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GROUND-WATER RECONNAISSANCE
IN FIVE ESKIMO VILLAGES
IN THE LOWER KUSKOKWIM-YUKON RIVER AREA, ALASKA

ALASKA DEPT. OF HEALTH and Welfare
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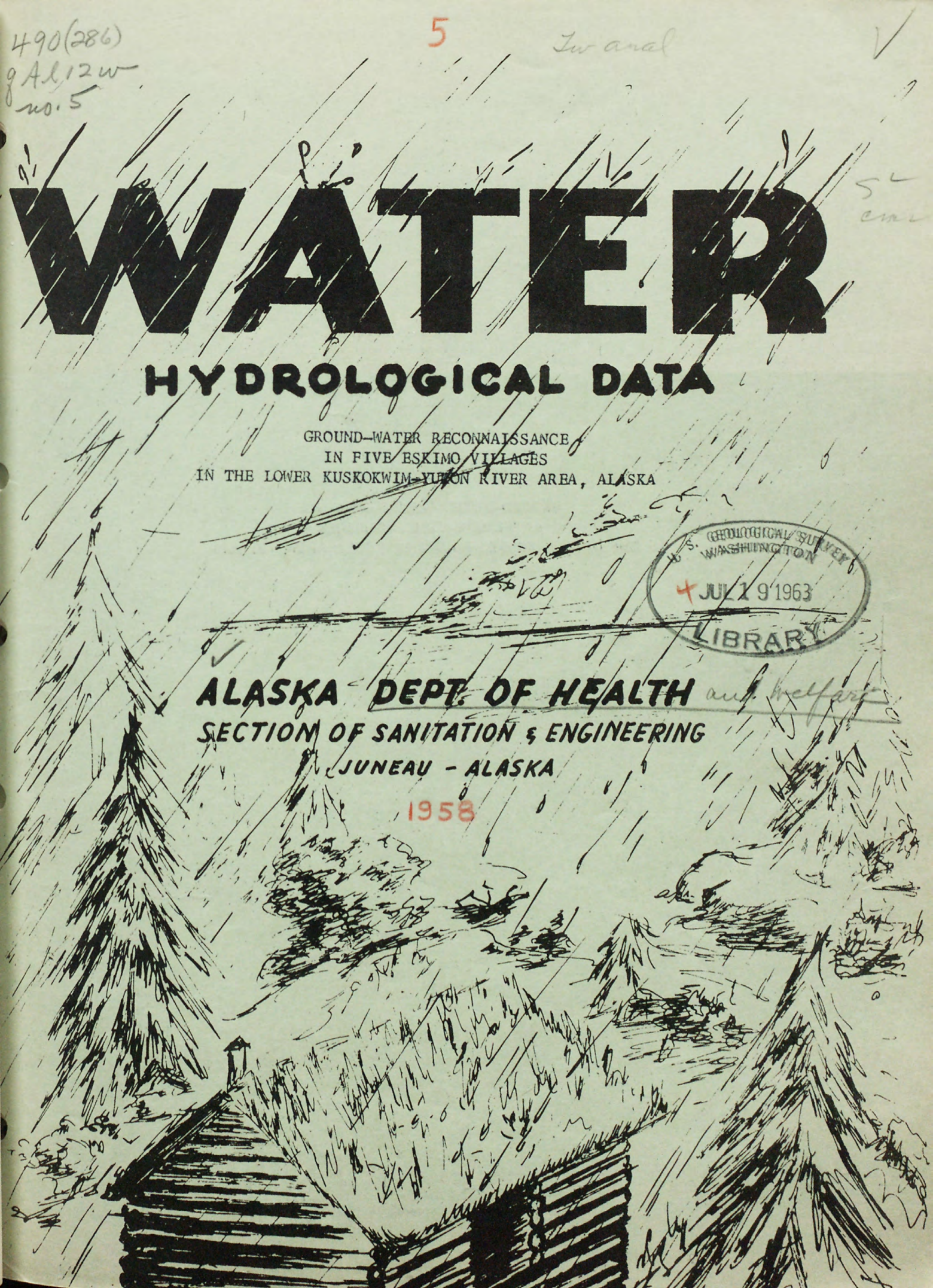

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UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey

GROUND-WATER RECONNAISSANCE IN FIVE ESKIMO VILLAGES IN THE LOWER KUSKOKWIM-YUKON RIVER AREA, ALASKA

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Elton

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Prepared in cooperation with the Alaska Department of Health

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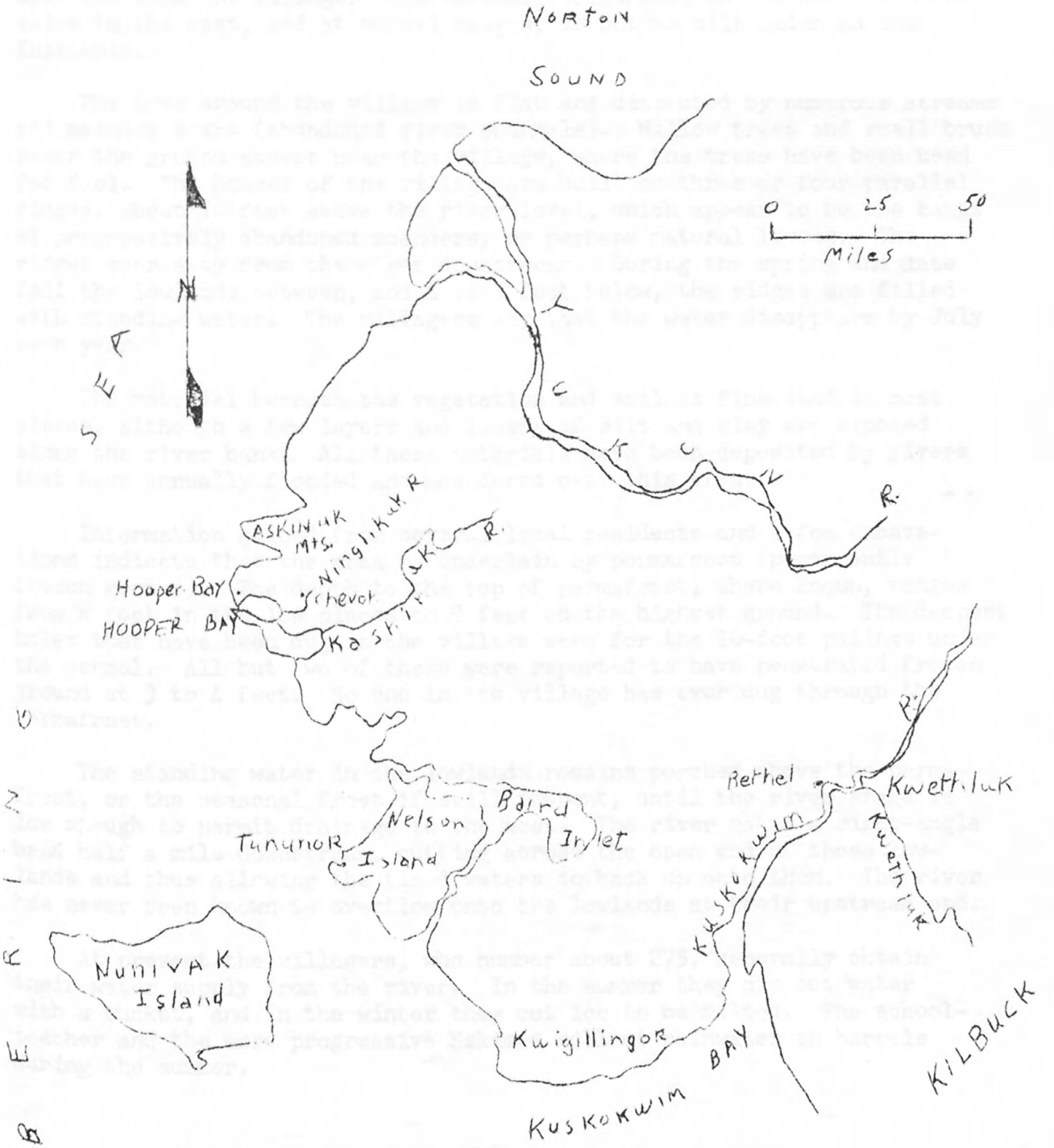
GROUND-WATER RECONNAISSANCE IN FIVE ESKIMO VILLAGES IN THE LOWER KUSKOKWIM-YUKON RIVER AREA, ALASKA

By Roger M. Waller

September 1955

In response to a request from the Sanitation and Engineering Section of the Alaska Department of Health, a reconnaissance of the possibility of obtaining ground-water supplies for the five villages in the lower Kuskokwim-Yukon River area was made by the Geological Survey early in June 1955. The five Eskimo villages--Kwethluk, Hooper Bay, Chevak, Tununak, and Kwigillingok--are in western Alaska between the lower reaches of the two rivers. (See sketch page two) As there has been no development of ground water in the area, this report is based on a brief investigation of the surficial geology and the topography.



Sketch map of part of western Alaska showing the location of the five Eskimo villages discussed in this report.

KWETHLUK

The village of Kwethluk is on the south bank of the Kwethluk River about 20 miles upstream from and east of Bethel. The Kwethluk River joins the Kuskokwim River 3 miles downstream to the west and is subject to flooding by the Kuskokwim through an adjoining slough about 4 miles upstream from the village. The Kwethluk originates in the Kilbuck Mountains to the east, and at normal stages, is not as silt laden as the Kuskokwim.

The area around the village is flat and dissected by numerous streams and meander scars (abandoned river channels). Willow trees and small brush cover the ground except near the village, where the trees have been used for fuel. The houses of the village are built on three or four parallel ridges, about 10 feet above the river level, which appear to be the banks of progressively abandoned meanders, or perhaps natural levees. The ridges veer away from the river downstream. During the spring and late fall the lowlands between, and 4 to 5 feet below, the ridges are filled with standing water. The villagers say that the water disappears by July each year.

The material beneath the vegetation and soil is fine sand in most places, although a few layers and lenses of silt and clay are exposed along the river bank. All these materials have been deposited by rivers that have annually flooded and meandered over this area.

Information gained from several local residents and a few excavations indicate that the area is underlain by permafrost (permanently frozen ground). The depth to the top of permafrost, where known, ranges from a foot in the low places to 8 feet on the highest ground. The deepest holes that have been dug in the village were for the 10-foot pilings under the school. All but two of these were reported to have penetrated frozen ground at 3 to 4 feet. No one in the village has ever dug through the permafrost.

The standing water in the lowlands remains perched above the permafrost, or the seasonal frost if still present, until the river stage is low enough to permit drainage to the west. The river makes a right-angle bend half a mile downstream, cutting across the open end of these lowlands and thus allowing the flood waters to back up onto them. The river has never been known to overflow onto the lowlands at their upstream end.

At present the villagers, who number about 275, generally obtain their water supply from the river. In the summer they dip out water with a bucket, and in the winter they cut ice to be melted. The schoolteacher and the more progressive Eskimos collect rainwater in barrels during the summer.

The depth to permafrost is too shallow to permit obtaining a sanitary water supply from a dug well. The thickness of the permafrost is not known. However, the topography suggests that the Kuskokwim River or its tributaries have meandered over this area in recent geologic times. The original permafrost was probably thawed, in part at least, while the river flowed over it, because water absorbs much heat in the summer and tends to warm the ground beneath. Since the river abandoned this area, the permafrost may have redeveloped, although there is no way of predicting whether it has reached its former extent. Thus, there may be a layer of unfrozen material that contains water.

A first attempt at obtaining a ground-water supply might be made by hand driving a well point into the ground. A well point possibly may be driven far enough to intersect a water-bearing stratum below or between the frozen layers. If, when the well point can no longer be driven, it is still in permafrost, the driller will have to resort to another method, such as jetting the point down with water.

Because the land is flat and is periodically flooded, a well should be attempted on the higher ground distant from any source of contamination. The area just east of the school appears to be most suitable.

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HOOPER BAY

The village of Hooper Bay is on a low, flat peninsula extending westward into the Bering Sea about 18 miles south of the Askinuk Mountains. The main part of the village is built on three low east-trending hills or ridges on the northwest side of an almost completely enclosed bay. Some of the approximately 400 Eskimos live on another low hill about a thousand feet to the south.

The land between these hills and the surrounding area is relatively flat and poorly drained and is occupied by more or less permanent lakes. A river that flows past the village connects the bay (Hooper Bay) with another outlet to the sea. Because it is a tide channel, its water is salty. The terrain to the west, along the seacoast, appears to be stabilized sand dunes having a tundra cover. The hills of the village also have the general shape of dunes, sloping gently to the north and west and steeply to the south and east. These hills rise about 15 to 25 feet above the land surface of the immediate area.

From a few excavations and local information it was found that the hills consist of fine to medium sand to a depth of at least 30 feet. The lowlands surrounding the hills have silt near the surface, which probably was deposited by high storm tides and annual runoff.

Permafrost has been encountered in almost every excavation. A 30-foot hole, dug at the village store in an unsuccessful attempt to obtain water, reached permafrost at a depth of 6 feet. At the school, on the highest hill, no permafrost was found in digging to a depth of 10 feet to set the pilings, but at the village chief's home, 150 feet east and 10 feet lower, permafrost was encountered at 8 feet. The lowlands are underlain by permafrost at lesser depths; the writer dug into frozen ground at depths of 1 or 2 feet in various places.

The villagers use snow and ice for their water supply in the winter. By catching rainwater in the summer, they can avoid using lake water, which is brackish; the low-lying lakes evidently are flooded at high tides during storms. One of the lakes, has not been subjected to flooding by ocean water; consequently, it is salt free and is used by the Eskimos living near it on the south hill. It is too far from the main village, however, for the convenient use of most of the population.

A well could be attempted by the jetting method almost anywhere in the village. The lakes between the hills would offer a convenient source of water needed in the jetting. Unfortunately, the hills do not have an extensive surface area to allow infiltration of sufficient rainfall and snowmelt to produce a shallow-water supply above the permafrost. A well would have to be put down by some such method as jetting, to reach water beneath the permafrost, which probably extends to a fairly deep level as

this area does not appear to have been thawed recently by stream action. However, there could be layers of relatively permeable material within the permafrost, in which ground water has circulated vigorously enough to keep the ground from freezing. Only test wells can determine whether this is the case.

Because this land has been built out into the ocean, water contained in it may be salty. The general flatness of the land and the absence of a major stream valley suggest that fresh water may not yet have flushed out the original sea water from the formations.

The hill to the south is on the north end of generally higher ground extending southeastward in a spitlike form. This hill may have better possibilities for a shallow-water supply; a well point driven near the fresh water lake might penetrate thawed ground.

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CHEVAK

The village of Chevak lies on the north bank of the Ninglikuk River, about 10 miles upstream from where the river empties into Hooper Bay. It is approximately 17 miles due east of the village of Hooper Bay. The river is only about 15 miles long and is affected by the daily tides at least as far upstream as the village.

Chevak was established at the present site in 1951. Previously it was located on the Kashunuk River about 10 miles south-southeast. There are now about 275 Eskimos in the village.

The land surface around Chevak has very little relief. At the village the Ninglikuk River makes a tight meander, open toward the south. There are two prominent river terraces here, which extend westward from a nearly vertical bluff at the apex of the river meander. The bluff is 50 to 60 feet above the river and is continually being eroded by it. The lower terrace is 9 feet above the river and the upper terrace is about 20 feet above the lower terrace. There is a lake on the upper terrace, about 150 feet north of the village.

The exposures in the high bluff and in a few excavations in the village show that the near-surface material is gray and brown silt. The silt grades into fine brown sand, which extends down to the present river level. An excavation beneath the church, which is near the east end of the village, revealed fine sand.

Permafrost is present throughout the village at an average depth of 1 foot. The high bluff reveals, upon digging, frozen ground at less than a foot, even though the face of it is to the south. As the permafrost melts here, the ground slumps and is eroded by the river more rapidly. The flat lower terrace has poor drainage because the permafrost does not permit water to seep into the ground, whereas the upper terrace slopes toward the large lake north of the village, allowing snowmelt and rainfall to percolate through the surface material on top of the permafrost. The deepest penetration of the permafrost was beneath the school where 8-foot holes for pilings were dug. The thickness of the permafrost is unknown but is believed to be several hundred feet.

The villagers use the large lake for their water supply the year round. Some of them also collect rainwater in barrels. The lake appears to be in a low area in the permafrost, about 13 feet below the general level of the village, where water can collect. The Eskimos have attempted to keep the lake area free from contamination by keeping the sled dogs away from it and by dumping their refuse on the river side of the village. A fresh-water pond on the river terrace has become contaminated by this practice; however, it had been used by only a few persons.

For a ground-water supply, the lower terrace may offer the best prospects. The terrace deposit has been formed in recent geologic time. Whether there are unfrozen permeable zones in it, however, can be determined only by test drilling. In any event, less jetting would be needed here than on the higher ground to reach the bottom of the permafrost if unfrozen zones are not encountered in it. At depth there may be coarser sediments, deposited by younger and swifter streams. The lower terrace, however, has the disadvantage of being the receptacle for all the refuse and drainage from the village, and if a well is put down there it should be carefully cased to exclude surface drainage. A well point could be driven first to determine if an unfrozen layer can be reached in the permafrost; if there is none, the point could be jetted down.

On the upper terrace, the area between the school and the church offers a sanitary location for a well. However, although it would require a long haul of water for jetting purposes, it would be convenient in other respects. This location would also be best for a deep test. There probably are no shallow unfrozen layers, but the same possibilities of obtaining water exist as at the lower-terrace location. The only location on this terrace where a shallow well might be successful is near the lake, where a drive point might intersect a shallow unfrozen.

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TUNUNAK

Tununak is on the west side of Nelson Island, facing the Bering Sea. The village is built on a narrow spit of land extending southwest across the mouth of a river. The river valley extends southeastward to a saddle that lies between two mountains which are more than a thousand feet high. These mountains form precipitous cliffs at the seashore on both sides of the river valley. The spit of land stands about 10 feet above the beach line and is 300 feet wide at its widest point. The river flows parallel to the coast for about half a mile before reaching the sea and forms the inner boundry of the spit. The village is near the northeastward (landward) end of the spit, where the land rises abruptly toward one of the mountains.

The spit has been built outward of material derived from the mountain, chiefly sandstone and shale. Small boulders, cobbles, and coarse sand are exposed along both sides of the spit, and on the river side are lenses made up of finer grained sediments. Hard, flat, dark-colored cobbles predominate.

No evidence of permafrost was found in the spit within the general area of the village. Just behind the schoolhouse, however, where the land slopes upward toward the mountain, frozen ground was encountered within a foot of the surface; this perhaps is seasonal frost. The slope is covered by tundra and has a mantle of soil, probably not very thick, overlying the consolidated rock.

Two well points have been driven into the material forming the spit, and it is reported that neither encountered frozen ground. The deepest well point, still in place, is about 14 feet down. As the spit is of more recent origin than the mainland and is composed of coarse material, permafrost may be absent or interrupted even at deeper levels.

The villagers use water from a stream that flows from the northeast mountain. It emerges as a spring about half a mile up the slope and empties into the river about 200 yards from the northeast end of the village. The 14-foot well is at the school, which is about 80 feet from the foot of the mountain slope, on a terracelike level about 6 feet above the general level of the spit. The well is inside the schoolhouse, and the water, the depth to which is about 11½ feet, does not freeze in the winter.

The entire spit should be underlain by water at shallow depth. In the immediate vicinity of the village, which is only about 10 feet above the beach and is underlain by coarse material, the water is likely to be salty. Well points can easily be put down in these low-lying places, however, to test whether the water is usable: - if driven closer to the river side than to the sea, salt-water contamination possibly can be

avoided. Cobbles or boulders may cause trouble, but by pulling the point and moving a few feet away, this difficulty may be solved. A good well location would be on the slightly higher ground near or between the school and the store, which are on the landward end of the spit. That area receives ground-water recharge from water percolating down the mountain slope, and a well there probably would reveal conditions similar to those at the present school well. Again, the location should not be too close to the ocean side of the spit, where pumping water for long periods of time would tend to draw in salt water.

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KWIGILLINGOK

The village of Kwigillingok is near the north shore of Kuskokwim Bay about 30 miles from the mouth of the Kuskokwim River. The village is built on the west bank of a small river that empties into the bay a mile down stream. The bay opens into the Bering Sea.

The area around the village for many miles is flat and poorly drained, containing many lakes, ponds, and streams. The riverbank is about 5 feet above the high-tide mark. Half a mile downstream is the site of a village where the present villagers abandoned 37 years ago for a place more distant from the stormy seacoast.

The material beneath the tundra is predominately gray to blue silt and clay. No coarser material has been observed. The general location of the village, with respect to the major geologic features of the lower Kuskokwim area; indicates that it is at the outer edge of deposits laid down by the Kuskokwim River. Only the finer grained material was transported in the sluggish lower reaches of the river. Consequently, only fine sediments have been deposited in this area, probably for a considerable time. There may be coarser sediments at depth, however, deposited by formerly more vigorous streams, either a greater Kuskokwim River in glacial times or river flowing from the Kilbuck Mountains 70 miles east.

Permafrost was found about a foot below land surface at several places in the area and probably extends to great depths. The fine sediments tend to hinder circulation of ground water and thus probably prevent any thawing action. However, locally there may be thawed zones in the permafrost near some of the larger lakes or along the river.

The approximately 300 villagers get their winter water supply by cutting ice from the "second lake" 300 yards west of the village. Water in the "first lake," about 3 feet lower, is too salty for human consumption. During the summer the villagers go by boat upstream a mile and a half to a larger lake for their water supply.

Because of the fineness of the underlying sediments, the possibilities of an adequate ground-water supply in Kwigillingok are not as good as in the other villages visited. A well point could be driven near the river, however, to test for any thawed shallow water-bearing zone that may be present. Otherwise, the well would have to be put down to a depth below the permafrost until material coarse enough to transmit water readily was found. The well should be located on the higher ground to avoid contamination and possible flooding by high tides.

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