Department of Natural Resourses for Tununak and Toksook Bay.	

Addendum 1, Attachment 2

12031

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
Alaska Hydrologic Survey

WATER WELL LOG Revised 08/18/2016

Drilling Started: ___/___/_____ Completed: 12 / 13 / 1964 Pump Install: ___/___/_____

City/Borough	Subdivision	Block	Lot	Property Owner Name & Address
Tununak				US BIA, TUNUNAK ,

Well location: Latitude ______________ **Longitude** ______________

Meridian S Township 006N Range 091W Section 28 , NE 1/4 of NE 1/4 of ___ 1/4 of ___ 1/4

BOREHOLE DATA: (from ground surface)
Suggest T.**M. Hanna's hydrogeologic classification system***
https://my.ngwa.org/NC__Product?id=a185000000BYub3AAD

	Depth From	To

Include description or sketch of well location (include road names, buildings, etc.):

North

AS 41.08.020(b)(4) and AAC 11 AAC 93.140(a) require that a copy of the well log be submitted to the Department of Natural Resources within **45 days of well completion**. Well logs may be submitted using the online well log reporting system available at:

https://dnr.alaska.gov/welts/

OR email electronic well logs to

dnr.water.reports@alaska.gov

Drilling method: ☐ Air rotary, ☐ Cable tool, ☐ Other ______

Well use: ☒ Public supply, ☐ Domestic, ☐ Reinjection, ☐ Hydrofracking ☐ Commercial, ☐ Observation/Monitoring, ☐ Test/Exploratory, ☐ Cooling, ☐ Irrigation/Agriculture, ☐ Grounding, ☐ Recharge/Aquifer Storage, ☐ Heating, ☐ Geothermal Exploration, ☐ Other ______

Fluids used: ______

Depth of hole: 38 ft Casing stickup: ______ ft
Casing type: ______ Casing thickness: ______ inches
Casing diameter: ______ inches Casing depth: 31 ft
Liner type: ______ Depth: ______ ft Diameter: ______ inches
Note: CASE TO 31 FT, SCREEN TO 36.5 FT

Well intake opening type: ☐ Open end, ☐ Open hole, ☐ Other ______
Screen type: ______, Screen mesh size: ______
Screen start: ______ ft, Screen stop: ______ ft, Perforated ☐ Yes ☒ No
Perforation description: ______ Perf from: ______ ft, Perf to: ______ ft, Perf from: ______ ft, Perf to: ______ ft
Gravel packed ☐ Yes ☐ No Gravel start: ______ ft , Gravel stop: ______ ft
Note: ______

Static water (from top of casing): 10 ft on ___/___/_____ Artesian well ☐
Pumping level & yield: ______ feet after ______ hours at 6 gpm
Method of testing: ______
Development method: ______ Duration: ______
Recovery rate: ______ gpm

Grout type: ______ Volume ______
Depth: From ______ ft, To ______ ft

Final pump intake depth: ______ ft Model: ______
Pump size: ______ hp Brand name: ______

Was well disinfected upon completion? ☐ Yes ☐ No
Method of disinfection: ______
Was water quality tested? ☐ Yes ☐ No
Water quality parameters tested: ______

Well driller name: ......
Company name: US BIA......
Mailing address: ......
City: ______ State: AK Zip: ______
Phone number: (______) ______ - ______
Driller's signature: ______
Date: ___/___/_____

Anchorage Municipal Code 15.55.060(I) and North Pole Ordinance 13.32.030(D) require that a copy of this well log be submitted to the Development Services Department/City within **30 days of well completion**.

City Permit Number: ______
Date of Issue: ___/___/_____

Parcel Identification Number: ______-______-______

*Guide for Using the Hydrogeologic Classification System for Logging Water Well Boreholes by Thomas M. Hanna NGWA Press

Anchorage Ala
Feb. 7th 1964

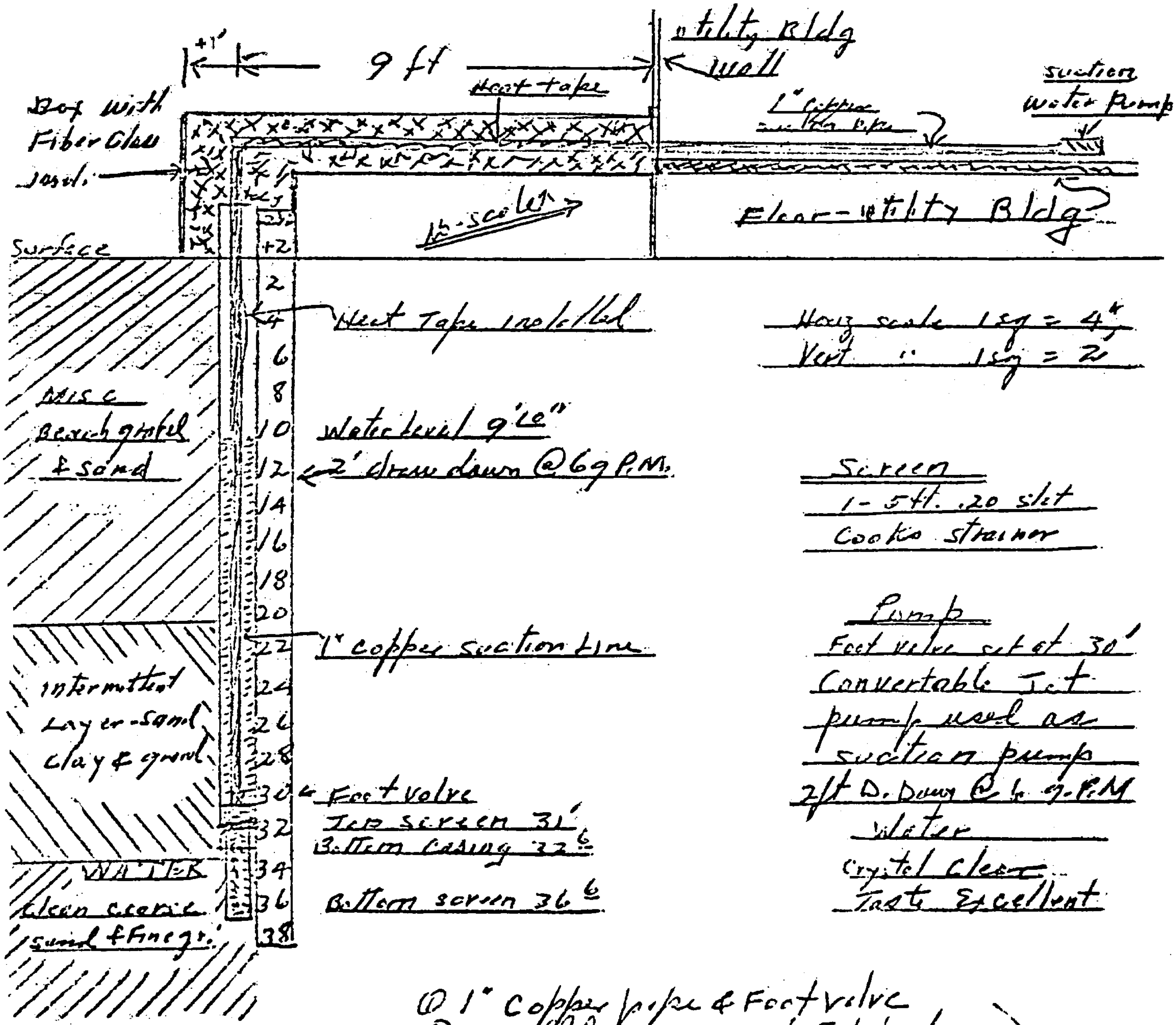
BUREAU OF INDIAN AFFAIRS
RECEIVED
FEB 12 1964
BRANCH OF
PLANT DESIGN & CONSTRUCTION

3050

Ralph Donelson
Const Supt.
Anchorage Alaska

Tununak Water Well PD&C

Mob 11/19/63 12/4/63 (Bethel to Tununak)
Drilling & Dev 12/4 - 12/13/64



Horiz scale 1 sq = 4"
Vert " 1 sq = 2'

Screen
1 - 5 ft. .20 slot
Cooks strainer

Pump
Foot valve set at 30'
Convertable Jet pump used as suction pump
2 ft D. Down @ 6 g.P.M
Water
Crystal Clear
Taste Excellent

(1) 1" Copper pipe & Foot valve
(2) Insulating Box with Fiberglas
(3) Heat Tape
were installed By school Janitor)

RECEIVED
JAN 3 1964
JAN 20 1964
BRANCH OF DESIGN & CONSTRUCTION

WELL DRILLING

PROJECT NO: BIA 63-30 TITLE: Tununak Alaska
LOCATION: Tununak
CONTRACTOR: Compton & Prince - Drillers TYPE OF RIG: Cable tool

DATE	START DEPTH FEET	STOP DEPTH FEET	DEPTH TO WATER	SAMPLE CLASSIFICATION
11/19/63	to 12/4			Moving Rig from Bethel & setting up at Tununak
12/4	0	20'	—	Beach gravel } assumed since Driller did not log material
12/5	20	36'	9'	Layers of Clay & gravel
				Hit water at 33'
12/6				Pumped 6 gal. per min. - 5 hrs. - 2½ ft drawdown
12/7				Pumped 6 gal per min for 16 hrs.
12/8				Sunday — storm blew Rig over.
12/9				straightened up rig after storm
12/10				set screen & started to develop well -
12/11,	12, 13			sustained production test at 6 gal per min -

MATERIAL LEFT IN WELL

	OPENING	DIAM.	LENGTH - FEET	MATERIAL
Screen	.20	4'	5 ft.	Everdur
Drive Casing				
Casing		4'	36'	

TEST OF WELL

[illegible]	[illegible]	YIELD - GPM	PUMPING W.L.	REMARKS
12/12	12/13	6	11 ft	2 ft Drawdown [illegible]

12031

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MAR 1 8 1964
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PLANT DESIGN & CONSTRUCTION

2GW

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER ANALYSIS

Location Bureau of Indian Affairs @ Tununak, Alaska County
Source Depth (ft) Diam (in.)
Cased to (ft) Date drilled Point of coll.
Owner
Treatment Use
WBF WL Yield
Temp (°F) Appear. when coll.
Collected December 13, 1968 By Sam Cotten
Remarks

	ppm	epm		ppm	epm
Silica (SiO_2)	9.8		Bicarbonate (HCO_3)	70	1.14
Aluminum (Al)			Carbonate (CO_3)		
Iron (Fe) (dis)	0.05				
Manganese (Mn)	0.05		Sulfate (SO_4)	5.0	0.10
			Chloride (Cl)	15	0.42
			Fluoride (F)	0.2	0.01
Calcium (Ca)	9.2	0.46			
Magnesium (Mg)	4.6	0.38	Nitrate (NO_3)	0.3	0.01
Sodium (Na)	17	0.73			
Potassium (K)	2.1	0.05			
Total		1.62	Total		1.68

	ppm		
		Specific conductance (micromhos at 25° C)	169
Dissolved solids: Calculated	97	pH	6.8
Residue on evaporation at 180°C		Color	-
Hardness as $CaCO_3$	42		
Noncarbonate	—		
Alkalinity as $CaCO_3$	57		

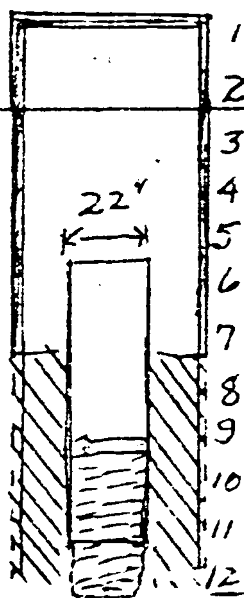
No. Col 7934 Field No. Project

M. M. Custard
Const. Supt.
~~Anchorage Alaska~~

Bethel Alaska
2/23/63

JHJ

TUNUNAK - WATER WELL



All material
Beach gravel
& Sand
Steel Cylinder
22" Diam.
6' Long -
Wood Cribbing

Static level 8' 9"
At 400 g.P.H.
pumping level 9' 11½"
Tests were made
with Temp. pump
set-up.

Permanent Pump test
were made at 800 gph
This was too fast

The out-put should
be choked to 500 gph
Or Less.
a weekly check
should be made
on Static water level
and Records Kept

The ½ H.P. Jet pump
was set up as a 2 pipe Jet.
This was abandoned due
Lack of proper seals for
pipe on head.
The pump was converted
to straight suction, using
only one pipe with foot valve
in well.

The Pump motor was
changed from 110v to 220v
Heat cables were checked
out O.K.

The Low-water cut-off
was set to pump ± 3000 gal
when cut in.
This was changed to pump
± 500 gal. when cut in.

This cut-in change results in the following.

1. ± 4000 gal storage at all times - case of Fire or Breakdown
2. Frequent pumping - less chance of Freezing
3. Less drain on well at any one time.

The above Tests and changes were personally
Made By Robt. Galbrath (Const. Supt.) In my
Presence.

Water Sample sent
to Palmer Alaska
water "hard" But taste good

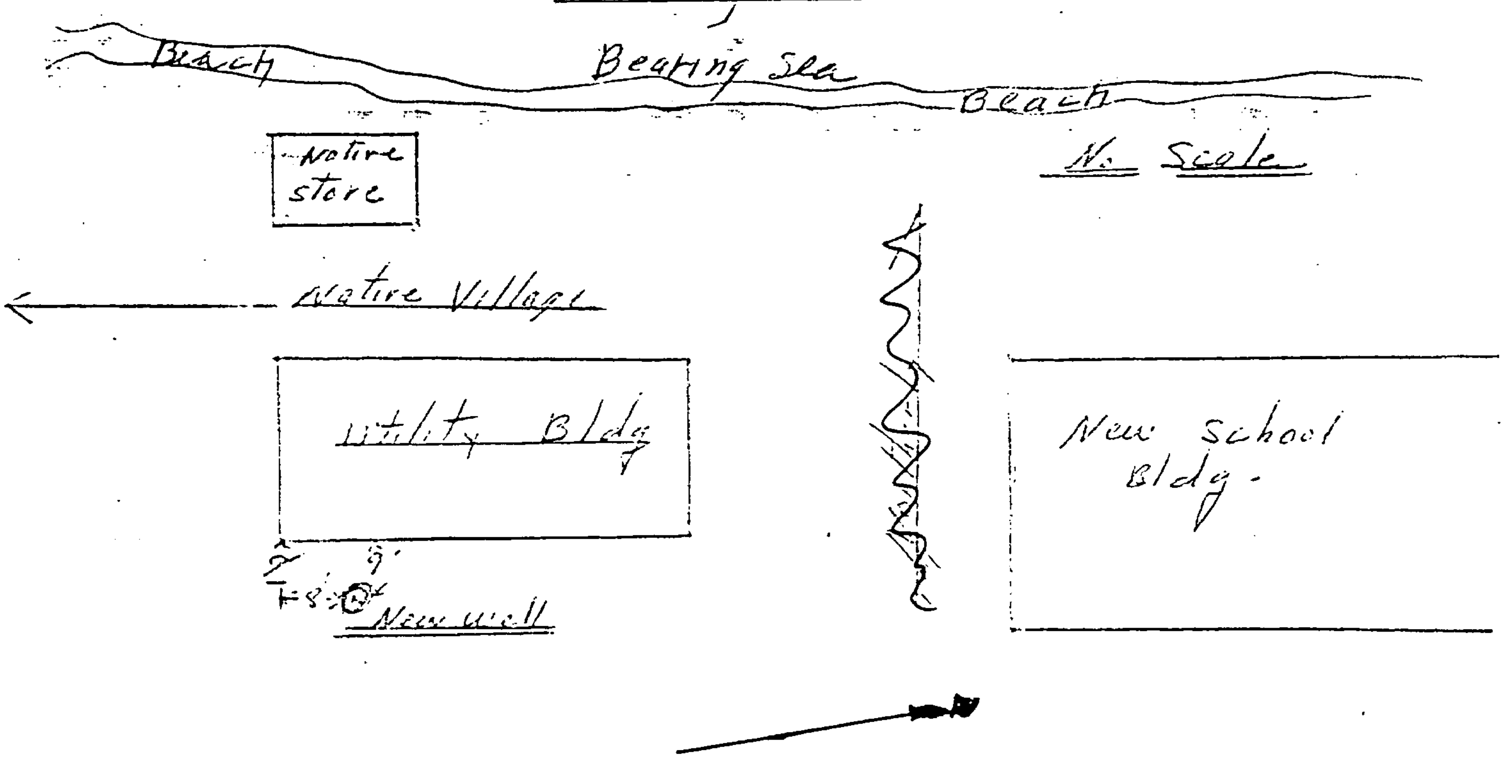
Sam L. Cotten
Drill-Foreman

Anchorage, Alaska
Feb. 7th, 1964

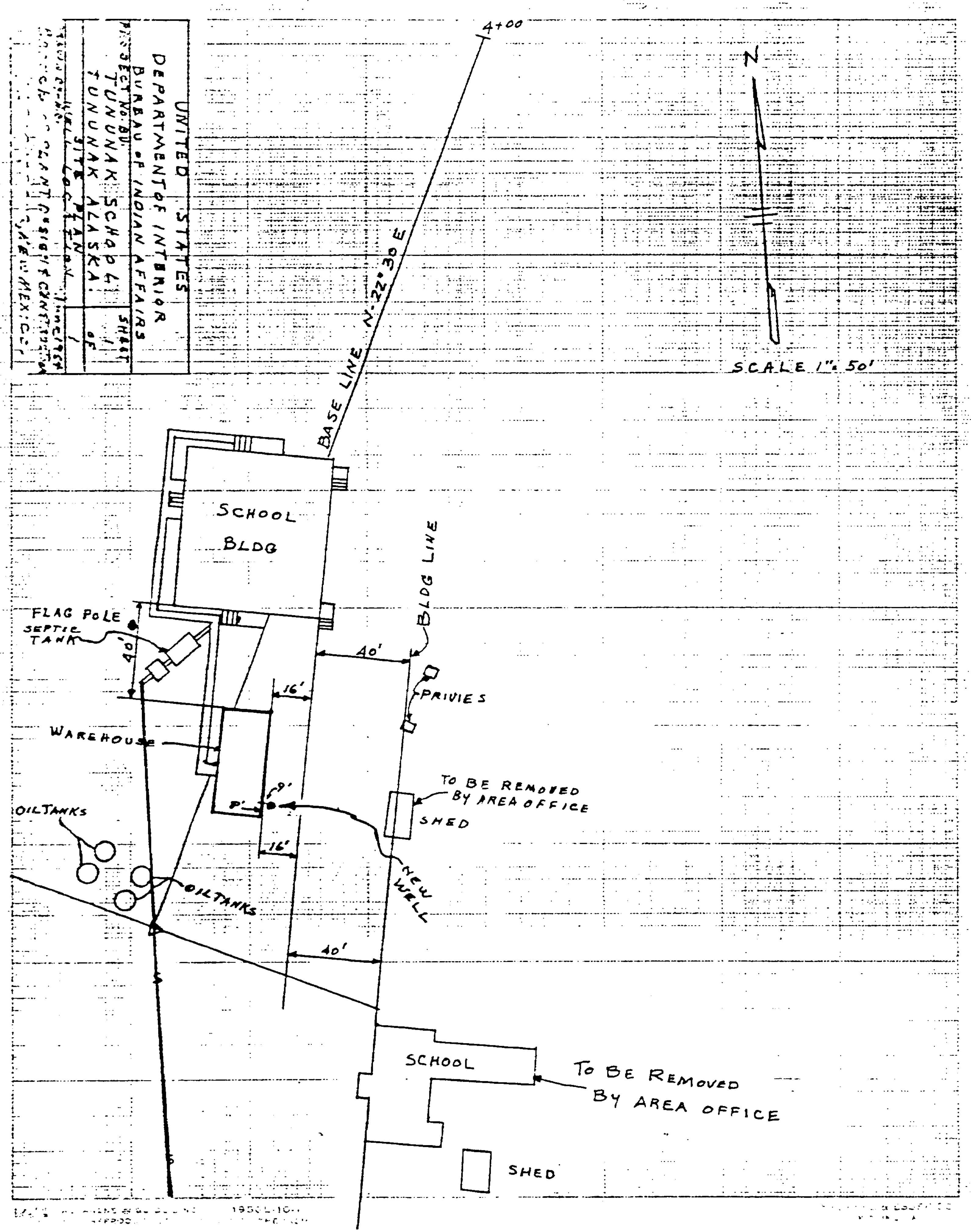
Ralph W. Donelson
Distr. Supt.
Anchorage Alaska

Tununak Water Well PDRC

Vicinity Sketch

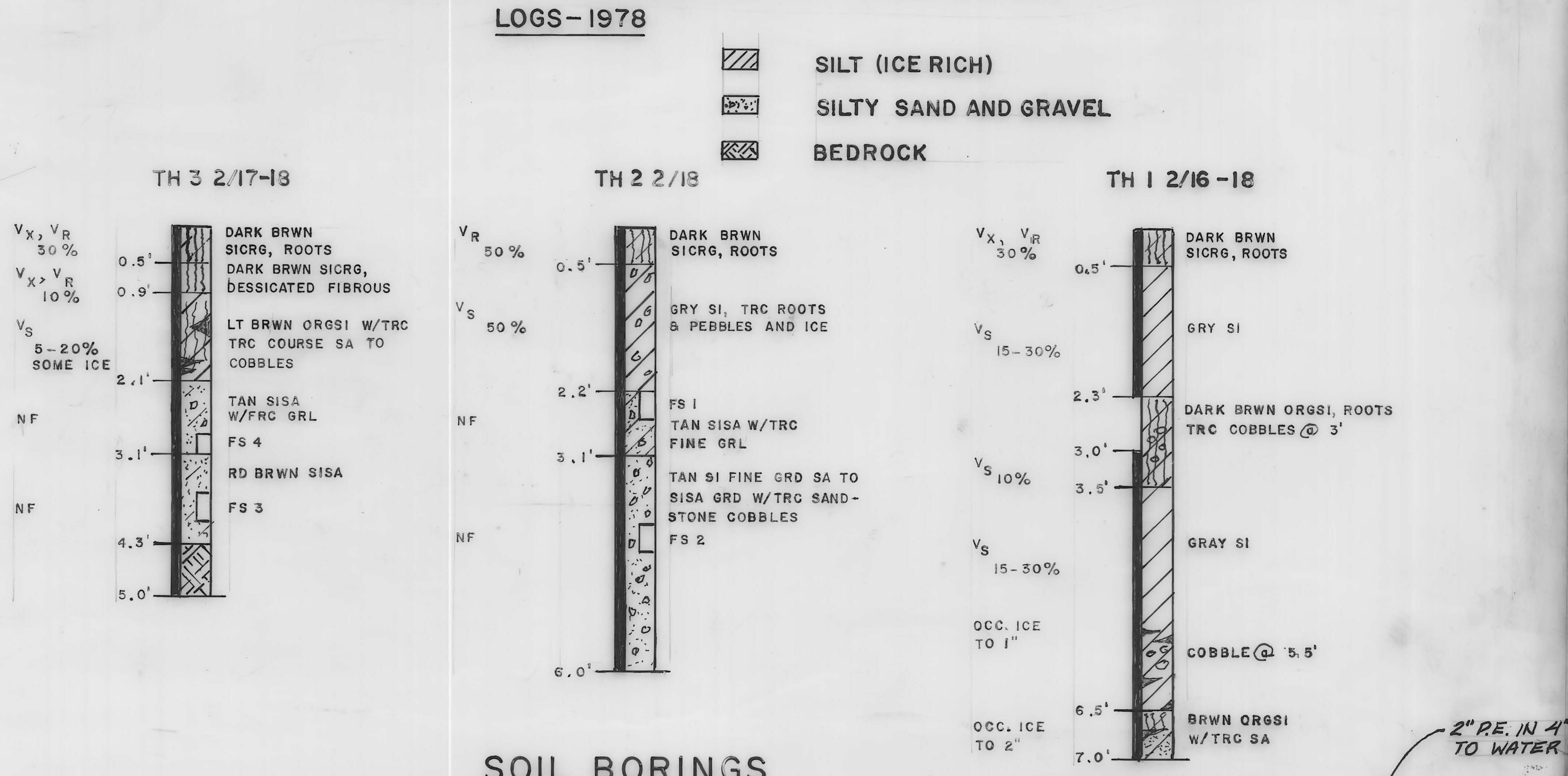


By Sam Patton
Well Drill Foreman


UNITED STATES
DEPARTMENT OF INTERIOR
BUREAU OF INDIAN AFFAIRS
TUNUNAK SCHOOL
TUNUNAK ALASKA
SITE PLAN
SHEET 1 OF 1
4+00
N
SCALE 1" = 50'
BASE LINE N-22°30'E
SCHOOL BLDG
BLDG LINE
FLAG POLE
SEPTIC TANK
40'
16'
PRIVIES
WAREHOUSE
TO BE REMOVED BY AREA OFFICE
SHED
9'
8'
OIL TANKS
NEW WELL
OILTANKS
SCHOOL
TO BE REMOVED BY AREA OFFICE
SHED

TUNUNAK WATER STORAGE TANK SITE

LOGS-1978



SOIL BORINGS

AS BUILT

SCALE 1" = 40'

DATE OF PHOTO 6-27-74

U. S. Department of Health, Education & Welfare
Public Health Service
DIVISION OF INDIAN HEALTH

TUNUNAK, ALASKA

WATER TREATMENT AND WASHETERIA BUILDING

PUBLIC LAW 86-121 PROJECT

PROJECT NO. AN-77-631

SHEET NO. 3 OF 23 TOTAL SHEETS

DRAWN BY B. KIRSCHBAUM
DATE MAY, 1978

CHECKED BY JTL
DATE 6/6/78

STATE OF ALASKA 49TH JOHN T. LOVETT No. 3512-E REGISTERED PROFESSIONAL ENGINEER

SANITATION FACILITIES CONSTRUCTION BRANCH
OFFICE OF ENVIRONMENTAL HEALTH
ALASKA AREA NATIVE HEALTH SERVICE
ANCHORAGE, ALASKA

Prepared by: NORTH PACIFIC AERIAL SURVEYS, INC. Anchorage Alaska

GEOTECHNICAL INVESTIGATION
AND FOUNDATION RECOMMENDATIONS

FOR

HIGH SCHOOL SITE
TUNUNAK, ALASKA

March, 1979

By

R&M Consultants, Inc.
5024 Cordova Street
Anchorage, Alaska 99502

For

LOWER KUSKOKWIM SCHOOL DISTRICT
Bethel, Alaska

R&M CONSULTANTS, INC. 5024 CORDOVA ■ BOX 6087 ■ ANCHORAGE, ALASKA 99502 ■ PH. 907-279-0483 ■ TLX. 090-25360

ENGINEERS
GEOLOGISTS
PLANNERS
SURVEYORS

March 20, 1979 R&M No. 951008

Lower Kuskokwim School District
P.O. Box 305
Bethel, Alaska 99559

Attention: Mr. David Chauvin, Contract Manager

Re: Geotechnical Investigation and Foundation Recommendations, High School Site, Tununak, Alaska.

Gentlemen:

We are pleased to submit 25 copies of our final report for the geotechnical investigation and foundation recommendations for the proposed High School at Tununak, Alaska. This work was accomplished under Amendment 3 of R&M Consultants' contract with the Lower Kuskokwim School District dated October 30, 1978 and in accordance with our interpretation of your geotechnical requirements.

Should you have any questions with regard to this report, please contact us at your convenience.

Very truly yours,

R&M CONSULTANTS, INC.

Dennis Nottingham, P.E.
Vice President

DN:BED/djb/G1-G

CONTENTS

1.0 INTRODUCTION

R&M Consultants, Inc. has undertaken a two phased study of the site at Tununak, Alaska (Drawing A-01), where a Lower Kuskokwim School District secondary school is to be constructed. Phase One of this study, published under separate cover, included a site survey, the development of comprehensive design determinants, and technical assistance, provided during public hearings in which the villagers selected a site. Phase Two of the site study was a geotechnical investigation of the school site. This phase included a detailed field drilling program, extensive laboratory testing and analysis of site soil conditions to provide site geotechnical recommendations. This Second Phase report presents the results of the subsurface soils investigation and soil engineering recommendations for the proposed high school. The site is shown on the attached location diagram, Drawing A-02.

The study of the subsurface conditions at the proposed project location was performed in accordance with R&M Consultants' contract with the Lower Kuskokwim School District. Mr. B. A. Weinberg, Superindentent of the Lower Kuskokwim School District authorized commencement of Phase II in a letter dated January 5, 1979. Phase II was carried out under the supervision of Mr. David L. Chauvin, Contract Manager, for the Lower Kuskokwim School District.

R&M Consultants' scope of work included a subsurface soils investigation, installation of temperature instrumentation to obtain subsurface temperature information; laboratory testing of recovered samples to determine index and engineering properties; geotechnical recommendations regarding general site development and foundation design; and preparation of a written report.

It is our understanding that the proposed 8800-square foot Tununak High School will be a one story wood-frame structure generating moderate foundation loads. Fuel storage tanks will also occupy the site. The feasibility of utilizing a subsurface sewage disposal system was another consideration of this investigation.

The purpose of this report is to:

1) describe the apparent subsurface soil, groundwater and permafrost conditions encountered at the site utilizing field and laboratory data,
2) present recommendations regarding foundation selection and design and general site development.

2.0 SUBSURFACE INVESTIGATION

The subsurface investigation for this site was conducted as part of a seventeen village program. Bethel served as a base of operations for the field investigations. Three drill rigs were simultaneously employed at different sites.

Three test holes, designated Test Holes 8-1, 8-2 and 8-3 were drilled on the subject site as shown on the attached Location Diagram, A-02. Nineteen and one half feet was the total depth of exploration. Logs of these test holes are presented in Drawings B-04 and B-05.

Soil boring and sampling operations were performed with a skid-mounted SIMCO 2400 rotary-type hydraulic drilling rig. The drill rig and drilling crew, were transported to Tununak by a Sky Van aircraft. A small dozer furnished by the State of Alaska Division of Aviation was used to transport the drill from the airstrip to the school site. The test holes were advanced using 6-inch hollow stem augers.

Representative subsurface materials were obtained by standard shelby sampling techniques and by means of a standard split-spoon sample procedure. In this procedure a split-spoon sampler (1.4-inch I.D.) is driven into undisturbed natural soil with a 140-pound drop hammer having a 30-inch free fall. The penetration resistance (as measured by blow count) in unfrozen soil provides an "N" value which can be correlated with the bearing capacity of the in situ soils. In frozen soils the blow count values give an indication of the relative strength of the soils but do not correlate to any absolute frozen strength values. After visual classification in the field, all soil samples were transferred to the R&M Laboratory in Anchorage for further examination and testing.

A 3/4-inch PVC casing and a thermistor string were installed in Test Hole 8-1 to measure soil temperatures. The 30-foot string contained 6 thermistor points located at 5-foot intervals. A summary of readings taken during the site investigation is shown on Drawing B-06. The thermistor string was left in the test hole for long term monitoring of subsurface temperatures.

3.0 LABORATORY TESTING

Soil samples recovered in a frozen state were kept frozen until laboratory testing was initiated. This allowed a direct determination of certain frozen soil properties during testing.

The laboratory testing program was limited to the evaluation of general soil index properties. Laboratory determination of water content of recovered samples was performed according to ASTM Specification D-2216. Particle size distribution analysis was performed on selected samples in accordance with ASTM Specification D-422. Organic contents were measured using State of Alaska Test Method T-6. Density tests used ASTM Specification D-2937; specific gravity used ASTM Specification D-853. Laboratory test results for selected samples are provided on Table C-01.

4.0 SITE CONDITIONS AND GEOLOGIC SETTING

The site (4.87 acres) selected by the people of Tununak for the proposed high school is located 250 feet east of the B.I.A. School on the northeast end of the spit. The site is located on the edge of a ridge formed by the lower reaches of the Ugchirnak Mountain. The site slopes upward to the north with an average gradient of 6 percent and is covered by tundra grass and moss vegetation. A gravel road has been constructed to the P.H.S. building just south of the site. The site is completely undeveloped. Maynard & Partch, Architects selected two school locations on the site, one an alternate in the event the preferred location proved unacceptable. The primary location near the south central portion of the site was investigated during this study and found satisfactory for the proposed structure.

The village of Tununak is situated on the west side of Nelson Island on a spit which separates the Tununak River from the Bering Sea. The village lies near the northeast end of the spit where it is joined to its headland, the lower slope of Ugchirnak Mountain. The spit is a beach deposit formed by action of longshore currents moving from the northeast. This beach and the beach adjacent to the airfield are made up of thawed sands and gravels.

The proposed school site is near the Public Health Service water and washeteria building on the nearby lower slope of Ugchirnak Mountain. The mountain slope is mantled by frozen ice-rich silts, colluvium and weathered bedrock which thicken at the mountain base.

Tununak is located within Seismic Zone 1 as defined by the 1976 edition of the Uniform Building Code.

5.0 SUBSURFACE CONDITIONS

As shown on the attached test hole logs the location of the proposed structures was underlain by permafrost. A surface organic layer (0 to 6") overlay a silt layer (with 5 to 40% ice) which extended to a depth of 1 1/2 to 5 feet below the ground surface. Beneath this stratum dense ice rich silty gravel was encountered, extending to depths of 13 to 16 1/2 feet. Fractured bedrock was found at a depth of 16 1/2 feet in T.H. 1.

At the time of drilling in January 1979, the seasonal frost had extended down to the top of the permafrost. Permafrost was encountered over the entire depths drilled. Ice content ranged from 40% near the surface to 3% at greater depths. The bedrock encountered contained significant amounts of ice.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The foundation recommendations and site geotechnical parameters contained in this report are based upon the fact that ice rich permafrost underlies the entire site. When these conditions are present it is imperative that the soils which support structures on the site remain in a frozen state over the life of the structures. Thus, all foundation design, construction, and operating conditions must be directed toward avoiding any thermal disturbance of the underlying permafrost. If the permafrost thaws, either during construction or the operating life of any of the structures proposed for this site, severe settlement may be expected.

We therefore recommend that all foundation construction be continually monitored by qualified personnel to insure that proper construction techniques (which preserve the permafrost) are employed. It is further recommended that a periodic inspection program be established after construction is complete, to insure that foundation systems are performing as expected and that long term thermal equilibrium of the site is maintained.

6.1 Design Parameters

Permanently frozen soils (permafrost) can generally be divided into three performance groups; high strength soil, medium strength soil and low strength soil. High strength soils are fine sands and silty sands with little or no visible ice. Medium strength soils are fine sands and silty sands with some organic material and/or visible ice. Low strength soils are fine-grained and organic soils with high ice contents. Soils at the proposed site should be considered medium strength for a refrigerated shallow foundation placed on the silt and sand stratum located at 5 feet below ground surface in Test Hole 8-1 and Test Hole 8-2. High strength soil parameters may be utilized for pile foundations.

Within the depth drilled soil temperatures range from 30.3°F to 31.6°F. For the recommended foundation system a temperature of 31.5°F should be considered representative of the thermal condition. Because of the continuously frozen nature of the soils at the time of drilling, the depth to permafrost, which lies directly beneath the active layer, could not be directly determined during this investigation. We estimate the active layer thickness is approximately 3 feet.

6.2 Recommended Foundation System

The preferred foundation design for support of the school building is the refrigerated shallow foundation system illustrated in Drawing D-01. Winter construction may be required for the successful installation of this system. A detailed schematic diagram for the recommended refrigerated foundation system is presented on Drawing, D-01.

Foundation components should bear on permanently frozen (permafrost), undisturbed, tannish brown, silt, sand and gravel which exists below the active layer at an approximate depth of 5 feet at the building location. If any natural bearing surfaces are disturbed (loosened) or thawed during construction, they should be removed and replaced with a thawed granular (sand or gravel) backfill placed in nine inch lifts compacted to a minimum of 95% density.

All footings should be placed below the active layer to a depth which will assure a minimum 12 inch embeddment in permafrost. We recommend that all excavations be inspected by a qualified person to insure that the soil beneath the footing is frozen and that the footing is founded on permafrost. The leveling course should consist of thawed well graded sand or gravel placed in lifts not exceeding nine inches in loose thickness. Each lift should be compacted to a minimum of 95% of maximum density. All backfill should be dry or moist. No backfill which is saturated or contains debris, ice or any deleterious material should be permitted.

No excavation should remain open more than 24 hours and no accumulations of rain, snow or other water should be permitted. This may require continuous pumping to maintain a dry excavation if groundwater is encountered in or below the active layer.

A thermistor or other temperature monitoring device should be placed directly beneath representative footings to insure that soil temperatures are below 31°F before placing loads on the footings.

In accordance with the Long-Term Footing Bearing Loads in Fine-Grained Frozen Soils Chart (Drawing D-03) and following the recommendations outlined in this report, a 2000 psf total load soil bearing pressure for expected long term loads may be used in foundation design. Short term or impact loads equal to twice the long term loads may be used. This should ensure that total settlement will not exceed one inch. Differential settlement should not exceed 3/4".

6.3 Alternate Foundation System

A pile foundation may be utilized for support of the proposed school at this site. Several types of pile foundations may be feasible including slurried self refrigerating structural piles (for example Long Thermo Piles), slurried timber piles, and driven H-piles.

Slurried timber piles and driven H-piles may require "heat pipes" to be installed adjacent to each pile to maintain acceptable long term soil temperatures.

Slurried piles (long piles and timber piles) require drilling of an oversize pile hole, followed by placement of the pile and slurry. The pile hole must remain frozen and dry prior to slurry placement. Loading of the pile cannot begin until the design slurry temperature which depends upon pile hole size, pile spacing and soil temperature has been achieved. For a slurried pile, the load bearing capacity is a function of the adfreeze strength between the pile surface and the slurry and the adfreeze strength between the interface of the slurry and the natural soil. Since the slurry composition is usually controlled by specifications it can normally be considered a high strength soil when bonding to the pile surface. The recommended allowable adfreeze bond for long term loading for the slurry-pile interface is 220 psf from 4 to 12 feet and 575 psf from 12 to 20 feet. The bond between the slurry and the natural soil is governed by the strength classification of the natural soil. For the long term bond between slurry and natural soil, adfreeze values of 145 psf from 4 to 12 feet and 500 psf from 12 to 20 feet are recommended. Slurried piles may require a minimum spacing of approximately 10 feet. Therefore, large vertical loads may have to be spread over several piles located some distance apart.

The adfreeze bond for driven H-piles should be based on the natural soil parameters. H-piles may be driven directly into the ground and immediately loaded. Driven piles may be spaced as closely as practical, although some reduction in individual pile capacities should be made to account for group action.

Any pile system used should have provisions for monitoring soil temperatures adjacent to individual piles.

A schematic diagram for a pile foundation system is presented on Drawing D-03.

Pile foundations may be difficult to install because of dense gravelly stratum and relatively shallow bedrock which begin at a depth of 13 to 20 feet.

6.4 Overexcavation and Backfill

All backfill placed below footings should be non-frost-susceptible (NFS) sands or gravels. All such backfill should be completely free of organic matter, debris, or ice. Backfill should be placed in a thawed condition in lifts not exceeding nine inches in loose thickness and compacted to a minimum of 95% maximum density determined in accordance with either ASTM Specification D1557-70 or the Corps of Engineers' Providence Vibratory Density Method.

If an overexcavation and backfill technique is utilized anywhere for foundation footings, backfill should extend from the footings to the underlying natural competent soil bearing surface at a maximum slope of 1:2 (horizontal to vertical).

6.5 Groundwater and Surface Water

Because of the continuous nature of the permafrost encountered in each test hole, groundwater is not expected at the site. However, when the active layer thaws, it should be anticipated that surface and near surface water could enter building excavations or pile holes. Therefore, measures should be taken to keep all footing excavations dry in order to prevent softening or thawing of bearing soils.

As a minimum we recommend that:

(1) surface water be isolated from entering all excavations and pile holes during construction,

(2) final surface grading be accomplished in a manner which will positively drain all water away from the structure, and

(3) diversion of concentrated runoff away from below ground building areas be provided, for example, from roof structures.

6.6 Restoration and Thermal Protection

High ice content soils at the building site are highly susceptible to thermal degredation if significant surface disturbance occurs. If severe surface disturbance is permitted, the natural environmental cycle may result in thermal erosion and thaw settlement. The following protective procedures are recommended:

(1) where feasible, all earthwork should be conducted during the winter season,

(2) surface disturbance by equipment should be kept to a minimum,

(3) the existing surface organic mat should be stripped and then replaced over disturbed areas wherever possible.

6.7 On Site Septic System

Frozen fine-grained soils which underlie the proposed site preclude consideration of a drainfield or absorption bed for subsurface disposal of sewage.

7.0 CLOSURE

The engineering recommendations presented in this report have been based on the pertinent development information listed in Section 1.0. Significant alteration of any of these concepts could substantially alter the foregoing engineering recommendations. We would, therfore, appreciate having the opportunity to review and evaluate any such design changes and, where necessary, present any required corresponding changes to our present recommendations. Additionally, because subsurface characteristics can change sharply within a given area, the possibility exists that important subsurface conditions not disclosed by this field investigation may be discovered during construction. Should this situation occur, the influence of the new information on the present recommendations should be evaluated without delay. Therefore we recommend a qualified soils engineer be on site during foundation construction.

The future performance of the structures at this site is highly dependent upon construction techniques. We therefore recommend that a construction quality control program be implemented so that the contractor can be continuously monitored to insure the specifications are followed.

We appreciate the opportunity to perform this subsurface investigation. Should you require further information concerning the subsurface investigation or this report, please contact us at your convenience.

Very truly yours,

R&M CONSULTANTS, INC.

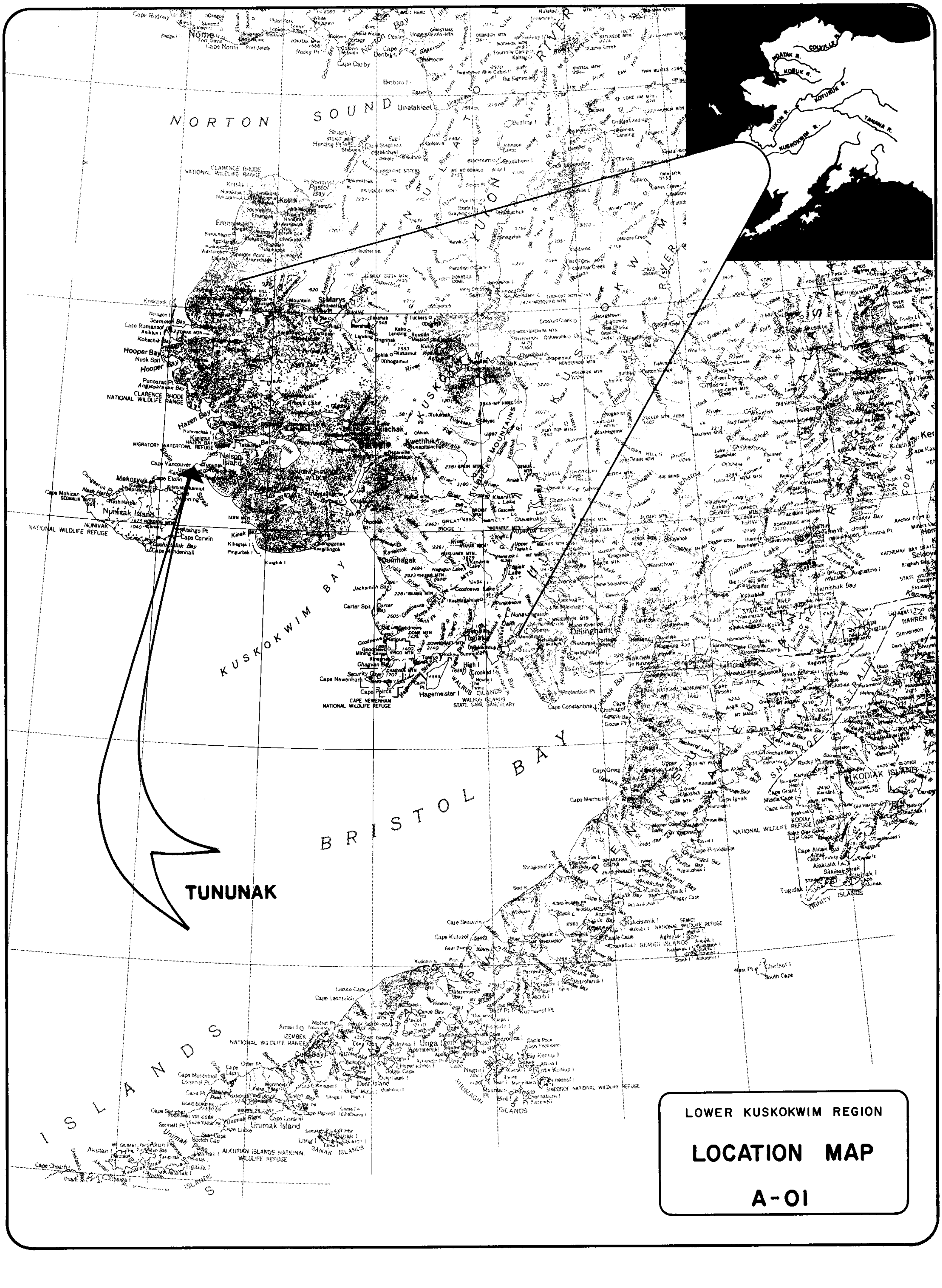
STATE OF ALASKA
49TH
D. Nottingham
No. 1204-E
REGISTERED PROFESSIONAL ENGINEER

Bruce E. Davison
Senior Geotechnical Engineer

Dennis Nottingham
Vice President

DN:BED/djb/G1-G

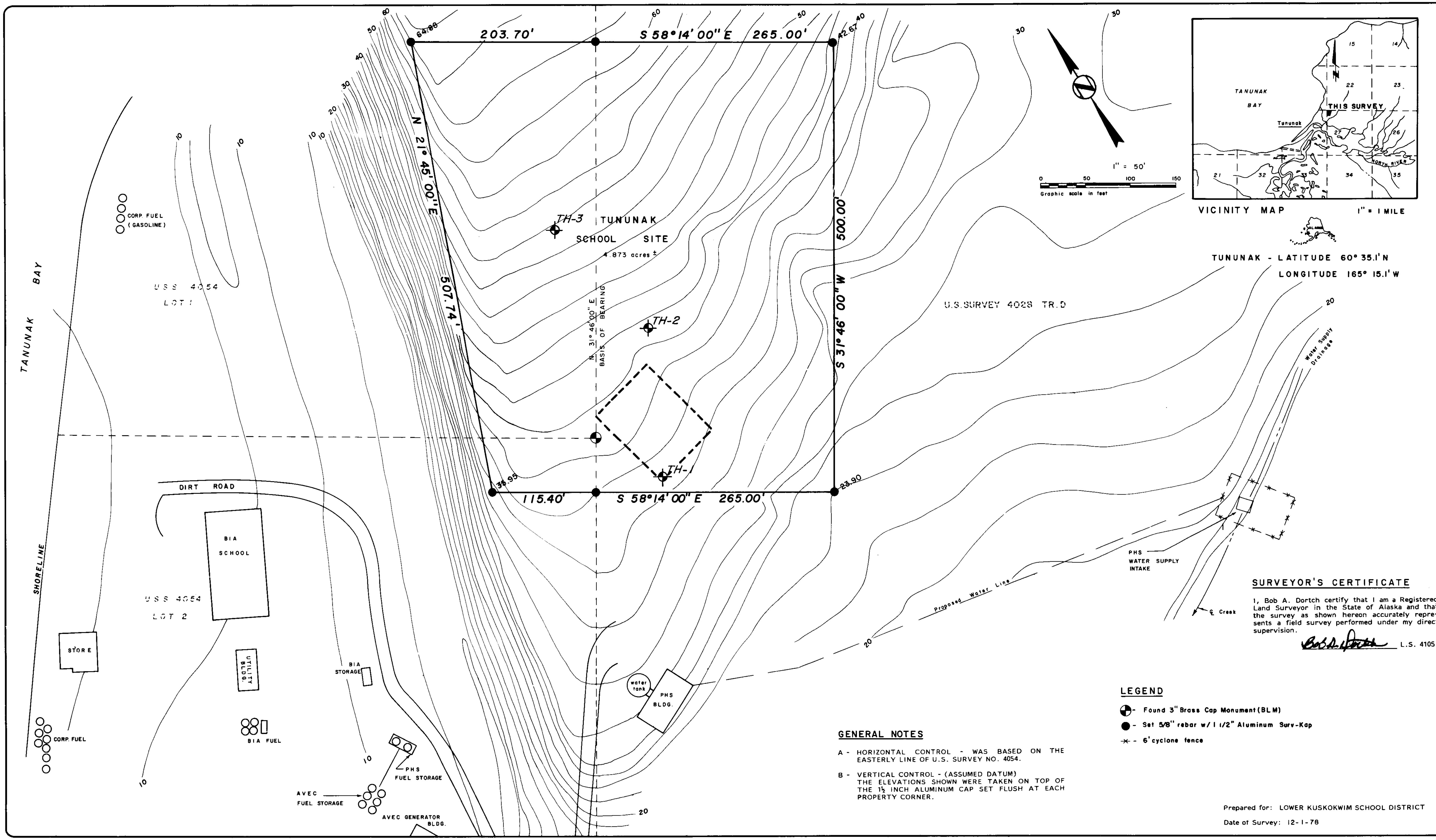
APPENDIX A



LOWER KUSKOKWIM REGION

LOCATION MAP

A-01



SURVEYOR'S CERTIFICATE

I, Bob A. Dortch certify that I am a Registered Land Surveyor in the State of Alaska and that the survey as shown hereon accurately represents a field survey performed under my direct supervision.

Bob A. Dortch L.S. 4105

LEGEND

- Found 3" Brass Cap Monument (BLM)
- Set 5/8" rebar w/ 1 1/2" Aluminum Surv-Kap
- 6' cyclone fence

GENERAL NOTES

A - HORIZONTAL CONTROL - WAS BASED ON THE EASTERLY LINE OF U.S. SURVEY NO. 4054.

B - VERTICAL CONTROL - (ASSUMED DATUM) THE ELEVATIONS SHOWN WERE TAKEN ON TOP OF THE 1½ INCH ALUMINUM CAP SET FLUSH AT EACH PROPERTY CORNER.

Prepared for: LOWER KUSKOKWIM SCHOOL DISTRICT

Date of Survey: 12-1-78

NO.	DATE	REVISION	BY	APRVD

DESIGN

DRAWN SRL

CHECK MS

APPROVED BD

STATE OF ALASKA 49TH Bob A. Dortch No. 4105-S REGISTERED PROFESSIONAL LAND SURVEYOR

R&M

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

TUNUNAK SCHOOL SITE SURVEY

DATE: 12-78
R&M NO. 853176

A-02

SHEET 1 OF 2

APPENDIX B

SOILS
CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION: Identification and classification of the soil is accomplished in accordance with the Unified Soil Classification System. Normally, the grain size distribution determines classification of the soil. The soil is defined according to major and minor constituents with the minor elements serving as modifiers of the major elements. For cohesive soils, the clay becomes the principal noun with the other major soil constituents used as modifier; i.e. silty clay, when the clay particles are such that the clay dominates soil properties. Minor soil constituents may be added to the classification breakdown in accordance with the particle size proportion listed below; i.e. sandy silt w/some gravel, trace clay.

no call - 0 - 3% trace - 3 - 12% some - 13 - 30%

SOIL CONSISTENCY - CRITERIA: Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e. fissure systems, shrinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

Cohesionless

	N*(blows/ft)	Relative Density
Loose	0 - 10	0 to 40%
Medium Dense	10 - 30	40 to 70%
Dense	30 - 60	70 to 90%
Very Dense	- 60	90 to 100%

*Standard Penetration "N": Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch OD split-spoon except where noted.

Cohesive

	T - (tsf)
Very Soft	0 - 0.25
Soft	0.25 - 0.5
Stiff	0.5 - 1.0
Firm	1.0 - 2.0
Very Firm	2.0 - 4.0
Hard	- 4.0

DRILLING SYMBOLS

WO:	Wash Out	WD:	While Drilling
WL:	Water Level	BCR:	Before Casing Removal
WCI:	Wet Cave In	ACR:	After Casing Removal
DCI:	Dry Cave In	AB:	After Boring
WS:	While Sampling	TD:	Total Depth

Note: Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious unfrozen soils, the indicated elevations are considered to represent actual ground water conditions. In impervious and frozen soils, accurate determinations of ground water elevations cannot be obtained within a limited period of observation and other evidence on ground water elevations and conditions are required.

WN.	
KD.	
DATE.	Feb. 1972
CALE.	None

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

GENERAL NOTES

F.B.	N/A
GRID.	N/A
PROJ.NO.	General
DWG.NO.	B-01

STANDARD SYMBOLS

ORGANIC MATERIAL	COBBLES & BOULDERS	IGNEOUS ROCK	SANDY SILT
CLAY	CONGLOMERATE	METAMORPHIC ROCK	SILT GRADING TO SANDY SILT
SILT	SANDSTONE	ICE, MASSIVE	SANDY GRAVEL, SCATTERED COBBLES (ROCK FRAGMENTS)
SAND	MUDSTONE	ICE - SILT	INTERLAYERED SAND & SANDY GRAVEL
GRAVEL	LIMESTONE	ORGANIC SILT	SILTY CLAY w/TR. SAND

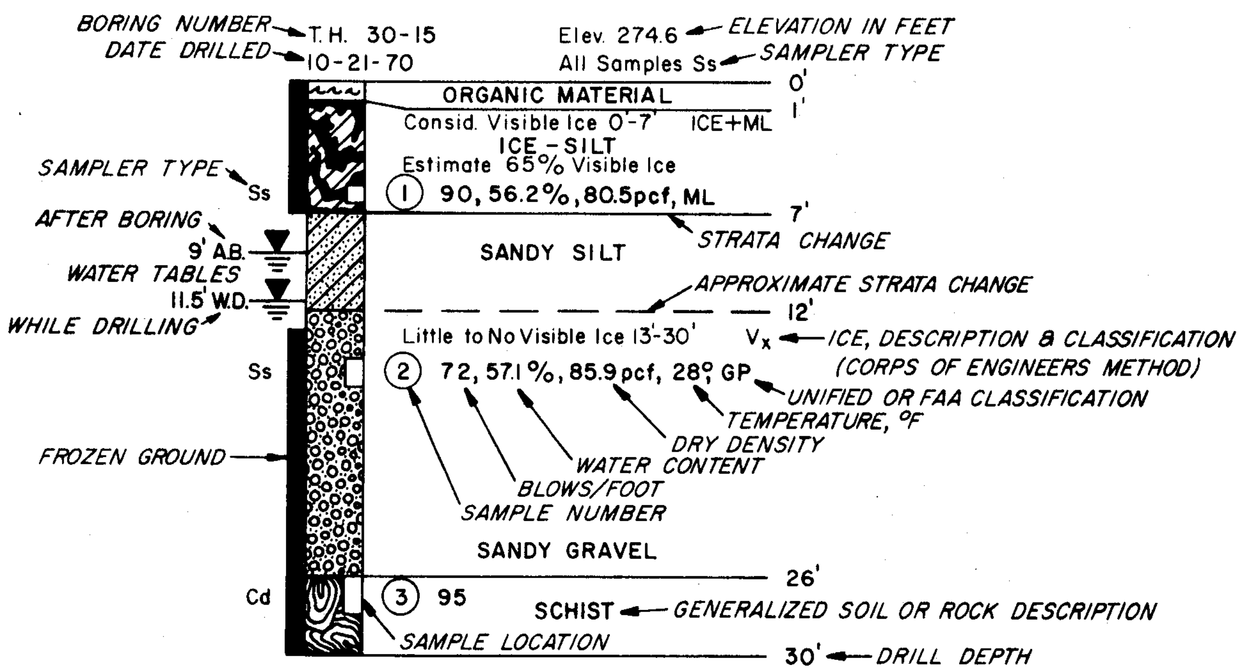
SAMPLER TYPE SYMBOLS

Ss . . . . . 1.4" SPLIT SPOON WITH 140 # HAMMER
Sz . . . . . 1.4" SPLIT SPOON WITH 340 # HAMMER
Sl . . . . . 2.5" SPLIT SPOON WITH 140 # HAMMER
Sh . . . . . 2.5" SPLIT SPOON WITH 340 # HAMMER
Sp . . . . . 2.5" SPLIT SPOON, PUSHED
A . . . . . AUGER SAMPLE

Ts . . . . SHELBY TUBE
Tm . . . . MODIFIED SHELBY TUBE
Pb . . . . PITCHER BARREL
Cs . . . . CORE BARREL WITH SINGLE TUBE
Cd . . . . CORE BARREL WITH DOUBLE TUBE
Bs . . . . BULK SAMPLE

NOTE: SAMPLER TYPES ARE EITHER NOTED ABOVE THE BORING LOG OR ADJACENT TO IT AT THE RESPECTIVE SAMPLE DEPTH.

TYPICAL BORING LOG



EXPLANATION OF SELECTED SYMBOLS

EXPLANATION OF ICE SYMBOLS

Percentage of visible ice has been grouped for the purpose of designating the amount of soil ice content. These groups have arbitrarily been set out as follows:

0%	No Visible Ice
1% - 10%	Little Visible Ice
11% - 20%	Occasional Visible Ice
21% - 35%	Some Visible Ice
>35%	Considerable Visible Ice

The ice description system is based on that presented by K. A. Linell, and C. W. Kaplar (1966). In this system, which is an extension of the Unified Soil Classification System, the amount and physical characteristics of the soil ice are accounted for. The following table is a brief summary of the salient points of their classification system as modified to meet the needs of this study.

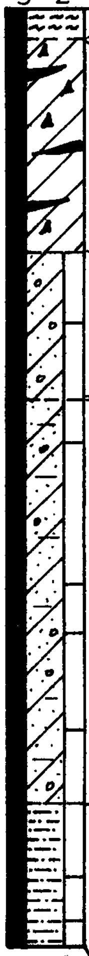
ICE DESCRIPTIONS

GROUP SYMBOL	ICE VISIBILITY & CONTENT	SUBGROUP DESCRIPTION	SUBGROUP SYMBOL
N	Ice not visible	Poorly bonded or friable	N_f
		Well bonded — No excess ice	N_b — N_{bn}
		Well bonded — Excess ice	N_b — N_{be}
V	Ice visible, <50%	Individual ice crystals or inclusions	V_x
		Ice coatings on particles	V_c
		Random or irregularly oriented ice formations	V_r
		Stratified or distinctly oriented ice formations	V_s
ICE	Ice visible, >50%	Ice with soil inclusions	ICE + soil type
	Individual layer >6" thick *	Ice without soil inclusions	ICE

* In some cases where the soil is ice poor a thin ice layer may be called out by special notation on the log, i.e. 2" ice lens at 7'

DWN:	L.D.S.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	EXPLANATION OF ICE SYMBOLS	F B	N/A
CKD	G.L.B.			GRID	N/A
DATE	3-1-72			PROJ. NO	GENERAL
SCALE	N/A			DWG. NO	B-03

T.H. 8-1
3-2-79



0'
ORGANIC MATERIAL
dark brown 0.5'
SILT
dark gray
Little Visible Ice, 0.5'-5',
Vx + Vs 5'
Ss (1) 100+, 44.2%, 77.5 pcf
SILT W/SOME SAND,
TRACE GRAVEL
Tm (2) tannish brown 8'
Tm (3) 22.2%, ML-CL
Tm (4) 22.4%, ML-CL
SILT W/SOME CLAY, SOME
SAND, TRACE GRAVEL
reddish brown
Tm (5) 25.1%
Ss (6) 84, 26.2%, 98.0 pcf
Little to Occasional Ice, 5'-16.5',
Vx
Tm (7) 19.8%
16.5'
Tm (8) SILTSTONE
light gray
Tm (9) 8.8%
Ss (10) 100+, 14.1%, 117.2 pcf
19.5'T.D.

Water Table Not Encountered
3/4-inch PVC installed to 19.5 ft.

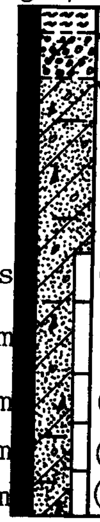
T.H. 8-2
3-3-79

0'
ORGANIC MATERIAL
dark brown 0.5'
SILT
dark gray
Little Visible Ice, 0.5'-2.5'
Vx + Vs 2.5'
SILT W/SOME SAND,
TRACE GRAVEL
tannish brown 5'
Ss (1) 54, 32.0%, 93.3 pcf
Tm (2) 26.6%
SILTY SAND W/SOME CLAY,
SOME GRAVEL
yellow-brown
Occasional Visible Ice, 2.5'-13.5'
Vx
Tm (3)
Tm (4) 18.1%, SM
Ss (5) 100+, 22.2% 13.0 'T.D.

Water Table Not Encountered
3/4-inch PVC installed to
12.5 ft.

DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	Test Hole Logs	F.B.	
CKD.		Geotechnical Investigation	GRID.	
DATE. Mar 1979		Tununak, Alaska	PROJ. NO.	951008
SCALE 1"=4'			DWG. NO.	B-04

T.H. 8-3
3-4-79



0'

ORGANIC MATERIAL
dark brown

0.5'

SILTY GRAVEL W/SOME SAND
tannish brown

1.5'

Little Visible Ice, 0.5'-10.5', Vx

Ss ① 100+, 28.1%, 90.9 pcf, SM

Tm ② 24.0%

Tm ③ 17.4%

Tm ④ 12.3%

Tm ⑤ 100+, 21.6%

SILTY SAND W/SOME GRAVEL, TRACE TO SOME CLAY
tannish brown

10.5'

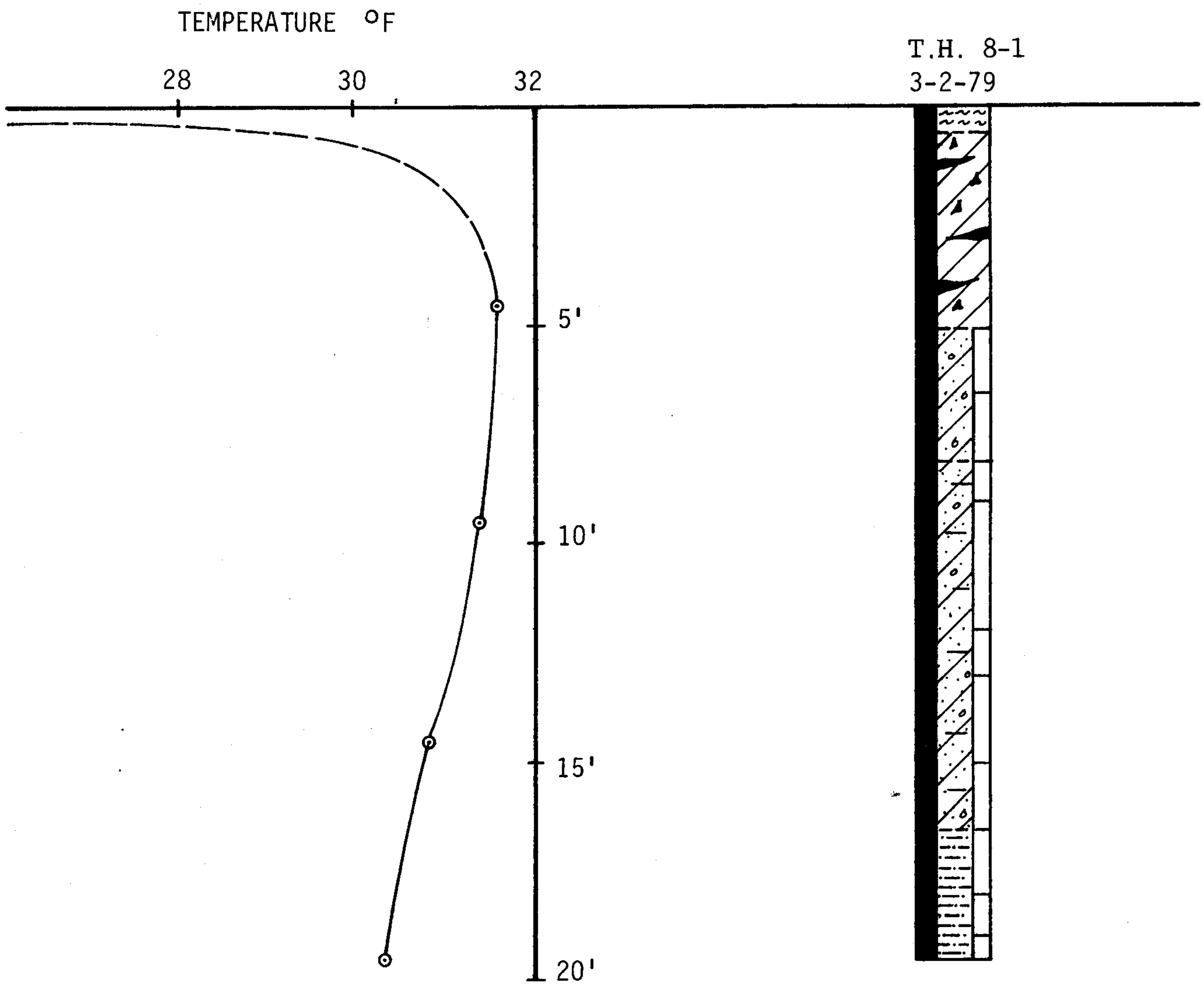
Water Table Not Encountered

DWN.
CKD.
DATE. Mar 1979
SCALE. 1"=4'

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

Test Hole Logs
Geotechnical Investigation
Tununak, Alaska

F.B.
GRID.
PROJ.NO. 951008
DWG.NO. B-05



Thermistor Measurements Summary						
Depth (ft.)	4.5	9.5	14.5	19.5		
Temp. (°F.)	31.6	31.4	30.8	30.3		

DWN.	
CKD.	
DATE.	Mar 1979
SCALE.	1"=4'

R&M
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

Thermistor Measurements
Geotechnical Investigation
Tununak, Alaska

F.B.	
GRID.	
PROJ.NO.	951008
DWG.NO.	B-06

APPENDIX C

PROJECT NO. 951008
CLIENT: LKSD
PROJECT NAME Tununak

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE 3-16-79
PARTY NO. ______ PAGE NO ______

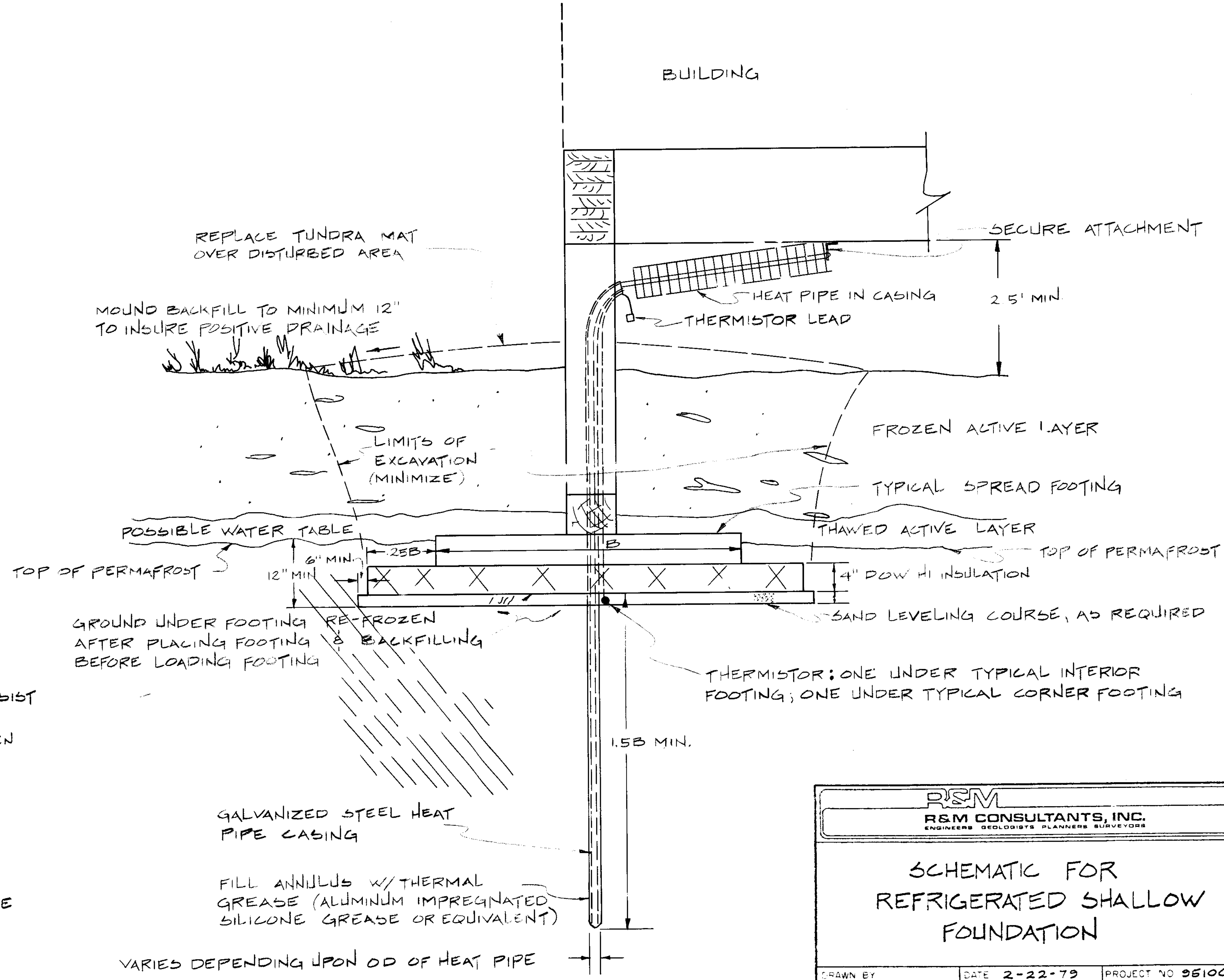
LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLASS
	8-1	1	5.0' - 6.5'																111.7	77.5	44.2	
		3	8.0' - 9.0'			100	98	95	89	83	79	74.0	30.9	20.4	12.3						22.2	
		4	9.0' -12.0'							100	95	82.6									22.4	
		5	12.0'-13.0'																		25.1	
		6	13.0'-15.0'																123.6	98.0	26.2	
		7	15.0'-16.5'																		19.8	
		9	18.0'-19.0'																		8.8	
		10	19.0'-19.5'																133.8	117.2	14.1	
	8-2	1	5.0' - 7.0'																123.1	93.3	32.0	
		2	7.0' -10.0'							100	99	93.8	61.1	41.7	29.2						26.6	
		4	11.5'-12.5'		100	94	93	91	87	82	68	45.5									18.1	
		5	12.5'-13.0'																		22.2	
	8-3	1	5.0' - 6.0'				100	91	74	62	52	44.1	12.5	6.2	2.4	2.75			116.4	90.9	28.1	
		2	6.0' - 7.5'																		24.0	
		3	7.5' - 8.5'		100	97	95	93	85	77	67	53.7	28.5	16.2	8.0	2.72					17.4	
		4	8.5' - 9.5'																		12.3	
		5	9.5' -10.5'				100	97	89	78	66	50.2									21.6	

REMARKS: ______

NOTE: SIEVE ANALYSIS = PERCENT PASSING

Janice Cecere
APPROVED

APPENDIX D



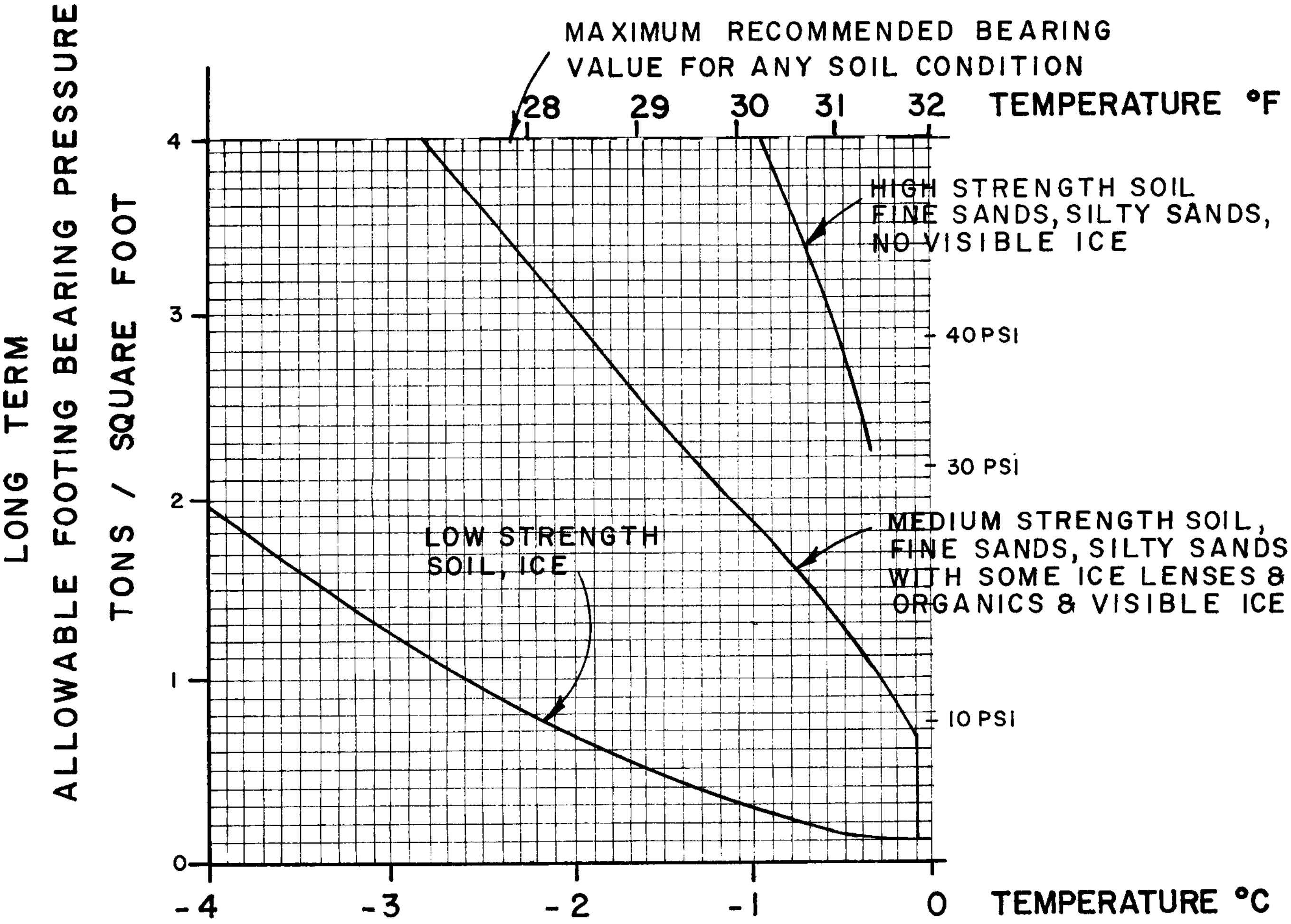
NOTES

1) EXCAVATION TO BE KEPT DRY
2) LEVELING COURSE TO BE COMPACTED TO MINIMUM OF 95% OF MAXIMUM DENSITY & PLACED IN THAWED STATE
3) INSULATION TO BE DOW.HI OR EQUIVALENT
4) FOUNDATION SYSTEM TO BE DESIGNED TO RESIST POTENTIAL FROST HEAVE & JACKING FORCES
5) GROUND UNDER INSULATION TO BE RE-FROZEN BEFORE LOADING FOOTING
6) DO NOT BLOCK HEAT PIPE FINS FROM PREVAILING WINDS
7) TEMPERATURE MUST BE 31° F OR LOWER BENEATH FOOTING BEFORE PLACING LOAD
8) PLACE ONE HEAT PIPE AT EACH FOOTING
9) SEE R&M SOIL REPORTS FOR APPROXIMATE ELEVATION OF TOP OF PERMAFROST

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

SCHEMATIC FOR
REFRIGERATED SHALLOW
FOUNDATION

DRAWN BY	DATE 2-22-79	PROJECT NO 951001
CHECKED BY BFD	SCALE NONE	DRAWING NO D-01

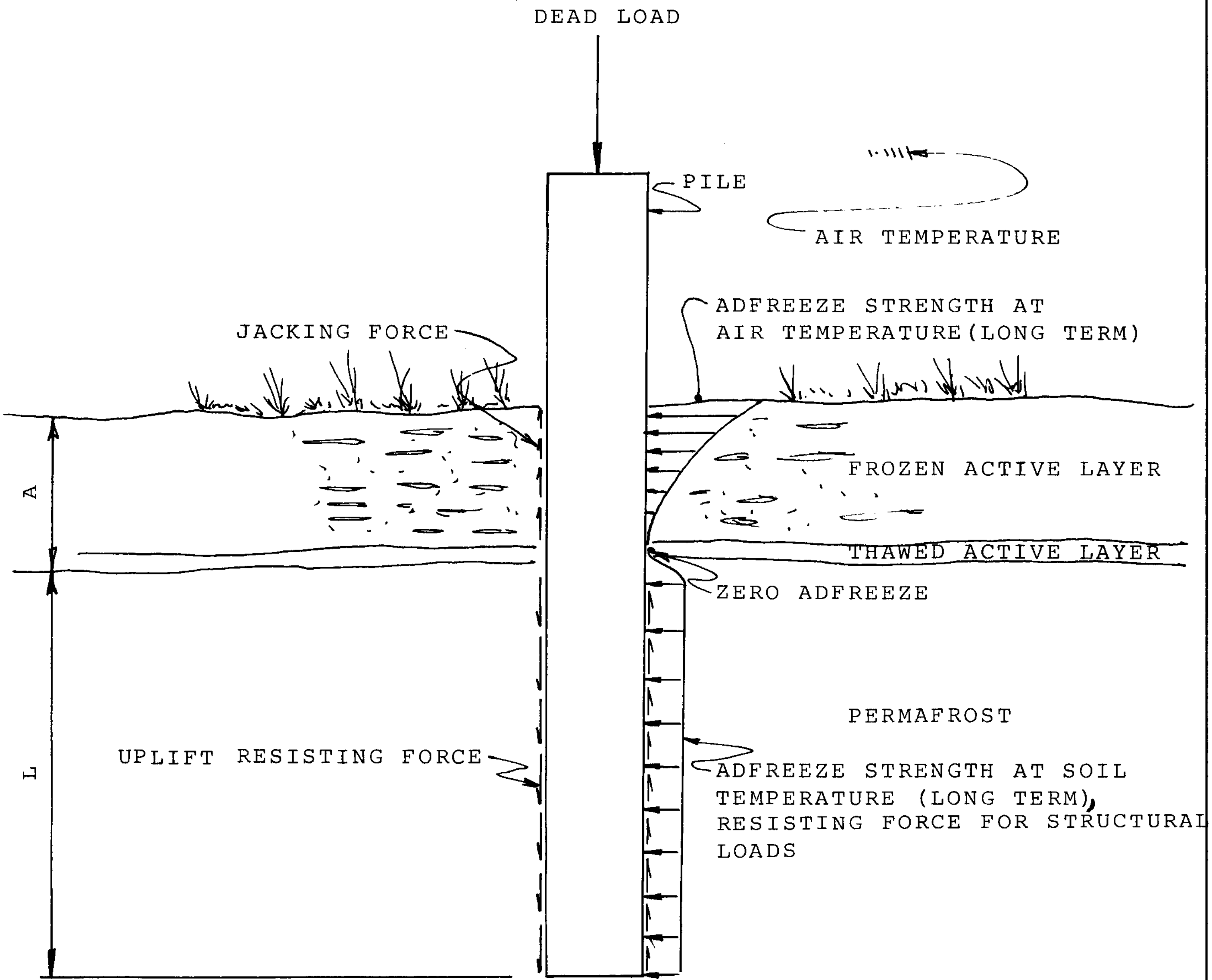


MAXIMUM TEMPERATURE DIRECTLY BENEATH FOOTING OVER LIFETIME OF STRUCTURE

NOTE: ALLOWABLE SHORT TERM OR IMPACT LOADS EQUAL TO TWICE LONG TERM VALUES TO A MAXIMUM OF 4 TSF

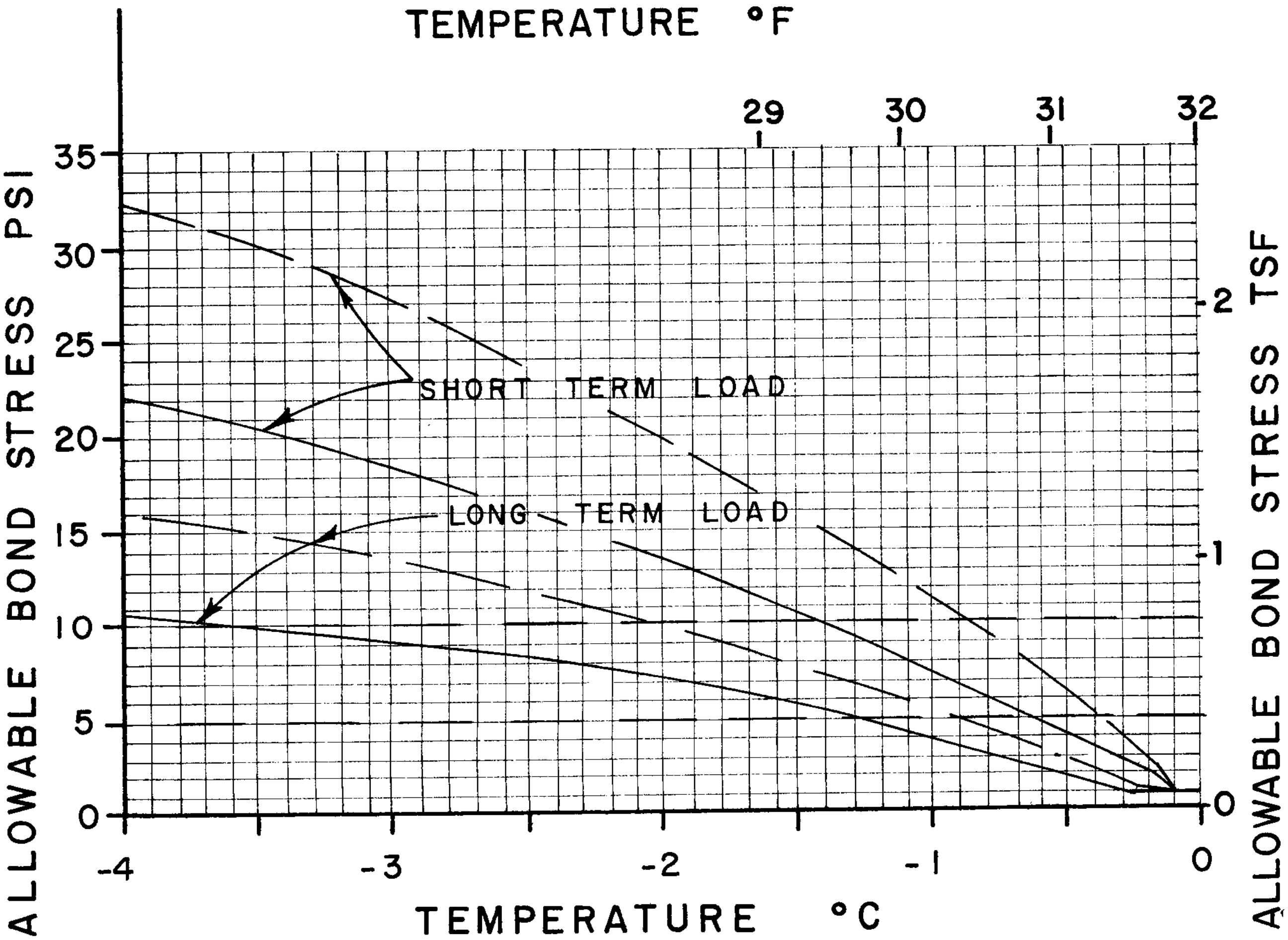
FOOTING MUST BE PLACED DIRECTLY ON PERMAFROST BENEATH ACTIVE LAYER

DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	LONG TERM FOOTING BEARING LOADS IN FINE GRAINED FROZEN SOILS	F.B.
CKD. BED			GRID.
DATE. 2/5/79			PROJ.NO. 951001
SCALE.			DWG.NO. D-02



RESISTING FORCE + DEAD LOAD > JACKING FORCE

DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	SCHEMATIC DIAGRAM OF PILE IN PERMAFROST	F.B.
CKD. B.E.D.			GRID.
DATE. 2/15/79			PROJ. NO. 951001
SCALE. N/A			DWG. NO. D-03



——— LOW STRENGTH SOIL, ICE RICH SILTS, ORGANIC SILTS WITH VISIBLE ICE

– – – HIGH STRENGTH SOIL, FINE SANDS, SILTY SANDS, NO VISIBLE ICE

DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	FROZEN FINE GRAINED SOIL PILE ADFREEZE VALUES	F.B.
CKD. BED			GRID.
DATE. 2/2/79			PROJ. NO. 951001
SCALE.			DWG. NO. D-04

APPENDIX E

LOWER KUSKOKWIM SCHOOL DISTRICT VILLAGE SCHOOL SITES

GEOTECHNICAL DATA SHEET

R&M No. 951008

SITE: TUNUNAK

DATE: 3-6-79

ARCHITECT: MAYNARD & PARTCH

1. BACKGROUND INFORMATION

a) Date Drilled:
   Site drilled on 3-4-79

b) Make of Drill:
   Simco 2400

c) Type of Drilling:
   6 inch Hollow Stem Auger

d) Type of Sampling:
   1.4 inch

e) Field Crew:
   Geologist: Hardcastle
   Driller: Reas
   Drillers/Helper/Mechanic: Harrigan

f) Comments:

2. <u>GENERAL SITE CONDITIONS</u>

a) Site Soils:

A surface organic layer (0 to 6") overlies a silt layer (with 5 to 40% ice) which extends to a depth of 1 1/2 to 5 feet below the ground surface. BEneath this stratum ice rich silty gravel was encountered, extending to depths of 13 to 16 1/2 feet. Fractured bedrock was found at a depth of 16 1/2 feet in T.H. 1.

b) Permafrost:

Permafrost was encountered over the entire depths drilled. Ice content ranged from 40% near the surface to 3% at greater depths. The bedrock encountered contained significant amounts of ice.

c) Groundwater:

No free ground table was encountered.

d) Site Drainage:

The proposed school site slopes uniformly at a 4 to 6% gradient. Tundra mosses and grasses over the site provide poor drainage, however, no ponded water was noted. The proposed school site receives little or no water as runoff from adjacent property.

A small stream which provides community drinking water is located east of the site. It is of utmost importance to residents that this water supply not be contaminated by runoff from the high school site.

e) Depth of Active Layer:

3 to 4 feet

f) Depth to Permafrost:

3 to 4 feet

g) Depth of Surficial Organic Layer:

12 inches

h) Ground Temperatures:

4'-12' 31.5°F 12'-20' 30.6°F

i) Laboratory Test Data:

j) Potential for Settlement if Thawing of Permafrost Occurs:

Moderate

k) Design Soil Classification:

Medium Strength for refrigerated shallow foundation placed on gravelly stratum located at 3' to 5' below ground surface. High strength for pile foundation.

3. FOUNDATION DETERMINANTS

a) Recommended Foundation Type

Preferred:
Refrigerated shallow foundation, placed on gravelly stratum at 3' to 5' below ground surface

Alternate 1:
Pile foundation

Alternate 2:

b) Load - Settlement Data for Preferred Foundation

Max Allowable Load:
2000 psf for shallow refrigerated foundation founded on permafrost

Max Expected Settlement:
1 inch total 3/4 inch diffential

c) Frost Susceptibility & Frost Jacking Potential
Moderate. Estimate 1500 psf over foundation area in active layer.

d) Recommended Specifications:

e) Special Considerations:
Pile foundations may be difficult to install because of dense gravelly stratum and relatively shallow bedrock.

4. <u>CONSTRUCTION CONSIDERATIONS</u>

a) Trafficability

The access road to the P.H.S. building should provide adequate access to within 150 feet of the proposed high school site. As the ground at the site is soft during summer months, an extension of the existing P.H.S. access road should be constructed if access by heavy equipment is required during this time.

Transportation is much less difficult over frozen ground making the site more accessible to heavy equipment.

b) Excavation

Excavation of on-site soils will probably be difficult while in a frozen state.

c) Borrow Material

Borrow material is generally obtained from the beach area, however it will probably no longer be allowed on the north-east side of the Tununak River due to recent high rates of erosion. Beach material (gravel) southwest of the Tununak River might be obtained, however, the bridge over the Tununak River may not support heavily loaded trucks.

Another source of material may be the cliff along the beach northeast of town. All easily excavatable material has been mined so blasting will be required to obtain borrow material. P.H.S. is reportedly planning to blast the cliff to obtain additional material for their project.

An additional material source was noted at Umkumiut, approximately 18 miles by boat from Tununak (Figure 1). Beach gravels are easily accessible at this location, however barges must be used to transport materials.

d) Access

Access as noted above

e) Seasonal Considerations

Winter construction of foundation preferred.

f) Site disturbance and Restoration

Site disturbance should be minimized to prevent thermal degradation of the permafrost. Disturbed areas should be revegetated or re-covered with tundra mat.

5. MISCELLANEOUS GEOTECHNICAL INFORMATION

a) Percolation Characteristics

Permafrost soils at this site are generally impermeable.

b) Suitability of on site soil for fill

On site soil in a frozen state is unsuitable for structural fill.

Addendum 1, Attachment 5

22663

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
Alaska Hydrologic Survey

WATER WELL LOG Revised 08/18/2016

Drilling Started: ___/___/_____ Completed: 4 / 14 / 1994 Pump Install: ___/___/_____

City/Borough	Subdivision	Block	Lot	Property Owner Name & Address
Toksook Bay				TOKSOOK BAY, CITY OF ,

Well location: Latitude ____________ **Longitude** ____________

Meridian S Township 005N Range 090W Section 8 , SE 1/4 of SE 1/4 of NE 1/4 of NW 1/4

BOREHOLE DATA: (from ground surface)
Suggest T.**M. Hanna's hydrogeologic classification system***
https://my.ngwa.org/NC__Product?id=a185000000BYub3AAD

	Depth From	To

Include description or sketch of well location (include road names, buildings, etc.):

North

AS 41.08.020(b)(4) and AAC 11 AAC 93.140(a) require that a copy of the well log be submitted to the Department of Natural Resources within **45 days of well completion**. Well logs may be submitted using the online well log reporting system available at:

https://dnr.alaska.gov/welts/

OR email electronic well logs to

dnr.water.reports@alaska.gov

Drilling method: ☐Air rotary, ☐Cable tool, ☐Other ____

Well use: ☐Public supply, ☐Domestic, ☐Reinjection, ☐Hydrofracking ☐Commercial, ☐Observation/Monitoring, ☐Test/Exploratory, ☐Cooling, ☐Irrigation/Agriculture, ☐Grounding, ☐Recharge/Aquifer Storage, ☐Heating, ☐Geothermal Exploration, ☐Other ____

Fluids used: ____

Depth of hole: 160 ft Casing stickup: ____ ft
Casing type: ____ Casing thickness: ____ inches
Casing diameter: ____ inches Casing depth: 30 ft
Liner type: ____ Depth: ____ ft Diameter: ____ inches
Note: CASED TO 30 FT

Well intake opening type: ☐Open end, ☐Open hole, ☐Other ____
Screen type: ____, Screen mesh size: ____
Screen start: ____ ft, Screen stop: ____ ft, Perforated ☐Yes ☒No
Perforation description: ____ Perf from: ____ ft, Perf to: ____ ft, Perf from: ____ ft, Perf to: ____ ft
Gravel packed ☐Yes ☐No Gravel start: ____ ft , Gravel stop: ____ ft
Note: ____

Static water (from top of casing): 23 ft on ___/___/___ Artesian well ☐
Pumping level & yield: ____ feet after ____ hours at ____ gpm
Method of testing: ____
Development method: ____ Duration: ____
Recovery rate: ____ gpm

Grout type: ____ Volume ____
Depth: From ____ ft, To ____ ft

Final pump intake depth: ____ ft Model: ____
Pump size: ____ hp Brand name: ____

Was well disinfected upon completion? ☐Yes ☐No
Method of disinfection: ____
Was water quality tested? ☐Yes ☐No
Water quality parameters tested: ____

Well driller name: ....
Company name: GOLDER ASSOCIATES
Mailing address: ....
City: ____ State: AK Zip: ____
Phone number: (____) ____-____
Driller's signature: ____
Date: ___/___/___

Anchorage Municipal Code 15.55.060(I) and North Pole Ordinance 13.32.030(D) require that a copy of this well log be submitted to the Development Services Department/City within **30 days of well completion**.

City Permit Number: ____
Date of Issue: ___/___/___

Parcel Identification Number: ____-____-____

*Guide for Using the Hydrogeologic Classification System for Logging Water Well Boreholes by Thomas M. Hanna NGWA Press

Well 3-B

WELL LOG

U.S. PUBLIC HEALTH SERVICE
OFFICE OF ENVIRONMENTAL HEALTH AND ENGINEERING

COMMUNITY Toksook Bay LOCATION Site #3 Well #3-B

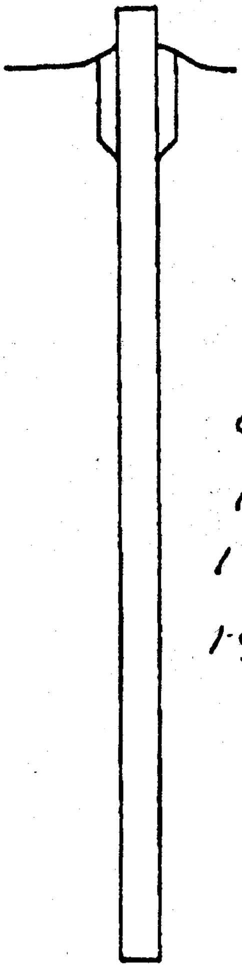
TOTAL WELL DEPTH 160' SCREEN SIZE —— DATE STARTED 4-13-94

CASING INSTALLED 70' LENGTH —— DATE COMPLETED 4-14-94

DIAMETER 6" MFG. ——

STATIC WATER LEVEL ____ HOURS PUMPED ____ RATE ____ DRAWDOWN

CREW John Williams DEVELOPMENT PROCEDURES Air Surging + Well Pump



DEPTH(ft.)	FORMATION	DATE
0 - 3	Stub up	
3 - 5	Over Burden	
5 - 18	Brown Clay	
18 - 24	Blue Clay	
24 - 87	Sand stone	
87 - 94	Fractured Sand stone	
94 - 138	Fractured Shale	
138 - 143	Sand stone	
143 - 151	Shale	
151 - 160	Sand stone	

SITE ID

LOCAL NO. SB-5-90-8 BADD

FIELD WATER TEST DATA: INITIAL 24 HOURS

TASTE Good

APPEARANCE/ODOR Clear without ODOR

IRON NA

PH NA

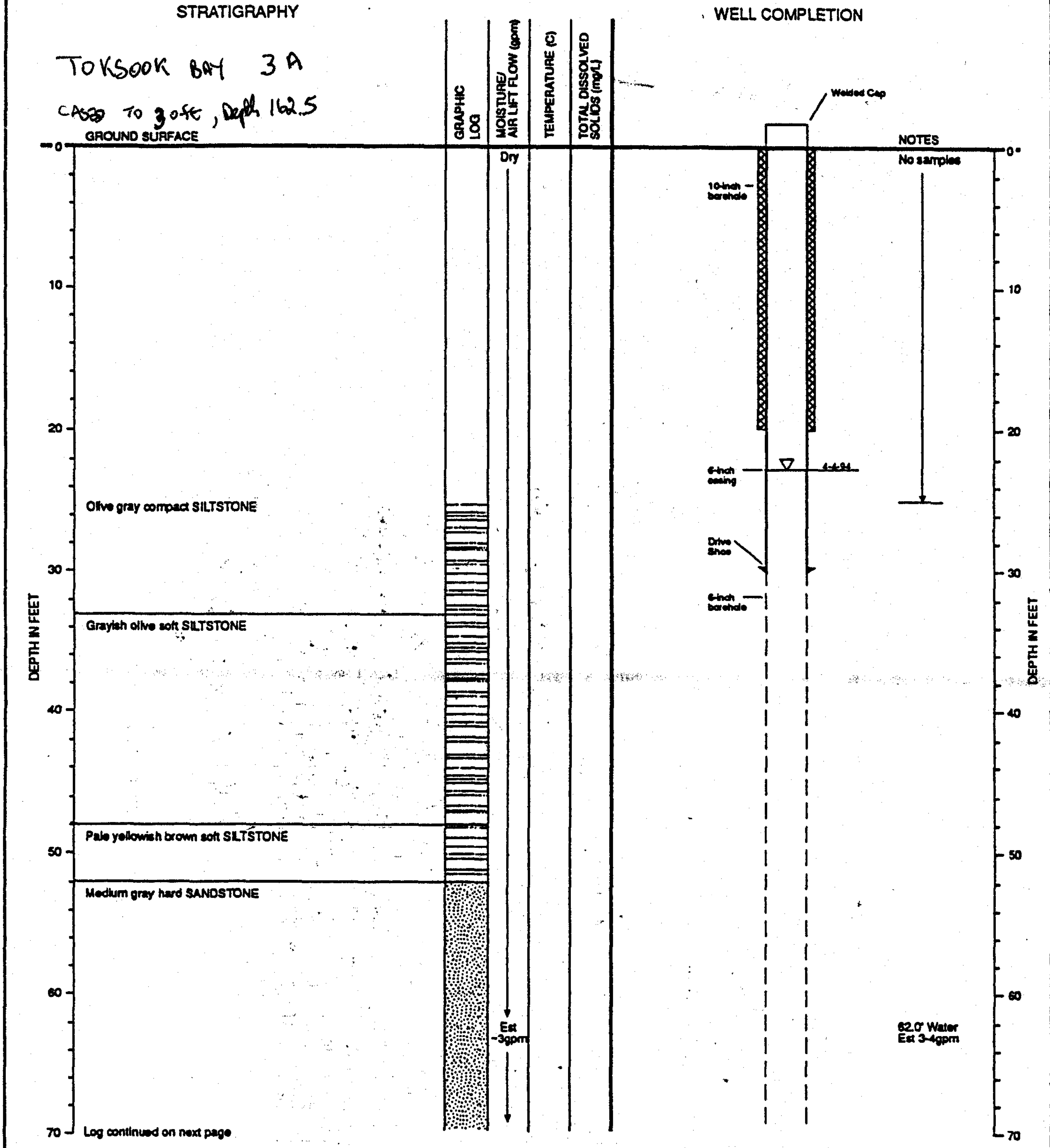
Well 3-B

NOTES: We Hit First Water at 87' and Had Fractures with water From 87 to 130

LAS 19549 Source B — 160' deep

cc: Hydro Sec 7/13/95

22663



WELL COMPLETION LEGEND

Bentonite Seal

SHEET 1 OF 3

WELL 3-A

RECORD OF ~~DRILLHOLE~~

TOKSOOK/PHASE II DRILLING/AK

PROJECT NO 933-5148 DWG NO 48191 DATE 6/6/94 DRAWN TK

Golder Associates

SB 5-90-8 BADD

LAS 19549 Source A — 162.5'

cc: Hydro Sec. 7/13/95 - alm

22663

STRATIGRAPHY | WELL COMPLETION

Depth (ft)	Stratigraphy	Graphic Title Log	Moisture/ Air Lift Flow (gpm)	Temperature (C)	Total Dissolved Solids (mg/L)	Notes
70	Medium gray hard SANDSTONE		~3 gpm			
82			~6 gpm			82.0', Water additional ~3gpm
95				5.1	140	
102	Dark gray hard SILTSTONE		Increasing Water			6-inch borehole; Increasing water through alternating sandstone and siltstone layers
107	Medium gray compact SANDSTONE					
117	Medium dark gray SILTSTONE, medium hard					
124.5			10 gpm	5.0	150	
126	Medium gray compact SANDSTONE					
134	Medium gray, medium hard SANDSTONE		Increasing Water			
140	Log continued on next page					

DEPTH IN FEET

WELL COMPLETION LEGEND

Bentonite Seal

SB5-90-8 6ADD

SHEET 2 OF 3
WELL 3-A
RECORD OF DRILLHOLE
TOKSOOK/PHASE II DRILLING/AK

PROJECT NO 933-5148 DWG NO 48192 DATE 6/6/94 DRAWN TK

Golder Associates

LAS 19549 (Source A-162.5')

cc: Hydro 7/13/95

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STRATIGRAPHY	GRAPHIC LOG	MOISTURE/ AIR LIFT FLOW (gpm)	TEMPERATURE (C)	TOTAL DISSOLVED SOLIDS (mg/L)
140 Medium gray medium hard SANDSTONE		Increasing Water		
Light gray soft SILTSTONE		14 gpm	4.6	154
Olive gray medium soft SANDSTONE; 150 Grades to hard		Increasing Water		
Medium dark gray medium hard SILTSTONE; 160		23 gpm	3.2	154.8
162.5' EOH - 165.0' BGS				

WELL COMPLETION

NOTES

6-inch borehole

Increasing water through altering sandstone and siltstone layers

DEPTH IN FEET: 140, 150, 160, 170, 180, 190, 200, 210

WELL COMPLETION LEGEND

Bentonite Seal

SB5-90-8BADD

SHEET 3 OF 3

WELL 3-A

RECORD OF DRILLHOLE

TOKSOOK/PHASE II DRILLING/AK

PROJECT NO 933-5148 DWG NO 48193 DATE 6/13/94 DRAWN TK

LAS 19549 (Source A - 162.5')

Golder Associates

cc: Hydro 7/13/95 alm

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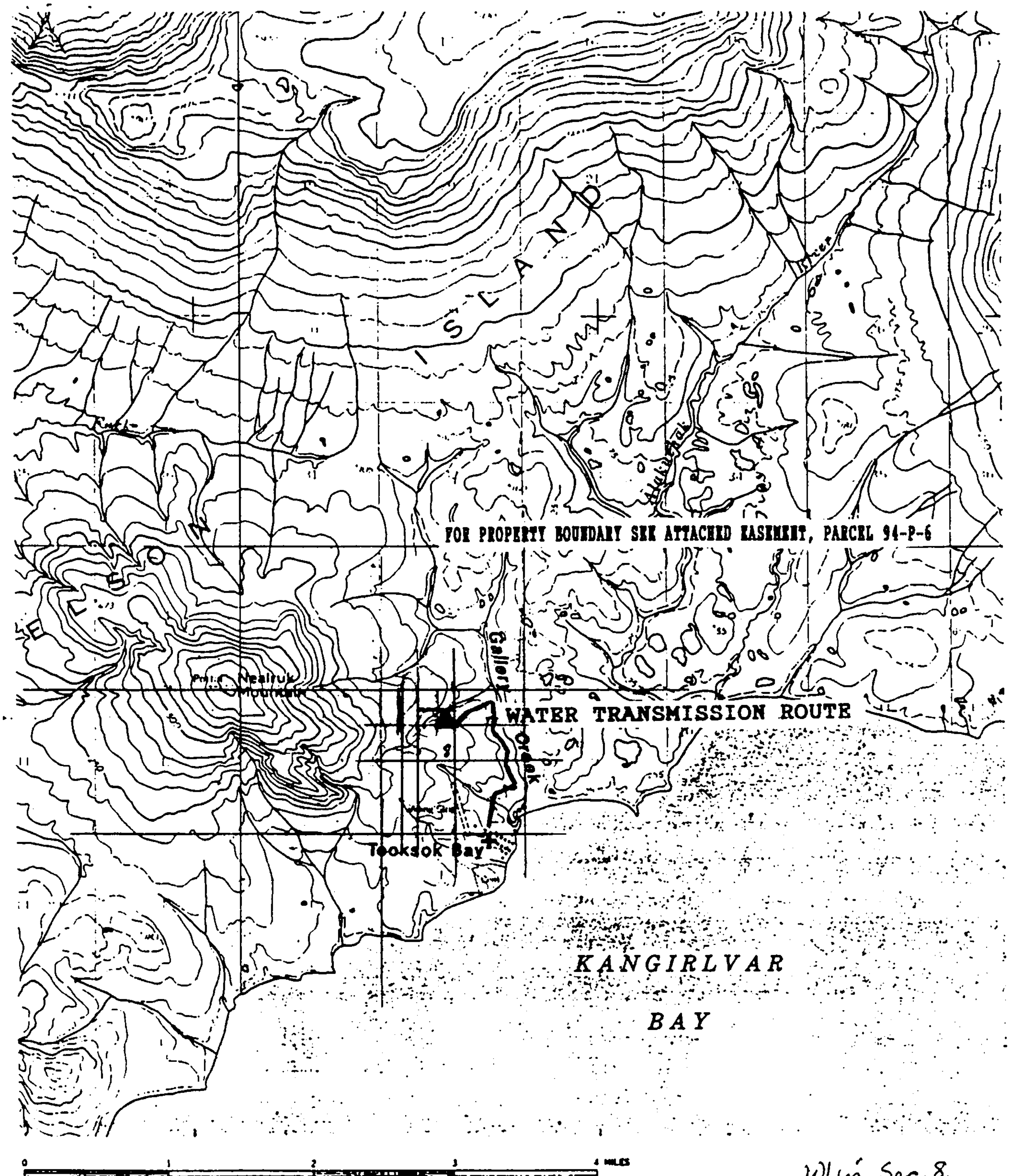

SB5-90-8 BADD

W/in Sec 8,
T5N,R90W,SM
2 wells (3-A + 3-B)
7/13/95

LEGEND:

▲ LOCATION OF WELLS

✚ CITY OF TOKSOOK BAY

Figure 1

PROJECT LOCATION MAP

CITY OF TOKSOOK BAY/TOKSOOK BAY/AK.

REFERENCE: ALASKA TOPOGRAPHIC, 1:63,360, NUNIVAK ISLAND (C-1), 1954.

933 5148 11/93 sjm

Golder Associates