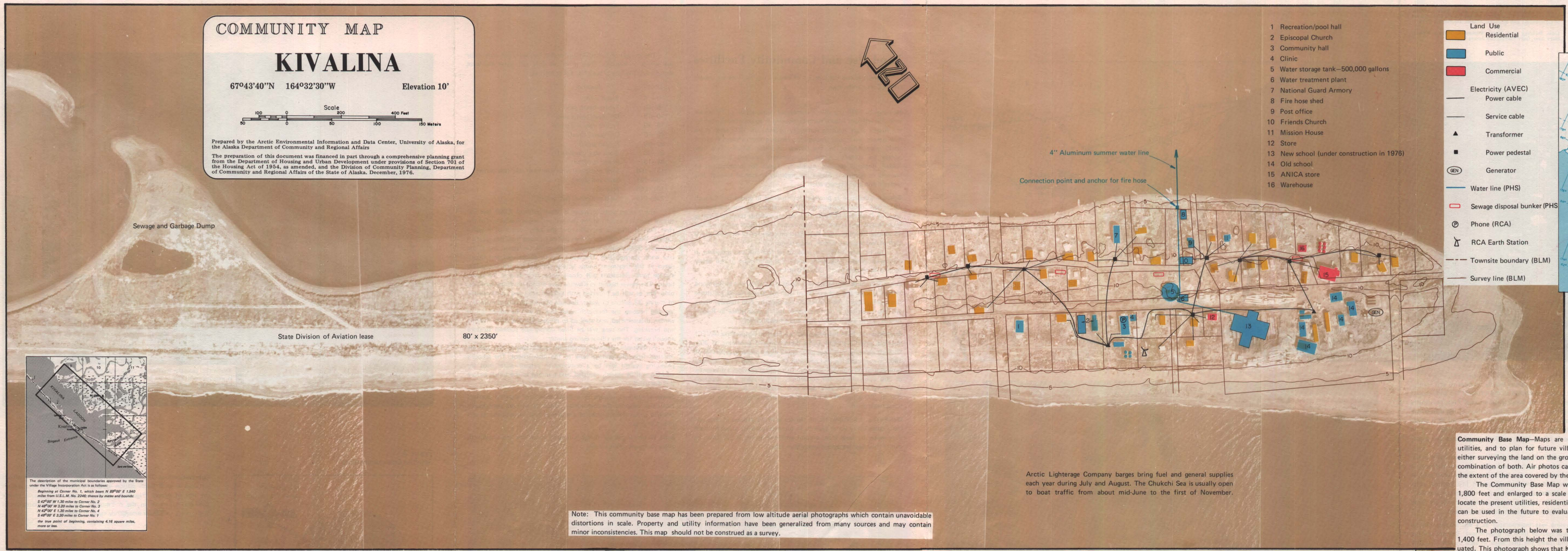
COMMUNITY MAP

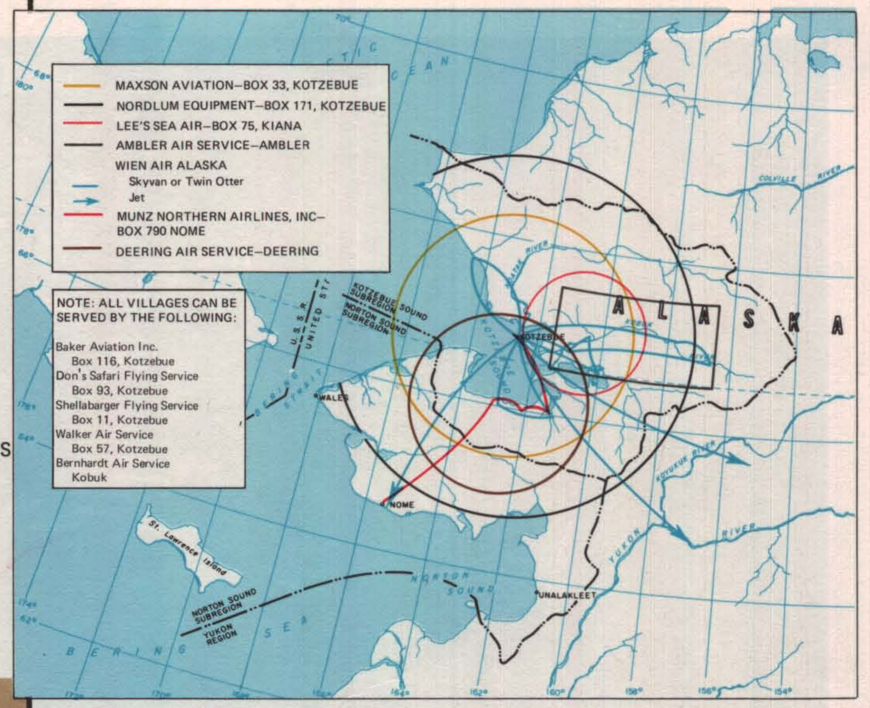
KIVALINA

67°43'40"N 164°32'30"W Elevation 10'

Prepared by the Arctic Environmental Information and Data Center, University of Alaska, for the Alaska Department of Community and Regional Affairs

The preparation of this document was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development under provisions of Section 701 of the Housing Act of 1954, as amended, and the Division of Community Planning, Department of Community and Regional Affairs of the State of Alaska. December, 1976.

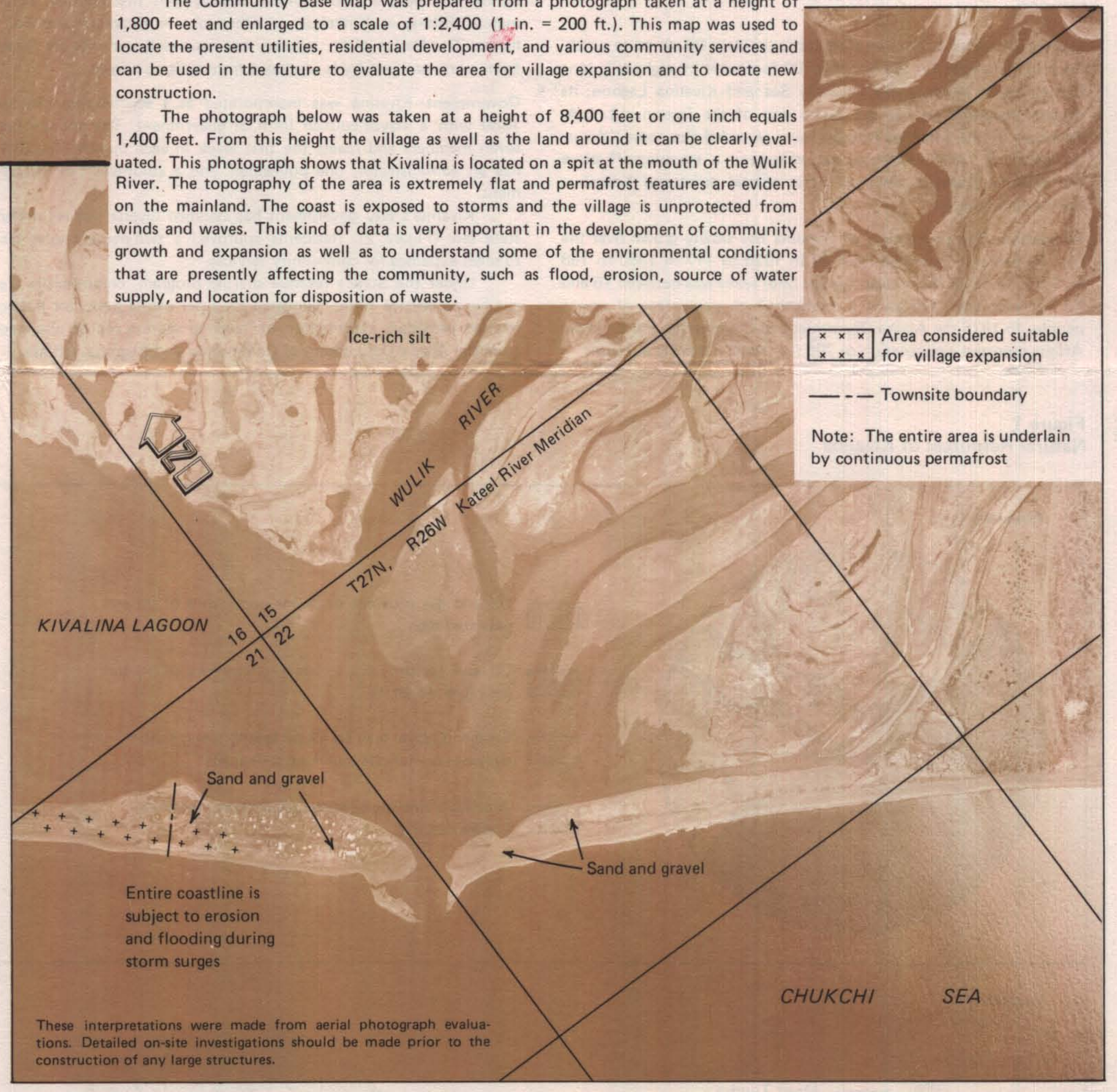




Community Base Map—Maps are needed to show land use, ownership, location of utilities, and to plan for future village improvements. These maps can be prepared by either surveying the land on the ground or through enlargement of aerial photos or by a combination of both. Air photos can be taken at various heights. The height determines the extent of the area covered by the photograph.

The Community Base Map was prepared from a photograph taken at a height of 1,800 feet and enlarged to a scale of 1:2,400 (1 in. = 200 ft.). This map was used to locate the present utilities, residential development, and various community services and can be used in the future to evaluate the area for village expansion and to locate new construction.

The photograph below was taken at a height of 8,400 feet or one inch equals 1,400 feet. From this height the village as well as the land around it can be clearly evaluated. This photograph shows that Kivalina is located on a spit at the mouth of the Wulik River. The topography of the area is extremely flat and permafrost features are evident on the mainland. The coast is exposed to storms and the village is unprotected from winds and waves. This kind of data is very important in the development of community growth and expansion as well as to understand some of the environmental conditions that are presently affecting the community, such as flood, erosion, source of water supply, and location for disposition of waste.



These interpretations were made from aerial photograph evaluations. Detailed on-site investigations should be made prior to the construction of any large structures.

Environmental Considerations for Community Development

Community development must consider all environmental factors that affect the engineering design and location of structures, including climate, topography, soils, permafrost, erosion, and flooding.

Climate

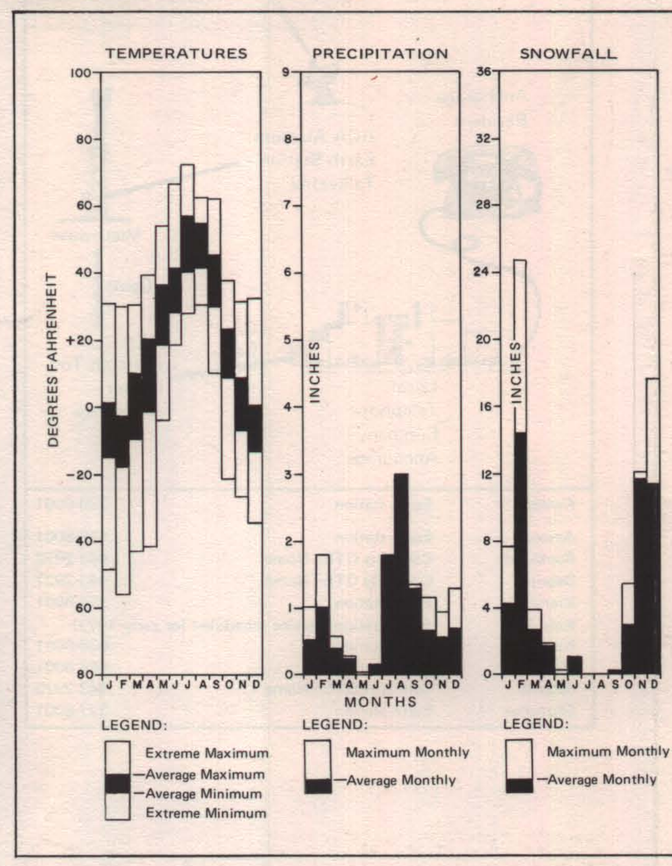
Climatic data on winds, precipitation, temperature, and snowfall (Figure 5) allow engineers to design buildings strong enough to withstand heavy winds and deep snow, select type and thickness of insulation to reduce heat loss, and estimate fuel requirements. Climatic data are also needed to determine the type of clothing needed to protect the human body against extreme temperatures.

Chill Factor—If the air temperature is below body temperature, a person loses heat to the atmosphere. When the wind blows, the rate of heat loss increases; therefore, air temperature and wind velocity are the two environmental factors which affect body heat loss. Wind chill data (Figure 6) were developed by combining wind and temperature measurements into numbers which express equivalent chill temperatures.

Figure 6
Wind Chill Temperatures

WIND SPEED MILES PER HOUR	COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE" TEMPERATURE (°F)																				
CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
	EQUIVALENT CHILL TEMPERATURE																				
5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT.	LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 min.)						GREAT DANGER (Flesh may freeze within 30 seconds)									
	DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS																				

Figure 5
Climatic Data Recorded at Kivalina



Note: Kivalina lies in the transitional climate zone which is characterized by long, cold winters and cool summers. Even though the village is located on the coast, the climate is more continental than maritime—partly because the Chukchi is ice-covered from November to June. Precipitation is light with an average of less than 10 inches annually, including 50 inches of snow. Winds average 10 knots. There are an estimated 701 growing degree days at Kivalina, less than half of the 1,500 considered necessary for large-scale agriculture. Additional information on climate is available at the Arctic Environmental Information and Data Center, University of Alaska.

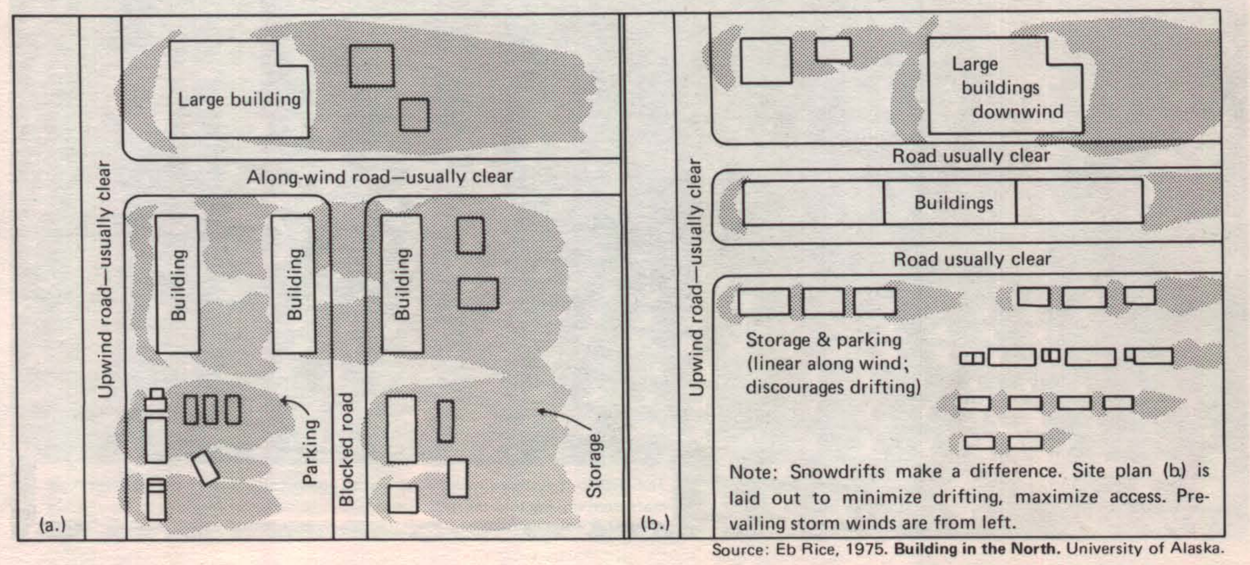
MONTH	TEMPERATURE (°F) Means Daily Maximum	Daily Minimum	Monthly	Extr. Record Highest	Record Lowest	PRECIPITATION (IN INCHES) Mean	Greatest Daily	Greatest Monthly	Snow, Ice Pellets Mean	Greatest Daily	Greatest Monthly	Greatest Depth on Ground	HEATING DEGREE DAYS
(a)	1-3	1-3	1-4	1-4	1-4	1-3	1-3	1-3	1-3	1-3	1-3	2	
J	2.3	-12.9	-10.8	35	-47	.47	.87	.97	4.1	4.3	7.5	43	2350
F	-1.6	-16.9	-8.8	34	-55	.95	.54	1.75	14.6	7.2	25.0	35	2085
M	11.3	-7.2	2.4	35	-42	.30	.24	.51	2.5	3.0	3.6	31	1941
A	22.5	0.5	10.3	42	-41	.18	.21	.21	1.4	1.4	1.6	30	1641
M	39.0	20.0	29.7	59	-2	T	T	T	T	T	T	29	1094
J	44.2	31.0	37.6	71	20	.07	.06	.07	.8	.8	.8	0	822
J	60.4	43.4	51.9	76	30	1.75	.54	1.75	0	0	0	0	406
A	58.0	44.1	51.1	65	32	2.96	.87	2.96	0	0	0	0	431
S	47.6	32.6	40.1	65	12	1.25	.30	1.28	T	T	T	T	747
O	25.5	11.4	18.5	40	-20	.58	.25	1.07	2.7	1.4	5.3	4	1442
N	10.6	-4.9	2.8	34	-25	.50	.38	.88	11.8	4.5	12.1	23	1866
D	2.2	-11.8	-4.8	35	-34	.64	.46	1.24	11.4	5.2	17.8	40	2164
YR	26.8	10.8	18.3	76	-55	9.65	.87	2.96	49.3	7.2	25.0	43	16989

Snow Load—Snow load data are used in the design of structures to determine the strength needed to withstand the weight of packed snow. The U.S. Army Cold Regions Research and Engineering Laboratory has estimated local ground snow loads in pounds per square foot (psf) for many areas of Alaska. The design load selected depends on the expected use, life span, and geographic location of the building. For example, a five-year life could be selected for a temporary facility. A structure that can withstand 56 pounds of snow per square foot is considered safe for five years in Kivalina. A building with a life expectancy of 25 years must be able to withstand a snow load of 77 psf; 88 psf for 50 years; and buildings with an anticipated life of 100 years or more, such as hospitals and other long-lasting, permanent facilities, should be able to withstand 95 psf.

Wind Speed—Information on wind speed and direction is necessary to design and orient airports and other structures. It has been estimated that for a structure with an expected life of 10 years a structural design that could withstand extreme wind speeds of at least 80 miles per hour should be chosen; 90 miles per hour for a structure with an expected life of 25 years; 95 miles per hour for a 50-year life; and 105 miles per hour for a structure with a life expectancy of 100 years or more.

In locating buildings, consideration must be given to the direction of wind to minimize snowdrifts (Figure 7).

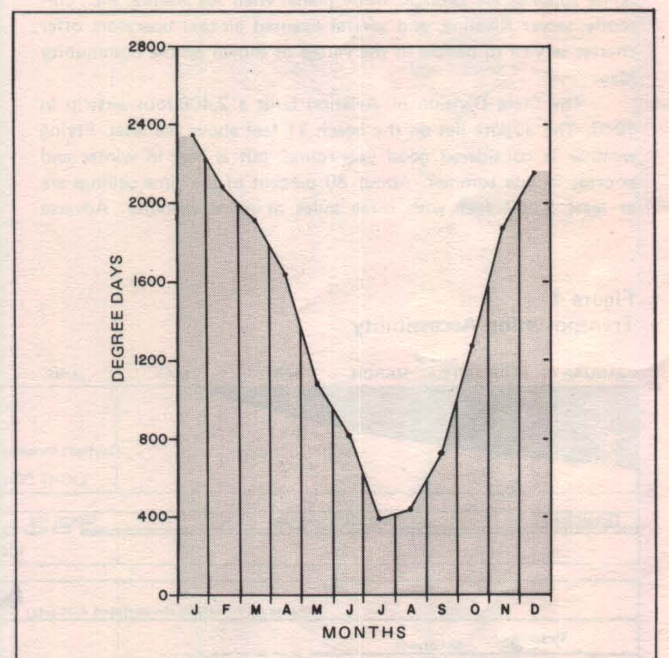
Heating Degree Days—Annual fuel requirements for a heated building can be calculated from heating degree days information. Structural heating usually begins when the air temperature is near 65 degrees F, the index temperature. If a particular day has a mean temperature of 50 degrees F, 15 heating degree days accumulate (65 minus 50). For the entire year the heating load is the sum of the daily degree days. The degree days for each month of the year for Kivalina are shown in Figure 8. This information, combined with an inventory of types, sizes, and insulative qualities of buildings, can determine the amount of fuel required for a specific time period in the village.



Note: Snowdrifts make a difference. Site plan (b) is laid out to minimize drifting, maximize access. Prevailing storm winds are from left.

Source: Eb Rice, 1975. **Building in the North.** University of Alaska.

Figure 7
Snowdrifts and Wind Direction



A rectangular 430-square-foot home insulated with fiberglass requires about 50 gallons of fuel oil for heating during January in Kivalina. This estimate is based on four-inch-thick fiberglass in the walls and floor, six inches in the ceiling, and a desired temperature of 70°F inside the home. Fuel consumption could be reduced by adding more insulation, minimizing window sizes, and by installing a subfloor to trap air between the floor and crawl space. Heaters should also be adjusted for efficient burning. Assistance in construction can be obtained from data developed by Dr. Eb Rice, University of Alaska, Fairbanks.

Figure 8
Heating Degree Days—Kivalina

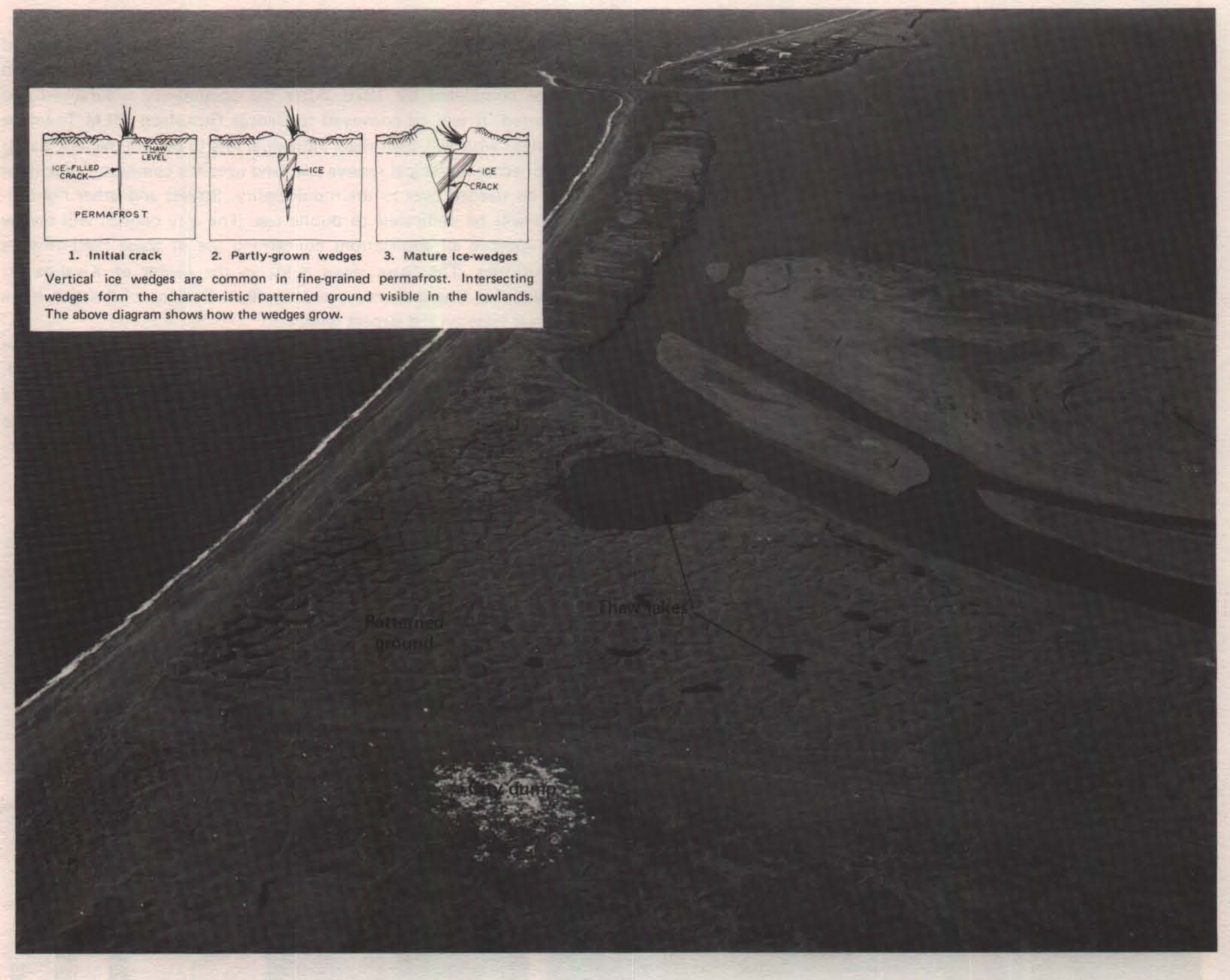
Topography and Soils

Kivalina lies on a flat sand and gravel spit. The spit is 11 feet above sea level at the airport. A well log indicates that sand and fine gravel exist to a depth of 18 feet and are underlain by frozen clay and gravel.

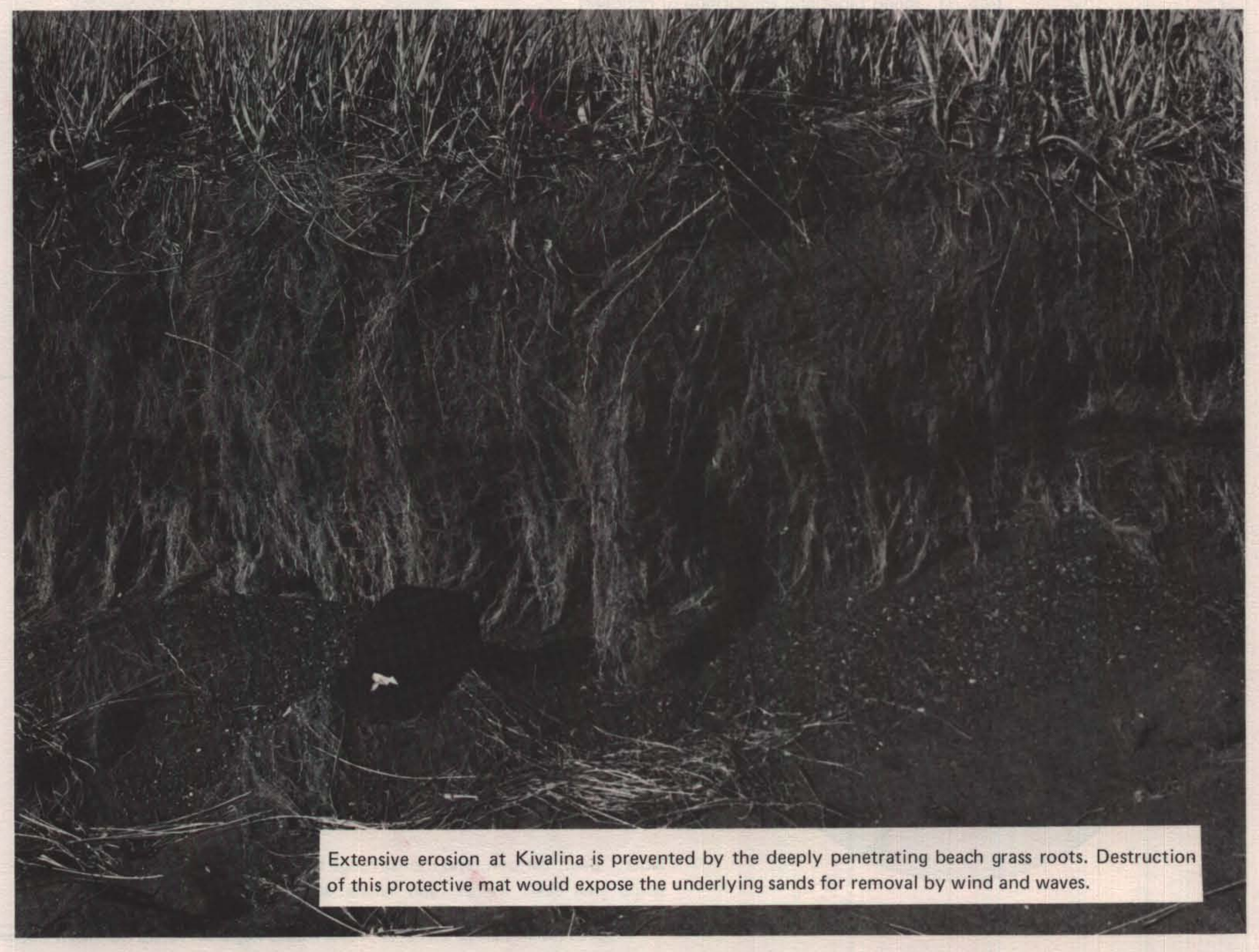
Permafrost—Permafrost (permanently frozen ground) is present on the mainland as well as beneath the thawed spit. Vertical ice lenses occur in frozen silts southeast of the village and throughout much of the lowland east of Kivalina Lagoon. If the village were ever expanded to the mainland, permafrost would have to be protected from thawing. The two most common methods of protecting permafrost are to place a thick gravel pad between the structure and the frozen ground to limit heat transfer or to raise buildings on pilings to allow air circulation under the structure. Utility pipes should be properly insulated or placed in utilidors so that a minimum of heat would transfer from the pipes to the adjacent ground. Frozen clays beneath the village are naturally protected by the thick layer of sand and fine gravel in the spit.

Erosion and Flooding—Storm surges and wind-driven waves can cause coastal flooding at Kivalina. According to the U.S. Army Corps of Engineers, 20 to 30 percent of the village was flooded in 1970. In spite of flooding and storms, very little beach erosion has occurred. In order to maintain the stability of the coastline, removal of sand and gravel should be restricted to the mainland side of the spit.

The most important thing to remember when building in the Arctic is that successful design requires site investigation and the advice of competent engineers because of the special conditions in the North. Neglecting these considerations can lead to complete failure of structures.



Vertical ice wedges are common in fine-grained permafrost. Intersecting wedges form the characteristic patterned ground visible in the lowlands. The above diagram shows how the wedges grow.



Extensive erosion at Kivalina is prevented by the deeply penetrating beach grass roots. Destruction of this protective mat would expose the underlying sands for removal by wind and waves.

Sources of Information

Alaska. Dept. of Community and Regional Affairs. 1972. *Alaska Community Survey: Kivalina.*

Alaska. Div. of Aviation. 1964. Data on file related to studies made prior to and during construction of the Kivalina airstrip. Unpublished.

Alaska. State Housing Authority. Dept. of Planning and Technical Services. 1971. *Statewide Housing Study. Volume 2: Housing Resources, Housing Related Services, Housing Plan.* 115 p.

Alaska Village Electric Cooperative. Various dates. Data and maps on file related to construction of the electric utility at Kivalina. Unpublished.

Carlson, A.R. 1970. Heat loss and condensation in northern residential construction. *Northern Engineer.* 2(2):14-17.

Erskiwe, R. 1969. Architecture and town planning in the north. *Northern Engineer.* 1(4):7-11.

Fryer, M.W. 1969. An engineering approach to architectural design for cold regions. *Northern Engineer.* 1(4):11-13.

Mauneluk Association, Inc. 1974. *The NANA Region; It's Resources and Development Potential.* 289 p.

Mirth, R.A. 1974. The sun can heat our homes—even in the north. *Northern Engineer.* 6(3):3-10.

Orth, D.J. 1967. (revised 1971). *Dictionary of Alaska Place Names.* U.S. Geological Survey. Professional Paper 567. 1084 p.

Rice, E. 1975. *Building in the North.* Geophysical Institute, University of Alaska, Fairbanks. 66 p.

Selkregg, L.L. et al. 1976. *Alaska Regional Profiles: Northwest Region.* Arctic Environmental Information and Data Center, University of Alaska, Anchorage. Prepared for the Office of the Governor and the Joint Federal/State Land Use Planning Commission. 265 p.

Tobiasson, W. and R. Redfield. 1973. *Alaska Snow Loads.* U.S. Army. Cold Regions Research and Engineering Laboratory.

U.S. Army. Corps of Engineers. 1976. Flood plain management services, Alaskan communities flood hazard and pertinent data on file.

U.S. Bureau of Indian Affairs. No date. *Village Survey: Kivalina.*

U.S. Geological Survey. Water Resources Div. Data on file related to water supply studies done for Kivalina. Unpublished.

U.S. National Oceanic and Atmospheric Administration. 1971. *Wind Chill (Equivalent Temperatures).* Environmental Information Series.

U.S. Public Health Service. 1975. Project Summary Sanitation Facilities Construction Community of Kivalina, Alaska. Project AN-76-113. Unpublished.