US Army Corps of Engineers
Alaska District
Soils and Geology Section

PRELIMINARY GEOTECHNICAL OVERVIEW
Village Relocation Site
Newtok, Alaska

November 2002

PRELIMINARY GEOTECHNICAL OVERVIEW
RELOCATION SITE
NEWTOK, ALASKA

Introduction The village of Newtok, Alaska has a severe erosion problem due to the migration of the Ninglick River. It has been estimated that the school and other structures in the community will be lost to the erosion in about eight years. To avoid the impact of the erosion, the village has decided that they should move to another location. The selected relocation site is about 15 miles south of the existing village on the north coast of Nelson Island and on the south bank of the Ninglick River. The Ninglick River connects the Bering Sea with Baird Inlet. The existing village, relocation site, and general area are shown on the Vicinity Map presented as Figure 1.

Newtok has hired an engineering firm, Arctic Slope Consulting Group (ASCG), to develop a new community layout. The plan shows a barge landing area, water source, airport, community area, and associated roads and streets. This proposed community layout, which was created by ASCG, is attached as Figure 2.

Purpose This site reconnaissance was undertaken to visually evaluate the surface and subsurface conditions at the proposed relocation site. Of particular interest was the identification of a potential materials source for development of the proposed infrastructure. Other goals of the site visit were to evaluate the suitability of the barge landing area, water infiltration gallery area, proposed airport location, and the area of the proposed village infrastructure and roads. The final goal of the reconnaissance was to recommend a scope of work for a future geotechnical exploration program to obtain specific subsurface information about the site and the identified materials source.

Concurrent with the geotechnical reconnaissance, an evaluation of the archeological assets of the proposed relocation site was undertaken. The archeological evaluation was preliminary in nature and was intended to only identify archeological sites within the primary area of proposed development. More archeological evaluation of the area will be required as the project moves forward.

Reconnaissance Fieldwork An Engineer from the Corps of Engineers, an Archeologist from the Corps of Engineers, and an Archeologist from U.S. Fish and Wildlife Service traveled to Newtok to perform the reconnaissance. The U.S. Fish and Wildlife Archeologist was along because the proposed relocation site is located within the Yukon Delta National Wildlife Refuge. A land swap between the village of Newtok and U.S. Fish and Wildlife Service is currently being negotiated. This land swap will exchange land currently owned by the village of Newtok for land currently controlled by the U.S. Fish and Wildlife Service that includes the relocation site.

A public meeting was held in Newtok to inform the community about the reconnaissance mission and to ask for input about features the crew should watch for while at the site. A boat and operator from Newtok were employed to transport the crew to the site and back

each day. The boat and operator remained with the crew while on-site because of variable weather conditions and the need to move to various locations along the shoreline.

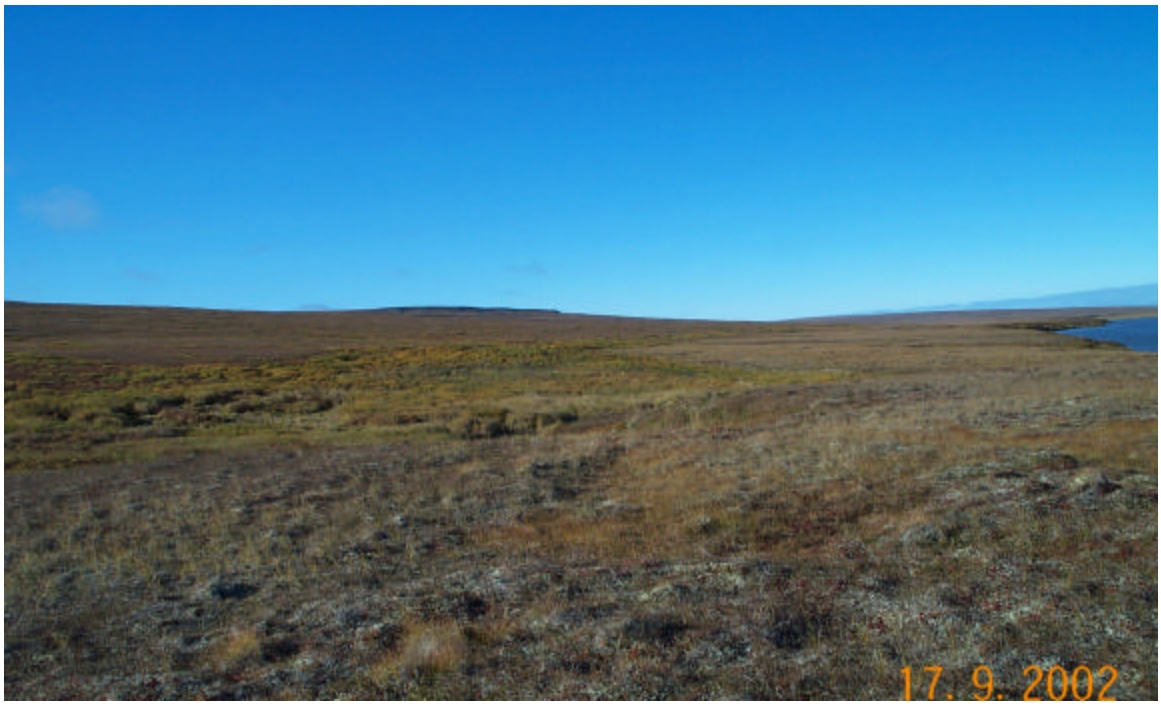


Photo 1. Looking west across relocation site from the beach bluff near the barge landing.

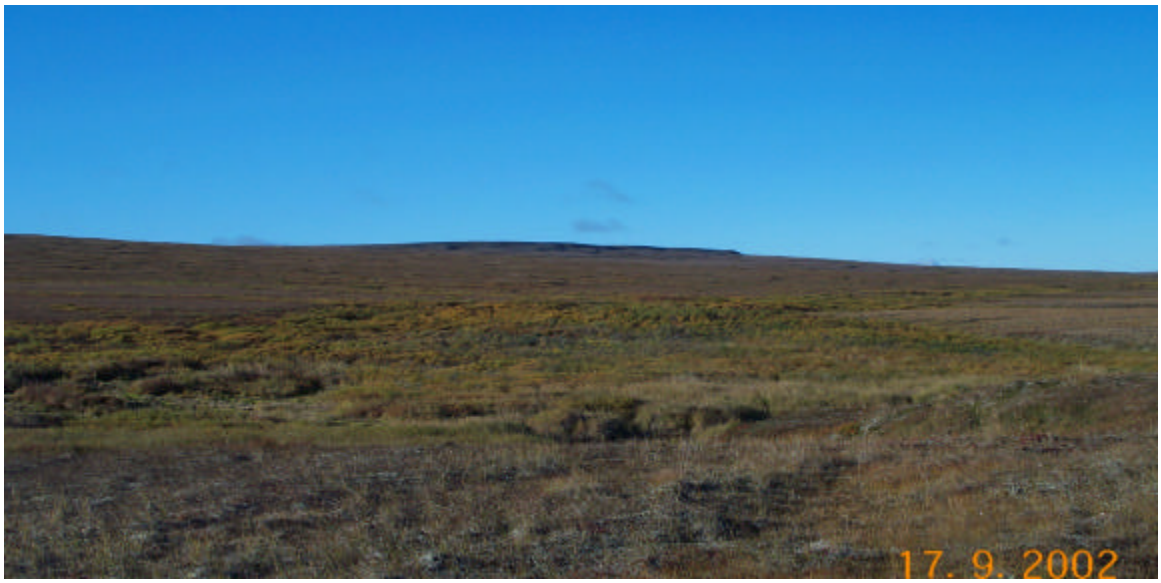


Photo 2. Looking southwest from the beach toward the potential borrow area on the ridge.

While at the site, the crew visited each of the proposed development areas and the potential material sources. Each area was visually inspected. In some areas a steel probe was used to determine the depth to permafrost or rock. At one site, a hole was hand-excavated to the top of the permafrost to confirm it was frozen ground and not rock. Areas were noted along the beach where drilling equipment might be unloaded to access the site.

Photo 3. Looking north from the middle of the relocation site.

Findings While at the site, the tide was observed to fluctuate about four feet. The western three-quarters of the beach area at the site have mud flats exposed during low tide or very shallow water (generally one foot or less). The eastern quarter of the site has relatively deep water near shore. The main river channel is adjacent to the beach in this area. No measurements of the water depth were made. Boulders to two feet are scattered in the tidal zone throughout the beach in the entire area. There are isolated areas of sand and gravel, but most of the beach is surfaced with a layer of angular basalt cobbles and boulders to 15 inches. Conducting hand probes along the beach indicated that the cobbles and boulders are surficial and underlain by low-plasticity, fine-grained soils. There is evidence along the beach bluff of sloughing of the adjacent uplands area. In

most areas, the beach bluff is about 10 to 20 feet high having a slope generally at an angle of about 30 to 45 degrees.

Photo 4. Beach area at the proposed barge-landing.

Photo 5. Beach area near the barge-landing site.

Photo 6. Beach area west of the barge-landing site.

The uplands, adjacent to the beach, slope upward to the south at an angle of about five to six degrees. The area generally is vegetated with tundra and stunted willows along the drainages. Most vegetation, including the willows, is less than two feet high.

In some areas, tussocks were observed and indicate the probable presence of permafrost. In other areas, thaw-ponds were observed and indicate permafrost degradation. These thaw-features generally are associated with areas having surface water. The hand-probe was used to determine depth to permafrost. In most areas, the frozen soil was encountered at a depth of about 18 to 24 inches. It was deeper along drainage channels and thaw-features. At one location, a hand-excavated pit confirmed that the hard layer encountered by the hand-probe was permafrost. The frozen soil exposed in the pit was ice-rich organic silt. Also, there is surface evidence that ice wedges are likely present in the area although none were observed in the beach bluff. It is probable, since the bluff area is generally not eroding and is relatively stable, that any exposed ice wedges may have melted and are no longer visible.

About 1000 to 2000 feet south of the beach bluff, the upland slope increases to an angle of about 15 degrees until it reaches a summit at an elevation of about 460 feet. The summit occurs about one mile south of the beach bluff. Exposed boulders are present on this steeper slope and their number increases toward the summit. At the top, a cap of exposed basalt is present. This exposed rock appears to be at least 30 to 60 feet thick and could be much more. The best exposure of this basalt cap is at the western end of the

Photo 7. Mouth of drainage (spring) just north of the village site.

ridge. The exposed cap has fractured into angular boulders generally in the size of one to two feet. These boulders are hard and difficult to chip or break with hand tools. No samples of the rock were obtained for testing since only weathered rock is exposed and may not be representative of the mass.

The areal drainage channels are generally perpendicular to the beach. They are typically about 20 feet deep near the bluff face and three to five feet deep inland. At the time of the reconnaissance, most channels had some water flow. Substantial beaver activity was observed.

The creek at the west end of the relocation site was visually inspected. It was estimated that the flow in the creek, at the time of the reconnaissance, was about 1200 cubic feet per second. This is only an estimate based on a relatively uniform cross-section and timing the rate at which a floating object passed through the cross-section. It is probable that the flow volumes in the creek are less in mid-winter than during the time when the reconnaissance was performed. It should be noted that the creek had many Coho salmon and some Dolly Varden present at the time of the reconnaissance. The residents of Newtok report that Pink salmon also spawn in the creek. The lower portion of the creek is tidally influenced and has meanders over a relatively wide area. It will be necessary to determine the area of tidal influence and locate the water infiltration gallery above that area. It will also be necessary to locate the infiltration gallery in an area where the creek is confined to a single channel. Hand probing the channel indicates that the creek bottom

is composed of gravel and sand. However, the probing extended only to a depth of about 18 inches.

During the reconnaissance, the wind direction was from the north. All of the airports in the area, with the exception of Tununak, are orientated in a north/south direction. It is reported that the surrounding mountains impact the wind direction at Tununak.

Photo 8. Mouth of creek at high tide.

The existing airport at Newtok is orientated at a bearing of about north 32 degrees west. The planned airport at the relocation site is shown on an east/west orientation. It appears this may require revision to a north/south alignment. As part of the reconnaissance, two sites for a north/south-oriented airport were identified and investigated. One is located just southeast of the barge landing area. That location appears to have a slope too great to be practical for an airport. The second area is parallel to the creek at the west end of the relocation site. It appears the airport may be constructed on either the east or west side of the creek depending on the desired orientation in this area. It should be noted that there are four Native Allotments located near the mouth of the creek. In addition, at least one grave is present and documented evidence of past habitation exists. The residents of Newtok report that it is common for the higher areas of the relocation site to be fog-covered during periods of poor-weather.

Conclusions The visual reconnaissance of the site did not identify any geotechnical site conditions that will preclude the site from use as the area for relocation of the village of Newtok. The orientation of the proposed airport may need to be modified and may

require relocation on the site due to the predominant wind direction. It is anticipated that the relocation site may be underlain with permafrost that will require special consideration when designing foundations and infrastructure. However, this is a condition common to the area and would probably not be different at other nearby sites. Engineering solutions exist to address the conditions observed. It would be appropriate to perform a geotechnical investigation of the site to determine the actual subsurface conditions at the site.

Recommendations There are several recommendations that are applicable to the layout of the proposed community at the relocation site based on the observations made during the reconnaissance visit. These recommendations, as well as the recommended subsurface exploration program for each of the infrastructure items, are presented below.

Photo 9. Grave on the west side of the creek near the mouth. Potential airport location in the background.

Airport The proposed airport needs to be relocated to another area of the site and reoriented to a north/south direction. The final orientation will be dependant on wind direction data gathered by the Alaska Department of Transportation prior to final design. The observations made and local reports indicate that the airport should be at as low an elevation as possible to limit foggy conditions. Another concern raised by the U.S. Fish

and Wildlife Service is that the island northwest of the creek mouth is a major nesting area for Black Brant. Any airport orientation should avoid over-flights of this area during landings and takeoffs. While there may be other suitable sites for the airport, the area parallel to the creek is considered a potential site. It is recommended that three test borings be drilled on each side of the creek to a depth of 20 feet to investigate subsurface conditions. Samples obtained from the borings should be tested to determine the general classification and physical characteristics of the soils encountered. These six test borings will provide preliminary information to be supplemented with additional borings after the final location and orientation of the airport has been selected.

Water Infiltration Gallery The water infiltration gallery should be sited as far upstream as feasible. It is critical that the site be upstream of the tidal zone and not located in a multi-channeled area. The location shown on the current plan appears to meet these criteria, but the final location should be selected in the field. The estimated flow volume in the creek at the time the reconnaissance was performed was about 1200 cubic feet per second, but lower flow rates probably occur during mid to late winter. Knowledge of periodic flow volumes is important. It is recommended that the flow volumes be measured with a system that will allow an accurate measurement during the winter lows. This will be important when applying for permits to install the gallery. Alaska Fish and Game and the U.S. Fish and Wildlife personnel will be interested in the percentage of flow that will be diverted to the village and the potential impact on the salmon spawning and survival characteristics of the creek.

Mr. Matt Dixon, who works for Alaska Native Tribal Health Consortium (ANTHC), was contacted to determine what other water source options have been successfully used in nearby villages. He reported that Toksook Bay had an infiltration gallery, but it proved difficult to maintain and was abandoned. It apparently had problems with silt deposition, ice buildup, and access due to depth of snow that drifted over the area. Toksook Bay is now using wells as a water source. Mr. Dixon reports that the wells have relatively low production with a pumping capacity of only about 15 gallons per minute. He also said that the wells tend to go dry or have a very low capacity during the early spring (March) that subjects the community to little or no water at those times. Toksook Bay is located on the south side of Nelson Island and is underlain with similar rock types as are found at the relocation site.

The subsurface condition that is critical for the infiltration gallery to properly function is a sufficient depth of alluvial material under the creek. This will protect the gallery from freezing and scour. The material also should be permeable enough for the gallery to gather sufficient water. To determine these characteristics, it is recommended that one boring be drilled to a depth of 20 feet on each side of the creek (at the waters edge). Drilling in the creek will not be allowed and no discharge or cuttings from the borings should enter the creek. Samples from the borings will be tested to determine the grain-size distribution of the material present. This will be used to design the gallery length, diameter, and slot size.

Barge Landing The area at the proposed barge landing will be investigated by drilling one test boring to a depth of 20 feet on the beach. It is anticipated that some type structure (probably rock or rock-filled) will be required for the barge to pull up to and tie-off. Also, it is anticipated that in addition to building a head-structure at the beach it will be necessary to remove the scattered boulders in the tidal zone. It will also be necessary to remove the boulders within the adjacent beach area that will be used by the residents as a landing area for their boats. A study needs to be performed at the barge-landing site to determine the water depths in the area.

Village Area The general subsurface conditions in the proposed village area will be investigated by drilling eight test borings to a depth of 30 feet. From the information gathered during the reconnaissance, the entire village area is expected to be underlain by permafrost. The purpose of the investigation will be to confirm the presence of permafrost and to gather sufficient information to allow a generalized design of pile foundations for support of the structures. While piles may not be the only appropriate foundation type, information sufficient for pile design will afford design of other foundation types if required. For new significant structures in the village, it may be necessary to perform additional investigation to develop the necessary data for design of a specific building foundation. Samples will be obtained and tested to determine the general classification and physical characteristics of the soils encountered. Sealed PVC pipe will be installed in the borings in the village area and ground temperatures will be measured prior to leaving the site. This information will also be useful for designing building foundations.

Roads and Streets The planned roads and streets at the relocation site are fairly extensive (6.7 miles). It is necessary to have that much roadway to connect the barge landing area with the water infiltration gallery area. It should be noted that this mileage does not include the necessary road to the potential materials source and to the airport if it is relocated adjacent to the creek. It does include the road to the airport where it is currently proposed. The current plan shows the road a sufficient distance away from the beach bluff area to avoid most of the deep drainage features.

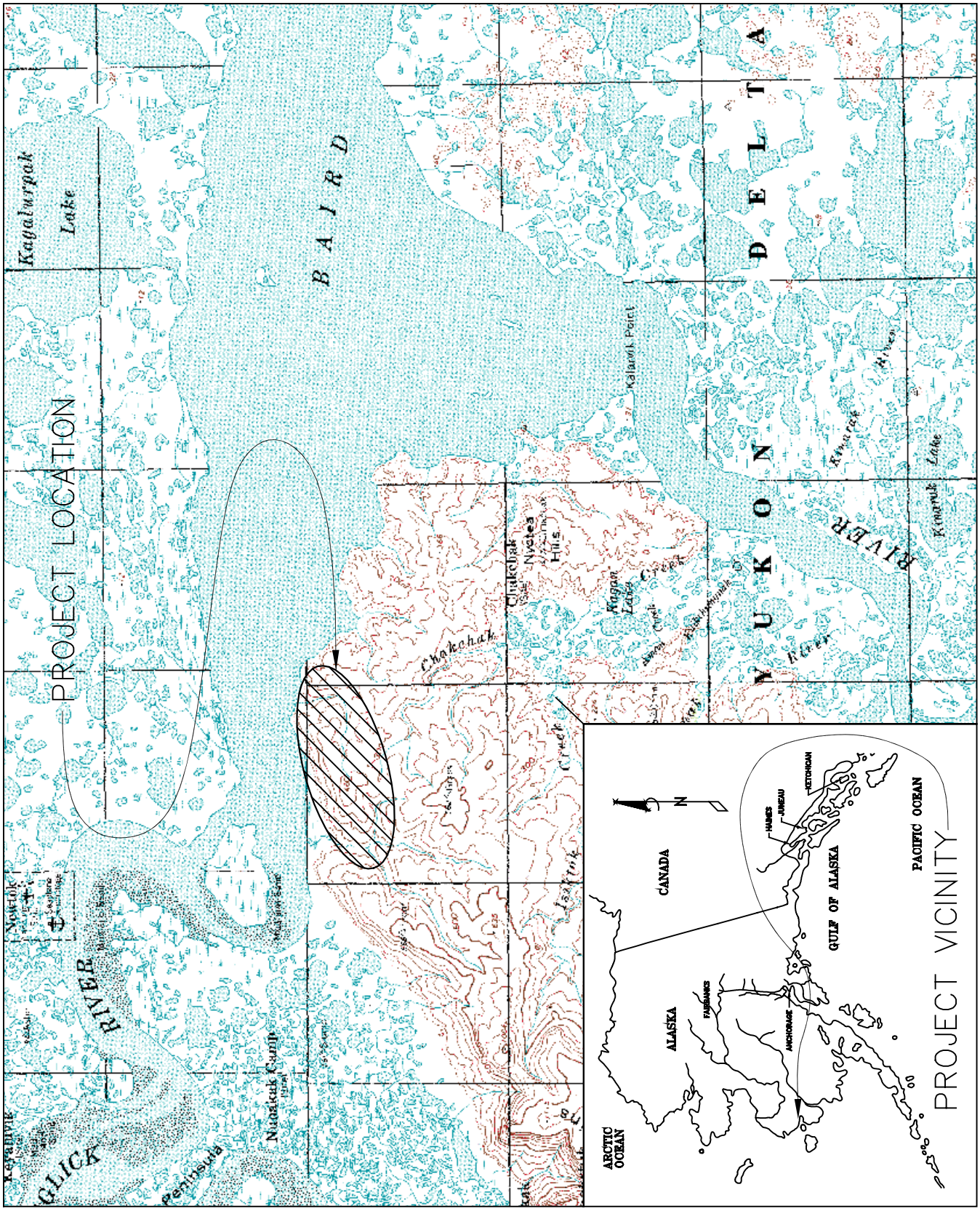
It is assumed that the roads and streets will be narrow built-up sections to accommodate low traffic volumes. The infrastructure along the roads, including the tank farm, sewage lagoon, and solid waste landfill area are included with the roads and will be investigated at the same time. The purpose of the subsurface investigation will be to define the soil and permafrost conditions along the road alignments in sufficient detail to allow design of these streets. Additional subsurface exploration may be necessary as the design of the tank farm, sewage lagoon and the solid waste disposal area is undertaken. The exploration that will be performed in the village area will also be used to supplement design of the streets. This leaves a total of about three miles of road to be investigated. The exploration plan will include drilling 20 test borings to a depth of 10 feet along the alignment and in the areas of associated infrastructure. One of the 10-foot borings in the lagoon area will be deepened to 30 feet to determine the soil conditions, particularly the presence and characteristics of permafrost. This will result in approximately one boring

for every 1000 feet of alignment. Samples will be obtained in the borings and laboratory testing will be performed to classify the soils and to define the physical characteristics.

Materials Source Site The potential materials source site that has been identified for construction of the infrastructure must be investigated to determine the thickness and lateral extent of the rock deposit. Testing must be performed to determine the suitability of the material for use as general fill as well as processed material for surfacing the roads and airport. The testing results and the Rock Quality Designation (RQD) obtained during the rock coring operation will allow a contractor to develop a blasting plan. The RQD will also give a general understanding of the size rock that will result from blasting. The laboratory results can be assessed to determine a general concept regarding the required equipment necessary to crush and process the rock.

Based on past experience with the Kivalina Relocation Project, it is anticipated that on the order of one million cubic yards of borrow material (very rough estimate) will be required to construct the infrastructure for the relocated community. It is recommended that three test borings be drilled to define the extent of the rock source. These borings each will be drilled to a depth of 60 feet. It is anticipated that rock will be encountered near the ground surface and that rock core will be obtained to a depth of 60 feet. The borings will be located at a spacing of about 500 feet and in a triangular pattern. No water source was observed during the site reconnaissance in the area where the coring will occur. Therefore, it will be necessary to import water for coring or use some other means (compressed air) to cool the bit and remove the cuttings from the hole.

The proposed subsurface exploration for the relocation site is presented graphically, superimposed on the proposed community layout prepared by ASCG (see Figure 2).



ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

PROJECT VICINITY AND LOCATION MAP
VILLAGE RELOCATION SITE
NEWTOK, ALASKA

SCALE: NTS
DATE: OCTOBER 2002
DRAWN/RVW: MDP/GWC
FIGURE 1

PLANNED ROAD PRIORITIES

Priority 1	BARGE LANDING ROAD Access to barge landing, barge unloading and storage area, marine fuel header, and fuel tanks.	Route 0010	.23 miles
	AIRPORT ROAD Access to airport	Route 0020	.68 miles
		Sub Total	.91 miles
Priority 2	MAIN STREET Access to landfill, sauna, teacher's housing, school, washeteria, church, residences, water treatment and tank, sewage lagoon, water filtration gallery & pump house.	Route 0030	3.63 miles
	QUGAGLIG ROAD Access to power plant, two stores, multipurpose building, health clinic, post office, residences, and shoreline	Route 0040	.88 miles
	PIUNRITARKAQ ROAD Access to residences and shoreline	Route 0050	.20 miles
		Sub Total	4.71 miles
Priority 3	MIKCYAQ ROAD Access to school, multipurpose building, residences and shoreline	Route 0060	.25 miles
	QASSAIULI ROAD Access to health clinic, washeteria, residences and shoreline	Route 0070	.29 miles
	QEATUAK ROAD Access to church, store, residences and shoreline	Route 0080	.26 miles
	ARNAPAGAQ ROAD Access to residences and shoreline	Route 0090	.29 miles
		Sub Total	1.09 miles
	TOTAL VILLAGE ROAD DISTANCE		6.71 miles

LAND USE PLAN

1. Consolidated Fuel Tanks
2. Barge Unloading and Storage Area
3. Barge Landing and Marine Fuel Header
4. Multipurpose Building
5. Store
6. Power Plant
7. Community Sauna Building
8. Teacher's House
9. Airstrip
10. Health Clinic
11. Washeteria
12. Water Treatment Building & Tank
13. Church
14. Post Office
15. Store
16. School
17. Landfill
18. Sewage Lagoon
19. Water Filtration Gallery & Pump House

BAIRD INLET

QUGAGLIG ROAD ROUTE 0040
MIKCYAQ ROAD ROUTE 0060
QASSAIULI ROAD ROUTE 0070
QEATUAK ROAD ROUTE 0080
ARNAPAGAQ ROAD ROUTE 0090
PIUNRITARKAQ ROAD ROUTE 0050
BARGE LANDING ROAD ROUTE 0030
MAIN STREET ROUTE 0030
AIRPORT ROAD ROUTE 0020
AIRSTRIP 4200' X 200'

NORTH

GRAPHIC SCALE
500' 0 500' 1000' 2000'

PHOTO DATE: 6/12/95

LEGEND
PROPOSED TEST BORING LOCATIONS AND DEPTHS

DEPARTMENT OF THE INTERIOR U.S. BUREAU OF INDIAN AFFAIRS March 3, 1824

ASCG INCORPORATED
ENGINEERS · ARCHITECTS · SURVEYORS · INSPECTION SERVICES
301 ARCTIC SLOPE AVENUE, ANCHORAGE, AK 99518
PHONE (907) 344-6141 FAX (907) 344-4211

FIGURE 2
PROPOSED TEST BORING LOCATION MAP

NEWTOK, ALASKA

BUREAU OF INDIAN AFFAIRS

JOB NO:	4209
DATE:	11/05/01
DRAWN BY:	DRM
CHECKED BY:	TM

DWG FILE: 0000XXXX.DWG
PLOT DATE: 00/00/00