SOUTHCENTRAL RAILBELT AREA ALASKA
UPPER SUSITNA RIVER BASIN

INTERIM FEASIBILITY REPORT

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SECTION G

MARKETABILITY ANALYSES

UNITED STATES DEPARTMENT OF THE INTERIOR
Alaska Power Administration
Upper Susitna River Hydroelectric Studies
Report on Markets for Project Power

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Part I INTRODUCTION

Purpose and Scope

This study will analyze the power market of an Upper Susitna hydroelectric development. Two major areas of concern will be investigated. These are:

1. Project design in relation to the use of the project power; and

2. Financial feasibility under existing repayment criteria.

Study elements include:

1. estimates of future power requirements

    a. timing
    b. magnitude
    c. load characteristics

2. estimates of future power sales and rates required for repayment

3. analysis of costs of alternative sources of power

The level of detail is that required for demonstration of project feasibility for purposes of consideration by the Congress for project authorization.

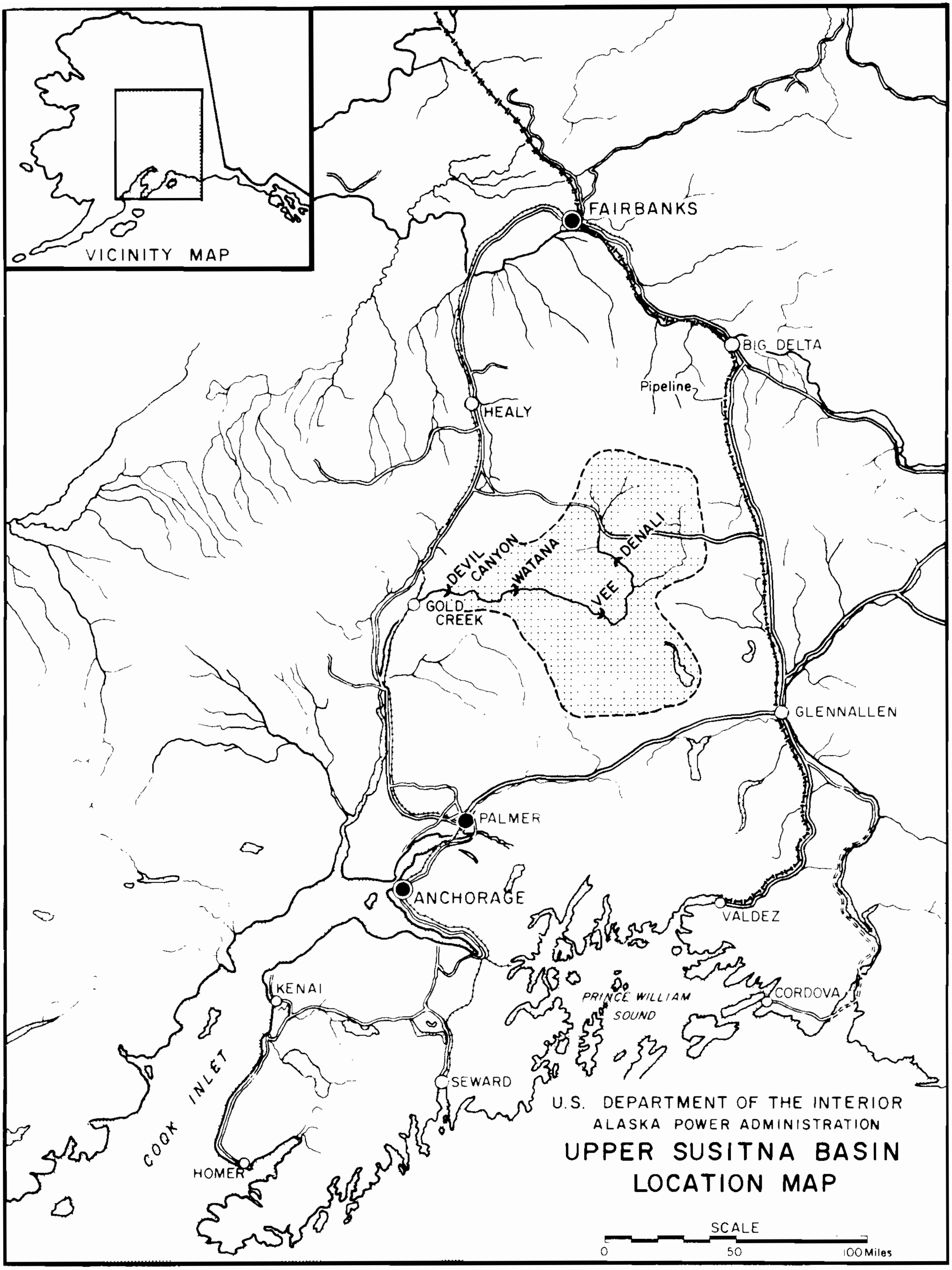
Alternative Plans for Upper Susitna Hydroelectric Development

Figure 1 shows general locations of the potential units of the Upper Susitna Project in relationship to the Alaska Railbelt. The four key Upper Susitna damsites are Devil Canyon, Watana, Vee, and Denali.

Several alternative systems for developing the Upper Susitna Project were evaluated. Table 1 summarizes data on energy and power capability for these alternative systems.

The Corps of Engineers proposes an initial development including the Devil Canyon and Watana sites. (System # 5)

System # 1 (Devil Canyon and Denali) is analogous to the intitial development plan advanced in earlier studies by the Bureau of Reclamation and APA. System # 4 is the four-dam ultimate development plan identified in previous USBR-APA studies.



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APA 2-74

Table 1. Alternative System Plans
Installed Capacity & Firm Energy

System	W.S. el. M.S.L.	P.O.L. Date	Devil Canyon Installed Capacity 1000 kw	Devil Canyon Firm Energy Million kwh	Watana Installed Capacity 1000 kw	Watana Firm Energy Million kwh	Vee Installed Capacity 1000 kw	Vee Firm Energy Million kwh	System Total Installed Capacity 1000 kw	System Total Firm Energy Million kwh	System Total Secondary Energy Million kwh
System #1											
Devil Canyon	1450	1985	580	2497							
Denali	2535	1990									
									580	2497	701
System #2											
Devil Canyon	1450	1985	600	2628							
Watana	2050	1990			470	2059					
									1070	4687	946
System #3											
Devil Canyon	1450	1985	700	3066							
Watana	2050	1990			670	2935					
Denali	2535	1995									
									1370	6001	350
System #4											
Devil Canyon	1450	1985	713	3119							
Denali	2535	1990									
Vee	2300	1995					300	1314			
Watana	1905	2000			421	1840					
									1434	6273	640
System #5											
Watana	2200	1986			792	3101					
Devil Canyon	1450	1990	776	3048							
									1568	6149	701

Notes: System #5 is the proposed initial development plan.

Data is from Corps of Engineers studies.

Previous Studies

There is a fairly substantial backlog of power system and project studies relevant to the current evaluation of the Upper Susitna River Project. A partial bibliography is appended. The previous studies most relevant to power market considerations include:

1. Advisory Committee studies completed in 1974 for the Federal Power Commission's (FPC) new Alaska Power Survey. The studies include evaluation of existing power systems and future needs through the year 2000, and the main generation and transmission alternatives available to meet the needs. The power requirement studies and alternative generation system studies for the new power survey were used extensively in the current study. The FPC summary report for its new survey is not yet available.

2. A series of utility system studies for Railbelt area utilities include assessments of loads, power costs, and generation and transmission alternatives.

3. Previous work by the Alaska Power Administration, the Bureau of Reclamation, the utility systems, and industry on studies of various plans for Railbelt transmission interconnections and the Upper Susitna hydroelectric potential. The most recent of these are the May 1974, Status Report on the Devil Canyon Project by APA and the September 1974, Reassessment Report on Upper Susitna River Hydroelectric Development prepared for the State of Alaska by the Henry J. Kaiser Company.

It should be noted that many of the studies listed in the bibliography represent a period in history when there was very little concern about energy conservation, growth, and needs for conserving oil and natural gas resources. Similarly, many of these studies reflected anticipation of long term, very low cost energy supplies. In this regard, the studies for the new power survey are considered particularly significant in that they provide a first assessment of Alaska power system needs reflecting the current concerns for energy and fuels conservation and the environment, and the rapidly increasing costs of energy in the economy.

Part II SUMMARY

1. Studies of future power requirements prepared for the FPC Alaska Power Survey were reviewed in light of new data for the years 1973 and 1974. New estimates of power requirements through the year 2000 were prepared reflecting the best current estimates of loads that would actually be served from an interconnected Railbelt power system serving the Fairbanks-Tanana Valley area and the Anchorage-Cook Inlet area. These new estimates are summarized on Table 11.

2. Additional data was compiled for potential loads in the Copper Valley area, and a preliminary analysis of electric service from the Upper Susitna Project to this area was made. It does not appear feasible to include service to this area during initial stages of the project.

3. Available data on area load characteristics were examined in light of future system operation; estimates of monthly energy distribution were prepared for sizing project reservoirs; and an annual plant factor of 50 percent was selected for sizing project power plants.

4. Studies of alternative power sources prepared for the FPC Alaska Power Survey were reviewed in light of recent studies and trends in energy. It was concluded that oil and natural gas fired generation is not a desirable alternative for major new power supplies in the Alaska Railbelt in 1985 and later years. It is considered that coal-fired steamplants would be the most likely alternative in lieu of Susitna hydro. The power survey steamplant cost estimates were updated for comparison purposes.

5. A set of preliminary rate studies was made for use in the scoping analysis of alternative Susitna hydro development plans. These studies are premised on September 1975 plans and cost estimates do not reflect latest estimates for the final project report. The studies indicated an average rate of 19.7 mills per kilowatthour for the Corps proposed plan of development (System #5) and average rates ranging from 20.9 to 24.5 mills for the alternative systems. The studies also indicated that alternative staging assumptions utilizing the same designs and cost estimates would narrow the range to 20.9 to 22.8 mills per kilowatthour, a difference of less than ten percent. These rates are substantially higher than present natural gas-fired generation in the Cook Inlet area, but significantly lower than current estimates for new coal-fired plants.

6. The above values were reviewed in light of the final plans and cost estimates, with the indication that the proposed plan (System #5) would have approximately a 10 percent advantage over the alternative hydro systems from the viewpoint of cost of power to the consumer.

7. APA estimates that an average rate for firm energy of 21.1 mills per kilowatthour would be required to repay costs of the project under current Federal repayment criteria. This is premised on cost estimates using January 1975 price levels and includes amortization of the investment and annual costs for operation, maintenance, and replacements. The compilations for the average firm energy rate appear on Table 21.

8. The studies reflect very rapidly changing values in energy and costs of doing business. It is estimated that increase in costs and Federal interest rate for repayment amount to over a 40 percent increase in rates for repayment as compared with conditions reported in APA's May 1974 status report on Devil Canyon. If the present costs are escalated at 5 percent per year, average rates for Upper Susitna power would likely exceed 40 mills per kilowatthour when the project is actually brought on line.

9. The changing costs for hydro development must be considered in light of the rapid changes in costs for other power producing facilities and fuels. It appears reasonable to assume that future cost escalation for hydro construction will be at a slower rate than for average energy costs in the economy. After completion, any increases in costs for the hydro power would likely be very small.

10. With the prevailing intersts rates, power rates are very sensitive to any stretch-out of construction period and the size of investment accumulated prior to start of revenues. Careful attention to staging opportunities will be needed in final design of the project.

11. APA also prepared estimates of annual costs for operation, maintenance, power markets, and interim replacements for use in the project economic and financial analysis. This date is summarized in Exhibit 2 of this report.

Throughout its history of investigations, the Upper Susitna River Project has been of interest for its central location to the Fairbanks and Anchorage areas which have Alaska's largest concentrations of population, economic activity, services, and industry. Under any plan of development, major portions of the project power would be utilized in these two areas. Additionally, the basic project transmission system servicing Anchorage and Fairbanks could provide electric service to present and future developments between the two points. Electrification of the Alaska Railroad is another possibility.

These major market areas are referred to as the Anchorage-Cook Inlet area and the Fairbanks-Tanana Valley area.

Additional potential markets are utility and industrial loads along the pipeline corridor between Delta Junction and Valdez.

Anchorage-Cook Inlet Area

Generally, this has reference to the developed areas around Upper Cook Inlet including the Anchorage area, the Kenai Peninsula, and the Matanuska and Susitna valleys. This includes most of the population and economic activity in the Matanuska-Susitna, Greater Anchorage Area, and Kenai Peninsula Boroughs.

This general area has been the focal point for most of the State's growth in terms of population, business, services, and industry since World War II. Major building of defense installations, expansion of government services, discovery and development of natural gas and oil in the Cook Inlet area, and emergence of Anchorage as the State's center of government, finance, travel, and tourism are major elements in the history of this area.

Because of its central role in business, commerce, and government, the Anchorage area is directly influenced by economic activity elsewhere in the State. Much of the buildup in anticipation of the Alyeska pipeline, much of growth related to Cook Inlet oil development, and much of the growth in State and local government services since Statehood have occurred in the immediate Anchorage vicinity. The Greater Anchorage Area Borough estimated its July 1, 1974, population at 162,500, or an increase of nearly 30% since the 1970 census. This is over 45 percent of total estimated State population in 1974.

The Matanuska-Susitna Borough includes several small cities (Palmer, Wasilla, Talkeetna) and the state's largest agricultural community. Other economic activities include a recreation industry and some light manufacturing. Much recent growth in the Borough has been in residential and recreation homes for workers in the Anchorage area. Estimated 1974 population was 9,787.

The Kenai Peninsula Borough includes the cities of Kenai, Soldatna, Homer, Seldovia, and Seward with important fisheries, oil and gas, and recreation industries. Estimated 1974 population was 13,962.

Both the Matanuska-Susitna and Kenai Peninsula Boroughs will have some urban expansion over the next few decades. Pressures for urban development would be substantially increased if the proposed surface crossings of the Knik and Turnagain Arms were constructed.

Present and proposed activities indicate likelihood of rapid growth in this general Cook Inlet area for the foreseeable future. Much of this activity is related to oil and natural gas including expansion of the refineries at Kenai, proposals for major LNG exports to the south "48" and probable additional offshore oil and gas development. The State's Capital Site Selection Committee has narrowed their search to four sites for the new capital city, of which three locations are in the Susitna Valley. The area will continue to serve as the transportation hub of westward Alaska, and tourism demands will likely continue to increase rapidly. Major local development seems probable.

Fairbanks-Tanana Valley Area

Fairbanks is Alaska's second largest city, the trade center for much of Alaska's Interior, service center for two major military bases, and site of the University of Alaska and its associated research center. Several outlying communities including Nenana, Clear, North Pole, and Delta Junction are loosely included in the "Fairbanks-Tanana Valley" area. Historically, the area is famous for its gold. Currently, it is in a major boom connected with the construction of Alyeska pipeline.

The Fairbanks-North Star Borough had an estimated 1974 population of 50,762 and the outlying communities within the power market area probably totaled about 10,000 population at that time.

It is generally felt that post-pipeline growth in the Fairbanks area will be at a slower pace than the Anchorage-Cook Inlet area. However, major future resource developments in the Interior and the North Slope would have direct impact on the Fairbanks economy.

Valdez-Glennallen

Like Fairbanks, the two communities are heavily impacted by pipeline construction, especially Valdez because of the concentration of work on the pipeline terminal. Longer range prospects probably include a more stable economy associated with the pipeline and terminal operations and the immensely valuable recreation resources of this area.

Utility Systems and Service Areas

The electric utilities in the power market area are listed below and areas presently receiving electric service are indicated on Figure 2.

Anchorage Area -

Anchorage Municipal Light and Power (AML&P)
Chugach Electric Association (CEA)
Matanuska Electric Association (MEA)
Homer Electric Association (HEA)
Seward Electric System (SES)

Fairbanks Area -

Fairbanks Municipal Utility System (FMUS)
Golden Valley Electric Association (GVEA)

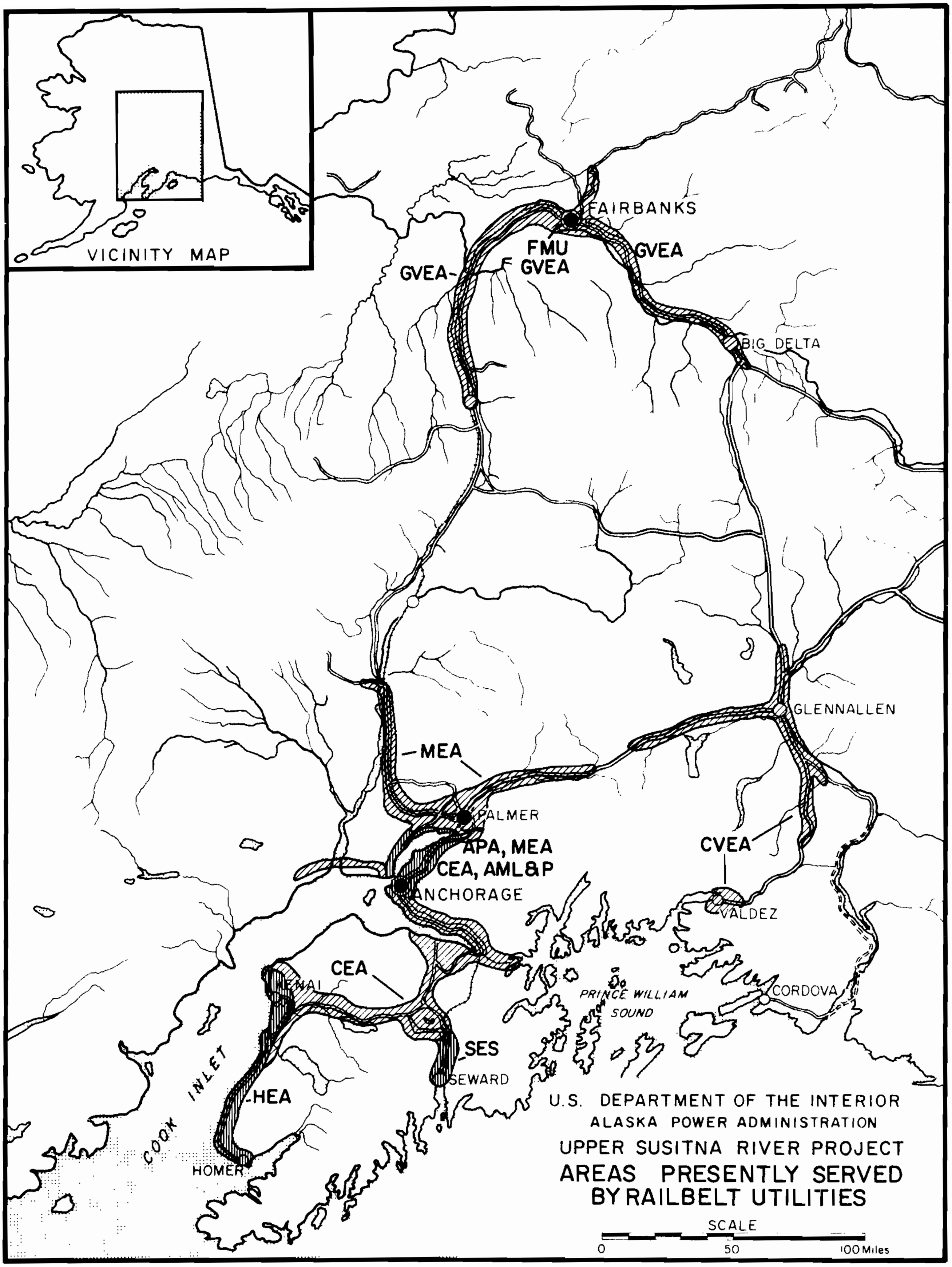
Valdez and Glennallen Area -

Copper Valley Electric Association (CVEA)

Alaska Power Administration operates the Eklutna Hydroelectric Project and markets wholesale power to CEA, AML&P, and MEA.

AML&P serves the Anchorage Municipal area. CEA supplies power to the Anchorage suburban and surrounding rural areas and provides power at wholesale rates to HEA, SES, and MEA. The HEA service area covers the western portion of the Kenai Peninsula including Seldovia, across the bay from Homer. MEA serves the town of Palmer, the surrounding rural area in the Matanuska and Susitna Valleys.

The utilities serving the Anchorage-Cook Inlet area are presently loosely interconnected through facilities of APA and CEA. An emergency tie is available between the AML&P and Anchorage area military installations. For this study it is assumed that Upper Susitna power would be delivered at a new substation on the CEA system in the vicinity of Point MacKenzie on the north side of Knik Arm, and that project power would be wheeled over the CEA system to other utilities in the general Cook Inlet area.



Appendix I
FIGURE G-2

FMUS serves the Fairbanks municipal area, while GVEA provides service to the rural areas. The Fairbanks area power suppliers have the most complete power pooling agreement in the State. FMUS, GVEA, the University of Alaska and the military bases have an arrangement which includes provisions for sharing reserves and energy interchange In addition, GVEA operates the Fort Wainwright steamplant under an agreement with the army.

The delivery point for Upper Susitna power to the GVEA and FMUS systems is assumed at the existing Gold Hill substation of GVEA near Fairbanks.

The Copper Valley Electric Association serves both Glennallen and Valdez. Radial distribution lines of CVEA extend from Glennallen 30 miles north on the Copper River, 55 miles south on the Copper River to Lower Tonsina and 70 miles west on Glenn Highway. For this study, it is assumed that project power would be delivered to the CVEA system at Glenallen.

National Defense Power Systems

The six major national defense installations in the power market area are: (there are numerous smaller installations)

Anchorage area -

- Elmendorf Air Force Base
- Fort Richardson

Fairbanks area -

- Clear Air Force Base
- Eielson Air Force Base
- Fort Greeley
- Fort Wainwright

Each of the major bases has its own steamplant used for power and for central space heating source. Except for Clear Air Force Base, each is interconnected to provide power to or receive power from the local utilities.

In the past, national defense electric generation has been a major portion of the total installed capacity. With the projected stability of military sites and the growth of the utilities, the national defense installation will become a less significant part of the total generation capacity.

Industrial Power Systems

Three industrial plants on the Kenai Peninsula maintain their own powerplants, but are interconnected with the HEA system. Colliers chemical plant generates its basic power and energy needs receiving only standby capacity from HEA. Kenai Liquified Natural Gas plant buys energy from HEA, but has its own standby generation. Tesoro Refinery does both; buys from HEA and furnishes part of its own needs.

Other self-supplied industrial generators include oil platform and pipeline terminal facilities in the Cook Inlet area. The Valdez pipeline terminal will have a sizable powerplant, and most of the pumping stations on the Alyeska pipeline will have small powerplants.

Existing and Planned Generation

Table 2 provides a summary of existing generating capacity. The table was generally current as of mid-1974. The Anchorage-Cook Inlet area had a total installed capacity of 414.8 MW in 1974. Natural gas fired turbines were the predominant energy source with 341.7 MW of installed capacity. Hydroelectric capacity of 45 MW was available from two projects, Eklutna and Cooper Lake. Steam turbines comprised 14.5 MW of capacity and diesel generation, mostly in standby service accounted for the remaining 13.5 MW.

The Fairbanks-Tanana Valley area utilities had a total installed capacity of 127.7 MW in 1974. Steam turbines provided the largest block of power in the area with an installed capacity of 53.5 MW. Gas turbine generation (oil-fired) provided 42.1 MW of power and diesel generators contributed 32.1 MW to the area.

Table 2. Summary of Existing Generating Capacity

	Installed Capacity - 1000 kw				
	Hydro	Diesel IC	Gas Turbine	Steam Turbine	Total
Anchorage-Cook Inlet Area:					
Utility System	45.0	13.5	341.7	14.5	414.8
National Defense		9.3		49.5	58.8
Industrial System		10.1	2.3		12.4
Subtotal	45.0	32.9	344.0	64.0	486.0
Fairbanks-Tanana Valley Area:					
Utility System		32.1	42.1	53.5	127.7
National Defense		14.9		63.0	77.9
Subtotal		47.0	42.1	116.5	205.6
Valdez and Glennallen		6.2			6.2

Notes: The majority of the diesel generation is in standby status except at Valdez and Glennallen.

Source: 1974 Alaska Power Survey, Technical Advisory Report, Resources and Electric Power Generation, Appendix A and Alaska Electric Power Statistics, 1960-1973, APA.

Generation facilities will need to be installed to meet requirements between 1975 and 1985 when the first Susitna River hydro unit could be on the line. Current plans of the utilities include the following units:

Utilities	Planned Capacity, MW 1975	1976	1977
Anchorage Area:			
Chugach Electric Association (CEA)			
Unit 4	10		
Units 5 & 6	53	53	
Anchorage Municipal Light & Power (AML&P)			
Units 8 & 9	15	15	
Unit 10		40	
Fairbanks Area:			
Golden Valley Electric Association (GVEA)			
North Pole		53	53
	78	161	53

Source: Environmental impact statements, public meetings and APA personal contacts.

The AML&P 15 MW units are steam turbine heat recovery units. The remainder of the units are gas turbines. The 53 MW ratings are baseload ratings. Winter peak load ratings are 70 MW. The Anchorage area units are natural gas fired, while the Fairbanks units are oil fired.

Estimates of future power requirements indicate substantial additional capacity needs by 1985 over and above the present plans. Studies of other generation, mainly coal fired steamplants, have been made by the utilities but commitments to longer range generation with coal have not been made.

Natural gas supply contracts have been secured by Chugach Electric Association through 1998 in the Beluga area. The natural gas available under present contracts could meet the expected 1982 CEA generation needs of approximately 536 MW. 1/

CVEA recently installed 1,000 kw and 2,624 kw diesel generators at Valdez and ordered two 2,624 kw diesel electric generators for Glennallen. Studies are underway on a 6,000 kw Solomon Gulch hydro project near Valdez.

In addition to the utility plans, some new self-supplied industrial plants are planned or under construction. These include power supplies for the Alyeska pipeline terminal (oil-fired steam) and for pumping stations (small diesel plants). Electric service requirements for the pumping stations in the immediate vicinity of Glennallen and Fairbanks are to be supplied by CVEA and GVEA, respectively.

There also may be new industrial powerplants in connection with refinery expansion and the proposed new LNG plants on the Kenai Peninsula. Generally, industry has shown a willingness to purchase power from the utilities if adequate reliable supplies can be guaranteed.

1/ CEA Environmental Analysis of Proposed 230 kv Transmission Line from Teeland substation to Reed substation, page 8.

Power requirement studies for this report included: a review of the regional power requirement studies for the new FPC Alaska Power Survey and other recent load estimates; analyses of recent trends in power consumption; and preparation of a new set of load estimates reflecting the present best estimates of future area requirements through the year 2000.

The studies also included analysis of load characteristics as needed to develop criteria for installed capacity and reservoir regulation for power production from the proposed hydroelectric development.

Power Requirements Data

This section summarizes data used in estimating future power requirements and determining criteria for energy distribution and peaking capacity for the Susitna hydroelectric development. The estimates of future requirements are premised on assumed data and annual future growth trends. Energy distribution and peaking capacity criteria are estimated from load distribution data.

Annual Requirements

Table 3 summarizes annual power requirement data for the Anchorage-Cook Inlet and Fairbanks-Tanana Valley areas for the years 1964 to 1974. The table includes: utility system annual energy requirements, annual peak load, annual load factor, and rates of increase in energy requirements; similar data for representative years for the national defense installations in the two areas; and 1972 requirements for the self-supplied industrial plants on the Kenai Peninsula.

Table 3 also includes a summation of these loads for the years 1964, 1972, and 1974 (assuming industrial loads in 1972 and 1974 are equal). The total area electrical energy requirements increased by a factor of 2.63 during the 1964-1974 period, for an average increase of just nine percent per year. The utility requirements increased at an average rate of 14.2 percent per year and exceeded 12 percent growth in all but two years of that period. Average growth was 14.5 percent and 13.2 percent for Anchorage and Fairbanks, respectively.

Table 3. Anchorage and Fairbanks Area Load Data, 1964 - 1974

Year	Energy Million Kwh	Peak Load MW	Load Factor Percent	Annual Increase Million-kwh	%
	Utility Requirements - Anchorage Area				
1964	338.2	83.6	46.1		
1965	401.0	91.9	49.8	62.8	18.6
1966	450.3	103.0	49.9	49.8	12.3
1967	497.1	112.1	50.6	46.8	10.4
1968	563.6	129.9	49.4	66.5	13.4
1969	630.5	139.6	51.6	66.9	11.9
1970	741.2	165.3	51.2	110.7	17.6
1971	887.1	189.3	53.5	145.9	19.7
1972	984.3	223.9	50.2	97.2	11.0
1973	1134.2	252.0	51.4	149.9	15.2
1974	1305.3	284.0	52.5	171.1	15.1
	Utility Requirements - Fairbanks Area				
1964	95.7	23.6	46.2		
1965	103.7	26.5	44.7	8.0	8.4
1966	115.9	27.8	47.6	12.2	11.8
1967	128.6	31.8	46.2	12.7	11.0
1968	158.2	42.7	42.2	29.6	23.0
1969	186.0	45.6	46.6	27.8	17.6
1970	231.0	57.0	46.3	45.0	24.2
1971	267.3	71.2	43.1	36.3	15.7
1972	305.5	71.9	48.4	38.2	14.3
1973	315.0	71.5	50.2	9.5	3.1
1974	330.0	82.9	45.4	15.0	4.8
	Utility Requirements - Anchorage & Fairbanks Area				
1964	433.9	107.2	64.1		
1965	504.7	118.4	48.7	70.8	16.3
1966	566.2	130.8	49.4	61.5	12.2
1967	625.7	143.9	49.6	59.5	10.5
1968	721.8	172.6	47.6	96.1	15.4
1969	816.5	185.2	50.3	94.7	13.1
1970	972.2	272.3	49.9	155.7	19.1
1971	1156.4	260.5	50.7	184.2	18.9
1972	1289.8	295.8	49.6	133.4	11.5
1973	1449.2	323.5	51.1	159.4	12.4
1974	1635.3	366.9	50.9	186.1	12.8

Table 3. Anchorage and Fairbanks Area Load Data, 1964 - 1974 (cont.)

Year	Net Million Kwh	Peak Load MW	Load Factor Percent
Self-Supplied Industry - Kenai Peninsula			
1972	54.3	9.7	53.2
National Defense - Anchorage			
1964	141	32	50.2
1972	166.5	33.9	55.9
1974	155.1	32.6	54.3
National Defense - Fairbanks			
1964	197	37	60.6
1972	203.3	41.4	55.9
1974	197.0	40.8	55.1
Total Requirements - Utility, Industrial and National Defense			
1964	772	176	50.1
1972	1,705	381	51.0
1974 1/	2,033	450	51.6

1/ Assumes Industrial loads in 1974 same as 1972.

Notes: "Anchorage" utility data reflects requirements of CEA, AML&P, MEA, HEA, and SES.
"Fairbanks" utility date reflects sum of GVEA and FMUS.

The data in Table 3 indicates that National Defense requirements have been quite stable over the period. National Defense requirements totaled 44 percent of total area requirements in 1964, but only 17 percent in 1974.

With the exception of the self-supplied industry in the Kenai Peninsula, area industrial loads are supplied by the utilities and included in the utility statistics.

Tables 4 and 5 illustrate the major components of growth in the utility requirements increase in customers and increase in use per customer. Number of customers is generally analogous to increase in area population and economic activities. Use per customer will reflect a variety of factors such as additional appliances, a general trend towards better housing and expanding business in the new suburban areas.

Table 5 shows energy use per customer and annual increased use for the period 1965 through 1973. The main observation is that the use per customer has increased significantly, and is still increasing. The Anchorage area customer averaged 5.2 percent annual increase while the Fairbanks area averaged 9.8 percent annual increase. The combined weighted annual growth was 6.2 percent.

Estimates of future power requirements presented subsequently assume this large rate of growth will not continue indefinitely, and that saturation of home appliances and conservation efforts will stabilize the per customer use.

The peak load data on Table 3 represents the sum of annual peaks from the various systems. Area total peak load would be somewhat smaller in most cases due to diversity.

The data shown on Table 3 indicated that both area load centers have a fluctuating annual utility load factor very close to 50 percent. The industry on the Kenai Peninsula has been slightly higher at 53 percent. National Defense has the highest at 55 percent. Area total load factor would be somewhat higher due to diversity.

The data in Table 3 indicates that for 1974, approximately 74 percent of the total system energy is used in the Anchorage area and 26 percent in the Fairbanks area. Comparable figures for the utility portion was 80 percent in the Anchorage area and 20 percent in the Fairbanks area.

Table 4. Utility - Sales and Customers - Railbelt Area, 1965-1973

		Residential			Commercial/Industrial			Total		
		1965	1970	1973	1965	1970	1973	1965	1970	1973
Anchorage Area										
AML&P	1000 KWH	34,656	54,518	84,000(e)	92,889	159,538	231,000(e)	133,083	222,200	325,200(e)
	Customers	6,664	8,860	11,400(e)	2,071	2,221	2,540(e)	8,742	11,233	14,100(e)
CEA	1000 KWH	111,587	198,856	287,879	49,747	99,387	174,187	164,507	309,049	483,029
	Customers	15,449	23,358	29,077	1,028	1,791	2,465	16,559	25,263	31,665
MEA	1000 KWH	17,115	29,702	52,305	16,708	19,681	29,501	33,952	49,564	82,018
	Customers	2,638	3,664	5,029	411	546	730	3,050	4,213	5,765
HEA	1000 KWH	6,176	19,290	31,848	16,749	53,845	73,943	23,855	75,000	108,407
	Customers	1,413	2,707	3,891	358	542	830	1,832	3,329	4,822
TOTAL	1000 KWH	169,534	302,366	456,032	176,093	332,451	508,631	355,397	655,813	998,654
	Customers	26,164	38,589	49,397	3,868	5,100	6,565	30,183	44,038	56,352
Fairbanks Area										
FMU	1000 KWH	16,172	23,619	27,300(e)	22,109	37,941	41,500(e)	43,962	71,408	83,000(e)
	Customers	4,147	4,443	4,500(e)	795	874	900	4,998	5,492	5,600(e)
GVEA	1000 KWH	23,142	67,123	106,882	25,850	69,064	98,744	49,357	136,486	206,108
	Customers	3,908	5,846	7,382	523	817	973	4,478	6,671	8,363
TOTAL	1000 KWH	39,314	90,742	134,182	47,959	107,005	140,244	93,319	207,894	289,108
	Customers	8,055	10,289	11,882	1,318	1,691	1,873	9,476	12,163	13,963
Railbelt Area										
TOTAL	1000 KWH	208,848	393,108	590,214	224,052	439,456	648,875	448,716	863,707	1,287,762
	Customers	34,219	48,878	61,279	5,186	6,791	8,438	39,659	56,201	70,315

(e) Estimated

Table 5. Energy Use Per Customer, 1965-1973

Units: Thousand Kilowatthours per Customer

	Residential				Commercial/Industrial				Total			
	1965	1970	1973	Annual Growth (%)	1965	1970	1973	Annual Growth (%)	1965	1970	1973	Annual Growth (%)
Anchorage Area												
AML&P	5.2	6.2	7.4	4.5	44.9	71.8	90.9	9.2	15.2	19.8	23.1	5.4
CEA	7.2	8.5	9.9	4.1	48.4	55.5	70.7	4.8	9.9	12.2	15.3	5.6
MEA	6.5	8.1	10.4	6.1	40.7	36.0	40.4	---	11.1	11.8	14.2	3.1
HEA	4.4	7.1	8.2	8.1	46.8	99.3	89.1	8.4	13.0	22.5	22.5	7.1
Average	6.3	7.8	9.2	4.9	45.5	65.2	77.5	6.9	11.8	14.9	17.7	5.2
Fairbanks Area												
FMU	3.9	5.3	6.1	5.7	27.8	43.4	46.1	6.5	8.8	13.0	14.8	6.7
GVEA	5.9	11.5	14.5	11.9	49.4	84.5	101.5	9.4	11.0	20.5	24.6	10.6
Average	4.9	8.8	11.3	11.0	36.4	63.3	74.9	9.4	9.8	17.1	20.7	9.8
Combined Area												
Average	6.1	8.0	9.6	5.8	43.2	64.7	76.9	7.5	11.3	15.4	18.3	6.2

Source: REA and APA data.

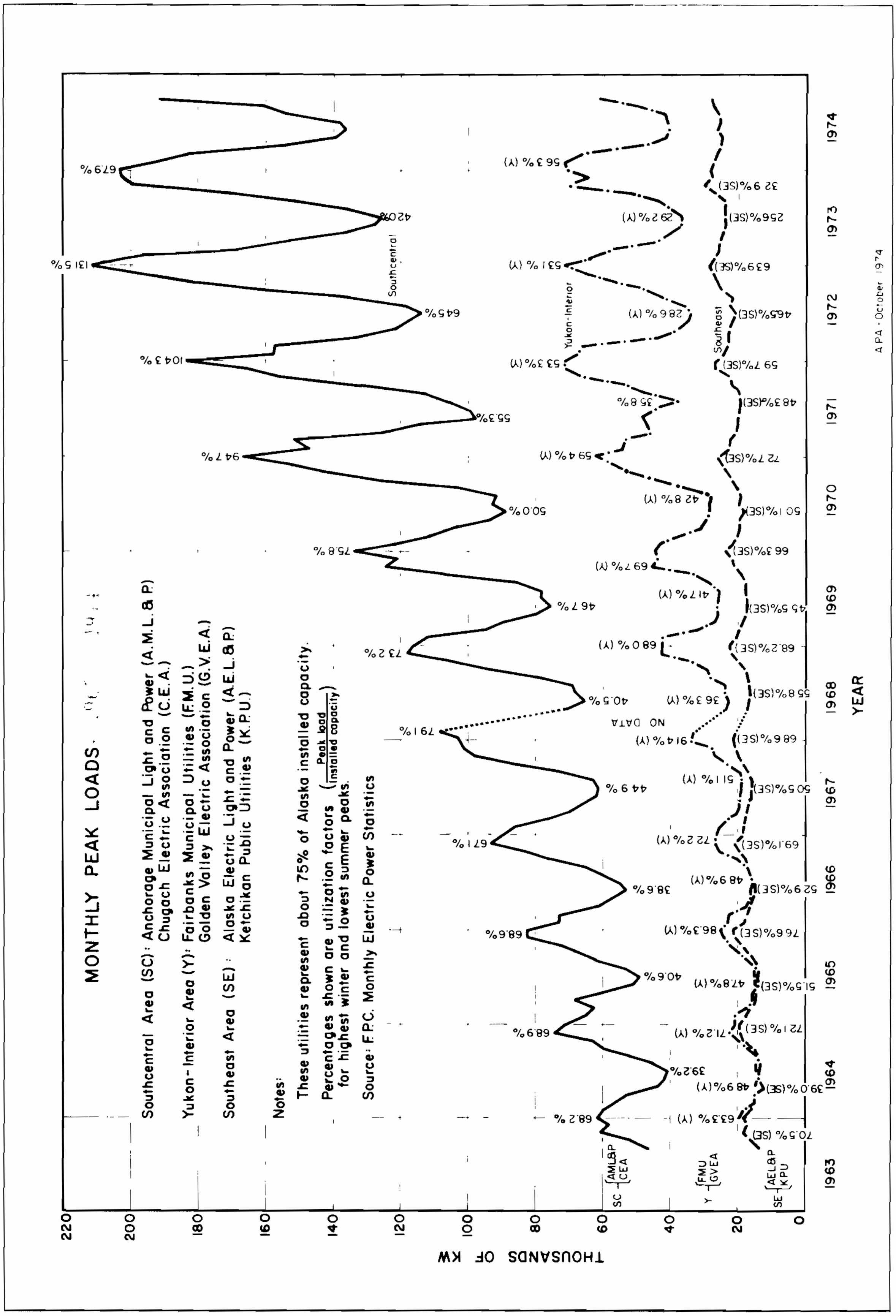
Load Distribution Data

Figure 3 shows monthly peak utility loads, 1963 to 1974, for the Anchorage-Cook Inlet and Fairbanks-Tanana Valley areas. Table 6 summarizes monthly peak data for the 1971 to 1974 period. The prominent aspect is that summer peaks are running about 60 percent of annual peak. This indicates that summer peaking requirements will not be very influential in determining capacity requirements. Winter peaks shown in the table probably reflect a combination of growth and climate differences. It is of interest that the 1973-1974 peaks in November, December, January, and February were of about the same magnitude, while January peaks the preceding two winters were very prominent.

Figure 4 shows representative weekly load curves for Anchorage area utilities. Summer and winter load shapes appear similar except that the winter show a more pronounced evening peak. The daily peaks in both summer and winter tend to be broad.

Data on Figure 4 indicates the minimum hourly load during summer ranging from 29 to 31 percent of the winter peak.

Table 7 shows representative monthly load factors. These are uniformly high throughout the year, in the range of 70 to 76 percent. It is anticipated that similar data on a weekly basis would show weekly load factors are frequently above 80 percent.



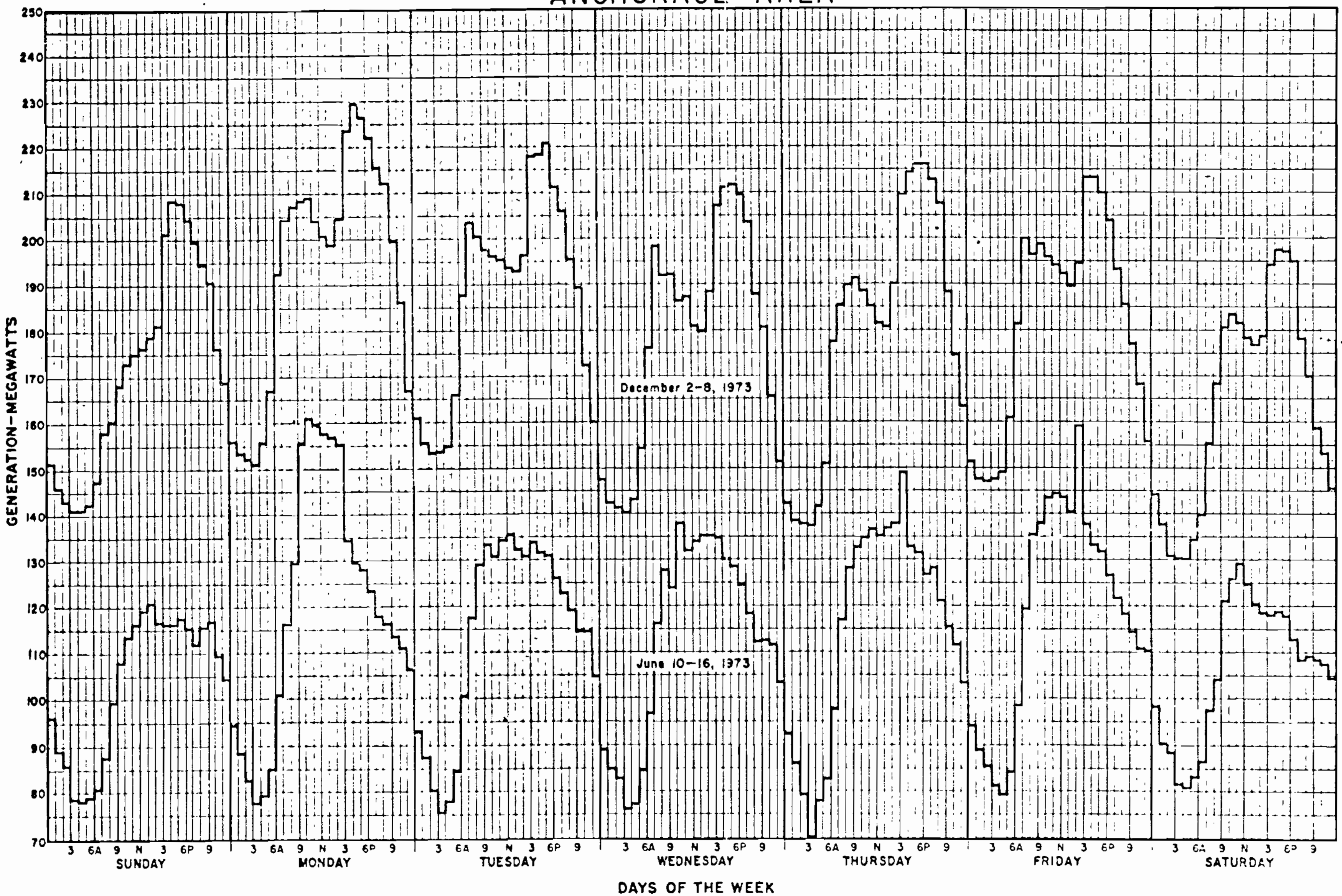
Appendix I
FIGURE G-3

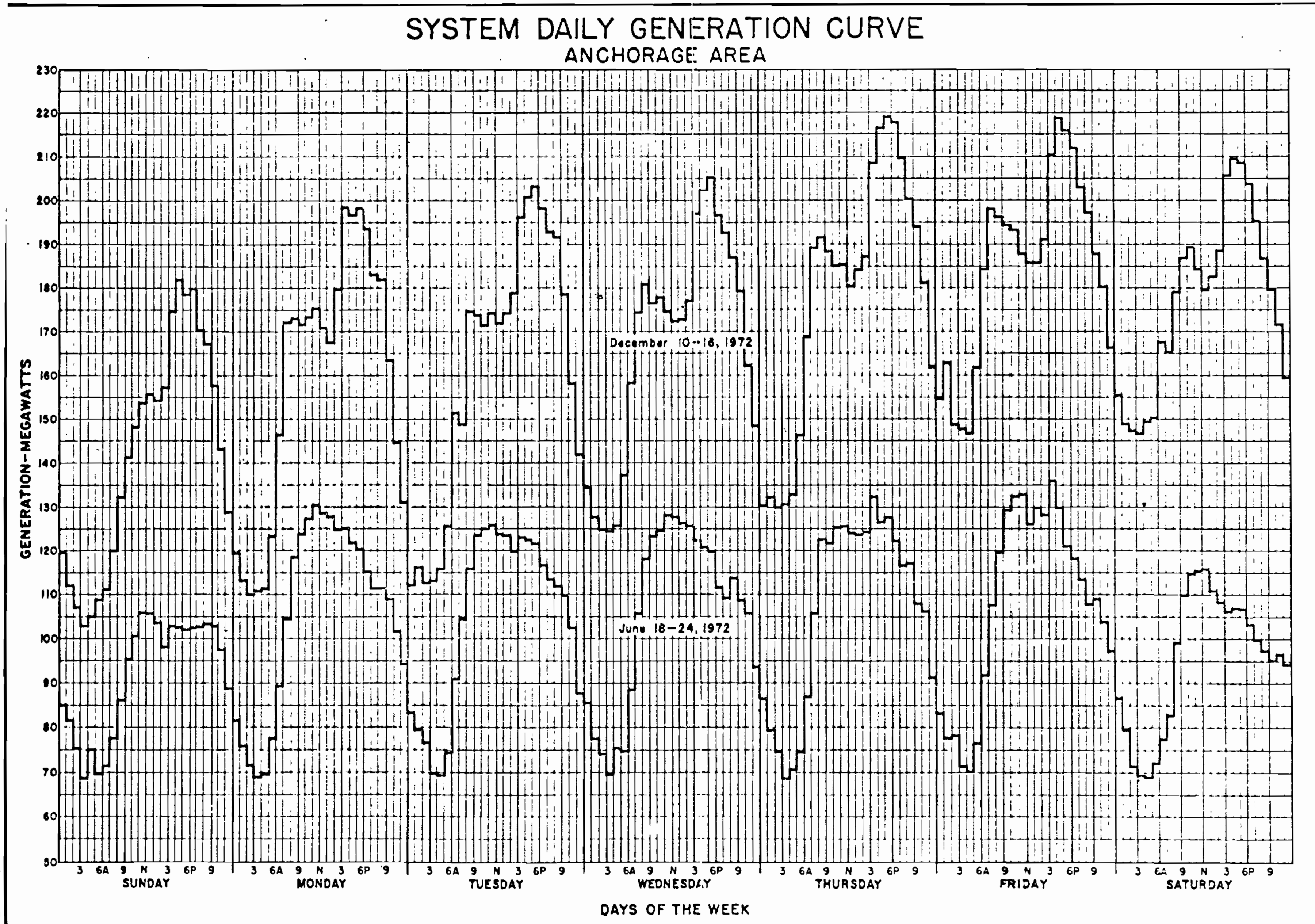
Table 6. Monthly Peak Loads, 1971 to 1974

Month	1971 - 1972 Peak MW	1971 - 1972 % Annual Peak	1972 - 1973 Peak MW	1972 - 1973 % Annual Peak	1973 - 1974 Peak MW	1973 - 1974 % Annual Peak
July	143.6	56	146.8	52	162.8	59
Aug.	143.3	56	154.5	54	175.9	64
Sept.	161.7	63	179.6	64	194.5	71
Oct.	185.8	73	209.2	74	224.3	82
Nov.	222.8	88	236.3	83	269.6	98
Dec.	236.2	93	260.7	92	266.9	97
Jan.	254.5	100	283.0	100	274.5	100
Feb.	224.5	88	259.6	92	264.2	96
Mar.	222.8	87	225.1	80	249.4	91
Apr.	176.7	69	196.4	69	201.6	73
May	157.9	62	176.7	62	180.4	66
June	152.1	60	165.2	58	176.2	64

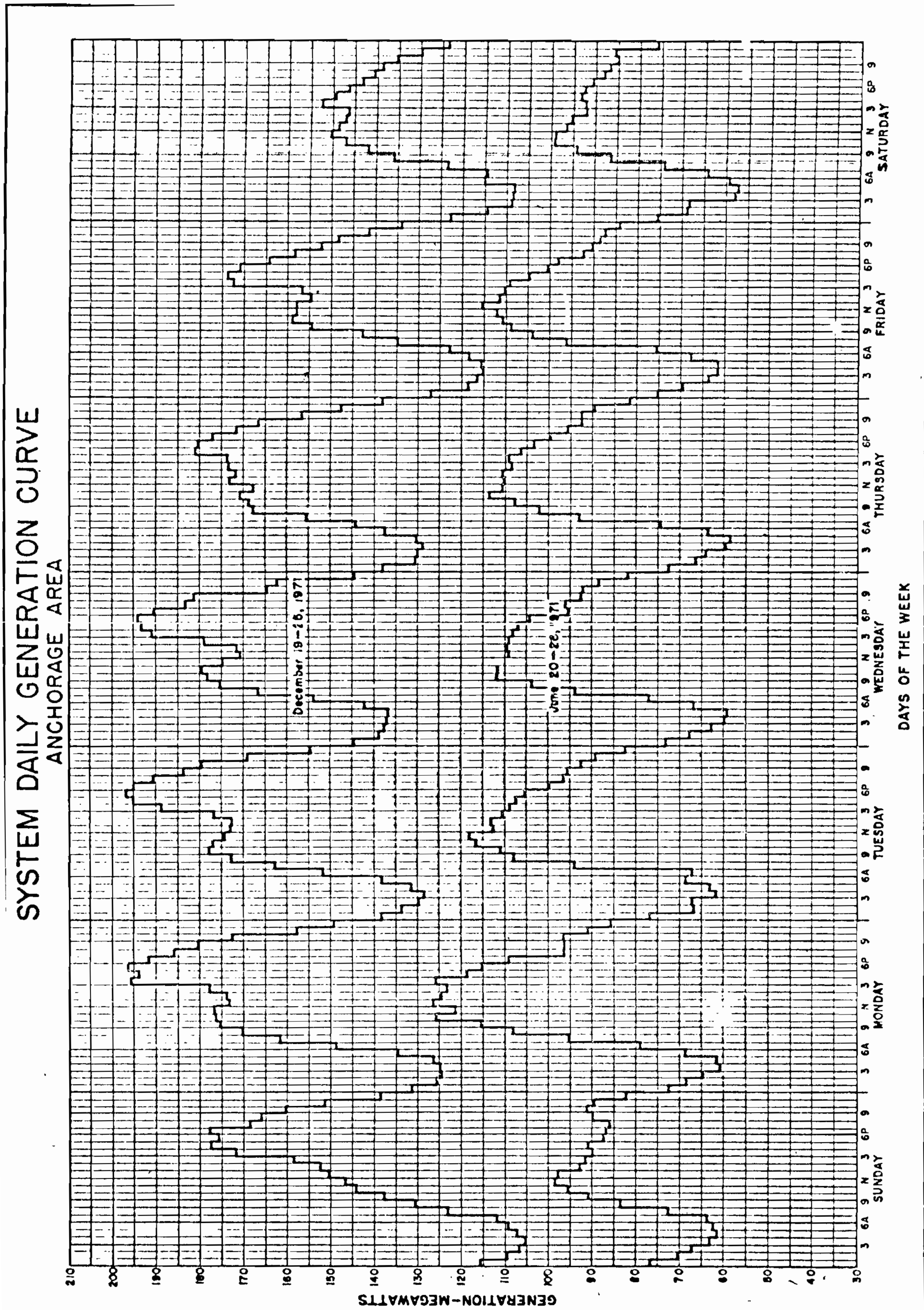
Note: Represents sum of loads for AML&P, CEA, FMUS, and GVEA as published in Alaska Electric Power Statistics, 1960-1973, APA, December 1974. Peaks within individual systems may have occurred at different times during the months.

SYSTEM DAILY GENERATION CURVE
ANCHORAGE AREA





Appendix I
FIGURE G-4-2



SYSTEM DAILY GENERATION CURVE
ANCHORAGE AREA
December 19-25, 1971
June 20-26, 1971
GENERATION-MEGAWATTS
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
3 6A 9 N 3 6P 9
SUNDAY
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
DAYS OF THE WEEK

Table 7. Monthly Load Factors, 1972 and 1973

Month	1972 Peak MW	1972 Energy Million kwh	1972 Monthly Load Factor	1973 Peak MW	1973 Energy Million kwh	1973 Monthly Load Factor
Jan.	254.5	135.3	72	283.0	153.6	72
Feb.	224.5	115.3	76	259.6	127.5	73
Mar.	222.8	119.2	70	225.1	125.5	75
Apr.	176.7	96.6	76	196.4	105.4	75
May	157.9	87.8	75	176.7	98.5	75
June	152.1	78.5	72	165.2	87.6	74
July	146.8	76.6	70	162.8	89.8	74
Aug.	154.5	86.9	75	175.9	96.2	73
Sept.	176.9	92.9	72	194.5	100.8	72
Oct.	209.2	108.8	70	224.3	122.7	73
Nov.	236.3	124.4	73	269.6	144.6	74
Dec.	260.7	143.3	74	266.9	147.0	74

Note: Represents sum of loads for AML&P, CEA, FMUS, and GVEA as published in Alaska Electric Power Statistics, 1960-1973, APA, December 1974.

Studies for Alaska Power Survey

The power requirement studies for the new FPC Alaska Power Survey are summarized in the May 1974 report of the Technical Advisory Committee on Economic Analysis and Load Projection. These studies included review of previous reports and recent load estimates prepared for the power system in the state, analysis of present and future trends in power consumption, and regional estimates of future power requirements through the year 2000. These regional estimates were developed as a range of future requirements depending upon assumed levels of change in the Alaska population and economy. All of the estimates assumed substantial reduction in growth rates for power demands after 1980 would be achieved through conservation measures.

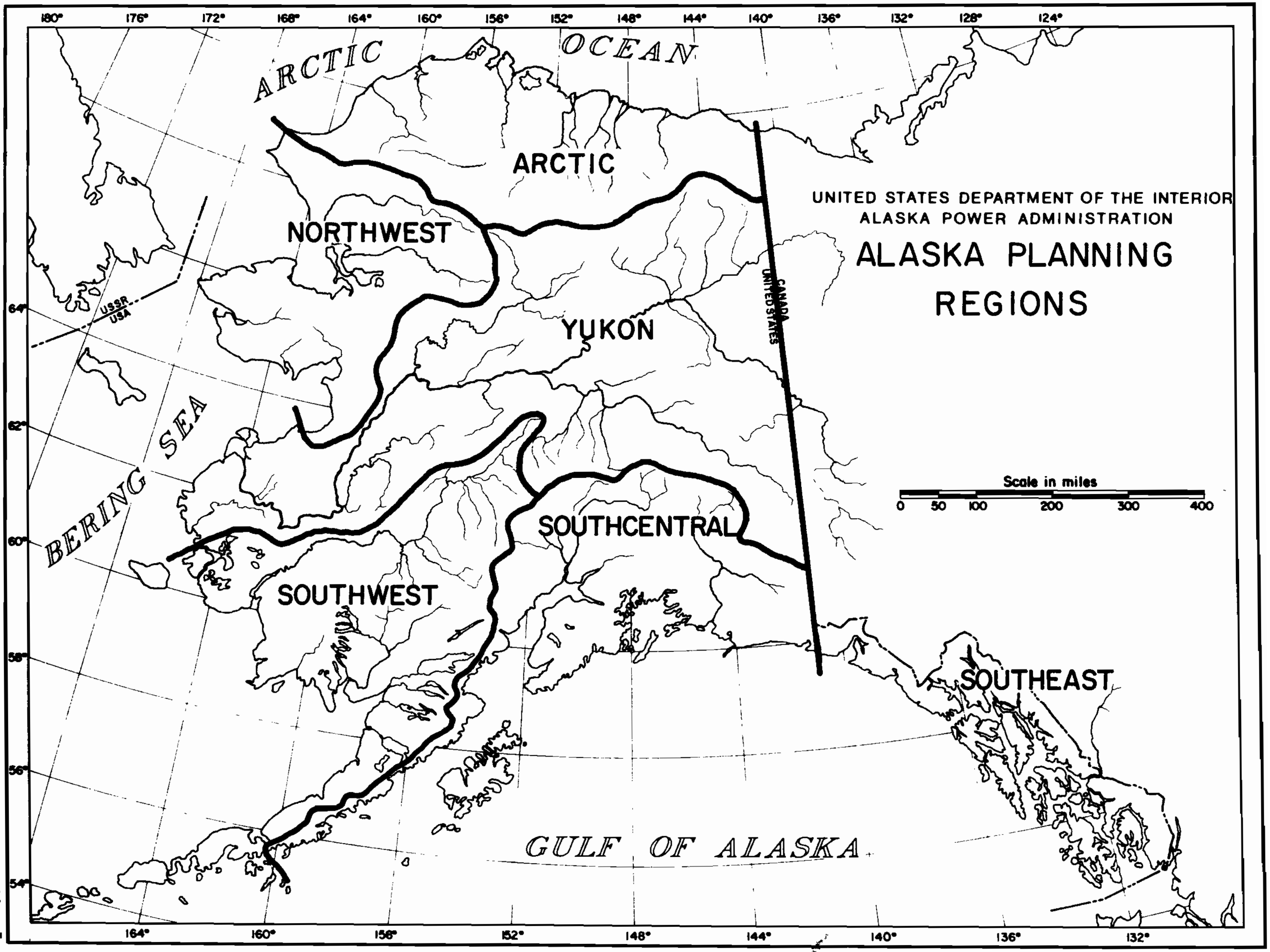
The power survey regional estimates included Railbelt area loads in the regional totals for the Southcentral and Yukon regions. Figure 5 shows the regional boundaries. For 1972, utility requirements immediately accessible to an interconnected Railbelt system amounted to about 96 percent of total utility loads for the two regions. Thus the regional totals are reasonably representative of Railbelt system requirements. The regional estimates also included evaluations of likely new industrial power requirements -- timber, mineral, oil and gas, etc. -- many of which would be remote from a Railbelt system, for the foreseeable future.

Table 8 summarizes regional utility system requirements for the 1960 to 1972 period as presented in the power survey. This analyses indicated Railbelt utility requirements were increasing at an average rate of 14 percent annually. In 1972, Railbelt utility loads totaled 1.3 billion kilowatthours, or about 80 percent of statewide requirements for the year.

Total 1972 Railbelt loads, including utility, national defense, and self-supplied industrial loads, were about 2 billion kilowatthours, or 77 percent of statewide total requirements for the year.

Tables 9 and 10 summarize the regional estimates from the power survey through the year 2000 for utility system requirements, and for total requirements including national defense systems and industrial requirements.

The power survey studies reflect future assumptions ranging from fairly limited to rather rapid development of the Alaska resources and economy. On the basis of the power survey mid-range estimates, expected increments in regional utility and total requirements are as follows:



Appendix I
FIGURE G-5

Table 8. Utility System Requirements, 1960-1972

Year	Southeast Alaska	Southcentral Alaska	Yukon (Interior)	Remainder of State 1/	State Total 2/
		Annual Gross Generation, Million kwh			
1960	104	234	86	7	431
1961	111	264	89	11	475
1962	120	294	93	12	520
1963	129	329	102	14	573
1964	141	362	110	15	628
1965	148	452	117	17	735
1966	160	510	132	20	821
1967	165	560	145	22	891
1968	177	633	171	25	1,007
1969	185	708	198	29	1,120
1970	202	831	243	35	1,311
1971	217	990	276	43	1,526
1972 3/	229	1,037	307	46	1,620
		Portion of Statewide Requirements, (%)			
1960	24	54	20	2	100
1966	19	62	16	2	100
1972	14	64	19	3	100
		Rates of Growth, (% per year)			
1960-1966	7.5	13.9	7.5	19.1	11.4
1966-1972	6.2	12.5	15.1	14.9	12.0

1/ Arctic, Northwest, and Southwest Regions.
2/ Totals may not balance due to rounding.
3/ 1972 data preliminary.

Table 8. Utility System Requirements, 1960-1972 (Cont'd)

Other Growth Indications

Factor	Annual Growth Rate
Population growth, 1960-1972:	
1. Statewide	
Total residential population	3.0%
Total civilian population	3.7%
2. Railbelt	
Total residential population	3.6%
Total civilian population	4.5%
Railbelt area utility power requirements, 1960-1971 growth:	
1. Total requirements	
Kwh sales	14.0%
Number of customers	6.0%
Kwh/customer	7.3%
2. Residential sales	
Kwh sales	13.8%
Number of customers	6.5%
Kwh/customer	7.0%

Source: Alaska Power Survey, Technical Advisory Committee on Economic Analysis and Load Projection.

Table 9. Regional Utility Load Estimates, 1972-2000

Region	Actual Requirements 1972		Estimated Future Requirements 1980		1990		2000	
	Peak Demand 1000 KW	Annual Energy Million KWH	Peak Demand 1000 KW	Annual Energy Million KWH	Peak Demand 1000 KW	Annual Energy Million KWH	Peak Demand 1000 KW	Annual Energy Million KWH
			Higher Rate of Growth					
Southcentral	224	1,037	680	2,990	1,640	7,190	3,590	15,740
Yukon (Interior)	69	307	200	870	460	2,020	970	4,230
Total	293	1,344	880	3,860	2,100	9,210	4,560	19,970
			Likely Mid Range of Growth					
Southcentral			610	2,670	1,220	5,350	2,220	9,710
Yukon (Interior)			180	780	340	1,500	600	2,610
Total			790	3,450	1,560	6,850	2,820	12,320
			Lower Rate of Growth					
Southcentral			530	2,340	980	4,290	1,470	6,430
Yukon (Interior)			160	680	270	1,200	390	1,730
Total			690	3,020	1,250	5,490	1,860	8,160

Note: Estimated future peak demand based on 50 percent annual load factor.

Source: Alaska Power Survey, Technical Advisory Committee on Economic Analysis and Load Projection.

Table 10. Regional Total Load Estimate, 1972-2000

Region	Actual Requirements 1972 Peak Demand 1000 KW	Actual Requirements 1972 Annual Energy Million KWH	Estimated Future Requirements 1980 Peak Demand 1000 KW	1980 Annual Energy Million KWH	1990 Peak Demand 1000 KW	1990 Annual Energy Million KWH	2000 Peak Demand 1000 KW	2000 Annual Energy Million KWH
			Higher Rate of Growth					
Southcentral	317	1,465	990	5,020	5,020	30,760	7,190	40,810
Yukon (Interior)	115	542	330	1,610	760	3,980	1,390	7,000
Total	432	2,007	1,320	6,630	5,780	34,740	8,580	47,810
			Likely Mid Range of Growth					
Southcentral			790	3,790	1,530	7,400	3,040	15,300
Yukon (Interior			280	1,310	470	2,270	910	4,610
Total			1,070	5,100	2,000	9,670	3,950	19,910
			Lower Rate of Growth					
Southcentral			650	3,040	1,160	5,430	1,790	8,510
Yukon (Interior)			250	1,140	370	1,760	530	2,540
Total			900	4,180	1,530	7,190	2,320	11,050

Note: Assume 80 percent annual load factor for industrial requirements; 50 percent for utility requirements. Higher estimate includes nuclear enrichment facility in 1980's with requirements of 2.5 million kilowatts.

Source: Alaska Power Survey, Technical Advisory Committee on Economic Analysis and Load Projection.

Southcentral and Yukon
Utility Load Increments

Period	Peak Demand MW	Annual Energy Million Kwh
1972-1980	497	2,106
1980-1990	770	3,400
1990-2000	1,260	5,470

Southcentral and Yukon
Total Load Increments

Period	Peak Demand MW	Annual Energy Million Kwh
1972-1980	638	3,093
1980-1990	930	4,570
1990-2000	1,950	10,240

Factors Influencing Power Demands

This section will discuss some of the factors that will influence future power demands in the Railbelt area. In many cases, direct impact on power demands cannot be quantified with any degree of accuracy, but all of the factors will be considered in the assumptions for future requirements.

Population Change

During the 1950-60 decade Alaska's population increased some 76 percent. The following decade, although adding over 76,000 persons, the net increase was 34 percent. 1/ Increases for the Southcentral and Interior regions were 117 and 50 percent; and 114 and 16 percent respectively.

1/ This may be compared with a net increase of the far West region of 14.7 percent, the Mountain Region with 15.9 percent and the United States with 13.8 percent, Review of Business and Economic Conditions.

Alaska Population 1950 - 1970 a/ and 1974 b/

Year	Alaska	Change No.	Change %	So. Central	Change No.	Change %	Interior	Change No.	Change %
1950	128,643			50,909			23,008		
1960	226,167	97,524	75.8	108,851	58,758	117.3	49,128	26,120	113.5
1970	302,647	76,480	33.8	163,758	54,907	50.4	56,799	7,671	15.6
1974	351,159	48,986	16.2	194,569	31,777	19.4	67,315	10,516	18.5

Each year from 1960 to 1970, Alaska and the Southcentral and the Interior regions added an average of some 7,600; 5,500; and 750 persons respectively. Since 1970, these same areas are estimated to have annually averaged an increase over 12,200; 7,900; and 2,600.

These figures predate start of construction of the Alyeska pipeline. Discounting direct employment on pipeline construction, Railbelt population has been increasing at a compound rate of around 3.5 percent per year. Most planners expect continued rapid increase for at least the next few years.

Economic Growth

Population change is of course related to economic activity and employment opportunities. Historically Alaska's economy was based on furs, gold and copper. Its modern economy has relied on fisheries, forestry and government services. Presently Alaska's growth economy is being driven by the exploration and development of the northern, (primarily Arctic Slope) oil and gas fields, the construction of the Alyeska oil pipeline and transhipment facilities at Valdez; and the accompanying growth in support services and facilities at Anchorage, Fairbanks and other towns along the pipeline route. Additional impetus is coming from state

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a/ Review of Business and Economic Conditions, University of Alaska, Institute of Social, Economic and Government Research, Dec. 1971, Vol. VII, No. 5.

b/ Derived from Current Population Estimates by Census Divisions, July 1, 1974, Alaska Department of Labor, Research Division.

expenditures, construction of local infrastructure, expansion of Alaska's service industry, and activities associated with the Alaska Native Claims Settlement Act (ANCSA).

Some of these activities such as the construction of the oil pipeline and transhipment facilities have a limited time in which their effect will continue to provide economy expansion. For example, the huge pipeline construction force is expected to decline very rapidly on completion of the actual pipe laying in late 1976, and longer term employment for operating the line will involve relatively few jobs.

Other factors such as ANCSA can be expected to have very long term effects as the regional and village corporations use their capital, land and resources to economic advantage.

There are very strong pressures for expanding oil and gas exploration and development in Alaska, representing a very complex set of interests at the national, state, and local levels. Several areas on the Alaska Outer Continental Shelf and Naval Petroleum Reserve #4 are very high priorities in the national programs directed to energy self sufficiency. State interest and involvement includes possible additional leasing (Beaufort Sea and others), recognition that leasing and royalty revenues will likely be the major source of state income for the foreseeable future, and decisions on state royalty oil and gas. Some of the Native Corporations have oil and gas exploration programs underway. If reserves are found, there will be strong pressures for development for these lands too.

Generally, it must be assumed that the oil and gas developments will continue to be a major factor in the Railbelt and state economy for the foreseeable future, and that additional major oil and gas developments impacting the Railbelt are probable within the next few years, including substantial expansion of the present petrochemical industry.

Other factors which will continue to support economic growth in the Railbelt include the Capital relocation, and any further developments in other industries including tourism, forestry, mining, and agriculture.

No one is suggesting that all of the above will occur in the short term. Each, however, has a possibility and any combination of the above events must increase the population of Alaska and the energy requirements.

Changes in Use of Electric Energy

Nationally, electric energy consumption has been expanding at a compound rate of around seven percent per year. This compares with around a four percent increase in total energy use. These increases correlate with or exceed trends in national gross product and substantially exceed rates of population growth.

Many factors can be cited in at least partial explanation of these trends -- high productivity of electric energy in industry, increasing affluence, low cost of energy, and so forth.

Preliminary statistics indicate that total U.S. energy consumption during 1974 declined by about two percent and that electric energy production for the year showed no growth over 1973. This was the first full year of widespread concern for energy conservation, and results of the conservation programs are reflected in the changes. However, the changes also reflect a large increase in relative cost of energy, a deep economic recession with high unemployment and large amounts of idle industrial capacity, and generally mild winters.

For Alaska, 1974 was not a recession year. Energy consumption continued to increase rapidly in the state, including increases exceeding 12 percent in electric energy requirements for the major Railbelt utilities. Data presented previously showed that increases in electric demands for the Railbelt reflect both increases in numbers of customers and increases in use per customer.

It is reasonable to assume that electric energy will be substituted for many direct uses of oil and gas in the future. This substitution is one of the few major options available for reducing dependency on oil and natural gas.

Only very rough estimates are available on the extent to which such substitutions may be desirable. Data presented in the power survey showed electric energy accounted for only 13 percent total energy used in Alaska in 1971, and that as of 1972, over 60 percent of the state's electric requirements were derived from oil and gas. In contrast, the Pacific Northwest derives over 90 percent of its electric energy from hydro power, and electricity accounts for about 40 percent of total regional energy use. It is APA's judgement that in the long term, electric energy will provide a similarly large share of total energy requirements in the Railbelt area, if alternative power sources of coal, hydro, and nuclear are developed. Assuming no growth in overall energy use, this would involve a three-fold increase in electric energy requirements.

The cold climates, especially in the Interior, provide additional incentive to substitute electric energy for direct use of fossil fuels. For example, an all electric economy for the Fairbanks area would substantially reduce future problems with air pollution, fog, and ice fog.

1975 Estimates of Future Power Requirements

This section presents future power requirement estimates developed for the current evaluation of the Upper Susitna Project. Work for the new estimates consisted of: (1) a review of the previous data and data from the power survey in light of new data for the years 1973 and 1974; (2) consideration of current regional and sectional trends in energy and power use; and (3) preparation of a new set of load estimates reflecting this most recent data.

The new analyses generally indicate that major premises for the power survey load estimates remain valid. Changes include the update for the most recent estimates and reducing the regional estimates from the power survey to reflect areas that could be served directly from an interconnected Railbelt system. This latter step eliminated loads for remote cities and villages as well as potential industrial loads for these remote areas.

For 1973 and 1974, the Anchorage area utilities energy demand increased 15.2 percent per year and peaking requirements increased 12.6 percent per year. The Fairbanks' utilities energy demand increased only 3.9 percent while the peaking requirement increased 7.4 percent. The smaller increase in the Fairbanks area is assumed due to the large buildup in anticipation of the oil pipeline construction, and then a subsequent delay of construction start until late 1974.

The new estimates are summarized in Table 11 and Figure 6. Indicated load increments, by decade, are:

Increments of Utility Power Requirements, 1,000 KW

	1974-1980	1980-1990	1990-2000	1974-2000
Higher Estimate	440	1,140	2,280	2,280
Mid-Range	370	740	1,180	2,290
Lower Estimate	320	560	600	1,480

Increments of Total Power Requirements, 1,000 KW

	1974-1980	1980-1990	1990-2000	1974-2000
Higher Estimate	540	3,960	2,300	6,800
Mid-Range	420	800	1,500	2,720
Lower Estimate	340	600	660	1,600

Table 11. Estimated Utility, National Defense, and Industrial Power Requirements

Type of Load / Area	Actual Requirements 1974 Peak Demand 1000 kw	Actual Requirements 1974 Annual Energy Million/kwh	Estimated Future Requirements 1980 Peak Demand 1000 kw	1980 Annual Energy Million/kwh	1990 Peak Demand 1000 kw	1990 Annual Energy Million/kwh	2000 Peak Demand 1000 kw	2000 Annual Energy Million/kwh
National Defense								
Anchorage	33	155	35	170	40	190	45	220
Fairbanks	41	197	45	220	50	240	55	260
Total	74	352	80	390	90	430	100	480
Industrial			High Rate of Development Assumed					
Anchorage	10	45	100	710	2,910	20,390	2,920	20,460
Fairbanks 1/	--	--	--	--	--	--	--	--
			Mid-Range Development Assumed					
Anchorage			50	350	100	710	410	2,870
Fairbanks 1/			--	--	--	--	--	--
			Low Development Assumed					
Anchorage			20	140	50	350	100	710
Fairbanks 1/			--	--	--	--	--	--

1/ Rounds to less than 10 MW

Note: Industrial development does not assume pipeline pumping.

Table 11. Estimated Utility, National Defense, and Industrial Power Requirements (Cont)

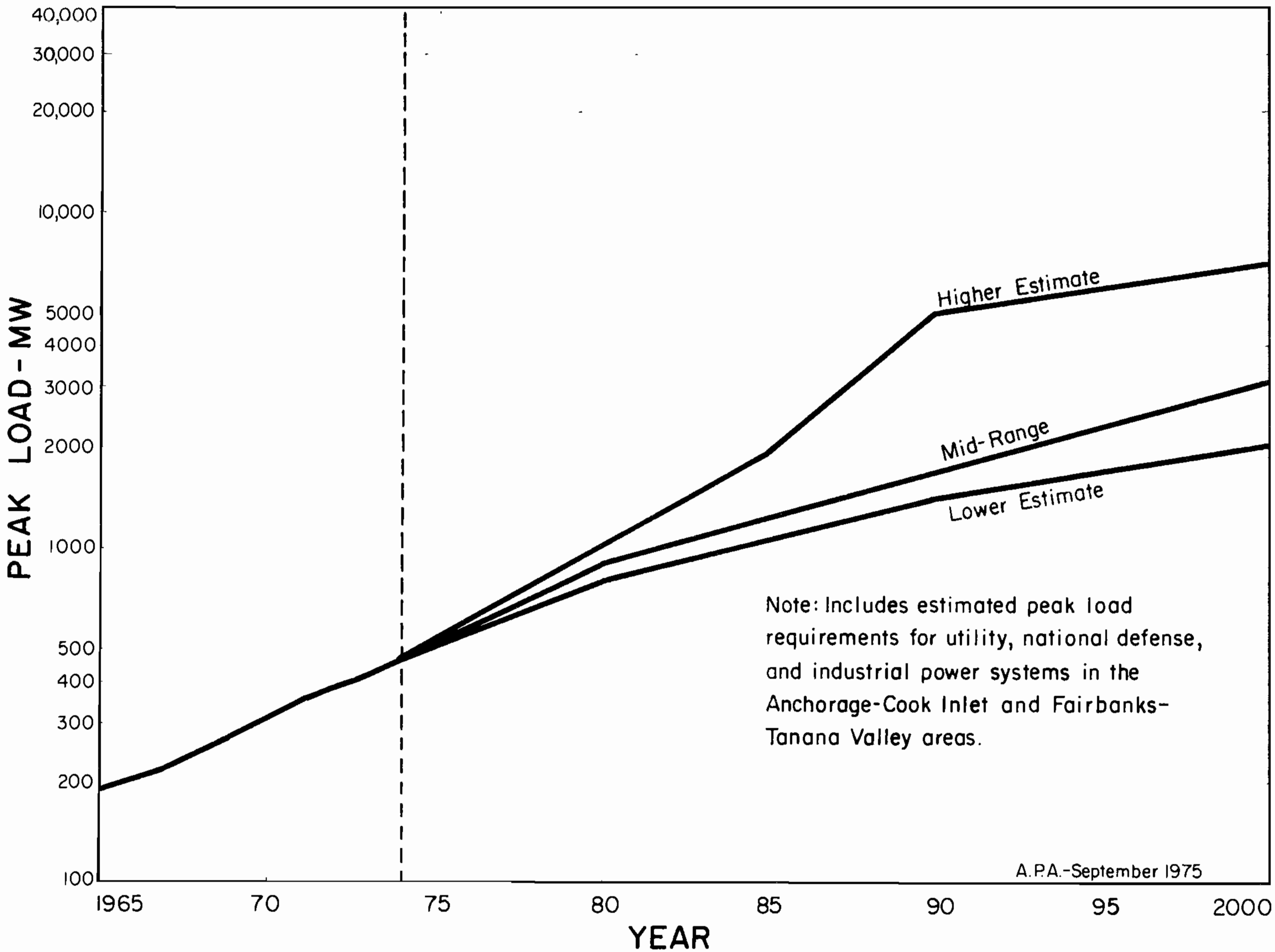
Type of Load	Actual Requirements 1974		Estimated Future Requirements 1980		1990		2000	
Area	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh
Utilities			High Rate of Growth					
Anchorage	284	1,305	650	2,850	1,570	6,880	3,430	15,020
Fairbanks	83	330	160	700	380	1,660	800	3,500
Total	367	1,635	810	3,550	1,950	8,540	4,230	18,520
			Likely Mid-Range Growth					
Anchorage			590	2,580	1,190	5,210	2,150	9,420
Fairbanks			150	660	290	1,270	510	2,230
Total			740	3,240	1,480	6,480	2,660	11,650
			Lower Rate of Growth					
Anchorage			550	2,410	1,010	4,420	1,500	6,570
Fairbanks			140	610	240	1,050	350	1,530
Total			690	3,020	1,250	5,470	1,850	8,100

Table 11. Estimated Utility, National Defense, and Industrial Power Requirements (Cont)

Type of Load	Actual Requirements 1974		Estimated Future Requirements 1980		1990		2000	
Area	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh	Peak Demand 1000 kw	Annual Energy Million/kwh
Combined Utility, National Defense, and Industrial Power Requirements								
Higher Growth Rate								
Anchorage	327	1,505	785	3,730	4,520	27,460	6,395	35,700
Fairbanks	124	527	205	920	430	1,900	855	3,760
Total	451	2,302	990	4,650	4,950	29,360	7,250	39,460
Likely Mid-Range Growth Rate								
Anchorage			675	3,100	1,330	6,110	2,605	12,510
Fairbanks			195	880	340	1,510	565	2,490
Total			870	3,980	1,670	7,620	3,170	15,000
Lower Growth Rate								
Anchorage			605	2,720	1,100	4,960	1,645	7,500
Fairbanks			185	830	290	1,290	405	1,790
Total			790	3,550	1,390	6,250	2,050	9,290

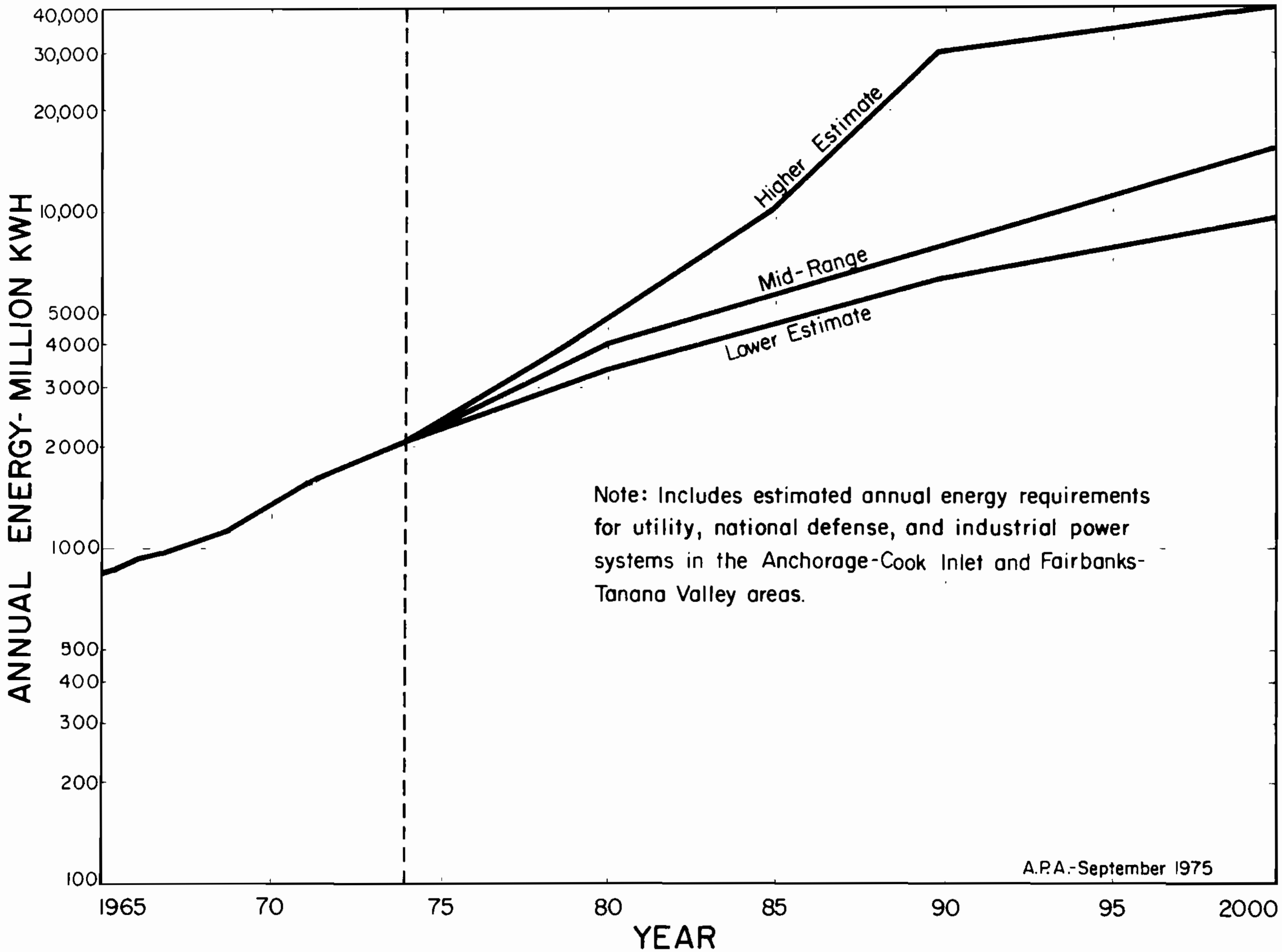
ESTIMATED FUTURE POWER REQUIREMENTS 1974-2000

I. PEAK LOAD REQUIREMENTS



ESTIMATED FUTURE POWER REQUIREMENTS 1974-2000

2. ANNUAL ENERGY REQUIREMENTS



With allowances for reserves and plant retirements, the indicated new capacity requirements by the year 2000 range from about two to eight million kilowatts with a mid-range estimate of over three million kilowatts.

Rates of increase in utility power requirements assumed for the future estimates are shown below:

Estimate	1974-1980	1980-1900	1990-2000
Higher Range	14.1%	9%	8%
Likely Mid-Range	12.4%	7%	6%
Lower Range	11.1%	6%	4%

It bears repeating that the assumed growth rates after 1980 are substantially below existing trends and that they assume substantial savings through increased efficiency in use of energy and conservation programs.

The estimates for the National Defense requirements are premised on the 1974 power use for the major bases and an assumed future growth of approximately one percent per year. These estimates are lower than presented in the power survey data, reflecting trends in 1973 and 1974.

The estimates for future utility requirements cover the same load sectors as now supplied by Alaska utility systems. This includes most light industry and industry support services. The utility estimates do not include allowances for industrial requirements for major new resource extraction and processing, new energy intensive industries, or heavy manufacturing.

The power survey studies included a review of potential new developments in the energy, mineral, and timber fields and a set of assumptions on individual developments considered likely through the year 2000. Basically, the estimates involved selecting a few developments considered most likely to occur from among the more promising potentials and rough estimates of the power requirements that would be involved. For this study, the power survey assumptions were screened to include only those developments which could be readily served from an interconnected Railbelt power system. This eliminated many potential new industrial loads listed in the Survey, particularly remote mining developments in the Yukon region.

Tables 12 and 13 summarize assumed new industrial power requirements for this report.

The basic assumptions incorporated in these new estimates are summarized below. In most cases, the assumptions are similar to those adopted for the power survey:

1. It is generally considered that the Railbelt area population will continue to grow more rapidly during the study period than the national average.

2. Utility statistics indicate individual customers' electric energy consumption has been increasing six to seven percent per year. However, all of the load estimates assume that saturation levels for many energy uses will be reached and that rates of increase for most individual uses will decline during the 1980's and 1990's. This reflects assumed effects of major efforts to increase efficiencies and conserve energy for all uses.

3. Rapid growth in the Railbelt area will continue through the balance of the 1970's, with economic activity generated by North Slope oil and gas development being a major factor.

4. Future additional energy systems, potential mineral developments, petroleum processing, and development of a petrochemical industry will all be very influential in use of electrical energy through the end of the century.

5. Major economic advances for all of Alaska and especially for the Alaska Native people should be anticipated as a result of the Alaska Native Claims Settlement Act.

6. There may be substantial substitution of electricity for direct use of oil and gas if the electricity is from other sources.

Load factors assumed were the same as for the power survey--utility systems, 50%; industrial loads, 80%; and national defense, 55%. The 50% and 55% are further supported by the data in Table 3. The 80% is an assumption based on higher utilization of generation equipment by industry. Minor differences may be reflected in the table due to combining and rounding.

The concept of range estimates presented in the power survey is continued. It attempts to balance the population and the growth factors with increasing conservation trends. The "higher" range anticipates significant new

Table 12. Assumed Industrial Development

INDUSTRY	RATE OF GROWTH	ASSUMPTION
Kenai Peninsula:		
Chemical Plant:	Low	Existing, with planned expansion by 1980, then, no change to 2000.
	Mid	Existing, larger expansion assumed by 1980, continued expansion to 2000.
	High	Existing, largest yet expansion assumed by 1980, larger expansion to 2000.
LNG Plant:	Low	Existing, with no change assumed to 2000.
	Mid	Existing, no change before 1980, steady expansion thereafter.
	High	Existing, expansion assumed before 1980 and continuing to 2000.
Refinery:		Existing, plus same assumptions as LNG plant.
Timber Processing:	Low	Small start before 1980, expansion to high value by 2000.
	Mid	Larger start before 1980, expansion to high value by 1990.
	High	Largest start before 1980, no change to 2000.

Table 12. Assumed Industrial Development

(continued)

INDUSTRY	RATE OF GROWTH	ASSUMPTION
Other Vicinities:		
Mining and Mineral Processing:	Low	Start-up after 1980, five-fold expansion by 2000.
	Mid	Start-up by 1980, five-fold expansion by 1990, double by 2000.
	High	Large start-up by 1980, double by 1990, no change to 2000.
LNG Plant:	Low	Start-up after 1980, no change to 2000.
	Mid	Start-up before 1980, no change to 2000.
	High	" " " " " " " "
Beluga Coal Gasification:	Low	Pilot project power between 1990 and 2000.
	Mid	Pilot project by 1990, full operation by 2000.
	High	Pilot project before 1980, full operation by 1990, no change to 2000.
Nuclear Fuel Enrichment:	High	Start at full operation before 1990, no change to 2000.
Timber:	Low	Start-up after 1980, full operation by 2000.
	Mid	Start-up before 1980, full operation by 1990, no change to 2000.
	High	Full operation start-up before 1980, no change thereafter.
New City:	Low	Initially loaded after 1980, load tripled by 2000.
	Mid	Initially loaded before 1980, tripled by 1990 2 1/3 expansion by 2000.
	High	Larger initial load before 1980, 2 1/3 expansion by 1990, no change to 2000.

Table 13. Estimated Industrial Power Requirements

Rate of Development	Industrial Capacity in MW								
	Low Range			Mid Range			High Range		
Year	1980	1990	2000	1980	1990	2000	1980	1990	2000
Anchorage Area: Kenai Peninsula:									
Chemical Plant 1/	11	11	11	12	14	16	13	16	20
LNG PLant 1/	.4	.4	.4	.4	.5	.6	.5	.6	.7
New Plant		10	10	10	10	10	10	10	10
Refinery 1/	2.2	2.2	2.2	2.2	3	4	3	4	5
Timber 1/	2	3	5	3	5	5	5	5	5
Other Vicinities:									
Coal Gasification			10		10	250	10	250	250
Mining and Mineral Processing		5	25	5	25	50	25	50	50
Nuclear Fuel Enrichment								2500	2500
Timber		5	7	5	7	7	7	7	7
New City		17	30	10	30	70	30	70	70
TOTAL (rounded)	20	50	100	50	100	410	100	2910	2920
Fairbanks Area 2/									

Source: 1974 Alaska Power Survey Technical Advisory Committee Report on Economic Analysis and Load Productions, pages 81-89.

1/ Existing Installations

2/ Timber processing and oil refinery loads totaled less than 10 MW.

energy and mineral developments from among those that appear most promising. The "lower" range generally assumes a slackening of the pace of development following the completion of the Alyeska pipeline. The "mid-range" appears to be a reasonably conservative estimate.

With the exception of the annual large load for a nuclear enrichment facility (2500 MW in the 1990 and 2000 "high range" estimates only) all of the assumed new industrial loads are considered very conservative. The main purpose of including the nuclear enrichment assumption is to illustrate that order of magnitude of loads for large energy-intensive uses.

Very rough estimates for requirements that might be anticipated for a new capital city are also included in Table 12.

The estimates do not assume major loads associated with OCS developments or very large petrochemical industries. Similarly, they do not assume rapid acceleration of mining and mineral processing.

Copper Valley Power Requirements

The Copper Valley Electric Association provides power at Valdez and Glennallen. Power requirements are relatively small, but recent rates of increase have been large because of activity related to the Alyeska pipeline and terminal construction.

Existing Situation

CVEA energy requirements have increased at an average annual rate of 10 percent from 5.6 million kwh per year in 1965, the first year CVEA served both Glennallen and Valdez, to 14.4 million kwh per year in 1974.

The 1974 peak load for the two towns was 3.5 MW. Combined installed capacity was 6.1 MW (all diesel).

CVEA recently installed 3.6 MW in Valdez and has 5.2 MW scheduled for Glennallen during 1975 with an additional 6 MW proposed for Valdez in 1976 and again in 1978. CVEA has under study a small hydro project (Solomon Gulch) and a potential intertie between Glennallen and Valdez.

Future Utility Loads

The most recent estimate of utility loads is presented in an October 1974 study prepared for CVEA.1/ The study estimated near future loads would peak at 9 MW and 46 million kwh upon construction completion of the pipeline,

1/ Copper Valley Electric Association, Inc. 15 Year Power Cost Study Hydro/Diesel, Robert W. Retherford Associates, October, 1974.

the pipeline terminal, and an electrical interconnection between Valdez and Glennallen in 1978. The loads were estimated to level off for a few years at that time. By 1989, the study estimated the loads at 15 MW and 75 million kwh. It was envisioned that CVEA would furnish energy to the construction camp, the pipeline refrigeration station, and the utility-type loads at two oil pipeline pumping stations. Alyeska Pipeline Company estimated these loads would amount to 21.8 million kwh annually.

APA estimated CVEA power requirements based on rate of growth assumptions similar to those used for estimating the Anchorage and Fairbanks area needs. The estimates are shown in the following tabulation:

	1980		1990		2000	
Growth During Period	Energy Million kwh	Peak MW	Energy Million kwh	Peak MW	Energy Million kwh	Peak MW
High	32	7	77	18	169	38
Mid-Range	29	7	58	13	105	24
Lower	27	6	49	11	73	17

Should the Valdez area become a major manufacturing or oil processing area, the above estimates of utility loads would be much too low.

Industrial Loads

Current industrial loads include the construction camps for the pipeline terminal and pumping stations. An oil-fired steamplant will supply electric requirements and process steam at the terminal. These are relatively small loads.

The concept of using electric power for oil line pumping requirements has been advanced in previous studies. For a variety of reasons, including economics and absence of a strong area transmission system, this plan was not attractive to the pipeline company. All recognize that a substantial savings in oil could be accomplished if the pipeline were electrified, and if the power were derived from another source such as hydro or coal. Total requirements for pipeline pumping south of the Yukon River were estimated at 225,000 KW in an APA study (1969).

The concept of utilizing electricity to displace fuels would bear further attention if an Alaska route is selected for transporting natural gas from Alaska's North Slope. The substantial amount of gas needed for compressor and refrigeration stations and for liquefying the gas could be saved by substituting electric power. Informal estimates from the El Paso Natural Gas Company indicate requirements of up to 900 MW if an Alaska gas line and LNG plant were powered by electricity.

Assuming an 80 percent plant factor, this would amount to around 6 billion kilowatt hours annual energy. A large portion of the load would be at tidewater at the LNG plant.

The availability of large amounts of oil and possibly natural gas at ports on the Gulf of Alaska further suggests the possibility of establishing refineries or petroleum plants in the area.

Industrial loads associated with oil and gas pipelines and other potential industrial loads in the Prince William Sound Area have not been considered in assessments of Upper Susitna power markets and financial feasibility of the project.

Criteria for Capacity and Energy Distribution

Reservoir and powerplant capacity criteria are premised on expected use of the project to meet power demands. This section discusses the data and assumptions incorporated in the capacity criteria for the Upper Susitna Project.

The basic approach involves a set of monthly energy distribution assumptions which are used to size the project reservoirs and to determine annual firm energy production from the project. The powerplant capacity assumptions reflect the capacity needed to market the project power.

Energy Distribution

It is assumed that the energy requirements from the hydroelectric project will be proportional to total system energy requirements on a monthly basis for any given year.

Table 14 summarized 1970-1972 monthly energy distribution for the area utilities, expressed as a percent of annual energy requirements. The table also shows energy distribution assumptions used in previous hydro-electric studies in the area.

Table 14. Monthly Energy Requirements as Percent of Annual Requirements

MONTH	1961 Devil Canyon 1/	1971 Bradley Lake 2/	1970-1972 Utility Loads 3/	Recommended for Current Studies 4/
Oct.	8.9	8.3	7.9	8.0
Nov.	9.4	9.1	8.9	8.8
Dec.	10.4	11.0	10.2	9.7
Jan.	9.3	9.9	11.3	10.6
Feb.	8.1	9.0	9.2	9.0
Mar.	8.3	8.4	9.8	9.4
April	7.7	7.8	8.0	8.1
May	7.6	7.4	7.2	7.5
June	7.2	7.2	6.5	6.9
July	7.4	7.2	6.4	6.9
Aug.	7.7	7.2	7.1	7.4
Sept.	8.0	7.5	7.5	7.7
Total	100.0	100.0	100.0	100.0
SEASONAL				
Oct.-Aug.	62.1	63.5	65.3	63.6
May-Sept.	37.9	36.5	34.7	36.4

1/ USBR Feasibility report.

2/ Corps draft report, 1971

3/ Combined loads of CEA, AML&P, GVEA, FMUS, for period Oct. 1970 - Sept. 1972.

4/ Assumes total requirements consisting of 25% industrial loads and 75% of the above combined loads of the four major utilities.

For the current studies, it assumes that future load patterns will be modified somewhat as a result of industrial requirements that would tend to have a fairly even energy distribution throughout the year. As indicated on Table 14, this assumption modified seasonal distribution of energy by less than two percent.

As used in the project operation studies, firm energy capability is determined for any given combination of reservoir capacity as the amount of energy that can be delivered under critical year runoff conditions using the assumed monthly energy distribution. Under these assumptions, substantial amounts of secondary energy are available in most years, and a significant part of the reservoir capacity is used only for long term storage to increase flows in the lowest runoff years.

These methods are quite traditional for planning studies, although it is recognized operations would not follow precisely the same patterns. The project would always operate in conjunction with other thermal and hydroelectric plants in the interconnected system. Energy demands on the Susitna Project would vary because of changes in fuel supplies, generator maintenance schedules, and other factors. It is also anticipated that actual project operations would be pointed more towards maximizing annual energy production rather than long term storage to augment flows in the critical year. However, the planning study assumption provides a reasonably conservative estimate of average annual firm energy and an adequate basis for determining merits of the project.

Capacity Requirements

As discussed previously, the utility systems have had combined annual load factors slightly over 50 percent in the past few years. This is premised on non-concurrent peaks in separate systems, so actual load factors would be somewhat higher due to diversity. Data presented earlier also shows that mid-summer peaks have been running about 60 percent of mid-winter peaks, that monthly load factors generally exceed 70 percent, and that winter and summer load shapes are quite similar.

It is anticipated that there will be a trend towards somewhat higher annual load factors in the future. In addition to benefiting from any load diversity in the interconnected system, peak load management (including such action as peak load pricing) offers considerable opportunity for improving load factors, which in turn reduces overall capacity requirements for the system in any given year. For planning purposes, it is assumed that the annual system load factor will be in the range of 55 to 60 percent by the latter part of the century.

System capacity requirements would be determined by winter peak load requirements, plus allowances for reserves and unanticipated load growth. The lower summer peaks provide latitude for scheduled unit maintenance and repairs.

Daily peak load shapes for the system indicate a very small portion of the capacity is needed for very low load factor operation. It is expected that some of the gas turbine capacity which is now used essentially for base load will eventually be used mainly for peak shaving purposes; that is, it will be operating during peak load hours for the few days each year when loads approach annual peak, and operating in standby reserve for the balance of the year.

It is expected that reliability standards will be upgraded as the power systems develop. This will likely include specific provisions for maintaining spinning reserve capacity to cover possible generator outages as well as substantial improvements in system transmission reliability.

Examination of the winter daily and weekly load curves (Figure 4) indicates the base load portion is about 70 percent of total load and the peak load is about 30 percent of total load. Load factor for the peak portion is about 50 percent, and winter weekly load factors are on the order of 80 percent.

An annual plant factor of 50 percent has been selected for the Upper Susitna Project. This is largely a judgment factor reflecting the following considerations:

1. This assumption would insure capability to serve a proportional share of both peaking and energy requirements throughout the year, and adequate flexibility to meet changing conditions in any given year.

2. Any significant reduction in this capacity could materially reduce flexibility.

3. There does not appear to be a significant market for low load factor peaking capacity within the foreseeable future. There is likelihood that load management and addition of some industrial loads will increase the overall system load factor in the future, and it is expected that several existing and planned gas turbine units could eventually be used for peak shaving.

4. It is recognized that the mode of operation for the hydro will change through time. In the initial years of operation, it is likely that the full peaking capacity would be used very infrequently. For example, the mid-range estimated system peak load for the year 2000 is 3,170 MW. Assuming load shapes similar to the current Anchorage area loads, the winter peak week would require about 2,000 MW of continuous power to cover the base loads and about 1,200 MW of peaking power. Load factors of the peak portion would be about 50 percent.

Part VI ALTERNATIVE POWER SOURCES

The proposed Upper Susitna hydroelectric development would provide large blocks of load factor power for the Railbelt area starting in about 1985. This section discusses alternative means of providing equivalent power supplies. It concludes that conventional coal-fired steamplants represent the most logical alternative to major hydro development for this time period.

The evaluation of alternatives is intended to help provide the basis for selecting the most appropriate course of action for meeting future demands. Reliability, prices, and environmental impacts are important aspects of such a comparison. Additionally, the range of alternatives must include only those for which technology is available (or may reasonably be expected to be available in this time frame).

Power Survey Studies

The studies for the new power survey includes fairly detailed analysis of generation costs for steamplants (coal and oil or gas-fired), gas turbines, and diesel engines. Key assumptions relative to the Railbelt were that (1) fuels suitable for use in gas turbines would be available in 1980 at a cost of from 60¢ to $1.00 per million Btu's at 1973 price levels (no inflation), and (2) that coal for steamplants would be available at a cost of from 30¢ to 60¢ per million Btu's in 1980 at 1973 prices. Table 15 summarizes the alternative generation costs presented in the survey.

Solar, wind, and tidal power were not considered as major planning alternatives.

Some very rough data on installation costs for nuclear power were presented. Most planned developments in the South "48" are in the 1000 MW class; reports at the time were indicating plant investments in the range of $500 to $600 per kilowatt; that comparable Alaska costs might be on the order of $900 to $1000 per kilowatt; and that smaller plants would likely be more costly.

Table 15. Future Generation Costs [1/]

1. Diesel-Electric (IC) Powerplants @ 50% Annual Load Factor (Public Financing)

Plant size, MW	0.2	1.0	5.0	10.0
Investment cost, $/kw	130	130	160	160
Unit generation cost, including fuels, mills/kwh:				
(Based on:	11,200 Btu/kwh		10,370 Btu/kwh)	
Fuel cost @ 20¢/gal.	30.4	25.8	23.1	21.9
Fuel cost @ 25¢/gal.	34.4	29.8	26.8	25.6
Fuel cost @ 30¢/gal.	38.4	33.8	30.5	29.3
Fuel cost @ 40¢/gal.	46.4	41.8	37.9	36.7

Notes: Costs would be higher for remote locations; alternate assumptions of private financing increases unit costs from 2.1 to 2.6 mills per kilowatthour.

2. Gas Turbine Powerplants @ 50% Annual Plant Factor (Public Financing)

Plant size, MW	20	35	50	500
Investment cost, $/kw	135	135	167	150
Unit energy costs, including fuels, mills/kwh:				
Fuel cost @ 20¢/MBtu	7.61	7.31	7.75	7.22
Fuel cost @ 30¢/MBtu	9.11	8.51	8.95	8.42
Fuel cost @ 60¢/MBtu	13.61	12.41	12.55	12.02
Fuel cost @ $1.00/MBtu	19.61	17.61	17.35	16.82
Fuel cost @ $1.41/MBtu (oil @ 20¢/gallon)	25.91	23.07	22.39	21.86

Equipment and heat rate assumptions:

20 MW open cycle, 15,000 Btu/kwh
35 MW open cycle, 13,500 Btu/kwh
50 MW regenerative cycle, 12,000 Btu/kwh

1/ Source: Advisory Committee Studies for FPC Alaska Power Survey.

Table 15. Future Generation Costs (cont.)

3. Coal-Fired Steamplants, Railbelt Area, 50% and 80% Plant Factor (Public Financing). (Assumed heat rate of 10,000 Btu/kwh)

Plant size, MW	100	200	500	1,000
Investment cost, $/kw	496	456	373	313
Unit energy costs including fuels, mills/kwh:				
	50% Plant Factor Plants			
Fuel cost @ 30¢/MBtu	14.4	12.9	11.1	9.9
Fuel cost @ 60¢/MBtu	17.4	15.9	14.1	12.9
	80% Plant Factor Plants			
Fuel cost @ 30¢/MBtu	10.1	9.2	8.0	7.3
Fuel cost @ 60¢/MBtu	13.1	12.2	11.0	10.3

4. Gas-Fired Steamplants, Railbelt Area, 50% and 80% Load Factor (Public Financing). (Assumed heat rate of 10,000 Btu/kwh)

Plant size, MW	100	200	500	1,000
Investment cost, $/kw	444	409	334	280
Unit energy costs including fuels, mills/kwh:				
	50% Plant Factor Plants			
Fuels @ 30¢/MBtu	13.0	11.7	10.1	9.1
Fuels @ 60¢/MBtu	16.0	14.7	13.1	12.1
Fuels @ $1.00/MBtu	20.0	18.7	17.1	16.1
	80% Plant Factor Plants			
Fuel costs @ 30¢/MBtu	9.2	8.4	7.4	6.8
Fuel costs @ 60¢/MBtu	12.2	11.4	10.4	9.8
Fuel costs @ $1.00/MBtu	16.2	15.4	14.4	13.8

Energy and Power Cost Trends

Energy and power economics are undergoing very rapid change, and these changes are extremely important in terms of new decisions on new sources of energy supply. Up until the early 1970's, most energy planning assumed that abundant, low cost energy supplies would be available on a long term basis from oil, natural gas, and nuclear fuels. Long term trends, especially since about 1950, seemed to support this assumption.

The more recent experiences, particularly since the 1973 oil embargo, provide the outlook that energy will be a precious and relatively costly commodity for the foreseeable future. Key changes include the huge increases in fuel prices, added costs for pollution control, very rapid increases in nuclear costs, and absence of any new technological break-through.

The studies for the new Alaska Power Survey reflect the start of trends towards much more costly energy supply in Alaska. Generally, these studies reflected data up through mid-1973. Events since that time indicate that most of the cost figures in the power survey are now too low. Fuel prices have continued to escalate rapidly as have costs for labor and materials.

The rapid pace of change makes many traditional cost comparisons obsolete. For example, the 1969 Alaska Power Survey and other studies at that time assumed long range generation costs using Alaska natural gas would be on the order of four mills per kilowatthour. Nationwide at that time, it was generally assumed that large nuclear and coal plants would have about the same four mill average generation cost. These figures generally became the yardsticks for measuring feasibility of new power installations.

The nuclear and coal-fired steamplants are still the major yardstick for the U.S., but is very difficult to put current values on the yardstick because of the rapid cost increase. It now appears that the minimum generation costs for large new baseload thermal plants may be in the range of 15 to 20 mills per kilowatthour for the South "48" states.

A recent Interior Department report estimated unit costs of 18.8 and 19.8 mills per kilowatthour for new baseload (70% capacity factor) nuclear and coal fired plants. [1/] This was premised on 1973 costs and 1,000 MW size plants.

1/ Energy Perspectives, USDI, 1974. Based on Project Independence studies.

That report indicated unit costs of 30 mills per kilowatthour for nuclear and 28 mills for coal if similar plants were operated at a 40 percent annual capacity factor.

In addition to rapidly increasing fuel costs, the investment costs for thermal plants have been increasing very rapidly, partly through inflation and higher rates and partly through added costs for pollution control devices. One publication indicated the following trends 1/:

	Dollars per Kilowatt Installed Capacity (Based on 1000 MW plants)			
	1965	1970	1974	1984
Nuclear plants	119	222	558	850
Fossil fired steamplants	95	178	446	680

A more recent report by Edison Electric Institute indicated construction costs for coal-fired steamplants ordered in 1974 for 1979 operation would cost $525 per kilowatt. Cost of scrubbers for air pollution control amount to an additional $140-$150 per kilowatt. 2/ Smaller plants suitable for use in the Railbelt area would logically cost more.

Review of Fuel Costs and Availability

It seems certain that by 1985 Alaska's production of oil and natural gas will be a major portion of total U.S. production, and that the bulk of the Alaska production will be for export to the South "48" markets. Some cost advantage should prevail in Alaska because of the high transportation costs, however, Alaska fuel costs will certainly reflect broader national and international trends. Policies governing choice of fuels will also reflect the broader national concerns.

1/ Olds, FC; "Power Plant Capital Costs Going Out of Sight", Power Engineering, August 1974.

2/ "Utilities Hedge on Nuclear Plans; Coal Plant Prospect Brightens," Engineering News Record, August 21, 1975.

At this time, it no longer appears appropriate to assume oil and natural gas will be an available option for major power supplies in the long range where options exist to utilize other sources. If this is true, the conventional nuclear and coal-fired plants will become the most readily available alternative to development of major new hydro sources for the Railbelt.

Availability of ample supplies of coal for electric generation in the Railbelt area seems assumed as reported in the power survey. In addition to the active mine near Healy, there are active leases in the Beluga area. Development of expanded coal mining is considered very likely in the near future. It is likely that new coal mining would be primarily for export to the South "48" but opening of new mines would probably assure adequate supplies of coal for utilities use in Alaska.

Current Alaska coal production is limited to the Usibelli mine near Healy which furnishes coal to the GVEA powerplant at Healy, Fort Wainwright near Fairbanks, and Fairbanks Municipal Utility System in Fairbanks. The power survey stated mine mouth coal delivered to the Healy steamplant was 47¢ per million Btu in early 1974. Prices at the end of 1974 were as follows:

	Cents Per Million Btu	$/ton
GVEA cost at Healy powerplant	53	8.80
FMUS cost delivered to Fairbanks	85.6	14.21
Ft. Wainwright cost delivered to Fairbanks	93.2	15.46
Freight cost to Fairbanks	32.6	5.21

The cost of transportation from Healy to Fairbanks at $5.21 per ton and 8,300 Btu per pound is equivalent to 3.2 mills per kilowatthour based on 10,000 Btu/kwh.

The Federal Power Commission recently estimated the value of coal for electric generation at 60¢ per million Btu for the Fairbanks area and at 50¢ per million Btu for the Anchorage/Kenai area; in their determination of power values for the current FPC studies. 1/

1/ FPC letter of Aug. 12, 1975, to Alaska District, Corps of Engineers.

There is a wide variety of opinion on probable future cost of coal. For many years, coal prices were set a small margine above production costs to compete with low cost oil and natural gas supplies. This pricing situation has changed dramatically in recent years with the changing energy situation. The much higher prices for oil and incentives for converting from oil and gas to coal substantially increases market value of the coal.

Nationwide average prices for utility coal have increased dramatically since the early 1970's. Average price nationwide increased 57 percent in 1974 (from 51.4 to 80.9 cents per million Btu) according to FPC statistics.

The Federal Energy Administration's draft environmental impact statement on "Energy Independence Act and Related Tax Proposals" predicted a long-term price of low-sulfur coal at around $1.50/million Btu. This is premised on current price levels (no inflation), and may be too low. According to some, the price of coal will eventually rise to equal the price of oil on a cost per Btu basis, providing transportation costs are accounted for.

It seems probable that any major Alaskan coal mining would result in a pricing structure tied to the broader U.S. market, in which case Alaska should have some advantages due to transportation costs.

For purposes of this study, it is assumed that 1985 costs without inflation of utility coal for major Railbelt power supplies will be in the range of $1.00 to $1.50 per million Btu.

Fuels for conventional nuclear powerplants have also increased substantially over the past few years, but remain a comparatively small portion of average costs of nuclear generation.

Review of Available Alternatives

Coal-fired Steamplants

It is assumed that any major new coal-fired plants would be located close to mining operations, probably in the Beluga area for power supplies to the Anchorage-Cook Inlet area, and in the Healy area for power supplies to the Fairbanks-Tanana Valley. Based on relative sizes of power markets, individual plant size would likely be 500 MW or less for the Anchorage-Cook Inlet area and 200 MW or less for the Fairbanks-Tanana Valley area, and individual plants would likely have at least two units. Because of operating characteristics, and maintenance and reliability requirements, it seems unlikely that very large unit sizes (500 MW and up) could be utilized before about the year 2000.

The power survey studies included evaluations of likely costs for coal fired steamplants of 200 MW, 500 MW, and 1,000 MW capacity. The 200 MW and 500 MW sizes are considered reasonably representative of plant sizes that could be considered as alternatives to Upper Susitna power for the Fairbanks-Tanana Valley and Cook Inlet areas, respectively. Cost estimates for the 200 MW and 500 MW plants were updated for use in the current study, and the results are summarized on Table 16.

Table 16. Alternative Generation Costs for Conventional Coal-fired Steamplants

	Plant Size, MW			
	200		500	
Number of Units	2		2	
Investment Cost, Railbelt, $/kw	526		430	
Cost of Environmental Equipment $/kw	200		200	
Installed Cost	726		630	
Capital Cost, mills/kwh	14.5		12.6	
Operation and Maintenance, mills/kwh	1.6		1.3	
Fuel Cost, mills/kwh	10.0	15.0	10.0	15.0
Transmission Cost to Load Center	2.5	2.5	2.5	2.5
Total Energy Cost mills/kwh	28.6	33.6	26.4	31.4

The principle assumptions reflected in this update include:

1. Updated investment costs presented in the power survey (January 1973 price levels) to January 1975 prices used the Engineering News Record composite construction cost index. Using the Handy-Whitman steam generation plant cost index, the estimated total energy cost would be slightly higher--approximately 6 percent. The basic estimate reflects South "48" construction costs and an Alaska construction factor of 1.8.

2. Increasing the investment cost by $200 per kilowatt to reflect estimated environmental protection costs which were not specifically included in the estimate for the Alaska Power Survey. The data used in the power survey was for plants completed during the 1960's; current practice involves considerable additional expense for control of sulfur, particulates, and nitrogen oxide in stack emission and substantially increased costs for cooling water facilities.

3. Annual capital cost was determined using a 35-year life and an interest rate of 6-5/8 percent. This equals the current (FY 1976) Federal repayment rate for water projects and closely approximates a current composite of municipal and REA borrowing costs. Annual fixed charges of 8.77 percent for public, non-Federal financing were determined (including cost of money, depreciation, interim replacements, insurance and payments in lieu of taxes).

4. Operation and maintenance costs presented in this power survey were updated to July 1975 costs, using the U.S. Department of Labor Cost of Living Index. The power survey estimates reflect an Alaska cost factor of 1.50.

5. Fuel cost range of $1.00 to $1.50 per million Btu and a heat rate of 10,000 Btu per kwh.

6. Annual capacity factor of 50 percent.

7. Transmission costs are on the same basis as costs of transmitting Susitna River hydro project power to the load centers. Smaller voltage lines were assured. Distances from Beluga Lake area to Palmer area and Healy to Ester are both approximately 100 miles.

The indicated average unit cost of 26.4 to 31.4 mills per kilowatthour is intended as an assessment of alternative costs for Railbelt area power supplies from coal-fired steamplants under current cost levels.

The Federal Power Commission prepared estimates of power values for the Upper Susitna studies premised on estimates for coal-fired steam-plants for the Fairbanks and Anchorage-Kenai area. [1/] These estimates incorporate the following assumptions:

1. Interest rates of 5-7/8 percent for Federal financing; and 6.25 percent and 5.95 percent for Anchorage and Fairbanks, respectively, for public, non-Federal financing.

2. A two-unit, 150 MW plant for the Fairbanks area with fuel cost of 60¢ per million Btu and a heat rate of 12,000 Btu/kwh.

3. A three unit, 450 MW plant for the Anchorage-Kenai area with fuel costs of 50¢ per million Btu and a heat rate of 9,800 Btu/kwh.

4. The power value estimates incorporate transmission costs to the load center and a credit for the hydro based on higher availability/reliability.

The FPC estimates were converted to an average mill rate for comparison with the other alternatives:

<u>Fairbanks Coal-fired Alternatives</u>

Public, non-Federal financing, 29.5 - 32.5 mills/kwh.
Federal financing (6-1/8%), 27.8 - 30.6 mills/kwh.

<u>Anchorage-Kenai Coal-fired Alternatives</u>

Public, non-Federal financing, 24.6 - 27.3 mills/kwh.
Federal financing (6-1/8%), 22.3 - 24.6 mills/kwh.

The above results are quite similar to the estimates based on the power survey. It is recognized that the interest rates used for FPC are somewhat lower than present Federal repayment criteria and that in other respects the two evaluations are somewhat dissimilar.

1/ FPC letter dated August 20, 1975, to Corps of Engineers.

Diesel-electric Powerplants

Several smaller towns will have no alternative but diesel electric generation until they are interconnected to a larger system.

Fuel costs remain the major cost for generation by diesel. However, equipment and construction costs have increased significantly since the power survey. Units identical to those costing $160/kw in the power survey cost $220/kw in late 1974 for 1975 delivery. 1/ Planning, engineering, and financing costs are additional. Heavy duty indoor units in the 2500 kw to 5000 kw size range are costing $300/kw, excluding site, engineering, contingencies, financing costs, and interest during construction. 2/

The following tabulation shows diesel generation costs using assumptions similar to those incorporated in the power survey studies and the more recent equipment cost data:

Plant size, MW		5.0	5.0 to 10
Type of Service		Medium duty	Heavy Duty
Heat Rate, Btu/kwh		10,370	10,000
Investment cost $/kw		270	400
Unit generation cost, including fuel, mills/kwh:			
Fuel cost @	30¢/gal	33.3	32.8
	40¢/gal	40.7	40.0
	50¢/gal	48.1	47.1
	60¢/gal	55.5	54.3

Assumptions include two units per plant, longer life and slightly higher efficiency for heavy duty units.

Distribution costs and losses are not included.

1/ Source: Glacier Highway Electric Association, Juneau, Alaska

2/ Source: CVEA/KPU experience

One recent study estimated diesel generation costs at 34.6 mills/kwh in 1974 based on $220/kw basic equipment costs and fuel at 33¢/gallon. 1/ Future costs for 1980 and 1985 were estimated at 58.6 and 85.4 mills/kwh assuming escalation of equipment costs at 6%/year and fuel costs at 10%/year. Actual manufacturers' cost estimates received by the same firm for similar generation equipment in July 1974 was $297/kw; considerably higher than the assumed $220/kw.

1/ R. W. Beck and Associates, Analysis of Electric System Requirements, City and Borough of Sitka, Alaska, April 1974.

Hydro

As a part of its work for the June 1967 report, Alaska Natural Resources and the Rampart Project, the Interior Department through the Bureau of Reclamation prepared an extensive inventory of Alaskan hydroelectric resources, including evaluation of potential large hydro projects that might be considered as alternatives to the Rampart proposal. The inventory with minor modification has been published in the 1969 FPC Alaska Power Survey and elsewhere.

The inventory studies, the evaluation of the few major hydroelectric potentials of Alaska (i.e., Rampart, Yukon-Taiya, Susitna, Wood Canyon, and Woodchopper) in the 1967 report, and the earlier basin and project reports of the Bureau of Reclamation are the basis of advancing Upper Susitna as the most logical major hydro development of the Alaska Railbelt at this time.

Nuclear

There are no authoritative studies of large nuclear plants for the Alaska Railbelt. There is a great deal of controversy on nuclear power -- many proponents and many opponents. APA feels that detailed evaluation would demonstrate existing nuclear technology is thoroughly adequate to assure engineering feasibility and safety for nuclear plants in the Alaska Railbelt.

However, several factors indicate nuclear power would be less attractive than coal-fired plants for near-future consideration. First is performance data on existing nuclear plants -- averaging about 70 percent machine availability nationwide because of down time for maintenance and repair and forced outages. This characteristic will improve over time, but for the present, the nuclear alternatives would probably require substantially larger system reserves.

Recent cost data indicates that for the South "48", nuclear and coal-fired costs are quite similar, with nuclear requiring a much larger initial investment. Because of higher construction costs, it is probable that nuclear power would be considerably more expensive than coal-fired power in Alaska at least for the foreseeable future.

Other Alternatives

There is a known large physical potential for tidal power development in the Cook Inlet area, but again no detailed studies are available. Tide range is considerably smaller than the better known potentials such as Passamaquoddy.

Several different concepts for developing the Cook Inlet tidal potential have been mentioned. These include a plan to drain the Inlet at the Forelands with pumped storage units to equalize output of power; and a two basin scheme which would utilize the Knik and Turnagain Arm. The latter in concept would be tied in with road or rail causeways.

Because of the interest in alternative energy sources, there is some merit to preparing a good reconnaissance of this alternative. However, considering the huge size of the work involved, the likely range of important environmental considerations, and inherent difficulty and cost of utilizing the low head available from the tide, tidal power does not constitute a reasonable alternative for determining merits of the Upper Susitna.

Similarly, geothermal power could eventually prove to be a very valuable resource for the Railbelt. Geothermal potential is considered high for the Wrangell Mountains and portions of the Alaska Range. Subsurface information is not adequate to define the resources.

Existing geothermal technology is basically limited to using the best of the resources -- preferably hot dry steam, or superheated water that can be reached at fairly shallow depth. As yet, there are no firm indications that large geothermal resources exist in Alaska that could be developed with available technology. On this basis, geothermal power cannot be considered a viable alternative at this time to major coal and hydro power.

Wind power is receiving great interest, but existing and likely near future technology is limited to small and relatively costly units. Like geothermal, the long range potential may prove very important, but wind is not a viable alternative for major new power supplies at this time.

Part VII FINANCIAL ANALYSIS

This section presents estimates of the market for project power and evaluations of power rates needed to repay the investment in power facilities.

The Upper Susitna Project is primarily for power, though present indications are that minor portions of project costs would be allocated to other purposes, such as recreation. Preliminary estimates are that such cost allocations to other purposes would be less than one percent of the total project investment. Thus financial viability of the project becomes the essential element in demonstrating feasibility of the power development. The size of market, amount of investment, and applicable interest rate are the main factors influencing rates for power. Operation, maintenance and replacement costs are a minor part of total annual costs, so they do not influence power rates significantly. If rates needed to repay the hydro development are attractive in comparison to other alternatives that may be available, the project may be considered financially feasible.

Present Federal criteria for power producing facilities call for repayment of project costs with interest within 50 years after the unit becomes revenue producing. The applicable interest rate for Fiscal Year 1976 is 6-5/8 percent.

Market for Project Power

Previous sections presented estimates of power requirements for the interconnected Railbelt system under a range of assumptions for future development. The portion of this power market that would represent demands for project power would depend on rates of growth, changes in operating modes of other facilities, fuel policies, availability and prices, and other factors.

At the time Susitna power becomes available, the Railbelt power systems will have several hundred megawatts of capacity in oil and natural gas fired (turbine) equipment. It is assumed that because of fuel cost and other incentives, it will be desirable to place much of the gas turbine equipment in cold reserve, except for limited operation in the peak shaving mode. This is particularly true of any oil-fired equipment and the least efficient of the gas turbine equipment.

By 1985, some of the older steam-fired plants would be at or near the end of useful life and likely candidates for early retirement.

Under these conditions, it is assumed that firm demands for Susitna power would develop very rapidly.

For purposes of these preliminary rate determinations, it is assumed that the firm market for Susitna power would be up to 75 percent of the total utility requirements for the mid-range load estimates for the Anchorage-Cook Inlet and Fairbanks-Tanana Valley area. This is conservative to the extent that it does not assume any demands from the national defense or industrial load sectors. It could be optimistic if the utilities continue very heavy reliance on oil and natural gas.

Table 17 shows the 75 percent assumption in comparison with total area load estimates. As indicated on the table, 75 percent of utility requirements is equivalent to 61 to 66 percent of total area requirements during the 1985-1995 period.

It is recognized that these are oversimplified market assumptions, and that the market estimates will require continued refinement as project plans and design are prepared. If it should develop that future demands for project power are somewhat lower, it is reasonable to assume that the project would be staged over a somewhat longer period of time.

Assumptions for secondary energy sales are as follows:

1. With Devil Canyon operating alone, there is relatively little flexibility for scheduling secondary energy so the market for such energy would be limited. The Corps operation studies indicate average annual secondary energy capability of 201 MW. It is assumed that the marketable portion would be 10 MW in the first year of operation (equivalent to 86 million kilowatthours at the market), and that this market would expand in 10 MW increments to 50 MW in the fifth year of operation.

   This assumes that the secondary energy could be offered in sizable blocks with guaranteed duration of two to six months, depending on forecasts of reservoir operations, but that relatively little of this energy would be available during mid-winter.

Table 17. Assumed Market for Upper Susitna Power

Potential market for new hydroelectric power and energy (based on 75% of estimated mid-range utility requirements)

	Annual Peaking Requirements 1000 kw			Annual Energy Requirements Million kwh		
Year	Anchorage	Fairbanks	Total	Anchorage	Fairbanks	Total
1985	630	160	790	2,760	690	3,450
1986	680	170	850	2,950	740	3,690
1987	720	180	900	3,165	790	3,955
1988	770	190	960	3,395	840	4,235
1989	830	200	1,030	3,640	900	4,540
1990	890	220	1,110	3,900	960	4,860
1991	940	230	1,170	4,140	1,010	5,150
1992	1,000	240	1,240	4,400	1,070	5,470
1993	1,060	260	1,320	4,670	1,130	5,800
1994	1,130	270	1,400	4,950	1,200	6,150
1995	1,200	290	1,490	5,250	1,260	6,510

Comparison With Total Area Power Requirements

	Anchorage & Fairbanks requirements (Mid-range Estimates)		Assumed Market for new Hydroelectric Power	
Year	Peak 1000 kw	Annual Energy Million kwh	Peak 1000 kw	Annual Energy Million kwh
1985	1,220	5,560	790 (65) 1/	3,450 (62) 1/
1990	1,670	7,620	1,110 (66) 1/	4,860 (62) 1/
1995	2,300	10,680	1,490 (65) 1/	6,510 (61) 1/

1/ Percent of total area requirements.

2. With the multiple reservoir systems, it is assumed that market flexibility could be substantially enhanced and that marketing policies would be premised on maximizing annual energy production. In practice, this would likely be achieved by setting firm energy contracts close to average annual energy capability with exchanges and off-peak purchases and to meet contract commitments during low runoff years.

   The Corps operation studies indicate average annual secondary capability ranging from 40 to 108 MW for the multiple reservoir system. For purposes of the rate studies, it is assumed the full amount of the secondary energy could be marketed starting in 1990. The Corps values for secondary power were converted to annual energy and transmission losses were deducted to derive the amounts of secondary energy sales used in the rate studies:

   System #1 - 690 x 10^6 kwh/year sales.
   System #2 - 932 x 10^6 kwh/year sales.
   System #3 - 345 x 10^6 kwh/year sales.
   System #4 - 630 x 10^6 kwh/year sales.
   System #5 - 690 x 10^6 kwh/year sales.

3. A rate of 10 mills per kilowatthour is assumed for secondary sales.

Scoping Analysis

APA prepared a set of estimates of average power rates needed to repay costs of the alternative hydro development plans. This provided a basis for looking at the alternative plans from the viewpoint of impact on power rates. These studies were premised on preliminary designs and estimates prepared by the Corps of Engineers (dams and powerplants) and APA (transmission systems and operation and maintenance) as reported in the September 1975 draft reports of the two agencies.

These preliminary rate estimates are summarized in Table 18 and the cost assumptions incorporated in them are summarized in Table 19. Note that there have been substantial changes in the cost estimates since the September draft report as dicusssed later.

Table 18. Average Rates for Repayment for Alternative Development Plans 1/

	System Plan	Average Rates for Firm Energy (Mills/kwh)
System #1	Devil Canyon (W.S. 1450), 1985 Denali (W.S. 2535), 1990	24.5
1-A	Devil Canyon and Denali both on line, 1985 (USBR plan; Corps costs).	21.9
1-B	Same, but USBR-APA costs, Denali	20.7
System #2	Devil Canyon (W.S. 1450), 1985 Watana (W.S. 2050), 1990	21.4
2-A	Watana, 1985 Devil Canyon, 1990 (Revise order of construction)	21.0
System #3	Devil Canyon (1450), 1985 Watana (2050), 1990 Denali (2535), 1995	20.9
System #4	Devil Canyon (1450), 1985 Denali (2535), 1990 Vee (2300), 1995 Watana (1900), 2000	24.2
4-A	Devil Canyon & Denali both on line, 1985 Vee 1990 Watana, 1995 (USBR plan; Corps costs).	22.8
System #5	Watana (2200), 1986 Devil Canyon (1450), 1990	19.7

1/ Preliminary scoping analysis for September 1975 draft report; does not reflect cost changes since that time.

Table 19. Cost Summary for Alternative Systems 1/

System # 1

Unit	Devil Canyon	Denali	Total System
W. S. Elev.	(1450)	(2535)	
Completion Date	1985	1990	
Costs - $1,000			
Power Production Facilities			
Construction Costs	389,000	231,400	
Interest During Construction	64,430	45,990	
Investment Cost	453,430	277,390	730,820
Transmission Facilities			
Construction Costs	114,100	-	
Interest During Construction	11,340	-	
Investment Cost	125,440		125,440
Total System Investment Cost			856,260
Annual Operation and Maintenance			1,538
Annual Replacement			177
Annual OM & R			1,715

1/ Costs are for preliminary scoping analyses in September 1975 draft report and do not reflect revisions since that time.

Table 19. Cost Summary for Alternative Systems 1/
(Continued)

System # 2

Unit	Devil Canyon	Watana	Total System
W. S. Elev.	(1450)	(2050)	
Completion Date	1985	1990	
	Costs - $1,000		
Power Production Facilities			
Construction Costs	389,000	600,000	
Interest During Construction	64,430	119,250	
Investment Cost	453,430	719,250	1,172,680
Transmission Facilities			
Construction Costs	184,310	18,540	
Interest During Construction	18,320	1,840	
Investment Cost	202,630	20,380	223,010
Total System Investment Cost			1,395,690
Annual Operation and Maintenance			1,883
Annual Replacement			396
Annual OM & R			2,279

1/ Costs are for preliminary scoping analyses in September 1975 draft report and do not reflect revisions since that time.

Table 19. Cost of Summary for Alternative Systems [1/]

(Continued)

System # 3

Unit	Devil Canyon	Watana	Denali	Total System
W. S. Elev.	(1450)	(2050)	(2535)	
Completion Date	1985	1990	1995	
Costs - $1,000				
Power Production Facilities				
Construction Costs	389,000	600,000	231,400	
Interest During Construction	64,430	119,250	45,990	
Investment Cost	453,430	719,250	277,390	1,450,070
Transmission Facilities				
Construction Costs	184,310	18,540	-	
Interest During Construction	18,320	1,840	-	
Investment Cost	202,630	20,380	-	223,010
Total System Investment Cost				1,673,080
Annual Operation and Maintenance				1,883
Annual Replacement				396
Annual OM & R				2,279

1/ Costs are for preliminary scoping analyses in September 1975 draft report and do not reflect revisions since that time.

Table 19. Cost Summary for Alternative Systems 1/
(Continued)

System # 4

Unit	Devil Canyon	Watana	Denali	Vee	Total System
W. S. Elev.	(1450)	(1905)	(2535)	(2300)	
Completion Date	1985	2000	1990	1995	
Costs - $1,000					
Power Production Facilities					
Construction Costs	389,000	486,400	231,480	399,000	
Interest During Construction	64,430	96,670	45,990	19,300	
Investment Cost	453,430	583,070	277,390	478,300	1,792,190
Transmission Facilities					
Construction Costs	184,310	7,930	–	29,130	
Interest During Construction	18,320	790	–	2,890	
Investment Cost	202,630	8,720		32,020	243,370
Total System Investment Cost					2,035,560
Annual Operation and Maintenance					2,269
Annual Replacement					549
Annual OM & R					2,818

1/ Costs are for preliminary scoping analyses in September 1975 draft report and do not reflect revisions since that time.

Table 19. Cost Summary for Alternative Systems [1/]
(Continued)

System # 5

Unit	Devil Canyon	Watana	Total System
W. S. Elev.	(1450)	(2050)	
Completion Date	1990	1986	
Costs - $1,000			
Power Production Facilities			
Construction Costs	403,000	737,000	
Interest During Construction	67,000	146,000	
Investment Cost	470,000	883,000	1,353,000
Transmission Facilities			
Construction Costs	6,000	197,000	
Interest During Construction		20,000	
Investment Cost	6,000	217,000	223,000
Total System Investment Cost			1,576,000
Annual Operation and Maintenance			1,883
Annual Replacement			396
Annual OM & R			2,279

1/ Costs are for preliminary scoping analyses in September 1975 draft report and do not reflect revisions since that time.

The method used involves calculating 1985 present worth values of investment and OM&R costs and energy sales and reducing both to equivalent annual values. Revenues from secondary energy (10 mills per kilowatthour) are deducted from equivalent annual costs. An average rate for firm energy to recover the remaining costs is then computed.

In each case, the repayment period covers 50 years after each unit becomes revenue producing under the market assumption presented earlier, the full firm energy capability of each unit could be marketed in the first year after completion. The rate determination also incorporates the market assumptions for secondary energy which were presented previously.

Table 21 summarizes the average rates for firm energy for the four systems and also illustrates effect on rates of alternate assumptions of scheduling project units.

The highest indicated rate is for System #1 (24.5 mills per kilowatthour). This reflects the very limited energy capability of a Devil Canyon Project for the first five years without upstream storage. System 1-A (21.9 mills) assumes the same design and costs, but completion of both Devil Canyon and Denali in 1985 as proposed in the USBR-APA plan. The indication is that if Devil Canyon operates for a significant time period without upstream storage, power rates would be significantly increased.

Power rates are of course very sensitive to design assumptions. The USBR estimates for Denali Dam were prepared on a very conservative design reflecting the foundation conditions at that site. This is discussed in the May 1974 Status Report. A rough update of the USBR costs to January 1975 price was made. This indicates the new Corps estimates for Denali are approximately 20 percent higher than would be derived from the Bureau estimates. System 1-B, (20.7 mills) using USBR costs updated to January 1975, indicates the added conservatism in the Corps estimate adds about 1.2 mills to the average rate.

System 2-A assumes Corps design and costs but reverses the order of construction. (Watana on line in 1985 and Devil Canyon on line in 1990.) This indicates a small reduction in average rate, again related to the limited storage capacity at Devil Canyon.

System 4-A assumes Corps design and costs completion of Devil Canyon and Denali in 1985, with Vee and Watana following at five-year intervals.

If USBR design assumptions were used for Denali, the rates for System #3, #4, and #4-A would be somewhat lower than shown on the table.

System #5 has the lowest indicated rate (19.7 mills per kilowatthour), or approximately 5 percent lower than System #1-B, #2-A, and #3.

The general conclusions from the preliminary analysis includes:

1. There appears to be several alternative development plans for the Upper Susitna that would yield approximately equivalent power rates to the consumer, and that on the basis of the power rates there is little preference as between plans.

2. The importance of upstream storage above Devil Canyon is evident.

3. The studies indicate merit to the Denali unit as a possible future addition.

Comparison with May 1974 Status Report

APA's May, 1974, Devil Canyon Status Report provides a basis for comparing recent cost changes. The development plan presented in the Status report is analogous to the Corps System #1, except that APA assumed completion of both the Devil Canyon and Denali units at the same time while the Corps System #1 assumes Denali would be completed five years after Devil Canyon.

The Status Report used January 1974 price levels and the applicable interest rates for FY 1974 which was 5-5/8 percent for repayment. The present studies are premised on the FY 1976 interest rate of 6-5/8 percent and January 1975 price levels.

The year ending January 1975 had very high rates of inflation in all segments of the economy. The Bureau of Reclamation's composite construction cost index increased 21 percent for the period.

The change in interest rates without any inflation would increase annual repayment requirements by about 18 percent. The combination of higher costs and higher interest rates represents approximately a 42 percent increase in annual costs as indicated on Table 20.

Table 20. Comparison with May 1974 Status Report

	Status Report Plan (Devil Canyon + Denali)		
	Costs as in May 1974 Status Report	Current Studies	Increase
Price Level	January 1974	January 1975	
Applicable interest rate for repayment	5-5/8%	6-5/8%	
Estimated construction cost, $ millions	597.1	724	+21%
Interest during construction $ millions	84.9	121	
Investment cost $ millions	682	845	
Annual payment, excluding OM&R, $ millions	41.0	58.1	+42%

Revised Cost Estimates

During the review process, there were some significant changes in cost assumptions for the various alternative development plans. From the viewpoint of the power market, the changes all favored System #5-- that is relative cost increases for System #5 were substantially smaller than for the other alternatives under consideration.

A preliminary check was made using the new costs which indicated the following average rates for the various systems: (same system designation as Table 18)

System #5 - 20.4 mills/kwh
System #2A - 22.3 mills/kwh
System #2 - 23.0 mills/kwh
System #1B - 23.0 mills/kwh
System #3 - 23.3 mills/kwh

Again the range is relatively small, but under the latest cost assumptions, System #5 would have about 10 percent lower power rates than the next most favorable plan.

Average Rate Determination for Proposed Plan

Table 21 summarizes the estimate of average rate for firm energy needed to repay investment in the project facilities. The methods used are the same as for the scoping analysis. The indicated average rate is 21.1 mills per kilowatthour.

Note that the scoping analyses discussed previously found a 20.4 mill average rate for System #5. The difference of 0.7 mills reflects added transmission costs adopted for the proposed plan (substation in Talkeetna vicinity, switchyard near Healy, and two single circuit lines in lieu of the double circuit assumptions used in the scoping analyses).

The indicated rate for the proposed plan is significantly lower than the estimated costs of power from coal-fired steamplants. The analysis does not reflect allowance for future inflation. A rough estimate indicates that with a five percent per year cost escalation and construction schedules as contemplated in the Corps proposal, required rates for the system would exceed 40 mills per kilowatthour.

Table 21. Average Rate Determination - System #5
(Watana + Devil Canyon)

Year	Project Costs, $1000 Revenue Producing Investment	Project Costs, $1000 OM&R	1986 PW Costs $1,000 Investment	1986 PW Costs $1,000 OM&R	Project Energy Sales, Million Kwh Firm Energy	Secondary Energy	1986 PW Firm Energy	1986 PW Secondary Energy
1986	1,278,810	1829	1,278,810		3054	86	(1986 to 1989)	81
1987		"			"	172	10,431	151
1988		"			"	258		213
1989		"			"	344		266
1990	489,240	2400	378,520		4860	690	3,527	(1990 to 2040)
1991		"			5150	"	3,505	7,732
1992		"			5470	"	3,491	
1993		"			5800	"	3,472	
1994		"			6058	"	(1994 to 2040)	
							51,873	
2040								
Totals			1,657,330				76,299	8,443
Annual or Annual Equivalent			113,345	2,267			5,218	577

Average Rate Computation:

(1) Annual Costs:

	Capital	$113,345,000
	OM&R	2,267,000
	Total	$115,612,000
(2) Revenue from secondary energy @ 10 mills/kwh		- 5,770,000
(3) Required revenue from firm energy sales		$109,842,000
(4) Equivalent annual firm energy sales		5,218,000,000 kwh

(5) Average rate for repayment 109,842,000/5,218,000,000 = 21.1 mills/kwh

Power Marketing Considerations

The average rate is useful mainly as a basis for easy comparison of the proposal and the alternatives. Actual marketing contracts would likely include separate provisions for demand and energy charges and account for wheeling charges, reserve agreements, and other factors.

There are some built in inequities for any given method of pricing. Most utility systems and most large Federal systems use essentially a postage stamp rate, that is power rates set the same for all delivery points on the system. Actual costs of serving the loads vary with the distance and size and characteristics of load--it is more costly to serve a small load several miles from the power source than to serve a larger load nearby. Policies vary from system to system as to portions of "hookup" costs born by the customers.

Actual rates for the Susitna system might reflect several items of costs and revenues not identified in the project studies. For example, it is likely that considerable use of project facilities would be made over the life of the project to wheel power from other sources. Any wheeling revenues would lower overall project power rates somewhat. Conversely wheeling costs for project power delivered over non-Federal transmission lines would need to be worked into project rate schedules. This is now done under APA marketing contracts for the Snettisham Project; there are many similar situations in other Federal power systems.

Rough estimates were made on a cost-of-service basis for power delivered at Fairbanks and at Point MacKenzie under the proposed plan. These indicated that about 85 percent of the project costs (or about 17.9 of the 21.1 mills per kilowatthour average rate) is involved in producing the power (Devil Canyon and Watana units and the transmission line between Devil Canyon and Watana). The remaining 15 percent is for transmission facilities to the major load centers. If the transmission costs were charged to power delivered at the two load centers on a cost of service basis, average rates would be about 25.2 mills per kilowatthour at Fairbanks and 20.2 mills at Point MacKenzie. The difference relates to distance and size of load.

As stated elsewhere, the transmission plan to deliver project power in Anchorage would need to be worked out in the detailed post authorization studies. It would involve added costs, either through wheeling charges for project power over non-Federal lines or project transmission lines around or under Knik Arm. These costs could be about the same for alternative power sources such as the Beluga coals.

It is considered essential that scheduling of project facilities be closely tied to the marketing function.

Market Aspects of Other Transmission Alternatives

It is reasonable to expect modifications of the project transmission system to meet changing requirements through time. The capacity of the main 345 kv and 230 kv lines could be upgraded substantially as needs arise by adding compensation and transformer capacity. Additional substations could be provided as warranted by future loads and subject to a case by case determination of economics. Similarly, extensions of the project transmission lines to serve other areas would be considered on the basis of needs, and economics, and available alternatives.

Anchorage-Cook Inlet Area

The costs in the proposed plan are premised on delivery points to substations near Talkeetna and Point MacKenzie. Rough estimates indicate similar costs for a plan with delivery points at Talkeetna, Point MacKenzie, and the existing APA Palmer substation. Thus, basically the project costs can provide delivery points on the existing CEA and APA systems north of Knik Arm, but do not include costs of delivering the power across or around the Arm.

With or without the Susitna Project, additional transmission capability is needed on the approaches to Anchorage. The CEA plan of Knik Arm loop at 230 kv is an important step in developing this capability, but additional capacity would be needed by the mid-1980's. Essentially the same problems would exist with alternative power sources such as the Beluga coals, so in this sense the solution doesn't bear on the merits of the Upper Susitna Project.

Detailed studies following project authorization would need to consider the several alternatives for providing power across Knik Arm. Costs would be worked into rate structures either through wheeling charges on non-Federal lines or project lines if needed.

Glennallen and Other Points on the Richardson Highway

Rough estimates were made for transmission systems to deliver project power to the CVEA system at Glennallen. Line distance from Palmer is approximately 136 miles.

The studies consisted of rough cost estimates for alternative 138 kv and 230 kv lines and comparison with load data presented previously. They indicated that on the basis of normal utility requirements, an intertie to Glennallen could probably not be justified until after 1990, then a line to Glennallen is included in the plans and costs for the initial development proposal.

Over the long term, it appears that a transmission loop from Palmer to Glennallen and then north along the Richardson Highway to interconnect with the CVEA system should receive further consideration.

EXHIBIT G-1

PARTIAL BIBLIOGRAPHY OF RELATED STUDIES

Partial Bibliography of Related Studies

1. Advisory Committee Reports for Federal Power Commission Alaska Power Survey:

   Report of the Executive Advisory Committee, December 1974
   Economic Analysis and Load Projections, May 1974
   Resources and Electric Power Generation, May 1974
   Coordinated Systems Development and Interconnection, December 1974
   Environmental Considerations and Consumer Affairs, May 1974

   (FPC has its summary report in preparation)

2. Alaska Power Survey, Federal Power Commission, 1969.

3. Devil Canyon Status Report, Alaska Power Administration, May 1974.

4. Devil Canyon Project - Alaska, Report of the Commissioner of Reclamation, March 1961, and supporting reports. Reprint, March 1974.

5. Reassessment Report on Upper Susitna River Hydroelectric Development for the State of Alaska, Henry J. Kaiser Company, Sept. 1974.

6. Project Independence, Federal Energy Administration, 1974. A main report, summary, seven task force reports and the draft environmental impact statement.

7. Engineering and Economic Studies for the City of Anchorage, Alaska Municipal Light and Power Department, R. W. Beck and Associates and Ralph R. Stefano and Associates, August 1970.

8. Power Supply, Golden Valley Electric Association, Inc., Fairbanks, Alaska, Stanley Consultants, 1970.

9. Copper Valley Electric Association, Inc. - 15 year Power Cost Study, Hydro/Diesel, Robert W. Retherford Associates, October 1974.

10. Environmental Analysis for Proposed Additions to Chugach Electric Association, Inc., Generating Station at Beluga, Alaska, Chugach Electric Association, October 1973.

11. Central Alaska Power Pool, working paper, Alaska Power Administration, October 1969.

12. Alaska Railbelt Transmission System, working paper, Alaska Power Administration, December 1967.

13. Electric Generation and Transmission Intertie System for Interior and Southcentral Alaska, CH2M Hill, 1972.

14. Central Alaska Power Study, The Ralph M. Parsons Company, undated.

15. Alaska Power Feasibility Study, The Ralph M. Parsons Company, 1962.

EXHIBIT G-2

UPPER SUSITNA RIVER HYDROELECTRIC STUDIES

REPORT ON OPERATION, MAINTENANCE, AND REPLACEMENTS

Contents

Tables

Figures

Introduction and Summary

This paper presents estimates of the annual recurring costs for project operations and maintenance, power marketing, and replacements for the Upper Susitna hydroelectric projects.

Figure 1 shows general locations of the potential units of the Upper Susitna project in relationship to the Alaska Railbelt. The four key Upper Susitna damsites are Devil Canyon, Watana, Vee, and Denali.

Separate estimates were prepared for each of five alternative development plans or systems. The five alternatives are identified on Table 1 along with power and energy capability for each system.

The Corps of Engineers proposes an initial development consisting of the Devil Canyon and Watana sites (System #5). The high Watana dam plan is proposed to be constructed first followed by the Devil Canyon unit.

The estimates reflect APA's assumed operation plan for the project powerplants, reservoirs, and transmission lines, as well as estimated costs for power marketing and overall project administration.

Summary of Operation, Maintenance, and Replacement Costs

	Annual Operation and Maintenance $1,000	Annual Replacement $1,000	Total OM&R $1,000
System #1 - Devil Canyon and Denali	1,538	199	1,737
System #2 - Devil Canyon and Watana	1,833	453	2,286
System #3 - Devil Canyon, Watana & Denali	1,833	453	2,286
System #4 - Devil Canyon, Watana, Denali, & Vee	2,269	618	2,887
System #5 - Devil Canyon & Watana (proposed plan)	1,833	517	2,340

Table 1. Alternative System Plans
Installed Capacity & Firm Energy

System	W.S. el. M.S.L.	P.O.L. Date	Devil Canyon Installed Capacity 1000 kw	Devil Canyon Firm Energy Million kwh	Watana Installed Capacity 1000 kw	Watana Firm Energy Million kwh	Vee Installed Capacity 1000 kw	Vee Firm Energy Million kwh	System Total Installed Capacity 1000 kw	System Total Firm Energy Million kwh	System Total Secondary Energy Million kwh
System #1											
Devil Canyon	1450	1985	580	2497							
Denali	2535	1990									
									580	2497	701
System #2											
Devil Canyon	1450	1985	600	2628							
Watana	2050	1990			470	2059					
									1070	4687	946
System #3											
Devil Canyon	1450	1985	700	3066							
Watana	2050	1990			670	2935					
Denali	2535	1995									
									1370	6001	350
System #4											
Devil Canyon	1450	1985	713	3119							
Denali	2535	1990									
Vee	2300	1995					300	1314			
Watana	1905	2000			421	1840					
									1434	6273	640
System #5											
Watana	2200	1986			792	3101					
Devil Canyon	1450	1990	776	3048							
									1568	6149	701

Notes: System #5 is the proposed initial development plan.
Data is from Corps of Engineers studies.

Operation Assumptions

For purposes of this study, it is assumed the project headquarters and main operations center would be near Talkeetna or at some other equally accessible point on the system. It is recognized the remote operations center is not dependent on being adjacent to a powerplant.

This central project headquarters, would house the remote powerplant operation and dispatch center. Powerplant operation and dam and reservoir operations would be from this operation-dispatch center for each plan. Electrician/operators and mechanic/operators would be located at the powerplants to provide for routine maintenance and manual operation when required. Denali dam would be remote controlled, with a caretaker in residence at the damsite. Specialized personnel such as electronic technicians, and meter and relay repairmen would serve at the several powerplants and substations, but would work out of project headquarters.

Project administration, including supervision of power production, water scheduling, and transmission facilities, would be from project headquarters.

Major turbine and generator inspection and maintenance work would be accomplished by electricians, mechanics, engineers, other experienced APA personnel, and manufacturers' representatives as required.

Alaska Power Administration's main office would handle power marketing, accounting, personnel management, and general administrative matters.

Transmission line maintenance would be handled by two linecrews with integration of the Eklutna Project linecrew. Transmission line maintenance warehouses and parts storage yard would be located at Devil Canyon or Watana, approximately midway between Devil Canyon and Fairbanks, and at project headquarters. Members of the linecrew would be stationed along the line, transmission maintenance stations, and the major substations to provide routine line patrol and minor caretaking tasks and security around the facilities. For major maintenance work, the transmission line crew members would gather at the problem area.

Visitor facilities with provisions for self-guided tours through the powerplant would require only occasional assistance from operation personnel.

Project related recreational facilities would involve cooperation between Federal, State, and local interests and likely be maintained by a State or local entity.

Project operation, maintenance and administration would likely include the existing Eklutna Project, with a resulting net savings to the electrical consumer. Eklutna would be supervisory controlled from the main operations center with electricians/operators and mechanic/operators stationed at Eklutna. It is estimated that approximately $100,000 per year could be saved by joint operation of the Eklutna and Susitna Projects.

Marketing and Administration

The marketing and administration aspects involve three main functions:

1. Administration

    Personnel management
    Property management
    Budgeting
    Marketing policy
    Rate and repayment studies

2. Accounting

    Customer billing
    Collecting
    Accounts payable
    Financial records
    Payroll

3. Marketing

    Rate schedules
    Power sales contracts
    Operating agreements
    System reliability and coordination

Part of this work would be carried out by the project headquarters; overall administration and support services would be handled by the APA headquarters staff.

Annual Costs

The estimated costs for operation, maintenance, marketing, and administration are based on itemized estimates of personnel, equipment, supplies, and services required to accomplish the work.

Operation and maintenance requirements for Systems #2, #3, and #5 would be substantially the same. Each of the three plans has powerplants at Devil Canyon and Watana that are similar except for installed capacity (1070 MW for System #2, 1370 MW for System #3, 1568 MW for System #5). Number of units and powerplant layout is the same for the three plans, so staffing would be essentially the same for each plan. System #3 includes Denali Dam, but added O&M costs for the structure would be minor. For purposes of this study, annual operation and maintenance costs are assumed the same for the three plans.

The estimate assumes Federally classified personnel providing management and administrative functions and wage grade personnel doing the physical day-to-day technical operation and maintenance of the project. Wage rates for the classified employees are based on the middle rate within a grade. Wage grade personnel rates are based on prevailing wages in effect in the Anchorage area and reflect basic hourly rates, benefits, and overtime provisions.

Costs of supplies, equipment and personnel requirements are based on Bureau of Reclamation Guidelines, characteristics of equipment, and Alaska Power Administration operating experience on the Eklutna and Snettisham Projects in Alaska. The Eklutna project is a fully staffed facility, including a transmission linecrew, which has been operated by APA and its predecessor agency since project construction in 1955. The Snettisham Project is an isolated project, separated from Juneau load center by 45 miles of rugged terrain and water. A maintenance crew performs routine maintenance at the project site, while project operations are remotely controlled from Juneau. It is envisioned that the Upper Susitna River Basin Project would have some characteristics of both projects.

Itemized costs for operation, maintenance, marketing, and administration for the alternative plans of development are present in Table 2.

Costs by major category and number of personnel are summarized on Table 3.

Replacements

The annual replacement cost provision establishes a fund to finance major items which have a life period of less than fifty years for project repayment. The objective is to cover costs and insure financing for a timely replacement of major cost items to keep the project operating efficiently throughout its entire life.

Items covered include generator windings, communication equipment, a small percent of the transmission towers, and several items in the substation and switchyards. Items covered by routine annual maintenance costs and not covered by the replacement fund include vehicles, small buildings, camp utilities, and materials and supplies. Major features such as dams and powerplant structures are considered to have service lives longer than the 50-year project repayment period and their costs are not covered by the replacement funds.

The annual replacement cost is based on experienced data by the Bureau of Reclamation. The procedure and basic factors have been adopted by the Department of Interior. The factors developed provide a sinking fund for the various items so that by the end of the items' service life, the fund will be large enough to replace it. The same interest rate used for project repayment is used to establish the sinking fund. The Fiscal Year [illegible] rate of 6-5/8 percent was established by the Department of the Treasury.

The factors apply to the entire powerplant, substation, and switchyard. They apply to the transmission towers, fixtures and conductors on the transmission system. Right-of-way and clearing costs are not included.

Table 4 presents the annual replacement factors based on 6-5/8 percent interest rate, the costs of the pertinent project feature, and the annual replacement fund for the alternative plans of development. The project costs are on a January 1975 basis. Powerplant costs are from Corps of Engineer estimates while Alaska Power Administration estimated the transmission, substation, and switchyard costs.

TABLE 2. ITEMIZED OPERATING & MAINTENANCE COST ESTIMATE

SYSTEM 1. DEVIL CANYON AND DENALI

Devil Canyon	600 MW	100 MW Future, 5 units
Denali	No Power	

Personnel

Supervisory & Classified		
Project Manager	GS-14	$ 30,000
Assistant Project Manager	GS-13	24,700
Electrical Engineer	GS-12	22,200
Mechanical Engineer	GS-12	22,200
Supply & Property	GS-9	14,500
Administrative Assistant	GS-7	12,000
Secretary	GS-5	9,600
Total Supervisory & Classified Wages		135,200
Wage Grade		
Electricians	2 @ 13.00 hr.	54,080
Mechanics	2 @ 13.00 "	54,080
Heavy Duty Equip. Operator	1 @ 13.00 "	27,040
Maintenance Man	2 @ 11.00 "	45,760
Meter Relay Mechanic	1 @ 13.00 "	27,040
Electronic Technician	1 @ 13.00 "	27,040
Powerplant Operators	6 @ 13.00 "	162,240
Ass't. Powerplant Operators	4 @ 11.00 "	91,520
Total Wage Grade Wages		488,800
Line Crew		
Foremen	2 @ 15.00 hr.	62,400
Linemen	4 @ 13.00 "	108,160
Equipment Operators	2 @ 13.00 "	54,080
Groundmen	4 @ 13.00 "	108,160
Total Line Crew Wages		332,800
C.O.L.A.--25%		33,800
Shift Differential		15,000
Sunday Pay		8,000
Overtime		25,000
Government Contributions		86,100
Longevity N. A.		--
Total Fringe Benefits for Personnel		167,900
TOTAL PERSONNEL COST		$1,124,700

TABLE 2. (Continued)--ITEMIZED OPERATION & MAINTENANCE COST ESTIMATE

SYSTEM 1--(Continued)--DEVIL CANYON AND DENALI

Miscellaneous

Telephone	$ 8,000
Official travel	15,000
Vacation travel	15,000
Supplies, Services & Maintenance--Powerplant	100,000
Supplies & Services--Vehicles & Equipment	40,000
Employee training	5,000
Line spray	20,000
Government camp maintenance	15,000
Total Miscellaneous	218,000

Equipment, Operation & Maintenance, Annual Replacement Cost

	I.C.*	S.L.*	ANNUAL COST
D-8 - (1)	$90,000	10	9,000
980 - (1)	50,000	10	5,000
Maintainer - (1)	50,000	10	5,000
Pickups - (4) & (6)	36,000	7	5,200
Sedan - (1)	4,000	7	600
Lowboy - (1)	45,000	10	4,500
Dumptruck - (1)	25,000	10	2,500
Flatbed - (4) & (2)	20,000	7	3,000
Firetruck - (1)	25,000	10	2,500
Sno tracs - (2)	16,000	7	2,300
Backhoe - (1)	20,000	10	2,000
Crane, 50 ton - (1)	150,000	20	7,500
Hydraulic Crane, 20 ton - (1)	90,000	20	4,500
Line trucks - (4)	100,000	10	10,000
Total Equipment, etc.			63,600

APA main office administration, accounting, collecting, marketing expenses.	132,000
TOTAL SYSTEM 1	$1,538,300

* S.L. = Service Life
I.C. = Initial Cost

TABLE 2. (Continued)--ITEMIZED OPERATION & MAINTENANCE COST ESTIMATE

SYSTEM 2. DEVIL CANYON AND WATANA 1/

Devil Canyon	700 MW
Watana	600 MW

Personnel

Watana Supervisory Control from Devil Canyon

Increase base staff of System 1.

2 Assistant operators	@ 11.00 hr.			$ 45,760
2 Electricians	@ 13.00 "			54,080
2 Mechanics	@ 13.00 "			54,080
1 Maintenance man	@ 11.00 "			22,880
				176,800
Overtime				10,000
Government Contributions				16,000
Foreman Pay				5,000
				31,000
Miscellaneous				
Vacation travel				3,000
Employee training				1,000
Supplies, Services & Materials				90,000
Supplies and Services				10,000
				104,000
Equipment				
	* I.C.	* S.L.		
2 Pickups	12,000	7		2,000
1 Snow tractor	8,000	7		1,000
				3,000
APA main office administrative, accounting, collecting & marketing expense				30,000
TOTAL ADDITIONS TO SYSTEM 1				344,800
SYSTEM 1				1,538,300
TOTAL SYSTEM 2				$1,883,100

1/ Same operation and maintenance estimate used for System #2, #3, and #5.

TABLE 2. (Continued)--ITEMIZED OPERATION & MAINTENANCE COST ESTIMATE

SYSTEM 4--DEVIL CANYON AND WATANA AND VEE

Vee 300 MW

Personnel

Add to System # 2:

1 Heavy equipment operator	@ 13.00 hr.	$	27,040
2 Electricians	@ 13.00 "		54,080
2 Mechanics	@ 13.00 "		54,080
2 Maintenance men	@ 11.00 "		45,760
1 Operator	@ 13.00 "		27,040
1 Assistant operator	@ 11.00 "		22,900
Total Wage Grade		$	230,900
Overtime			10,000
Government Contributions			20,800
Foreman Pay			5,000
Total Fringe Benefits			35,800

Miscellaneous

Vacation travel	6,000
Employee training	2,000
Supplies, Services and Materials--Powerplant & vehicles	50,000
Total Miscellaneous	58,000

Equipment, Operation & Maintenance, Annual Replacement Cost

D-8	9,000
Maintainer	5,000
Pickups - (4)	3,400
Dumptruck	2,500
Firetruck	2,500
Sno tracs - (2)	2,300
Backhoe	2,000
Hydraulic Crane, 20 ton	4,500
Total	31,200

APA main office administration, accounting, collecting, marketing expenses.	30,000
Total Additions to System 2	385,900
System 2	1,883,100
TOTAL SYSTEM 4	$2,269,000

TABLE 3. OPERATI_N AND MAINTENANCE COST SUMMARY

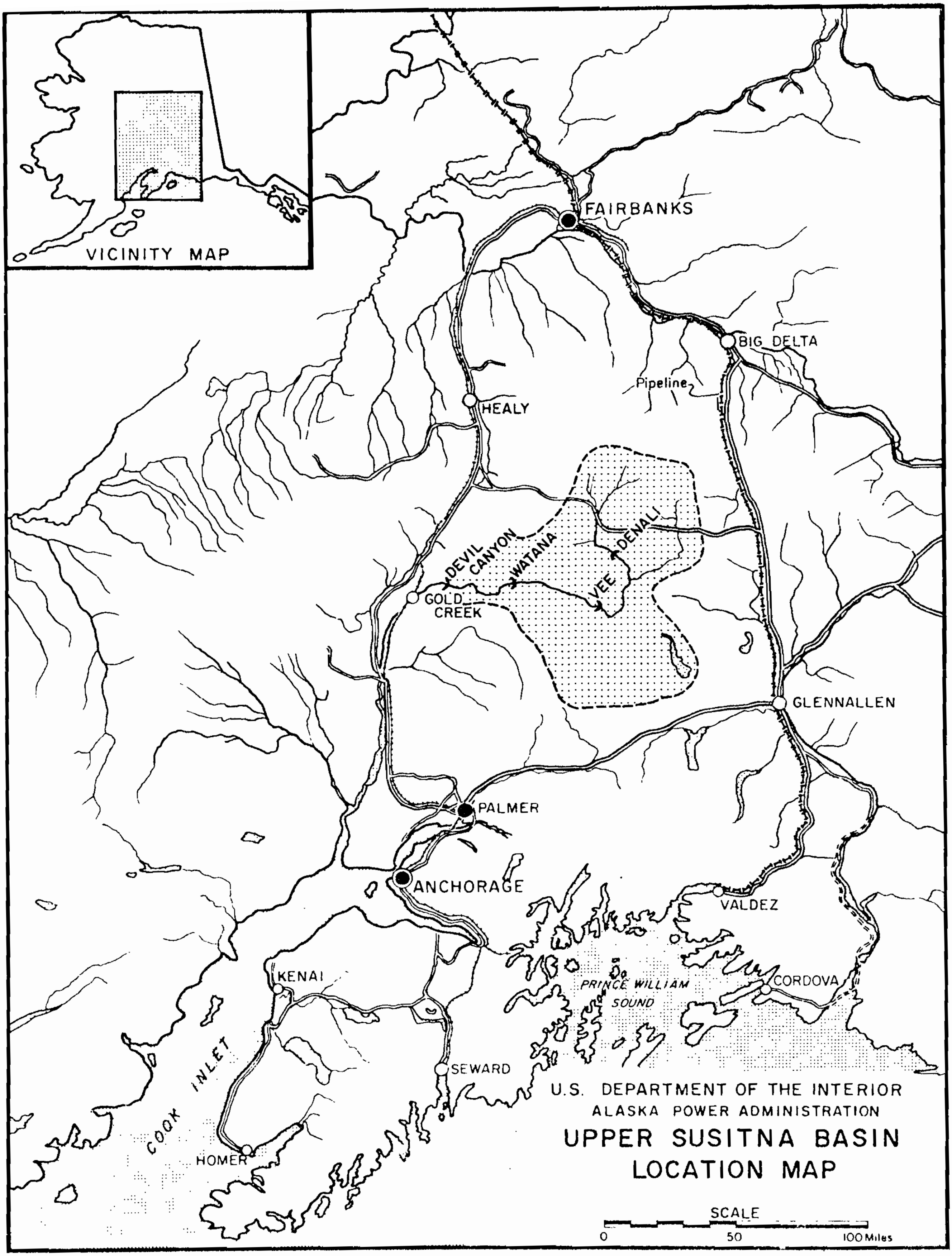
	System 1 Devil Canyon & Denali		System 2 Devil Canyon & Watana 1/		System 3 Devil Canyon, Watana & Denali		System 4 Devil Canyon, Watana, Denali, & Vee	
	Number	Dollars	Number	Dollars	Number	Dollars	Number	Dollars
Personnel:								
Direct costs, COLA, benefits, overtime		1,124,700		1,332,500		1,332,500		1,599,200
Number of classified persons	7		7		7		7	
Number of wage board persons	31		38		38		47	
Miscellaneous:								
Telephone, travel, supplies, services, training, line spray, camp maintenance		218,000		322,000		322,000		380,000
Equipment:								
Annual cost to replace		63,600		66,600		66,600		97,800
Subtotal		1,406,300		1,721,100		1,721,100		2,077,000
Marketing and Administration								
APA main office administration, accounting, collecting, marketing expense		132,000		162,000		162,000		192,000
TOTAL		1,538,300		1,883,100		1,883,100		2,269,000

1/ System #5 cost would be the same as System #2.

Table 4. Replacement Costs

Feature	Annual Replacement Factor	System #1 Devil Canyon and Denali: Cost to Construct	System #1: Annual Replacement Cost	System #2 & #3 Devil Canyon and Watana (includes Denali): Cost to Construct	System #2 & #3: Annual Replacement Cost	System #4 Devil Canyon, Watana, Vee and Denali: Cost to Construct	System #4: Annual Replacement Cost
Powerplant	0.0012	$128,000,000	$153,600	$283,600,000	$340,300	$404,400,000	$485,300
Transmission towers, fixtures & conductors	0.0001	85,200,000	8,500	150,000,000	15,000	163,400,000	16,300
Substations and switchyards	0.0039	9,400,000	36,700	25,100,000	97,900	29,900,000	116,600
			198,000		453,200		618,200

Feature	Annual Replacement Factor	System #5 Watana (el.2,200) and Devil Canyon: Cost to Construct	System #5: Annual Replacement Cost
Powerplant	0.0012	$301,191,000	$361,400
Transmission towers, fixtures & conductors	0.0001	180,362,000	18,000
Substations and switchyards	0.0039	35,235,000	137,400
			516,800


VICINITY MAP
FAIRBANKS
BIG DELTA
Pipeline
HEALY
DEVIL CANYON
WATANA
DENALI
VEE
GOLD CREEK
GLENNALLEN
PALMER
ANCHORAGE
VALDEZ
KENAI
PRINCE WILLIAM SOUND
CORDOVA
SEWARD
COOK INLET
HOMER
U.S. DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
UPPER SUSITNA BASIN
LOCATION MAP
SCALE
0
50
100 Miles

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SECTION H

TRANSMISSION SYSTEM

UNITED STATES DEPARTMENT OF THE INTERIOR
Alaska Power Administration

Upper Susitna River Hydroelectric Studies
Report on Transmission System

December 1975

Contents

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Part I INTRODUCTION

Purpose and Scope

This report covers the transmission system studies by the Alaska Power Administration for the proposed Upper Susitna hydroelectric development. The studies are of pre-authorization or feasibility grade. They consist of evaluation of alternative corridor locations from the viewpoints of engineering, costs, and environment; studies of transmission systems needed for alternative project development plans; and consideration of alternative transmission technologies. These studies deal with general corridor location; the more detailed studies following project authorization would include final, on the ground route location.

The engineering and environmental evaluations for the transmission systems are parts of the same study, and Alaska Power Administration's environmental assessment for the transmission system is a companion report to this volume.

Alternative Plans for Upper Susitna Hydroelectric Development

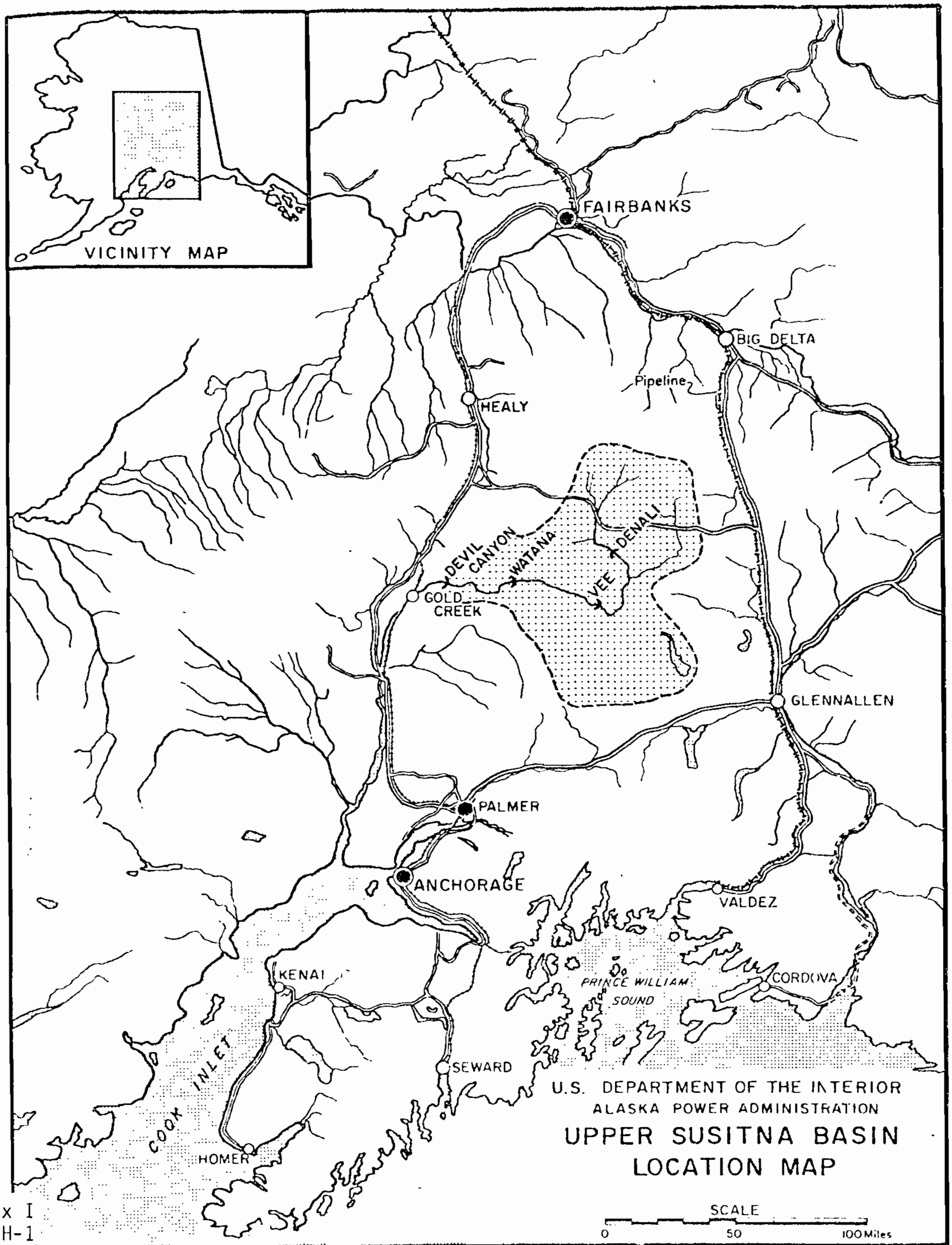
Figure 1 shows general locations of the potential units of the Upper Susitna Project in relationship to the Alaska Railbelt. The four key Upper Susitna damsites are Devil Canyon, Watana, Vee, and Denali.

The Corps of Engineers proposes an initial development including the Devil Canyon and Watana sites with the Denali site considered as a potential future stage. Table 1 summarizes data on energy and power capability and costs for this proposed plan and the principal alternative system for developing the Upper Susitna hydroelectric potential. System #5 is the Corps proposed plan.

Previous Studies

There is a fairly substantial backlog of power system and project studies relevant to the current evaluation of the Upper Susitna River Project. A partial bibliography is included in the power market report. The previous studies most relevant to power market and transmission system planning include:

1. Advisory Committee studies completed in 1974 for the Federal Power Commission's new Alaska Power Survey. The studies include evaluation of existing power systems and future needs through the year 2000, and the main generation and transmission alternatives available to meet the needs. The FPC summary report for its new survey is not yet available.


VICINITY MAP
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GOLD CREEK
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U.S. DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
UPPER SUSITNA BASIN
LOCATION MAP
SCALE
0
50
100 Miles

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Alternative System Plans
Installed Capacity & Firm Energy

System	W.S. el. M.S.L.	P.O.L. Date	Devil Canyon Installed Capacity 1000 kw	Devil Canyon Firm Energy Million kwh	Watana Installed Capacity 1000 kw	Watana Firm Energy Million kwh	Vee Installed Capacity 1000 kw	Vee Firm Energy Million kwh	System Total Installed Capacity 1000 kw	System Total Firm Energy Million kwh	System Total Secondary Energy Million kwh
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Devil Canyon	1450	1990	776	3048							
									1568	6149	701

Notes: System #5 is the proposed initial development plan.
Data is from Corps of Engineers studies.

2. A series of studies for Railbelt area utilities include assessments of loads, power costs, and generation and transmission alternatives.

3. Previous work by the Alaska Power Administration, the Bureau of Reclamation, the utility systems, and industry on studies of various plans for Railbelt transmission interconnections and the Upper Susitna hydroelectric potential. The most recent of these are the May, 1974 Status Report on the Devil Canyon Project by APA and the September, 1974 Reassessment Report on Upper Susitna River Hydroelectric Development prepared for the State of Alaska by the Henry J. Kaiser Company.

It should be noted that many of the studies listed in the bibliography represent a period in history when there was very little concern about energy conservation, growth, and needs for conserving oil and natural gas resources. Similarly, many of these studies reflected anticipation of long term, very low cost energy supplies. In this regard, the studies for the new power survey are considered particularly significant in that they provide a first assessment of Alaska power system needs reflecting the current concerns for energy and fuel conservation and the environment, and the rapidly increasing costs of energy in the economy.

Acknowledgements

We have attempted to reference principal data sources in the text. The corridor studies utilized data from many different sources--USGS mapping; ERTS photo mosaics obtained through the Geophysical Institute of the University of Alaska; soils survey and snow survey information from Soil Conservation Service reports for portions of the corridors; resources maps and reports from the statewide resources inventory by the Resources Planning Team of the Federal-State Land Use Planning Commission; the State of Alaska's Regional Profile for the Southcentral Region; climate records from the National Weather Service; and other data sources.

The Bonneville Power Administration provided technical assistance in several ways: participation in the aerial and surface reconnaissance of the potential corridors; structural designs and unit costs for transmission lines and substations; consultations on the transmission environmental assessment and reviews of design and cost studies prepared by APA.

The electric utilitity systems of the Railbelt area provide the Alaska experience base for considering future transmission systems; utility personnel provided valuable assistance through consultation on their transmission system experiences and practices and on alternative plans for transmitting Susitna power to the load centers.

SUMMARY

1. The main elements of the study were: (1) evaluation of alternative corridors for locating project transmission lines considering environmental, engineering, reliability and cost aspects; (2) preparation of designs and cost estimates for the transmission systems needed for alternative project development plans.

2. The power market analyses (APA report on project power markets) show that the bulk of the project power would be utilized in Fairbanks - Tanana Valley and Anchorage - Cook Inlet areas, with smaller potential markets in the Glennallen and Valdez areas and other points along the Richardson Highway. Because of the relatively large demands, electric service to the Anchorage and Fairbanks areas is the largest single consideration in design of project transmission facilities. Service to the other areas would be added when feasible.

3. The corridor evaluation started with map identification of all potentially feasible corridors and a field reconnaissance which eliminated those for which topography, elevation, and climate factors would be unacceptable. The remaining corridors were then evaluated in more detail to determine their relative advantages and disadvantages. Much of the detail of this evaluation is presented in the APA environmental assessment of the project transmission facilities.

4. It was concluded that the most desirable corridor location would follow existing surface transportation systems whenever possible. The principle disadvantage of such location is line visibility from the existing road and rail systems. Careful attention to use of natural vegetation and topography to screen the lines, locating the lines at an appropriate distance from roads, and selection of non-reflecting materials in final route selection and design would minimize visibility problems; it is recognized that even with best location and design, portions of the line would be highly visible. Significant advantages of locating the lines near existing surface transportation systems include minimizing requirements for new access roads, savings in costs for construction and operation and maintenance, a significant improvement in reliability, and avoiding need for pioneering new corridors in presently undeveloped areas.

5. Except for constricted passes through the mountains, the proposed corridors should be considered as very broad and general locations within which many alternatives are possible for final route locations. The final route locations would be determined through detailed post authorization studies.

6. The most serious conflicts in the final route selection will likely be encountered in the Nenana Canyon route through the Alaska Range. The Fish and Wildlife Service has recommended that a route west of the Parks Highway be selected through the Nenana Canyon to minimize possible conflicts with raptor habitat. Any route through the Canyon area would involve lines visible from portions of Mount McKinley National Park and the FWS proposal would place portions of the route within park boundaries. APA considers use of the corridor through the Nenana Canyon will result in substantially less environmental damage than would the pioneering of new corridors through the Alaska Range.

7. Additional conflicts are anticipated in final route selection along the approaches to Anchorage because of the Knik Arm, and topography, and land use and ownership patterns on possible routes around Knik Arm. Cost estimates presented in this report assume delivery of project power to points on the CEA transmission system north of Knik Arm. It is recognized that the detailed studies following authorization would need to consider several alternative plans to transmit power across or around Knik Arm to Anchorage.

8. The initial set of transmission plans and estimates were prepared for use in evaluating the alternative Susitna hydroelectric development plans. It was found that conventional overhead lines at 230 kv and 345 kv would be suitable for the distances and amounts of power involved. The initial plans used double circuit lines on a single set of towers and assumed delivery points at Fairbanks and Anchorage.

9. As a result of review by area utilities, the Bonneville Power Administration, and others, the transmission plan and cost estimate for the initial hydro development plan (Watana and Devil Canyon) was modified to incorporate: the added costs for two single circuit lines in lieu of double circuit lines; an additional substation in the general vicinity of Talkeetna; and a switching station in the vicinity of Healy. The resulting transmission plan includes: two single circuit 230 kv lines from

Watana to Devil Canyon (30 miles), two single circuit 230 kv lines from Devil Canyon to Fairbanks (198 miles) within intermediate switching station at Healy; and two single circuit 345 kv lines from Devil Canyon to points on the north shore of Knik Arm (136 miles) with an intermediate substation in the vicinity of Talkeetna. The estimated construction cost based on January 1975 price levels is $256 million. It is estimated that three years would be required for construction of the transmission facilities following completion of detailed route studies and final designs and acquisition of necessary rights-of-way.

10. Rough plans and estimates were prepared for transmission systems to deliver project power to Glennallen and other points along the Richardson Highway, and results are summarized along with economic analyses of such plans in the APA power market study.

11. Alternative transmission technologies were considered in plan selection, including DC systems and underground lines. With exsiting and likely near future technology, reliability and cost considerations appear to rule out use of underground systems for the lines under consideration. Operating characteristics of DC systems would essentially rule out their application for an initial system to distribute project power to Railbelt power markets.

12. The general corridor locations and transmission designs and estimates are considered adequate for purposes of demonstrating project feasibility.

Part III EXISTING TRANSMISSION SYSTEMS

The power market studies make it very clear that a major part of the project power would be utilized in the Anchorage - Cook Inlet and Fairbanks - Tanana Valley areas, respectively. Additional potential power markets exist in the Glennallen and Valdez areas and along the Alyeska pipeline.

Anchorage-Cook Inlet Area

The five electric utility companies serving this area are:

Anchorage Municipal Light and Power (AML&P)
Chugach Electric Association (CEA)
Matanuska Electric Association (MEA)
Homer Electric Association (HEA)
Seward Electric System (SES)

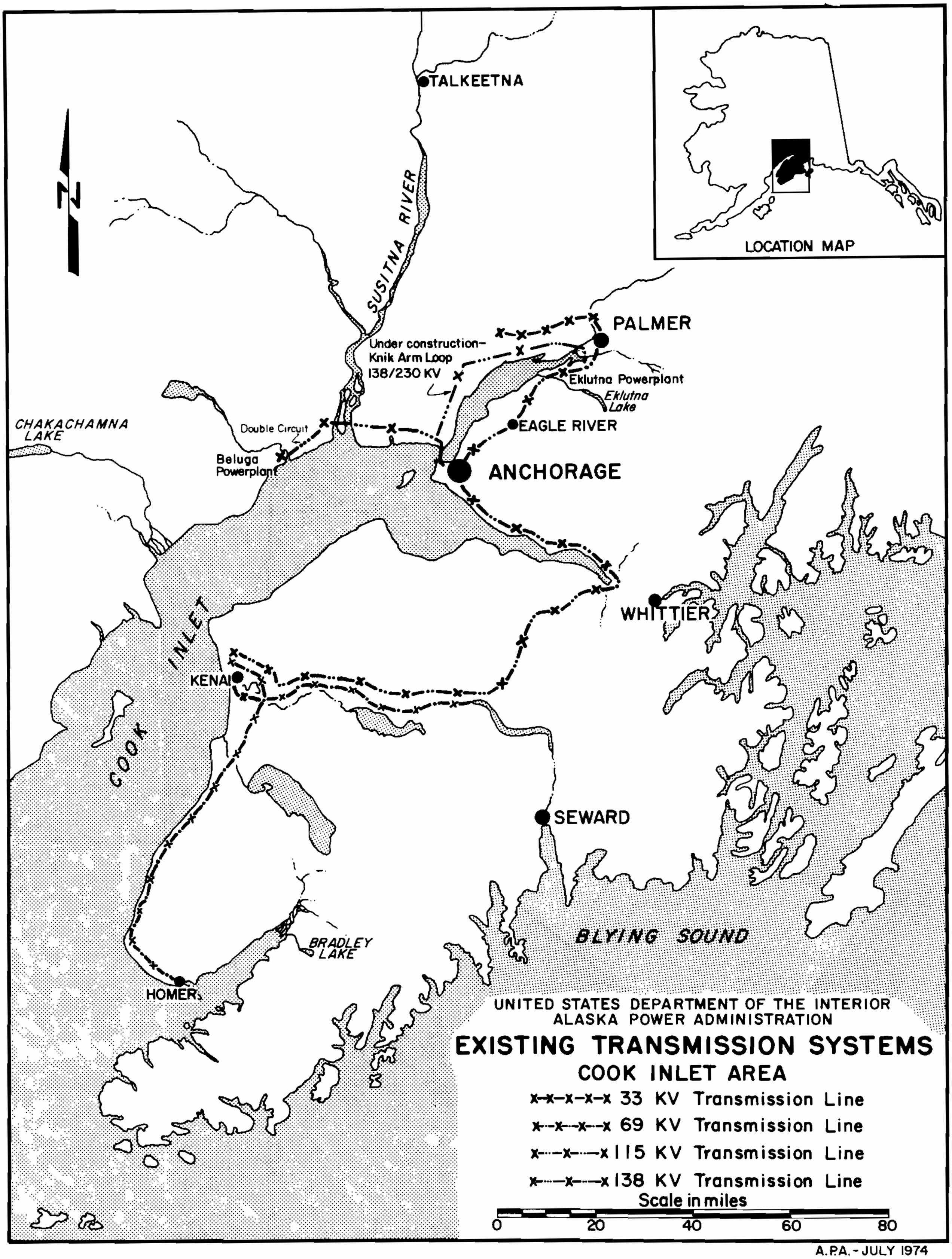
Alaska Power Administration operates the Eklutna Hydroelectric Project and markets wholesale power to CEA, AML&P, and MEA.

AML&P serves the Anchorage Municipal area. CEA supplies power to the Anchorage suburban and surrounding rural areas and provides power at wholesale rates to HEA, SES, and MEA. The HEA service area covers the western portion of the Kenai Peninsula including Seldovia, across the bay from Homer. MEA serves the town of Palmer and the surrounding rural area in the Matanuska and Susitna Valleys. SES serves the city of Seward.

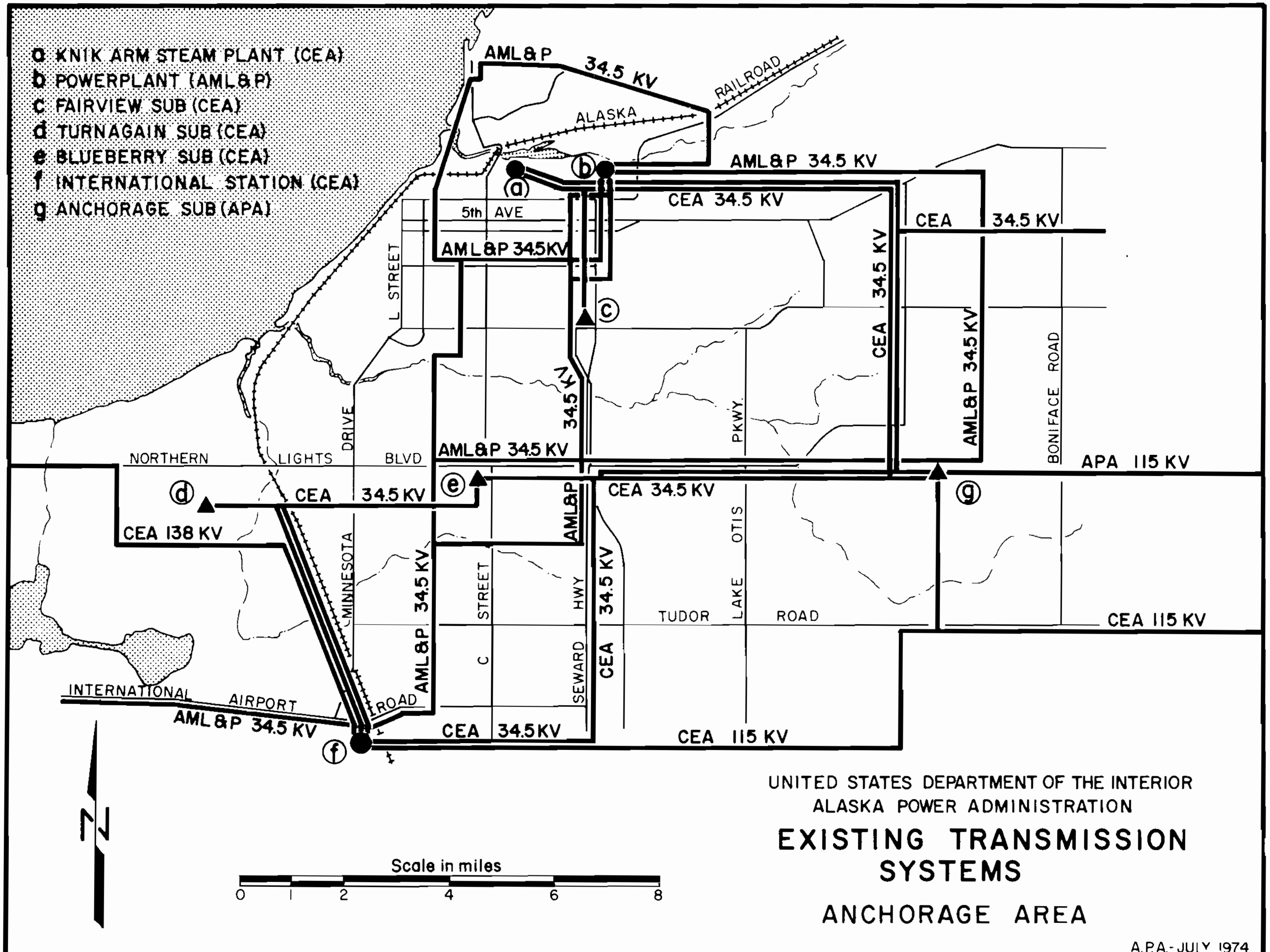
The utilities serving the Anchorage-Cook Inlet area are presently loosely interconnected through facilities of APA and CEA. An emergency tie is available between the AML&P and Anchorage area military installations.

The existing transmission systems in this area are indicated on Figures 2 and 3. Table 2 has a summary of existing lines and interconnections. The area presently has a total of about 545 circuit miles at 33 kv or higher voltage.

CEA has under construction a 230 kv overhead line around Knik Arm to Anchorage including interconnections with the MEA and APA systems. The initial phase is now under construction; initial operation will be at 138 kv.



Appendix I
FIGURE H-2


a KNIK ARM STEAM PLANT (CEA)
b POWERPLANT (AML&P)
c FAIRVIEW SUB (CEA)
d TURNAGAIN SUB (CEA)
e BLUEBERRY SUB (CEA)
f INTERNATIONAL STATION (CEA)
g ANCHORAGE SUB (APA)
AML&P 34.5 KV
RAILROAD
ALASKA
AML&P 34.5 KV
CEA 34.5 KV
5th AVE
AML&P 34.5KV
CEA 34.5 KV
L STREET
34.5 KV
CEA 34.5 KV
AML&P 34.5 KV
BONIFACE ROAD
PKWY.
DRIVE
NORTHERN LIGHTS BLVD
AML&P 34.5 KV
APA 115 KV
CEA 34.5 KV
CEA 34.5 KV
CEA 138 KV
AML&P
OTIS
MINNESOTA
AML&P 34.5 KV
C STREET
SEWARD HWY
CEA 34.5 KV
LAKE
TUDOR ROAD
CEA 115 KV
INTERNATIONAL AIRPORT ROAD
AML&P 34.5 KV
CEA 34.5KV
CEA 115 KV
N
Scale in miles
0 1 2 4 6 8
UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
EXISTING TRANSMISSION SYSTEMS
ANCHORAGE AREA
A.P.A.-JULY 1974

For purposes of this study, it is assumed that Susitna power would be made available at a substation in the vicinity of Talkeetna and at points on the CEA 230 kv loop around Knik Arm, and that the power would be wheeled over the CEA and APA Eklutna systems to serve Anchorage. As discussed later in the report, the actual plan for delivering project power in the Anchorage-Cook Inlet area will need to be determined through detailed systems studies following project authorization.

Fairbanks-Tanana Valley Area

The two electric utilities in this area are:

Fairbanks Municipal Utility System (FMUS)
Golden Valley Electric Association (GVEA)

FMUS serves the Fairbanks municipal area, while GVEA provides service to the suburban and rural areas. The Fairbanks area power suppliers have the most complete power pooling agreement in the State. FMUS, GVEA, the University of Alaska and the military bases have an arrangement which includes provisions for sharing reserves and energy interchange accounts. In addition, GVEA operates the Fort Wainwright steamplant under an agreement with the army.

The existing transmission systems are indicated on Figure 4; Table 2 includes a summary of the lines and existing interconnections.

The delivery point for Upper Susitna power to the GVEA and FMUS systems is assumed at the existing Gold Hill substation of GVEA near Fairbanks.

Glennallen and Valdez

The Copper Valley Electric Association serves both Glennallen and Valdez. Radial distribution lines of CVEA extend from Glennallen 30 miles north on the Copper River, 55 miles south on the Copper River to Lower Tonsina and 70 miles west on Glenn Highway.

CVEA has given some consideration to a 115 kv intertie between Valdez and Glennallen. For this study, it is assumed that project power would be delivered to the CVEA system at Glennallen.

Transmission Lines and Major Interconnections

(Note: Lines under 33 kv not included)

		Transmission Lines			Interconnections 1/	
Area	Owner	Designation	KV	Mileage	With	Substation
Fairbanks	GVEA	Healy-Gold Hill	138	104	U.of Alaska	University
		Gold Hill-Johnson Rd.	69	45	Ft.Wainwright	Ft.Wainwright
		Zehnder-Fox	69	8	Eielson AFB	Eielson
		Misc. within City	69	3	Ft. Greely	Highway Park
		Gold Hill-Murphy Dome	34.5	24	FMU	Zehnder
		Fox-Pilot Bluff	34.5	18		
	FMU	Muni. Pwr. Plt.-Zehnder	69	1	Ft.Wainwright (See GVEA)	19th Street
Anchorage-Cook Inlet	MEA	Eagle River Tap-Walter Pipple	115	3/4	APA	Palmer
		Palmer-NW Knik Arm Sym.	34.5	42	APA	Reed
		Palmer-Lucas-Reed	34.5	18	APA	Eagle River
	APA	Eklutna-Palmer	115	15	AML&P	Anchorage
		Eklutna-Reed-Eagle River-Anchorage	115	32	CEA	Anchorage
					Elmendorf	Anchorage
	AML&P	Anchorage APA Sub-City System	34.5	23-1/3	(See APA)	

(cont.) **Transmission Lines and Major Interconnections**

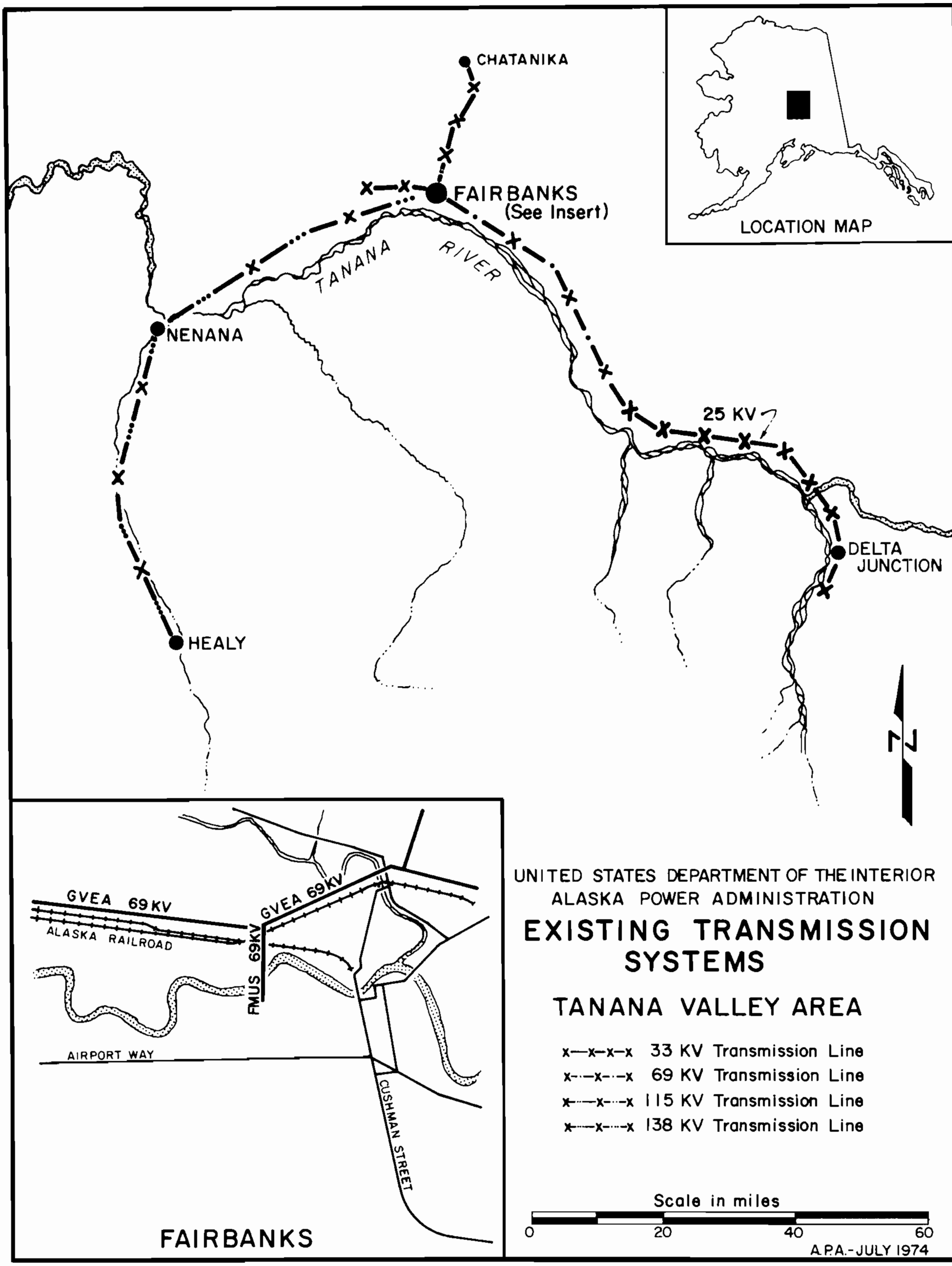
(Note: Lines under 33 kv not included)

		Transmission Lines			Interconnection 1/	
Area	Owner	Designation	KV	Mileage	With	Substation
Anchorage-Cook Inlet (cont.)	CEA	Beluga-International	138	52 (incl. 4 mi.submarine)	(See APA and HEA)	
		Anchorage APA Sub-Bernice Lake 2/	115	165-¼		
		Cooper Lake-Quartz Creek	69	6		
		3 Lines to Soldotna 3/	69	86		
		Misc. within Anchorage	34.5	31		
	HEA	Kasilof Sub-Homer	69	61	CEA	Kasilof
		Kenai Area Line	33	12-½		

1/ Listed only once under substation ownership (National Defense-owned substations are listed under the interconnected utility).

2/ Incl. Tudor Sub. - International and spur line to Portage. Quartz Creek-Bernice Lake portion leased from HEA.

3/ Leased from HEA: Soldotna-Quartz Creek, Soldotna-Bernice Lake, Soldotna-Kasilof.



Appendix I
FIGURE H-4

Part IV TRANSMISSION CORRIDOR STUDIES

This portion of the transmission study evaluates alternative corridors for transmission facilities to deliver project power to the power markets. The term "corridor" means general location of transmission facilities, and the studies are intended to show relative merits of alternative transmission corridors from the viewpoints of the environment, engineering, economics, and reliability.

Width of corridor is not defined precisely. The actual right-of-way needed is fairly narrow. Except where limited by specific physical or environmental considerations, the corridors themselves should be considered several miles wide.

The major mountain ranges--Alaska, Talkeetna, and Chugach--limit the range of choice in corridors (See Figure 5). The higher elevations in these mountains are completely unsuitable for transmission lines, and there are relatively few low-elevation passes through these ranges. Away from the mountains, a wide range of locations could be considered.

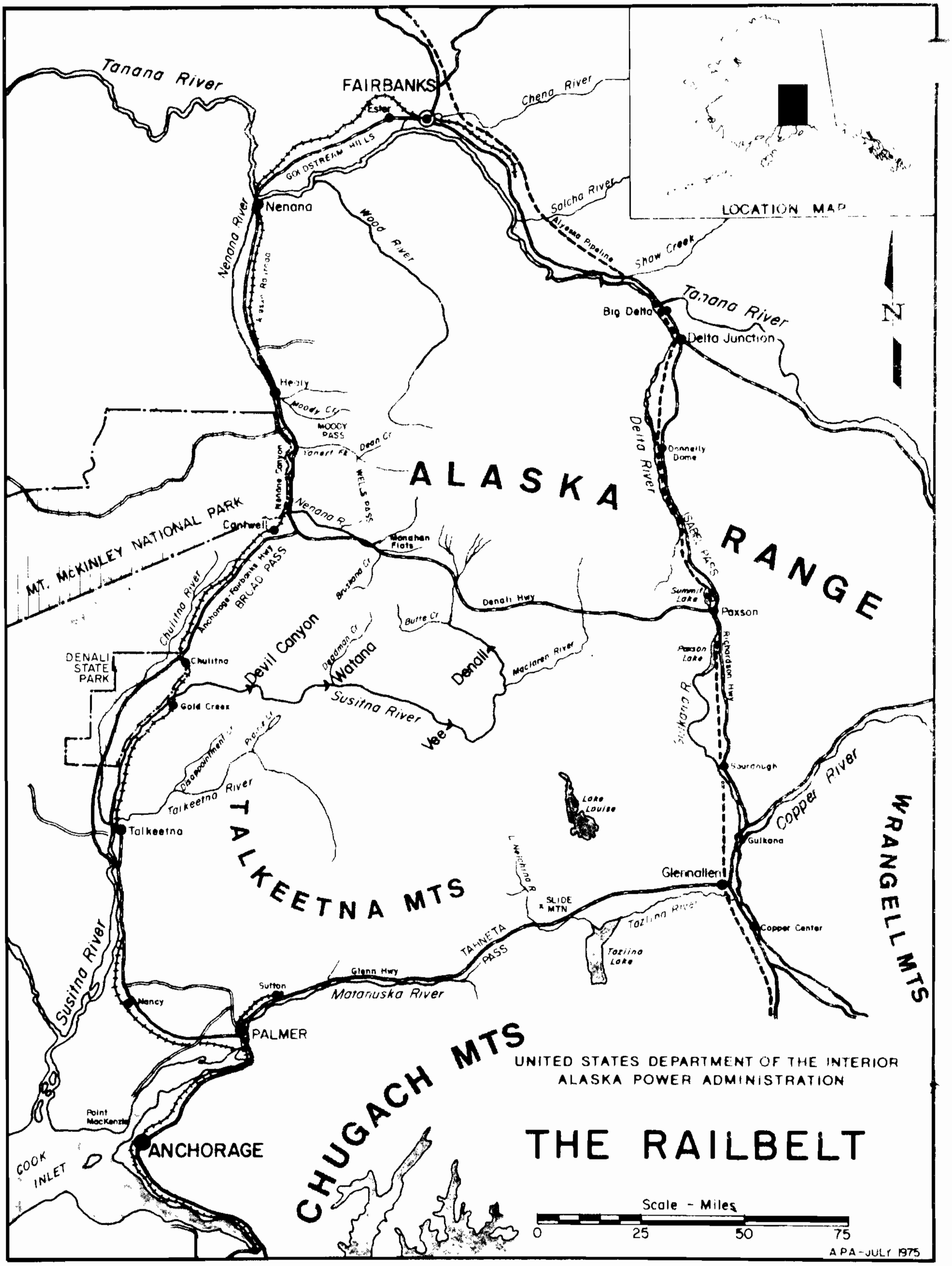
Figure 6 illustrates on a very broad scale, the alternatives for locating the lines. From the project south to the Anchorage area, the heart of the Talkeetna mountains can be avoided by corridors which generally follow the Susitna River Valley (Susitna Corridor) or ones that pass to the east of the mountains and approach Anchorage from the Matanuska Valley (Matanuska Corridors).

From the project north to the Fairbanks area, the options for crossing the Alaska Range are limited to the pases in the Nenana River drainage (Nenana Corridor) or to the east generally along the Richardson Highway (Delta Corridor).

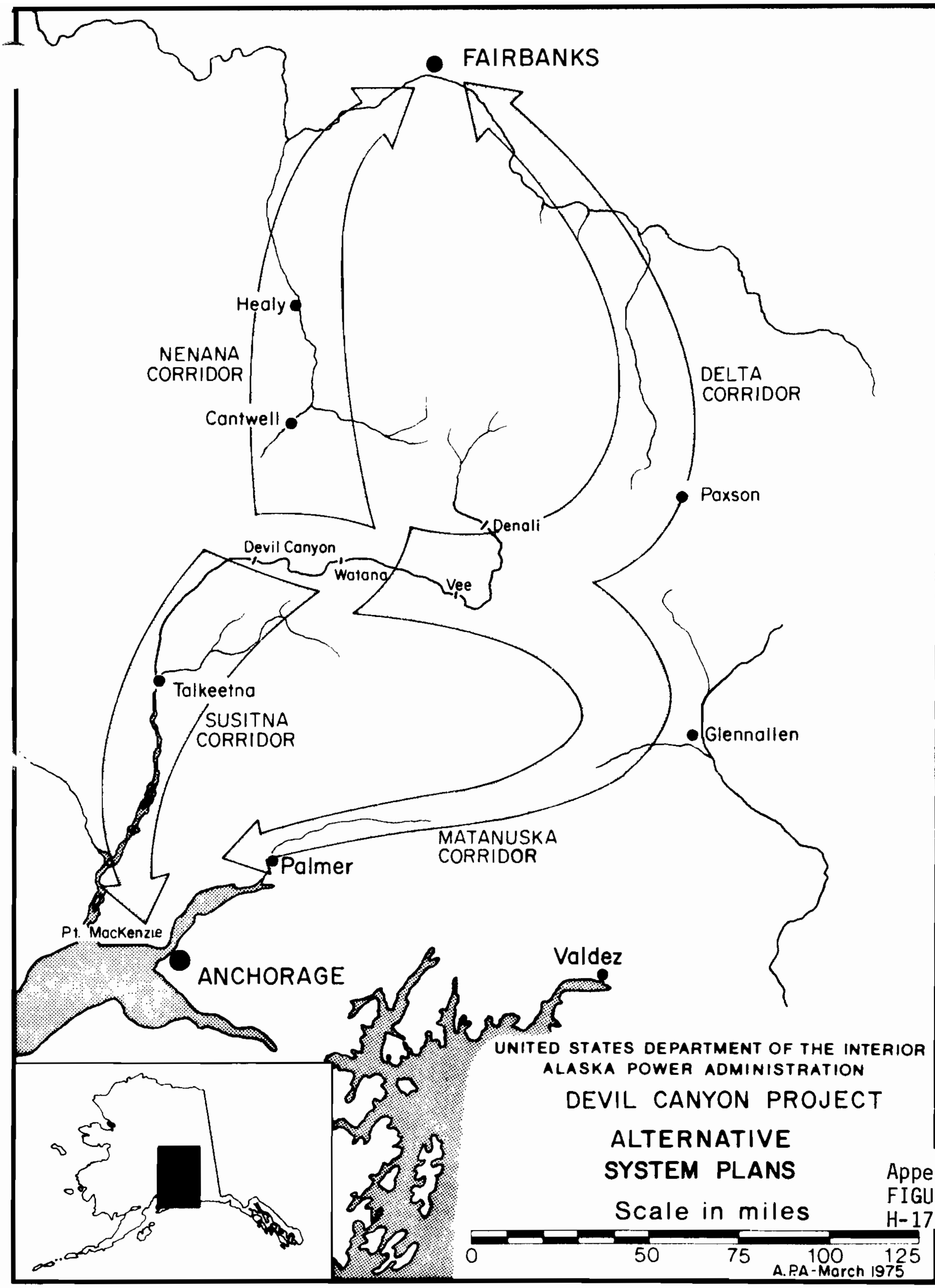
Method of Evaluation

A preliminary identification of potential corridors was made utilizing large scale topographic maps and photo mosaics prepared from satellite photography. This involved primarily identifying potentially feasible passes through the mountains. Figure 7 indicates the corridors identified in this step.

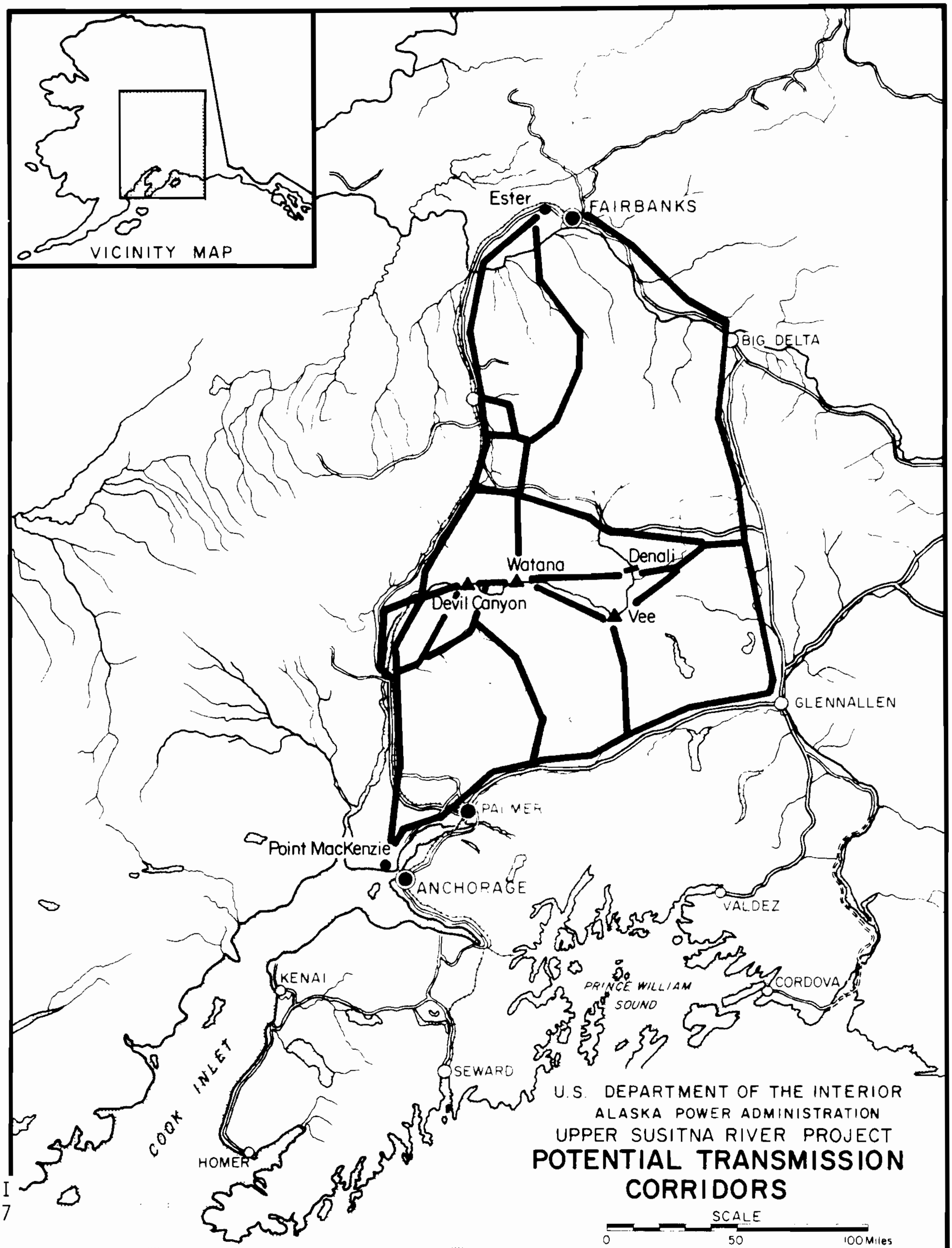
The second step involved an aerial reconnaissance to determine which of these corridors were actually feasible for constructing lines. Several were found to have "fatal flaws" or characteristics that would preclude their use for transmission lines. Reasons for eliminating corridors at this stage included completely unsuitable topography, obstruction by major glaciers, or excessive elevations.



Appendix I
FIGURE H-5
H-16



Appendix I
FIGURE H-6



Appendix I
FIGURE H-7

The remaining potential corridors, which are indicated on Figure 8, were then analyzed in more detail. The basis for the analysis was individual corridor segments which are indicated on Figure 9. For convenience, the alternative corridors and the individual segments were numbered as shown on the maps. Table 3 provides a key to this numbering system. All of these remaining corridors are considered physically feasible for transmission lines.

The evaluation is intended to identify the relative advantages and disadvantages of utilizing the alternatives for transmission lines. The steps in the evaluation were:

(1) Description and inventory by segment of the key resources that would be impacted by a transmission line.

(2) Evaluation of probable impacts of locating, building, and operating transmission lines for each segment.

(3) Determination of relative cost and reliability for lines utilizing the alternative corridors.

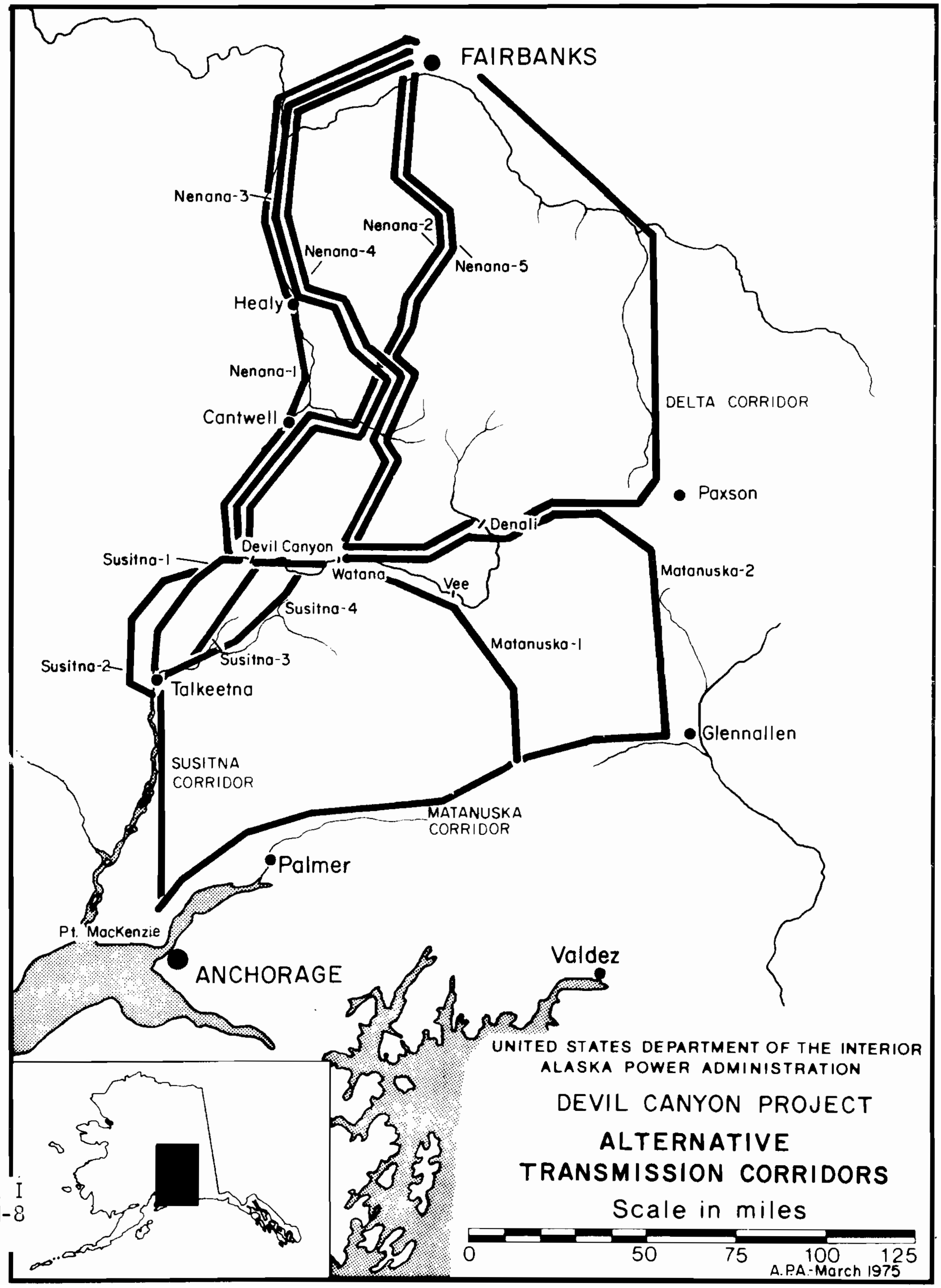
(4) Summarization of advantages and disadvantages from the viewpoint of environment, engineering, costs, and reliability of service.

(5) Selection of preferred corridors.

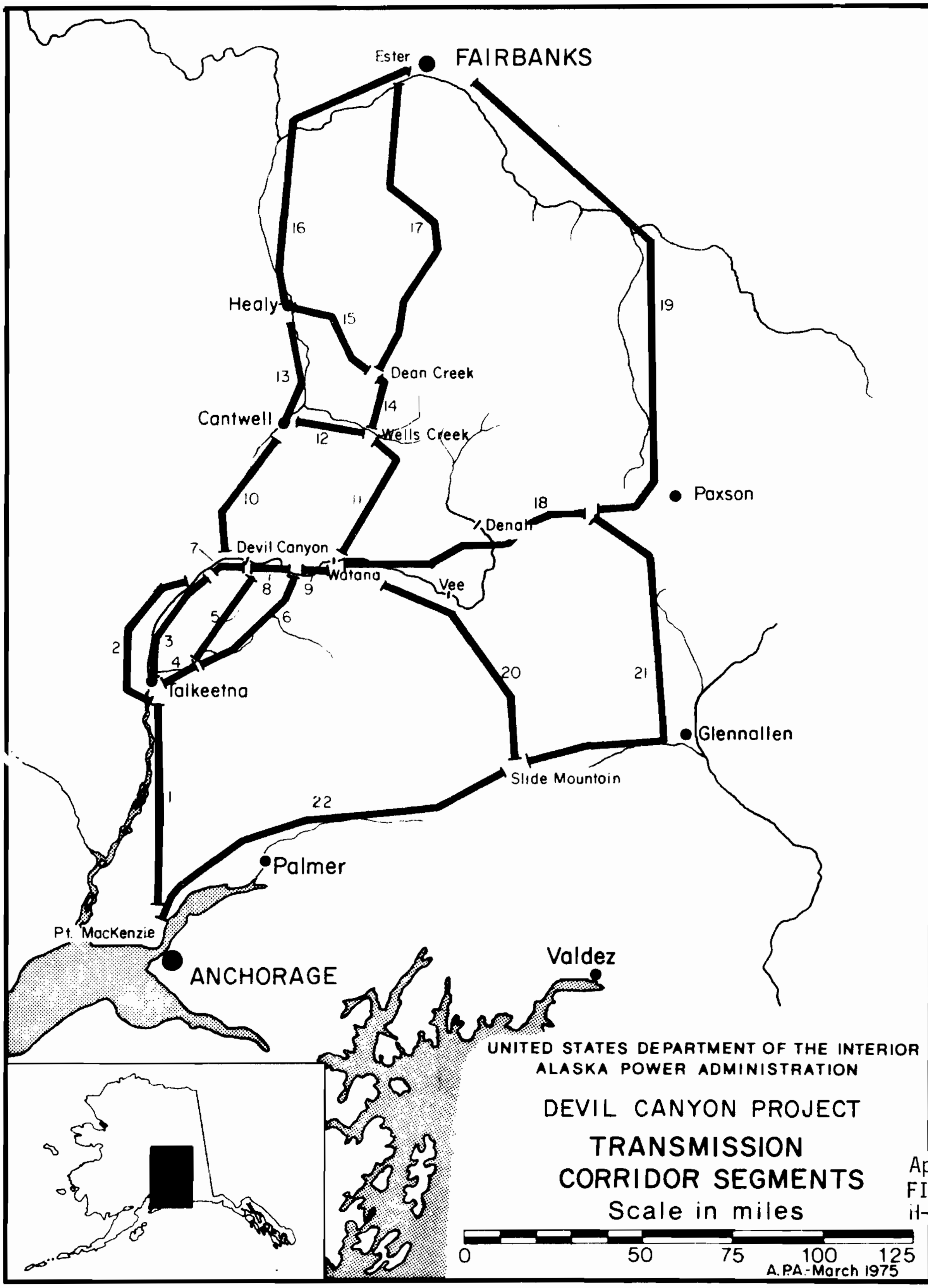
The comparisons between alternatives used parameters that could be quantified, such as length and cost, while judgment ranking was used for those parameters that could not be readily quantified.

The descriptions and inventory and evaluation of impacts are reported in more detail in the A.P.A. environmental assessment, with only summary information presented in this report. The description and inventory grouped data and interpretations under nine broad categories:

(1) Topography and Geology
(2) Soils
(3) Vegetation
(4) Wildlife
(5) Climate
(6) Existing Developments
(7) Land Ownership and Status
(8) Relation to Existing Rights of Way
(9) Scenic Quality and Recreation



Appendix I
FIGURE H-8
H-20



Appendix I
FIGURE H-9

Key to Alternative Corridors and Segments

Corridor	Segments of Corridor	Approximate Total Mileage
	Susitna Corridors	
Susitna #1	1, 3, 7, 8, 9	166
Susitna #2	1, 2, 7, 8, 9	170
Susitna #3	1, 4, 5, 8, 9	159
Susitna #4	1, 4, 6, 8, 9	164
	Matanuska Corridors	
Matanuska #1	8, 9, 20, 22	258
Matanuska #2	8, 9, 18, 21, 22	385
	Nenana Corridors	
Nenana #1	9, 8, 7, 10, 13, 16	228
Nenana #2	9, 8, 7, 10, 12, 14, 17	250
Nenana #3	9, 8, 7, 10, 12, 14, 15, 16	261
Nenana #4	8, 9, 11, 14, 15, 16	223
Nenana #5	8, 9, 11, 14, 17	212
	Delta Corridor	
Delta #1	8, 9, 18, 19	280

The probable impacts are identified and described under five broad categories in the environmental assessment.

(1) Soils
(2) Vegetation
(3) Wildlife
(4) Existing Developments
(5) Scenic Quality and Recreation.

Alternative corridors were compared utilizing a judgment ranking under each of the five impact categories.

The cost aspect of the corridor analysis is premised on rough reconnaissance costs for a double circuit steel tower line located in the corridor. The estimate included access facilities using the following criteria:

(1) For corridors within approximately five miles of existing surface transportation, pioneer access suitable for four-wheel drive vehicles would be provided where terrain and soils are favorable. Where soils are not suitable for pioneer road type of access, no road is provided and overland access for construction and operation and maintenance would be limited to winter periods with adequate snow cover. Otherwise, access would be by helicopter.

(2) For corridors pioneering into new areas, or more than five miles from existing surface transportation, the estimates include a new road to minimum standards suitable for access to the line and to provide appropriate environmental protections--adequate erosion control, permafrost protection, etc. Such new roads would be single lane, gravel surface, with periodic passing areas.

Relative cost and difficulty for operation and maintenance activities are shown by judgment ranking for this analysis. This reflects ease of access, terrain, climate, and other factors that bear on the operation and maintenance activities.

Reliability is also shown by judgment ranking reflecting relative hazards to major outages and relative difficulty of making repairs.

The Corridors

The alternatives represent only general corridors, and do not attempt to define an actual right-of-way. Thus, the alternatives do not distinguish among many minor variations, and as a result, are fairly flexible.

Only brief descriptions of the corridors are included here since details of resources and identified impacts are available in the APA environmental assessment. As a summary reference, the "Inventory" and "Impact" matrixes from the assessment are appended to this report.

Susitna Corridors

There are basically four feasible corridors which connect Devil Canyon to Anchorage via the Susitna drainage. All four of these incorporate the segment that runs from the endpoints of Point MacKenzie to Talkeetna, so this segment can, therefore, be treated as separate and not included in a comparison of the alternative corridors.

Of the four corridors that run from Talkeetna to Devil Canyon-Watana, the first follows the Susitna Valley north, paralleling the Alaska Railroad to Gold Creek, where it leads east to tie into Devil Canyon-Watana (Susitna - 1).

The next, and farthest west, parallels the Anchorage-Fairbanks Highway through Denali State Park, along Troublesome Creek, eventually leading east to tie into Gold Creek and Devil Canyon-Watana (Susitna - 2). The third goes up the Talkeetna River and gaining the ridge to the east of Disappointment Creek, leads north to the ridge leading to Devil Canyon (Susitna - 3).

The fourth and most easterly corridor follows the Talkeetna River to Prairie Creek, which it follows to Stephan Lake, halfway between Devil Canyon and Watana (Susitna - 3).

Nenana Corridors

There are five feasible corridors connecting the Upper Susitna with Fairbanks by way of the Nenana River. The first is a corridor paralleling the highway and railroad from Gold Creek to Cantwell, to Healy, and to Fairbanks (Nenana - 1).

The second duplicates the first corridor to Cantwell, but then leads east paralleling the Denali Highway, as far as Wells Creek and north over the pass to Louis Creek, continuing over the Dean Creek Pass to the Wood River. It then follows the Wood and Tanana Rivers to Fairbanks (Nenana - 2).

The third corridor, (Nenana - 3), duplicates the second to Dean Creek, where it then continues up Yanert Fork and over Moody Pass, ending up at Healy and joining the first corridor.

Corridor four (Nenana - 4) leaves Watana and heads north, emerging onto the Denali Highway near the Brushkana River. It then leads west, goes up Wells Creek, and joins corridor three to Healy and Fairbanks.

Corridor five starts the same way as corridor four, except instead of going over Moody Pass to Healy, it leads east over Dean Creek into the Wood River, and then leads north to Fairbanks, (Nenana - 5).

Delta Corridor

For this study, only one corridor along the Delta River was considered. This corridor leaves Watana damsite and leads east down Butte Creek to the Denali damsite and continues east along the Denali Highway. It then proceeds north near Paxson over the Isabel Pass and parallels the Richardson Highway into Fairbanks. Alternatives could be very limited in the vicinity of Isabel Pass, but additional alternatives could be considered in the Tanana Valley and Copper River Valley.

Matanuska Corridors

Two corridors were considered utilizing the Matanuska Valley as access to Anchorage. The first corridor connects Watana to Vee damsite, leads southeast to the Little Nelchina River, which it follows to the Glenn Highway and corridor one, which it follows to Point MacKenzie (Matanuska-1).

The second follows the Delta route to Paxson, then leads south to Glennallen. It then goes west, over Tahneta Pass, and into the Matanuska Valley, tying into Point MacKenzie (Matanuska-2).

Available Data

A variety of data sources were used in the study, including U. S. Geological Survey maps at scale 1:250,000 and 1:63,360, ERTS photo mosaics, and uncontrolled aerial and ground photo mosaics of critical areas.

The data compiled by the Resource Planning Team of the Land Use Planning Commission in their statewide inventory studies was used extensively. This data is available in a set of 1:250,000 overlay maps and supporting reports. It includes information on geology, vegetation, wildlife habitat, soils, water resources, recreation, land status, archaeological and historic sites, and other resource aspects.

More detailed soil survey data from the Soil Conservation Service is available for some corridor segments. U.S. Geological Survey permafrost maps were utilized.

Available climatological data from the National Weather Service were utilized for Fairbanks, Anchorage, Palmer, Talkeetna, Summit, McKinley Park, Clear, and other locations in the Railbelt.

In September, 1974, personnel from APA and Bonneville Power Administration made an aerial and surface reconnaissance of the alternative corridors to examine critical areas and obtain first-hand information on the terrain and other factors.

Over 2,600-35mm slides were taken, processed, indexed, and catalogued to record and preserve details of the observations. Interviews with management and maintenance personnel of the two major utilities operating transmission lines in the marketing areas of Anchorage and Fairbanks were made. The objective was to determine the criteria, problems, experience, and suggestions they could offer in planning, locating, and designing an upper Susitna transmission system.

Panoramic photo mosaics were prepared using photographic color prints made from the slides to help evaluate the impact of a transmission line constructed through critical, scenic, and other potential problem areas. Reports covering impressions and data gathered from the reconnaissance and rough cost evaluations were prepared to further assess the merits of the various alternative corridors.

Uncontrolled aerial photo mosaics of the alternative corridors were prepared to assist in the resolution of questions in critical problem areas.

Several environmental impact statements were used to provide information not readily available elsewhere.

Aerial photographs of the various corridor routes are available from Bureau of Land Management, U.S. Geological Survey, and Alaska State Highway Department.

Numerous magazines, newspapers, publications, and other reports were also incorporated into the study data.

Location Considerations

Corridor location objectives are to obtain an optimum combination of reliability and cost with the fewest environmental problems. In many cases, these objectives are mutually compatible. However, this is often not the case with respect to line visibility and scenic impacts. Throughout the corridor evaluation, the question arises of whether it is more desirable to place lines relatively close to existing surface transportation facilities or to pioneer new corridors where the line would be seen by few people.

The following items are major factors considered in the evaluation of alternative corridors:

Climate and Elevation

Winds, icing, snow depth, and low temperatures are very important parameters in transmission designs, operation, and reliability. Experience with existing lines of the area utilities indicates few unusual climatic problems for the areas away from the mountains, except for winter low temperatures that inhibit operation and maintenance activities.

The climate factors become more severe in the mountains. High winds, longer winters, more snow, and colder average temperatures are charactistic. APA believes that elevations above about 4000 feet in the Alaska Range and Talkeetna Mountains are completely unsuitable for locating major transmission facilities. Significant advantages in reliability and cost are expected if the lines can be kept well below 3000 feet in elevation.

Extreme winds in excess of 100 MPH are expected for exposed areas and passes in the mountains. The potential for icing is probably not as serious as in coastal areas of Alaska, so long as the lower elevation passes are used. The corridors under consideration do not involve unusually heavy snow depths.

Topography

Topography plays a threefold role in transmission location--(1) it affects cost of construction, inspection, and maintenance; (2) it affects visual impact; and (3) it affects reliability.

Transmission costs rise dramatically in areas of broken or steep terrain--towers require special foundations, individual design for variation in leg lengths to accommodate sloping sites. Broken relief also increases cost by increasing the number of towers required per mile due to decreased spacing. These same topographic characteristics increase access difficulties which, in turn, increase access road costs, time spent in transit, and difficulty in transporting construction and maintenance supplies and materials. Inspection of lines in rough terrain changes a routine operation into an ordeal or increases costs by making utilization of aircraft a necessity.

It is increasingly difficult to visually shield a line and its clearing scar as topographic relief increases. This is especially true under certain orientations, particularly when the line runs parallel to a steep side hill in view of a road, railroad, or other view point.

Conditions of instability pose physical threats to the reliability of the line. Broken terrain, steep slopes, or conditions in which the angle of the terrain exceeds the angle of repose of the soil, increase the chances of land, rock, or mud slides. Snow slides are an additional hazard on steep slopes.

Soils and Foundation

Transmission lines are less affected by soils and foundation limitations than are roads, railroads, and pipelines. Good examples of this exist in the GVEA and CEA transmission systems which traverse sensitive muskeg and permafrost areas with few problems. This requires designs of tower foundations that are compatible with the soil situation and careful design and control of access for construction and operation and maintenance.

Vegetation

Heavily forested areas in the valleys would require essentially continuous clearing of the transmission right-of-way. The higher elevations and muskeg areas would involve essentially no clearing. Impacts are diverse: in the forested areas, opportunities to shield the lines from view are good, but the continuous scar is generally unavoidable. At higher elevations, there would be very little impact on vegetation, but line visability is high.

Wildlife

There will be some habitat changes due to clearing and access facilities. Probably the major consideration for wildlife is the extent to which the transmission lines change the access to land by people. This is subject to some control by managing access, but new corridors and new access roads tend to encourage public use and thus increase pressures on fish and wildlife.

Visual Aspects

More than any other factor in transmission location, the visual aspect is controversial and subject to a wide range of opinion. Existing criteria provide for utilizing natural vegetation and topographic relief as a shield, minimizing crossings over roads, and otherwise utilizing route selection and orientation techniques to minimize visability. Other options include use of non-reflective conductors and towers. At best, such measures are only partly effective.

Socio-Economic Aspects

Land status, ownership, use, and value are important factors in the location of transmission corridor alignments.

Consideration of existing uses, costs of right-of-way and easements tend to influence the selection of alignments which will affect other uses least. Hunting lodges, tourist accommodations, and facilities with high scenic uses or values, such as parks, scenic viewpoints, recreation areas, etc., also should be avoided or skirted by transmission corridors or the corridor should be well screened.

Recent trends in land management tend to favor the corridor concept for combining transportation, utility, and communication facilities. The rationale is to confine man's influence to a relatively small zone .

Distance

The economics of transmission line construction and maintenance dictate that line distances should be kept as short as possible while recognizing other criteria. This will result in lower construction costs and shorter construction periods. Lower operation and maintenance costs will result because it will take less time to find a fault on a shorter line. A shorter line will be subjected to fewer hazards because it is physically smaller. Power and energy losses will be lower on a shorter line.

Other impacts of a shorter line include less clearing--fewer trees must be cut, thus less land will be subjected to man's influence and less wildlife habitat will be altered.

Longer lines require higher voltages with a resultant requirement of higher capacity and larger conductors, towers, and hardware. This combination increases costs as well as right-of-way width.

Relative Transmission Construction Cost for Alternative Corridors - Upper Susitna to Anchorage

	Susitna Corridors				Matanuska Corridors	
	S - 1	S - 2	S - 3	S - 4	M - 1	M - 2
Length, miles	166	170	159	164	258	385
Max. elevation, feet	2,100	2,100	3,800	2,200	3,000	4,000
Clearing, miles						
Med. heavy	166	146	132	142	166	228
Light	---	10	10	13	17	157
None	---	14	17	9	75	---
Access Roads, miles						
New roads	0	0	12	32	84	64
4-Wheel drive access	122	126	122	104	138	290
None	44	44	25	28	36	31
Tower Construction, miles						
Heavy steel	44	44	68	62	30	94
Normal	122	126	91	102	228	291
Comparative Cost, $1,000						
Clearing	3,000	3,000	3,000	3,000	600	1,100
Access	8,000	8,200	9,500	10,900	19,900	27,200
Transmission Lines	82,000	84.000	81,300	82,200	132,700	196,200
Total	93,000	95,200	93,800	96,100	153,200	224,500

(continued) Relative Transmission Construction Cost for Alternative Corridors - Upper Susitna to Fairbanks

	Nenana Corridors					Delta Corridor
	N - 1	N - 2	N - 3	N - 4	N - 5	D
Length, miles	228	250	261	223	212	280
Max. elevation, feet	2,400	4,300	4,000	4,000	4,300	4,000
Clearing, miles						
Med. heavy	125	139	127	99	111	114
Light	0	0	0	0	0	21
None	103	111	134	124	101	145
Access Roads, miles						
New roads	0	136	50	96	182	168
4-Wheel drive access	97	22	119	97	0	82
None	131	102	92	30	30	30
Tower Construction, miles						
Heavy steel	155	194	188	121	127	198
Normal	73	56	73	102	85	82
Comparative Cost, $1,000						
Clearing	400	400	400	200	300	400
Access	7,800	21,800	17,400	20,500	24,800	27,300
Transmission lines	77,200	84,900	88,500	75,000	71,400	94,800
Total	85,400	107,100	106,300	95,700	96,500	122,500

Relative Cost

Rough reconnaissance cost estimates were made for transmission lines in the alternative corridors to illustrate relative costs. The estimates are summarized on Table 4.

The estimates reflect access, clearing, and line construction costs. For the Susitna and Matanuska Corridors, they are premised on a 345 kv double circuit line; the Nenana and Delta Corridors are based on a 230 kv double circuit line.

Corridor Evaluations

This section summarizes results of the evaluations and identification of preferred corridors. In the assigned ranking, lower numbers reflect a preference or fewer impacts.

Project Power to Anchorage-Cook Inlet Area

Six corridors were considered. A summary of the analysis is presented on Table 5.

The Matanuska Corridors were found to offer no significant advantage for major power supplies to the Anchorage-Cook Inlet area. Disadvantages include added length, significant distance at higher elevations which could complicate construction and operations, and additional impacts associated with more access and longer lines.

The four Susitna Corridors assume a common alignment from Talkeetna to Pt. MacKenzie. This should be depicted as a fairly broad corridor at this time, since the terrain is quite favorable for transmission and there would be a great deal of flexibility in locating the final route to minimize impacts and interference with existing developments. This will require very careful route studies.

North of Talkeetna, there are some critical factors of terrain and access. The feasible routes between Devil Canyon-Watana and the Talkeetna area are:

S-1, generally along the Alaska Railroad.
S-2, which generally follows the Anchorage-Fairbanks Highway
S-3 and S-4, which approach Talkeetna through the Talkeetna River Valley.

S3, the shortest route, also involves the most difficult terrain and highest elevations. This would be the least advantageous from the viewpoint of building and operating a transmission line.

Appendix I

TABLE H-5

Corridor Analysis - Project Power to Anchorage/Cook Inlet Area

Analysis Factor:	Susitna Corridors S - 1	Susitna Corridors S - 2	Susitna Corridors S - 3	Susitna Corridors S - 4	Matanuska Corridors M - 1	Matanuska Corridors M - 2
Length, miles	166	170	159	164	258	385
Max. elevation, feet	2,100	2,100	3,800	2,200	3,000	4,000
Ranking	1	1	2	1	3	4
Environmental Impacts						
Soils	1	2	1	1	2	2
Vegetation	2	3	1	3	4	5
Wildlife	1	2	3	3	4	3
Existing developments	3	3	2	1	3	3
Scenic quality/recreation:						
Developed areas	3	3	2	1	3	3
Remote areas	1	2	3	4	4	3
Ranking	1	3	1	3	4	4
Costs						
Construction	1	1	2	1	3	4
Operation and maintenance	1	1	2	1	3	3
Ranking	1	1	2	1	3	4
Reliability						
Exposure to hazards	1	1	2	1	2	3
Ease of repair	1	2	2	2	3	3
Ranking	1	2	3	2	4	4
Summary Ranking	1 (preferred corridor)	2	3	2	4	4

Reconnaissance of the four Susitna Corridors indicates that vegetation and topography would facilitate screening of lines to minimize visual impacts.

S-4 would involve pioneering a new road up the Talkeetna River to the Stephan Lake area; similarly, S-3 would involve considerable new road construction in the Talkeetna Valley. S-2 would traverse the existing Denali State Park, which would require a new access between Gold Creek and the Anchorage-Fairbanks Highway. The aspects of the State Park for S-2 and the new corridors required for S-3 and S-4 were major factors in the evaluations.

There does not appear to be a great deal of difference in terms of impacts on soil, vegetation, and wildlife, except that involved in new access road construction.

Cost aspects are quite similar for S-1, S-2, and S-3; S-1 appears most desirable from the reliability viewpoint because of proximity to existing transportation and lower elevations.

The preferred corridor is S-1.

Project Power to Fairbanks-Tanana Valley Area

Six corridors were considered, and a summary of the analysis is presented on Table 6.

The Delta Corridor involves several disadvantages which relate primarily to longer distances and a considerable distance at fairly high elevations. The potential advantages are avoiding entirely the Broad Pass-Nenana Canyon area and the potential for extending electric service to the Paxson area and portions of the Upper Tanana Valley.

Much of the Delta Route is in areas where lines would be quite visible because of limited vegetation and limited opportunity to shield lines with topography.

The Nenana alternatives fall into two general classes: (1) corridors paralleling the existing transportation corridor containing the Anchorage-Fairbanks Highway and the Alaska Railroad, and (2) alternatives to the east of this corridor through the Alaska Range to the Fairbanks area.

N-1 follows the Alaska Railroad to the Broad Pass area and Cantwell, proceeds through the Nenana Canyon to Healy, and generally parallels the existing GVEA transmission line from Healy to Fairbanks.

Corridor Analysis - Project Power to Fairbanks/Tanana Area

Analysis Factor:	Nenana Corridors					Delta Corridor
	N - 1	N - 2	N - 3	N - 4	N - 5	D
Length, miles	228	250	261	223	212	280
Max. elevation, feet	2,400	4,300	4,000	4,000	4,300	4,000
Ranking	1	3	3	2	3	3
Environmental Impacts						
Soils	1	3	2	2	3	3
Vegetation	2	2	3	2	1	3
Wildlife	1	3	2	3	3	3
Existing developments	3	2	2	2	1	2
Scenic quality/recreation:						
Developed areas	3	2	2	1	1	3
Remote areas	1	3	2	2	3	2
Ranking	1	3	3	2	1	3
Costs						
Construction	1	4	2	3	5	6
Operation and maintenance	1	4	2	3	5	3
Ranking	1	4	2	3	5	4
Reliability						
Exposure to hazards	1	4	3	2	4	4
Ease of repair	1	4	2	3	4	3
Ranking	1	3	2	2	3	3
Summary Ranking	1 (preferred corridor)	4	2	2	3	4

N-1 is an obvious first choice from the viewpoint of transmission line construction and operation because of the proximity to existing transportation throughout its length and use of the most favorable pass through the Alaska Range.

Because of proximity to existing transportation, impacts on soil, vegetation, and wildlife would likely be less severe than the other alternatives which pioneer routes in remote areas.

N-1 also has obvious disadvatages in that the area from Broad Pass through the Nenana Canyon offers very limited opportunities to shield transmission lines from view, and from Cantwell to Healy, the route parallels the eastern boundary of Mt. McKinley National Park. Portions of the line would be visible from the Park Headquarters. The environmental assessment includes a number of photos illustrating terrain and vegetation in this area.

The other Nenana alternatives provide a basis for exploring feasibility of avoiding the areas of Broad Pass and the Nenana Canyon.

N-1, N-2, and N-3 follow the same alignment from Devil Canyon to Cantwell. N-2 and N-3 follow east along the Denali Highway, and then head north through the Alaska Range about 30 miles east of the Nenana Canyon.

N-2 crosses two passes and returns to the Nenana River at Healy just below the Nenana Canyon. From Healy to Fairbanks, N-2 follows the existing GVEA line, as does N-1.

N-3 continues north through a third pass and approaches Fairbanks through the Wood River Drainage.

N-4 and N-5 avoid both the Broad Pass area and the Nenana Canyon. They head north from the vicinity of Watana Dam to Wells Creek and then north to the Fairbanks area using the same route as N-2 and N-3, respectively.

The primary advantages to this group of alternatives are avoiding highly scenic areas along the Alaska Railroad and Anchorage-Fairbanks Highway. N-2 and N-5 additionally are removed from the Railroad and the Highway between the Alaska Range and Fairbanks.

Other than visual impacts in presently utilized areas, N-2, N-3, N-4, and N-5 seem to offer no significant advantages. Because they involve pioneering new routes in remote areas, including substantial requirements for new access roads, the four alternatives would have greater impacts on soil and wildlife than would N-1.

APA believes it would be feasible from the engineerng viewpoint to construct and operate transmission lines in any of these corridors. However, because of remoteness, more rugged terrain, and the high elevation passes, alternatives N-2, N-3, N-4, and N-5 would involve significantly higher initial cost as well as operational costs and significantly lower reliability than alternative N-1.

On the grounds of environment, engineering, costs, and reliability, N-1 is the preferred corridor.

Project Power to Valdez and Other Points on the Richardson Highway

Analysis has not been completed of alternative corridors for delivering power to the Glennallen area and other points along the Richardson Highway.

The basic alternatives appear to be:

(1) Constructing a line from the Palmer area to Glennallen.

(2) Constructing a line from the Devil Canyon-Watana area to Glennallen.

(3) Completing a loop from Palmer to Glennallen and then north along the Richardson Highway to the Fairbanks area.

Existing studies by APA and area utilities evaluate possible electric service to points along the Richardson Highway from Glennallen to Valdez with and without power to electrify the pumping stations along the Alyeska pipeline. The studies indicate 138 kv system would suffice if pipeline pumping loads are not included, and that a 230 kv system would be needed with pipeline pumping. Neither of these alternatives would provide significant additional capacity to transfer power between the Anchorage and Fairbanks areas.

APA's present thinking is that a 138 kv or 230 kv line to Glennallen, either from Palmer or the Devil Canyon-Watana area should be evaluated for possible inclusion in early stages of project construction, and that completing a loop along the Richardson Highway may be desirable as a later stage of the project.

Part V TRANSMISSION SYSTEM DESIGNS AND ESTIMATES

This part summarizes designs and estimates for transmission systems for the four alternative development plans referenced in Table 1. The transmission studies assume lines located in the preferred corridors from the project to the Anchorage and Fairbanks areas. Transmission to the Glennallen area is treated as a separate alternative.

Electrical Design

Transmission Capacity

Based on firm power capability of the alternative systems, the relative size of power markets in the Anchorage-Cook Inlet and Fairbanks-Tanana Valley areas, and an assumed margin for flexibility, design capacities for the transmission systems were assumed as follows:

	Project Installed Capacity MW	Assumed Transmission Capacity, MW		
		Anchorage	Fairbanks	Anchorage + Fairbanks
System #1: Devil Canyon+Denali	580	500	250	750
System #2: Devil Canyon+Watana	1,070	1,000	300	1,300
System #3: Devil Canyon+ Watana+Denali	1,370	1,200	300	1,500
System #4: Devil Canyon+Watana +Vee+Denali	1,434	1,200	300	1,500
System #5: Watana+Devil Canyon	1,568	1,200	300	1,500

As discussed subsequently, these design capacities are not necessarily ultimate capacities of the transmission system. For example, with minor cost additions and nominal increases in losses at peak loading, the transmission system capacity for the proposed plan (System #5) could be upgraded by at least 50% without basic change in voltage, tower design, or conductors.

Voltage Selection and Line Characteristics

Based on nominal carrying capacities, both 230 kv and 345 kv systems entered consideration. Because reliability has high priority, the systems used multi-circuit configurations, except System #1. Conductor sizes, spacings, stranding, and bundling were assumed for each voltage. The following table summarizes these assumptions. It also indicates a measure of capability to be subsequently discussed. Design studies will determine final parameters, including series compensation.

Voltage	230 kv	345 kv
Conductor:		
Type	ACSR	ACSR
Name	Pheasant	Rail
Size	1272 MCM	954 MCM
Stranding	54/19	45/7
Number per phase	Simplex	Duplex
Flat Spacing:		
Conductor	---	16"
Phase	20'	28'
Towers:		
Material	Steel or Aluminum	Steel or Aluminum
No. per mile	6	5
Right-of-Way Width 1/	125'	140'
Single Circuit Capacity without Compensation	29,300 MW-mi.	82,200 MW-mi.

The two voltage options indicate minimum and maximum considerations. Alaska's first 230 kv line is now being constructed in the Anchorage area will be operated initially at 138 kv. Based on a conservative or "safe" stability criteria of 25° power angle between high voltage buses, the 138 kv transmission system is capable of less than 12,000 MW-mi. That is, the power transmitted times miles transmitted must be less than 12,000. The minimum acceptable capability north or south from the Susitna Project is over 50,000 MW-mi. and eventually could be as high as 188,000 MW-mi. Clearly, even a compensated 138 kv system of several lines would be inadequate and uneconomical.

Under the same stability criteria, a single circuit, uncompensated 230 kv transmission line has a capability of about 29,300 MW-mi. A 345 kv duplex system carries 82,000 MW-mi. A 500 kv line is capable of 186,000 MW-mi., which is too large to apply to the Susitna Project. The voltage alternatives therefore are bracketed by the standard 230 kv and 345 kv systems.

Conductors chosen for use in this study have not been subjected to detailed economic evaluation. The 1272 MCM applied to the 230 kv option is often used for that voltage but seldom is it exceeded. The 345 kv 954 MCM duplex conductor has been used extensively. Thermal constraints necessitate larger conductors with larger kv systems. The carrying capacity of the 345 kv transmission voltage can be accommodated by a simplex conductor, and there are many such in the U. S. However, the conductor size approaches an unwieldy diameter. Duplex bundling widely used in 345 kv systems reduces the diameter, retains thermal capacity, and increases stability limit. Higher voltages also produce more corona phenomena. This is

1/ Would be 50% greater for two single circuit lines on adjacent rights-of-way.

relieved somewhat by larger conductors. The 954 MCM duplex conductor approximates an average among all these factors for use in feasibility studies.

DC options were considered only briefly. Operating characteristics made DC systems inappropriate for a first major Railbelt intertie. The line lengths between the Project and the Anchorage and Fairbanks areas are 136 and 212 miles, respectively. It is generally considered that DC economics would not be attractive at these relatively short transmission distances.

Table 7 summarizes a comparison of 230 kv and 345 kv systems for the alternative hydro development systems. On the basis of this comparison, a 230 kv transmission plan was selected for System #1 with two circuits to Anchorage and a single circuit to Fairbanks. For Systems #2, #3, #4 and #5, two 345 kv circuits would be needed between Devil Canyon and Anchorage, and two 230 kv circuits between Devil Canyon and Fairbanks.

The assumed transmission system layout is indicated on Figure 10. The main lines go from the Devil Canyon switchyard to substations at Point MacKenzie and Ester-Gold Hill. Systems #2, #3, and #5 have a switchyard at Watana and two 230 kv circuits from Watana to the Devil Canyon switchyard. System #4 has a similar switchyard at Vee and two 230 kv circuits from Vee to Watana.

All transmission plans are relatively simple, radial systems that have distances, voltages, and loads well within experience of existing systems in the South 48. Hand studies were used to determine required compensation and system losses and to check for voltage drop and stability.

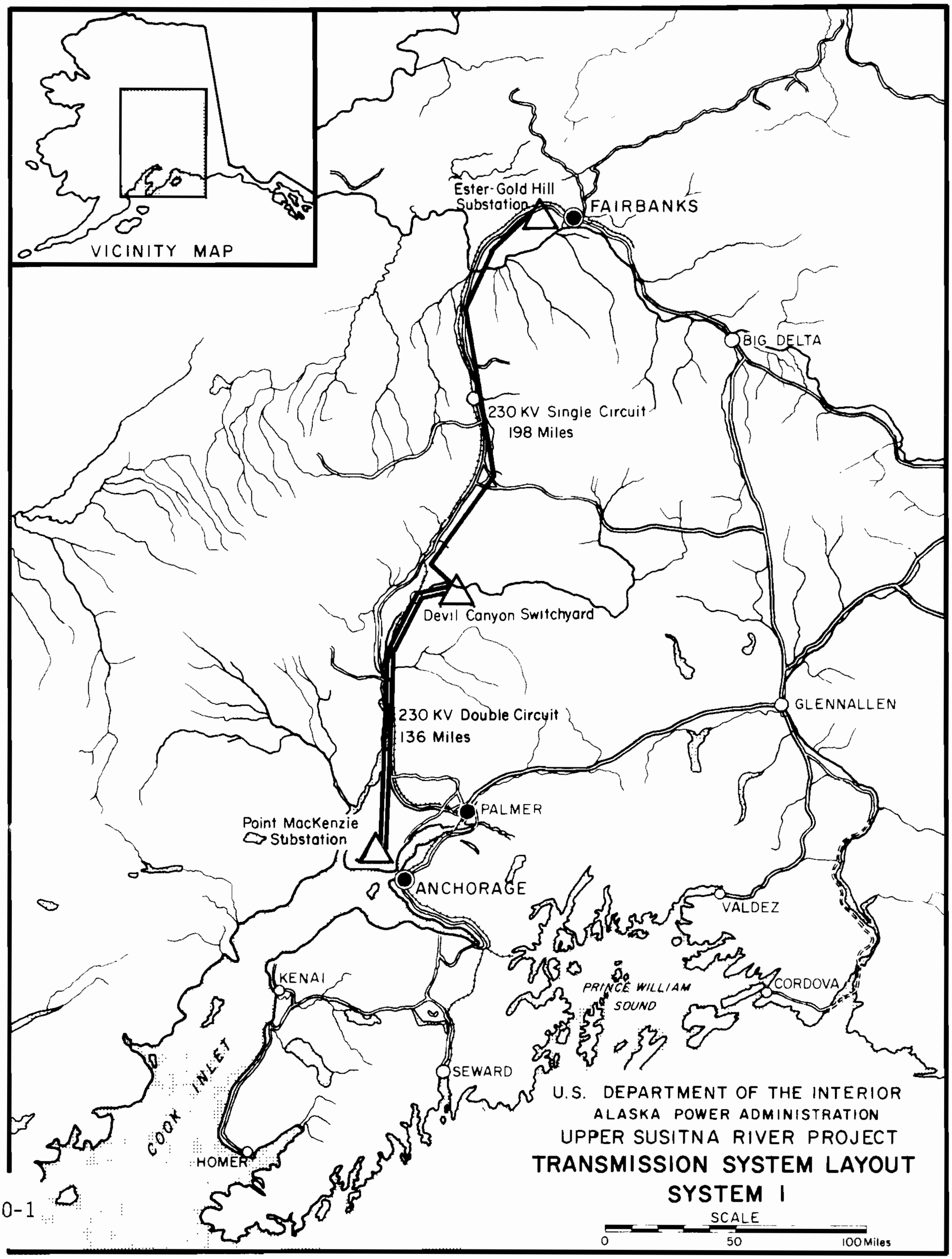
Table 8 summarizes line characteristics and system losses for the transmission systems. The 230 kv line from Devil Canyon to Fairbanks in System #1 appears to be close to stability limits. All of the double circuit lines could provide considerable additional capacity by adding series compensation.

Substations and Switchyards

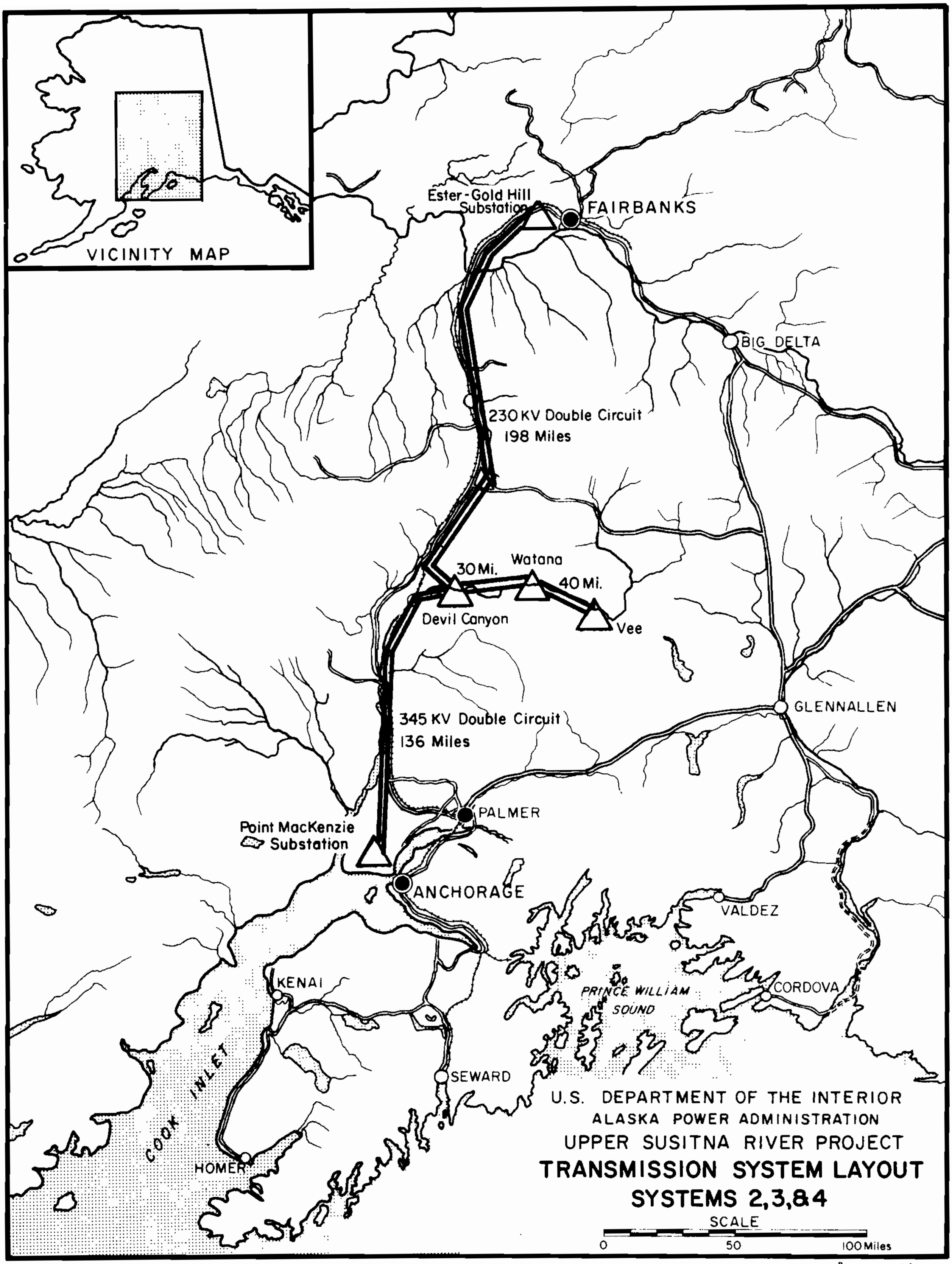
The transmission studies included switchyard and substation design, layouts, and cost estimates. Switchyard and substation designs assumed the nominal "breaker and one-half" scheme. Each line and transformer is protected by one and one-half circuit breakers. This is a compromise between the cost of a "two-breaker" plan and the reduction in reliability inherent in a "one-breaker" scheme. Figure 11 indicates substation layouts at the load center and switchyard layouts at powerplants.

Comparison of 230 and 345 KV Systems

Alternative System and Installed Capacity	# 1 (580MW)	# 2 (1070MW)	# 3 (1370MW)	# 4 (1434MW)	# 5 (1568MW)
Anchorage Line (136 mi.)					
Capability Requirement (MW-mi.)	70,000	140,000	164,000	164,000	164,000
230 kv Compensated Transmission Line (Pheasant Conductor):					
Compensation (%)	20	40	50	50	50
Maximum Capability (MW-mi.) (per circuit)	36,600	48,800	58,600	58,600	58,600
Number of Circuits Required	2	3	3	3	3
Power Loss (%)	4.8	6.5	7.7	7.7	7.7
345 kv Duplex Uncompensated Transmission Line (Rail Conductor):					
Maximum Capability (MW-mi.) (per circuit)	82,200	82,200	82,200	82,200	82,200
Number of Circuits Required	1	2	2	2	2
Power Loss (%)	2.9	2.9	3.5	3.5	3.5
Fairbanks Line (198 mi.)					
Capability Requirement (MW-mi.)	50,000	60,000	60,000	60,000	60,000
230 kv Compensated Transmission Line)Pheasant Conductor):					
Compensation (%)	5	12	12	12	12
Maximum Capability (MW-mi.) (per circuit)	55,000	33,300	33,300	33,300	33,300
Number of Circuits Required	1	2	2	2	2
Power Loss (%)	7	4.6	4.6	4.6	4.6
345 kv Duplex Uncompensated Transmission Line (Rail Conductor):					
Maximum Capability (MW-mi.) (per circuit)	82,200	82,200	82,200	82,200	82,200
Number of Circuits Required	1	1	1	1	1
Power Loss (%)	2.3	2.7	2.7	2.7	2.7



Appendix I
FIGURE H-10-1



Appendix I
FIGURE H-10-2

Transmission Line Characteristics

	Transmission Data For Alternative Systems				
	System # 1	System # 2	System # 3	System # 4	System # 5
Devil Canyon to Pt. MacKenzie (136 miles):					
Number of circuits	2	2	2	2	2
Nominal line loading, MW	500	1,000	1,200	1,200	1,200
Voltage, kv	230	345	345	345	345
Conductor (ACSR)	1,272	954	954	954	954
Losses:					
Peak MW	24	28	40	40	40
Peak %	5	3	3	3	3
Energy MWH/yr.1/	19,100	22,700	32,700	32,700	32,700
Devil Canyon to Ester-Gold Hill (198 miles):					
Number of circuits	1	2	2	2	2
Nominal line loading, MW	250	300	300	300	300
Voltage, kv	230	230	230	230	230
Conductor (ACSR)	1,272	1,272	1,272	1,272	1,272
Losses:					
Peak MW	17	12	12	12	12
Peak %	7	4	4	4	4
Energy MWH/yr.1/	13,900	10,000	10,000	10,000	10,000

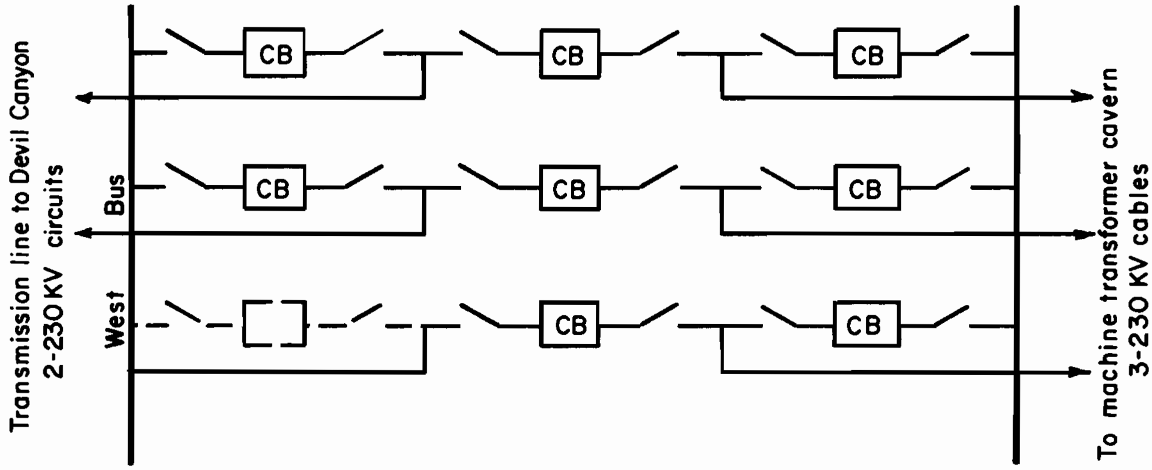
1/ At 40% Line Loading Factor.

(continued)

	Transmission Data For Alternative Systems				
	System # 1	System # 2	System # 3	System # 4	System # 5
Watana to Devil Canyon (30 miles):					
Number of circuits		2	2	2	2
Nominal line loading, MW		470	670	721	750
Voltage, kv		230	230	230	230
Conductor (ACSR)		1,272	1,272	1,272	1.272
Losses:					
Peak MW		Less than 2% of peak			
Watana to Vee (40 miles):					
Number of circuits				2	
Nominal line loading, MW				300	
Voltage, kv				230	
Conductor (ACSR)				1,272	
Losses:					
Peak MW		Less than 2% of peak			

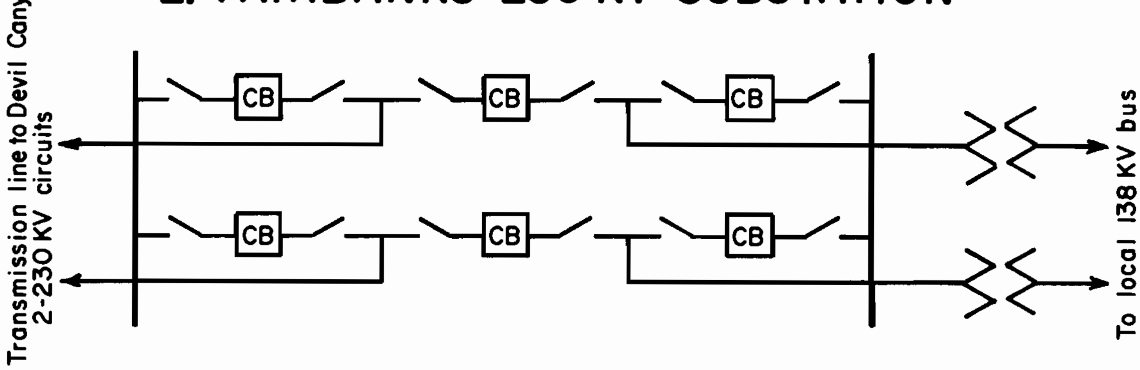
SUBSTATION LAYOUT

I. WATANA 230KV SWITCHYARD



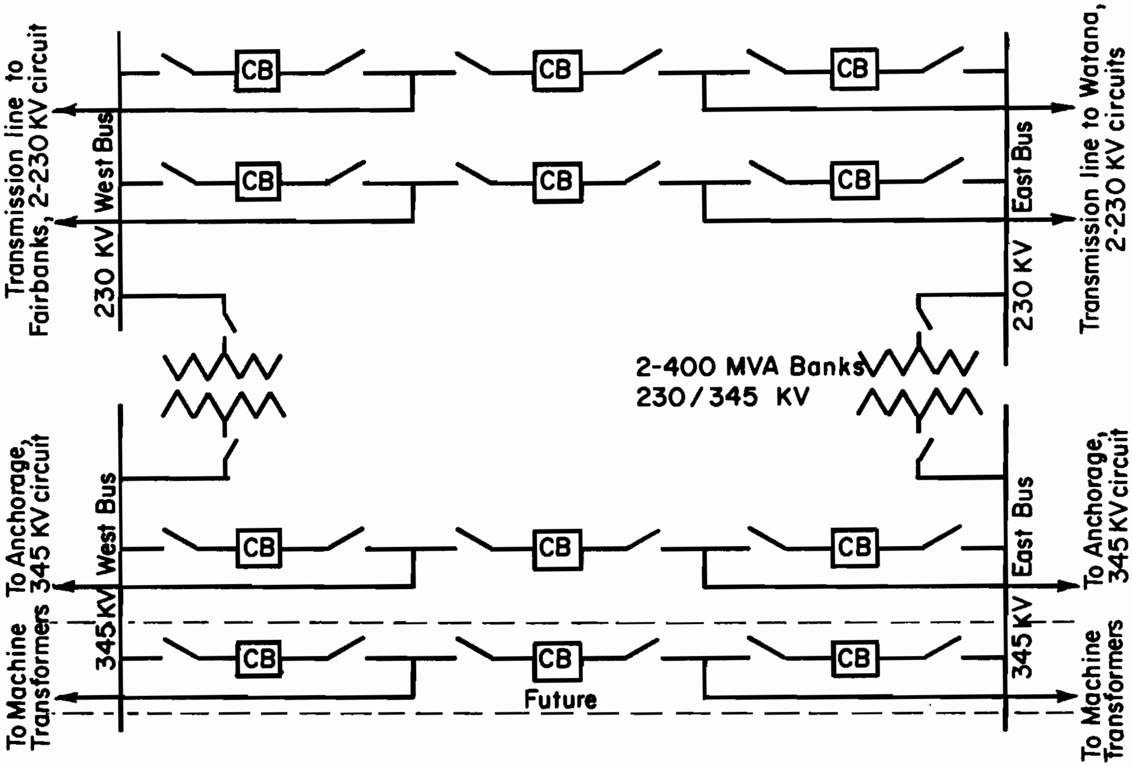
DEVICE	SIZE	No. OF UNITS
Circuit Breakers	230 KV	8
Sta. Svc., Reac., Capacitor	Mach. KV	5% of above

2. FAIRBANKS 230 KV SUBSTATION



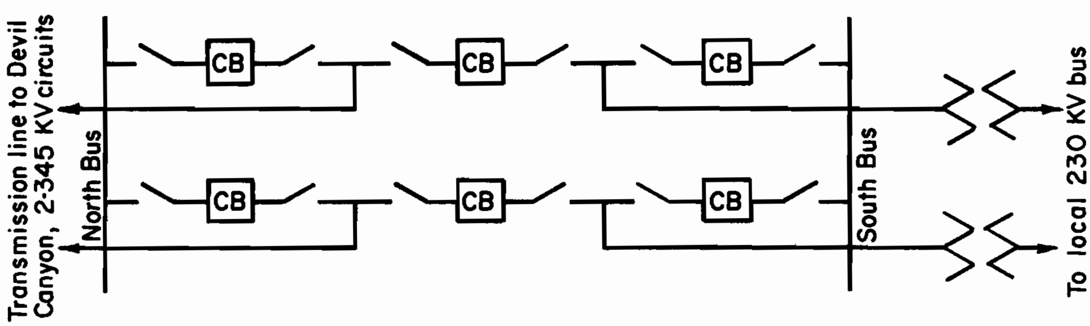
Power Transformers	230/138 KV-200MVA-3Ø	2-3Ø Units
Circuit Breakers	230 KV	6
Sta. Svc., Reac., Capacitors	Tertiary KV	5% of above

3. DEVIL CANYON SWITCHYARD



DEVICE	SIZE	No. OF UNITS
Power Transformers	2-400 MVA Bks. 230/345 KV	7-1Ø Units (133.3 MVA ea.)
Circuit Breakers	230 KV-345 KV	6-230 KV, 3-345 KV
Sta. Svc., Reac., Capacitors	Tertiary KV	5% of above

4. ANCHORAGE 345 KV SUBSTATION



Power Transformers	750 MVA Bks.-345/230 KV	7-1Ø Units (250 MVA ea)
Circuit Breakers	345 KV	6
Sta. Svc., Reac., Capacitors	Tertiary KV	5% of above

Note: Single-phase (1Ø) transformers are connected 3 per 3Ø bank with 1Ø spare per switchyard or substation.

In addition to the breakers, each end of the transmission line has transformers, bus work, and, where pertinent, reactors and capacitors. Transformers were provided between transmission voltages.

Power Flow Studies

As stated previously, hand studies were used to determine transmission system design parameters and losses. Several computer runs were made at the Bonneville Power Administration to check basic system performance under load and with assumed outages. The computer studies confirm that the system design assumptions are adequate for feasibility study purpose, that is, to provide an adequate basis for determining physical and financial feasibility of the system. The more detailed studies for actual design would include the full range of systems analysis appropriate for a major new power system.

Reliability

The preliminary transmission evaluations assumed multiple circuit configuration; substations, and switchyards use the "breaker and one-half" scheme. The various systems assume two circuits on a single tower except for a single circuit 230 kv line to Fairbanks in System #1. Tower designs are free-standing, steel with NESC "heavy" loading for the low-level portions of the corridors, and an additional safety factor for rugged terrain and mountain passes.

There have been no specific studies of system reliability. Based on experience elsewhere, the double circuit lines would have very high reliability. They would be vulnerable to outages due either to tower failure (landslides, etc.) or to a failure caused by interference with both circuits (such as an aircraft accident).

The next higher level of reliability would be to utilize two single-circuit lines. If these were in close proximity to each other, they could utilize the same access facilities. Right-of-way and clearing requirements would increase.

Some further reduction in vulnerability to serious outages would be obtained by parallel or looped lines in separate rights-of-way.

During review of the preliminary studies by the Bonneville Power Administration and area utilities, strong preference was indicated for placing each circuit on a separate set of towers. The reviewers felt the added reliability of such a plan would justify the additional costs.

Right-of-Way

Estimated width and area of rights-of-way are as follows:

Line	ROW Width	Acres Per Mile
230 kv, single or double circuit	125	15.2
2-230 kv, adjacent ROW	190	22.8
345 kv, single or double circuit	140	17.0
2-345 kv, adjacent ROW	210	25.5

Over most of the route, the normal ROW width would be adequate for both the lines and the access facilities.

Detailed analysis of land ownership would be needed as a part of final route selection. It is anticipated that some private lands will be crossed and that easements would be obtained (rather than purchased in fee). Where the lines are on public land, it is assumed that ROW can be obtained without cost to the project. The estimates include an allowance of $700 per acre for easements on portions of the lines which are assumed to involve private lands. On the basis of judgment evaluation of broad land ownership patterns for each corridor segment, approximately 75 miles along the Devil Canyon to Fairbanks and 89 miles along the Devil Canyon to Point MacKenzie route may require easements.

Clearing

Heavily forested areas in the Susitna and Tanana Valleys would require essentially continuous clearing. However, tree size varies from small to medium and clearing operations are not particularly difficult.

Based on USGS maps with vegetation overprint and Forest Service maps showing timber types, approximately 231 miles of line under System #1 and 261 miles for System #2, #3, #4, and #5 would require essentially continuous clearing. A unit cost of $500 per acre for clearing was assumed, based on recent highway construction bids. Acreage for clearing were premised on 4.6 acres per mile for the 230 kv lines and 5.1 for the 345 kv lines.

The remaining portions of the lines would involve only nominal clearing of occasional small trees and some brush removal.

Access Roads

Since the preferred corridor is in close proximity to existing surface transportation, requirements for new access roads are minimal. Where soils and topography are favorable, a primitive access road suitable for four-wheel drive vehicles is assumed. Such access roads would consist of little more than a trail along the right-of-way with occasional cross drainage structures and small amounts of gravel fill. Access to existing roads would be provided periodically. No major stream crossings would be involved. These rudimentary roads would be used in both the construction and operation and maintenance phases.

Between Gold Creek and the project powerplants, it is assumed that the access roads built for dam construction would be adequate for transmission access.

For the remainder of the line, an estimated 219 miles is suitable for four-wheel drive access roads. The estimates include $50,000 per mile for roads.

From Gold Creek to Cantwell and Healy, terrain, vegetation, and soils do not favor use of the primitive access roads. It is assumed that no new roads would be provided for this line segment. For this portion of the line, access would be limited to helicopter and winter over-snow vehicles for construction and operation and maintenance. Significant portions of the existing GVEA and CEA transmission systems have been built and operated in this manner.

Structural Design

Wind and Ice Loading

There is not a great deal of hard data on wind and icing extremes for the selected corridors. However, there is a sufficient experience base to establish that wind and ice conditions should not be unusually severe.

Existing transmission lines in the Matanuska-Susitna Valleys and from Healy to Fairbanks have not experienced any unusual icing problems. Hoarfrost is a fairly common experience in winter, but not a problem for HV lines. Climate and topography generally do not favor formation of heavy glaze or rime ice--during most of the year it is either too hot, too cold or too dry for heavy icing to occur.

This is markedly different from conditions in some mountainous areas along the Gulf of Alaska where temperature and moisture conditions favorable to heavy icing are quite common.

Key stations for wind data are at Anchorage, Talkeetna, Summit, Nenana, and Fairbanks. All of these stations have fairly lengthy records of wind observations; none have recorded unusually severe winds. The available recorded data is on the basis of fastest mile, so actual peak gusts would be higher.

Station	Period of Record	Maximum Wind Recorded MPH	Source (all from National Weather Service)
Anchorage	1914-1974	61	1974 Annual Station Summary
Talkeetna	1940-1974	38	1974 Annual Station Summary
Summit	1941-1974	48	1974 " " "
Nenana	1949-1967	less than 40	NWS Uniform Summary, Part C
Fairbanks	1929-1974	40	1974 Annual Station Summary

It is known that more severe winds occur through the Nenana Canyon. During initial operations of the Healy-Fairbanks 138 kv line, 3 towers in the immediate vicinity of Healy were lost due to high winds. The problem area is right at the mouth of Nenana Canyon. The Alaska State Highway Department operated an anemometer at the Moody Bridge site in Nenana Canyon for a short period during construction of the Anchorage-Fairbanks Highway. Maximum recorded wind was 62 MPH, and a more severe wind storm was observed during a period when the recorder was not operating. 1/

The basic transmission cost data for this study are premised on the Bonneville Power Administration designs for National Electric Safety Code Heaving Loading assumptions--4 pound wind concurrent with ½" radial ice or an alternative 8 pound wind loading. The NESC loading assumption is consistent with normal utility practice for this area and is considered adequate for the portions of the line from Talkeetna to Anchorage and from Healy to Fairbanks.

It is expected that more severe wind load criteria would be appropriate for portions of the line through the Broad Pass area and the Nenana Canyon. A more detailed study of climate conditions for these corridor segments, including collecting additional wind data, would be needed along with the detailed design studies. This study makes allowance for more severe wind conditions in these areas by increasing tower steel 10 percent.

1/ Communication from Alaska Department of Highways, June 1975.

Very severe icing is not considered likely based on the topography and climate data, comparatively low elevations through the Alaska Range, and absence of reports of severe icing. The available data also indicates possibilities are remote for simultaneous occurrence of maximum wind and maximum icing. A summary of data for the station at Summit follows. Heaviest winds occur from November to March when air temperatures are well below freezing.

Snow

Available snow depth data from Soil Conservation Service Snow Survey publications were reviewed primarily to determine if there were any areas along the corridor where snow depths are large enough to affect tower designs.

Standard tower designs assumed for this study are generally adequate to handle snow depths up to 10 feet. For areas of larger snow accumulation, added tower height would be needed to obtain necessary clearance. This is often handled by adding "snow legs" to standard tower designs.

Based on the snow data, maximum snow accumulation well under 10 feet is expected over the entire route, except for occasional areas subject to drifting. The snow depthwill not likely affect transmission designs and costs significantly.

Tower Design

The cost estimates are premised on free-standing, steel-lattice towers. This assumption reflects fully-proven technology for which there is a good experience base in costing and construction methods.

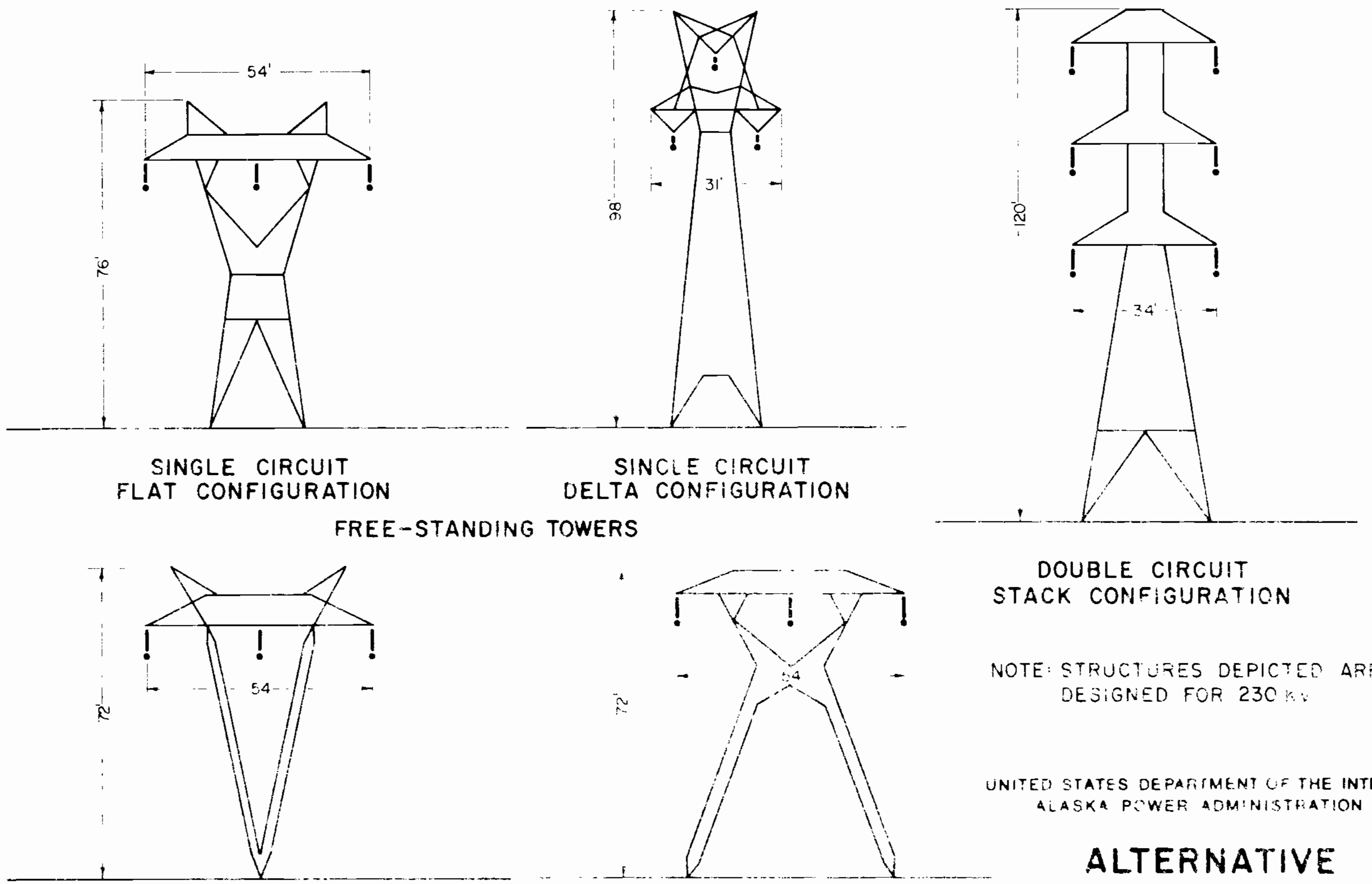
The final designs would consider several alternative designs and may result in selecting guyed towers for portions of the line and use of special tower designs in areas where the lines are most visible. Figure 12 indicates representative sizes and shapes for several 230 kv towers; 345 kv towers are somewhat larger because phase to phase and phase to ground clearances must be 8 to 10 feet greater than for 230 kv.

Foundations

Available soils and foundation data include: detailed soil surveys from the Soil Conservation Service for part of the lower Susitna Valley and the immediate Fairbanks area; general geologic and permafrost maps from the USGS; 1:250,000 scale reconnaissance level interpretation of soil types prepared by the Resources Planning Team of the Land Use Planning Commission; and data from route studies for existing transmission lines and highways. The environmental assessment includes a regional permafrost map and strip maps showing general soil types for the corridors.

Temperature, Precipitation, and Wind for Summit

	Average Temperature, °F			Mean	Wind Speed, MPH	
	Mean Month	Maximum Month	Minimum Month	Precip. Inches	Mean	Fastest Mile
Jan.	0.8	7.3	- 5.7	0.9	15.1	44
Feb.	6.3	13.0	- 0.5	1.17	11.9	46
Mar.	10.4	18.7	2.0	1.01	11.0	48
Apr.	23.4	32.7	14.0	0.64	7.6	33
May	37.4	45.6	29.1	0.72	7.7	28
June	48.8	57.9	39.7	2.18	8.3	29
July	52.1	60.3	43.9	2.98	7.8	30
Aug.	48.7	56.1	41.2	3.25	7.4	26
Sept.	39.8	47.1	32.5	2.75	7.5	37
Oct.	23.7	30.1	17.2	1.62	8.0	35
Nov.	9.5	15.5	3.5	1.23	11.3	39
Dec.	3.0	9.3	- 3.3	1.17	12.7	44



SINGLE CIRCUIT
FLAT CONFIGURATION

SINGLE CIRCUIT
DELTA CONFIGURATION

FREE-STANDING TOWERS

DOUBLE CIRCUIT
STACK CONFIGURATION

NOTE: STRUCTURES DEPICTED ARE
DESIGNED FOR 230 kv

SINGLE CIRCUIT
FLAT CONFIGURATION

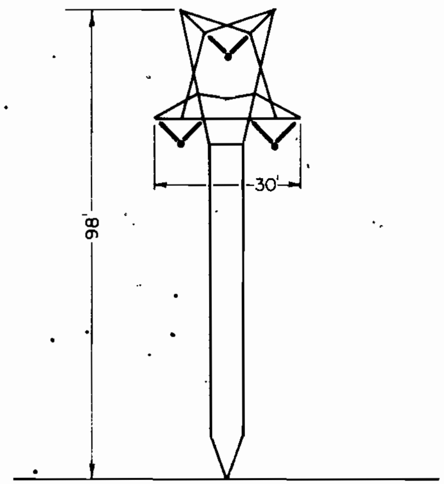
SINGLE CIRCUIT
FLAT CONFIGURATION

GUYED TOWERS

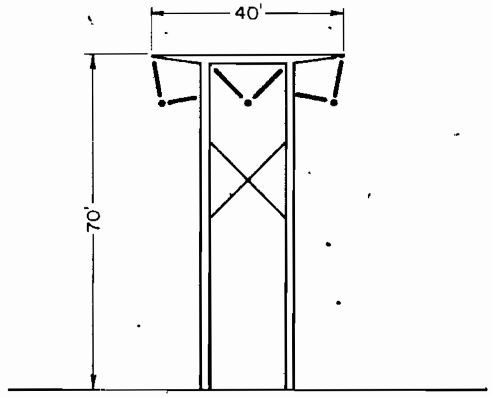
UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION

ALTERNATIVE TRANSMISSION LINE STRUCTURES

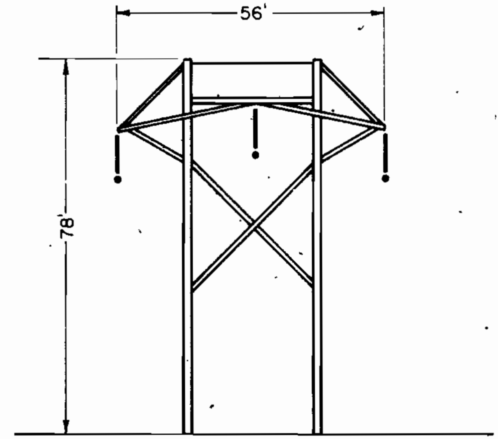
A.P.A.-JANUARY 1975



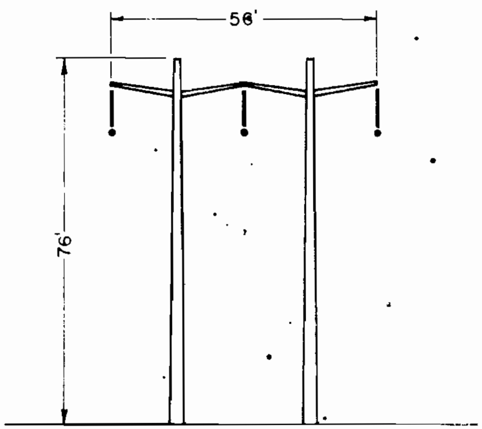
SINGLE CIRCUIT
DELTA CONFIGURATION
GUYED TOWER



SINGLE CIRCUIT
METAL H-FRAME STRUCTURE



SINGLE CIRCUIT
WOOD H-FRAME STRUCTURE



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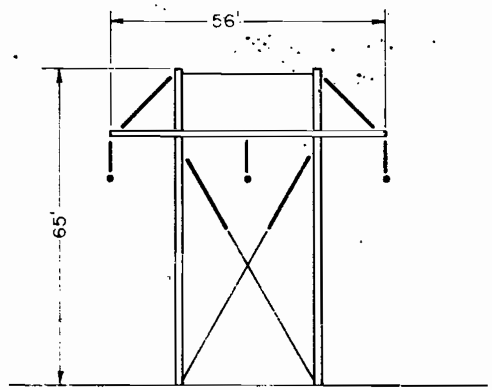
METAL H-FRAME STRUCTURE



SINGLE CIRCUIT
WOOD H-FRAME STRUCTURE

NOTE: STRUCTURES DEPICTED ARE DESIGNED FOR 230 KV.

UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION

ALTERNATIVE TRANSMISSION LINE STRUCTURES

A.P.A.-JANUARY 1975

Areas of muskeg, frost susceptible soils, and permafrost will require careful foundation design. It is estimated that up to about 30 percent of the line would require foundations designed specifically to accommodate these conditions. Experience suggests that such special designs would not involve major increased costs for the line.

A number of different design approaches have been used. Portions of existing CVEA lines through muskeg areas that have considerable frost action have used guyed towers set on steel pile foundations. The GVEA Healy-Fairbanks line crosses some very sensitive permafrost areas. It also uses guyed towers, but the foundation is a single pedestal. A further option would be use of thermal pilings to keep foundations in a frozen state.

Transmission lines for Canada's Nelson River Project use free standing towers with footings set on a grillage foundation to cross permafrost and muskeg. This technique involves setting a grillage of steel or timber below the active frost zone for the foundation. The estimates for this report are premised on use of the grillage foundations.

This is a conservative assumption since much of the route will undoubtably be suitable for normal tower foundations -- concrete footings under each tower leg. Foundation considerations will of course be a major consideration in the detailed route and design studies, following authorization.

Transmission Cost Estimates

This section summarizes the transmission system cost estimates. The basic estimates are premised on cost experiences of the Bonneville Power Administration with adjustments to reflect Alaska construction costs and January 1975 price levels. As noted previously, costs for rights-of-way, clearing, and access were estimated separately.

The first set of estimates were prepared to allow comparison of the several alternative hydro development plans and were used in the Corps of Engineers scoping analysis.

Further studies were made on alternative transmission plans for the proposed initial development plan (Watana and Devil Canyon) resulting in the transmission plan and estimate included in the project proposal.

Alaska Cost Factors

The basic cost data from BPA reflects Pacific Northwest conditions. Alaska construction would involve substantially higher labor costs and additional transportation costs to deliver materials fabricated in the South "48" to Alaskan construction sites.

APA derives "Alaska factors" of 1.9 for labor and 1.1 for added transportation. The BPA data were separated into components of labor and materials and the appropriate factors were applied to estimate Alaska costs.

The 1.9 labor cost factor is premised on a comparison of wage and fringe benefits data under recent IBEW contracts for the Anchorage and Portland areas with appropriate allowances for overtime and subsistance pay for remote work in Alaska.

The 1.1 transportation cost factor is premised on current barge and rail tariffs between Seattle and various points along the Alaska Railroad, with an allowance for loading and unloading.

Transmission Line Costs

Typical mile costs for constructing transmission lines were furnished by the Bonneville Power Administration. These costs were itemized by major components and portions of costs for labor and material. APA adjusted these costs with the Alaska factors for labor and transportation derived above. The estimates are summarized on Table 10.

The BPA typical mile costs were premised on January 1974 price levels and APA made adjustments to January 1975 prices. Based on advice from BPA personnel, tower steel costs were increased from $450 to $800 per ton. Other basic cost items were updated using USBR indexes.

The estimates include allowances for: handling and storage of materials; contingencies and unlisted items; and overhead items. The allowance for handling and storage is 15% of tower steel costs plus 10% of other material costs. There is a 25% allowance for contingencies and unlisted items such as communications equipment and series compensation. The 20% overhead item includes surveys, designs, inspection, and contract administration.

Typical Mile Transmission Line Costs

	230 kv Single Circuit		230 kv Double Circuit		345 kv Double Circuit	
	Labor	Materials	Labor	Materials	Labor	Materials
	January 1974 Costs, $1,000					
Tower Steel	13.18	13.95	22.95	24.30	42.71	45.23
Conductors	10.49	13.73	16.26	27.47	18.31	37.48
Hardware & Accessories		.82		1.64		4.00
Insulators		1.14		2.28		4.21
Miscellaneous	4.41	3.58	4.41	5.05	4.41	9.24
Subtotal (Pacific NW)	28.08	33.22	43.62	60.74	65.43	100.16
	January 1975 Costs, $1,000 1/					
Tower Steel	16.74	24.83	29.15	43.25	54.24	80.51
Conductors	13.32	17.44	20.65	34.89	23.25	47.60
Hardware & Accessories		1.04		2.08		5.08
Insulators		1.45		2.90		5.35
Miscellaneous	5.60	4.55	5.60	6.41	5.60	11.73
Subtotal (Pacific NW)	35.66	49.31	55.40	89.53	83.09	150.27
Alaska Factor	1.9	1.1	1.9	1.1	1.9	1.1
Alaska Cost	67.75	54.24	105.26	98.48	157.87	165.30
Subtotal	121.99		203.74		323.17	
Handling & Storage 2/	9.52		16.99		29.81	
Subtotal	131.51		220.73		352.98	
Contingencies & Unlisted Items (25%)	32.88		55.18		88.25	
Subtotal	164.39		275.91		441.23	
Admin. overhead, survey, design & inspection (20%)	32.88		55.18		88.25	
Total Alaska Construction Cost	197.27		331.09		529.48	
Rounded	200		330		530	

1/ Cost increase reflect following assumption:

Tower Steel: $\frac{\text{Jan 1975}}{\text{Jan 1974}}\ \frac{\$800/\text{ton}}{\$450/\text{ton}} = 1.78$

Other items based on USBR transmission cost index:

$\frac{\text{Jan 1975}}{\text{Jan 1974}}\ \frac{1.87}{1.47} = 1.27$

2/ 15% of tower steel cost plus 10% of other materials costs.

Typical Mile Transmission Line Costs - cont.

	345 kv Single Circuit Labor		345 kv Single Circuit Materials
	January 1974 Costs, $1,000		
Tower Steel	26.35		27.90
Conductors	11.81		18.74
Hardware & Accessories			2.00
Insulators			2.10
Miscellaneous	4.41		5.95
Subtotal (Pacific NW)	42.57		56.69
	January 1975 Costs, $1,000 1/		
Tower Steel	33.46		49.60
Conductors	15.00		23.80
Hardware & Accessories			2.54
Insulators			2.70
Miscellaneous	5.60		7.60
Subtotal (Pacific NW)	54.06		86.24
Alaska Factor	1.9		1.1
Alaska Cost	102.71		94.86
Subtotal		197.57	
Handling & Storage 2/		17.67	
Subtotal		215.24	
Contingencies & Unlisted Items(25%)		53.81	
Subtotal		269.05	
Admin. overhead, survey, design & inspection(20%)		53.81	
Total Alaska Construction Cost		322.86	
Rounded		320.00	

1/ Cost increase reflect following assumption:

Tower Steel: $\frac{\text{Jan 1975 \$800/ton}}{\text{Jan 1974 \$450/ton}} = 1.78$

Other items based on USBR transmission cost index:

$\frac{\text{Jan 1975 1.87}}{\text{Jan 1974 1.47}} = 1.27$

2/ 15% of tower steel cost plus 10% of other materials costs.

As noted previously, tower steel was increased 10% above that for the typical mile costs for portions of the line in higher elevations through the Alaska Range.

Switchyard and Substation Costs

Table 11 shows sample computations of switchyard and substation costs.

These were estimated using basic cost data for major equipment items from Bonneville Power Administration's "Substation Design Estimating Catalog" with price levels of January 1975. The major cost items are the transformers and circuit breakers. As in the transmission estimates, costs for the major equipment items were adjusted for Alaska labor and transportation costs. Additional allowances were made for: handling and storage (15% of material cost); contingencies and unlisted items (25%); and overhead (20%).

Costs for individual switchyards and substations were determined by increasing the major equipment item as derived above by an additional 10% allowance for station service items.

Transmission Maintenance Facilities

The estimates include provision for transmission maintenance headquarters at roughly the mid-points of the Devil Canyon-Fairbanks and Devil Canyon-Anchorage lines. Each headquarters would consist of a lineman's residence, vehicle storage building, warehouse, and fenced storage yard.

Estimates for Alternative Hydro Development Plans

Table 12 summarizes cost estimates for transmission systems assumed for the Corps of Engineers scoping analysis of alternative hydro development plans. The plans include substations at Fairbanks and Point MacKenzie with switchyards at each powerplant. Transmission lines assumed for the scoping analysis are as follows:

System #1 assumes a single circuit 230 kv line from Devil Canyon to Fairbanks and a double circuit 230 kv line from Devil Canyon to Point MacKenzie.

The transmission plans in the scoping analysis for systems #2, #3, and #5 assume a double circuit line from Devil Canyon to Fairbanks, a 345 kv double circuit line from Devil Canyon to Fairbanks, and a 230 kv double circuit line from Watana to Devil Canyon. System #4 adds a 230 kv double circuit line from Vee to Watana.

Switchyard and Substation Costs

Part I - Sample Calculation, Derivation of Circuit Breaker and Transformer Costs

	Equipment Cost ($1,000 - January 1975 Costs)			
	Power Transformer 345/230 kv		Circuit Breaker 345 kv	
	Labor	Material	Labor	Material
Equipment Cost	11	320	15	265
Structures & Accessories	+ 5	+ 138	+ 8	+ 138
Subtotal	16	458	23	403
Alaska Factor	x1.9	x 1.1	x1.9	x 1.1
Alaska Cost	30	504	44	443
Subtotal	534		487	
Handling & Storage (15% of material)	76		66	
Contingencies and unlisted items (25%)	+ 134		+ 122	
Administrative overhead and design (20%)	+ 107		+ 97	
Total, Alaska Construction Cost	851		772	
Rounded	850		770	

Part II - Sample Calculation, Devil Canyon Switchyard

	Construction Cost January 1975 Costs
Six - 230 kv Circuit breakers 6 x $565,000 =	$ 3,390,000
Six - 345 kv Circuit breakers 6 x $770,000 =	4,620,000
Seven - 345/230 kv Single phase transformers 7 x $850,000 =	5,950,000
Subtotal	13,960,000
10% station service, capacitors, reactors	1,400,000
Total Construction Cost	$15,360,000

Appendix I
TABLE H-11

Switchyard and Substation Costs (cont.)

Part III - Summary, System 5 Switchyard and Substation Costs

	Watana Switchyard	Devil Canyon Switchyard	Ester-Gold Hill Substation	Point MacKenzie Substation	Intermediate Del. Point Substation	Switching Station (Compensation)
Circuit Breakers	8@230 kv	6@230 kv 6@345 kv	6@230 kv 2@138 kv	6@230 kv 2@138 kv	5-345 kv 1-138 kv	6-230 kv
Transformers	---	7@ 345/230 kv 1/	2@ 230/138 kv 2/	7@ 345/138 kv 1/	4@ 345/138 kv 1/	
Construction Cost ($1,000-January 1975)	4,970	15,360	9,150	12,420	7,890	3,720

1/ Single-phase transformers
2/ Three-phase transformers

Summary of Transmission System Cost Estimates

	System # 1	System #2-3-5	System #4
Length of line, miles	334	364	404
Portion requiring easements, miles	164	164	164
Portion requiring clearing, miles:			
Medium-Heavy	231	261	301
None	103	103	103
Access roads, miles:			
4-Wheel Drive	219	219	219
None	115	145	185
Tower Construction, miles:			
NESC Heavy	195	195	195
Added Steel (Mountains)	139	169	209

Estimates for Scoping Analyses

	Construction Costs ($1,000)		
	System # 1	System #2 & 3	System # 4
Clearing	1,010	1,210	1,210
Easements	2,240	2,410	2,410
Access Roads	14,240	14,240	14,240
Transmission Lines	87,190	151,960	165,700
Substations & Switchyards	19,320	41,900	46,870
TOTAL	124,000	211,720	230,430

Estimate for Proposed Plan (System #5)

	Construction Costs ($1,000)
Clearing	2,430
Easements	3,620
Access Roads	14,370
Transmission Lines	182,100
Substations & Switchyards	53,520
TOTAL	256,040
Rounded	256,000

Transmission Estimates for Proposed Plan

On the basis of reviews of the preliminary designs by area utilities, the Bonneville Power Administration, and others, further consideration was given to alternative circuit configuration, alternative service plans for the Anchorage-Cook Inlet area, and sectionalizing the Devil Canyon to Fairbanks line. This resulted in the following changes in the transmission plan adopted for the proposed project: (see Figure 13)

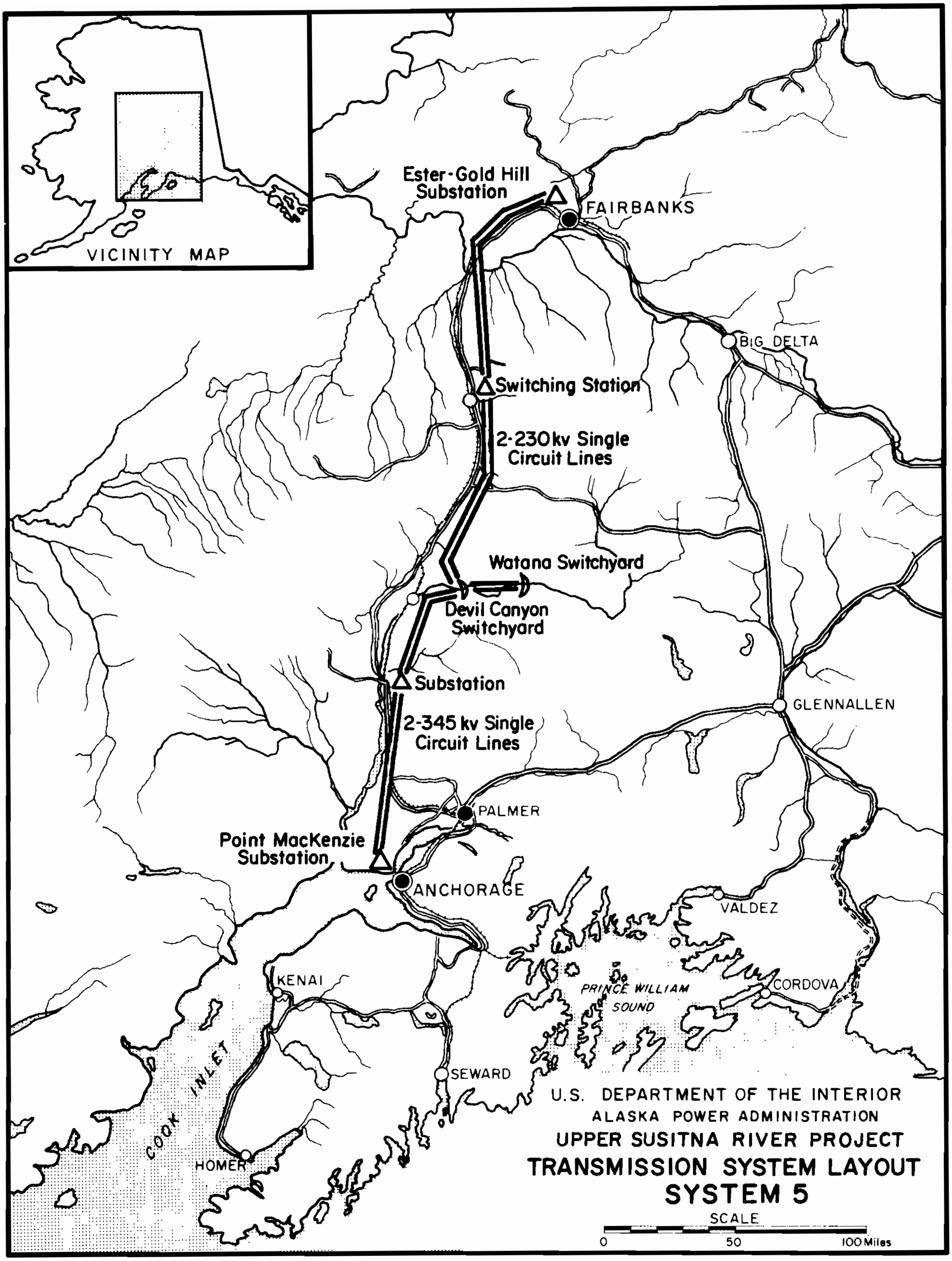
1. Addition of a switching station at the approximate mid-point of the Devil Canyon-Fairbanks line (this is assumed at Healy and estimated added costs are $3.7 million).

2. An additional substation in the vicinity of Talkeetna which appears warranted by the pattern of load development in the MEA system (estimated added costs of $7.9 million).

3. Including costs for parallel single circuit lines on adjacent rights-of-way in lieu of the double circuit lines in the preliminary estimates (added costs of $32.7 million).

With these changes, total construction costs of $256 million are included in the proposed initial development plan:

Item	Construction Cost $1,000
Transmission Lines:	
Clearing	2,430
Rights-of-Way	3,620
Access Roads	14,370
Lines	182,100
Subtotal, Transmission Line	$ 202,520
Switchyard and Substations:	
Fairbanks Substation	9,150
Talkeetna Substation	7,890
Point MacKenzie	12,420
Healy Switchyard	3,730
Watana Switchyard	4,970
Devil Canyon Switchyard	15,360
Subtotal, Switchyards and Substations	$ 53,520
Total Transmission Costs	$ 256,040
Rounded	$ 256,000



Appendix I
FIGURE H-13

Construction Schedule

It is estimated that actual construction of the backbone transmission system could be accomplished readily over a three-year period. It is assumed that construction would be keyed to completing the system at the same time that first generating units come on line.

Other Transmission Alternatives

Service Plans for Anchorage-Cook Inlet Area

It must be anticipated that there will be continuing problems and controversy as to bulk transmission facilities in the approaches to Anchorage. Knik and Turnagain Arms are formidable barriers; the Chugach Range and existing land use designation and ownership patterns combine to restrict alternatives for locating lines. Existing underwater cables across Knik Arm have had serious problems; overhead lines will continue to draw opposition; environmental groups would like to see all new lines underwater or underground; this technology has some severe problems in reliability and costs and is particularly vulnerable to extended outage.

The transmission alternatives for this area include the following:

- Additional underwater cables and locating cables at different crossing points to reduce hazards of failure.

- Cables constructed on a Knik or Turnagain causeway. This would eliminate much of the hazard to extended outages since cables would be easily accessible for repairs.

- Overhead lines around the two arms. One option is rebuilding along the Eklutna transmission right-of-way to provide additional capacity.

- Overhead lines across shallower portions of Knik and Turnagain Arms (place tower structures on piers).

Detailed cost estimates for these alternatives were not developed for this study. The same problems will exist with or without the Susitna Project since the available power supply alternatives also require lines crossing or routed around Knik Arm.

The basic cost estimates for the proposed plan assume two single circuit lines terminating at Point MacKenzie. An alternative estimate was prepared assuming one line terminating at Point MacKenzie and a second at the existing APA substation at Palmer. Total costs for the two alternatives were similar.

It is recognized that the detailed studies following project authorization will need to include careful study in cooperation with the area utilities to determine appropriate facilities in a final plan and that such studies may demonstrate need to include additional capacity to deliver project power to Anchorage. While the plan advanced in this report is not intended as a fixed plan, it is considered an adequate basis for determining merits of the proposed project.

Service to Other Railbelt Power Loads

The total Railbelt power system will include bulk transmission facilities such as those presented in this report and extensive transmission and distribution systems at lower voltage. The bulk power facilities do not replace the need for the distribution systems.

For example, the concept of electrifying the Alaska Railroad has been advanced from time to time. This would require power at distribution voltage along the railroad right-of-way. The high voltage lines for the Susitna Project may encourage consideration of Railroad electrification, but a separate line at lower voltage would be needed to serve the railroad.

Similarly, the proposal of GVEA to extend its 25 kv distribution line to Mount McKinley Park Headquarters and Cantwell is compatible with the Susitna plan. Again, the high voltage line does not replace the need for the distribution facilities--Susitna power would reach Cantwell through the GVEA distribution system.

As a part of the Susitna studies, very rough costs estimates were prepared for transmission lines to deliver Susitna power to Glennallen and other points along the Richardson Highway. These alternatives are discussed in the Power Market Report.

SECTION I

ENVIRONMENTAL ASSESSMENT

FOR

TRANSMISSION SYSTEMS

UNITED STATES DEPARTMENT OF THE INTERIOR
Alaska Power Administration
Environmental Assessment for
Transmission Systems for
Devil Canyon and other
Potential Units of
The Upper Susitna
River Project

December 1975

Contents

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LIST OF FIGURES

LIST OF EXHIBITS

INTRODUCTION

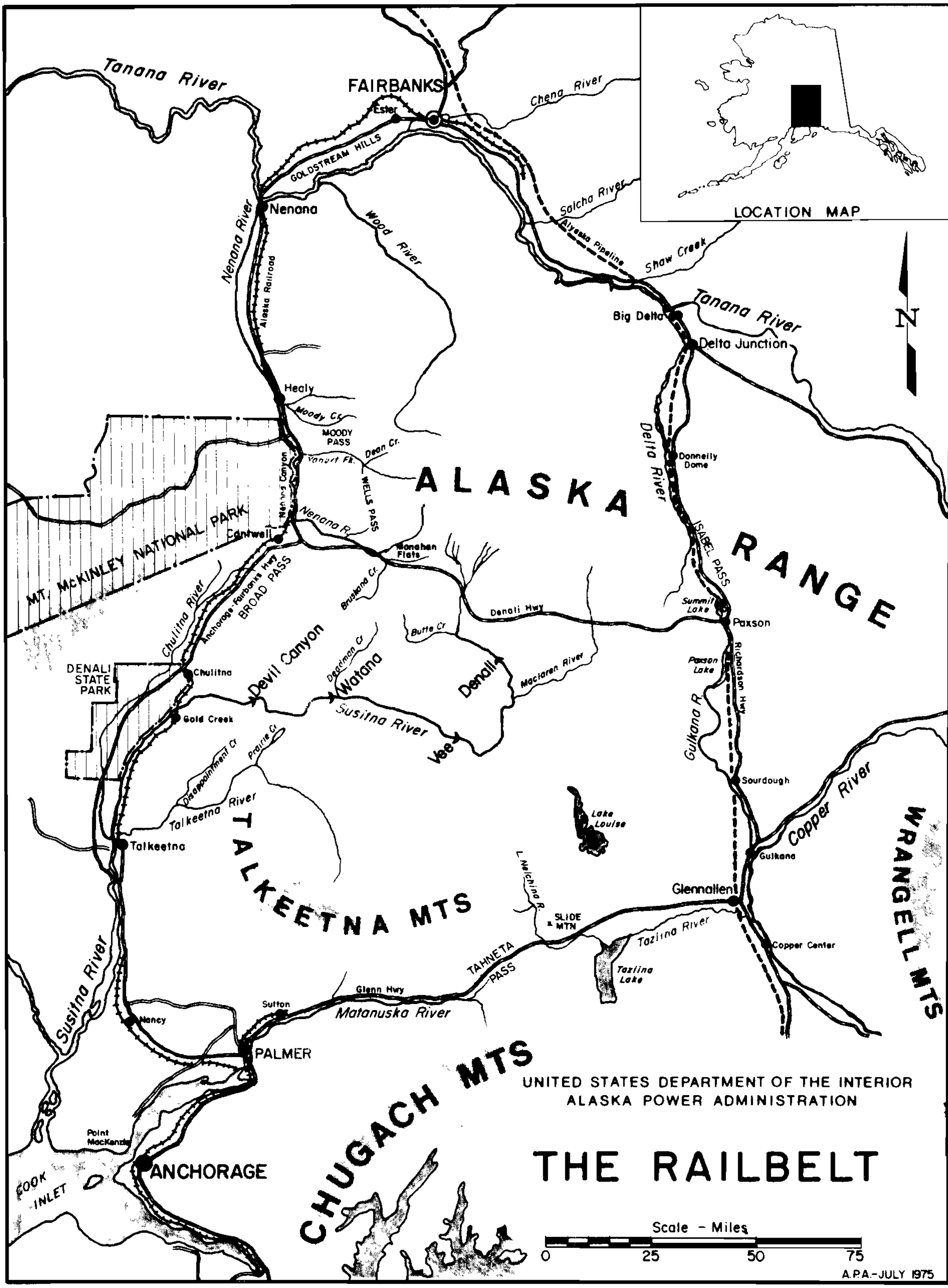
The Transmission System Environmental Assessment for the Upper Susitna Project is one of three reports produced by the Alaska Power Administration as supporting studies for investigations by the U. S. Army Corps of Engineers of hydroelectric development in the Upper Susitna River Basin. The other two APA reports that complement this Assessment are the Transmission System Report and the Power Markets Report. Although there is considerable overlap in these three documents, each of the three discusses basically different facets in the transmission systems.

The Corps studies considered several alternative hydro development plans involving four main damsites on the Upper Susitna River above Gold Creek. Four of these sites were identified in previous Bureau of Reclamation investigations (Devil Canyon, Watana, Vee and Denali, as indicated in Figure 1.) The fifth site (High Devil Canyon) is located between Devil Canyon and Watana and is an alternative for developing the head in that reach of the river. Based on engineering, cost, and environmental factors, the Corps proposes an initial development plan including the Watana and Devil Canyon dam and power plants at each site.

The transmission system studies for the Upper Susitna River Project are of preauthorization or feasibility grade. They consist of evaluation of alternative corridor locations from the viewpoints of engineering, costs, and environment; reconnaissance studies of transmission systems needed, for alternative project development plans for use in overall project formulation studies; consideration of alternative transmission technologies; and feasibility grade designs and cost estimates for the preferred transmission plan. These studies deal with general corridor location; the more detailed studies following project authorization would include final, on-the-ground route location.

The purpose of a preliminary transmission corridor survey is to eliminate those which do not appear to be feasible, whether for technical, economic, or environmental reasons. The preliminary survey then analyzes those remaining corridors and presents the data on the various alternative corridors in such a way so that comparisons can be made. At this point, it is not within the scope of the preliminary survey to show preference for some corridors over others, only to reject obviously unfeasible ones and to analyze the feasible ones. Further analysis then provides the basis for the selection of the preferred system plan.

The width of the corridors is variable. In stretches confined by mountainous terrain, the corridor may be almost as narrow as the final route; in flat country, the corridor can be several miles wide. Within a given corridor there can be several feasible routes to be selected from in the final route survey.



Appendix I
FIGURE I-1

Basically, the selection of corridors devolves on the need to transmit power from a generation site -- the Devil Canyon-Watana damsites -- to two load centers, Anchorage and Fairbanks (See Figure 1). The load centers are almost equally to the north and south of the Upper Susitna complex, and are connected to each other by two basic corridors -- the Anchorage-Fairbanks Highway/Alaska Railroad and the Glenn/Richardson Highway. The alternatives are all variations upon these two basic corridors, which are dictated by the topography and climate of the Railbelt area.

Although the most economical transmission corridor is theoretically a straight line joining generation site and load center, physical and social factors force deviations from this shortest-distance ideal. Thus, it can often happen that physical and social factors are in opposition to economic factors, and a balance has to be found. This striving for a balance results in alternatives, from which, eventually a most desirable corridor has to be chosen.

The method of analysis for the alternatives uses the shortest segments between intersections of alternative corridors as the units of evaluations; these may vary in length from 15 to over 100 miles. These segments were evaluated on a set of physical and social criteria, but are not to be compared to each other. These evaluations are shown in the matrixes on pages 19-22 and pages 34-37.

Using these segments as basic units in combination, several alternative corridors can be devised and can then be compared. To save repetition, segments common to alternative corridors being compared can be omitted from the comparison. The corridor presented in the Description of the Proposed Action is that route which produces the minimum adverse impacts consistent with economic feasibility.

DESCRIPTION OF THE PROPOSED ACTION

The proposed action includes the construction and operation of a transmission system to deliver power generated by dams and powerplants on the Upper Susitna to the two primary load centers of Anchorage and Fairbanks, and perhaps other load centers that may prove feasible. The design and location of this line will provide for the most economical construction and reliable operation consistent with minimal damage to the environment. If approved, construction would begin by about 1980.

Besides delivery of power from the Upper Susitna Project, another quite important function of the transmission line is the interconnection of the systems presently serving the Anchorage and Fairbanks areas. Interconnection will have several results. It will provide increased reliability for the entire system in that severe shortage or outages in one utility can then be alleviated by a transfer of power from other utilities. Each utility will need less reserve capacity and surplus from one part of the system can offset deficits in another. Communities presently not served by the larger utilities, or near the fringes of service may benefit from interconnection by tying into the system, thus allowing them to avoid local generation, which is usually a more expensive alternative. Interconnection of the Anchorage and Fairbanks utilities would be a step toward an intertie with Canada and the Lower 48, with benefits on a larger scale than local interconnection. This would lead to the most efficient generation and distribution of energy, resulting in great savings of fossil fuels.

The proposed corridor runs from the Devil Canyon powerhouse west to Gold Creek, then southwest along the Susitna River and the Alaska Railroad to Talkeetna. From Talkeetna the corridor follows the east bank of the Susitna River to the Nancy Lake area and then due south to Point MacKenzie. The second half of the corridor runs from Gold Creek north to Chulitna and then parallels the Anchorage-Fairbanks Highway and the Alaska Railroad through Broad Pass, the Nenana Canyon, and to Healy. From Healy the corridor will follow the existing GVEA 138 kv transmission line to the existing substation at Gold Hill to Ester, although the existing right-of-way may not necessarily be used. The section of corridor from Devil Canyon to Point MacKenzie is about 140 miles; from Devil Canyon to Ester is about 200 miles.

The proposed facilities are a double circuit 345 kv transmission line to Anchorage, a double circuit 230 kv transmission line to Fairbanks, a switchyard at each powersite, and the necessary substations to deliver power to the utility systems. Access road suitable for four-wheel drive vehicles will follow the right-of-way where feasible. In areas of highly erodable soils, scenic sensitivity, or vulnerability to impacts stemming from improved access, these access roads will be omitted. This assessment was premised upon stacked double circuits, both circuits using the same set of transmission structures. However, reviews by Bonneville Power Administration and other agencies voiced concern for the reliability of this system, and an alternative arrangement of circuits studied.

In this arrangement, two single circuit systems parallel each other, not necessarily along the same right-of-way. This parallel single circuit system will reduce the probability of a total break in transmissions, but will cost somewhat more and require more right-of-way and clearing than the stacked double circuit system. The right-of-way for double and single circuits of similar voltage is identical; in the case of 345 kv it is 140 feet, for 230 kv it is 125 feet. A parallel single circuit could require up to twice the right-of-way area and clearing of a single or double circuit.

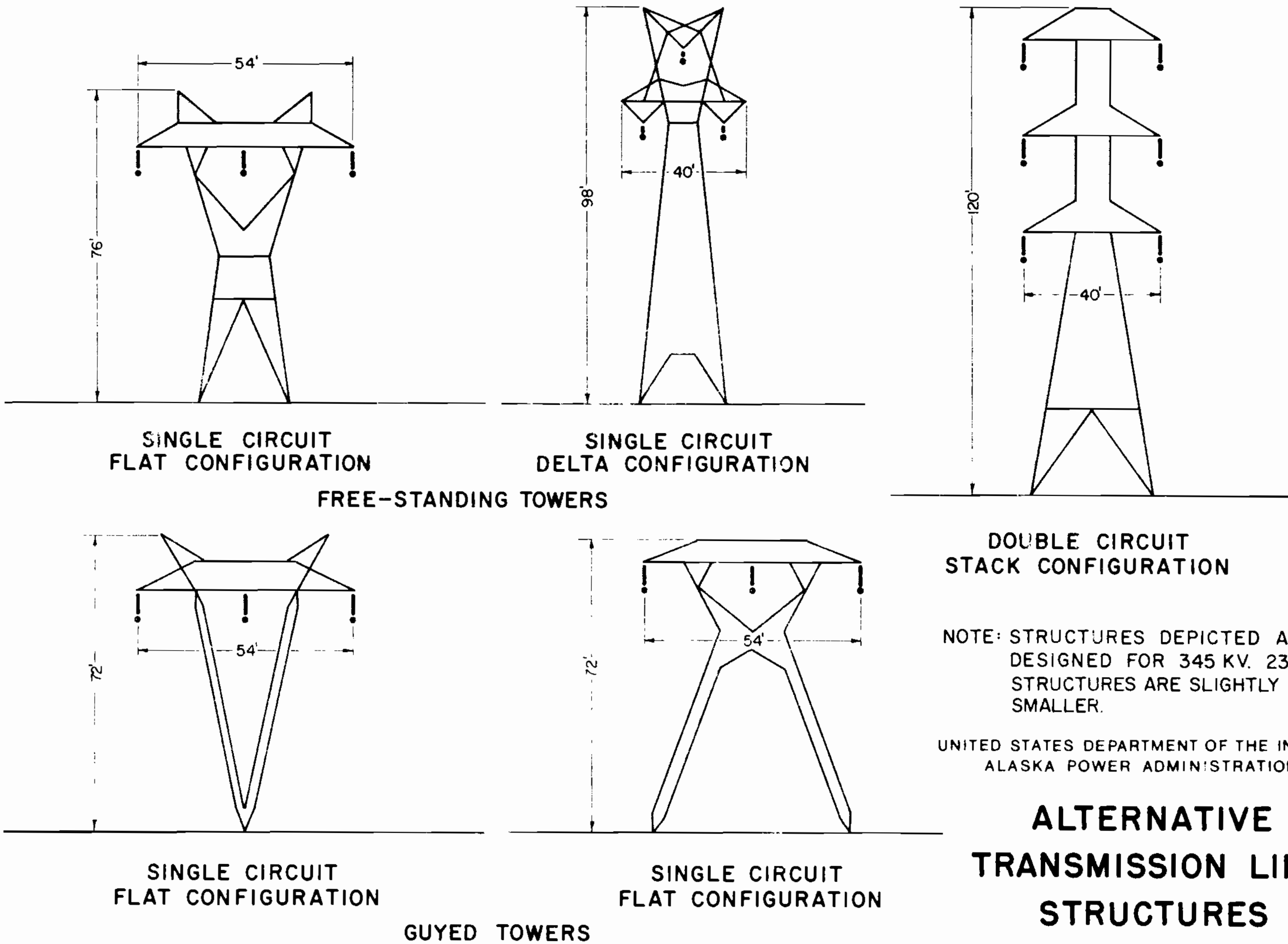
The proposed action will include the alternatives of parallel single circuits and stacked double circuit. Neither system will be exclusive; it is very possible to use both systems along different stretches of the transmission line. In the following discussions of impacts, the acreage of right-of-way and clearing will be premised upon stacked double circuit.

The sequence of final routing and construction follows a general sequence of final survey to locate towers and clearing widths, clearing and access construction, erection of towers, stringing, tensioning, and right-of-way restoration.

The final survey will involve photogrammetric determination of clearing widths to minimize the amount of clearing; not only is this more economical, but it also avoids the method of total clearing within set distances from the center line. Final tower locations are also determined at this time; tower spacings are usually on the order of four or five per mile, but will be spaced closer as conditions warrant.

Towers will be either steel or aluminum and of the free-standing type, although depending upon final design and local conditions, guyed towers may be used in some areas. The conductors are of aluminum conductor reinforced with steel.

Appendix I
FIGURE I-2
I-6



NOTE: STRUCTURES DEPICTED ARE DESIGNED FOR 345 KV. 230 KV STRUCTURES ARE SLIGHTLY SMALLER.

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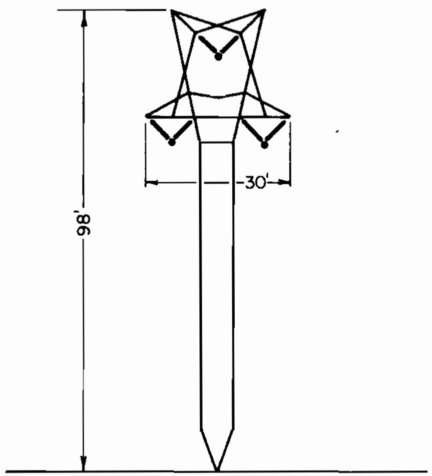
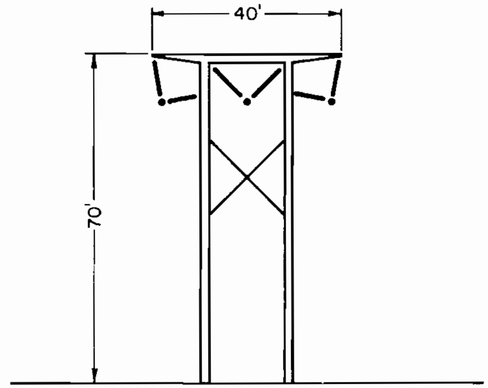
ALTERNATIVE TRANSMISSION LINE STRUCTURES

Source · Edison Electric Institute

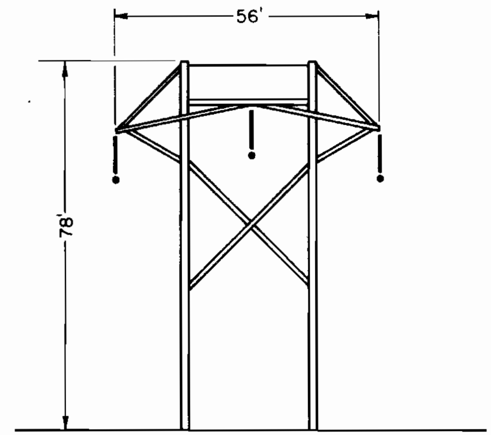
A.P.A.-JANUARY 1975



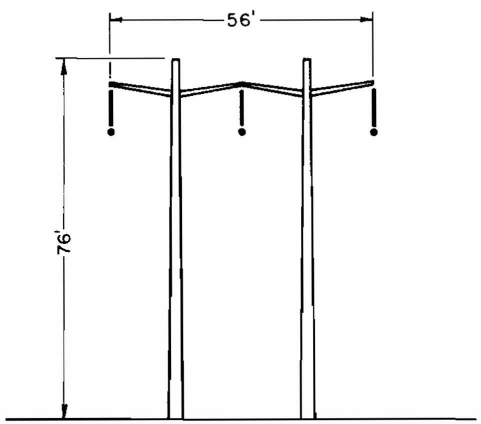
SINGLE CIRCUIT
DELTA CONFIGURATION
GUYED TOWER



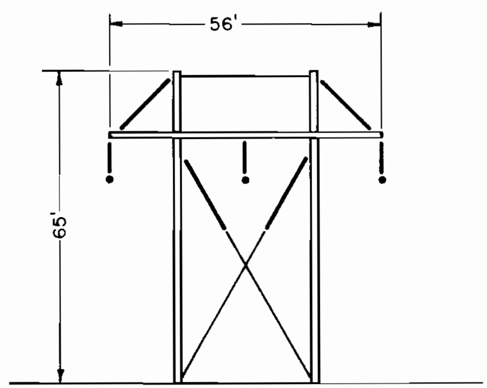
SINGLE CIRCUIT
METAL H-FRAME STRUCTURE



SINGLE CIRCUIT
WOOD H-FRAME STRUCTURE



SINGLE CIRCUIT
METAL H-FRAME STRUCTURE



SINGLE CIRCUIT
WOOD H-FRAME STRUCTURE

NOTE: STRUCTURES DEPICTED ARE DESIGNED FOR 345 KV. 230 KV STRUCTURES ARE SLIGHTLY SMALLER.

UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION

ALTERNATIVE TRANSMISSION LINE STRUCTURES

Source: Edison Electric Institute

A. P.A.-JANUARY 1975

Tower designs will be determined in the final design; varying conditions may call for several designs being used. Free standing towers are more easily constructed on sections with good access roads; guyed towers are more suitable for helicopter construction. Various guyed and free-standing tower designs, for single and double circuits, and several alternate structures for use in lieu of these towers in special circumstances are shown on Figures 2 and 3.

In heavily forested areas, clearing will be done by brush blades, or rotary cutters on bulldozers and by hand removal of the cleared area and individual danger trees outside of the main cleared strip. Danger trees are those trees that may grown to such a size within five or ten years that they may fall within a set distance from a conductor or tower. Distance from the center line, growth rate, and maximum obtainable height will determine danger trees. Disposal of cleared materials may vary from selling of merchantable timber to chipping or burning of slash.

There are known and potential archeological and historical sites along the proposed corridors. To minimize possible vandalism or disturbance, no sites other than those on the National Register shall be located either on a map or on the narrative of this assessment. To preserve the integrity of these known and potential sites, a preconstruction archeological survey of the corridors will be carried out and the final transmission route will be adjusted to minimize disruption. Inadvertent discovery of an unsuspected site at a later stage will entail either the minor relocation of a segment of the transmission line or the salvage of the site as prescribed by Executive Order #11593 and P.L. 93-291.

In sections where permanent access roads are required, the road will be built and maintained to a standard suitable for four-wheel vehicles. Not all sections will have access roads; in critical areas, winter construction, or helicopter construction will be used.

Right-of-way restoration after construction includes removal of temporary structures and temporary roads, disposal of slash and refuse and revegetation. In some cases, it may be necessary not only to maintain access roads, but to upgrade them if it is determined by the State Department of Highways that such a road would be a suitable addition to the secondary road system.

At each terminus, and at any future taps on the line to serve other communities, a substation will be required. Basically, a substation is required to adjust the voltage supplied by the transmission line to match that of the recipient system. In addition, the substation fulfills a switching function.

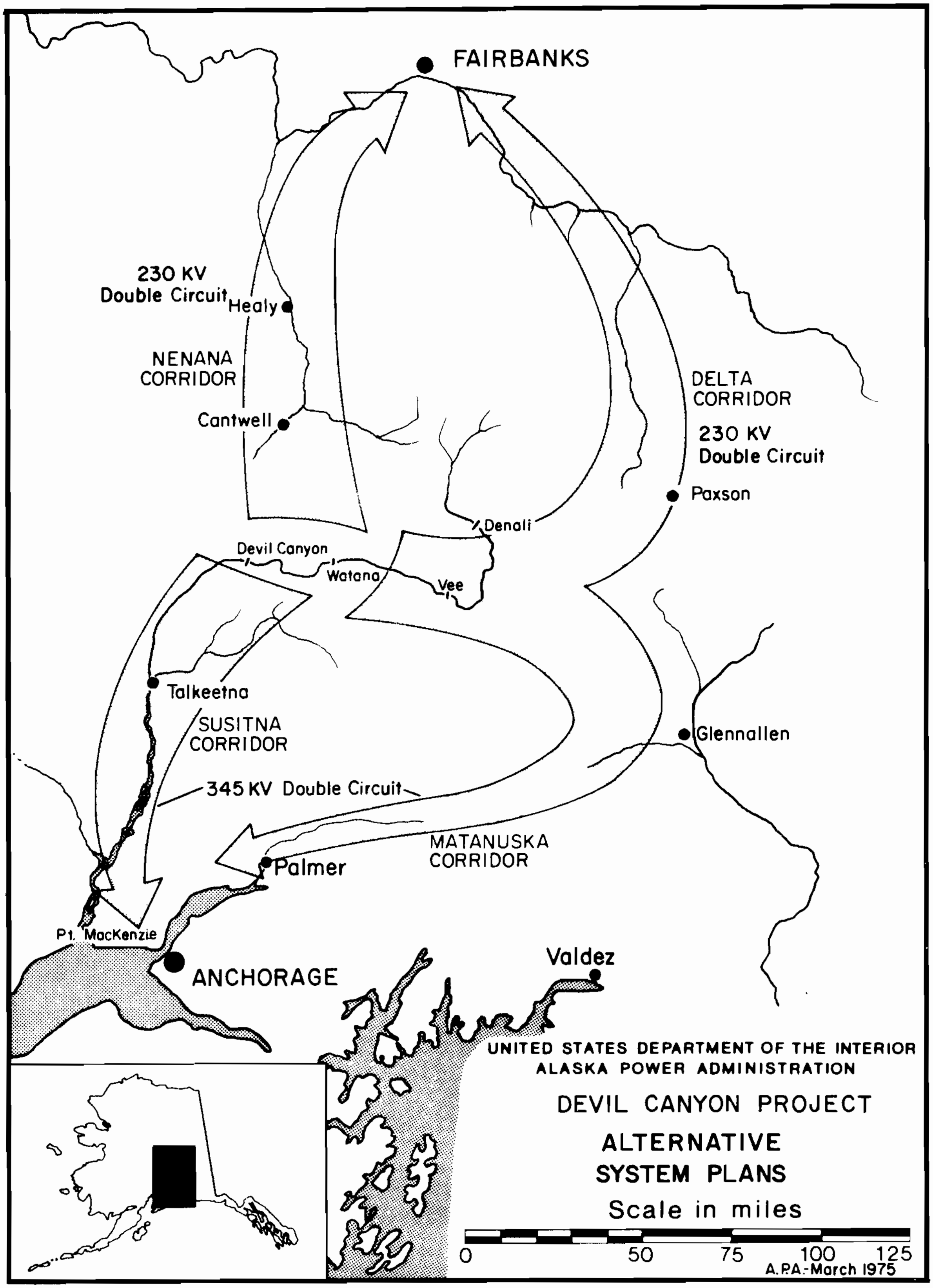
At the north terminous of Ester, the existing Gold Hill substation could be used with appropriate modification. At the south terminus at Point MacKenzie, the existing underwater cable terminal could be enlarged to accommodate a substation. If an alternative end point near Palmer is finally selected over Point MacKenzie, a substation presently serving the APA 115 kv Eklutna system could be used.

Along some sections, periodic suppression of tall vegetation will be necessary. This will be accomplished with manual application of herbicides or hand clearing, or both. Vegetation maintenance will need to be repeated every five years or longer.

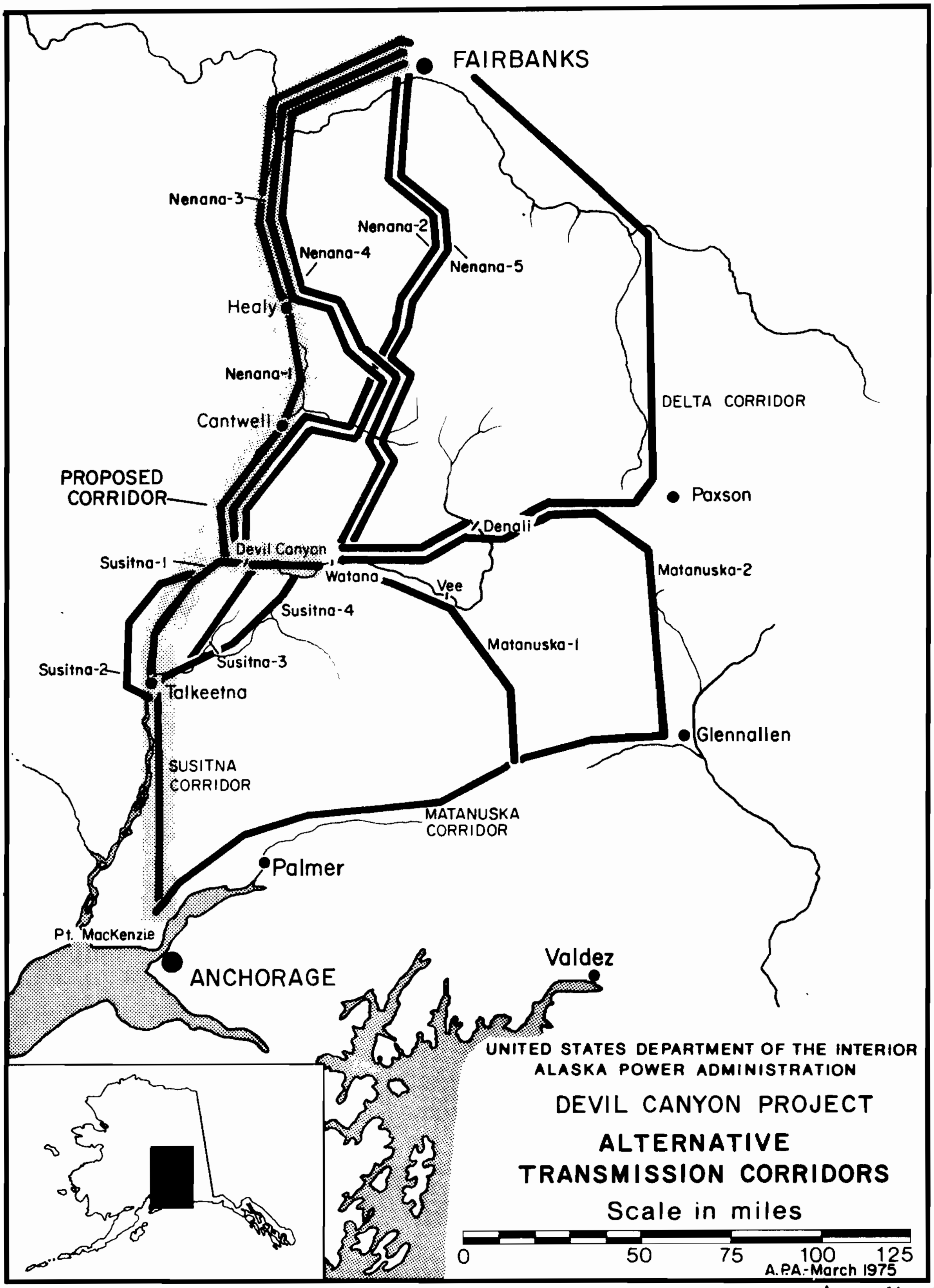
Periodic inspection of the line will be done from the air, complemented by less frequent inspection from the ground. Inspection will reveal potential failure of tower components such as vibration dampers, insulators, and guy lines; condition of tower footings; condition of conductor; presence of danger trees; and condition of access roads.

Alternative methods of construction and maintenance which were referred to above, will be discussed in greater detail in the section Alternatives to the Proposed Action.

The preferred system plan was chosen by Alaska Power Administration after preliminary study of all feasible corridors joining the Upper Susitna complex to Anchorage and Fairbanks. The most feasible corridor was selected on the basis of cost, reliability, and potential environmental impact; the remaining corridors represent alternatives of varying degrees of feasibility.



Appendix I
FIGURE I-4



Appendix I
FIGURE I-5

THE CORRIDORS

The alternative system plans represent only general corridors, and do not attempt to define an actual right-of-way. Thus the alternatives do not distinguish among many minor variations, and as a result, are fairly flexible.

Four alternative dam systems for the Upper Susitna are outlined in the Transmission Systems Report, and two alternative transmission systems to connect them with Anchorage and Fairbanks. Details of the alternative dam systems will be found on Table 1 of the Transmission Systems Report. For three of these alternative systems--one of which is the Devil Canyon-Watana System proposed by the Corps of Engineers--the transmission system will consist of the proposed 345 kv double circuit to Anchorage and the 230 kv double circuit to Fairbanks. For the fourth dam system, a 230 kv double circuit to Anchorage and a 230 kv single circuit to Fairbanks will be used.

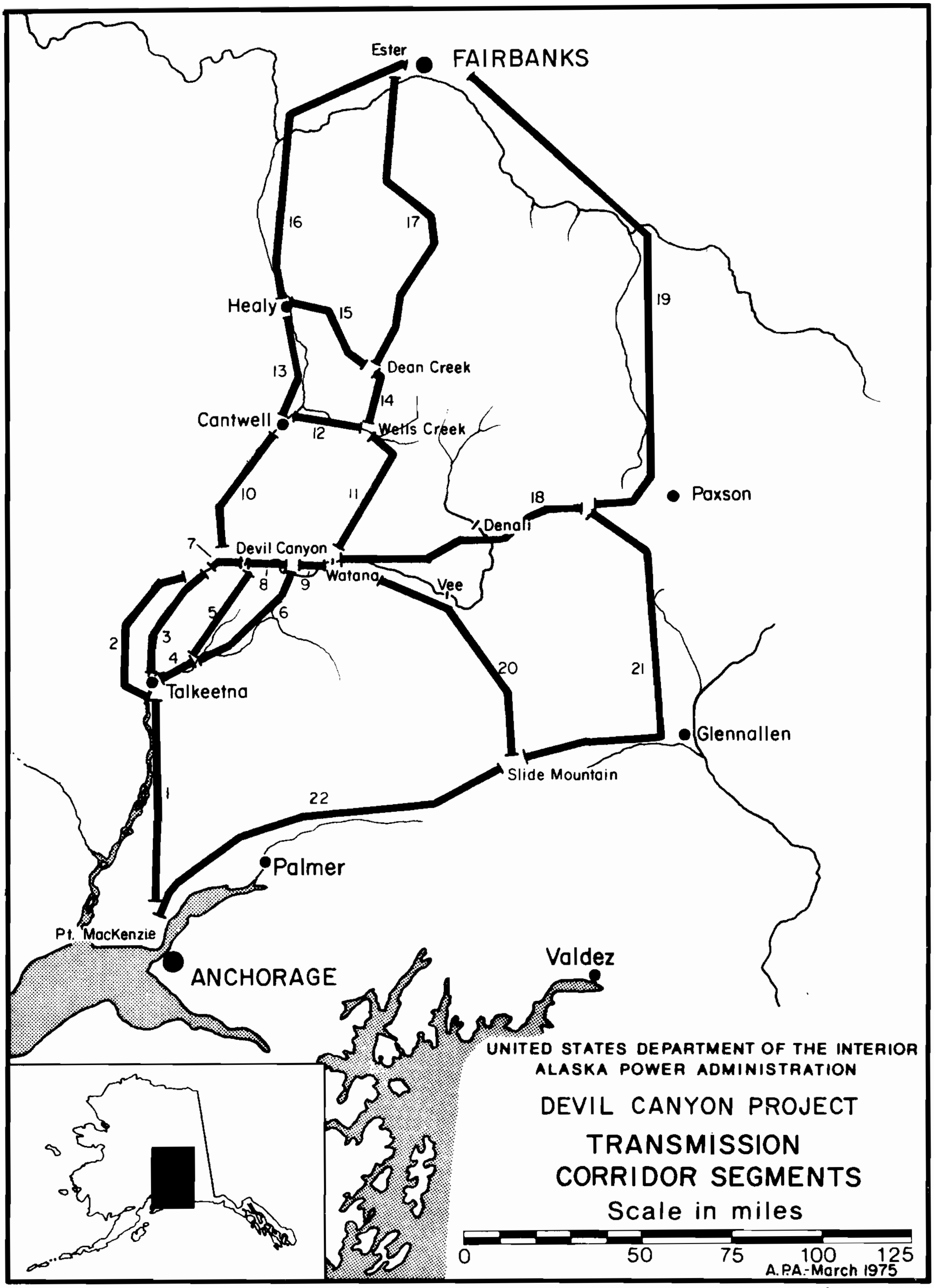
These two alternative designs in conjunction with the alternative transmission corridors, constitute the alternative system plans. The degree of environmental impact is more dependent upon the alternative corridor and, to a lesser degree, upon the voltage; the number of circuits affects environmental impacts least.

The width of the corridors is variable. In stretches confined by mountainous terrain, the corridor may be almost as narrow as the final route; in flat country, the corridor can be several miles wide. Within a given corridor, there can be several feasible routes to be selected from the final route survey.

There are four groups of alternatives: first, those that lead from Devil Canyon-Watana to Anchorage via the Susitna watershed; second, those that lead to Fairbanks via the Nenana and Tanana drainage; third, those that lead to Fairbanks via the Delta and Tanana drainages; and fourth, those that lead to Anchorage via the Copper and Matanuska drainages (see Figures 4 and 5, and Strip Maps in **Exhibit** I-2).

Susitna Corridors

There are basically four feasible corridors which connect Devil Canyon to Anchorage via the Susitna drainage. All four of these incorporate the segment that runs from the endpoints of Point MacKenzie to Talkeetna, so this segment can, therefore, be treated as separate and not included in a comparison of the alternative corridors.



Appendix I
FIGURE I-6

Key to Alternative Corridors and Segments

Corridor	Segments of Corridor	Approximate Total Mileage
	Susitna Corridors	
Susitna #1	1, 3, 7	136
Susitna #2	1, 2, 7	140
Susitna #3	1, 4, 5	129
Susitna #4	1, 4, 6, 8	147
	Matanuska Corridors	
Matanuska #1	8, 9, 20, 22	258
Matanuska #2	8, 9, 18, 21, 22	385
	Nenana Corridors	
Nenana #1	7, 10, 13, 16	198
Nenana #2	7, 10, 12, 14, 17	220
Nenana #3	7, 10, 12, 14, 15, 16	231
Nenana #4	8, 9, 11, 14, 15, 16	223
Nenana #5	8, 9, 11, 14, 17	212
	Delta Corridor	
Delta #1	8, 9, 18, 19	280

Of the four corridors that run from Talkeetna to Devil Canyon-Watana, the first is the southern half of the proposed corridor, which follows the Susitna valley north, paralleling the Alaska Railroad to Gold Creek, where it also leads east to tie into Devil Canyon-Watana (Susitna-1, in Figure 5).

The next, and farthest west parallels the Anchorage-Fairbanks Highway through Denali State Park, along Troublesome Creek, eventually leading east to tie into Gold Creek and Devil Canyon-Watana (Susitna-2). The third goes up the Talkeetna River and gaining the ridge to the east of Disappointment Creek, leads north to the ridge leading to Devil Canyon (Susitna-3).

The fourth and most easterly corridor follows the Talkeetna River to Prairie Creek, which it follows to Stephan Lake, halfway between Devil Canyon and Watana (Susitna-4).

Nenana Corridors

There are five feasible corridors connecting the Upper Susitna with Fairbanks by way of the Nenana River. The first is a corridor paralleling the highway and railroad from Gold Creek to Cantwell, to Healy, and to Fairbanks. This is the northern half of the preferred corridor (Nenana-1, in Figure 5).

The second duplicates the first corridor to Cantwell, but then leads east paralleling the Denali Highway, north up as far as Wells Creek and over the pass to Louis Creek, continuing over the Dean Creek Pass to the Wood River. It then follows the Wood and Tanana Rivers to Fairbanks (Nenana-2).

The third corridor, (Nenana-3), duplicates the second to Dean Creek, where it then continues up Yanert Fork and over Moody Pass, ending up at Healy and joining the first corridor.

Corridor four (Nenana-4) leaves Watana and heads north, emerging onto the Denali Highway near the Brushkana River. It then leads west, goes up Wells Creek, and joins corridor three to Healy and Fairbanks.

Corridor five starts the same way as corridor four, except that instead of going over Moody Pass to Healy, it leads east over Dean Creek into the Wood River, and then leads north to Fairbanks, (Nenana-5).

Delta Corridor

There is only one basically feasible corridor along the Delta River. This corridor leaves Watana damsite and leads east down Butte Creek to the Denali damsite and continues east along the Denali Highway. It then proceeds north near Paxson over Isabel Pass and parallels the Richardson Highway into Fairbanks.

Matanuska Corridors

There are two corridors utilizing the Matanuska Valley as access to Anchorage. The first follows the Delta route to Paxson, then leads south to Glennallen. It then goes west, over Tahneta Pass, and into the Matanuska Valley, tying into Point MacKenzie.

The second corridor connects Watana to Vee damsite, leads southeast to the Little Nelchina River, which it follows to the Glenn Highway and corridor one, which it follows to Point MacKenzie.

Corridor Segments

In order to more easily assess environmental impacts of a transmission line on these corridors, they are reduced to smaller units, or corridor segments. A segment is thus that part of a corridor, either between two intersections with other corridors, or between an intersection and one of the endpoints near Anchorage or Fairbanks. The length of a segment is not standard, nor is the length set by any physical criteria. These segments are the minimum number of units that can be combined to form the previously described alternative corridors (see Figure 6).

Assessment of the existing environment and of impacts of a transmission corridor will be done on the segment level. As a convenience, these assessments will be summarized in matrix form, differentiated as to environmental inventory and assessment of impacts. The Susitna and Nenana corridors will each have separate matrixes; the Matanuska and Delta corridors will be combined because of the fewer number of alternatives.

Segments are labelled in two ways; the first is a nodal label, in which the nodes identify the segment (e.g. Wells Creek-Dean Creek), the second is an assigned number which corresponds to a key map. Both labels are used on the matrix. Matrixes will be found on pp. 18-20 and pp. 32-34.

Matrixes for Inventory of Corridor Segments:

The following matrixes are for inventory of the environment by nine categories. The definitions of the categories and general information are given in the Exhibit I-1. The process from which the 22 corridor segments are derived is explained on pages 15 - 20.

Due to the problems attendant to reducing such large amounts of information to such a constrained format, it would appear that some of the categories are not treated on the same level of detail as others. Specifically, climate, which is of greater concern from the design than the environmental stand point, and thus is relatively lightly treated in this Environmental Assessment. Only data that was found by searching the literature was entered. Thus, for example, caribou may be found in a segment although no mention of it is made in the matrix. One advantage to the matrix system of presentation is that it is easily updated; thus, discrepancies brought to our attention can easily be changed.

The constraints of this format also oblige the use of abreviations; MMCPM zone stands for the Mount McKinley Cooperative Planning and Management zone, GVEA refers to the Golden Valley Electric Association, MEA refers to the Matanuska Electric Association, and the ARR is the Alaska Railroad.

The land status entries are based upon the land status situation of March 1974. State selections refer to not only patented, but also all pending and tentatively approved State selections. Native village deficiencies and regional deficiencies (NVD and NRD) will perhaps be the most unstable areas at present, so it is quite likely that the entries regarding these lands may not be presently valid.

Exhibit I-1

The following appendix will discuss general characteristics of the physical and social categories used in the assessment of the proposed corridors and their alternatives. Both a definition or description of the category and a description of potential impacts in these categories from a transmission line corridor will be discussed. Note the phase "potential impacts"; not all impacts described will necessarily occur.

This section is intended only for background information; specific and more detailed treatment of the proposed corridors and their alternatives is covered under "Environmental Assessment of Corridors" and "Assessment of Impacts".

Topography and Geology

This is one of the more important categories, for topography influences most of the succeeding ones. Topography is itself a surface expression of underlying geology and tectonics (for convenience, tectonics will be considered under geology while hydrology will be covered along with topography).

The Railbelt area is characterized by three lowland areas separated by three major mountain areas. To the north is the Tanana-Kuskokwim Lowland, which is delineated by the Alaska Range to the south. The Susitna Lowland is to the southwest, bounded to the north by the Alaska Range, and to the east by the Talkeetna and Chugach Mountains. The Copper River Lowland in the east is bounded on the north by the Alaska Range, and the west by the Talkeetna Mountains. Each basin is underlain by quaternary rocks surfaced with glacial debris, alluvium, and eolian deposits. The mountains are primarily metamorphic and sedimentary rocks of the Mesozoic, with several areas of intrusive granitic rocks in the Talkeetna Mountains and the Alaska Range, and Mesozoic volcanic rocks in the Talkeetna Mountains. Figure 1 delineates the major features.

The Railbelt is an active seismic area; the 1964 earthquake was perhaps one of the most destructive earthquakes on record. The seismic history is short relative to the time over which strains accumulate to produce an earthquake, so historic seismicity is a poor guide to potential seismic risks. There are several significantly active faults in the Railbelt area. The most spectacular fault in terms of length and prominence is the Denali Fault, a long arc bisecting the entire Railbelt through the Alaska Range. Maximum expectable earthquakes in the area can be of at least a magnitude of 8.5 on the Richter Scale. Figure 2 depicts seismic history of the railbelt from 1899 to 1964.

LEGEND

SEDIMENTARY AND METAMORPHIC ROCKS

QUATERNARY
Surficial deposits, alluvium, glacial debris, eolian sand and silt

TERTIARY
Sandstone, conglomerate, shale, mudstone; nonmarine and marine

MESOZOIC
Sandstone and shale; marine and nonmarine; includes some metamorphic rocks

PALEOZOIC AND PRECAMBRIAN
Sandstone, shale, limestone; mostly marine; includes some early Mesozoic rocks

PALEOZOIC AND PRECAMBRIAN
Metamorphic rocks: schist, gneiss, etc.; mainly Paleozoic

IGNEOUS ROCKS

Quaternary and Tertiary volcanic rocks

Mesozoic intrusive rocks; mainly granitic

Mesozoic volcanic rocks

Paleozoic volcanic rocks

Paleozoic intrusive rocks; granitic and ultramafic

Fault
(Dashed where inferred)

Source: U.S.G.S.
APA-1975

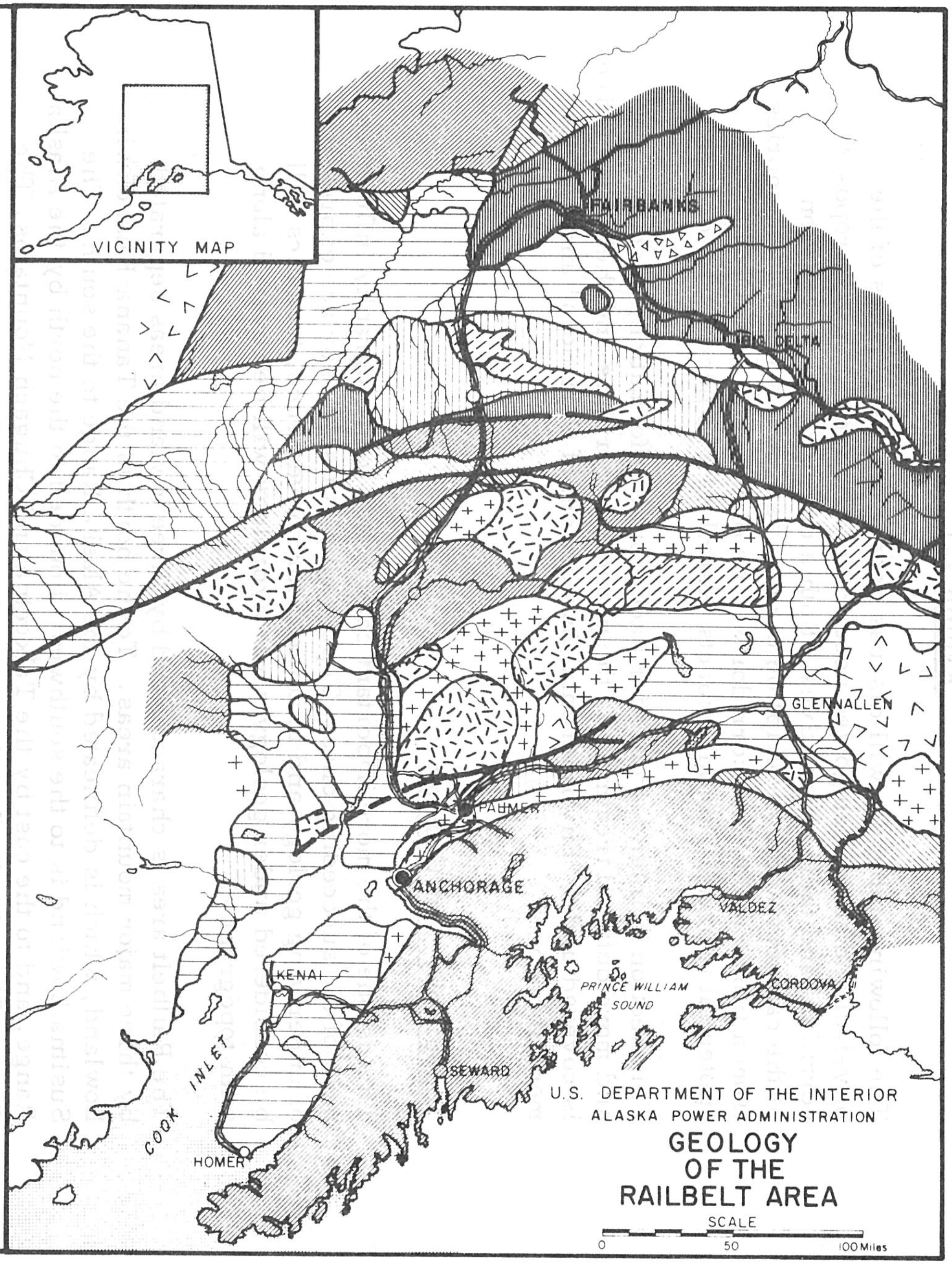
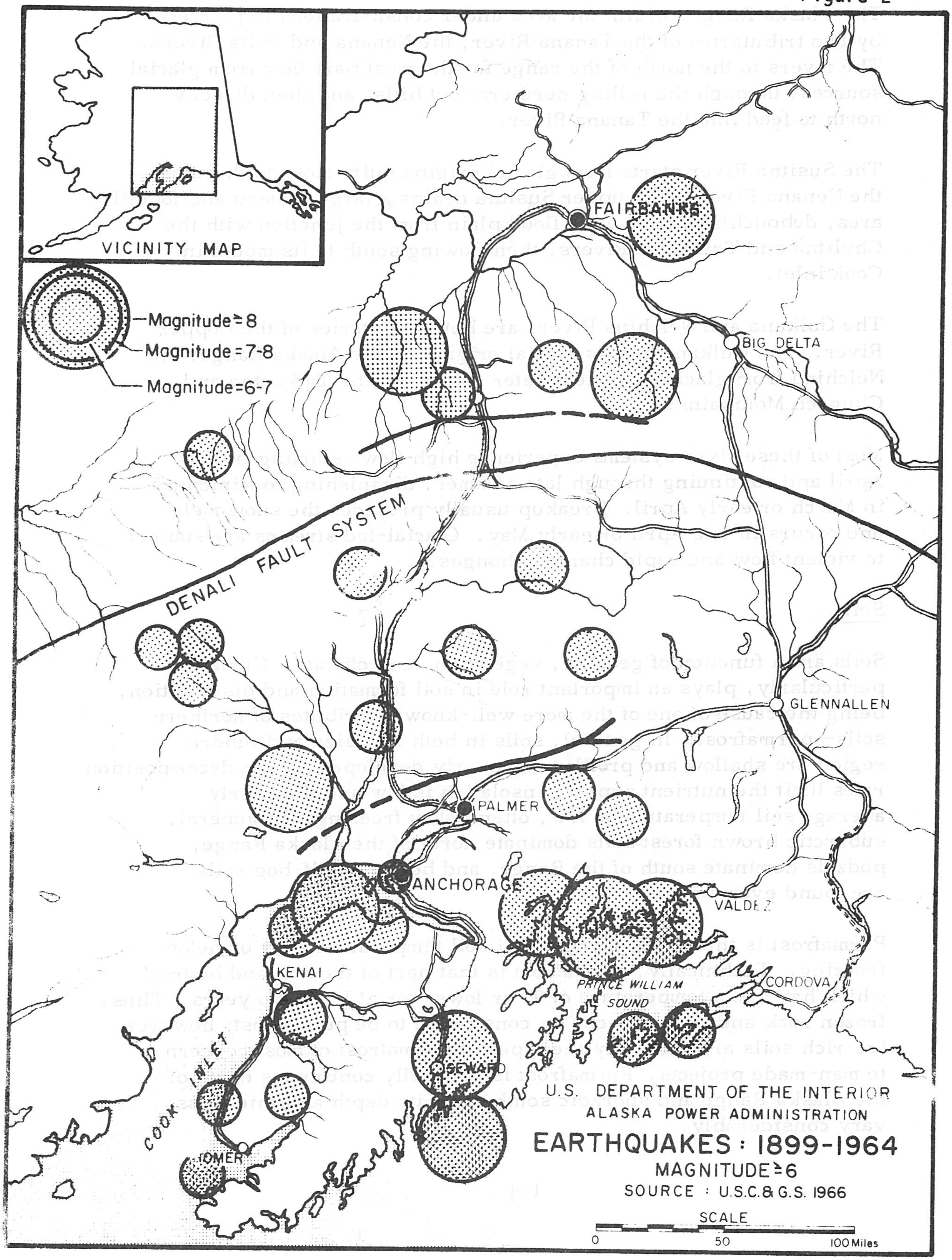


Figure 1

Figure 2



A.P.A.-JULY 1975

The Alaska Range, within the area under consideration, is pierced by two tributaries of the Tanana River, the Nenana and Delta Rivers. The rivers to the north of the range for the most part flow from glacial sources, through the rolling northern foot hills, and then directly north to feed into the Tanana River.

The Susitna River starts from glacial origins quite close to those of the Nenana River. The upper Susitna drains a large plateau and foothill area, debouching onto a wide flood plain from the junction with the Chulitna and Talkeetna Rivers, then flowing south to its mouth in Cook Inlet.

The Gulkana and Nelchina Rivers are both tributaries of the Copper River. The Gulkana has its glacial origins on the Alaska Range, the Nelchina from glacial and clearwater origins in the Talkeetna and Chugach Mountains.

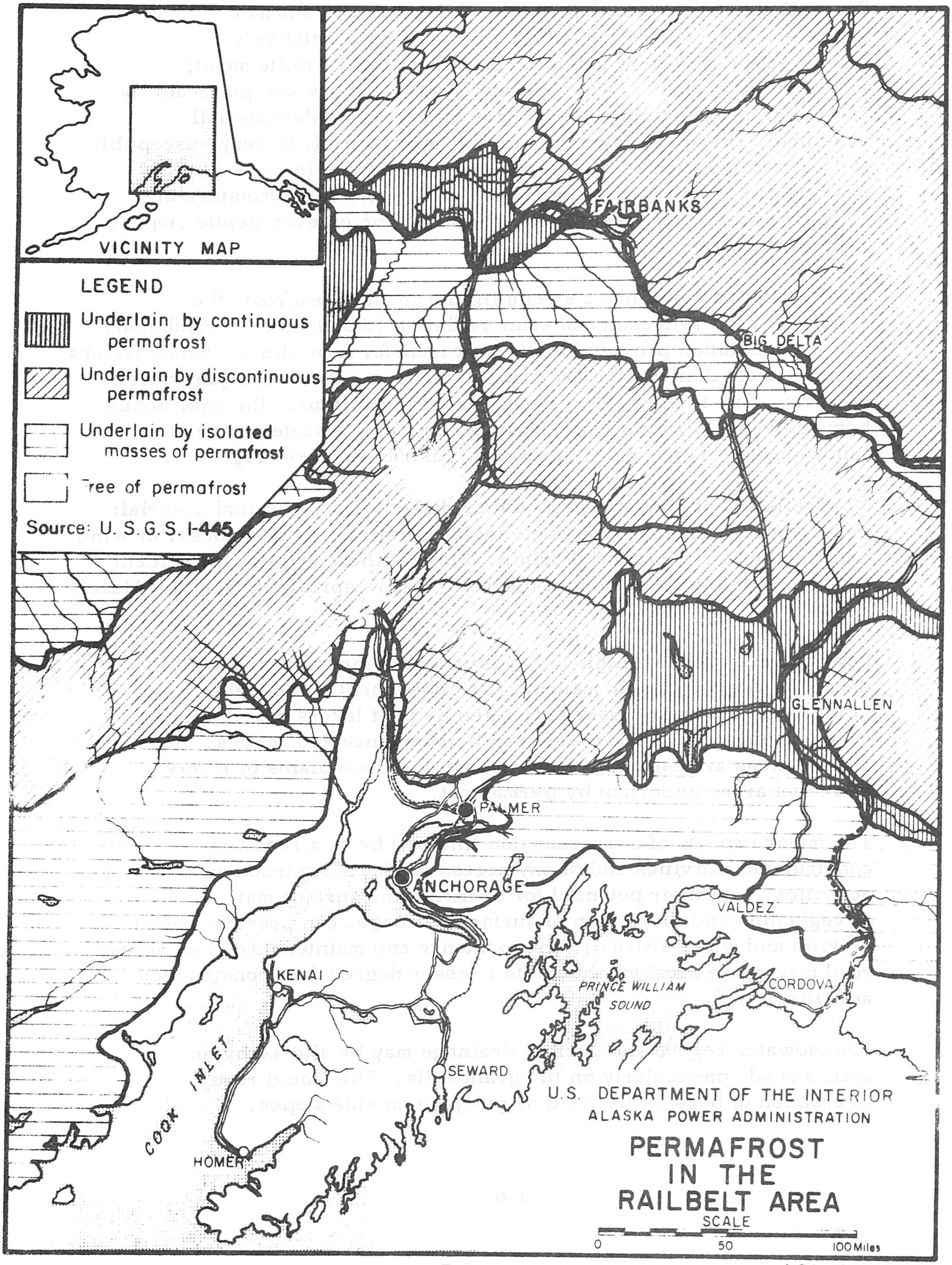
Most of these river systems experience high flows starting in late April and continuing through late summer, diminishing to minimums in March or early April. Breakup usually precedes the snow melt and occurs in late April or early May. Glacial-fed streams are subject to violent flow and rapid channel changes.

Soils

Soils are a function of geology, vegetation, and climate. Climate, particularly, plays an important role in soil formation and distribution, being the cause of one of the more well-known attributes of northern soils--permafrost. In general, soils in both the taiga and tundra region are shallow and profiles are poorly developed. Slow decomposition rates limit the nutrient supply; insolation is low and the yearly average soil temperature is low, often below freezing. In general, subarctic brown forest soils dominate north of the Alaska Range, podzols dominate south of the Range, and bog and half-bog soils are found everywhere.

Permafrost is the result of an annual soil temperature near or below freezing. Technically, permafrost is that part of the soil and bedrock which has had a temperature of 0^{o} or lower for at least two years. Thus, frozen rock and dry soils can be considered to be permafrost; however, ice-rich soils are generally the types of permafrost of most concern to man-made projects. Permafrost is generally continuous north of the Alaska Range and sporadic south of it; its depth and thickness vary considerably.

Figure 3



A.P.A.-JANUARY 1975

The soil above the permafrost table which thaws in summer is known as the active layer. Since ice-rich permafrost is relatively impermeable, a shallow active layer will tend to be quite moist; runoff is slight due to low evaporation rates and low soil permeability, so even in the relatively dry interior there is considerable soil moisture. The active layer, if of finegrain material, is very susceptible to frost action, such as heaves and formation of ice lenses. Shallow moist active layers may be lubricated due to excessive moisture at the permafrost table, resulting in mass wasting on even gentle slopes, called solifluction.

The vegetative cover has a strong influence on permafrost; the relatively high reflectance of solar radiation (albedo) limits insolation, and the insulation provided limits heat transfer from above. Other factors in permafrost distribution are slope and aspect, and underlying parent material. Due to the warmer mean annual temperature, the equilibrium between vegetation and permafrost can be more delicate in taiga than in tundra areas. For general permafrost distribution, see Figure 3.

Most soils are of glacial origin; either directly from morainal material; or from glaciolacustrine or glaciofluvial materials; or from loess, or wind deposited material of glacial origin. Some of these origins are evident in the continuing deposition of the major rivers springing from the Alaska Range.

Low temperatures and high soil moisture combine to cause slow decomposition of organic material and subsequently cause the ubiquitious bogs and muskeg, typified by peat layers over finegrain material, supporting little else than black spruce and sedges. Bogs and muskegs are especially prevalent in the flood plains of rivers and level areas underlain by permafrost.

The major impacts of a transmission line will be as a result of construction activities and of any access roads. Construction activities, with their potential for breaking the surface mat of vegetation and disruption of surface drainage, can possibly result in wind and water erosion. The existence and maintenance of an access road may cause erosion, though to a lesser degree than construction activities.

Groundwater regime and surface drainage may be altered by an access road, particularly on finegrain soils. This could result in creation of bogs on flat land or gullying on side slopes.

Destruction of permafrost and the resultant settling and erosion may result from increased insolation where the vegetation mat has been destroyed, either from direct destruction from vehicles, or from over-compaction of winter roads. Destruction of permafrost may also occur from erosion and severe wildfires. Fire control procedures may result in greater damage to the vegetation cover than that caused by the fire itself.

Other potential results from destruction of permafrost are lowering of the water table with an increase in thickness of the active layer, and slope instability which manifests itself as slumping and solifluction.

In some local areas, thixotropic soils exist, which become plastic under stress such as would be caused by earthquake. The integrity of a transmission line can be threatened in these situations either by failure of tower foundations or by slide or slumps.

Wet, finegrain soils are particularly vulnerable to frost-heaving, which could cause damage to tower footings and the roadway; since heaving is a seasonal phenomenon, this might result in constant maintenance of these areas.

Vegetation

There are seven general vegetation types present within the study area. They are classified as to the predominant vegetation type and topographic location; this classification is derived from that of the ecosystem classification of the Joint Federal-State Land Use Planning Commission. These are depicted in Figure 4; forest density in Figure 5.

Bottom land spruce-poplar is confined to broad flood plains and river terraces, and warmer south slopes of major rivers. Characteristic vegetation is white spruce, balsam poplar, birch and aspen.

Upland spruce-hardwood is similar to bottomland spruce-poplar in the presence of the same characteristic trees, but is limited to the higher portions of watersheds. Actual species composition varies due to slope and exposure.

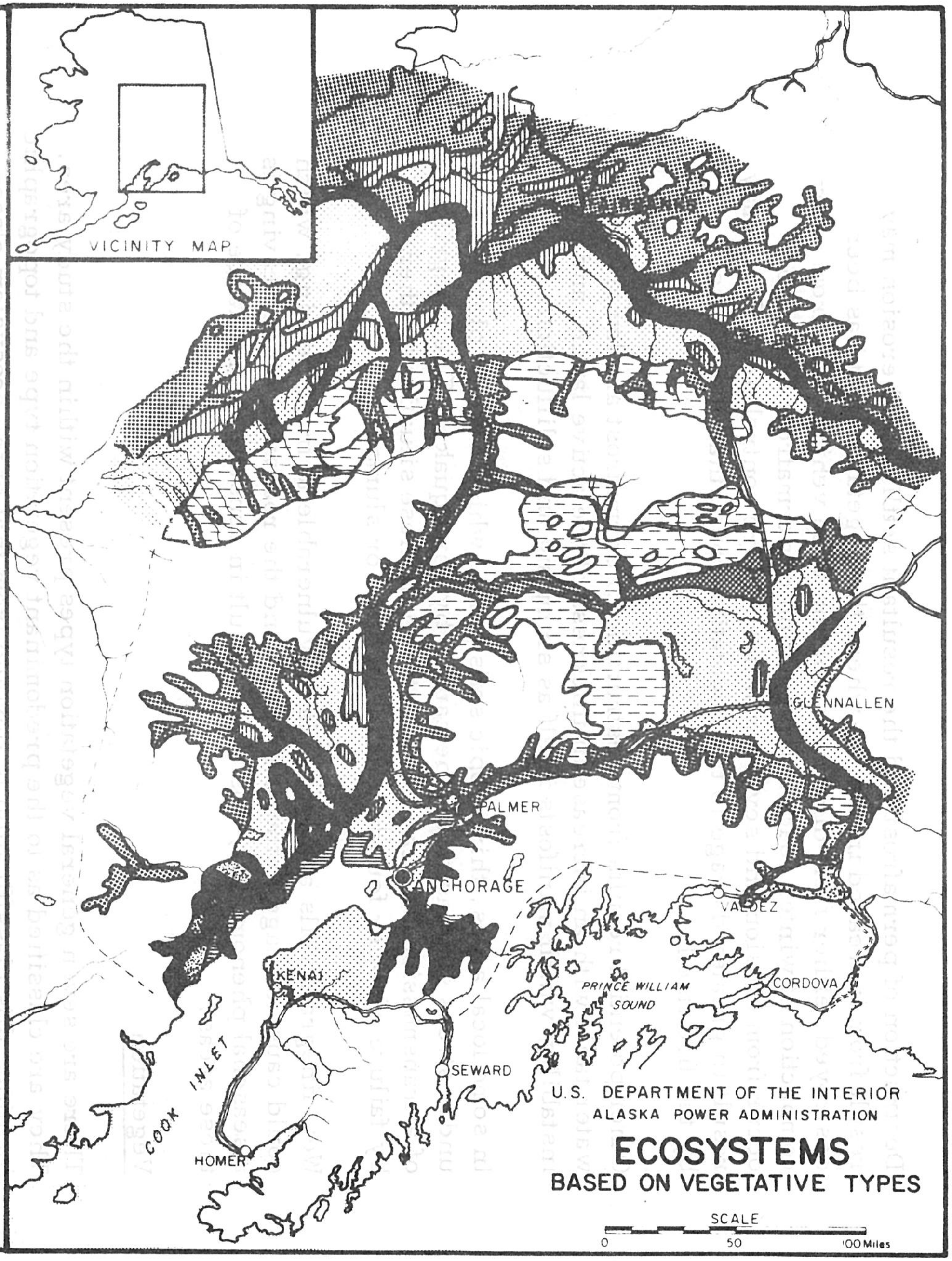
Lowland spruce-hardwood is generally found on poorer soils or sites, such as on peat, glacial deposits, outwash plains and alluvial fans, or on north-facing slopes. Characteristic trees are white spruce, black spruce, tamarack, aspen and birch.

Legend

- Coastal Hemlock-Spruce
- Bottomland Spruce-Poplar
- Upland Spruce-Hardwood
- Lowland Spruce-Hardwood
- High Brush
- Low Brush, Muskeg-Bog
- Moist Tundra
- Alpine Tundra
- Wet Tundra

Source: Joint Federal-State Land Use Planning Commission

APA - July 1975



U.S. DEPARTMENT OF THE INTERIOR
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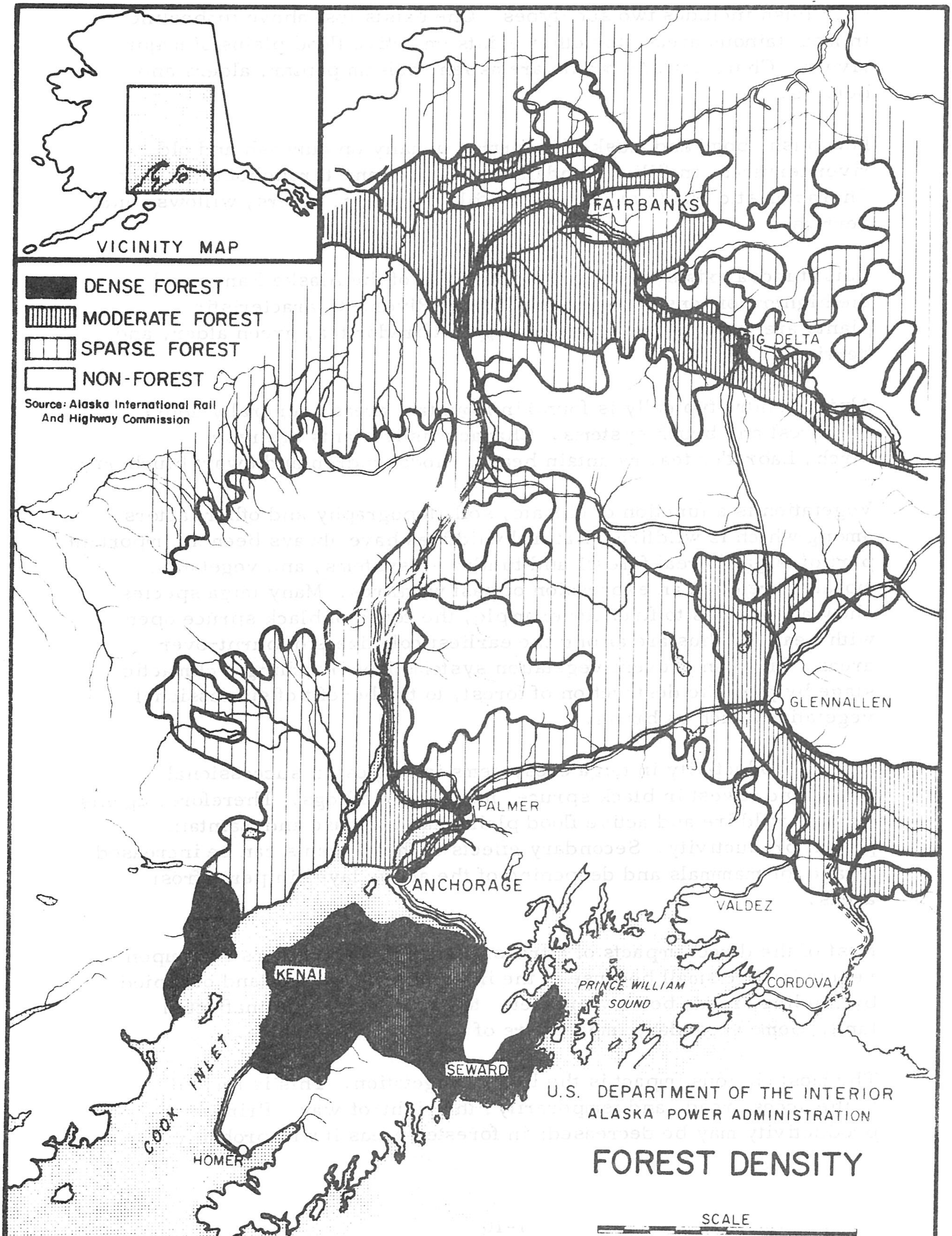
ECOSYSTEMS
BASED ON VEGETATIVE TYPES

Figure 4

Figure 5


VICINITY MAP
DENSE FOREST
MODERATE FOREST
SPARSE FOREST
NON-FOREST
Source: Alaska International Rail And Highway Commission
FAIRBANKS
BIG DELTA
GLENNALLEN
PALMER
ANCHORAGE
VALDEZ
CORDOVA
PRINCE WILLIAM SOUND
KENAI
SEWARD
COOK INLET
HOMER
U.S. DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
FOREST DENSITY
SCALE
0
50
100 Miles
A.P.A.- JULY 1975

High bush includes two sub-types. One exists just above timberline in mountainous areas, the other exists on active flood plains of major rivers. Characteristic plants are aspen, balsam poplar, alders and berries.

Low bush, bog, and muskeg is formed usually on outwash and old river terraces, in filling ponds and sloughs, and throughout lowlands. Characteristic plants are tamarack, black spruce, alders, willows, and berries.

Moist tundra exists on the rolling foothills of the Alaska Range and the higher portions of the upper Susitna River. Characteristic plants are dwarf willows and birches, Labrador tea, green alder, and berries.

Alpine tundra typically is found in mountain areas, generally above the forest and brush systems. Characteristic plants are resin birch, Labrador tea, mountain heath, rhododendron and dwarf blueberry.

Vegetation is a function of climate, soil, topography and other factors, among which is wildfire. Natural wildfires have always been an important part of taiga (boreal forest) and tundra ecosystems, and vegetation mosaics are often an expression of past wildfires. Many taiga species show adaptations to fire; for example, the cones of black spruce open with heat and thus are among the earliest colonizers of burnt-over areas. Fire can prevent vegetation systems from reaching a climactic stage by periodic destruction of forest, to the benefit of successional vegetation, such as brush.

Primal productivity in taiga ecosystems is highest in successional brush and lowest in black spruce, muskegs and bogs. Therefore, agents such as wildfire and active flood plains can increase and maintain primal productivity. Secondary effects of these agents can be increased forage for mammals and deepening of the active layer in permafrost areas.

Most of the direct impacts of a transmission line and access road upon vegetation are small because of the insignificant ratio of land occupied by the line, road, borrow pits, etc. to the surrounding unaffected land. Some secondary impacts are of greater consequence.

The most obvious impact is the loss of vegetation. This is limited to the access road, and temporarily, the right-of-way. Primary productivity may be decreased; in forested areas it will probably be increased. Limited regrowth and maintenance along the right-of-way will result in a subclimax plant community in forested areas; regrowth in brush and tundra areas will eventually reach climax as far as natural conditions allow. In any case, direct changes in primary productivity along the right-of-way upon the total productivity of the area are negligible.

There is a potential for introduction of non-native or "weed" species into cleared areas. However, few plants not already adapted to the harsh climate, especially of the tundras, will be able to compete with the native species.

Where clearing has resulted in slash and debris, this slash must be disposed of. Although stacked or dispersed slash may provide habitat for small animals, there is a high potential that slash may result in increased fire hazard and increases in insect populations and possibly affecting sorrounding forests. Slash can be burned in the open, burned in forced-draft burners, or chipped. Open burning results in considerable smoke and ash, yet is simple and direct. Forced-draft burning is more expensive than open burning. Both burning methods are subject to open burning ordinances of boroughs. Chipping eliminates smoke and ash entirely, but is very expensive and requires more machinery to travel along the right-of-way. Disposal of the chips is a problem, because ideally they should be dispersed to prevent killing the plants on the ground. Since decomposition rates are slow, chips may not revert to humus for quite some time. Disposal of chips in lakes and ponds will result in eutrophication and contamination.

Slow growth rates will keep vegetation management along the right-of-way to a minimal maintenance. Periodic control will still be necessary in forest areas however. Mechanical control, the physical destruction of trees, can be time consuming, expensive, and detrimental to the right-of-way cover. The use of brush hogs and other large mechanized clearing machines is not only inefficient, but also entails damage to the soil and small plants. Cutting will again raise the problem of slash disposal.

The use of herbicides to control vegetation in the right-of-way is considerably cheaper than physical destruction. Herbicides can either be of a broad-spectrum type or species-specific; application can be from the air or on the right-of-way.

Overspray and drifting are problems with aerial application; application on the ground is much more selective and accurate. Degeneration of herbicides depends on the chemical used, soil temperature, moisture, texture, and the rate of biodegradation. Most herbicides used in right-of-way control are of low toxicity to animals, and appear to be non-cumulative, unlike many pesticides. Contamination of lakes and streams is possible; potential destruction of aquatic plants may result, destroying fish habitat. However, this possibility is offset by the decomposition and dilution of herbicides. There is little or no evidence of long-term accumulation of herbicides on the soil; leaching, sunlight, microbial action, and degradation by vegetation itself inhibits accumulation.

Physical disruption of the vegetative mat, either from clearing or machine tracks, or from road construction, will reduce the insulation of frozen soil from summer warmth. The exposure of darker soil will increase warmth from insolation; these factors can combine to alter the permafrost-vegetation relationship. Settling from permafrost destruction will cause erosion and thermokarst; lowering of the permafrost table will alter the ground water regime. These effects in turn will affect the vegetation cover. Areas with thin permafrost, such as in the taiga, are in a more delicate balance with vegetation than more heavily frozen areas, particularly if the active layer is shallow also. Experience in farming in the Tanana Valley has shown that lowering of the permafrost table due to disruption of the original vegetation can also cause lowering of the water table and subsequent changes in vegetation due to a deeper active layer and dryer topsoil.

Although taiga ecosystems are adapted to wildfire, exceptionally deep-burning fires in peat can change the permafrost regime of an area, with subsequent change in vegetation. Excessive repetition of fires in an area can achieve the same result, and also can have a result of maintaining a low subclimax vegetation. Secondary impacts to wildlife are varied, from destruction of habitat and cover to enhanced habitat due to increased primary productivity. Construction and maintenance activities provide additional potential for fire; to what degree fires will increase is impossible to predict. Potential man-caused fires depend upon the distribution and flammability of plant communities along the right-of-way, the seasonal schedule of construction, and annual climatic variation. During construction, potential of man-caused fire will be great, but detection should be early, and areas burned small. During operation and maintenance of the transmission line, potential of man-caused fire will be low, but detection slower, and consequently, areas burned will be larger. Operation of fire-fighting machinery off the access roads may cause considerable damage.

Various plant communities differ in rate of fire spread and resistance to fire control:

Type	Rate of Spread	Resistance to Control
Upland Spruce-Hardwood	High	Medium
Lowland Spruce-Hardwood	High	High
Bottomland Spruce-Poplar	Medium	High
High Brush	Low	High
Moist Tundra	Medium	Medium
Alpine Tundra	High	Low

Man-caused fire potential exists mainly during the period of May through September. Uncontrolled use of access roads will increase the potential for man-caused fires.

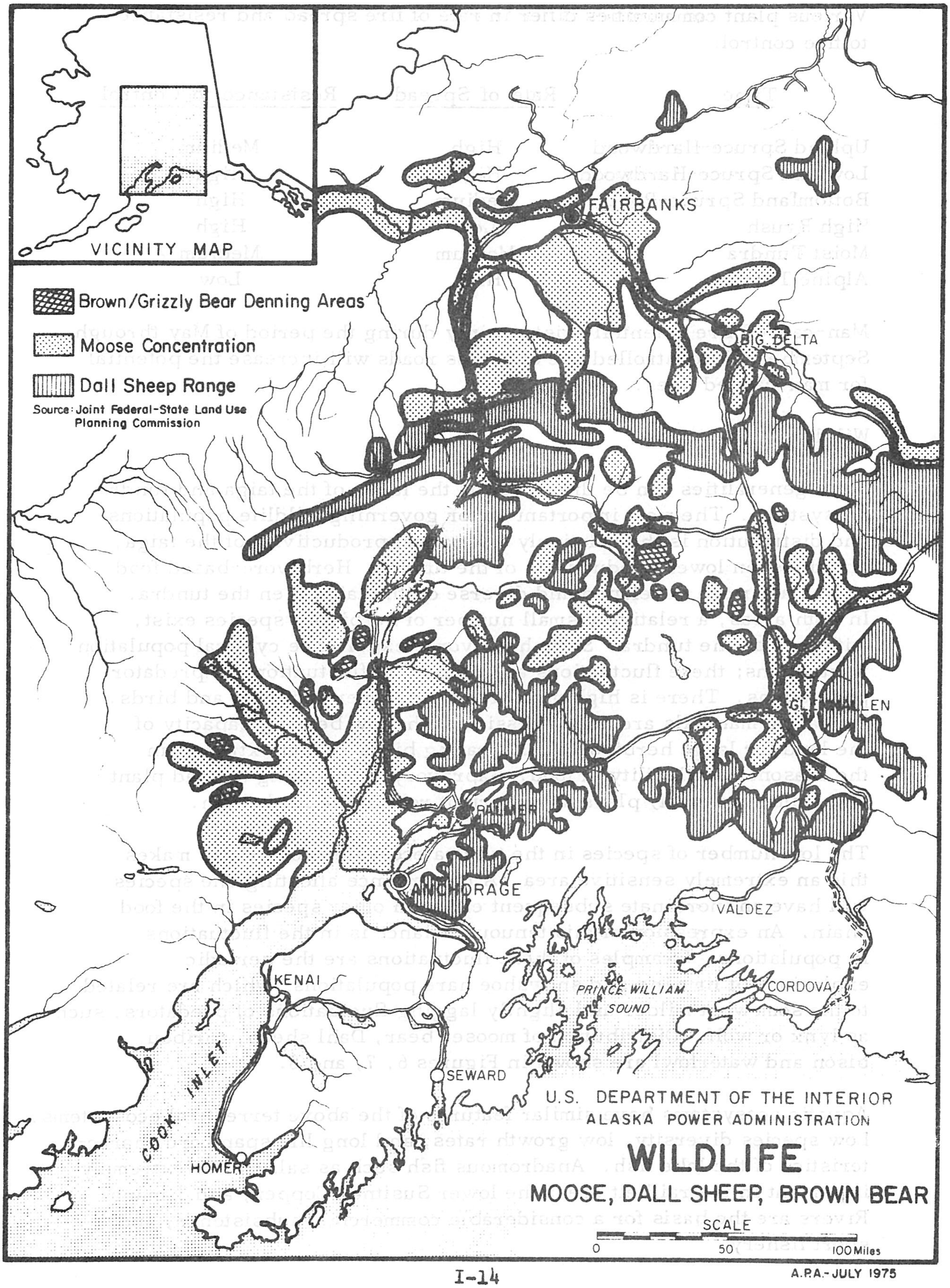
Wildlife

Some generalities can be drawn for as the fauna of the taiga and tundra ecosystems. The most important factor governing wildlife populations and distribution is the relatively low primal productivity of the taiga, and the even lower productivity of the tundra. Herbivore-based food chains are more developed and diverse on the taiga then the tundra. In both areas, a relatively small number of herbivore species exist, with less on the tundra. Some herbivores experience cyclical population fluctuations; these fluctuations are coupled to fluctuations in predator populations. There is high mobility of the larger mammals and birds. Migrating mammals are an expression of the low bearing capacity of the land for large herbivores. Migrating birds reflect extremes in the seasonal availability of food. Sapravory (consuming of dead plant and animal material) plays an important role in the food chain.

The low number of species in the tundra ecosystem food chain makes this an extremely sensitive area. A disturbance affecting one species will have an inordinate subsequent effect on other species in the food chain. An expression of this tenuous balance is in the fluctuations in populations. Examples of these fluctuations are the periodic explosions of limming and snowshoe hare populations, which are related to the somewhat milder and slightly lagging fluctuations of predators, such as lynx or wolf. Distribution of moose, bear, Dahl sheep, caribou, bison and waterfowl are shown in Figures 6, 7, and 8.

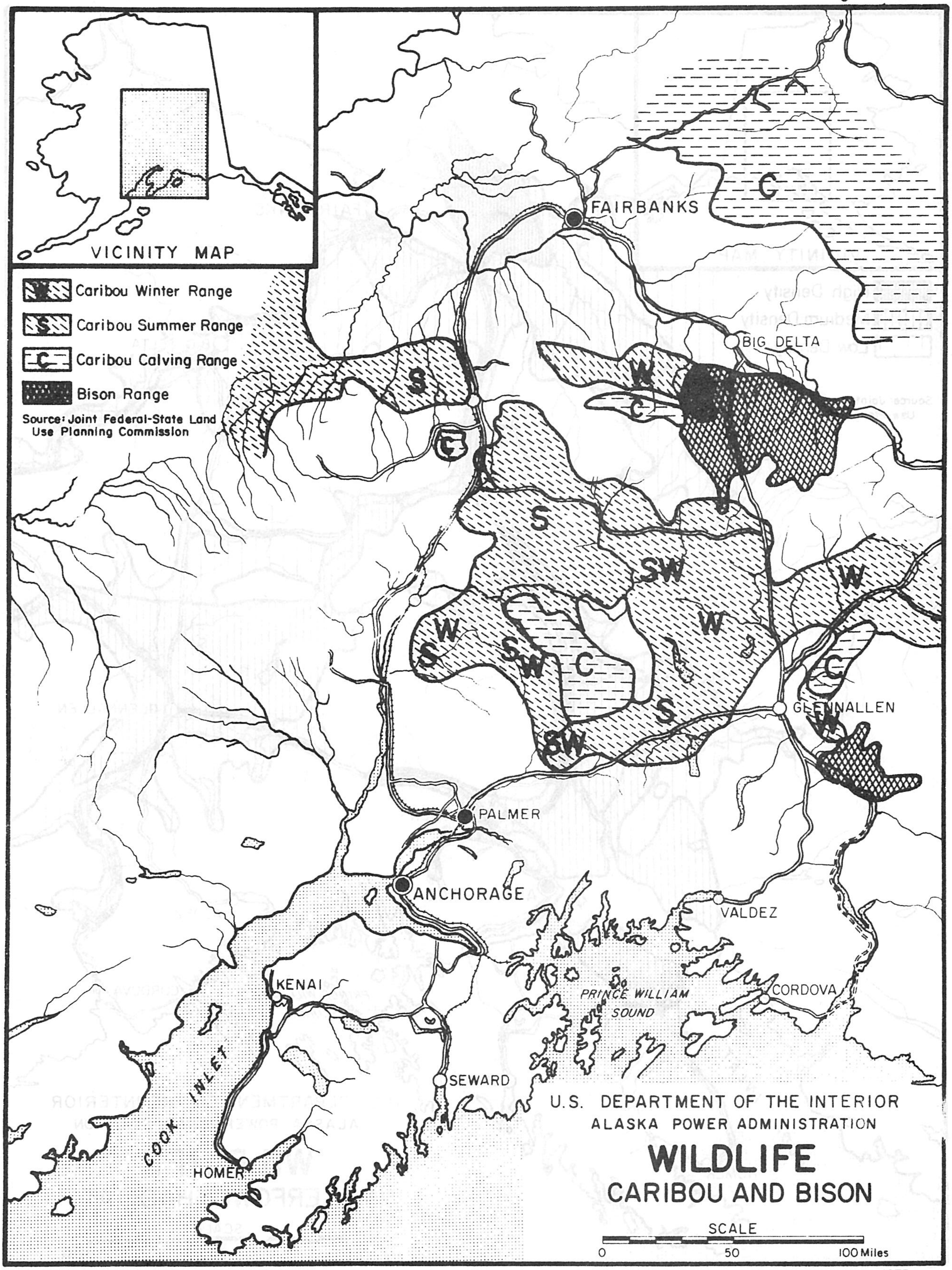
Aquatic ecosystems have similar features of the above terrestrial ecosystems. Low species diversity, low growth rates, and long life spans are characteristics of the lake fish. Anadromous fish such as salmon are extremely important in the railbelt area; the lower Susitna, Copper, and Tanana Rivers are the basis for a considerable commercial, subsistence, and sport fishery.

Figure 6



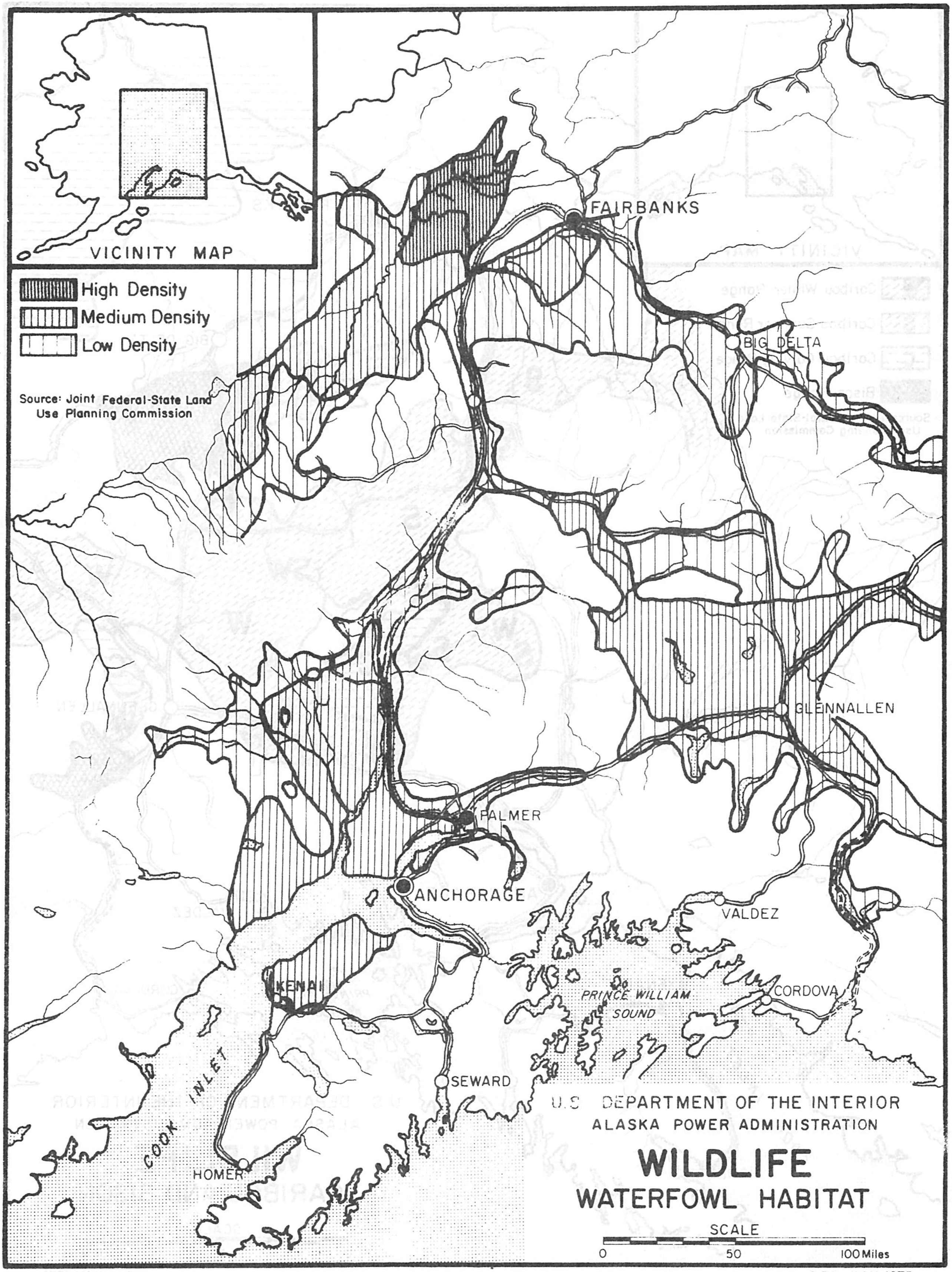
A.P.A.-JULY 1975

Figure 7



A.P.A.-JULY 1975

Figure 8



A.P.A.-JULY 1975

A transmission line per se will not have many impacts upon wildlife; most of the impacts will be as a result of construction and maintenance. Direct destruction will affect the less mobile animals such as the small mammals, whose territories may be small enough to be encompassed by the construction area. The significance of this impact is small in relation to the animal population in the surrounding areas unless the area effected is a key area for a particular species. The construction area will be reinvaded to a degree by animals from the surrounding area after the line is built and regrowth proceeds. Hunting and trapping by construction workers can be considered direct destruction; mortality from project-related fires can also be considered direct destruction.

A more serious impact than direct destruction is the preemption of habitat. Animals forced out of their habitat by construction may not find another niche; this assumes that the land is at its carrying capacity for that species which is affected. Some animals, such as carnivores, will flee at almost all human intrusion; if they are forced into a lower-grade area, or are dislocated for a long period, they will be weakened and increased mortality can be expected.

Deliberate or inadvertent harassment of wildlife, particularly large mammals, will be a serious impact. Flights to construction sites, maintenance flights, and operation of vehicles on open areas, all have the potential for animal harassment. Harassment during calving for sheep and caribou can cause increased stillbirth.

Although a transmission and access road will not impose a barrier to migration of caribou, construction work during certain seasons may inhibit herds from approaching work areas. The creation of a cleared corridor through heavy forest may result in increased animal movement along the right-of-way.

Migrating birds may suffer some mortality from collisions with towers of lines, but these losses should be negligible. Collisions of birds will be most likely near areas of bird congregations, such as resting or feeding areas, particularly during times of poor visibility and during takeoff or landing. The cables are not spaced close enough nor are they invisible enough to be efficient snares. The size of conductor for the 230 kv line is 1.4 inches across and the spacing is 18 to 40 feet between cables. The probability of a bird flying in an appropriate area at the right elevation and at the proper angle to the line simultaneously is rather small.

Electrocution of birds is also unlikely; the distance between lines over 115 kv and between lines and ground is great enough to make shorting out by a bird almost impossible. Birds can safely perch on cables or towers. There is little experience of proven bird fatalities from collision or electrocution with the present APA transmission lines in Juneau and Anchorage.

The most significant impacts result from habitat modification resulting from impacts on soils and vegetation. Clearing in forest areas and maintenance of a subclimax plant community of brush and low plants will enhance habitat by increasing the primary productivity of the cleared area. Browse for moose will be increased; the conjunction of good cover in the original forest with a swath of browse creates a diverse "edge" habitat for many animals dependent on subclimax growth. Animals dependent on climax or near-climax vegetation will suffer loss of habitat; examples are the red squirrel and northern flying squirrel, both of which depend upon White Spruce.

Destruction of climatic lichen on tundra areas will destroy winter browse for caribou. The decline of the caribou herds in Alaska is attributed not only to hunting, but also to destruction of tundra lichen by man-caused fires. Lichen is the key browse for caribou, for it is their prime food during the winter. It is estimated that approximately 50 years are required for a burned area to recover a usable cover of lichen for caribou.

Destruction of climactic vegetation by fire often enhances moose habitat. Tiaga ecosystems are adapted to wildfire, and present mosaics of vegetation communities are often a reflection of former fires. An increase of fires resulting from man-made causes will, up to a point, have not much more impact than the incidence of lightning-caused fires. A significant increase over natural-caused fires will result in increased mortality from fires, excessive destruction of cover and habitat for wildlife dependent upon climactic or near-climactic vegetation, increased silting of rivers and lakes, potential disruption of seasonal habits and migrations, and potential disruption of the permafrost-vegetation relationship.

Impact upon aquatic life from a transmission line should be small. The aquatic food chain in the taiga and tundra is extremely simple, and as a result, disruption of habitat for one species quite often indirectly affects many other species. Potential impacts are the increased sedimentation of rivers and lakes; alteration of flows; eutrophication and pollution of lakes and streams; disruption of habitat due to gravel borrow, fill, and excavation; and withdrawal of water, especially during winter.

Sedimentation can result from erosion along the construction sites, burned-over areas, borrow pits, and river crossings. The impact of sedimentation depends upon the severity of sedimentation, the existing water quality, and the amount of aquatic life in the stream or lake.

In rivers already carrying glacial sediment, the effect of man-caused sedimentation will be slight. Clear water streams and lakes supporting large aquatic populations will be most affected. Suspended sediment can cause gill damage in fish and sediment settling out of suspension can fill interstices in gravel beds, reducing suitability for spawning.

Alteration of drainage by an access road may influence river flow, but a transmission line project should not affect surface drainage to any appreciable degree.

Spills of oil or fuel, herbicides, and other chemicals into water bodies will impact aquatic habitat. Fast-flowing streams will be the least affected by spills, due to the rapid dispersal and dilution of the contaminant; lakes and slow streams will be most affected. The actual impact is dependent upon the type of spill, the amount, and the volume of water affected. Addition of excessive nutrients or organic matter to lakes, such as disposal of slash, may cause eutrophication, either from excessive algal growth or from decomposition or organic material. Excessive oxygen depletion in lake waters will lead to fish kills.

Alteration of stream and lake beds will destroy habitat. Some of the alterations, such as gravel extraction, will add an inordinate amount of sediment to a clear water stream.

A secondary impact of great significance to wildlife from a transmission line will be the increased access to areas now unserviced by roads. If an access road is maintained for line maintenance, it is very likely that it will be used by the public. Bonneville Power Administration has experienced unauthorized public use of those access roads which are supposedly closed to all non-maintenance use. To many mammals, the presence of man has an impact, particularly the presence of hunters. Increased access to presently inaccessible areas will certainly add to hunting pressures on game in those areas. The degree of the impact depends upon regulation by game management agencies, the quality of the area for hunting, and the season.

Climate

This category adheres to the definition of climate, that is, the average weather conditions over a long period; however, there are very few climatic data for the study area, particularly in regards to wind speeds. Thus, each segment is assigned to one or more of three general climatic zones. These are the Transitional, Interior, and Mountain zones.

The Transitional Zone is a modified continental climate, having some of the characteristics of the Maritime Zone along the coast of the Gulf of Alaska, yet being partially subject to the greater temperature extremes and drier climate of the Interior Zone.

The yearly average temperature for this zone is about 29°F in the northerly part to 38° in the southerly part. Temperature extremes range from about -40° to 85°F. Precipitation ranges from 12 to 24 inches per year; snowfall ranges from less than 50 to more than 200 inches per year. Winds are generally calm, although high winds over 50 mph can be expected.

The Interior Zone is a true continental climate. It is relatively dry, being dominated by high pressure air masses. As a result, extreme seasonal temperature variations and relatively mild winds can be expected.

The yearly average temperature for this zone is about 24° to 29°F; annual temperature extremes range from -60° to nearly 100°F. Precipitation has an annual range of about 8 to 16 inches a year. Snowfall amounts from less then 50 to almost 100 inches a year. Winds are generally very light, with high winds recorded at less than 50 mph.

Since this area is dominated by stable high pressure air, temperature inversions are common, and ventilation is low. Thus the potential exists for smog, fog, and ice-fog around sources of particulates and/or moisture. Ice-fogs repeatedly cover Fairbanks and seriously reduce visibility; the temperature usually must be below -35°F for this to occur.

The Mountain Zone is basically a modification of a more prevalent zone, in this case, either the Transitional or the Interior Zones. The causes of the modification are elevation and relief. Increased elevation tends to lower the yearly average temperature without decreasing seasonal temperature variations present at lower elevations. High relief combined with elevation results in increased precipitation due to adiabatic cooling of uplifted air masses, and an increase in the force of local winds. Since mountainous terrain is anything but uniform, wind patterns can vary tremendously. However, it is safe to assume high extremes of wind throughout the entire zone.

Land Ownership and Status

Land ownership is considerably less influenced by physical factors and more by social factors. At present, land ownership is an unstable situation, for although the majority of the land traversed by the route segments is presently Federal land, that ratio is destined to change, with more land being in State and Native ownership. With the exception of the Matanuska Valley and the more heavily settled areas, there is presently relatively little privately owned land.

Land Status is an even more changing situation than land ownership. The present land status situation is largely a result of the Statehood Act of 1959, ANCSA in 1971, and the Alaska Conservation Act of 1974. All Federal lands in Alaska are presently in a withdrawal status; not only will a considerable portion of Federal land be transferred to State and Native ownership, but all the remaining Federal lands are slated either for inclusion into either the existing National systems such as National Parks and the National Forests, or for withdrawals for classification and public interest.

At present, apart from private holdings, only patented State land and existing Federal withdrawals can be considered constant. Most of the corridor segments lie in lands that are pending or tentatively approved State selections, Native village withdrawals, and Native regional deficiency withdrawals, all of which are in flux at the present.

Therefore, assessment of the land status of a segment reflects only the situation at the time of this publication.

Direct impacts on existing developments will generally be low, mainly because there are so few existing developments along the segments. Due to the changing nature of land use and ownership, impacts may change considerably in the space of a few years.

With the present pattern of land ownership, there will be few conflicts with land ownership, as most of the land along the routes are presently in Federal and State ownership. Distribution of lands to Natives and other private owners by the Federal and State governments in the future will increase the likelihood of purchase of easement of private lands and possible subsequent displacement of private owners.

Little impact is expected upon existing land use; the right-of-way width required for a transmission line is a small fraction of the land the line traverses. There will be almost no conflict with agricultural lands; at present, agriculture is basically limited to the lower Matanuska Valley, and smaller areas in the Tanana and Copper River Valleys. The potential for agriculture exists over a considerable area of the railbelt (see Figure 9), but the impact of a transmission line on these potential areas is less than on the existing areas. Forestry at present is very limited in the Railbelt, more from ownership causes then natural causes. Forestry can be expected to increase, but impacts from a transmission line will be minimal.

Known and potential areas of coal, oil, natural gas, and minerals exist in the Railbelt area. The fossil fuels are predominant in the three basins of the Tanana River, Cook Inlet, and the Copper River lowland. Minerals are more usually found in the more mountainous areas. A transmission line itself will have little effect on development of these resources. The availability of power from the Upper Susitna project might spur development, but this is dependent upon the local utilities and their distribution systems. Location of these mineral resources is shown in Figure 10, 11, and 12.

Little direct impact on towns from a transmission line can be expected; this results from the ability to circumvent the few towns encountered. The endpoint substations are outside of Anchorage and Fairbanks, so these towns will not be penetrated by a right-of-way.

Social Impacts

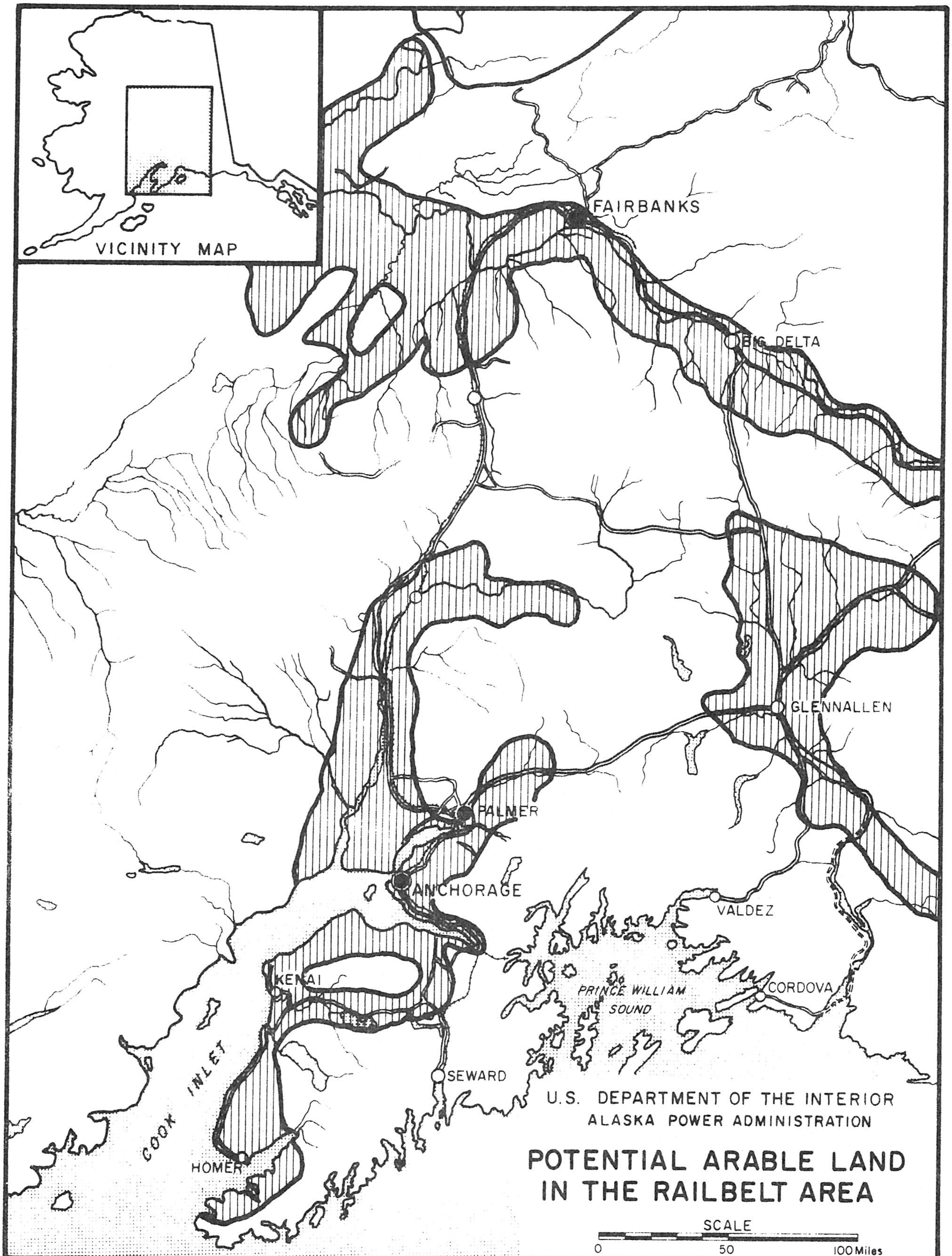
The prediction of social impacts and their mitigation is difficult; quite a few variables are involved, such as the labor supply, the desires of the affected communities, and the occurrence of other large projects in the area of the proposed corridor.

However, it is certain that because of its size, there will be social impacts due to the construction activity, interconnection, and the availability of power.

Construction activity will affect communities in direct proportion to the involvement and in indirect proportion to their size. Perhaps the best way to minimize the effects of construction activity upon small communities is with the use of construction camps spaced along the corridor, avoiding the communities of Talkeetna and the lower Susitna, Cantwell, Healy, and Nenana. These camps will be temporary, to be constructed and maintained in such a manner as to minimize damage to their surroundings. Upon completion of the project, the camps shall be removed and restored as closely as possible to their original condition or can be re-used for other purposes. The spacing of the camps is dependent upon the nature of the terrain and the method of construction; spacing will vary from forty to one hundred miles. Not all camps will necessarily operate simultaneously.

The estimated time needed for construction is three years; assuming that the camps are not operating simultaneously, but progress from one section to another; then it follows that the construction period for a given area along the proposed corridor will be considerably shorted than three years. Thus, impacts from construction activities can be expected to last less than three years.

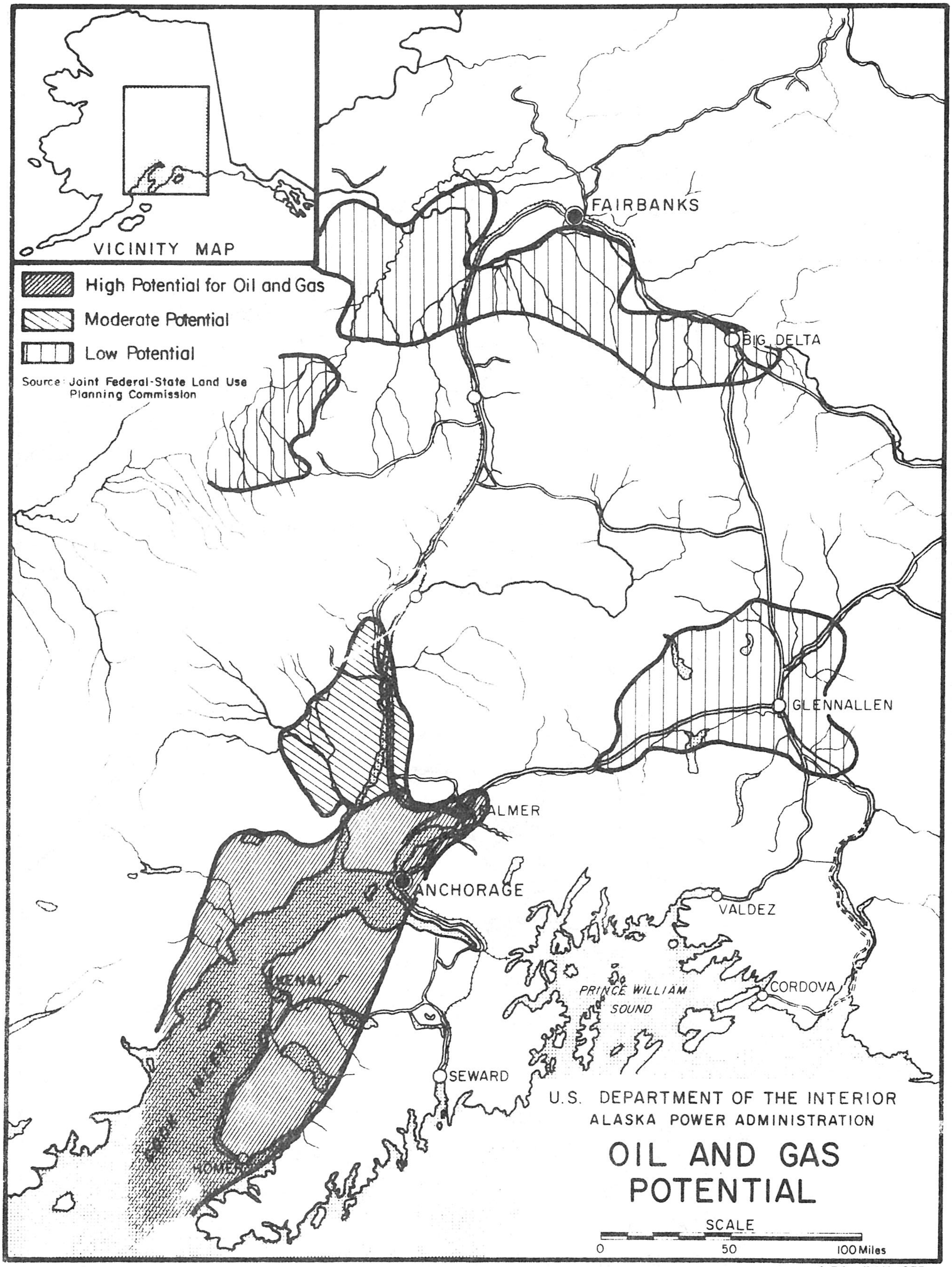
Figure 9



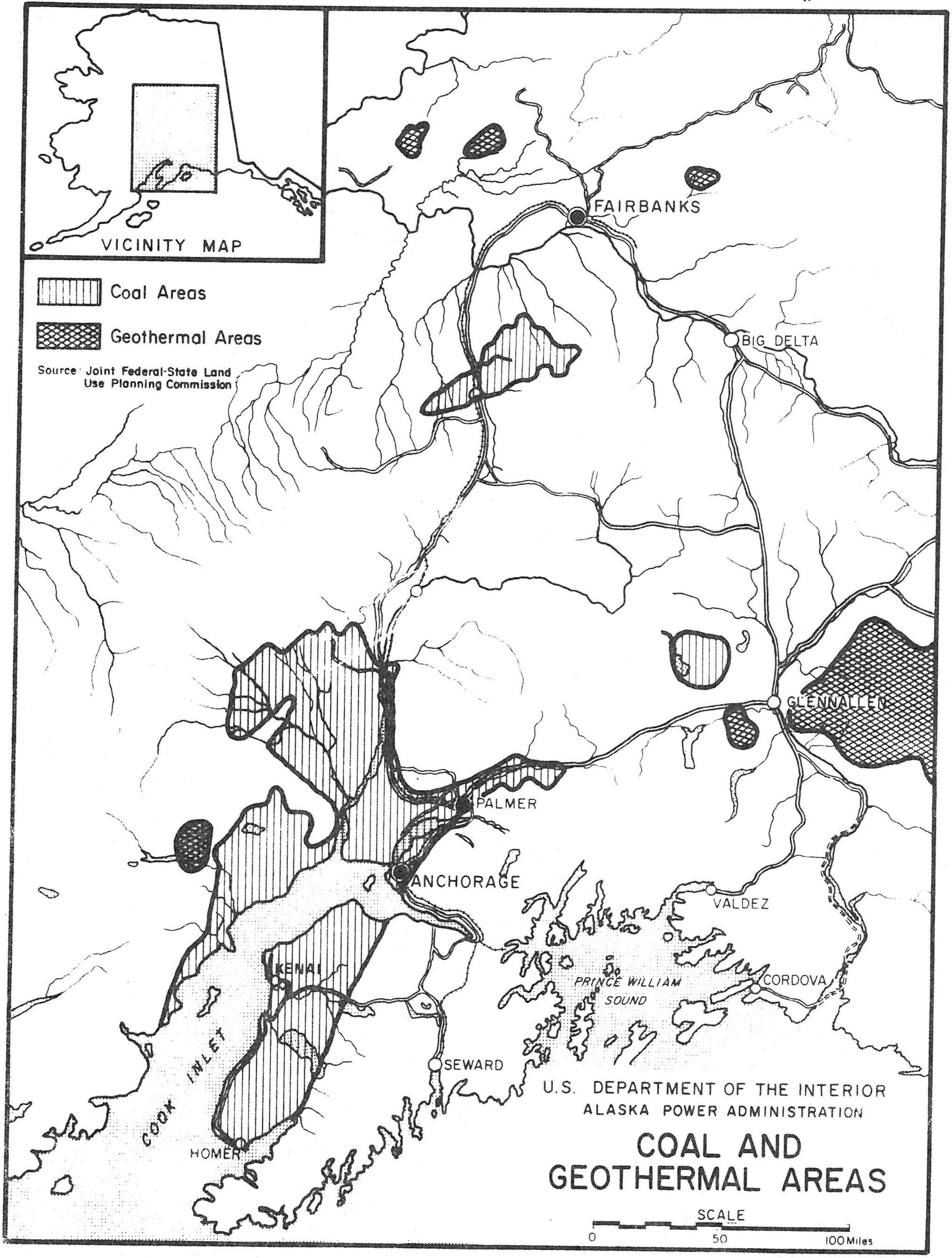
SOURCE: ALASKA INTERNATIONAL RAIL AND HIGHWAY COMMISSION

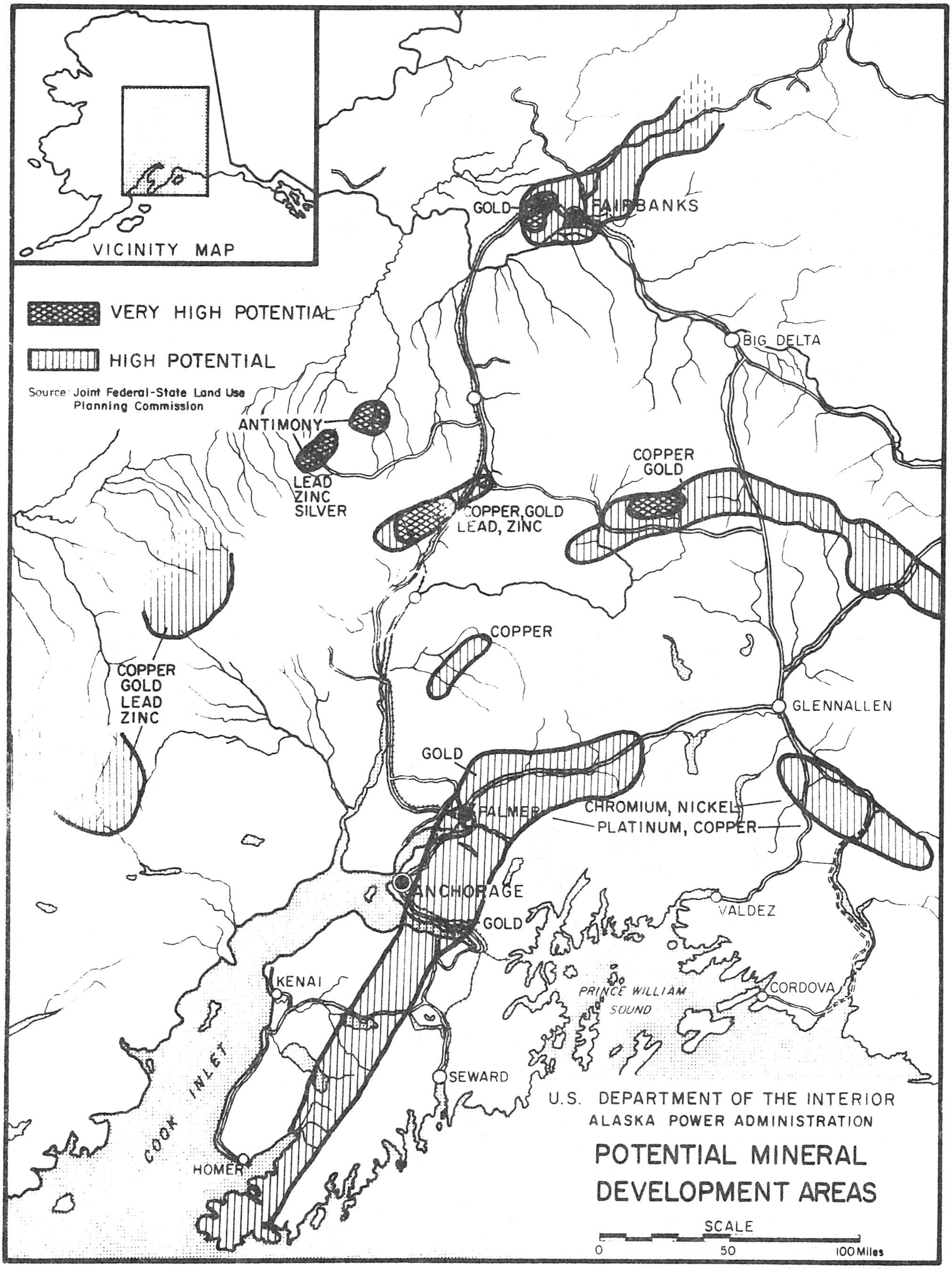
A. P. A.-JANUARY 1975

Figure 10



A.P.A.-JULY 1975


VICINITY MAP
Coal Areas
Geothermal Areas
Source: Joint Federal-State Land Use Planning Commission
FAIRBANKS
BIG DELTA
GLENNALLEN
PALMER
ANCHORAGE
VALDEZ
CORDOVA
PRINCE WILLIAM SOUND
KENAI
SEWARD
COOK INLET
HOMER
U.S. DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
COAL AND GEOTHERMAL AREAS
SCALE
0
50
100 Miles
A.P.A.-JULY 1975



A.P.A.-JULY 1975

The work force is dependent upon the contractor, the time schedule, and the availability of workers. A figure can be obtained as follows: assume that work is progressing simultaneously along the entire corridor; that camps are an average of sixty miles apart, and that it requires five men per tower for transmission line construction. Within a 60 mile stretch of line there are 300 towers, and if it takes ten working days on the average to place a 345 kv tower, including foundations, then five crews could complete the towers in range from camp in 60 days. The time needed to string and tension the stretch with three conductors will be another 20 days; associated work prior to and following this construction will occupy the rest of the season of about 15-20 weeks.

If this rate of work is progressing at the other camps, and if six camps are planned in all, then a total of 150 line workers are required. Other workers are needed such as drivers, pilots, laborers, cement workers, surveyors, camp support, and administration. This could bring the total up to 250 people; however, actual numbers may be as high as twice or three times the estimate. Associated with the employment generated directly by this project is the effect on services in the railbelt area, such as suppliers, machinery sales, shippers, etc.

The impact on a small community, such as Cantwell, will be that of a camp separated from the town, with about 100-125 workers for the space of one or two working seasons; apart from incidental contacts, such as entertainment, and service to visitors to the project, this impact will be rather low, and of short duration.

Operation and maintenance impacts will also be low. A relatively small work force can handle operations at the powersites, substations, and intervening transmission line. Most operations will occur at the powersites and the terminal substations at Ester and Point MacKenzie; a much smaller force can patrol the transmission periodically, making necessary repairs and maintaining effective clearance. If the smaller communities are served, they will require their own substation and crew, which can handle both substation operation and line maintenance for their area.

The interconnection and availability of Upper Susitna power will have some effects. For the smaller communities along the proposed corridor, connection with the interconnected system would provide electric power cheaper than the present local generation. Many families presently without electric power because of the cost of generators and fuel would find it more economically available. The availability of power, not

Figure 13

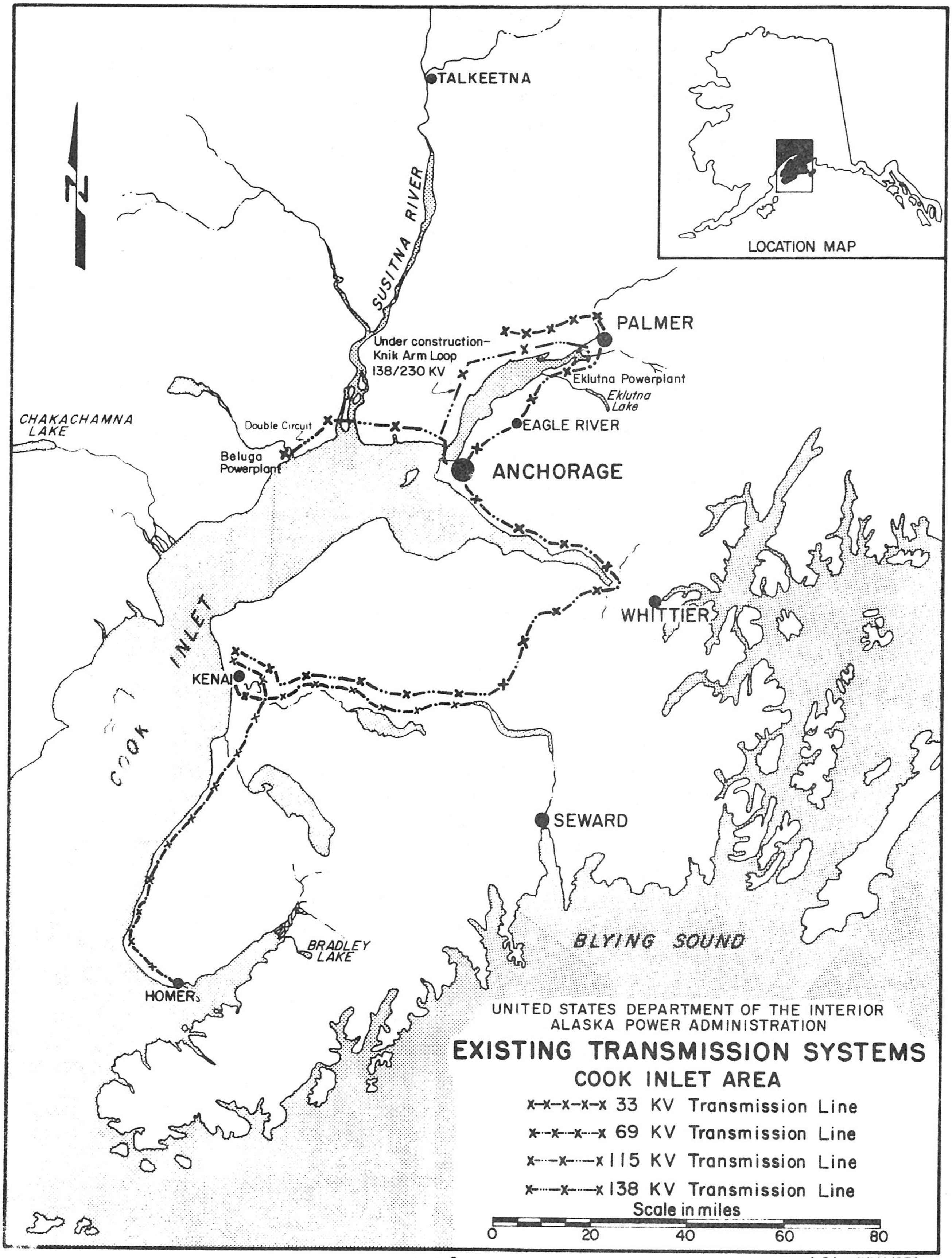
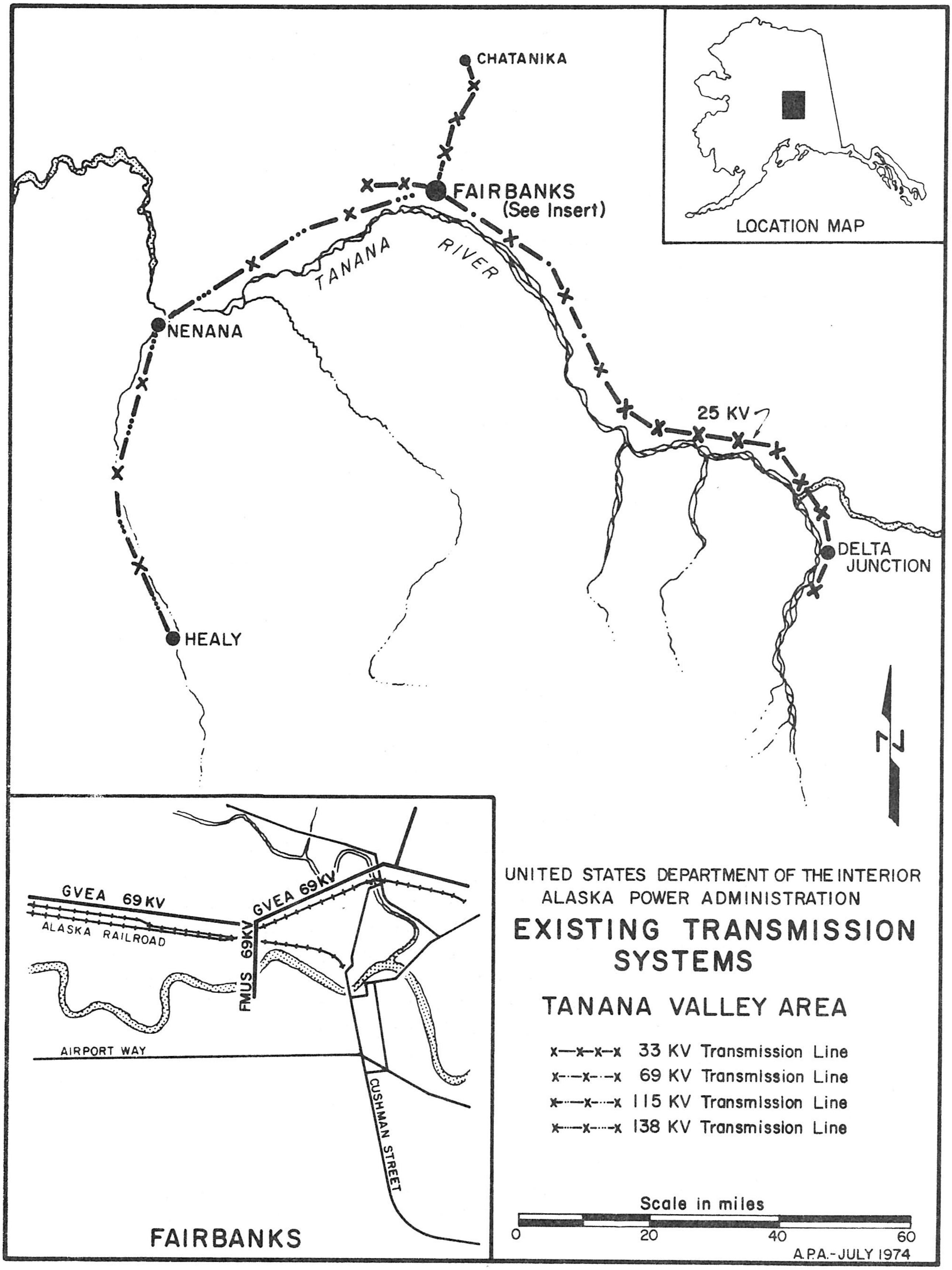

LOCATION MAP
TALKEETNA
SUSITNA RIVER
PALMER
Under construction-
Knik Arm Loop
138/230 KV
Eklutna Powerplant
Eklutna
Lake
CHAKACHAMNA
LAKE
Double Circuit
EAGLE RIVER
Beluga
Powerplant
ANCHORAGE
WHITTIER
INLET
KENAI
COOK
SEWARD
BLYING SOUND
BRADLEY
LAKE
HOMER
UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
EXISTING TRANSMISSION SYSTEMS
COOK INLET AREA
x-x-x-x-x 33 KV Transmission Line
x--x--x--x 69 KV Transmission Line
x---x---x 115 KV Transmission Line
x----x----x 138 KV Transmission Line
Scale in miles
0
20
40
60
80
A.P.A. - JULY 1974

Figure 14


CHATANIKA
FAIRBANKS
(See Insert)
NENANA
HEALY
TANANA RIVER
25 KV
DELTA JUNCTION
LOCATION MAP
GVEA 69 KV
ALASKA RAILROAD
GVEA 69 KV
FMUS 69 KV
AIRPORT WAY
CUSHMAN STREET
FAIRBANKS
UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
EXISTING TRANSMISSION SYSTEMS
TANANA VALLEY AREA
33 KV Transmission Line
69 KV Transmission Line
115 KV Transmission Line
138 KV Transmission Line
Scale in miles
0
20
40
60
A.P.A.-JULY 1974

necessarily cheap power, will probably be a cause of some growth in these communities. However, it is extremely unlikely that industry would be attracted to outlying communities as a result of the availability of power; the high costs of transportation, labor and material would outweigh the benefit of accessible power.

The probability of development of a new State capital along the proposed corridor would be enhanced somewhat by the existence or promise of available power and a connection to the present utilities in the Anchorage and Fairbanks areas. The location of the new State capital would, however, be influenced more by transportation. In any case, if the new capital were to be connected to Upper Susitna power, it would have a projected load of less than ten percent of the present Anchorage load.

Unlike the smaller communities presently not serviced by one of the railbelt utilities, the availability of Upper Susitna power would not significantly affect growth in Anchorage or Fairbanks. Growth in these areas is a problem that already exists, and increased power for these towns is a response to, not a cause of growth.

For more information on socio-economic factors, see the Power Market Report.

Existing Rights-of-Way

Existing rights-of-way is concerned with surface transmission and transportation routes. The possibility exists for shared rights-of-way or shared access with an existing transmission or transportation system.

Some of these existing rights-of-way are the highway system, the Alaska Railroad, transmission corridors, the Alyeska Pipeline, and for a proposed natural gas pipeline system. Federal land has been withdrawn for a utility corridor along parts of the Alyeska pipeline route. The possibility exists not only for shared right-of-way, but also for a "symbiotic" use of an existing right-of-way in which a transmission line could provide power for the present occupant. Two examples are electrification of the Alaska Railroad, and using electric pumping stations along the Alyeska Pipeline. Existing transmission systems are shown on Figures 13 and 14.

Scenic Quality

Scenic quality does not lend itself well to quantification; this is a much more ambiguous category than the preceding ones, due to the difficulty in definition of such terms as "scenic quality". There are several components of scenic quality, which when defined, will define this category. "Existing scenic quality" is a statement of the present visual aspect of an area, whether it is an area of perceived high scenic value, or an area of low scenic value. Perceived scenic values (beautiful, ugly, monotonous, vibrant, etc.) are extremely variable, not only by location, but also by season, weather, and most importantly, by the individual viewer.

Some of the more important components of scenic quality are scale, unity, intactness, variety and vividness. Scale is relationship of a viewed area to the viewer. Scales range from detail, or close-up views, (such as views of small elements of the landscape as plants, rock formations, etc.) to middle views, such as one could have in a forest, in which individual elements still hold most of the attention; to distant or scenic views, in which individual elements are subordinate to the entire view (perception of a forest rather than perception of individual trees).

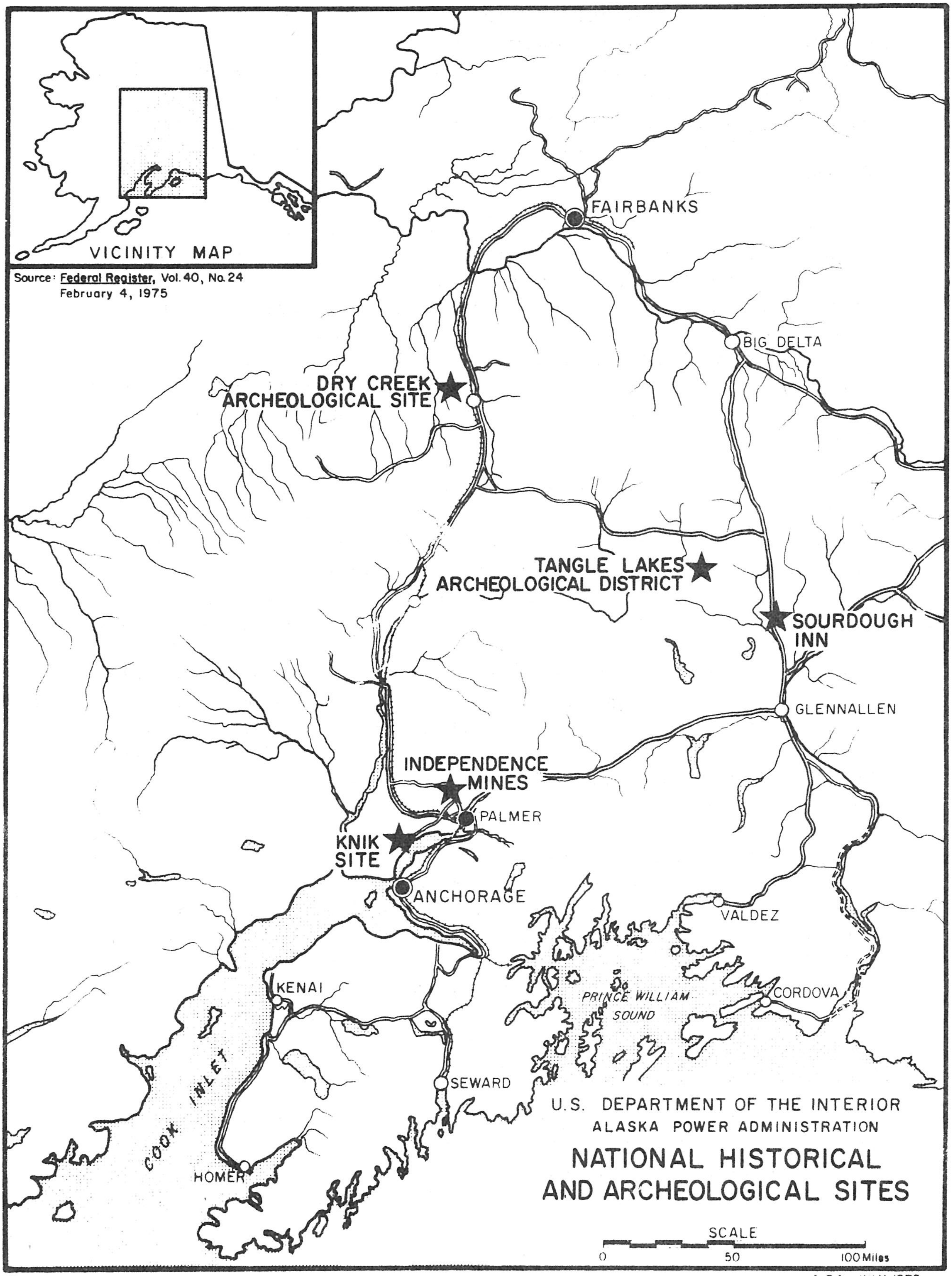
Unity is the degree of harmony among elements in a landscape; put another way, it is the degree of the lack of discordant elements. A wheat farm of five acres is considered by most people to be less discordant in an otherwise forested landscape than a five acre tank farm. Unity is a learned concept, and as such, is variable not only among the individuals and groups, but also is variable over time as tastes change.

Variety is the degree of diversity in a landscape; its converse is uniformity, the degree of homogeneity. Variety may be a function of scale; a landscape perceived as uniform, such as tundra, may have detail views of amazing variety, particularly in its plant life. There appears to be no obvious relationship between variety and unity or between variety and intactness.

Vividness is the strength of the impression of landscape. It is a function of the degree of pronouncement of the major qualities in a landscape. Vividness is interrelated with the components of unity, intactness, and variety. It does not imply strong variety or strong uniformity, but rather the degree to which variety or uniformity is perceived and remembered. As two examples, the highly diverse view of Mt. McKinley as seen from Wonder Lake and the highly uniform landscape around Lake Louise are both very vivid to the author, whereas the landscape of lower Talkeetna River is much less vivid.

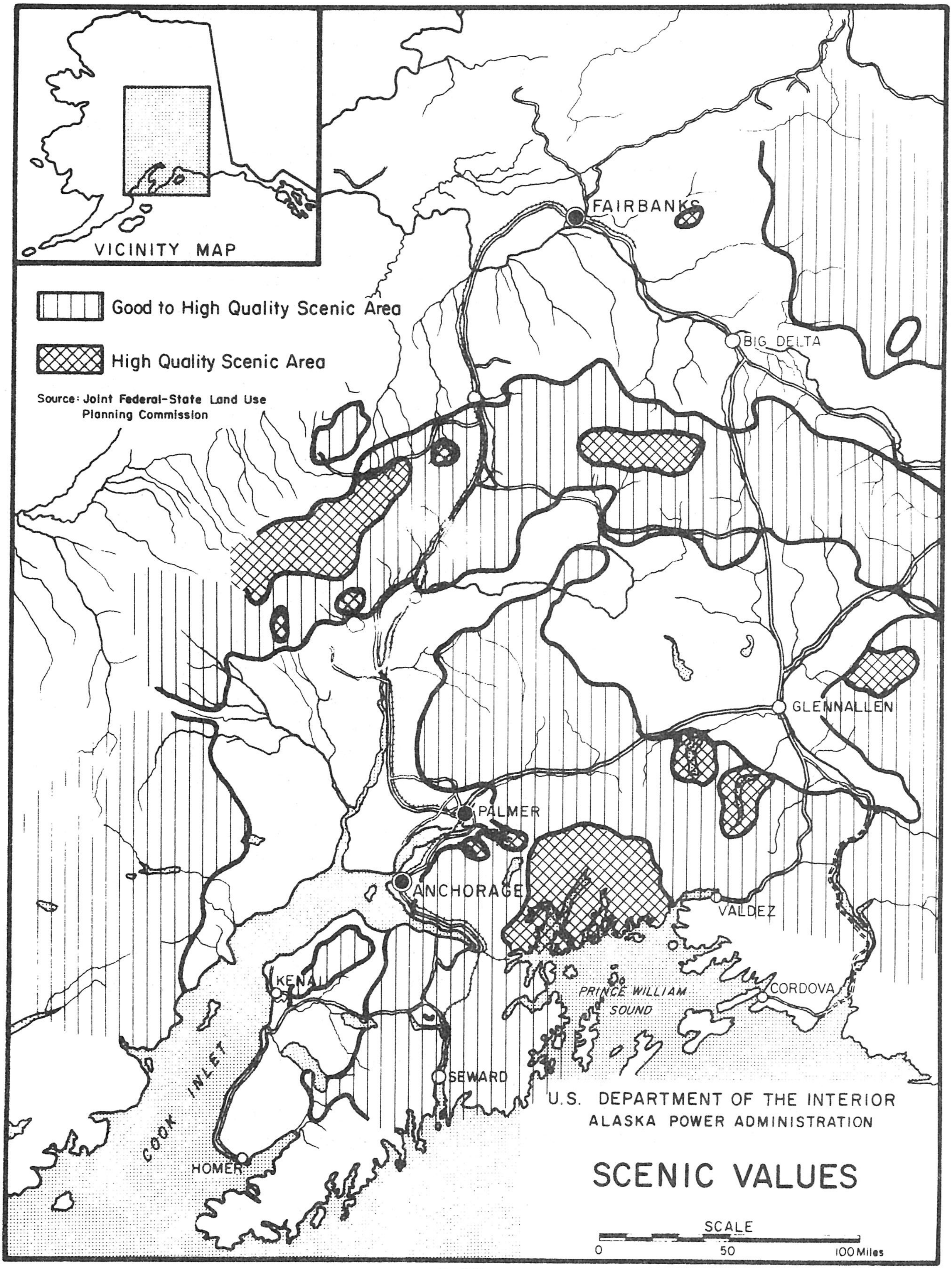
Since scenic quality is a complex subject, some assumptions must be made in order to use it as category in a matrix. The first assumption is that we will only be considering large-scale views; detail and middle-views should not be affected by a transmission line. Second,

Figure 15



A.P.A.-JULY 1975

Figure 16


VICINITY MAP
Good to High Quality Scenic Area
High Quality Scenic Area
Source: Joint Federal-State Land Use Planning Commission
FAIRBANKS
BIG DELTA
GLENNALLEN
PALMER
ANCHORAGE
VALDEZ
KENAI
PRINCE WILLIAM SOUND
CORDOVA
SEWARD
COOK INLET
HOMER
U.S. DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
SCENIC VALUES
SCALE
0
50
100 Miles

no attempt will be made to quantify scenic qualities; the study of perception is not yet advanced to the point where one can confidently quantify a subject of such widely varying individual perceptions. Third, the area within National and State Parks or other scenic reserves will automatically be considered more sensitive to scenic degradation because of their recognized scenic qualities. Fourth, landscapes visable from major surface public transportation routes will be considered more sensitive than those that are not. The reasoning behind this is that all scenic values are not intrinsic to the landscape, rather, they are responses of the individuals perceiving that landscape. An area with a high number of viewer contacts would then be more sensitive to scenic degradation than an area with no viewers, or with very few viewers.

Obtrusiveness is the lack of unity of an element with the rest of a landscape, the degree to which an element is perceived as incongruous. A transmission line in a valley bottom seen from two miles away is less obtrusive and visible than a line silhouetted on a ridge one mile away. Factors affecting obtrusiveness are tower design and height; design and width of clearing; reflectiveness of tower and cable; topography; and distance from viewer. Where natural cover and topography enable a line to be hidden, impact on scenic quality is low; on open tundra, impact will be medium to high, depending on distance and topography.

There are several recreation and scenic reserves affected by the alternative routes; most important are Mount McKinley National Park and Denali State Park. Both are rather sensitive areas, as they attract and are the result of a considerable tourist trade. Parks in Alaska have the image of open, unspoiled wilderness, particularly to tourists from outside the State. Visibility of a transmission line in or around these parks will have a greater impact than in other areas. There are a variety of State-owned recreational areas and waysides adjacent to the highways in the Railbelt; impact on these recreational sites will be low; due to their relatively small size, they can be circumvented easily.

The National Register of February 4, 1975 lists six registered historical and archaeological sites that might possibly be affected by the alternative routes. These are shown on Figure 15.

There are known and potential archeological and historical sites not on the National Register along the proposed corridors. To minimize possible vandalism or disturbance no sites other than those on the National Register shall be located either on a map or on the narrative of this assessment. To preserve the integrity of known and potential sites, a pre-construction archeological survey of the corridors will be carried out, and the final transmission route will be adjusted to minimize disruption. Inadvertent discovery of an unsuspected site at a later stage will entail either the minor relocation of a segment of the transmission line, or the salvage of the sites as prescribed by Executive Order 11593 and P.L. 93-291.

The alternative routes cross no proposed or existing scenic, wild or recreational rivers, nor do they cross any proposed or existing wilderness areas or wildlife refuges. However, in segments where the transmission line will pioneer a corridor through a previously intact area, the quality of wilderness will suffer, especially if the transmission line is easily visible. However, in most segments the transmission line will parallel existing corridors or will traverse no significantly large areas of intact wilderness. A pioneer corridor crossing a significantly large wilderness area will have a high impact on access and future location of other rights-of-way. These in turn will degrade wilderness quality further, but to the benefit of increased access for recreational uses involving motorized access.

Figure 16 shows an approximation of existing scenic quality.

Hazards and Inconvenience

One of the more obvious potential hazards is that of electrical shock. Three distinct hazards can be defined. One is the brief voltage briefly appearing on the ground near a dropped conductor. The second is the direct contact with a conductor. The third hazard is that of induced current in metallic objects near an operating transmission line.

When a conductor is dropped, either as a result of tower or conductor failure, it is switched off in a fraction of a second. During this short time, a voltage is caused in the immediate vicinity of the contact; the hazard would vary with the distance to the contact point, the voltage produced, and other factors. Dropped conductors are a rare event in most transmission systems; they are the result of vandalism (rifle fire), storms, and occasionally, defects of components.

Direct contact can be a lethal hazard; usually it involves inadvertently shorting one of the conductors with machinery or other equipment working under a transmission line. Construction booms, pipes, and poles must be maneuvered with care near an operating transmission line. Since ground clearance increases with operating voltage, this hazard is less with the higher voltages.

It is possible to induce a voltage in metallic conductors paralleling a transmission line, such as rail lines and fences. This could present a potential hazard dependent upon the conductivity and length of the object, and its distance from the transmission line. Proper grounding of potential inducting objects will eliminate this hazard.

Overhead transmission systems near airfields and areas of heavy low-flying air traffic present a potential hazard to aircraft. Proper placement and routing will reduce this hazard; the use of taut-span short towers can reduce the height of an overhead system, and marking conductors that span valleys and notches will increase visibility to aircraft.

An operating overhead transmission system will generate audible noise immediately adjacent, particularly if the voltage is 345 kv or higher.

For a 345 kv line, audible noise at the edge of the right-of-way will be less than 45 decibels, roughly equivalent to the noise level of light traffic at 100 feet. Actual audible noise levels are related to voltage, configuration, and height of conductors, atmospheric conditions, and individual sensitivity.

Radio and television reception immediately adjacent to an overhead transmission system may suffer from electromagnetic interference (EMI). Such interference is localized, and is more intense during rain. Other factors influencing levels of EMI are the voltage and configuration of the conductors, height of conductor above ground, age and surface finish of conductor, and atmospheric conditions.

A good reference for EMI and audible noise is the EHV Transmission Line Reference Book.

Evidence of effects on life from exposure to electrical fields present in the vicinity of transmission lines is inconclusive. Several tests cited in the Battelle Report "Measuring the Social Attitudes and Aesthetic and Economic Considerations Which Influence Transmission Line Routing" indicate no ill effects noted on linemen working in very strong electrical fields, and mice exposed to electrical fields; however, other sources in the USSR and Germany cited by this report indicated possible harmful effects on animals and humans.

Ozone production by Corona losses from transmission lines is low. The Battelle Report cited above indicates that ozone concentration adjacent to a 765 kv line was on the order of only 2 to 3 parts per billion by volume; this concentration should be considerably less for 230 kv lines.

STRIP MAPS COVERING THE

ALTERNATIVE CORRIDORS

APPENDIX I

EXHIBIT I-2

Exhibit I-2

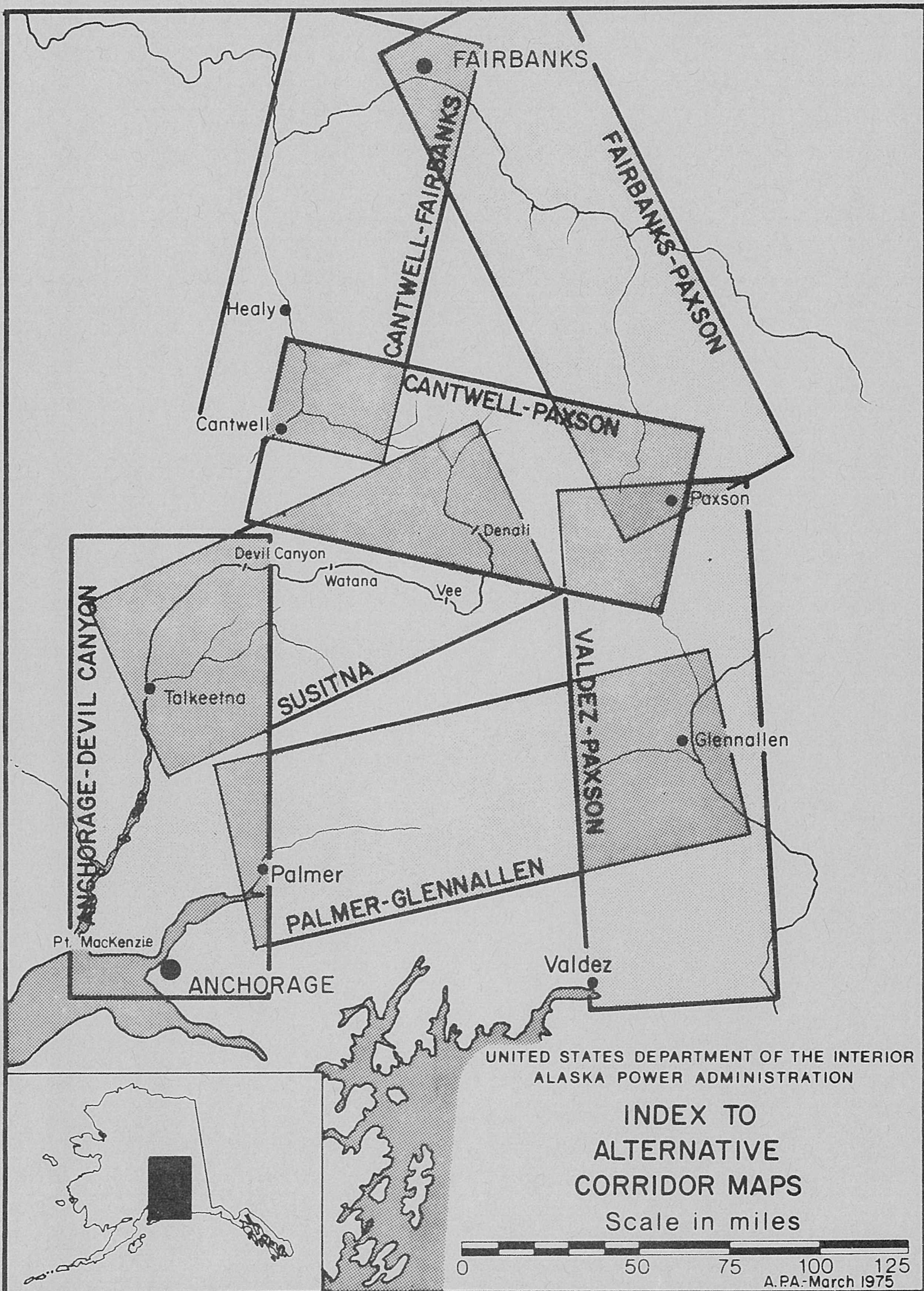
Strip Maps covering the Alternative Corridors.

The following strip maps are in three groups: those showing the general features, those depicting land status, and those delineating soil types. The alternative corridors are covered by seven maps for each group; there is some overlap from map to map, but not all alternative corridors are entirely depicted on any one map.

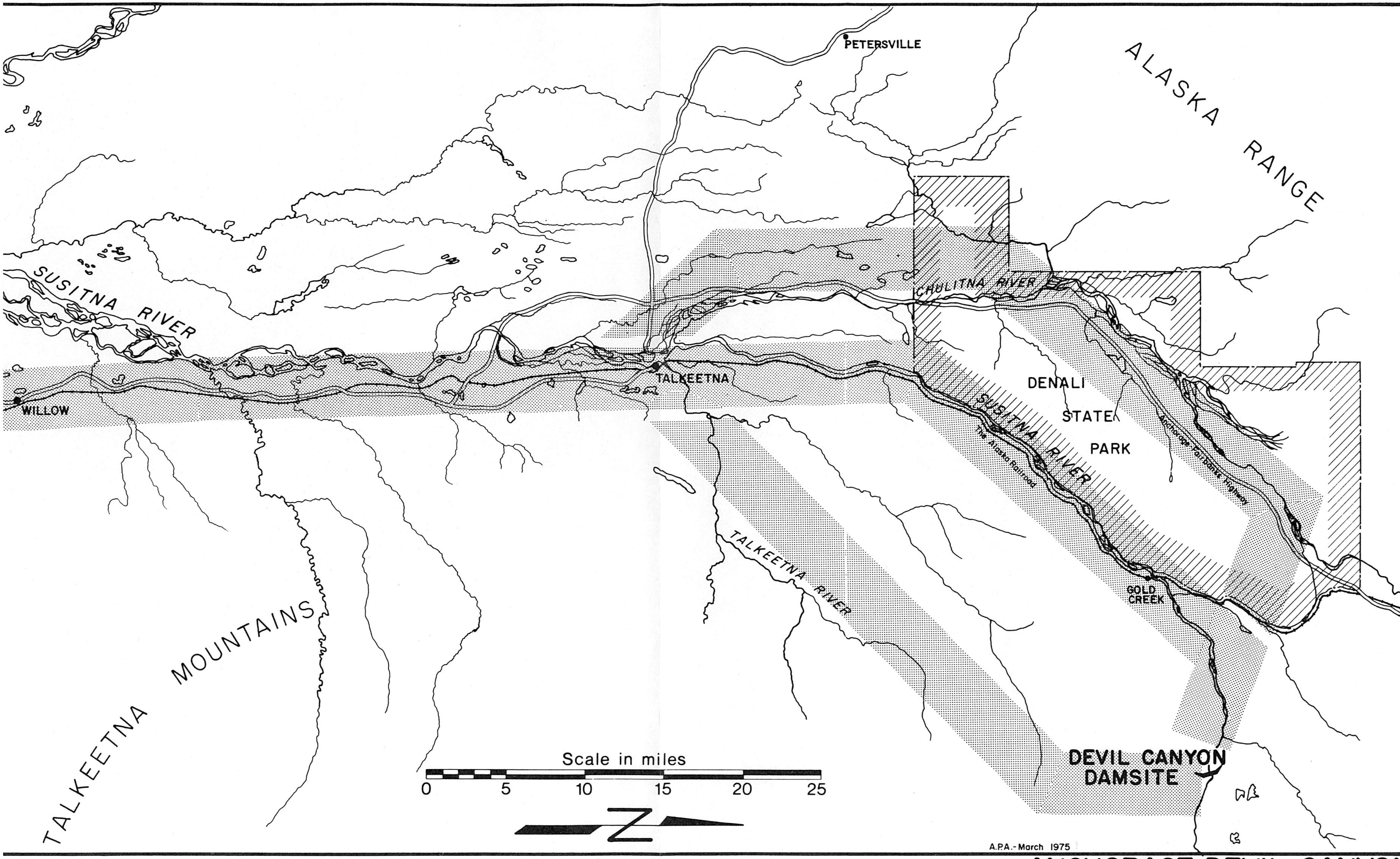
On each map is a gray stripe showing the approximate position of an alternative corridor on that map; these positions are very approximate, and the exact location and width are indeterminate.

The land status mapped is based upon the land status situation of March 1974. State selections include patented, pending, and tentatively approved State-selected lands. Due to the present unstable condition of land status, it must be recognized that there may be changes since the date of the map.

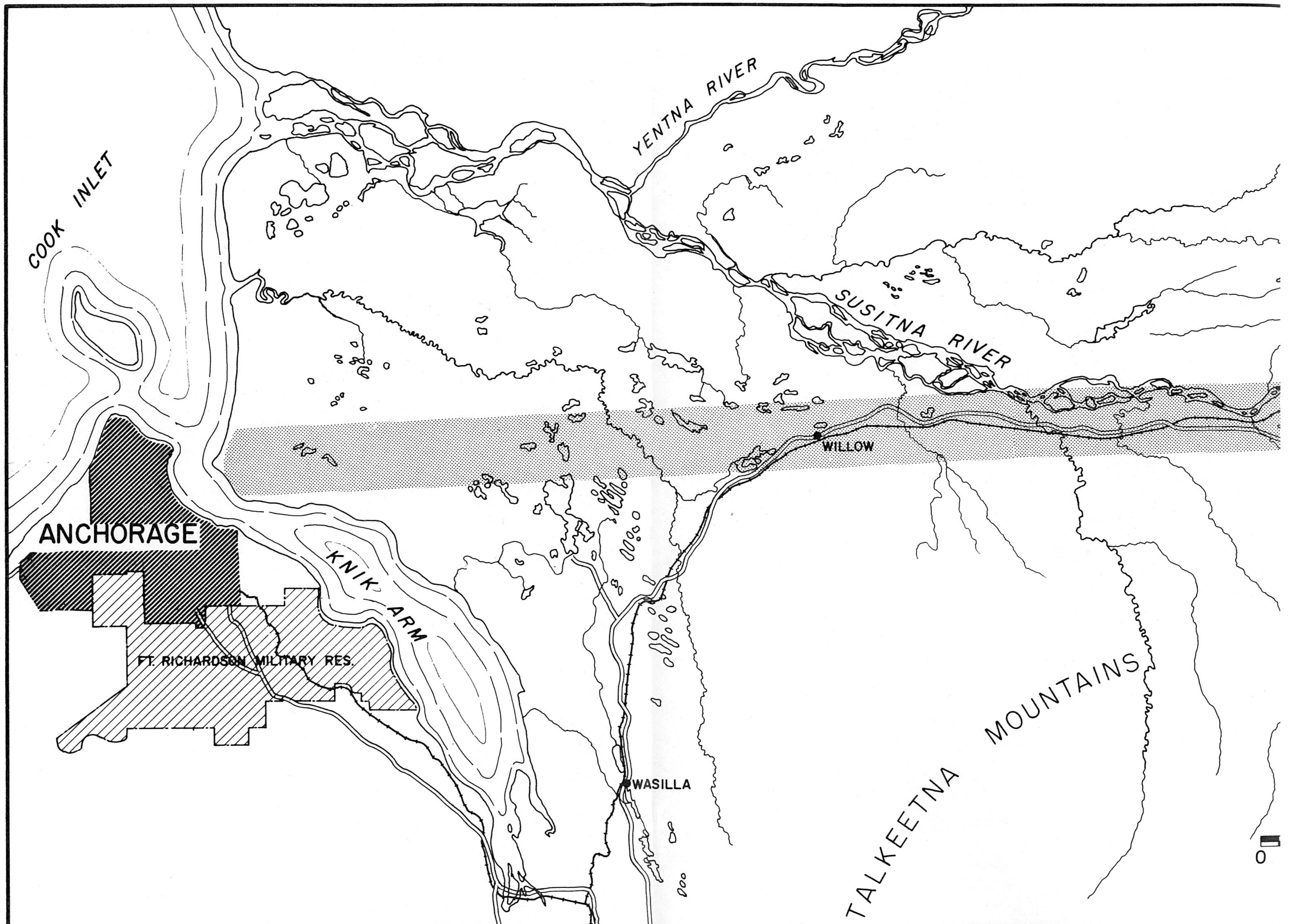
The soils maps are based upon the 1:250,000 soils overlay map published by the Joint Federal-State Land Use Planning Commission.

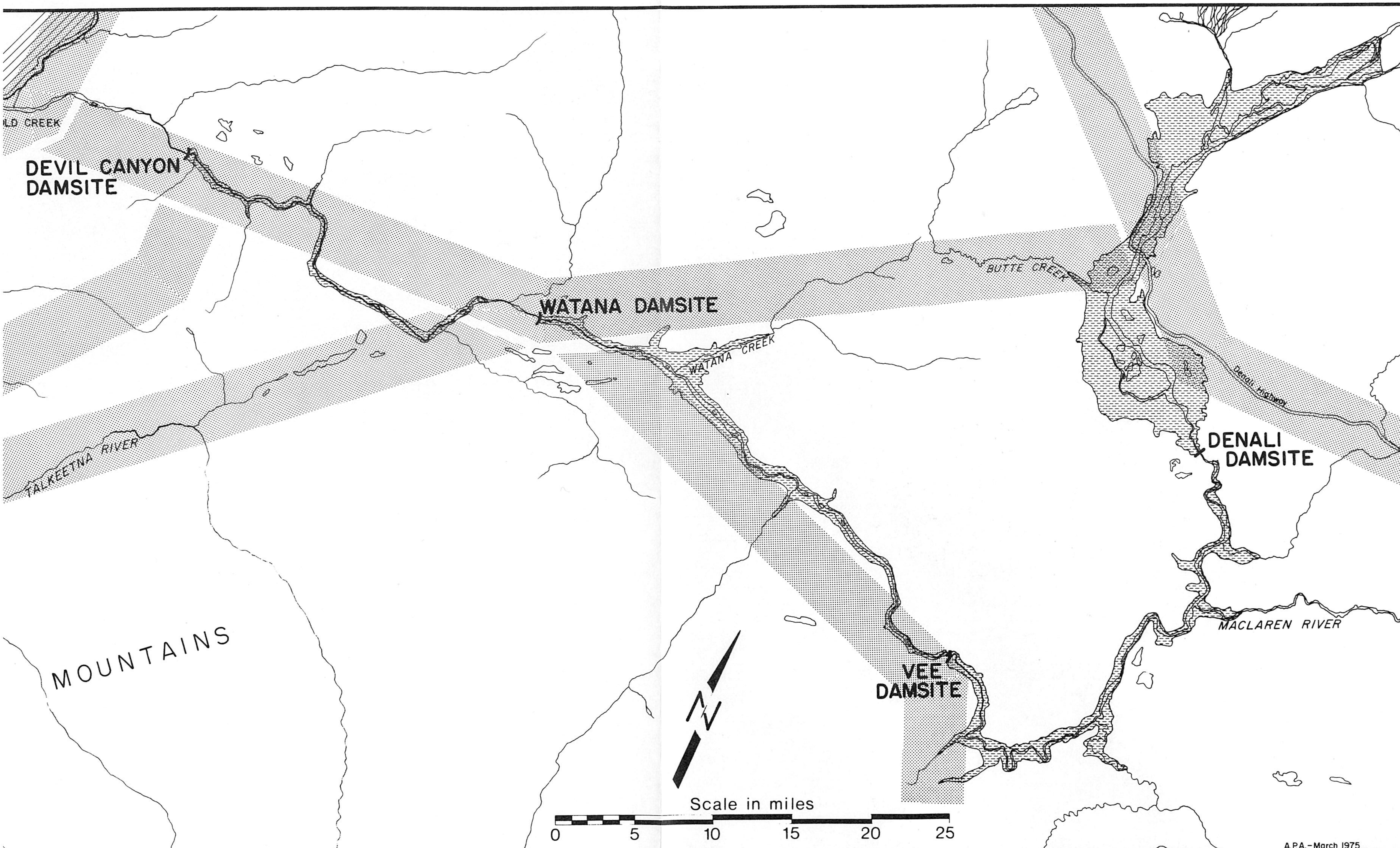


FAIRBANKS
CANTWELL-FAIRBANKS
FAIRBANKS-PAXSON
Healy
CANTWELL-PAXSON
Cantwell
Paxson
Denali
Devil Canyon
Watana
Vee
ANCHORAGE-DEVIL CANYON
Talkeetna
SUSITNA
VALDEZ-PAXSON
Glennallen
Palmer
PALMER-GLENNALLEN
Pt. MacKenzie
ANCHORAGE
Valdez
UNITED STATES DEPARTMENT OF THE INTERIOR
ALASKA POWER ADMINISTRATION
INDEX TO
ALTERNATIVE
CORRIDOR MAPS
Scale in miles
0
50
75
100
125
A.P.A.-March 1975

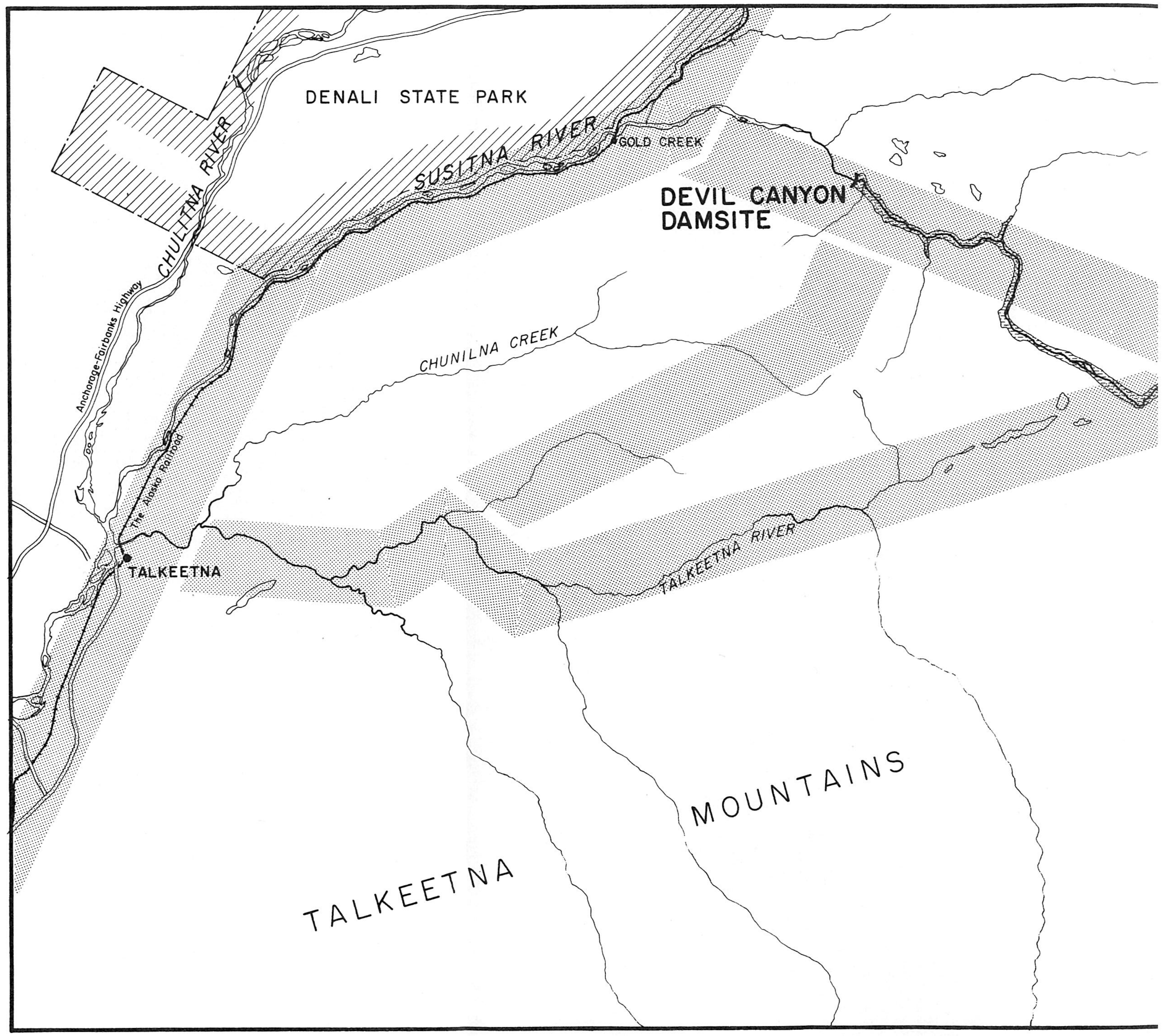


ANCHORAGE-DEVIL CANYON


COOK INLET
YENTNA RIVER
SUSITNA RIVER
WILLOW
ANCHORAGE
KNIK ARM
FT. RICHARDSON MILITARY RES.
WASILLA
TALKEETNA MOUNTAINS
0

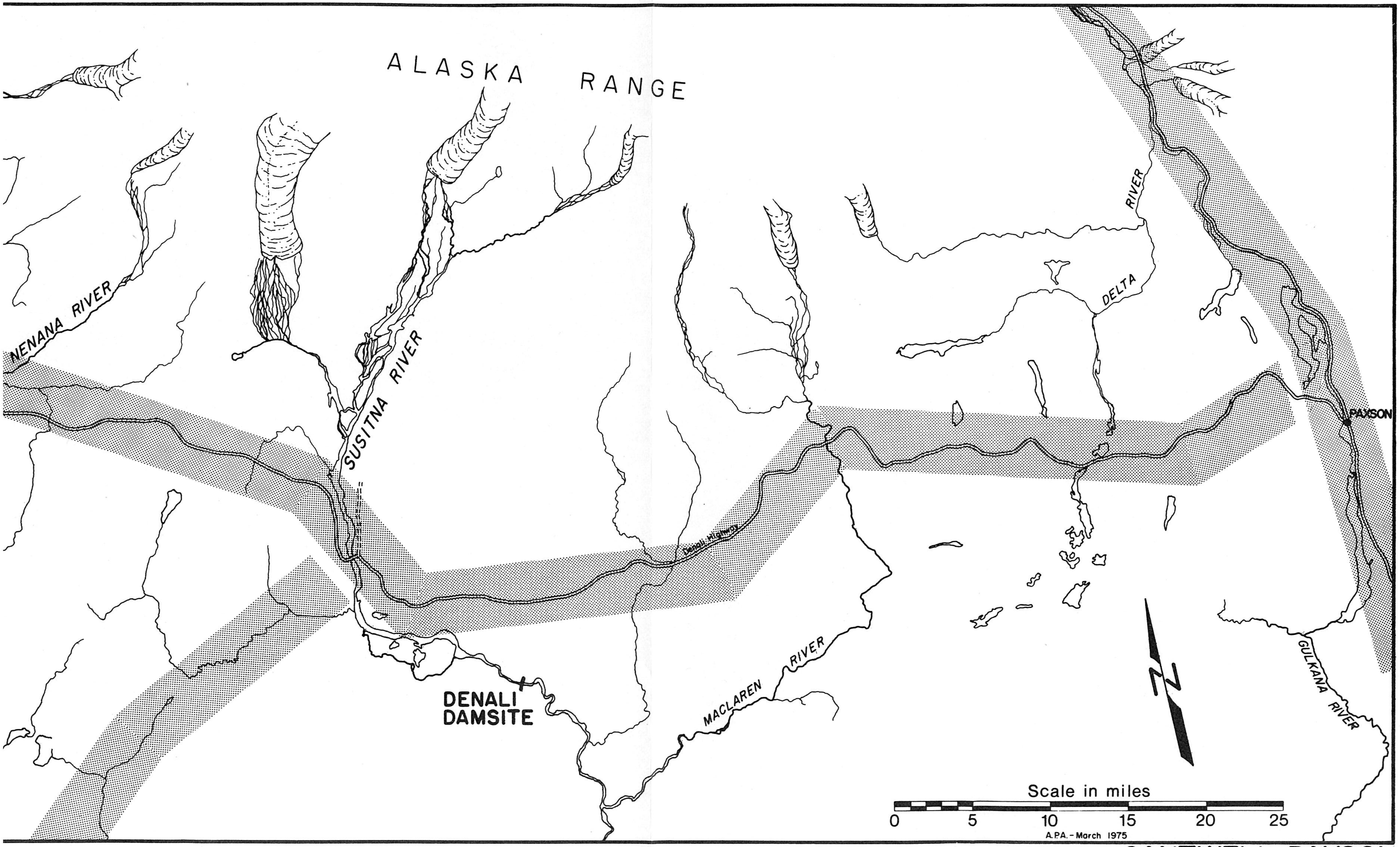

LD CREEK
DEVIL CANYON DAMSITE
WATANA DAMSITE
BUTTE CREEK
WATANA CREEK
TALKEETNA RIVER
Denali Highway
DENALI DAMSITE
MACLAREN RIVER
VEE DAMSITE
MOUNTAINS
N
Scale in miles
0
5
10
15
20
25
A.P.A.-March 1975

SUSITNA

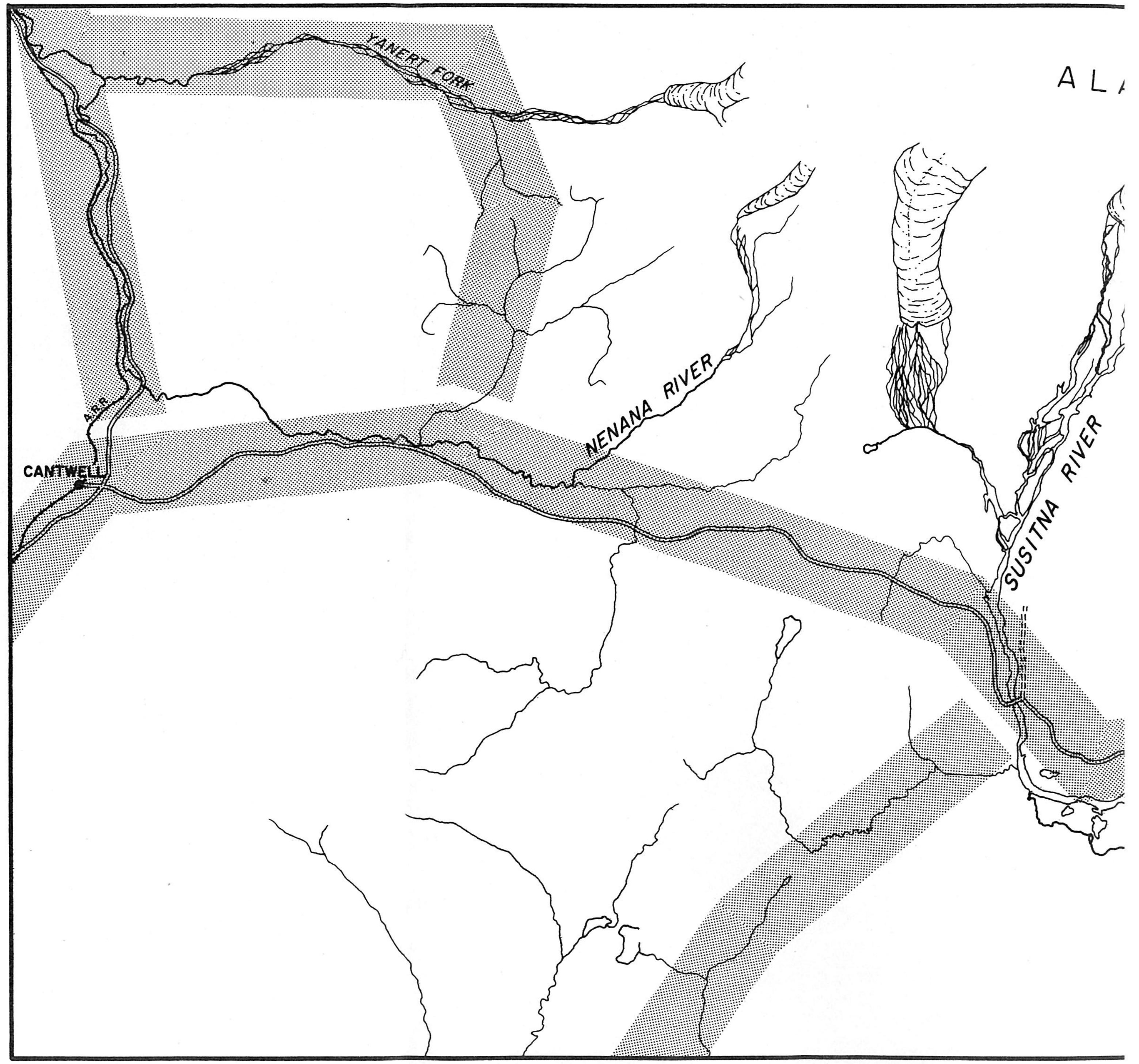


DENALI STATE PARK
CHULITNA RIVER
SUSITNA RIVER
GOLD CREEK
DEVIL CANYON DAMSITE
Anchorage-Fairbanks Highway
The Alaska Railroad
CHUNILNA CREEK
TALKEETNA
TALKEETNA RIVER
TALKEETNA MOUNTAINS

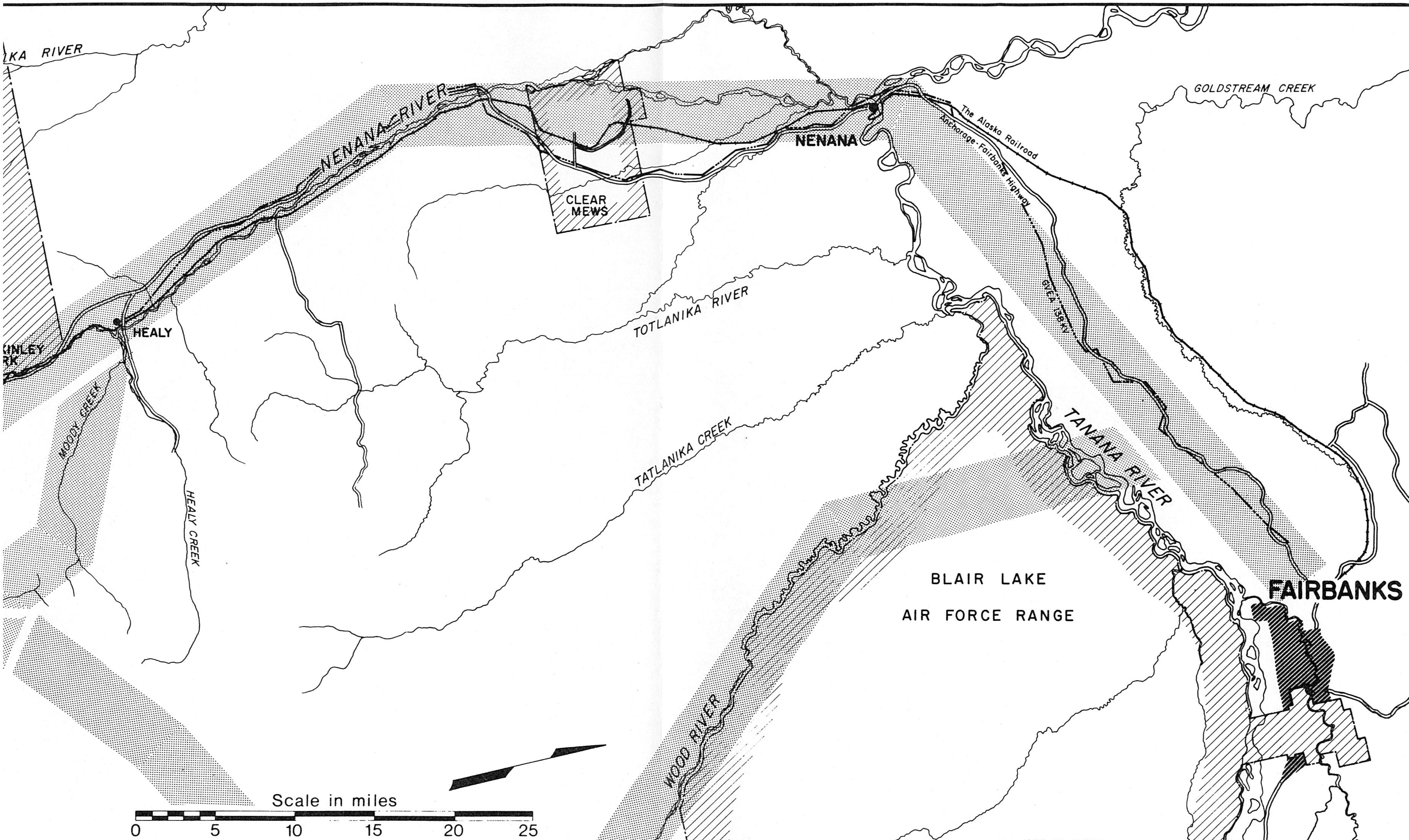
3



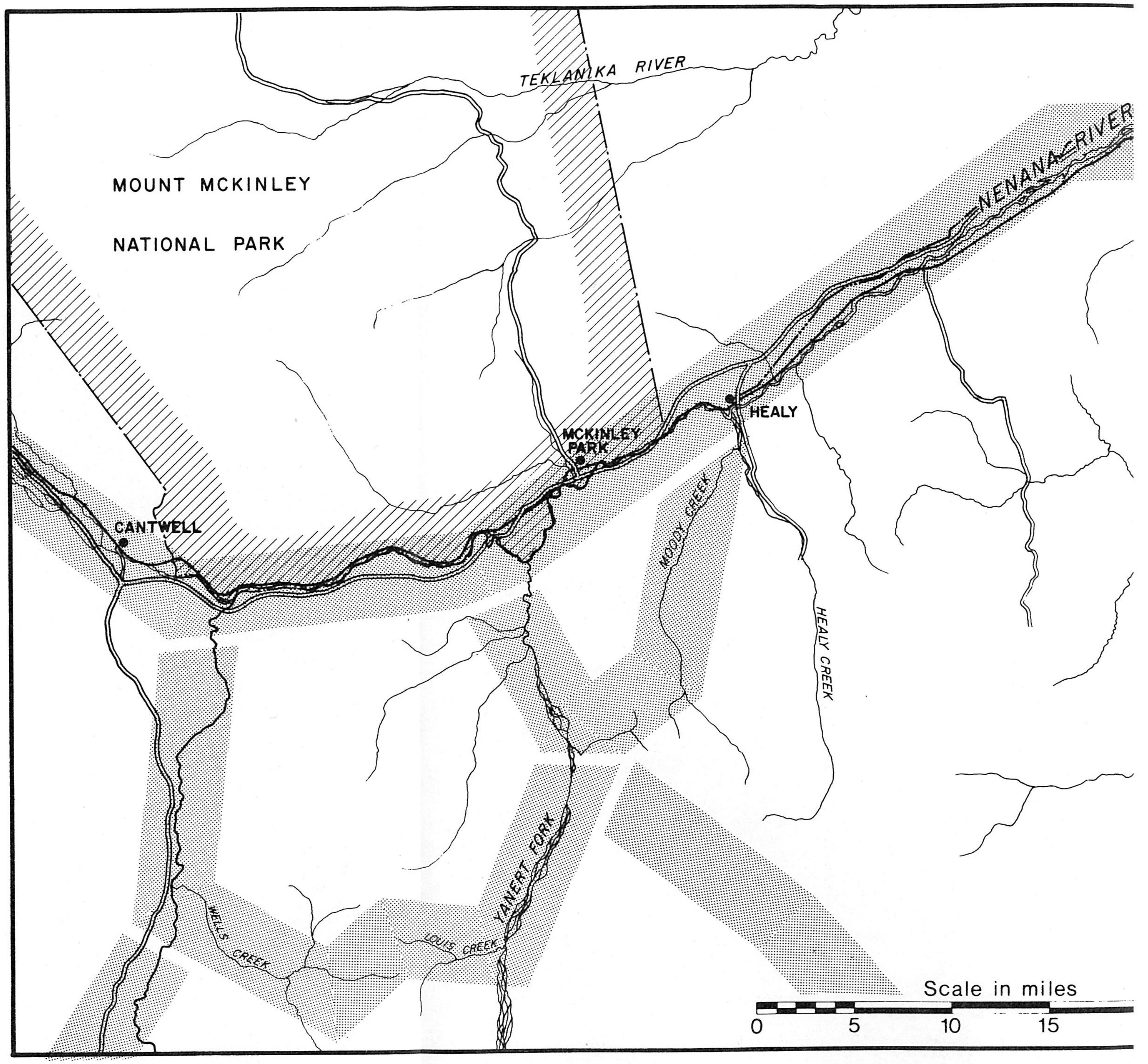
CANTWELL-PAXSON



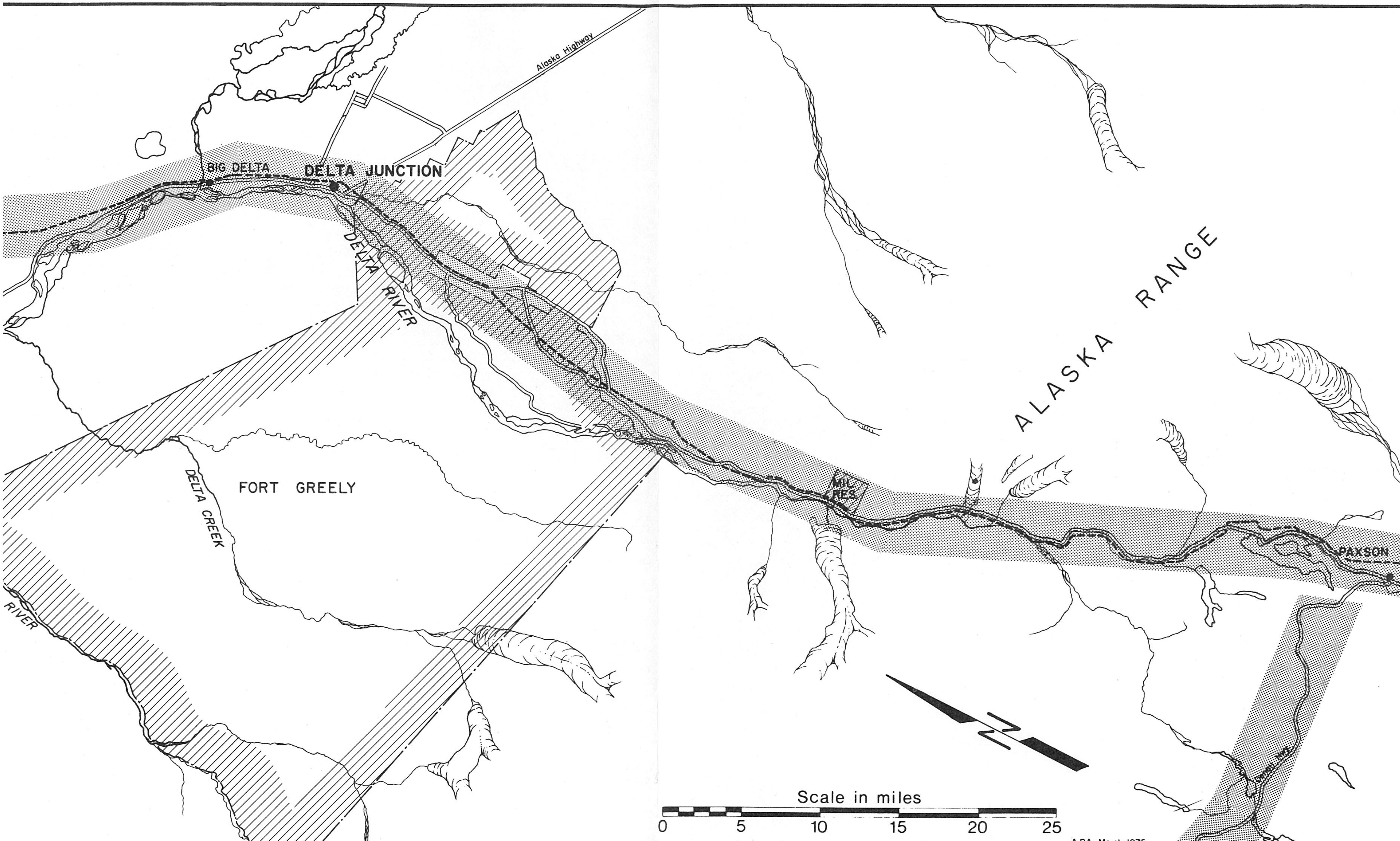
YANERT FORK
ALA
NENANA RIVER
A.R.R.
CANTWELL
SUSITNA RIVER



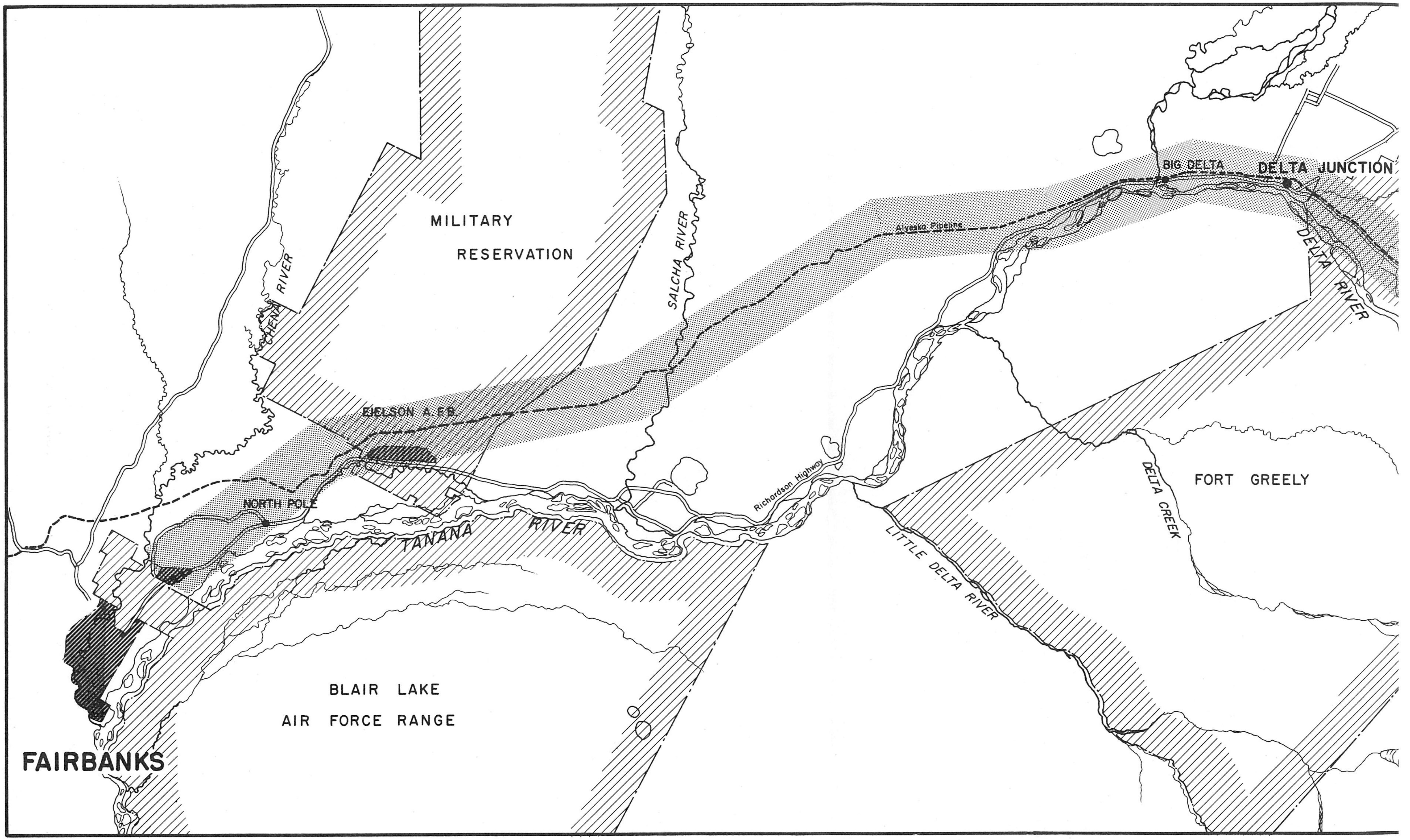
CANTWELL-FAIRBANKS

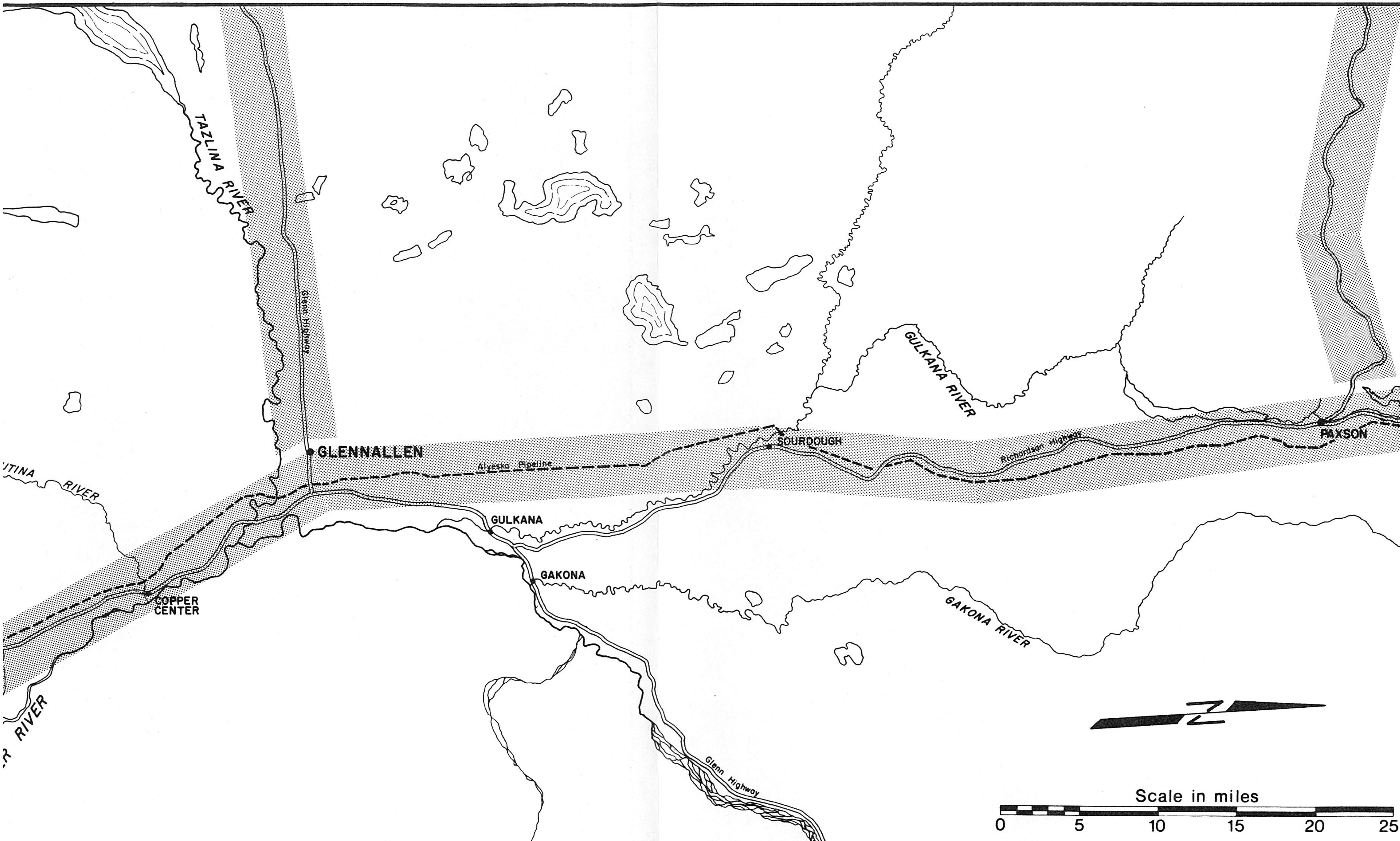

TEKLANIKA RIVER
MOUNT MCKINLEY
NATIONAL PARK
NENANA RIVER
HEALY
MCKINLEY PARK
CANTWELL
MOODY CREEK
HEALY CREEK
YANERT FORK
WELLS CREEK
LOUIS CREEK
Scale in miles
0
5
10
15

4

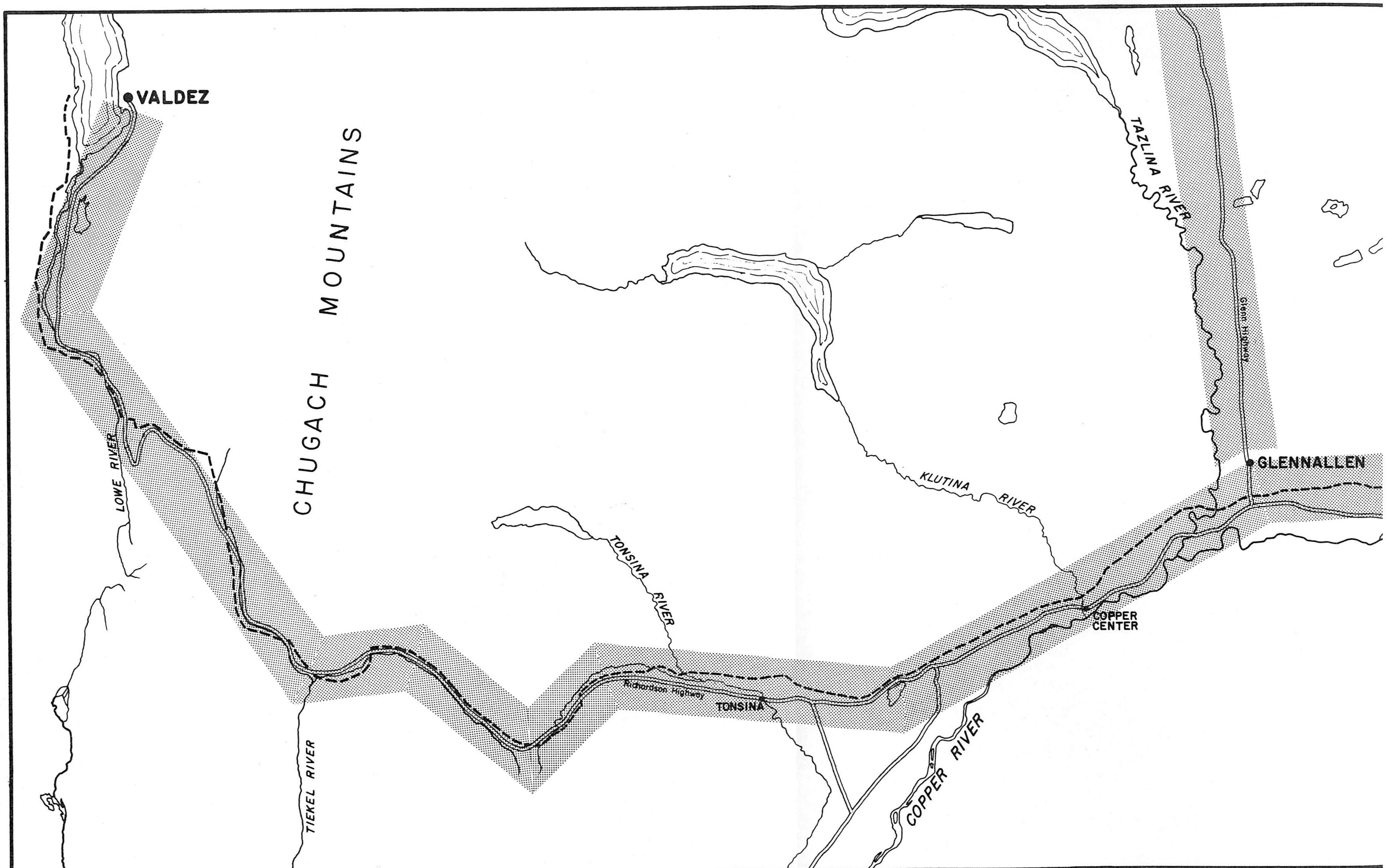


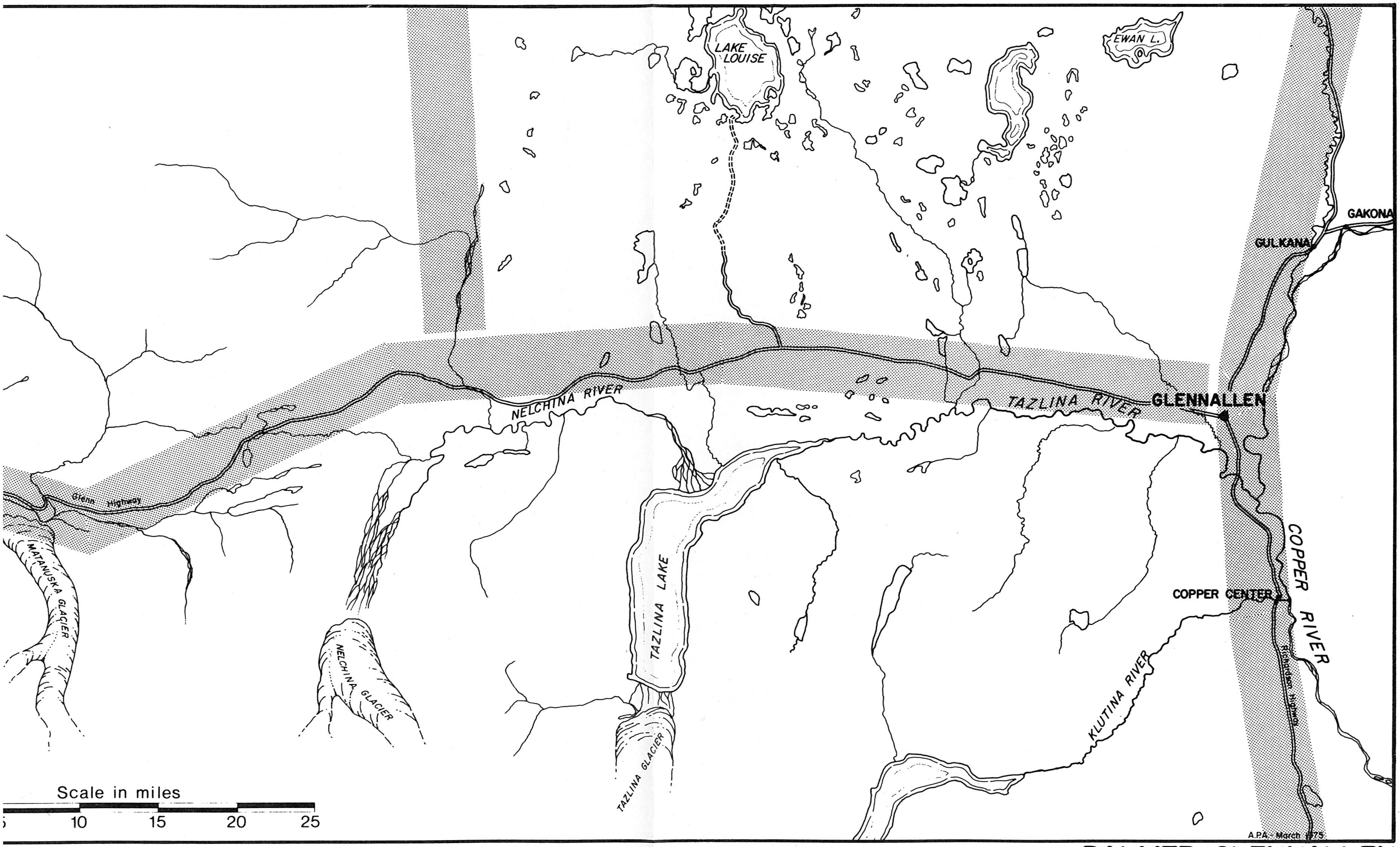
FAIRBANKS-PAXSON


MILITARY
RESERVATION
CHENA RIVER
SALCHA RIVER
Alyeska Pipeline
BIG DELTA
DELTA JUNCTION
DELTA RIVER
EIELSON A.F.B.
NORTH POLE
TANANA RIVER
Richardson Highway
FORT GREELY
DELTA CREEK
LITTLE DELTA RIVER
BLAIR LAKE
AIR FORCE RANGE
FAIRBANKS

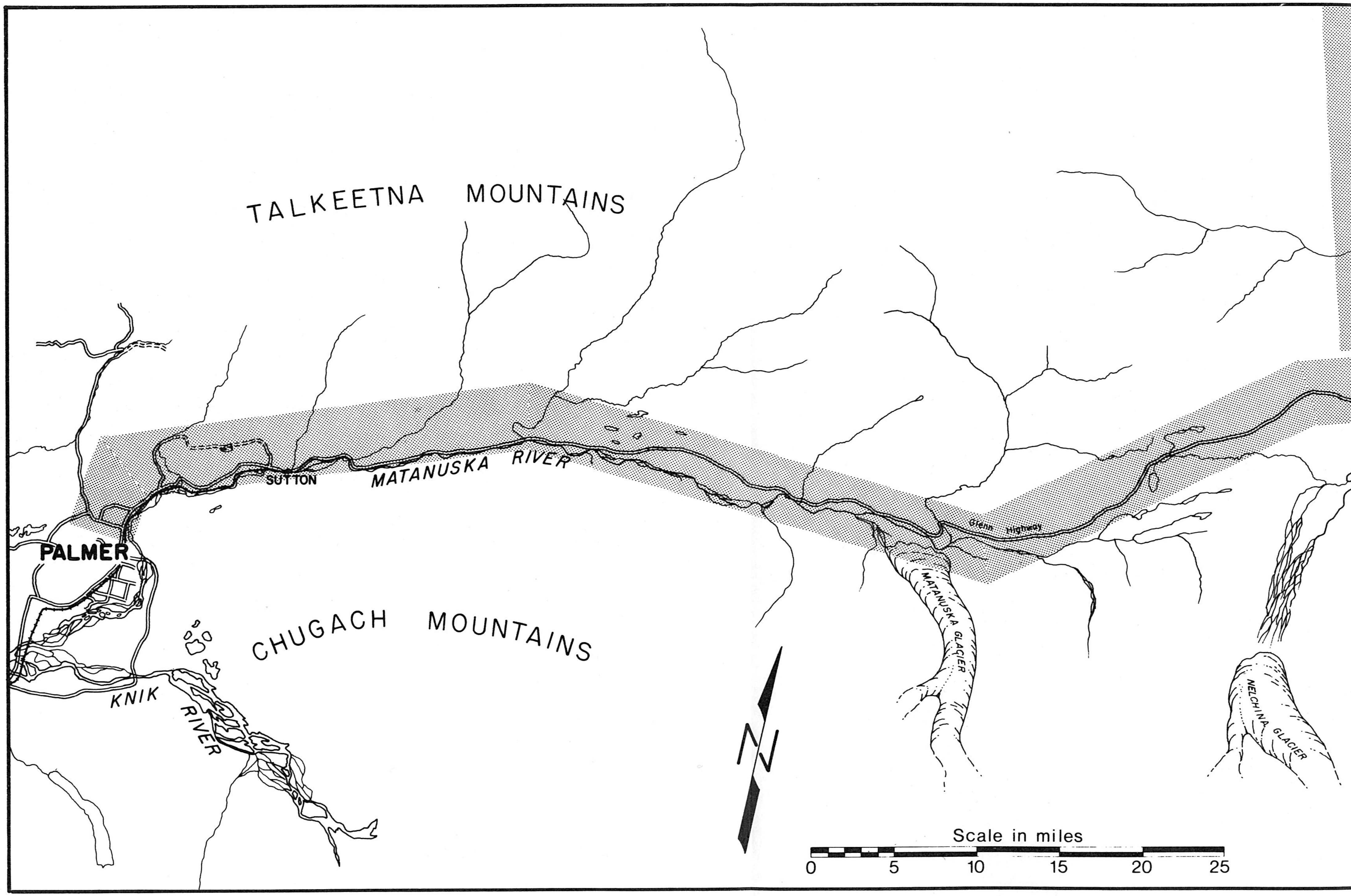


VALDEZ-PAXSON


VALDEZ
CHUGACH MOUNTAINS
LOWE RIVER
TIEKEL RIVER
TONSINA RIVER
Richardson Highway
TONSINA
KLUTINA RIVER
COPPER CENTER
COPPER RIVER
TAZLINA RIVER
Glenn Highway
GLENNALLEN



PALMER–GLENNALLEN



TALKEETNA MOUNTAINS
CHUGACH MOUNTAINS
PALMER
SUTTON
MATANUSKA RIVER
KNIK RIVER
Glenn Highway
MATANUSKA GLACIER
NELCHINA GLACIER
N
Scale in miles
0 5 10 15 20 25

8

SOILS LEGEND

Soils

EAT - Poorly drained soils, normally in waterlaid materials.
EFT - Well drained soils, in stratified materials on flood plains and low terraces.
EOL - Well drained gray soils; shallow bedrock.
EOP - Well drained loamy or gravelly gray soils; deep permafrost table.
HMT - Poorly drained partially decomposed peat; seldom freezes in winter.
HMV - Poorly drained partially decomposed peat; contains lenses of volcanic ash.
HY(B)G - Poorly drained fibrous peat; freezes in winter.
HYP - Poorly drained fibrous peat; shallow permafrost table.
IAHP - Poorly drained soils with peaty surface layer; shallow permafrost table.
IAP - Poorly drained soils; shallow to deep permafrost table.
IAW - Moderately well to poorly drained soils; may contain deeply buried ice masses.
ICF - Well drained brown soils; contains lenses of fine-grain material.
ICP - Well drained thin grown soils; deep permafrost table.
ICT - Well drained grown soils; non-acid.
IND - Well drained dark soils formed in fine volcanic ash.
IUE - Well drained soils with dark, acid surface layer.
IUL - Well drained soils with dark, acid surface layer; shallow bedrock.
IUP - Well drained thin soils with dark acid surface; deep permafrost table.
RM - Very steep, rocky, or ice-covered land.
SOP - Well drained, thin, strongly acid soils; deep permafrost table.
SOT - Well drained strongly acid soils.
SOU - Well drained, strongly acid soils; very dark subsoil.

The mapping units, while referring to only one or two dominant soils in the association, include other soils and less extensive soils.

Slope Groups

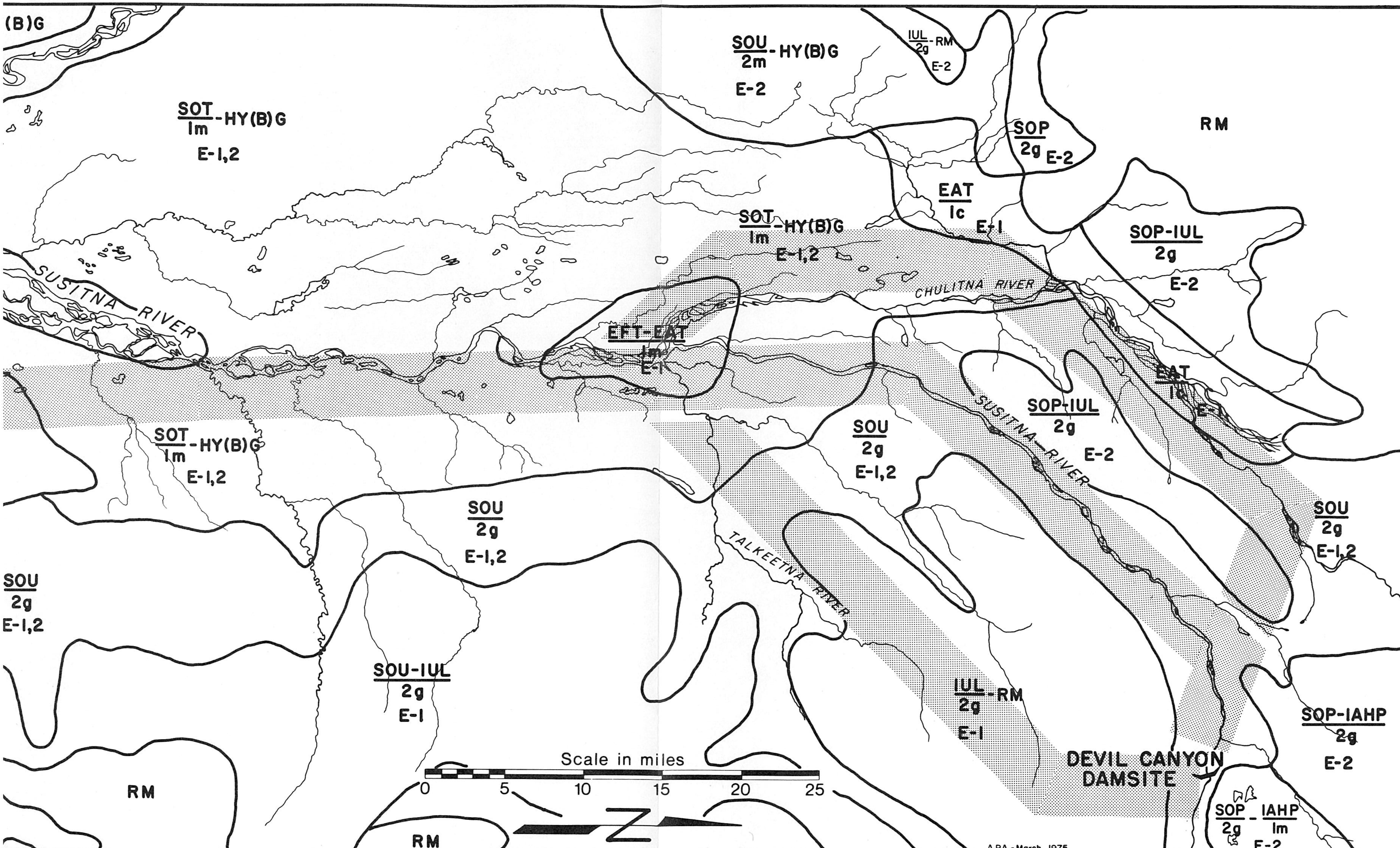
1 - Slopes dominately less than 12%.
2 - Slopes dominately steeper than 12%.

Textural Groups

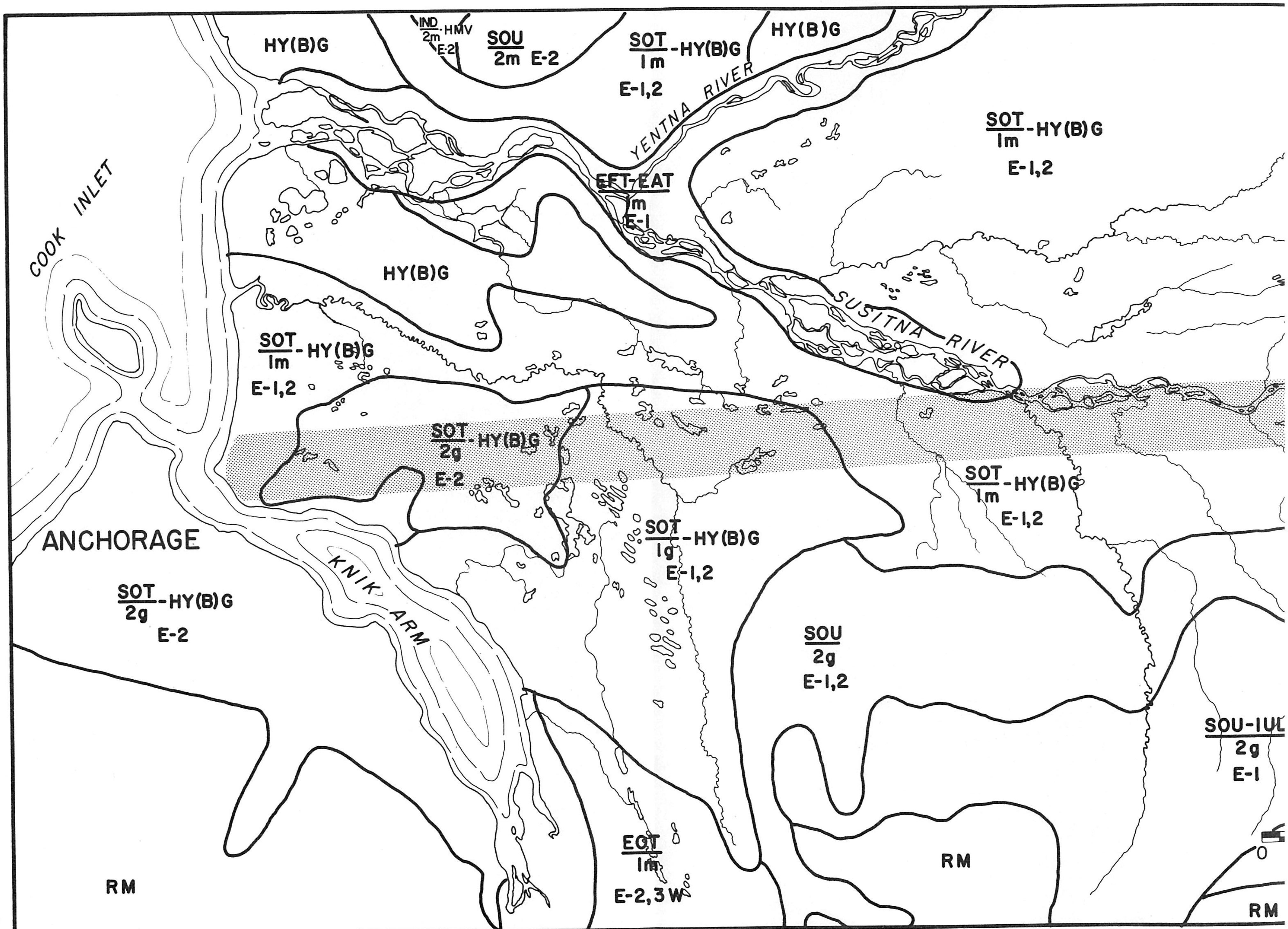
c - sandy
f - clayey
g - very gravelly
m - loamy (medium)

Erosion Potential

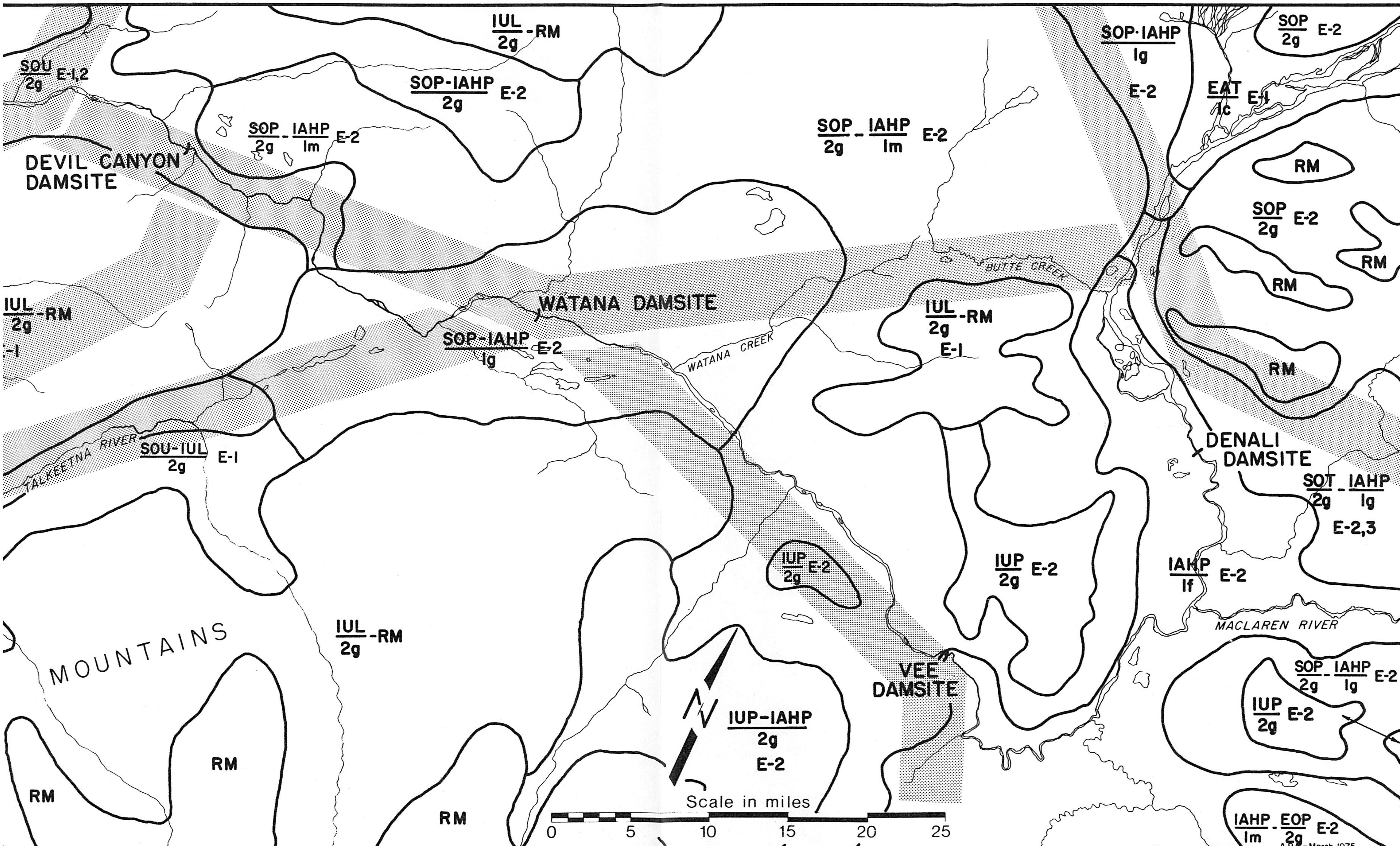
E-1 - low
E-2 - medium
E-3 - high



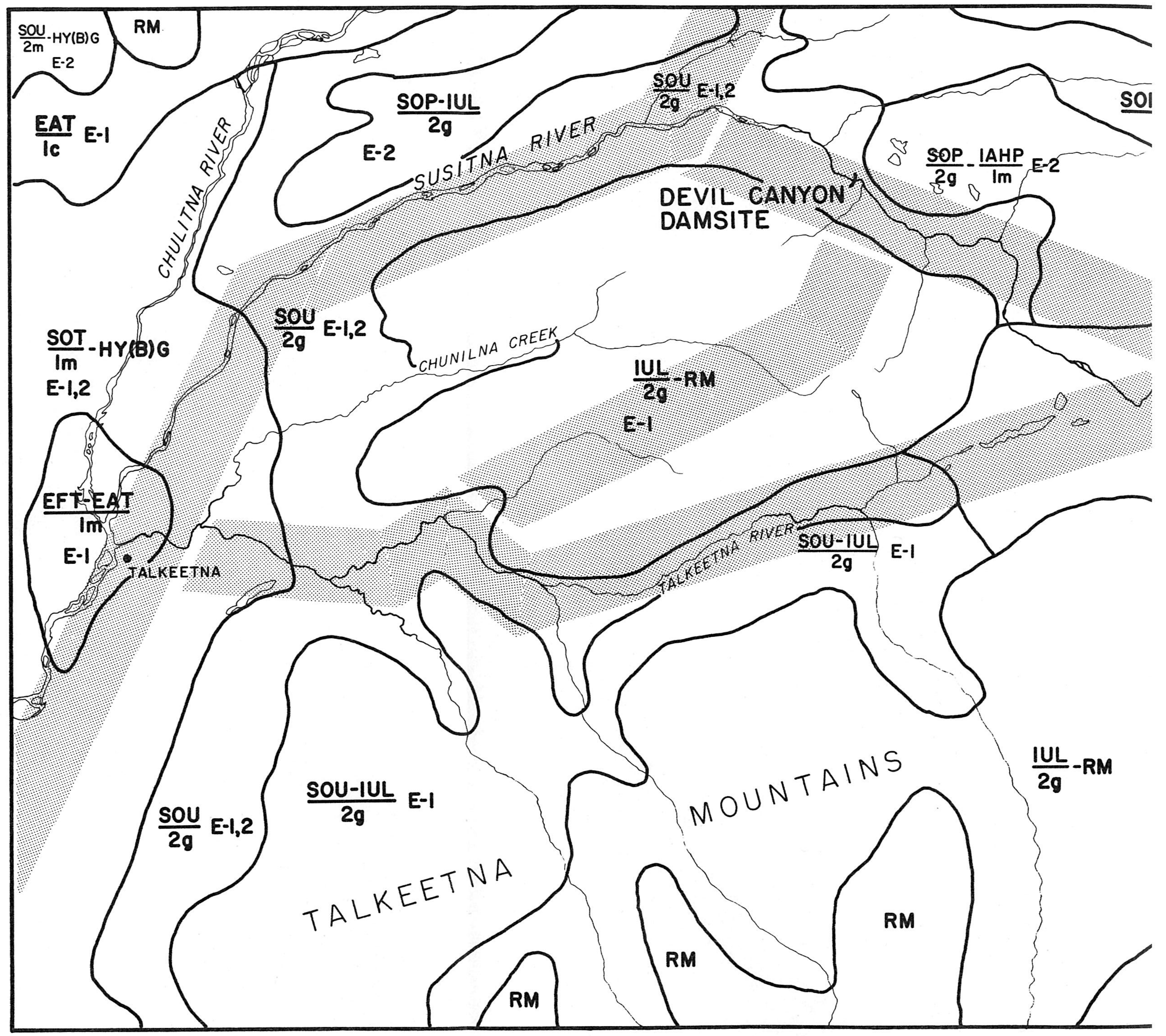
SOILS: ANCHORAGE-DEVIL CANYON

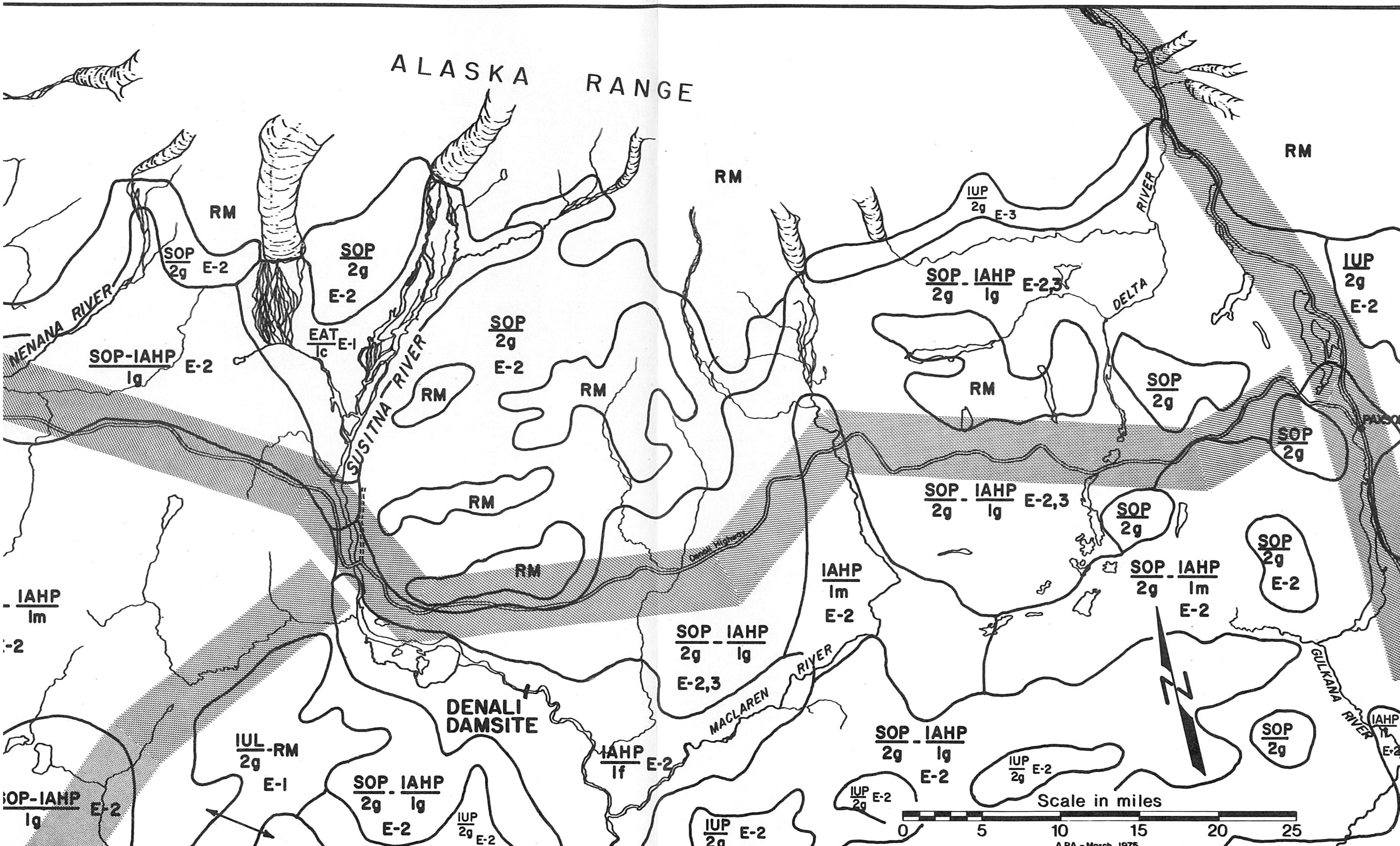

HY(B)G
IND
2m
E-2
HMV
SOU
2m E-2
SOT
1m
-HY(B)G
E-1,2
HY(B)G
YENTNA RIVER
SOT
1m
-HY(B)G
E-1,2
COOK INLET
EFT-EAT
1m
E-1
HY(B)G
SUSITNA RIVER
SOT
1m
-HY(B)G
E-1,2
SOT
2g
-HY(B)G
E-2
SOT
1m
-HY(B)G
E-1,2
ANCHORAGE
SOT
1g
-HY(B)G
E-1,2
SOT
2g
-HY(B)G
E-2
KNIK ARM
SOU
2g
E-1,2
SOU-IUL
2g
E-1
EGT
1m
E-2,3W
RM
RM
RM
0

9

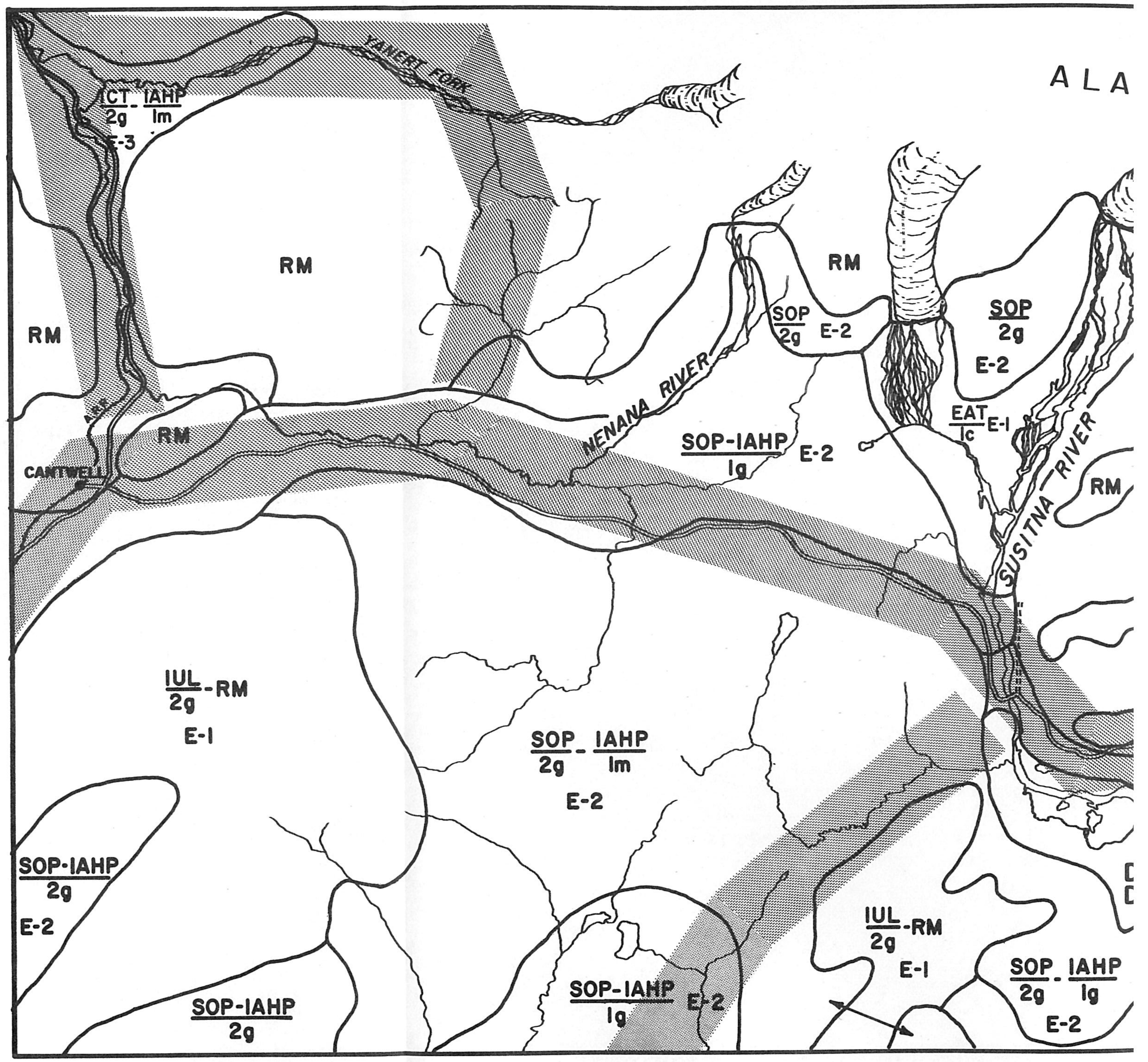


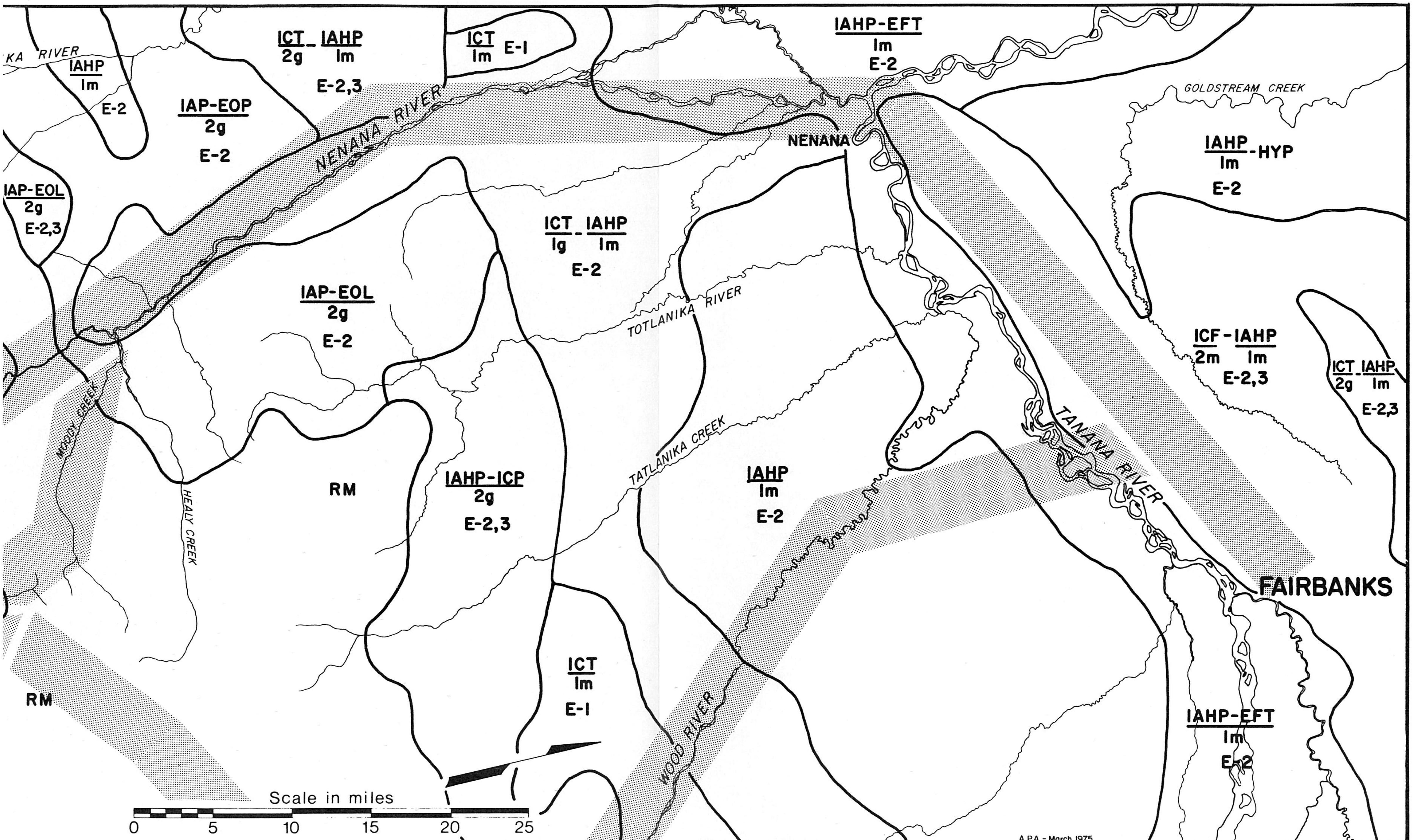
SOILS : SUSITNA


SOU/2m -HY(B)G E-2
RM
EAT/Ic E-I
CHULITNA RIVER
SOP-IUL/2g
E-2
SUSITNA RIVER
SOU/2g E-I,2
SOP/2g - IAHP/Im E-2
DEVIL CANYON DAMSITE
SOU/2g E-I,2
SOT/Im -HY(B)G E-I,2
CHUNILNA CREEK
IUL/2g -RM
E-I
EFT-EAT/Im
E-I
TALKEETNA
TALKEETNA RIVER
SOU-IUL/2g E-I
IUL/2g -RM
MOUNTAINS
SOU-IUL/2g E-I
SOU/2g E-I,2
TALKEETNA
RM
RM
RM

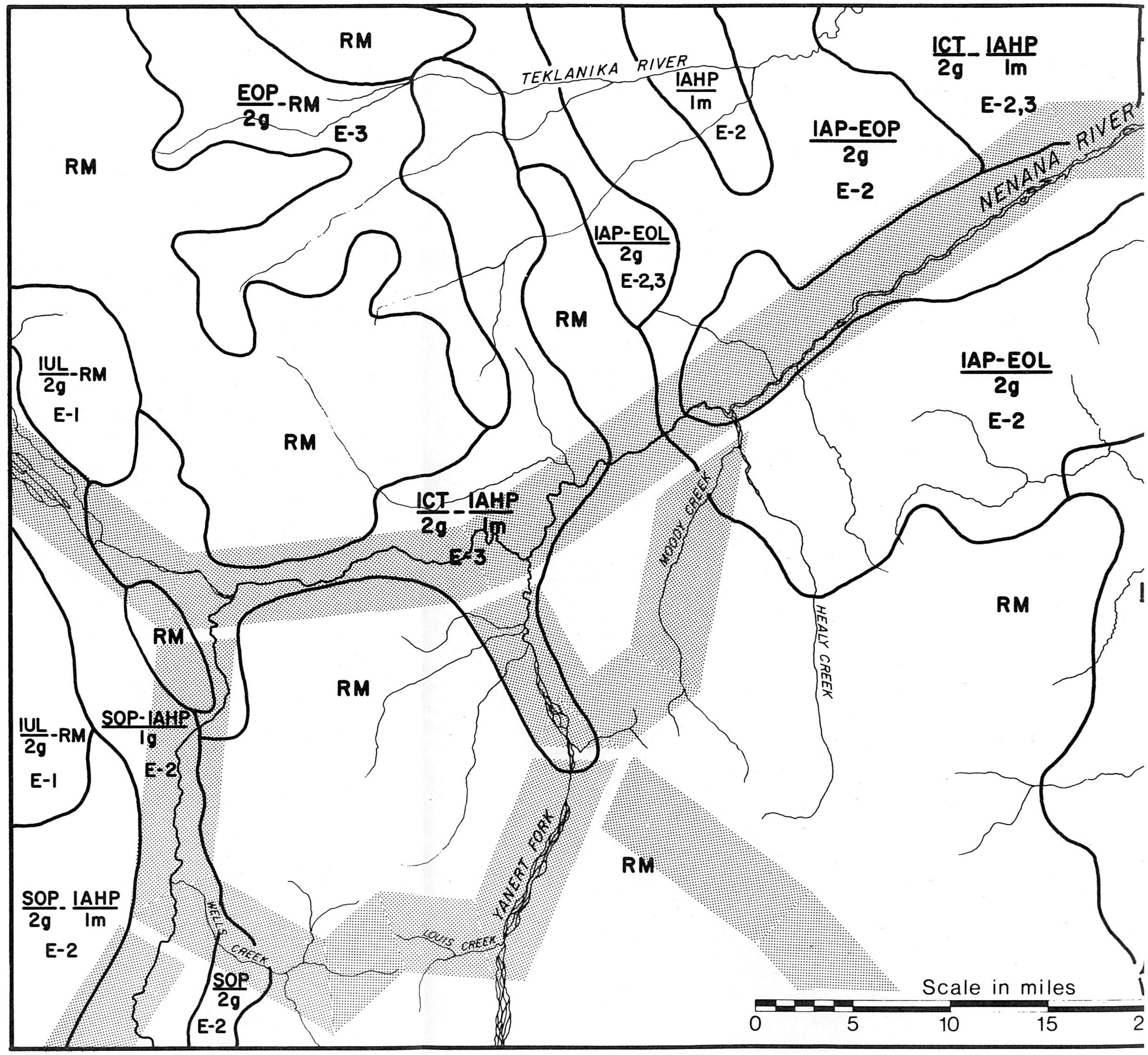


SOILS - CANTWELL-PAXSON

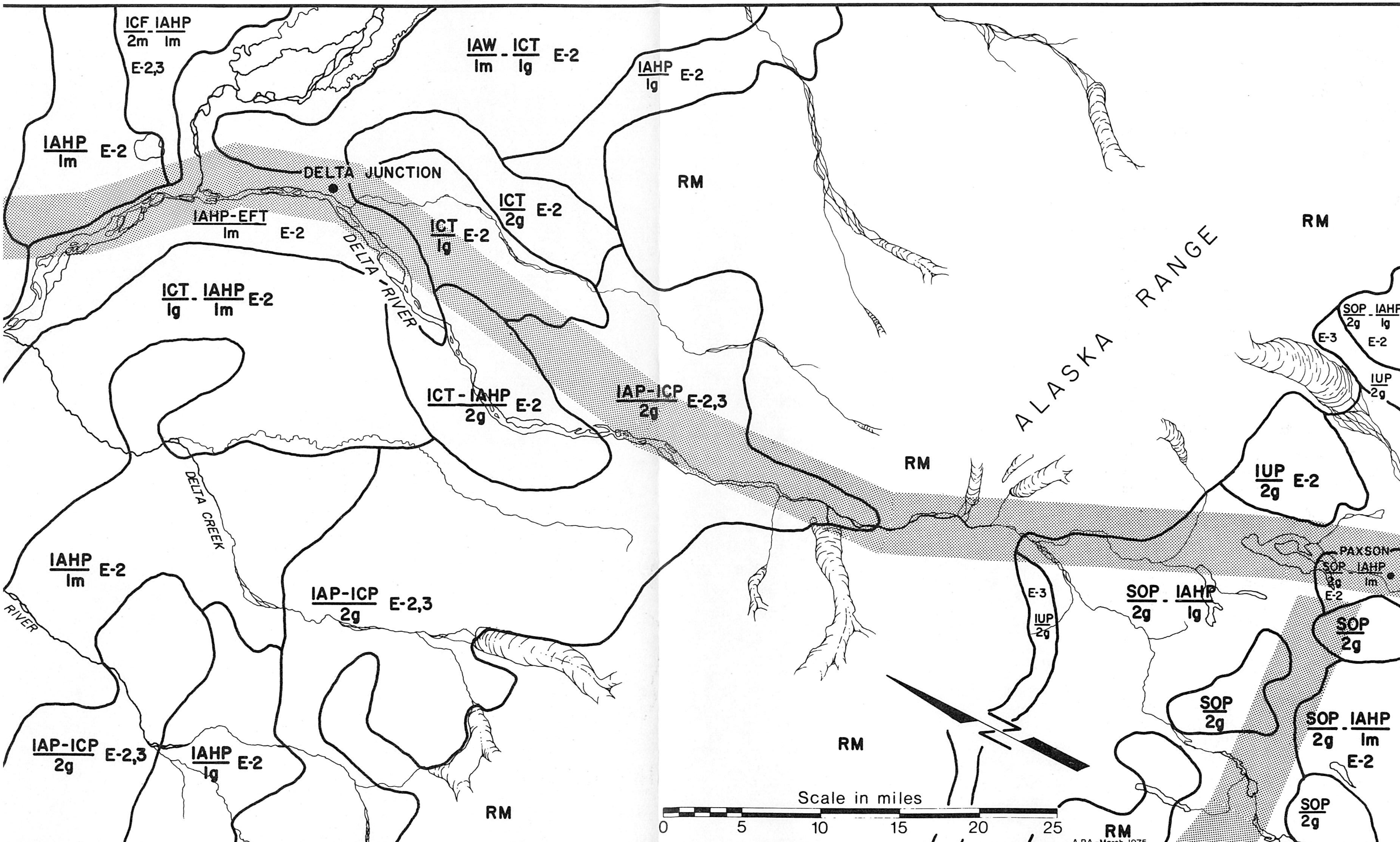

ALA
YANERT FORK
ICT - IAHP
2g lm
E-3
RM
RM
RM
CANTWELL
NENANA RIVER
SOP
2g E-2
RM
SOP
2g
E-2
EAT
lc E-1
SOP-IAHP
lg E-2
SUSITNA RIVER
RM
IUL
2g -RM
E-1
SOP - IAHP
2g lm
E-2
SOP-IAHP
2g
E-2
SOP-IAHP
2g
SOP-IAHP
lg E-2
IUL
2g -RM
E-1
SOP - IAHP
2g lg
E-2



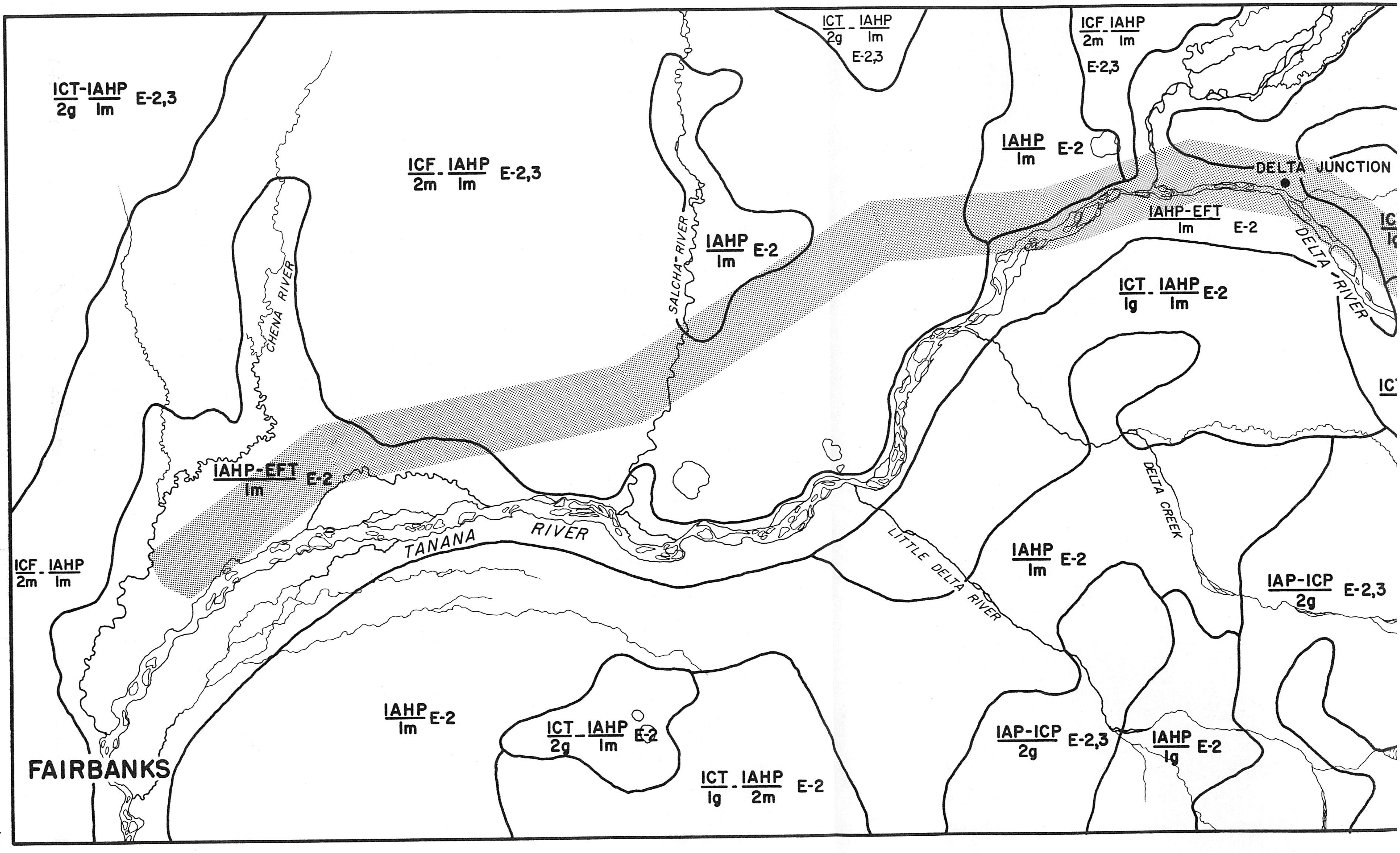
SOILS : CANTWELL-FAIRBANKS

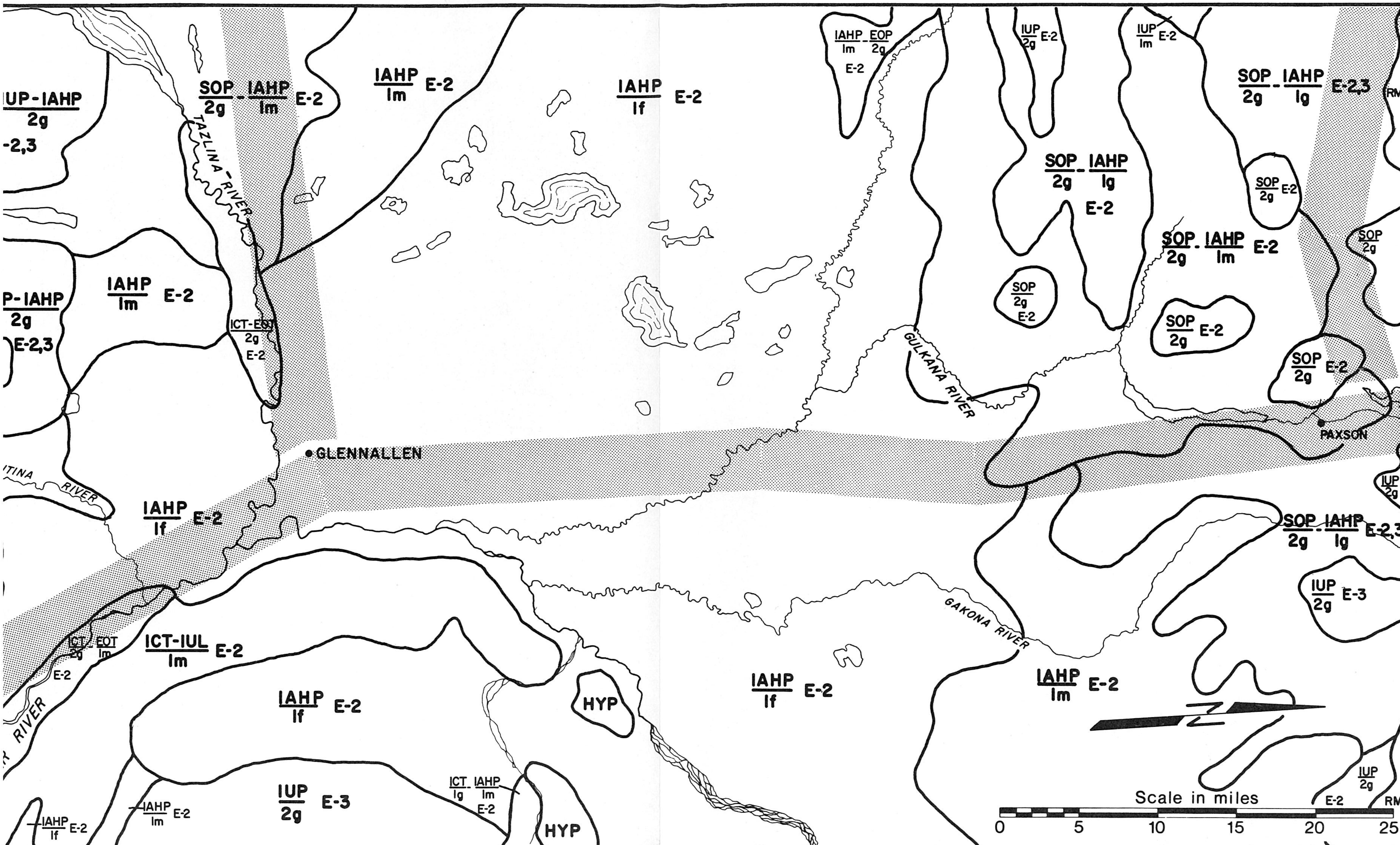


RM
EOP/2g - RM
E-3
TEKLANIKA RIVER
IAHP/lm
E-2
ICT/2g - IAHP/lm
E-2,3
IAP-EOP/2g
E-2
NENANA RIVER
RM
IAP-EOL/2g
E-2,3
RM
IUL/2g - RM
E-1
RM
IAP-EOL/2g
E-2
ICT/2g - IAHP/lm
E-3
MOODY CREEK
HEALY CREEK
RM
RM
RM
IUL/2g - RM
E-1
SOP-IAHP/lg
E-2
YANERT FORK
RM
SOP/2g - IAHP/lm
E-2
WELLS CREEK
LOUIS CREEK
SOP/2g
E-2
Scale in miles
0
5
10
15

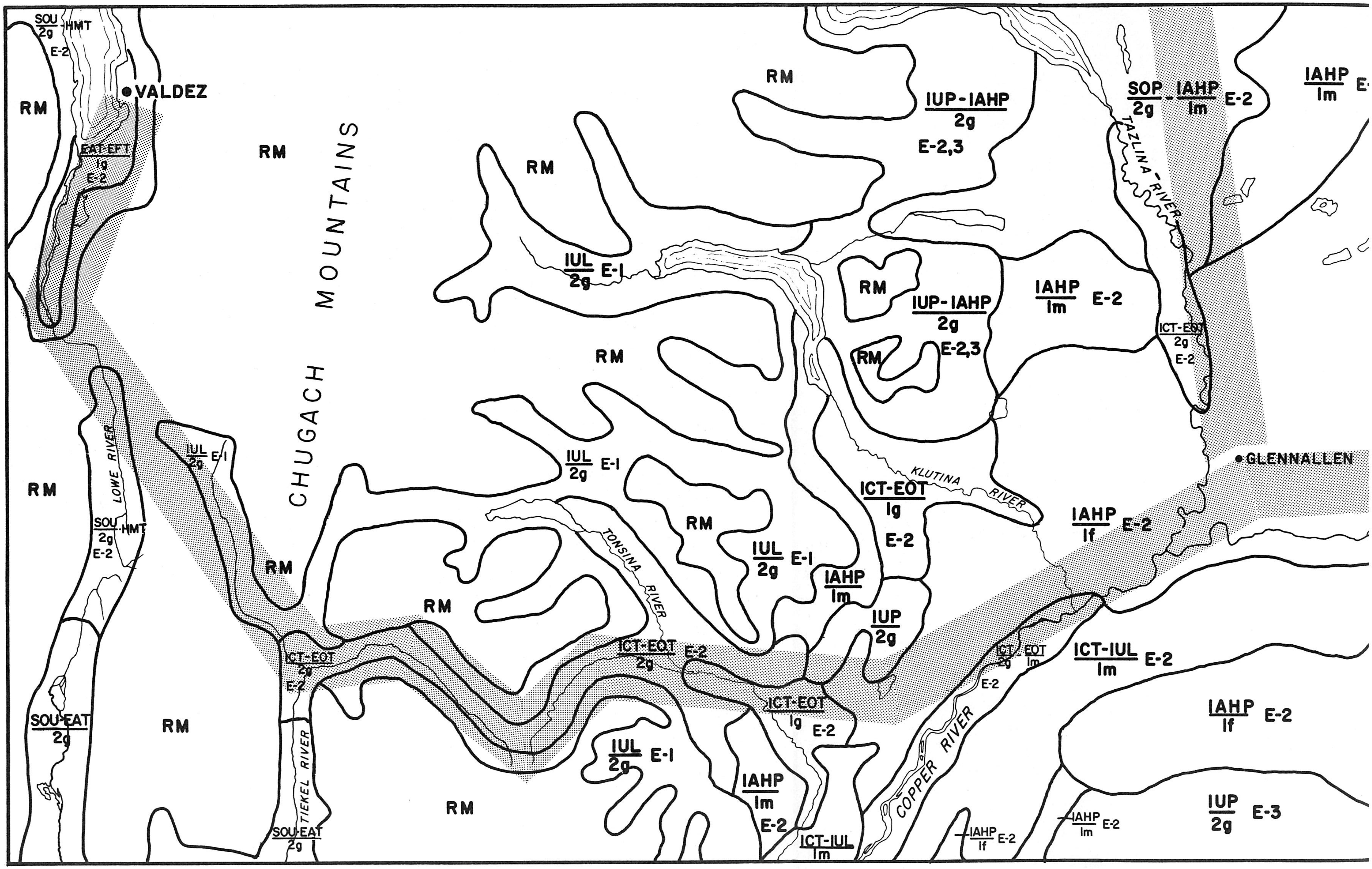


SOILS: FAIRBANKS-PAXSON


ICT-IAHP 2g lm E-2,3
ICF-IAHP 2m lm E-2,3
ICT-IAHP 2g lm E-2,3
ICF-IAHP 2m lm E-2,3
IAHP lm E-2
DELTA JUNCTION
IAHP-EFT lm E-2
IAHP lm E-2
CHENA RIVER
SALCHA RIVER
DELTA RIVER
ICT-IAHP lg lm E-2
IAHP-EFT lm E-2
TANANA RIVER
LITTLE DELTA RIVER
DELTA CREEK
ICF-IAHP 2m lm
IAHP lm E-2
IAP-ICP 2g E-2,3
IAHP lm E-2
ICT-IAHP 2g lm E-2
IAP-ICP 2g E-2,3
IAHP lg E-2
ICT-IAHP lg 2m E-2
FAIRBANKS



SOILS: VALDEZ-PAXSON


VALDEZ
CHUGACH MOUNTAINS
GLENNALLEN
LOWE RIVER
TIEKEL RIVER
TONSINA RIVER
KLUTINA RIVER
TAZLINA RIVER
COPPER RIVER
RM
SOU/2g -HMT E-2
EAT-EFT/1g E-2
SOU/2g -HMT E-2
SOU-EAT/2g
SOU-EAT/2g
IUL/2g E-1
ICT-EOT/2g E-2
IUP-IAHP/2g E-2,3
SOP/2g - IAHP/lm E-2
IAHP/lm
IAHP/lm E-2
ICT-EOT/2g E-2
ICT-EOT/lg E-2
IAHP/lf E-2
IAHP/lm
IUP/2g
ICT-EOT/lg E-2
IAHP/lm E-2
ICT-IUL/lm
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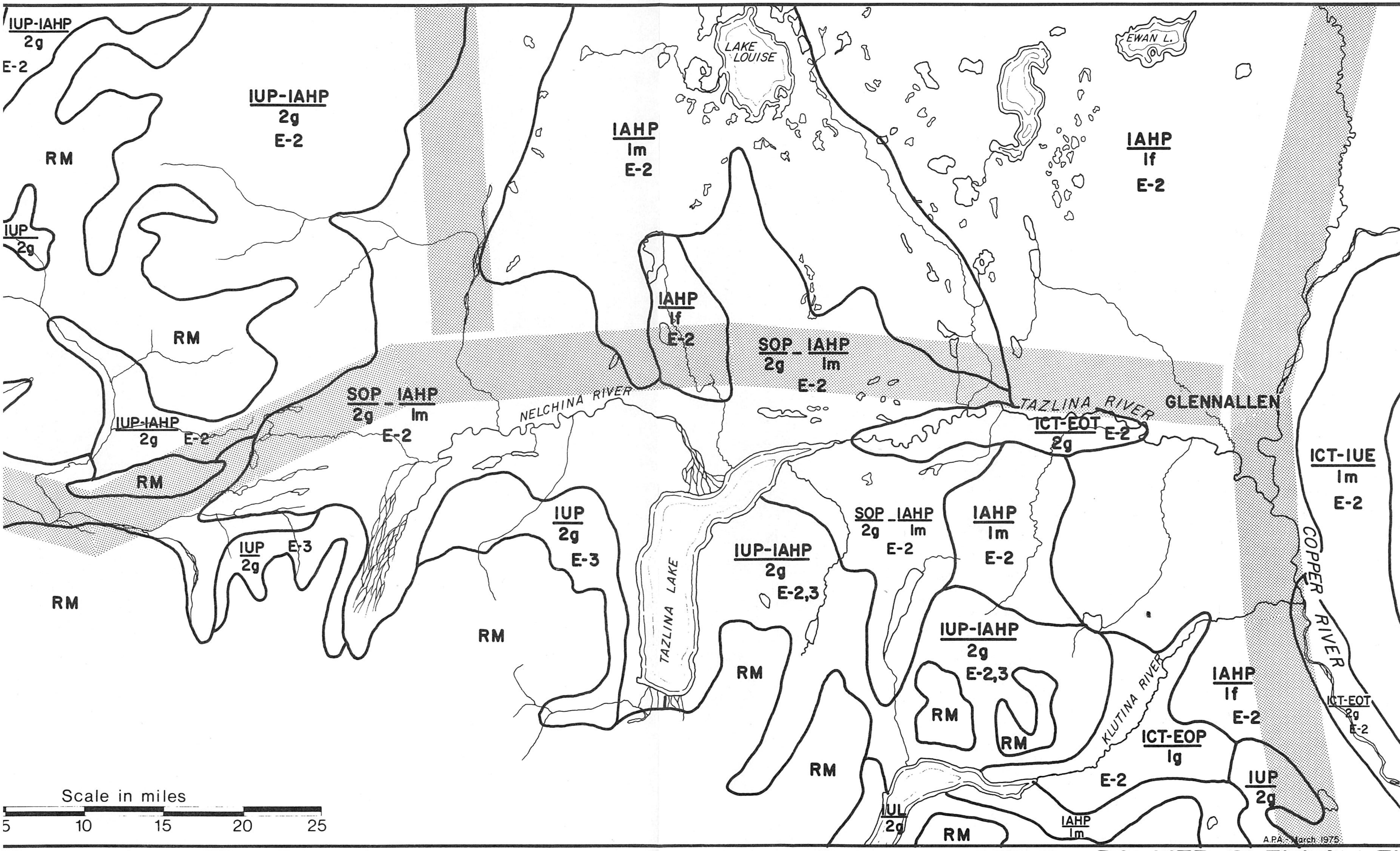
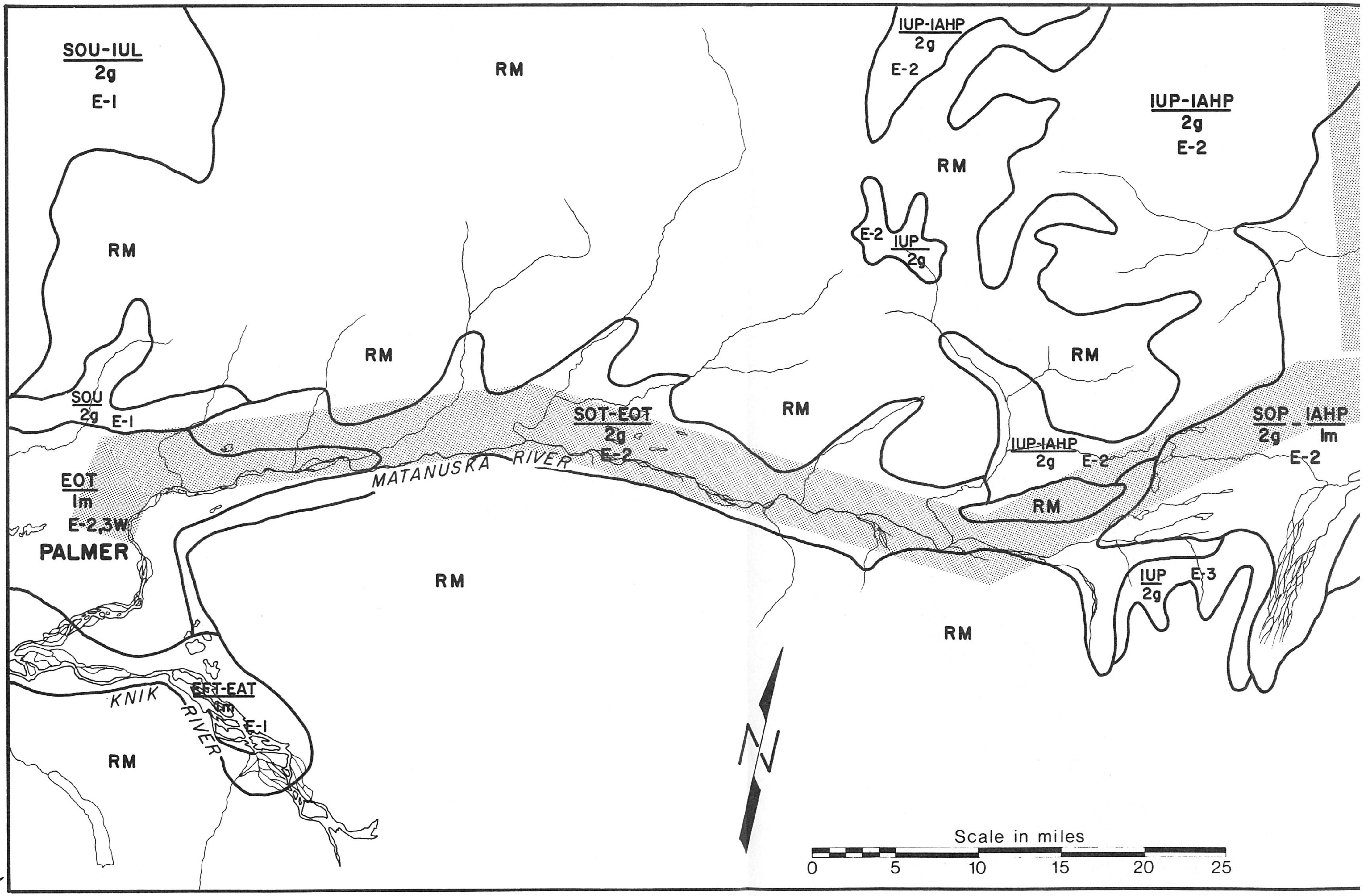
IAHP/lm E-2



SOILS : PALMER-GLENNALLEN


SOU-IUL
2g
E-1
RM
IUP-IAHP
2g
E-2
RM
IUP-IAHP
2g
E-2
RM
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IUP
2g
RM
RM
RM
SOU
2g
E-1
SOT-EOT
2g
E-2
RM
IUP-IAHP
2g
E-2
SOP
2g
IAHP
lm
E-2
MATANUSKA RIVER
EOT
lm
E-2,3W
PALMER
RM
RM
IUP
2g
E-3
RM
KNIK RIVER
E-1
RM
N
Scale in miles
0
5
10
15
20
25

LAND STATUS LEGEND

Major withdrawals prior to Alaska Native Claims Settlement Act, (December 18, 1971)

Withdrawals for possible inclusion on the four National systems (D-2)

Withdrawals for classification and public interest (D-1)

State selections - patented, tentatively approved, and pending (SS)

Withdrawals for Native villages eligible for land selections

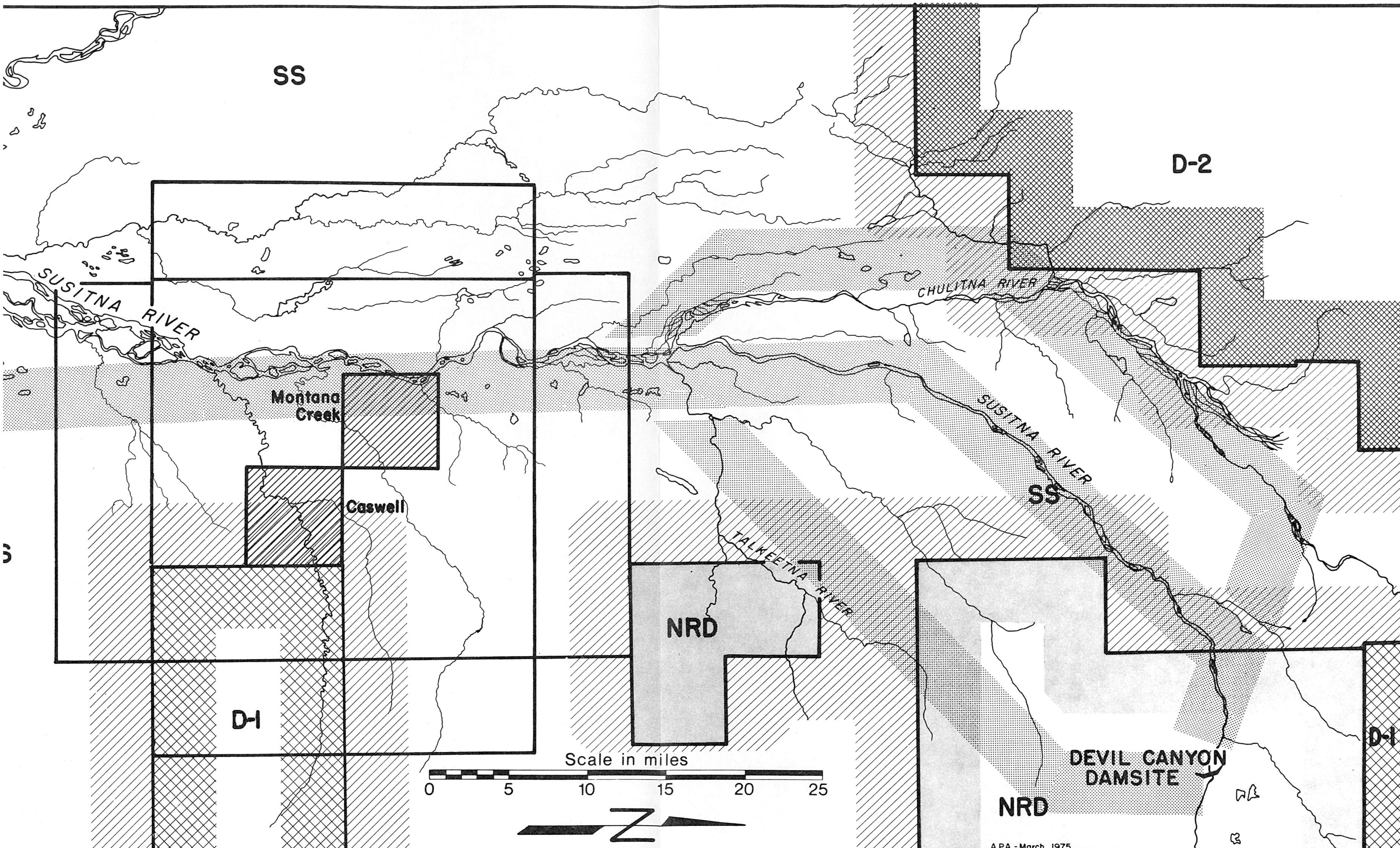
Withdrawals for Native villages, eligibility for land selection not finally determined

Village deficiency withdrawals (NVD)

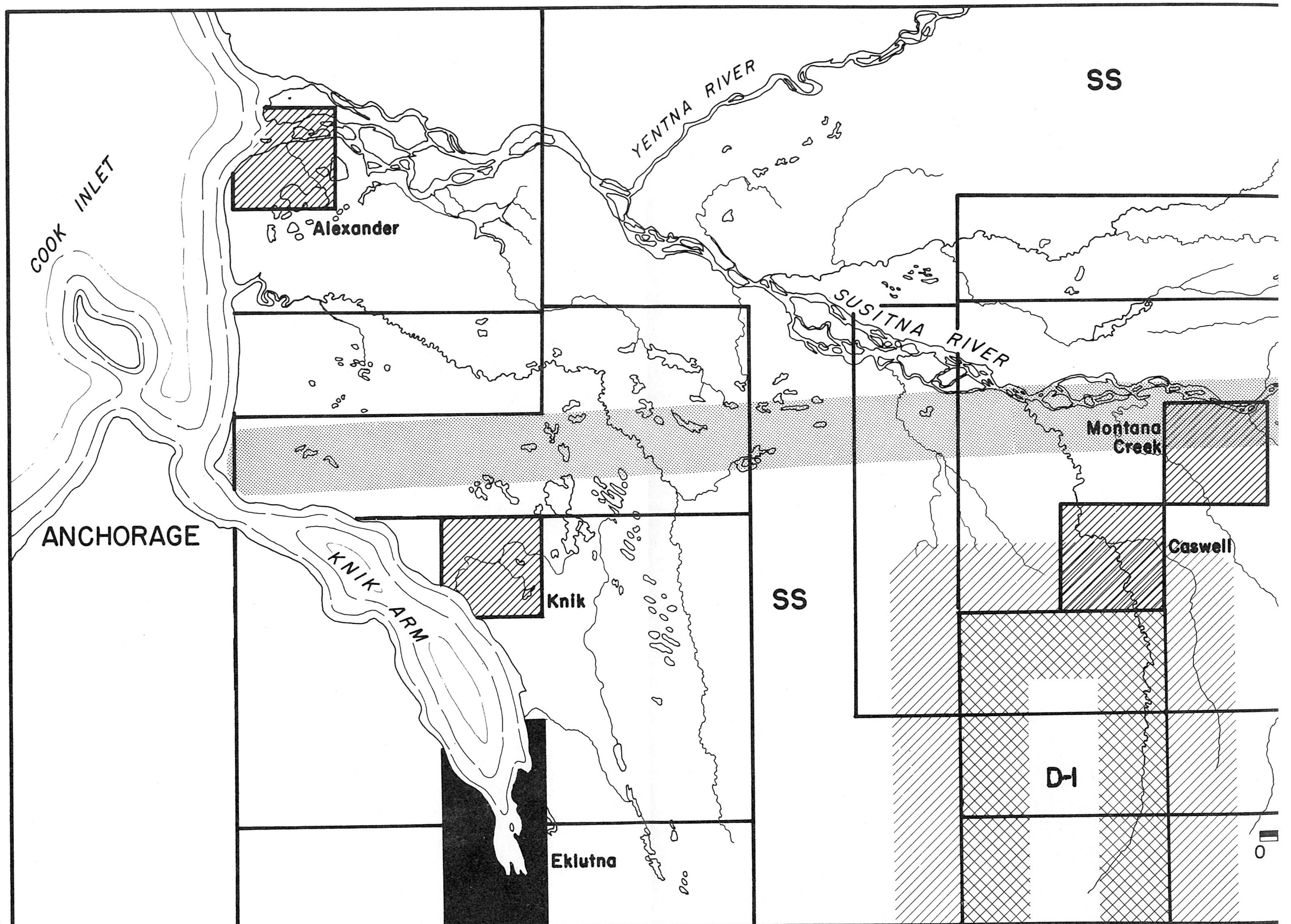
Regional deficiency withdrawals (NRD)

Utility corridor (UC)

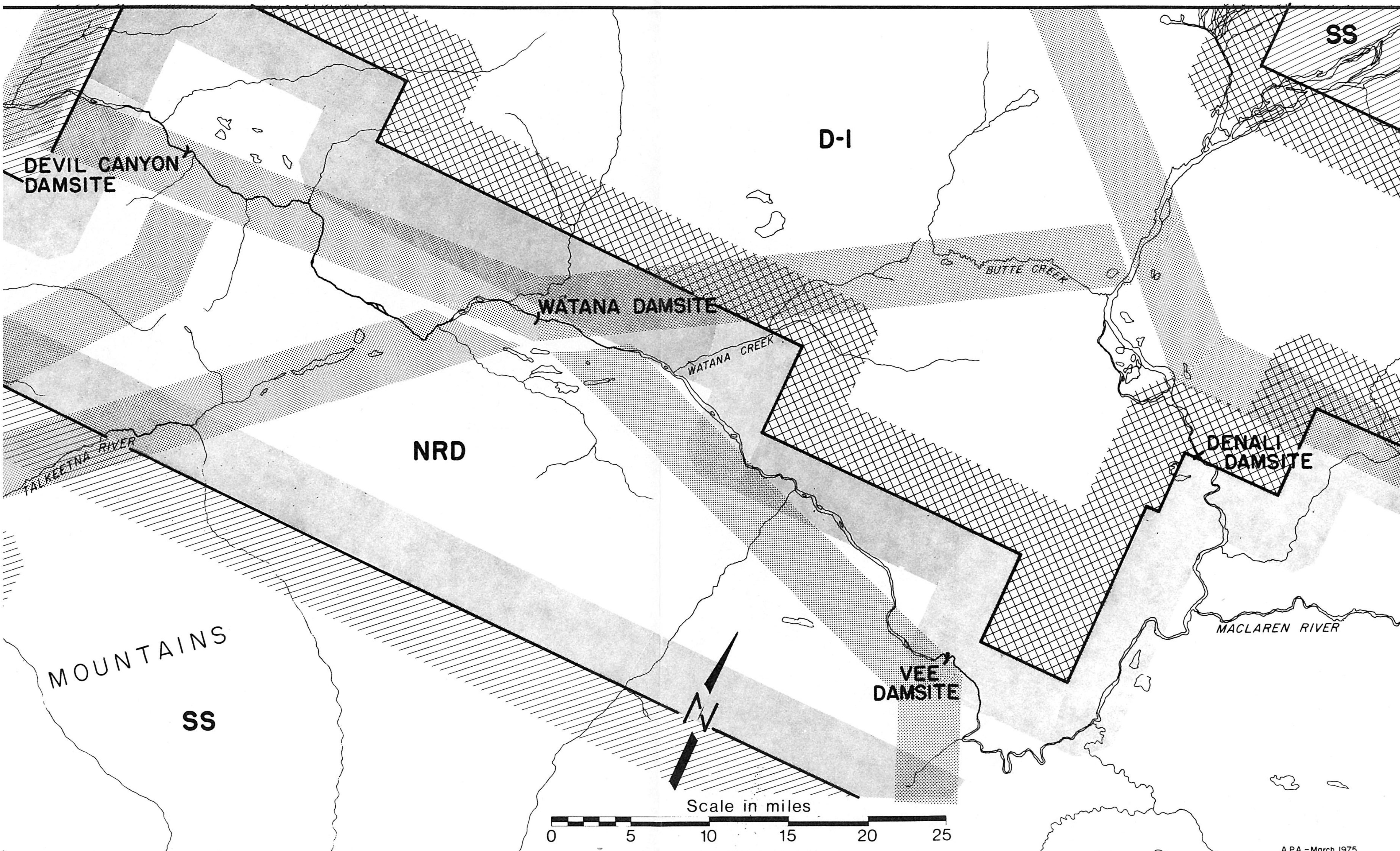
These maps represent the land status situation as determined by the Bureau of Land Management, December 18, 1973



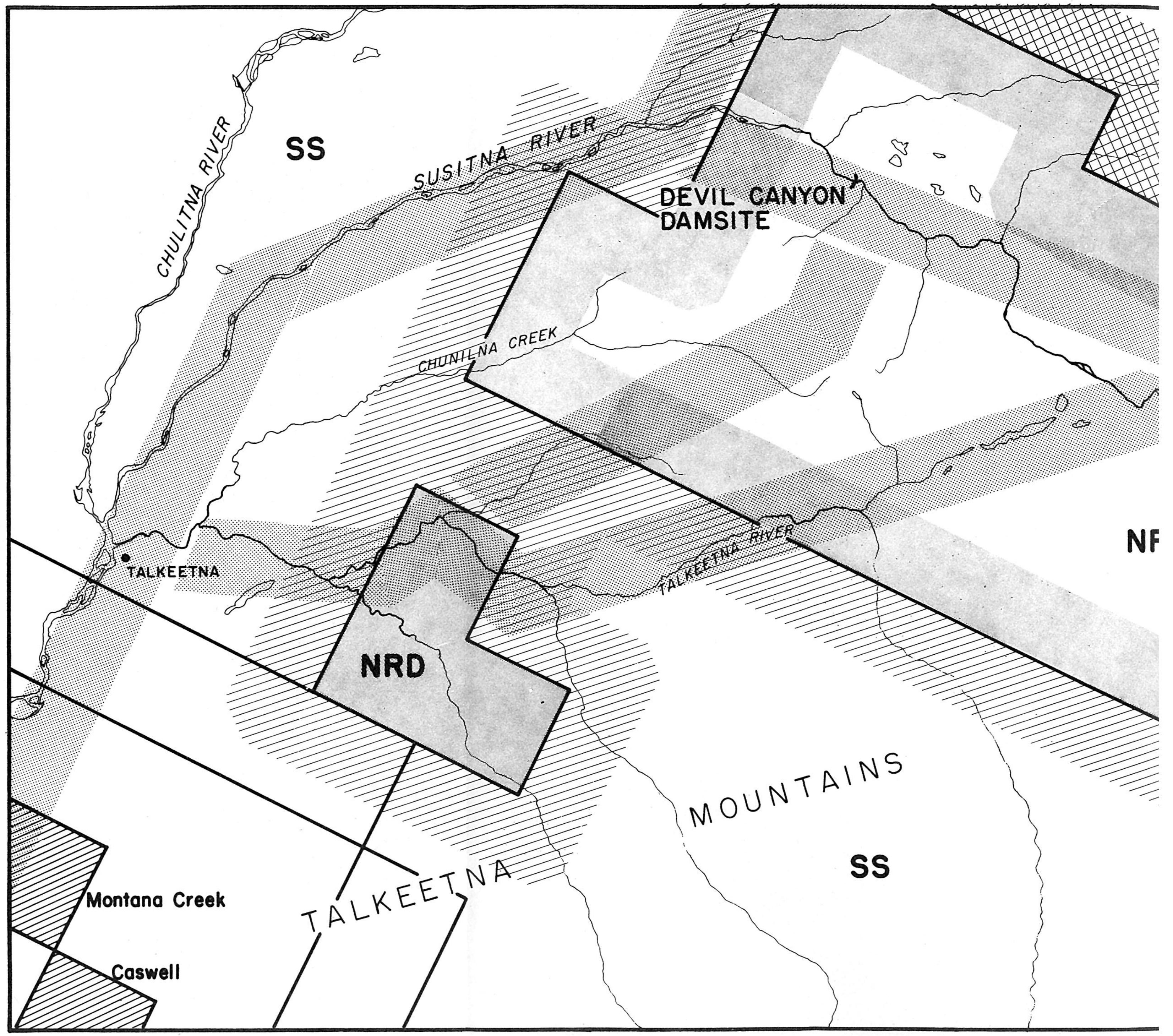
LAND STATUS: ANCHORAGE-DEVIL CANYON

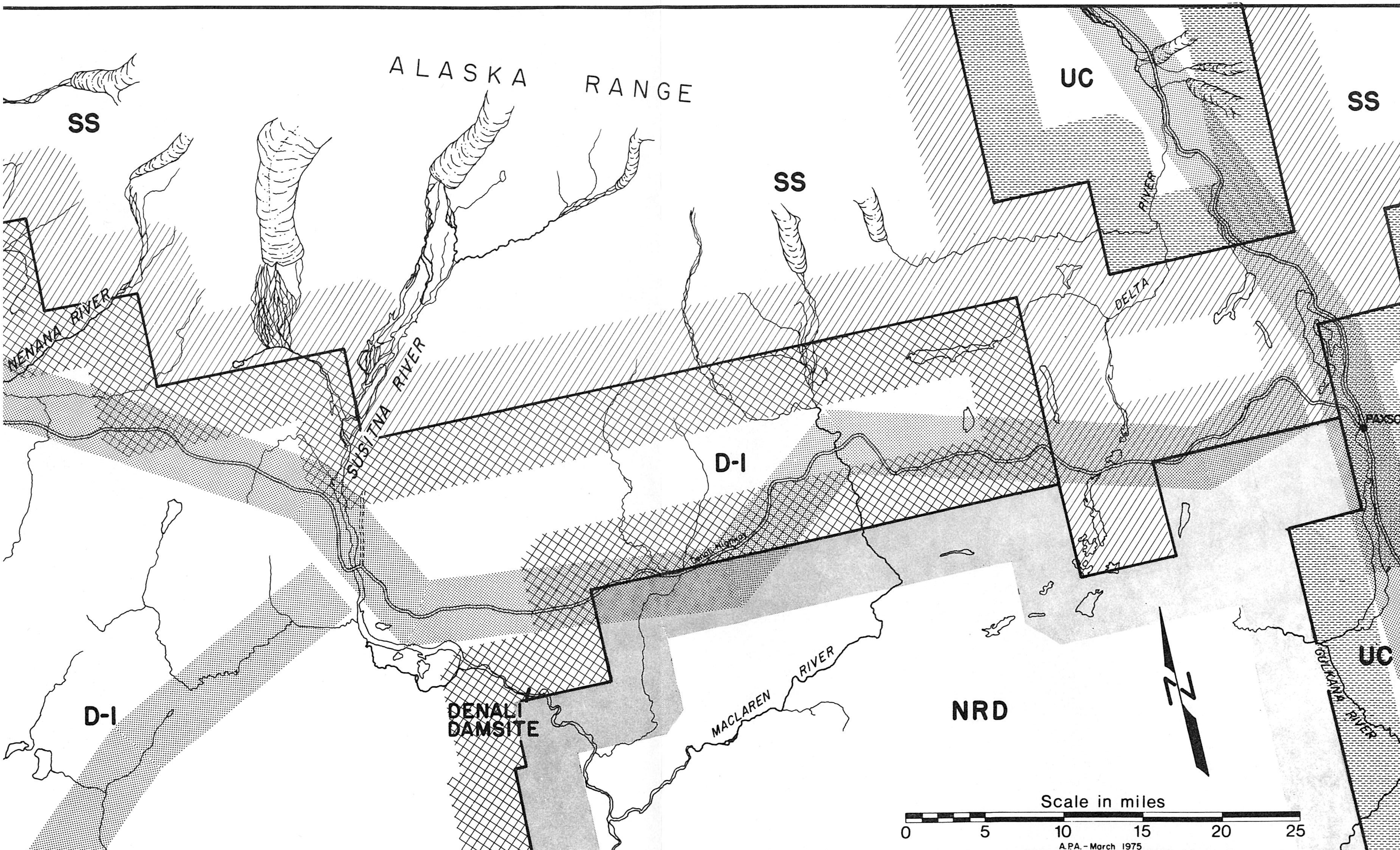

COOK INLET
Alexander
YENTNA RIVER
SS
SUSITNA RIVER
Montana Creek
Caswell
ANCHORAGE
KNIK ARM
Knik
SS
D-1
Eklutna
0

16

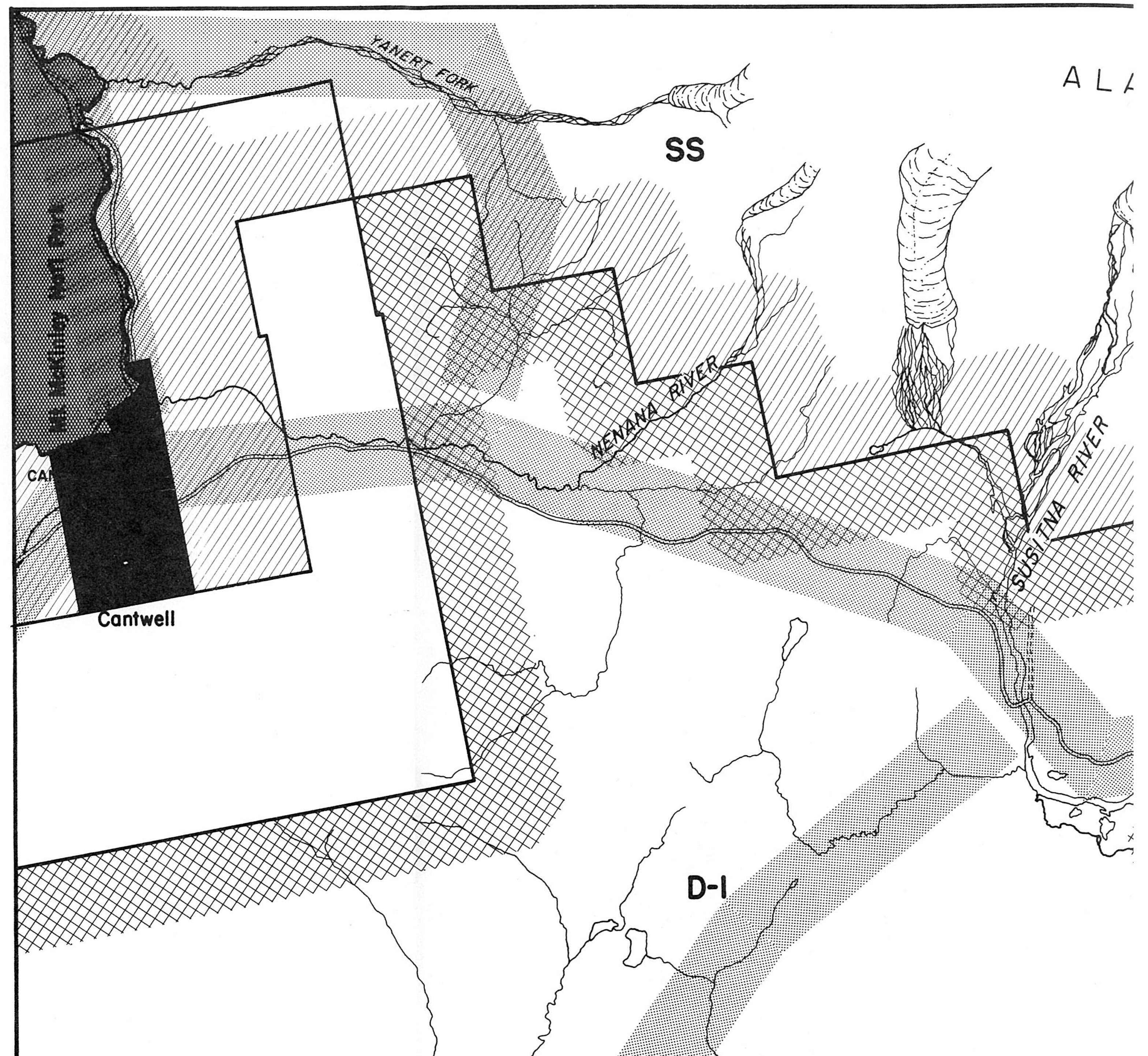


LAND STATUS: SUSITNA


SS
CHULITNA RIVER
SUSITNA RIVER
DEVIL CANYON
DAMSITE
CHUNILNA CREEK
TALKEETNA
TALKEETNA RIVER
NF
NRD
MOUNTAINS
SS
Montana Creek
Caswell
TALKEETNA



LAND STATUS: CANTWELL-PAXSON


YANERT FORK
SS
NENANA RIVER
SUSITNA RIVER
Cantwell
D-I

SUSITNA CORRIDORS

INVENTORY

	CLIMATE	EXISTING DEVELOPMENTS	LAND OWNERSHIP/STATUS	EXISTING RIGHTS-OF-WAY	SCENIC QUALITY/RECREATION
bear, n y.	Transitional - milder and wetter in southern end of segment.	Various small towns along transportation corridor. Several recreation areas and campgrounds along highway.	Primarily State potential selections; indeterminate (as of 3 - 74)Native villages of Montana Creek, Caswell, and Knik.	Anchorage-Fairbanks Highway, Alaska Railroad, MEA lines.	Recreation areas: Big Lake, Rocky Lake (Sucker Lake), Nancy Lake, Willow Creek. Medium to low scenic quality in south. Medium to high around Talkeetna.
, black	Transitional/mountain.	None.	State selected land. Denali State Park.	Parallels Anchorage-Fairbanks Highway in midsection.	Runs through Denali State Park. High scenic quality.
earers.	Transitional.	Towns of Gold Creek, Curry, Lane, Chase, and Sherman. Most are small communities, not all served by Alaska Railroad.	State selected land, borders on Denali State Park.	Parallels A.R.R.	Parallels east boundary of Denali State Park.
bearers.	Transitional.	None.	State selected land.	None.	Medium scenic value, relatively accessible by boat.
and grizzly ige.	Mountain/transitional.	None.	1/3 State selected land, 2/3 Native regional deficiency.	None.	High scenic quality area - relatively inaccessible.
bears.	Mountain/transitional.	None.	1/3 State selected land, 2/3 Native regional deficiency.	None.	Some recreational use of lakes in Prairie Creek Pass area. High scenic quality - accessible by float plane.
	Transitional.	None.	1/2 State selections, 1/2 Native regional deficiency.	None.	High scenic quality - impressive river valley. Limited accessibility.
bear,	Mountain/transitional.	None.	Native regional deficiency, powersite withdrawal for Denali Canyon Reservoir.	None.	High scenic quality - limited accessibility.
bear,	Mountain.	None.	Native regional deficiency, powersite withdrawal for Denali Canyon Reservoir.	None.	Recreational use of Fog Lakes area. High scenic quality - accessible by float plane.

SUSITNA INVENTORY

	TOPOGRAPHY/GEOLOGY	SOILS	VEGETATION	WILDLIFE	CLIMATE
Point MacKenzie - Talkeetna	84 miles. Highest point 500' at Talkeetna to sea level at Pt. McKenzie. Wide river valley; east bank more rolling than extremely flat west bank. Valley widens and flattens to south. Poorly drained, many bogs and lakes.	Glacial debris-ground moraine altered by outwash, flood plains, silt, sand, gravel, swamps and lakes. Free from permafrost. Poorly drained fibrous peat soils, other poorly drained soils and well drained strongly acid soils. Low to medium erosion potential.	Bottomland spruce-poplar, lowland spruce-hardwood, muskeg/bog.	Moose everywhere, black bear, fur bearers. Trumpeter Swan habitat in ponds along Susitna Valley.	Transitional - milder and w in southern end of segment.
Talkeetna - Gold Creek via Troublesome Creek (2)	42 miles. Rolling high plateau to north, becoming flatter, lower, forested hills to south. Merges into Susitna Valley. High point around 2000'.	In northern part, well drained thin soils, strongly acid; deep permafrost table. Southern part poorly drained fibrous peat, other poorly drained soils and well drained strongly acid soils. Slopes on north > 12%. Low to medium erosion potential.	Bottomland spruce-poplar, upland spruce-hardwood, low brush, muskeg/bog. Alpine tundra (?).	Caribou might be present, black bear, moose.	Transitional/mountain.
Talkeetna - Gold Creek via Alaska Railroad (3)	38 miles. High point 900'. Vee Canyon - moderately narrow valley floor widening to the south.	Well drained, gravelly, strongly acid soils. Southern third, poorly drained, fibrous peat and well drained, strongly acid soil. Slopes on north > 12%. Low to medium erosion potential.	Bottomland spruce-poplar, upland spruce-hardwood.	Moose, black bear, fur bearers.	Transitional.
Talkeetna River (4)	8 miles. 500' elevation. Wide, rolling valley bottom. Many lakes.	Poorly drained fibrous peat, vulnerable to heaving and well drained, strongly acid soils. Slopes < 12%. Low to medium erosion potential.	Bottomland spruce-poplar.	Moose, black bear, fur bearers.	Transitional.
Disappointment Creek (5)	37 miles. 3800' elevation. Rolling hills increase in elevation to high plateau with several incised creeks.	Well drained, strongly acid soils thin in northern parts in conjunction with very steep and rocky ground. Gravelly soil. Slopes > 12%. Low erosion potential.	Bottomland spruce-poplar, upland spruce-hardwood, low brush, muskeg/bog and alpine tundra.	Moose in lower elevations and stream bottoms, black and grizzly bear, possible caribou range.	Mountain/transitional.
Prairie Creek - Stephan Lake (6)	42 miles. 2200' elevation. Wide valley narrows gradually as it rises to wide, flat, poorly drained pass.	Well drained, strongly acid, gravelly soils. Slopes > 12%. Low to medium erosion potential.	Bottomland spruce-poplar, upland spruce-hardwood, low brush, muskeg/bog in pass area.	Moose, black and grizzly bears.	Mountain/transitional.
Devil Canyon - Gold Creek (7)	14 miles. 1500' elevation above damsite. Narrow canyon incised in plateau widens as plateau changes to rolling hills to west.	Well drained, strongly acid, gravelly soils. Slopes > 12%. Low to medium erosion potential.	Upland spruce-hardwood.	Moose, black bear.	Transitional.
Devil Canyon - Stephan Lake (8)	13 miles. 2200' elevation. High plateau with deeply incised creeks and rivers.	Well drained, strongly acid, gravelly soils. Slopes > 12%. Low to medium erosion potential.	Upland spruce-hardwood in river and stream valleys, low brush and bog/muskeg on plateaus.	Moose, black and grizzly bear, fur bearers.	Mountain/transitional.
Stephan Lake - Watana (9)	17 miles. 2200' elevation. Flat plateau bounded by hills to north and south, incised river and creeks	Well drained, thin, strongly acid soils with deep permafrost table and poorly drained soils with shallow to deep permafrost table. Gravelly soils. Slopes < 12%. Medium erosion potential.	Upland spruce-hardwood in river and creeks, brush and bog and muskeg on plateau.	Moose, black and grizzly bear, fur bearers, caribou.	Mountain.

NENANA CORRIDORS

INVENTORY

ɴ	WILDLIFE	CLIMATE	EXISTING DEVELOPMENTS	LAND OWNERSHIP/STATUS	EXISTING RIGHTS-OF-WAY	SCENIC QUALITY/RECREATION
›oplar, up- .ow brush -	Moose present, especially in lower valleys, black bear on forested areas.	Mountain/transition. Summit weather: annual temperature 25.9 F., annual precipitation 21.85".	Several small communities along transportation lines. FAA strips at Summit and Cantwell. Southern part borders Denali State Park.	State selected land, Native village withdrawal, area within MMCPM Zone.	Anchorage-Fairbanks Highway, Alaska Railroad.	High scenic quality along most of this route, southern part borders Denali State Park. Major views to west and north of transportation corridor of Alaska Range.
lowland ısh - muskeg	Caribou concentrations, moose in lower valleys and plateaus, Dall sheep in high areas, black bear on forested areas.	Mountain.	None.	D-1 withdrawal, northern part within MMCPM Zone.	None.	Medium scenic quality but inaccessible.
ırdwood.	Caribou concentrations, moose present, Dall sheep in high areas, black bear in forested area.	Mountain.	Denali Highway, some settlement along highway.	Native village withdrawal, State selected land, within MMCPM Zone.	Denali Highway.	High scenic quality, good views to all sides.
d, lowland ne tundra, muskeg.	Caribou concentrations south of canyons, moose present in more open parts of canyons, Dall sheep in high areas, black bear present.	Mountain. High winds reported by GVEA to have knocked down 138 KV towers. McKinley weather: annual temperature 27.7 F., annual precipitation 14.50".	Several small communities. McKinley Park on west bank of Nenana River. Flight strips of Yanert and McKinley Village and Healy (FAA at McKinley).	State selected land and McKinley National Park, within MMCPM Zone.	Anchorage-Fairbanks Highway, Alaska Railroad.	High scenic quality, impressive canyons interspersed with open areas of more distant views. Good possibility of viewing wildlife. High tourist traffic along this major transportation corridor.
, upland ısh-muskeg/ High brush	Caribou concentrations, moose in lower elevations, Dall sheep in high areas, black bear in forested area, grizzly bear in higher areas.	Mountain.	None.	D-1 and State selected land, Wells Creek within MMCPM Zone.	None.	High scenic quality but inaccessible.
l, upland ush - muscalpine wer Moody	Caribou concentrations, moose in lower elevations, Dall sheep in high areas, black bear in forested areas, grizzly bear in higher areas.	Mountain.	None in mountains; Usibelli Coal Mines at Healy.	State selected land.	None.	Medium scenic quality but inaccessible.
ır, upland ıd spruce-muskeg/bog, gs, north ice-hard- upland	Caribou concentrations on west bank of Nenana between Healy and south of Clear AFB, moose along whole route, black bear in forested areas. Trumpeter Swan habitat along ponds of Tanana Valley.	Interior. Healy weather: annual temperature 26.4°F., annual precipitation 11.34"	Small communities along transportation lines. Several flight strips. FAA station at Nenana. Town of Nenana, Clear Military Reservation.	Primarily State-selected land with some existing Federal withdrawals and Native village withdrawals.	Anchorage-Fairbanks Highway, Alaska Railroad, GVEA 138 kv. line.	High scenic quality near Healy and the Goldstream Hills. Low to medium scenic quality along lower Nenana River. Dry Creek Archeological Site (National Register).
sh, low oist tundra, , lower ıterspersed ıds with ə patterns.	Caribou concentrations in upper Wood River, moose present in lower elevations and stream bottoms, Dall sheep on high areas of upper Wood River, black and grizzly bear present. Trumpeter Swan habitat along ponds of Tanana Valley.	Mountain and interior.	Blair Lake Military Reservation.	Primarily State selected land. Native village deficiency and existing Federal withdrawals.	None.	Scenic quality ranges from high to medium but inaccessible.

NENANA INVENTORY

	TOPOGRAPHY/GEOLOGY	SOILS	VEGETATION	WILDLIFE	CLIMATE
Gold Creek - Cantwell (10)	48 miles. 2400' elevation. Wide valley with moderately incised rivers in south, becoming very wide depression in Broad Pass, traveling NE, with rolling valley bottom.	Well drained, thin, strongly acid soils, deep permafrost table and poorly drained with surface peat and shallow permafrost table. Both soils gravelly with medium erosion potential. Slopes < 12%.	Bottomland spruce and poplar, upland spruce-hardwood, low brush - bog/muskeg.	Moose present, especially in lower valleys, black bear on forested areas.	Mountain/transition. Summit er: annual temperature 25.9 annual precipitation 21.85".
Watana - Wells Creek via Brushkana Creek (11)	46 miles. 3300' at Deadman Pass. Series of moderately wide valleys joined by gentle passes, culminating on wide valley of Brushkana Creek and Nenana River.	On slopes > 12%: Well drained thin strongly acid soils with deep permafrost table, gravelly. On slopes < 12%: Poorly drained loamy soils with surface peat and shallow permafrost table. Medium erosion potential.	Upland spruce-hardwood, lowland spruce-hardwood, low brush - muskeg bog. Alpine tundra.	Caribou concentrations, moose in lower valleys and plateaus, Dall sheep in high areas, black bear on forested areas.	Mountain.
Wells Creek - Cantwell (12)	22 miles. 2500' elevation. Valley at Wells Creek widens to west, with flat bottom bound by mountains to north and south.	Well drained, thin, strongly acid soils with deep permafrost table in conjunction with poorly drained soils with surface peat and shallow permafrost table. Medium erosion potential. Gravelly soils. Slopes < 12%.	Lowland spruce-hardwood.	Caribou concentrations, moose present, Dall sheep in high areas, black bear in forested area.	Mountain.
Cantwell - Healy (13)	39 miles. 2200' at Cantwell. Wide valley narrows to north to series of tight canyons separated by wide valley of Yanert Fork. North of canyon to Healy is wide rolling plain with stream terraces adjacent to Nenana. Denali fault crosses at Windy.	Well drained nonacid brown gravel soils in conjunction with poorly drained loamy soil with surface peat and shallow permafrost table. High erosion potential. Thin rocky soils and rock on lower canyon.	Upland spruce-hardwood, lowland spruce-hardwood, alpine tundra, some low brush - bog/muskeg.	Caribou concentrations south of canyons, moose present in more open parts of canyons, Dall sheep in high areas, black bear present.	Mountain. High winds report[...] GVEA to have knocked down 13[...] towers. McKinley weather: [...] temperature 27.7 F., annual [...]itation 14.50".
Wells Creek - Dean Creek (14)	26 miles. 4,000' at Wells Pass. Wide valley narrowing to the north to pass with Louis Creek, a high saddle. Abrupt drop into Louis Creek, down to Yanert Fork and extremely wide aggrading channel.	Thin soils and rock, very steep slopes. Level areas poorly drained.	Lowland spruce-hardwood, upland spruce-hardwood, low brush-muskeg/bog, and alpine tundra. High brush in Yanert Valley.	Caribou concentrations, moose in lower elevations, Dall sheep in high areas, black bear in forested area, grizzly bear in higher areas.	Mountain.
Dean Creek - Healy (15)	24 miles. 2700' at Moody Pass. North up wide valley and over wide flat pass into sinuous v-canyon, dropping into wider valley of Healy Creek.	Thin rocky soils and rock, steep slopes on upper parts. Steep gravelly poorly drained soils with variable permafrost table in conjunction with steep gravelly well drained gray soils, shallow bedrock. Moderate erosion potential.	Lowland spruce-hardwood, upland spruce-hardwood, low brush - muskeg/bog (in pass area), alpine tundra (ridges along lower Moody Creek).	Caribou concentrations, moose in lower elevations, Dall sheep in high areas, black bear in forested areas, grizzly bear in higher areas.	Mountain.
Healy to Ester (16)	97 miles. 1400' at Healy. 350' at Nenana, 1500' in Goldstream Hills. Wide, terraced valley of Nenana flows north to merge with Tanana flood plain. Over Tanana River trending N.E. are low rolling hills Active fault at Healy. Ice-rich clay and silt at Moody.	Healy-Nenana: Well-drained brown gravel soils and poorly drained loams with surface peat, shallow permafrost table. Nenana-Ester: well-drained brown loams with lenses of fines and poorly drained loams with surface peat, shallow permafrost table. Medium to high erosion potential.	Bottomland spruce-poplar, upland spruce-hardwood, lowland spruce-hardwood, low brush - muskeg/bog, level areas tend to bogs, north slopes are lowland spruce-hardwood, sunny slopes are upland spruce-hardwood.	Caribou concentrations on west bank of Nenana between Healy and south of Clear AFB, moose along whole route, black bear in forested areas. Trumpeter Swan habitat along ponds of Tanana Valley.	Interior. Healy weather: temperature 26.4°F., annual cipitation 11.34"
Dean Creek to Ester (Wood River) (17)	110 miles. 4300' at Dean-Wood Pass Dean Creek, sharp mountain valley heads in high pass into Wood River, a u-shaped glacier valley with aggrading stream, which eventually debouches onto Tanana flood plain, flat and poorly drained.	Upper Wood River: Thin rocky soils Lower Wood River: Poorly drained loamy soils with surface peat and shallow permafrost table. Gentle slopes. Some well drained brown nonacid soils. Low to medium erosion potential.	Alpine tundra, high brush, low brush bog and muskeg, moist tundra, lowland spruce-hardwood, lower Wood River is area of interspersed bogs and levees and mounds with corresponding vegetative patterns.	Caribou concentrations in upper Wood River, moose present in lower elevations and stream bottoms, Dall sheep on high areas of upper Wood River, black and grizzly bear present. Trumpeter Swan habitat along ponds of Tanana Valley.	Mountain and interio[r]

DELTA AND MATANUSKA CORRIDORS

INVENTORY

	WILDLIFE	CLIMATE	EXISTING DEVELOPMENTS	LAND OWNERSHIP/STATUS	EXISTING RIGHTS-OF-WAY	SCENIC QUALITY/RECREATION
l; upland rush bog l.	Nelchina caribou herd (presently about 4000-5000), moose present in moderately high numbers, black and grizzly bears, wolves present.	Mountain.	None. Low to no potential for commercial foresting and agriculture due to soils.	State selections, Native regional deficiency withdrawals, and D-1 withdrawals. Denail Damsite withdrawal. Area around Denali Damsite is within MMcPMZ.	Denali Highway.	Tangle Lakes Archeological District (National Register). Denali Campground. Tangle River Boat Launch. High scenic quality - easily accessible with good views to north of Mt. Hayes section of Alaska Range, Clearwater and Amphitheater Mountains.
ve types -poplar	Trumpeter Swan habitat along ponds of Tanana Valley. Big Delta bison herd fall range (200 animals), Dall sheep common on Alaska Range, black and grizzly bears, good duck habitat in sloughs and oxbows of Chena and Salcha Rivers and morainal ponds of Donnelly Dome. Peregrine falcon habitat, particularly near Salcha R.	Interior.	Considerable settlement along highway near Fairbanks. Military bases, towns of Big Delta and Delta Junction, potential agriculture at Big Delta-Clearwater Lake.	State selections, utility corridors and military reservations.	Richardson Highway, Alyeska Pipeline.	Proposed Historical Sites: Rapids Hunting Lodge, Mile 220; Big Delta Roadhouse, Mile 252. Clearwater, Donnelly, Fielding Lake, Wayside Parks. Delta Campground, proposed Delta Wild River. Excellent views of Alaska Range from Big Delta south. Easily accessible.
ood; low g; moist	Nelchina caribou herd, moose in moderately high numbers, black and grizzly bears, wolves present.	Mountain/interior.	None. Low to no potential for commercial forestry or agriculture due to soils.	Native regional deficiency and state selections. Watana and Vee powersite withdrawals.	None.	To east is Lake Louise recreational land complex. High scenic quality - land of lakes and ponds. Accessible by dirt road from Glenn Highway to Lake Louise or by float plane.
low brush	Nelchina caribou and very high moose concentrations on Gulkana drainage, black and grizzly bears, wolves present, good duck habitat along Gulkana from Summit and Paxson Lakes, Thaw Lakes. Gulkana is most important fishery in Copper River system. Paxson and Summit Lakes are important fish lakes.	Interior.	Towns of Glennallen, Gulkana, settlement along highway. Recreational development north of Glenn Highway. This area has low potential for commercial forestry and agriculture due to soils.	State selections and Utility Corridor. Native village withdrawals of Gulkana, Gakona, Tazlina and Copper Center.	Richardson Highway, Alyeska Pipeline, Glenn Highway.	Sourdough Lodge (National Register) Proposed historical sites of McCreary's Roadhouse, Mile 104; Gakona Roadhouse, Mile 132; Paxson Lake Wayside Park; Sourdough Campground, Dry Creek Wayside, Little Nelchina, Tolsona and Lake Louise Waysides. Proposed Paxson Lake Recreation Area and Gulkana Wild River. High to medium scenic quality.
low brush pruce- uce-poplar	Moose present, black and grizzly bear, Dall sheep on surrounding mountains.	Transition/mountain.	Considerable development in Matanuska Valley. Coal deposits near Sutton. Farming in lower valley, recreation use along Knik Arm.	State selections primarily. Some Native regional deficiency and D-1 lands. Native village withdrawals of Chickaloon, Eklutna and Knik.	Glenn Highway, Alaska Railroad, various minor roads.	Knik Archeological Site - Independence Mines near Palmer (National Register). Big Lake/Rocky Lake Waysides. Chugach State Park to south. Matanuska Valley is high scenic quality area. Several scenic overlooks along highway. Highly vivid landscape.

	TOPOGRAPHY/GEOLOGY	SOILS	VEGETATION	WILDLIFE	CLIMATE
Watana to Paxson via Butte Creek (18)	98 miles. 4000' near Rock Creek. Varies from wide, flat, open terrain to rolling, post-glacial terrain. Valley floors are usually wide and flat, poorly drained. Many lakes, kettles, and morainal ridges east to Maclaren River. This upland area contains altiplanation terraces and is underlain with discontinuous permafrost.	Low areas: poorly drained soils with surface peat and shallow permafrost table. Textures range from gravelly to fine. Slopes: Well-drained, thin, strongly acid soils; deep permafrost table. Medium to high erosion potential.	Lowland spruce-hardwood; upland spruce-hardwood, low brush bog and muskeg moist tundra.	Nelchina caribou herd (presently about 4000-5000), moose present in moderately high numbers, black and grizzly bears, wolves present.	Mountain.
Paxson to Fairbanks (19)	152 miles. 2700' at Paxson, 3000' at Isabel Pass. Rolling hills at Paxson lead to high flat pass and north to U-shape Mountain Valley near Rainbow Ridge-Black Rapids area. Rolling hills near Donnelly Dome decrease to flat land by Eielson AFB.	Low areas: Poorly drained soils with surface peat and shallow permafrost table. Slopes: Well drained soils; some containing lenses of fines. Shallow to deep permafrost table, if any. Medium erosion potential. Rocky soil and bedrock in Delta Canyon area. Thixotropic silts just north of Summit Lake. Permafrost continuous from Shaw Creek to Tanana River.	Full range of vegetative types from bottomland spruce-poplar to alpine tundra.	Trumpeter Swan habitat along ponds of Tanana Valley. Big Delta bison herd fall range (200 animals), Dall sheep common on Alaska Range, black and grizzly bears, good duck habitat in sloughs and oxbows of Chena and Salcha Rivers and morainal ponds of Donnelly Dome. Peregrine falcon habitat, particularly near Salcha R.	Interior.
Watana to Slide Mtn. via Vee (20)	90 miles. 3000' elevation at plateau at head of Little Nelchina River. Generally flat and rolling terrain; a high plateau extending from Susitna River to Lake Louise area. Numeros lakes and bogs.	Low areas: Poorly drained soils with peaty surface; shallow permafrost table. Medium erosion potential. Uplands: Well drained thin soils with dark acid surface; deep permafrost table. Gravelly texture. Medium erosion potential. Permafrost is continuous on this poorly drained, ice-rich area of fine sediments.	Upland spruce-hardwood; low brush bog and muskeg; moist tundra.	Nelchina caribou herd, moose in moderately high numbers, black and grizzly bears, wolves present.	Mountain/interior.
Paxson to Slide Mtn. via Giennallen (21)	119 miles. 2700' at Paxson. Rolling hills and flat plateaus, cut by incised streams. Poorly drained, having many lakes and bogs.	Major portion of route: Poorly drained, fine grain soils with surface peat; shallow permafrost table. Medium erosion potential. Upland areas: Well drained, thin, strongly acid soils with deep permafrost table. Permafrost is continuous in this area.	Lowland spruce-hardwood, low brush bog and muskeg.	Nelchina caribou and very high moose concentrations on Gulkana drainage, black and grizzly bears, wolves present, good duck habitat along Gulkana from Summit and Paxson Lakes, Thaw Lakes. Gulkana is most important fishery in Copper River system. Paxson and Summit Lakes are important fish lakes.	Interior.
Slide Mts. to Point MacKenzie (22)	138 miles. 3000' at Tahneta Pass. Wide pass approached from east becomes narrow valley to west of pass. Incised river and low ridges occupy valley bounded by major mountain ranges on north and south. Valley debouches onto Matanuska-Knik flood plain, to Pt. McKenzie, route crosses many lakes on flat flood plains and poorly drained uplands.	Matanuska Valley: Well drained loamy or gravelly gray soils and strongly acid soils. Medium to high erosion potential. Knik Arm: Poorly drained fibrous peat, vulnerable to frost heaving, and well drained acid soils. Low to medium erosion potential.	Lowland spruce-hardwood, low brush bog and muskeg; upland spruce-hardwood; Bottomland spruce-poplar agricultural land.	Moose present, black and grizzly bear, Dall sheep on surrounding mountains.	Transition/mountain.

SUSITNA CORRIDORS

IMPACTS

SOILS	VEGETATION	WILDLIFE	EXISTING DEVELOPMENTS	SCENIC QUALITY/RECREATION
›il vulnerable to frost heaving but ·rosion potential. Upland soils are ›ptible to erosion. Thermal dis- unlikely. No major river crossings ated on this route.	Considerable clearing is needed. Upland vegetation will warrant maintenance; poorly drained areas will probably need little maintenance. Slash must be disposed of to inhibit infestation of remaining trees with spruce beetle or ips beetle. Vegetation has high resistance to fire control.	Destruction of habitat for small animals. Enhancement of habitat for larger mammals due to increased successional growth. Harrassment unlikely due to good cover throughout area. From Nancy Lake to Pt. McKenzie, access will be improved if access road left in; increased hunting pressure may result.	Some possible conflicts with private lands from Nancy Lake to Talkeetna. No impact on foreseeable agriculture - most soils are unsuitable for agriculture.	Little impact on scenic quality from Nancy to Pt. McKenzie since line can be concealed. Possible conflict with recreation areas in Wasilla-Big Lake area and Nancy Lake area, depending upon final location. No conflict with Knik archeological site. Talkeetna to Nancy: line can be almost totally concealed or laid parallel and adjacent to existing line clearings.
problems inherent to soils around Frost heaving, possible permafrost, ge, slow revegetation. Upland ell drained, but erosion potential Possible river crossing needed for Creek, three needed for Susitna na Rivers. Access road crossing on Creek may cause siltation.	Lower elevation forest will need considerable clearing; regrowth rate fast enough to warrant maintenance. Upland areas will require less clearing and maintenance. Except for area above timberline, vegetation has a high rate of spread of fire and a high resistance to control.	Route opens up an inaccessible area within Denali State Park; closed to hunting.	None	High impact on scenic quality - invades Denali State Park. Line can be concealed somewhat, but will undoubtedly interfere with potential trail users.
River only major river crossing; iere is not a problem as river carries lt already.	Tree clearing needed along entire segment; maintenance will be needed. Vegetation has high rate of spread and high resistance to control. Brush will be introduced by regrowth.	No extensive inaccessible areas opened up line parallels A.R.R.; access road would allow vehicles to reach this area independently from the A.R.R., so hunting pressure may increase. If the A.R.R. right-of-way is adjourned or shared, impacts will be very low.	If line adjoins Alaska Railroad, railroad could be electrified and corridor consolidated. Increased access to an area presently having only a few flag stops on Alaska Railroad.	Medium impact on scenic quality. Most traffic through this stretch is by A.R.R., and line can be well hidden from passengers using rail lines unless corridor is consolidated.
·ained soils susceptible to frost ınd poor foundations; well drained ;lopes less apt to cause problems. edium erosion potential. Little d of serious permafrost degradation.	Expensive clearing of heavy forest needed with maintenance. Brush will be introduced by regrowth. Vegetation has high rate of fire spread and high resistance to control.	Pioneer route will open up new areas to access. Hunting pressure will increase. Brush introduction in this area will enhance habitats for moose, bear.	None	Low impact on scenic quality. Line is not visible. Wilderness quality somewhat impacted, but ease of concealment keeps impact low.
degradation of local permafrost. Few ›le impacts from erosion, siltation, or st degradation.	Clearing and maintenance need in lower elevations. Most of route is highland spruce-hardwood and alpine tundra. Preservation of ground vegetation essential - disruption can result in longlived scars due to slow regrowth rate. Upper elevations have high rate of fire spread, low resistance to control.	Pioneer route will open up considerable new areas to access. Most of this area is open forest toalpine tundra - damage to habitat could be severe (from fires, erosion, ORV's).	None	Line will cross open alpine tundra for quite a distance, having high impact on wilderness quality.
›eable impacts from erosion, siltation ·rost degradation.	Heavy forest clearing needed on Talkeetna River valley with introduction of brush requiring maintenance. Less clearing required and more care for vegetative mat needed in Prairie Creek valley to Stephen Lake. High to medium rate of fire spread, high to medium resistance to control.	Pioneer route will open up considerable new areas to access. Impact will be less on upper areas due to less disruption of vegetation by clearing. Area is presently accessible by float plane and received considerable hunting pressure already.	Private land and/or cabin leases on lake shores in the pass areas. Most of these can be avoided. Otherwise, no impacts on existing developments.	Where line emerges from Talkeetna River valley to Stephen Lake, scenic quality receives medium impact; lakes received some recreational use. Impact on wilderness is medium due to the existing recreational use and easy accessibility by float plane.
eeable impacts from erosion, siltation rost degradation.	Clearing of medium forest with periodic maintenance. High rate of fire spread, medium resistance to control.	Moose and bear habitat enhanced by regrowth on clearings. Access road may result in increased hunting pressure.	Old jeep road exists, connecting Devil Canyon Damsite to Alaska Railroad. Mining claims, no longer operating, on Portage Creek. These roads could be part of the access road system.	Low impact on scenic quality - this area is not presently easily accessible, and Devil Canyon Damsite road will not be used much by non-project personnel; line can be concealed from this road or can be used as the line access road also.
eeable impacts from erosion, siltation rost degradation.	Clearing of medium forest in river valley; less clearing needed on plateau. Fire rate of spread in valley high, resistance to control medium. On plateau, rate of fire spread low, resistance to control high.	Little impact on habitat of large mammals such as moose and bear, minimal clearing on plateau areas and creek canyons can be spanned. Access road would be under control from damsite so unauthorized use for hunting would be low.	None	Low impact on scenic quality - area is of medium scenic quality. Some recreational use in Stephen Lake area. Line can be partially concealed but not totally.
on impacts but possible permafrost ›n and frost heaving in poorly ›ils.	Heavier vegetation in creek bottoms can be spanned over by line. Vegetation on plateau does not require extensive cleaning. Rate of fire spread low, resistance to control high.	Little impact on habitat of moose and bear, minimal clearing on plateau areas and spanning of creek canyons. Access would be under control of damsites so unauthorized use for hunting would be low.	None	Medium impact on scenic quality - area is of medium scenic quality. Some recreational use of Stephen Lake area. Line can be partially concealed but not totally.

SUSITNA IMPACTS

	SOILS	VEGETATION
Point MacKenzie - Talkeetna	Lowland soil vulnerable to frost heaving but with low erosion potential. Upland soils are more susceptible to erosion. Thermal disruption is unlikely. No major river crossings are anticipated on this route.	Considerable clearing is needed. Uplar tation will warrant maintenance; poorly areas will probably need little maintena Slash must be disposed of to inhibit infe of remaining trees with spruce beetle or beetle. Vegetation has high resistance control.
Talkeetna - Gold Creek via Troublesome Creek (2)	Some design problems inherent to soils around Talkeetna: Frost heaving, possible permafrost, poor drainage, slow revegetation. Upland soils are well drained, but erosion potential is higher. Possible river crossing needed for Troublesome Creek, three needed for Susitna and Talkeetna Rivers. Access road crossing on Troublesome Creek may cause siltation.	Lower elevation forest will need consi clearing; regrowth rate fast enough to maintenance. Upland areas will requir clearing and maintenance. Except for above timberline, vegetation has a hig of spread of fire and a high resistanc control.
Talkeetna - Gold Creek via Alaska Railroad (3)	Talkeetna River only major river crossing; siltation here is not a problem as river carries glacial silt already.	Tree clearing needed along entire seg maintenance will be needed. Vegetati high rate of spread and high resistar control. Brush will be introduced by growth.
Talkeetna River (4)	Poorly drained soils susceptible to frost heaving and poor foundations; well drained soils on slopes less apt to cause problems. Low to medium erosion potential. Little likelihood of serious permafrost degradation.	Expensive clearing of heavy forest n with maintenance. Brush will be int by regrowth. Vegetation has high ra fire spread and high resistance to c
Disappointment Creek (5)	Possible degradation of local permafrost. Few foreseeable impacts from erosion, siltation, or permafrost degradation.	Clearing and maintenance need in lower tions. Most of route is highland spru hardwood and alpine tundra. Preservat ground vegetation essential - disrupti result in longlived scars due to slow rate. Upper elevations have high rate spread, low resistance to control.
Prairie Creek - Stephan Lake (6)	Few foreseeable impacts from erosion, siltation or permafrost degradation.	Heavy forest clearing needed on Talkee River valley with introduction of brush ing maintenance. Less clearing requir more care for vegetative mat needed in Creek valley to Stephen Lake. High to rate of fire spread, high to medium res to control.
Devil Canyon - Gold Creek (7)	Few foreseeable impacts from erosion, siltation or permafrost degradation.	Clearing of medium forest with periodi tenance. High rate of fire spread, me sistance to control.
Devil Canyon - Stephan Lake (8)	Few foreseeable impacts from erosion, siltation or permafrost degradation.	Clearing of medium forest in river vall less clearing needed on plateau. Fire of spread in valley high, resistance to medium. On plateau, rate of fire sprea resistance to control high.
Stephan Lake - Watana (9)	Few erosion impacts but possible permafrost degradation and frost heaving in poorly drained soils.	Heavier vegetation in creek bottoms ca spanned over by line. Vegetation on p does not require extensive cleaning. fire spread low, resistance to control

NENANA CORRIDORS

IMPACTS

SOILS	VEGETATION	WILDLIFE	EXISTING DEVELOPMENTS	SCENIC QUALITY/RECREATION
pact is low. Shallow permafrost in ined areas susceptible to degrada- the access road can avoid these impact will be low.	Successively less clearing as segment goes north. In Broad Pass, no trees need clearing and the only vegetation lost would be from access road. Slow regrowth implies that maintenance will not be needed and also that revegetation may be necessary along some areas. Medium to high rate of fire spread; high resistance to control.	Some enhancement of bear and moose habitat in southern part of segment; no change in northern part. This route opens up no major new areas to hunting; overall impact is low.	Few private holdings - small chance of conflict. Low impact - very few existing developments.	Entire segment within Mt. McKinley Cooperative Planning and Management Zone. Southern part borders Denali State Park. Visible line will have high impact, particularly if to west of highway and railroad. Line can be concealed somewhat, however, in most of segment. Broad Pass has least cover for line.
ined loam: impact on permafrost in s high, and frost heaving is poss- nd soils: impact is low on perma- ium on erosion.	Clearing varies from dense spruce-hardwoods to alpine tundra. Most vegetation loss will be from access road. Slow regrowth implies that maintenance will not be needed and that in places revegetation may be necessary. Medium to high rate of fire spread; high resistance to control; low resistance in alpine tundra.	Some enhancement of bear and moose habitat in heavier forested areas, but no significant change. Access road opens up a previously inaccessible area to intrusion and hunting; since caribou and moose are present, this could have a significant impact on hunting preserve. Firing on tundra areas could severely impact caribou habitat.	None	Low impact on scenic quality; this area is of medium scenic quality and not readily accessible. However, there is a high impact on wilderness, especially if an access road is built.
act is low level. Shallow permafrost ained areas susceptible to degrada- he access road can avoid these mpact will be low.	Clearing varies from spruce-hardwoods to high brush. Most vegetative loss from access roads. Slow regrowth implies that maintenance will not be needed. Medium to high rate of fire spread; high resistance to control.	Some enhancement of bear and moose habitat in heavier forested areas, but little significant change. No new areas opened up. Overall impact is low.	Apart from settlements along Denali Highway, no developments - no impacts.	Medium impact on scenic quality; area is of high scenic quality, but line can be concealed. Entire segment within MMPCPM Zone.
n potential throughout stretch. drock in canyons will provide solid lations but will inhibit access road n if needed on canyon slopes. ned areas have high permafrost susceptibility. Low siltation impact.	Heavy clearing in valley bottom by Yanert Fork; lighter clearing throughout rest of route. High rate of fire spread, high resistance to control on valley floor; low resistance in alpine tundra.	Some habitat destruction and enhancement due to clearing; overall impact of clearing is low. No new areas opened up to hunting. Construction activities combined with transportation use of corridor may temporarily repulse some mammals such as wolf and bear.	The addition of a third right-of-way through the canyons may cause congestion unless rights-of-way are consolidated. Possible connection to GVEA line at Healy. Potential tap to provide connection of Cantwell into system.	Severe impact on scenic quality; not only is the canyon an area of high scenic quality, concealment of the line is hard and the west bank of the Nenana is park land.
potential and exposed bedrock on e areas of poorly drained soil sus- ermafrost degradation in wider val- River too deep for fording and is ormally, so siltation will have low	Heavy clearing on valley bottoms to no clearing in alpine tundra. Slow regrowth in higher elevations. High rate of fire spread; high resistance to control at lower elevations; low resistance to control in alpine tundra.	Construction activities may inhibit caribou and sheep activities. Overall habitat modification low, especially if winter roads and/or helicopter construction is used. Fire can seriously impact sleep and caribou habitat. Large new area opened by access road will increase hunting pressure.	None	High impact to wilderness quality, but limited to the immediate valley occupied by line; nature of terrain will adequately conceal line unless it is run on ridges (unlikely in this segment).
n potential on slopes; high suscepti- mafrost degradation on poorly ley floors. Towards Healy, well s are subject to medium erosion d low susceptibility to permafrost . Crossing needed on Healy Creek: impact.	Heavy clearing in Yanert Fork; little to no clearing elsewhere. Slow regrowth in higher elevations and poorly drained areas. High to low rate of fire spread; high to low resistance to control.	Construction activities may inhibit caribou and sheep activities. Overall habitat modification low, especially if winter roads/helicopter construction is used. Fire can seriously impact sheep and caribou habitat. Large new area opened by access road will increase hunting pressure.	Possible line connection at Healy Power Plant - Usibelli Mine roads may be used for access.	High impact to wilderness quality except for lower Moody Creek (Usibelli Mine works). Nature of terrain will conceal line except for ridge along lower Moody Creek where line will be silhouetted.
l plain has medium erosion potential. ed areas subject to potential perma- ation and frost heaving. Goldstream hly erosive and susceptible to legradation and slope instability. Tanana River needed: low siltation	Heavy clearing for most of route except near Healy. Introduction of brush into right-of-way. High rate of fire spread; high resistance to control.	Clearing will enhance considerable amount of moose habitat. Caribou confined to west bank of Nenana and thus will not be affected if line runs on east bank. No new significant areas opened up, particularly if GVEA right-of-way is paralleled or adjoined.	Private holdings (claims, homesteads, etc.) along route - towns of Healy, Lignite, Nenana: These towns may be affected by construction activities since they are transportation centers along the segment. If GVEA line is adjoined, there will be a conflict with the FAA airport at Nenana for clearance.	No impact on Dry Creek archeological site since line will travel on east bank of Nenana River. Medium impact near Healy and in the Goldstream Hills; low impact along lower Nenana River. Impact will be less if GVEA right-of-way is adjoined. Low impact on wilderness.
River: low erosion and permafrost wer Wood River: medium to high mpacts on permafrost. High sus- to heaving. Low to medium ero- ial. Crossing of Tanana River	Heavy clearing on Tanana lowlands. Light to no clearing in Upper Wood River in alpine and moist tundra, and the Tanana flood plain muskegs. Varying rates of fire spread and controllability.	Construction activities and fire in Upper Wood River will negatively affect caribou and sheep. Clearing in Lower Wood River will enhance moose habitat. Very large area opened up by access road will be subjected to greater hunting pressure.	None	Low impact on scenic quality due to extreme inaccessibility. Wilderness quality will receive high impact in upper Wood River, medium to low along lower Wood River because of varying concealment and presence of civilization.

NENANA IMPACTS

	SOILS	VEGETATION
Gold Creek - Cantwell (10)	Erosion impact is low. Shallow permafrost in poorly drained areas susceptible to degradation; since the access road can avoid these areas, this impact will be low.	Successively less clearing as segment g north. In Broad Pass, no trees need clearing and the only vegetation lost would be from access road. Slow regrow implies that maintenance will not be ne and also that revegetation may be neces along some areas. Medium to high rate fire spread; high resistance to control
Watana - Wells Creek via Brushkana Creek (11)	Poorly drained loam: impact on permafrost in this case is high, and frost heaving is possible. Upland soils: impact is low on permafrost, medium on erosion.	Clearing varies from dense spruce-hardw to alpine tundra. Most vegetation loss will be from access road. Slow regrowt implies that maintenance will not be needed and that in places revegetation may be necessary. Medium to high rate fire spread; high resistance to control low resistance in alpine tundra.
Wells Creek - Cantwell (12)	Erosion impact is low level. Shallow permafrost in poorly drained areas susceptible to degradation; since the access road can avoid these areas, this impact will be low.	Clearing varies from spruce-hardwoods high brush. Most vegetative loss from cess roads. Slow regrowth implies that maintenance will not be needed. Mediu high rate of fire spread; high resista to control.
Cantwell - Healy (13)	High erosion potential throughout stretch. Exposed bedrock in canyons will provide solid tower foundations but will inhibit access road construction if needed on canyon slopes. Poorly drained areas have high permafrost degradation susceptibility. Low siltation impact.	Heavy clearing in valley bottom by Yan Fork; lighter clearing throughout rest route. High rate of fire spread, high sistance to control on valley floor; l resistance in alpine tundra.
Wells Creek - Dean Creek (14)	High erosion potential and exposed bedrock on slopes. Some areas of poorly drained soil susceptible to permafrost degradation in wider valley floors. River too deep for fording and is silt-laden normally, so siltation will have low impact.	Heavy clearing on valley bottoms to no clearing in alpine tundra. Slow regro in higher elevations. High rate of fi spread; high resistance to control at lower elevations; low resistance to con trol in alpine tundra.
Dean Creek - Healy (15)	High erosion potential on slopes; high susceptibility to permafrost degradation on poorly drained valley floors. Towards Healy, well drained soils are subject to medium erosion potential and low susceptibility to permafrost degradation. Crossing needed on Healy Creek: low siltation impact.	Heavy clearing in Yanert Fork; little to clearing elsewhere. Slow regrowth in hi elevations and poorly drained areas. Hi to low rate of fire spread; high to low resistance to control.
Healy to Ester (16)	Nenana flood plain has medium erosion potential. Poorly drained areas subject to potential permafrost degradation and frost heaving. Goldstream hills are highly erosive and susceptible to permafrost degradation and slope instability. Crossing of Tanana River needed: low siltation impact.	Heavy clearing for most of route excep near Healy. Introduction of brush int right-of-way. High rate of fire sprea high resistance to control.
Dean Creek to Ester (Wood River) (17)	Upper Wood River: low erosion and permafrost impacts. Lower Wood River: medium to high potential impacts on permafrost. High susceptibility to heaving. Low to medium erosion potential. Crossing of Tanana River needed.	Heavy clearing on Tanana lowlands. Lig no clearing in Upper Wood River in alpi and moist tundra, and the Tanana flood muskegs. Varying rates of fire spread controllability.

DELTA AND MATANUSKA CORRIDORS

IMPACTS

VEGETATION	WILDLIFE	EXISTING DEVELOPMENTS	SCENIC QUALITY/RECREATION
ing throughout segment; no need :e. Possible disruption of id subsequent erosion on slopes degradation on poorly drained have low to medium resistance	Construction activities may interfere with caribou movements. Low impact on moose activities. Little change in habitat from construction, unless severe scarring or excessive fires affect vegetation. Access road will open up the Butte Creek area and hunting pressures may increase.	No existing developments except for scarce settlements along Denali Highway. No impact.	Low impact on Butte Creek area, medium impact on view as seen from Denali Highway; line can be concealed somewhat from highway. Preliminary route surveys in Tangle Lakes Archeological District will locate archeological sites; adjustment of route would alleviate conflict. Right-of-way will avoid recreation areas and east end of Denali Highway to lessen impact on recreation and scenic quality.
from Paxson to Donnelly Dome learing as route goes north. tion in clearings in Spruce- ts. Slash must be disposed of tle infestations. Vegetation high rate of fire spread and resistance to control. Impacts be less if Alyeska right-of-way oined.	Possible interference with caribou and bison movements. Low impact on moose in southern part, but will enhance habitat on more heavily forested areas. Low impact on Dall Sheep in Delta Canyon since line will stay low. Minimal destruction of duck habitat if right-of-way crosses Salcha sloughs and ponds by Donnelly Dome. Siltation in Gulkana, Salcha and Shaw creeks will affect anadromous fish.	Settlements along Richardson Highway may be impacted by line right-of-way acquisition. Towns of Delta Junction and Big Delta will receive some impacts, mostly beneficial, from transit of material and labor. Possible congestion of right-of-way through Delta Canyon unless rights-of-way are consolidated. Overall impacts would be less if Alyeska right-of-way were to be adjoined.	High impacts on scenic quality from Paxson to Donnelly Dome, medium to Delta Junction, and low to Eielson A.F.B. Impact is a function of existing scenic quality and ability to conceal the transmission line. If transmission line is routed parallel to Richardson Highway, recreation areas and historic sites will be negatively affected. If line adjoins the Alyeska right-of-way, impacts will be less.
: over most of route; some clear- ruce-Hardwoods necessary around 'elchina River. Risk of beetle ' slash. Vegetation on Upper u has low to medium rate of fire lium to high resistance to con- :ion on lower Little Nelchina has pread and high resistance to	Possible interference with Nelchina caribou herd movements. Low impact on moose except on lower Little Nelchina, where clearings will enhance caribou habitat. This route opens a very large area to hunting.	None	Wilderness quality suffers since this would be a pioneer corridor.
y clearing throughout segment. :tion will occur in clearings. : infestation of slash. Vege- gh rate of fire spread and high control. Overall impacts would Alyeska right-of-way were to be possible.	Possible interference with Nelchina caribou herd movements. Although moose are numerous, major impact should be the enhancement of habitat along clearings. Fire will be destructive to caribou habitat, may enhance moose habitat. Overall impacts would be less if the Alyeska right-of-way were to be adjoined.	Town of Glennallen will receive some impacts, mostly beneficial, from transit of material and labor. No other major impacts. Overall impacts would be less if Alyeska right-of-way were to be adjoined.	Low impact on scenic quality - line can be easily concealed for entire segment. Possible conflicts with recreational and historic sites depending on final location. Impacts would be less if Alyeska right-of-way were to be adjoined.
neta Pass and Gunsight Mountain required medium to heavy clear- : length. Brush introduction clearings. Clearings will need :enance. Risk of beetle infest- i. Vegetation has medium to :ire spread and high resistance	Low impact on Dall Sheep. Clearing will enhance moose habitat. Low impacts on wildlife in general.	Considerable farming community on Palmer - conflicts may arise in land use. Roads by abandoned coal mine areas can be used as access. Lower Matanuska Valley has a high ratio of privately owned land which will result in acquisition for right-of-way.	Severe impact on scenic quality of Upper Matanuska Valley and Tahneta Pass. Partial concealment is possible. Impact lessens as valley widens, and agricultural use becomes more apparent and concealment increases. Low impact on Knik Arm area; line can avoid all recreation areas and be concealed from roads.

DELTA/MATANUSKA IMPACTS

	SOILS	VEGETATION	WILDLIF
Watana to Paxson via Butte Creek (18)	Vulnerable to permafrost degradation. Low-lying areas are susceptible to heaving and settlement. Erosion potential is medium to high. Access road will need to be adequately culverted over areas of poor drainage.	Minimal clearing throughout segment; no need for maintenance. Possible disruption of surface mat and subsequent erosion on slopes or permafrost degradation on poorly drained areas. Fires have low to medium resistance to control.	Construction activities m caribou movements. Low i activities. Little chang construction, unless seve cessive fires affect vege road will open up the But hunting pressures may inc
Paxson to Fairbanks (19)	In Delta Canyon bedrock is easily reached for tower foundations. Thixotropic silts north of Summit Lake combined with seismic risk will affect reliability of line. Phelan Creek, Tanana River, Gulkana River, Shaw and Salcha Creeks need crossings.	Light clearing from Paxson to Donnelly Dome area. Heavy clearing as route goes north. Brush introduction in clearings in Spruce-Hardwood forests. Slash must be disposed of to prevent beetle infestations. Vegetation has medium to high rate of fire spread and high to medium resistance to control. Impacts overall would be less if Alyeska right-of-way were to be adjoined.	Possible interference witl movements. Low impact on part, but will enhance hal heavily forested areas. Lo Sheep in Delta Canyon sinc low. Minimal destruction if right-of-way crosses S ponds by Donnelly Dome. kana, Salcha and Shaw cree anadromous fish.
Watana to Slide Mtn. via Vee (20)	Low areas vulnerable to heaving. Considerable impact to permafrost possible from access road; winter construction preferable. Access road will need to be adequately culverted over areas of poor drainage.	Light clearing over most of route; some clearing through Spruce-Hardwoods necessary around lower Little Nelchina River. Risk of beetle infestation of slash. Vegetation on Upper Susitna plateau has low to medium rate of fire spread and medium to high resistance to control. Vegetation on lower Little Nelchina has high rate of spread and high resistance to control.	Possible interference wit herd movements. Low impa on lower Little Nelchina, will enhance caribou habi opens a very large area t
Paxson to Slide Mtn. via Glennallen (21)	Vulnerable to heaving. Considerable impact to permafrost possible from access road; winter construction preferable. Access road will need to be adequately culverted in areas of poor drainage. Overall impacts would be reduced if Alyeska right-of-way were to be adjoined where possible.	Medium to heavy clearing throughout segment. Brush introduction will occur in clearings. Risk of beetle infestation of slash. Vegetation has high rate of fire spread and high resistance to control. Overall impacts would be reduced if Alyeska right-of-way were to be adjoined were possible.	Possible interference witl herd movements. Although major impact should be the habitat along clearings. destructive to caribou hal moose habitat. Overall in less if the Alyeska right- be adjoined.
Slide Mts. to Point MacKenzie (22)	Erosion impact from construction and access road can be high. Permafrost degradation is unlikely. Impact of construction and road on Knik Arm soils will be low. Frost heaving is very probable in poorly drained areas.	Except for Tahneta Pass and Gunsight Mountain area, segment required medium to heavy clearing for entire length. Brush introduction will occur in clearings. Clearings will need periodic maintenance. Risk of beetle infestation of slash. Vegetation has medium to high rate of fire spread and high resistance to control.	Low impact on Dall Sheep. hance moose habitat. Low in general.

Impacts of Preferred Corridor Susitna-1

Soils: In the lower Susitna Valley the corridor will encounter substantial areas of poorly drained soils that although not vulnerable to erosion will, however, pose the problem of frost-jacking of tower footings and anchors. Unless measures are taken to counteract this potential problem, additional maintenance and its corresponding impacts will be necessary. The better drained upland soils are less vulnerable to heaving, but, as with many flood plain soils, is rather susceptible to erosion, particularly stream erosion. Since the relative proportions of these two soil types vary from poorly drained soils in the southern portion to well drained upland soils in the northern, the impacts associated with them will have a similar distribution.

Access road construction, although requiring heavy clearing, will be relatively easy in the upland soils. Water erosion will occur somewhat, particularly during the construction phase, influencing water quality in the clearwater streams crossed. Road construction in the areas of poorly drained peats will involve problems of hardening the surface sufficiently to bear construction traffic. Rutting and gouging of tracks will occur if conventional vehicles attempt to cross an unhardened surface. Corduroy, piles, deep fills, and drainage are methods of hardening muskeg surfaces, all of which are expensive and will involve local impacts. Avoidance of the problem by careful routing, winter construction, and/or use of low-pressure tread vehicles will involve less impacts.

Permafrost is generally not present. Where isolated masses do exist, they are buried fairly deeply. Potential thermal disruption of permafrost along this corridor is unlikely.

The corridor parallels the Susitna, involving no crossing, but intersects several tributaries from the Talkeetna Mountains. Fording of machinery and yarding of logs across these streams will result in increased sedimentation. In the smaller clearwater streams this may result in reduction of spawning habitat and potential gill damage in fish downstream of the crossing.

Vegetation: If the line to Point MacKenzie is 345 kv, the amount of clearing for the right-of-way will be up to 2,308 acres; if the line is to be 230 kv, the amount of clearing will be up to 2,060 acres. The actual clearing will probably not be as high as these acreages since vegetation along some stretches may not require clearing, except around tower bases. The terrain being relatively flat, the access road can utilize the right-of-way without additional clearing.

The immediate effect of this clearing will be the destruction of the vegetation; the much more significant impact will be upon erosion and wildlife habitats. In hilly terrain mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires, and to reduce potential infestation of healthy trees by spruce beetles (Dendroctomus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of marketable timber or by burning. Although burning will reduce air quality temporarily, it is more economical and less damaging than the alternatives. (See Mitigating Measures)

Regrowth rates along this corridor are fast enough, particularly in the southern portion, to warrant periodic suppression of tall growing trees which pose a hazard to the transmission line. The preferred method along this corridor is manual application of a suitable herbicide. The amount of clearing to be maintained, the modest regrowth rates, and high cost of labor make this alternative preferrable in this corridor over aerial application of herbicides on the one hand, or hand cutting of residual trees on the other. If proper application techniques are adhered to (see Mitigating Measures), there will be no other impacts other than the maintenance of a sub-climax vegetation. Accidental overspraying or wind drift, or improper dilution resulting in unnecessary destruction of vegetation, and spraying of water bodies resulting in habitat destruction for aquatic life are not likely to occur with manual application. Sections needing vegetation suppression occurs in the bottomland spruce-poplar, lowland spruce-hardwood, and upland spruce-hardwood forests, particularly in the bottomland spruce-poplar and muskeg-bog areas, which comprise a significant proportion of the ecosystems crossed by this corridor, will need little clearing and no vegetation suppression. Lowland spruce-hardwood areas will not need to be maintained as often as bottomland spruce-poplar.

<u>Wildlife:</u> Alteration of vegetation patterns will affect wildlife. This corridor traverses many areas of moose concentration, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition,

changing from the brush phase to some other phase nearer the climactic phase; the brush in a transmission clearing can be counted as a more permanent source of browse.

Animals dependent upon climactic forest, such as squirrels, will suffer loss and displacement. However, their faster reproductive rates will allow their populations to adjust rapidly.

Most animals will benefit from the edge environment, offering both forage and cover for the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover this will be limited. In any event, this impact should be low in this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant.

Recreation: The Susitna-1 corridor will approach within 10 miles of several recreational and wayside areas in the lower Susitna valley. The largest of these is the Nancy Lakes Recreation Area. In addition, the corridor will run adjacent to the Denali State Park for 22 miles. However, the Susitna River will separate the corridor from the Park; the main access to lands within the Park is the Anchorage-Fairbanks Highway, and this is an average of 10 miles away to the west over a 2,000 to 2,500 feet high ridge.

Depending upon the policies of the land managing agencies involved, this corridor will provide access to areas previously difficult of access. The largest such area is that south of Nancy Lake to Point MacKenzie. Dense forest and muskeg limit travel. Another such stretch is that from Talkeetna north. Although the service road parallels the Railroad, it will offer a significantly easier access by car or truck to this corridor. Many cabins along these stretches will be provided with better access; however, the creation of easier access may interfere with isolation desired by many of the owners. If no bridge is provided over the Talkeetna River, the service road will be less attractive to casual travellers.

Cultural Resources: The National Register of Historic and Archeological Sites lists only one site in the area, Knik Village. The corridor will run at least 10 miles to the west of this site. It is likely that archeological sites will be found along the corridor, either during the location survey or during construction. If so, minor route relocations, or careful tower locations, will protect these sites. Inadvertent alteration of a site will reduce or destroy its historical value.

Scenic Resources: This corridor does not traverse any areas of good or high quality scenic values. The northern portion is, however, more scenic than the southern portion. In the northern portion the fairly continuous moderately dense forest will provide ample screening from transportation routes. Further south, the forests are more intermingled with open muskeg. Glimpses of the transmission line can then be seen from the highway or railroad through these muskegs. South of Nancy Lake the corridor and the transportation corridors diverge, and although cover becomes more sporadic, the line will no longer be visible from the transportation routes. The transmission line will not be visible from the Nancy Lake Recreation Area.

As the Alaska Railroad and the transmission corridor approach Gold Creek, the valley becomes more confined, and screening becomes more difficult. However, it appears that the line can be concealed through most of this portion.

Land Use and Resources: From Point MacKenzie to Nancy Lake the corridor follows no existing corridor for 32 miles. North of Nancy Lake to Gold Creek the corridor parallels the Alaska Railroad, and to Talkeetna the Anchorage-Fairbanks Highway and Matanuska Electric Association distribution lines. No impact is expected on these utilities.

Although agriculture in this area is generally limited to a few farms and subsistence gardens, there is potential in the better drained soils to support farming. The corridor will encounter some agriculture near Nancy Lake, and again about 25 miles north near the settlement of Montana. Impact on agriculture will be very low.

Good stands of black cottonwood and balsam poplar exist near the Talkeetna River, but there is no extensive forestry to be impacted by the corridor. Future forestry may utilize the access road both for logging and as a fire road, but this impact is low and depends also upon the land ownership.

Impact on mineral resources is low; the corridor does not traverse significant areas of potential metallic minerals, and does not approach any existing coal or oil developments although the potential for coal, oil and gas exists along nearly the entire length of the corridor. Due to the high cost of a low-load tap on a 345 kv line, the likelihood of the development of these resources due to the proximity of a transmission line is low.

Social: Few towns are encountered by the corridor. Whenever possible, the final location will circumvent communities. The construction phase can last somewhere from three to five years. During that time, work on the transmission line will affect these communities. The numbers of workers needed on a transmission line relative to a pipeline is low. Workers will be housed in camps, or will be based in Anchorage or Fairbanks, both of which are large enough to absorb the workforce. Labor will probably be recruited from these cities or brought in by the contractors. Little or no labor force will be drawn from the smaller communities since it is not expected that their residents might have the skills and qualifications for transmission line work.

Some economic impact can be expected, as flying services, motels, restaurants, and entertainments receive business, not only from the transmission line workers, but from related personnel, also. Talkeetna is the only community, except Anchorage, receiving these impacts from corridor Susitna-1. It can be expected that Anchorage could accept this impact with little strain, but the impact may be high for Talkeetna. The impacts may be adverse in that services might be temporarily monopolized by the construction activity, and good in that it would bring considerable money to business in the town.

Impacts of Preferred Corridor Nenana-1

Soils: The incidence of permafrost increases from Devil Canyon north to Fairbanks; however, it is generally discontinuous, with a fairly deep table. Impacts resulting from thermal degradation will be low, except for soils in the Moody area which are ice-rich.

As in Susitna-1, soils vary from poorly drained soils on lowlands, and better drained soils on slopes. Erosion potential for the majority of the corridor is low to medium since the greater portion of the corridor is on relatively level land. Two significant exceptions are the sections in the Nenana Canyon and the "Goldstream Hills."

The Nenana Canyon area would pose severe erosional problems for an access road due to the steep slopes encountered. Discontinuous permafrost is found, which presents a high potential for degradation.

Due to the physical and political restraints, the corridor will have to traverse many slopes. Soils are often shallow on these slopes; indeed, many of them are talus. The upper canyon is constricted between Panorama Mountain and the Nenana River, and an extensive, unstable talus slope lies at the foot of Panorama Mountain. In the lower canyon, thin, unstable soil blankets the steep slope to the east of the highway. Where the corridor traverses slopes such as these, erosion will be a serious problem, especially on thin soils or unstable soils. This impact will be especially objectionable since erosion scars may be visible from the Anchorage-Fairbanks Highway and Mt. McKinley National Park. Because of the potentially severe impact of our access road in this area, none will be built and helicopter construction will be used.

The Nenana Canyon area is also in the vicinity of several large faults. The Denali Fault crosses the corridor just north of Cantwell, and another active fault is encountered near Healy, north of the lower canyon. This factor will affect location of the transmission line on unstable slopes.

The soil in the Goldstream Hills contains lenses of fine grain material which, combined with the slopes encountered by the corridor, poses a potential erosion problem. Fortunately, rainfall is scant in this area. The low lying areas in the Goldstream Hills have a shallow permafrost table; so avoiding the potentially erodable fine grain soils by locating the transmission line low will present a problem with frozen soils and muskegs.

The corridor will cross Portage Creek, the West and Middle Forks of the Chulitna River, the Jack River, the Nenana River, Yanert Fork, Healy and Lignite Creeks, and the Tanana River. With the exception of the Nenana and Tanana Rivers and Yanert Fork, these are clearwater streams. Fordings and crossings which disturb the bottom will affect water quality, as will run-off into these streams from a disturbed clearing.

Vegetation: Up to 1,440 acres will need clearing along this corridor. Actual acreage of clearing will probably be much less since this figure assumes clearing to the full width of the right-of-way. In many areas, only the areas around the tower bases will require clearing, particularly in the lowland spruce-hardwood and muskeg-bog ecosystems. The heaviest clearings will be necessary in the bottomland spruce-poplar and upland spruce-hardwood ecosystems along the lower Nenana River and the Tanana floodplain. Along the greater part of the corridor, the access road can be incorporated into the clearing due to level terrain. From Devil Canyon to Healy, there will be no access road.

The most immediate effect of clearing will be the destruction of the cleared vegetation. The timber cleared from the bottomland spruce-poplar will be sold, if merchantable. Non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly in the bottomland spruce-poplar ecosystem.

Some disruption of the soil from clearing is to be expected; increased erosion because of this, and enhanced by the lack of cover, will result. If vegetation is cleared up to river banks on stream crossings, this may result in additional sedimentation. Clearing will entail habitat modification, to be discussed under "Wildlife."

Regrowth rates along this corridor are slow enough to not require a program of vegation suppression other than occasional cutting during routine inspection and maintenance patrols.

Wildlife: There will be loss of individual smaller animals, and displacement of others; however, this is a temporary setback. High reproductive rates of smaller mammals and re-invasion will alleviate this impact.

A permanent habitat modification will result from the clearing and maintenance; a corridor of brush will be maintained through otherwise forested land. Animals dependent upon climax forest, such as squirrels, will suffer some habitat loss. Animals dependent upon brush and forbs for browse will gain.

Apart from local concentrations, the only major moose concentration along this corridor occurs from Healy to the Tanana River along the Nenana River.

After the construction phase, moose will benefit from the "edge" environment, offering increased browse immediately adjacent to forest, which provides cover.

Depending upon the final location, the access road may result in additional hunting pressure upon moose in this area. This will also depend upon the chance of more hunters in the area than presently since if the number of hunters remains the same, there is no reason to suspect that increased access will result in better hunting success.

In passing through the lower Nenana Canyon, the Nenana-1 corridor traverses Dall sheep habitat. However, since the sheep tend to inhabit areas higher than any feasible line location, and since no access road will be used in this area, impact on Dall sheep will be low to none.

Recreation: The Nenana-1 corridor will parallel eight miles of the northeast border of Denali State Park, but will be separated from the boundary by Indian River, the Alaska Railroad, and at least one mile of buffer. Further north, it parallels the east border of Mt. McKinley National Park for 30 miles, being separated by the Nenana River, the Anchorage-Fairbanks Highway, and the Alaska Railroad. At no point will the corridor cross lands proposed as additions to the Mt. McKinley National Park.

The access road will open up no extensive previously inaccessible areas since it will parallel existing transportation a few miles distant; no recognized wilderness areas are infringed. Use of the access road by the public will be determined by the relevant land-managing agency. If the final route location crosses the Clear MEWS, restrictions may be placed upon public use of this portion of the access road.

Cultural Resources: The National Register of Historic and Archeological Sites lists only one site approached by the Nenana-1 corridor, the Dry Creek archeological site. This lies to the west of Healy, the Nenana River, and the existing transportation corridors. Since the corridor runs along the east bank of the Nenana, there will be no impact on this site.

If the final route survey discloses an unsuspected archeological or historical site with potential for inclusion in the National Register, minor route relocations, or careful tower location, will protect these sites. Inadvertant alteration of a site will reduce or destroy its historical value.

Scenic Resources: The corridor passes through an area recognized as being of good to high scenic quality from Devil Canyon to Healy. The possibility of screening throughout this area varies from moderate in the southern portion around Chulitna, to minimal in the Broad Pass and the upper and lower canyons of the Nenana River. Scenic quality will be impacted, the impact being a function of existing scenic quality and the opportunity for screening. Impact in the Nenana Canyon will be high; impact on Broad Pass will be moderate to high; impact elsewhere will be moderate. Two favorable factors mitigate the impact somewhat: 1) The corridor is not visually intact as the Alaska Railroad and the Anchorage-Fairbanks Highway have already reduced scenic quality somewhat. 2) The major views south of the canyons are to the west, toward the Mt. McKinley massif, whereas the corridor lies to the east of the transportation routes, the most likely viewpoints. (See Mitigating Measures.)

Land Use and Resources: The Nenana-1 corridor follows existing corridors for its entire length. For 10 miles it follows the Alaska Railroad from Gold Creek. From north of Chulitna to Ester it follows a combined Railroad/Highway corridor. From Healy north it also parallels the Golden Valley Electric Association 138 kv transmission line. It is possible the corridor could adjoin this right-of-way or the GVEA line could be rebuilt to a higher capacity and the existing right-of-way utilized.

Although the potential for agriculture exists along this corridor in the Tanana Valley portion, it exists in the form of home gardens and grazing if at all. Impact on existing and potential agriculture is low to none.

Some forestry exists in the bottomland spruce-poplar forests along the lower Nenana River and the Tanana River. Possible sales of merchantable timber from the clearing in this area will bring short-lived business to the town of Nenana, but this impact will be low. Use of the access road as a logging road and firebreak may occur, but this use will not significantly affect logging in this area.

Although the corridor approaches and crosses several mineralized areas and fossil fuel deposits, it will not make power directly available for development except through distribution systems of the existing electric utilities. The access road may be used as a prospecting road, but will not serve for heavier use. The value of the minerals and fuel is such that if a profitable area were to be developed, it would be feasible to relocate small sections of the transmission line. On the whole, impact cn existing and potential mineral and fuel extraction is low.

Slightly more than half of the length of this corridor passes through the Mt. McKinley Cooperative Planning and Management Zone of Ecological Concern. This is a study area of a joint State-Federal Planning and Management Committee responsible for land use planning in the area peripheral to the Mt. McKinley National Park.

Social: These towns will be affected by the corridor: Cantwell, Healy, Nenana, and Fairbanks. Cantwell is a small community with no electric utility, and few services apart from a railroad station and a few restaurant/motel/gas stations. Incoming material may arrive at the Alaska Railroad; possible congestion of the station may occur. This is an insignificant impact, however, and quite temporary. It is possible that Cantwell will tap directly from the 230 kv transmission line.

Electrical service will either be via future distribution lines of one of the existing utilities or by tapping from a new substation. The proposed 25 kv distribution line to McKinley Park may eventually extend south to serve Cantwell and Summit. If the transmission line is constructed first, pressure is expected to be greater for a substation to serve Cantwell and Summit. The presence of a nearby transmission line will undoubtedly result in increased pressure from the community for electrical service; although which of the two methods will be determined by the cost and feasibility of both. Healy is similar to Cantwell, except that it is served by the GVEA system's Healy steamplant.

Nenana is a fairly important transportation node, situated at the crossing of the Tanana River, a navigable waterway, by the railroad and highway corridors. Situated in a bottomland spruce-poplar area, if the timber from a line clearing is to be sold, then the logs will pass through Nenana, offering some business and jobs. It is unlikely that much labor for the actual line construction will be drawn from Nenana. The town is already served by the GVEA system. The existing Healy 138 kv line passes very close to the town. For a short stretch it uses shorter towers and spans to minimize hazards to aircraft using the FAA strip south of town. The corridor will be far enough from the airstrip to reduce this hazard to a minimum, and any spans deemed hazardous by the FAA will be marked.

Impacts of Alternative Susitna-2

Alternative corridor Susitna-2 duplicates Susitna-1 from Point MacKenzie to Talkeetna. Impacts are identical for this segment, and are discussed under impacts of preferred corridor Susitna-1. Impacts discussed here are for the segment from Talkeetna to Gold Creek via Troublesome Creek.

Soils: In the southern portion of this alternative there is a high proportion of poorly drained soils which can be expected to present problems for tower footings and access roads. The severity of the problem will depend upon the vulnerability of the soil to frost heaving and the ability of the final line survey to avoid areas of poor soils.

In the upland areas around Troublesome Creek, gravelly soils will present erosional problems, particularly since steeper slopes are encountered. Frost heaving should be less of a concern, and maintenance of footings will be less.

There will be little or no problem with thermal disruption of permafrost as there is only discontinuous, deeply buried permafrost along this alternative. However, final line survey can locate and avoid any high risk areas. Thermal disruption, particularly in the upland areas, could lead to gulleying and other forms of erosion.

Crossings of the Talkeetna and Susitna Rivers, paralleling of Whiskers Creek, and a possible crossing of Troublesome Creek are necessary. Fording of the Talkeetna and Susitna Rivers is unlikely. In any event, the rivers are both already sediment laden rivers and will be little affected by additional sediment. Sediment will negatively impact fish habitat in the Whiskers and Troublesome Creeks, both of which are clearwater streams.

Vegetation: The amount of clearing for the Susitna-2 alternative is up to 2,375 acres, 67 acres more than that for Susitna-1, if the line is to be 345 kv. A 230 kv line would require up to 2,121 acres, 61 more than a similar line along Susitna-1. The actual acres of clearing will probably be less than these figures since some stretches may only require clearing for the access road and the tower bases. In the southern portion the terrain is flat enough so that the clearing will include the access road; in the steeper terrain the access road may have to deviate from the right-of-way to maintain grade, and this will require additional clearing.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain, mechanical clearing methods such as bulldozing will cause considerable disruption of the soil, and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires, and to reduce potential infestation of healthy trees by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber or by burning. Although burning will reduce air quality temporarily, it is more economical and less damaging than the alternatives. (See Mitigating Measures.)

Regrowth rates along this corridor are fast enough, particularly in the southern portion, to warrant periodic suppression of tall growing trees which pose a hazard to the transmission line. The preferred method along this corridor is manual application of a suitable herbicide. The amount of clearing to be maintained, the modest regrowth rates, and high cost of labor make this alternative preferable in this corridor over aerial application of herbicides on the one hand, or hand cutting of individual trees on the other. If proper application techniques are adhered to (see Mitigating Measures), there will be no other impacts other than the maintenance of a sub-climax vegetation. Accidental overspraying or wind drift, or improper dilution, resulting in unnecessary destruction of vegetation and spraying of water bodies resulting in habitat destruction for aquatic life are not likely to occur with manual application. Sections needing vegetation suppression occurs in the bottomland spruce-poplar, lowland spruce-hardwood, and upland spruce-hardwood forests, particularly in the bottomland spruce-poplar and muskeg-bog areas, which comprise a significant proportion of the ecosystems crossed by this corridor, will need little clearing and no vegetation suppression. Lowland spruce-hardwood areas will not need to be maintained as often as bottomland spruce-poplar.

Wildlife: Alteration of vegetation patterns will affect wildlife. This corridor traverses many areas of moose concentration, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase approaching the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

Animals dependent upon climactic forest, such as squirrels, will suffer loss and displacement. However, their faster reproductive rates will allow their populations to adapt rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover, this will be limited. In any event, this impact should be low in this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant.

Recreation: This corridor penetrates 26 miles of the Denali State Park, coming within 4 miles of the Anchorage-Fairbanks Highway near the Park's southern border. This puts the corridor within easy walking distance of the highway for a significant part of its length within the Park. This will affect present and potential trails intersecting the corridor.

Accessibility to the Park would be increased by the creation of an access route parallel to the highway; however, the highway and the Susitna River are not separated more than nine or less than four and a half miles, so the corridor, which separates the two, will not service an inaccessible area. Hunting is presently prohibited in Denali State Park so an access road will have no value as hunters' access. Impact on recreation will be negative since the entire area of the Park to the east of the highway will be limited for hiking and day trails.

Cultural Resources: The National Register lists no historical or archeological sites along this corridor. If the final route survey locates an archeological site, minor relocation or careful tower location will avoid disruption of the site. Inadvertant disruption of an archeological site will reduce or destroy its archeological value.

Scenic Resources: The transmission line can be effectively hidden from the highway for its entire length; however, its impact is still high because of conflicts with the existing and potential trails in the State Park. A significant value of these trails is aesthetic, and visibility of a transmission line from an intercepted or adjacent trail will seriously detract from the original purpose of these trails.

Land Use and Resources: The major land use of this segment is scenic and recreational. Impacts are as described above under "Recreation" and "Scenic Resources."

There will be no significant impact on forestry or agriculture because of the exclusive nature of the State Park land use. There will be no impacts on other resources in this segment.

Impacts of Alternative Susitna-3

Soils: The soils encountered along this alternative are basically well suited to the construction of an access road. The low erosion potential, absence of significant permafrost, and the gravelly texture indicate that effects of erosion and consequent sedimentation will be low.

Depending upon the final route survey, several small clearwater creeks will be crossed. Some sedimentation will occur from fording of construction equipment. This sedimentation will be of a temporary nature, and of low significance since this upland area is not an important fishery. The Talkeetna River will need at least one crossing, but probably will not be forded. Since the Talkeetna River carries a glacial silt load, any additional sedimentation will not be significant.

The upland soils are quite shallow; excavation of footings may require blasting. Access road location may have to deviate from the transmission line in order to keep an acceptable grade without extensive excavation.

Vegetation: The Susitna - 3 alternative for 345 kv could require up to 1,900 acres, 407 acres less than that for Susitna - 1. For 230 kv, this alternative would require up to 1,696 acres, 364 acres less than a similar line along corridor Susitna - 1. The majority of this clearing will occur in the Talkeetna River valley. Little or no clearing will be required in the upland areas toward Devil Canyon.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain mechanical clearing methods, such as bulldozing, will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes, hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires and to reduce potential infestation of healthy trees by spruce beetles (Dendroctomus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber or by burning. Although burning will affect air quality temporarily, it is more economical and less damaging than the alternatives. (See Mitigating Measures.)

Regrowth rates along this corridor are fast enough, particularly in the southern portion, to warrant periodic suppression of tall growing trees which pose a hazard to the transmission line. The preferred method along this corridor is manual application of a suitable herbicide. The amount of clearing to be maintained, the modest regrowth rates, and high cost of labor make this alternative preferrable in this corridor over aerial application of herbicides on the one hand or hand cutting of individual trees on the other. If proper application techniques are adhered to (see Mitigating Measures), there will be no other impacts other than the maintenance of a sub-climax vegetation.

Wildlife: Alteration of vegetation patterns will affect wildlife. This corridor traverses many areas of moose concentration in the Talkeetna River valley, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase nearer the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

Animals dependent upon climactic forest, such as squirrels, will suffer loss and displacement. However, their faster reproductive rates will allow their populations to recuperate rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover, this will be limited. This impact should be low in this corridor.

There may be a possible impact on the caribou winter range reported to exist in in the upland areas along this alternative. Summer construction will reduce contacts of caribou and the construction activity. Fires started by construction may destroy potential winter browse. The degree of this impact depends upon the area burned and the season of the burning.

Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant. Herbicides will not directly affect animals in the dilutions used for manual spraying; herbicides used on right-of-way maintenance are non-cumulative and are readily excreted. The overall adverse impact of herbicide spraying will be low, as it will be necessary only every five to ten years, whereas the availability of forage provided is as permanent as the transmission line.

Recreation: This corridor approaches no recognized recreation area. Since the entire length of this segment from Talkeetna to Devil Canyon parallels no existing transportation line, a sizeable amount of land is opened up to access by four-wheel drive vehicles, dependent upon the policies of the landowners or managing agency. For recreation requiring vehicular access, this increased access will have a beneficial impact. For recreation dependent upon primitive values, increased access will have a detrimental aspect.

Cultural Resources: There is no known impact on cultural resources in this segment.

Scenic Resources: In terms of viewer contacts, this corridor will have a low impact on scenic quality due to its relative inaccessibility. However, this corridor will have a higher impact upon the intactness of this area than the comparable segments of Susitna-1 and Susitna-2. The high primitive values and medium to high scenic value of this corridor, coupled with relatively high visibility of a transmission line in the upland area, will result in a high impact on scenic quality, disregarding the factor of viewer contacts.

Land Use and Resources: No impact on agriculture is anticipated along this corridor from Talkeetna to Devil Canyon. An access road will not enhance forestry in the Talkeetna River valley since it would be unsuitable for a logging road unless it were overbuilt, and since the access road would run very close to the transmission line itself. Impacts on mineral resources will also be low; not enough potential exists along the corridor to be influenced by the increased access.

Social: No communities are encountered along this corridor; so there is no impact.

Impacts of Alternative Susitna-4

Soils: For soils in the portion of this corridor that follows the Talkeetna River and Prairie Creek, impacts from erosion, siltation, and permafrost degradation are low. Crossings of the Talkeetna River and Iron Creek will be necessary. Both of these streams are sediment laden; so additional sedimentation will have little effect.

The soils on the upland portion of this corridor are more susceptible to erosion, although the slopes are shallower. An improperly constructed access road will cause erosion. Very few creeks are crossed. Sedimentation would be a very minor problem. Some permafrost associated with poorly drained, peaty soils may present problems, not only of permafrost degradation, but of frost-heaving. However, final line survey should reduce this potential impact. Unavoidable stretches of poorly drained soils may be rutted and scarred by vehicle tracks unless the access road is hardened with a gravel bed.

Vegetation: For a 345 kv line this corridor could require up to 2,257 acres of clearing, 50 acres less than Susitna-1. For a 230 kv design it would require up to 2,105 acres, 45 acres less than a similar line on

Susitna-1. Actual acreages of clearing will probably be less than these figures since the entire right-of-way will in most cases not be cleared, and along some stretches only the access road and tower bases need to be cleared.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain, mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes, hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires and to reduce potential infestation of healthy trees by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber or by burning. Although burning will affect air quality temporarily, it is more economical and less damaging than the alternatives. (See Mitigating Measures.)

Regrowth rates along the Talkeetna River valley are high enough so that periodic suppression of tall growing trees within the clearing is required. The method to be used will be manually applied herbicide, applied to target trees during regular maintenance patrols. If properly applied, there will be no contamination of water bodies or destruction of non-target vegetation. The most important impact of this program will be the maintenance of sub-climax brush within forested areas.

Wildlife: Alteration of vegetation patterns will affect wildlife. This corridor traverses an area of moose concentration in the Talkeetna Valley, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase nearer the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

Animals dependent upon climactic forest, such as squirrels, will suffer loss and displacement. However, their faster reproductive rates will allow their populations to adapt rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover, this will be limited. In any event, this impact should be low in this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant. Herbicides applied as outlined under "Vegetation," will produce few effects upon animals. Since the herbicides are applied only to target vegetation, the probability of ingestion is reduced to a minimum. Herbicides are not toxic to animals in the concentrations normally used, and are not cumulative in effect.

Recreation: Although this corridor does not approach any State or Federal recreation areas or parks, it will affect the recreational use of the upland area near Stephen Lake. Readily accessible by float plane, this area is popular with sportsmen and vacationers. The lakes have many cabins along their shores. The access road would provide another means of access for this area, which would tend to increase the recreational use, and at the same time, the transmission line would be visible for most of its length over the upland area. If one of the perceived values of this area is its relative inaccessibility, then increased access and a visible transmission line would have a highly detrimental impact. Increased accessibility to other areas traversed by the corridor would be beneficial to recreational use dependent upon easy access.

Cultural Resources: If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: In terms of viewer contacts, impact of a transmission line along the Talkeetna River valley will be low. Along the upland area it will be high. This area is a heavily used recreation area, sparsely forested, and of moderate to high scenic quality. Thus, the construction of a transmission line and the inherent visibility of such a line would result in a high impact.

Land Use and Resources: There will be significant impacts, both beneficial and detrimental, on the predominant land use, recreation. These impacts are discussed under the "Recreation" section above. There will be no impact on agriculture, forestry, and mineral resources.

Social: There will be no social impacts from this corridor.

Impacts of Alternative Nenana-2

Soils: Impacts on soils along this corridor will be identical to those outlined in Nenana-1 up to Cantwell. The generally flat, gravelly soil from Cantwell to Wells Creek is vulnerable to water erosion. Construction activities may cause gulleying in this area. The peaty permafrost soils also found in this area will present problems in constructing the access road. Possible rutting and scarring may lead to degradation of the underlying permafrost and further erosion.

From Wells Creek to the upper Wood River, impacts will vary with the type of soil encountered, which can be localized poorly drained frozen soil, thin soils and gravel, and bare bedrock and talus. Local pockets of poorly drained soils can be avoided to an extent. Unavoidable encounters will result in disturbance of the soil and possible consequent disruption of the permafrost. Thin soils and gravel are very susceptible to erosion, particularly since they will be found in conjunction with steep slopes. Access road construction will have a detrimental affect in both these soils. No impact on bare bedrock and talus is anticipated; however, footings for towers will require blasting and construction of an access road will be extremely difficult.

Increasing amounts of poorly drained, frozen, peaty soils encountered from along the lower Wood River to the Tanana River will cause increasing problems with access road construction, footing stabilization, and rutting and scarring of the soils. Unless the access road is bedded on gravel, there is a strong potential for permafrost degradation and consequent gulleying and maintenance problems. Immediately adjacent to the Tanana River, stratified soils present a potential water erosion problem, yet are easier to construct on than the surrounding poorly drained peats. These stratified materials are often levees of extinct or existing channels. They are linear, but sinuous, and may provide not only the best foundation for a road, but also the highest point above flood waters.

The impact of sedimentation on glacial rivers will be low. Sedimentation impact on clearwater streams will be medium for Wells Creek, Louis Creek, and Dean Creek. Sedimentation impacts upon the numerous clearwater tributaries of the Wood River will be low since they will be crossed close to their confluences with the silt laden Wood River.

Vegetation: This corridor could require up to 1,500 acres of clearing, 60 acres more than that for Nenana-1. Actual acreage cleared will probably be less than this figure since the entire right-of-way need not be cleared, and the terrain requiring the heavier clearing is generally flat enough to allow the access road to run within the clearing.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades and rotary cutters will reduce this effect. On steep slopes, hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires and to reduce potential infestation of healthy trees in the bottomland spruce-poplar ecosystem by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be done by sale of merchantable timber, by chipping, or by burning. Although burning will affect air quality temporarily, it is more economical and less damaging than the alternatives. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. (See Mitigating Measures.)

Except for the bottomland spruce-poplar forest along the Tanana River, regrowth rates are low enough so that little vegetation suppression other than routine trimming of danger trees is necessary. More extensive cutting programs may be necessary in the area around the Tanana River.

In the moist tundra and alpine tundra ecosystems, disturbed areas will be very slow to recuperate. Revegetation with appropriate species will be necessary to minimize surface erosion and permafrost degradation. Proper construction and access road design will limit vegetation loss to the area occupied by the roadbed and tower bases. No clearing is necessary in these areas.

Fires caused by construction and maintenance will have little impact, providing they are discovered quickly and stopped without excess disturbance of the soil. The present patterns of forests are caused by previous naturally caused fires which are an integral factor of these ecosystems. Impact from a small number of additional fires of limited area will be low.

Wildlife: The greatest anticipated impact upon wildlife will be the alteration of vegetative patterns, and this impact will be a function of the degree of clearing. Animals dependent upon climax forest will suffer loss of individuals and loss of habitat. Generally, these are the small mammals such as squirrel and marten. Moose will benefit from the creation of an area of maintained browse. Since the clearing will not be allowed total regrowth, the browse created can be considered as permanent as the line. The conjunction of forest and open brush creates a favorable "edge" environment for most animals, offering forage on the clearing and cover in the forest.

Construction activity will temporarily frighten away wildlife; however, this is an extremely local and temporary impact. Maintenance patrols will not be frequent enough to keep animals from returning to the corridor.

Impact upon the caribou wintering ranges on either sides of the Alaska Range will be low if construction is done in summer, which may be preferrable in any case because of better working conditions. Dall sheep habitat will be impacted in that they will be frightened away from construction activity more so than caribou and moose. Again, this impact is of a temporary nature. Unchecked fire in either of these habitats will adversely impact both caribou and sheep. With caribou particularly, destruction of their key winter browse, lichen, may have long lasting effects due to slow regrowth rates.

Recreation: This corridor does not traverse any Federal or State parks or recreation areas. It does, however, briefly approach within five miles the southeast corner of McKinley National Park.

Except for 22 miles along the Denali Highway, the corridor will provide access to an area previously accessible only by air or foot. In some cases, access is presently possible with all-terrain vehicles. Increased access will impact game animal populations somewhat; the actual impact will depend upon the desirability of the area for hunting, and access and hunting regulations imposed by the land managing agencies.

Cultural Resources: This alternative approaches no National Historic or Archeological Sites. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: This alternative traverses areas of low to high scenic quality. In terms of viewer contacts, this corridor will have little impact since it will not be visible from transportation routes for most of its length. Disregarding viewers, high visual impact to scenic and wilderness quality in the mountainous portion of the corridor can be expected.

Land Use and Resources: There will be no impacts on forestry and agriculture throughout this alternative. There will be no impacts on mineral or fossil fuel resources.

Apart from obtaining easements, no impact is expected on existing land use.

Impacts of Alternative Nenana-3

Soils: The majority of the soils on the portion of this alternative which differs from the proposed Nenana-1 corridor are rocky, thin soils and bedrock, and as such are well suited generally for tower foundations. Access road construction will be hampered by steep slopes, bedrock, and talus encountered by this corridor. Erosion will generally be low, although on thin soils or unstable slopes, erosion will be severe unless corrective measures are employed. Permafrost can be assumed to be continuous, but will not usually be of concern to tower location unless the soil is ice-rich. This condition is assumed to be restricted to valley floors.

Soil impacts for the remainder of the alternative are described under soil impacts of the proposed corridor.

Vegetation: The Nenana-3 corridor could require up to 1,318 acres of clearing, 121 acres less than Nenana-1. Almost no clearing is needed on the portion which differs from the Nenana-1 corridor since mostly alpine and moist tundra ecosystems are encountered in this portion. Impacts resulting from clearing will be similar to those discussed under Nenana-1. Along the differing segment destruction of vegetation will be limited to those areas directly occupied by the roadbed and the tower bases. This will be a permanent impact, although some revegetation of tower bases can be expected.

Destruction of the vegetative mat in tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrence of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Wildlife: Impacts on wildlife for those segments of this alternative corridor to Nenana-1 are discussed under impacts to wildlife of the proposed corridor.

Along the differing segment, there will be little impact from habitat modification due to clearing. Increased incidence of fire resulting from operation or construction will adversely affect habitat for Dall sheep and caribou. Moose habitat will be enhanced, up to a point, by fire.

Construction activity may cause avoidance of the corridor by animals; however, this is a temporary impact. Operation and maintenance will not affect the animals' occupation of the corridor.

Increased access afforded by the access road may increase hunting pressure on Dall sheep, caribou, and to a lesser degree on moose. The degree of this impact is dependent upon the desirability of this corridor for hunting, and access and hunting regulations imposed by the land managing agencies.

Recreation: This corridor does not traverse any Federal or State parks or recreation areas. It does, however, briefly approach within 5 miles the southeast corner of McKinley National Park.

Except for 22 miles along the Denali Highway, the corridor will provide access to an area previously accessible only by air or foot. In some cases, access is presently possible with all-terrain vehicles. Increased access will impact game animal populations somewhat. The actual impact will depend upon desirability of the area for hunting, and access and hunting regulations imposed by the land managing agencies.

Cultural Resources: This alternative approaches no National Historic or Archeological Sites. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: This alternative traverses areas of moderate to high scenic quality. In terms of viewer contacts, this corridor will have little impact since it will not be visible from transportation routes for most of its length. Disregarding viewers, high visual impact to scenic and wilderness quality in the mountainous portion of the corridor can be expected.

Land Use and Resources: There will be no impacts on forestry and agriculture throughout this alternative. There will be no impacts on mineral or fossil fuel resources.

Impacts of Alternative Nenana-4

Soils: From Healy to Ester, this corridor duplicates Nenana-1, and impacts to soils are identical to those discussed under impacts of Nenana-1.

The soils from Watana Damsite to Wells Creek will be very vulnerable to permafrost degradation and frost heaving. The vegetative mat must be preserved, and construction activity must be planned to minimize disruption of the soil. Erosion caused by permafrost degradation and access road construction will have adverse impacts on water quality in the clearwater streams encountered.

Fording of streams in this segment, given the sensitive soil conditions, could result in extensive bank erosion. To minimize this and to ensure the integrity of the transmission line, the corridor will avoid river crossings when possible.

From Wells Creek to Healy via Nenana-4, the soils are rocky, thin soils and bedrock, and as such are well suited generally for tower foundations. Access road construction will be hampered by steep slopes, bedrock, and talus encountered by this corridor. Erosion will generally be low, although on thin soils or unstable slopes, erosion will be severe unless corrective measures are employed. Permafrost can be assumed to be continuous, but will not usually be of concern to tower location unless the soil is ice-rich. This condition is assumed to be restricted to valley floors.

Vegetation: The Nenana-4 alternative could require up to 1,182 acres of clearing, 257 acres less than Nenana-1. Actual acres cleared will probably be less than this since the entire right-of-way need not be cleared.

Impacts on vegetation from Healy to Ester are identical to those discussed for that segment under impacts of Nenana-1. Almost no clearing is needed on the portion which differs from the Nenana-1 corridor since mostly alpine and moist tundra ecosystems are encountered in this portion. Impacts resulting from clearing will be similar to those discussed under Nenana-1.

Along the differing segment, destruction of vegetation will be limited to those areas directly occupied by the roadbed and the tower bases. This will be a permanent impact, although some revegetation of tower bases can be expected.

Destruction of the vegetative mat in tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrenc of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Wildlife: Impacts on wildlife for those segments of this alternative corridor to Nenana-1 are discussed under impacts to wildlife of the proposed corridor.

Along the differing segment there will be little impact from habitat modification due to clearing. Increased incidence of fire resulting from operation or construction will adversely affect habitat for Dall sheep and caribou. Moose habitat will be enhanced, up to a point, by fire.

Construction activity may cause avoidance of the corridor by animals; however, this is a temporary impact. Operation and maintenance will not affect the animals' occupation of the corridor.

Increased access afforded by the service road may increase hunting pressure on Dall sheep, caribou, and to a lesser degree on moose. The degree of this impact is dependent upon the desirability of this corridor for hunting, and access and hunting regulations imposed by the land managing agencies.

Recreation: This corridor does not traverse any Federal or State parks or recreation areas. The corridor will provide access to an area previously accessible only by air or foot. In some cases, access is presently possible with all-terrain vehicles. Increased access will impact game animal populations somewhat. The actual impact will depend upon the desirability of the area for hunting, and access and hunting regulations imposed by the land managing agencies.

Cultural Resources: This alternative approaches no National Historic or Archeological Sites. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: This alternative traverses areas of low to high scenic quality. In terms of viewer contacts, this corridor will have little impact since it will not be visible from transportation routes for most of its length. Disregarding viewers, high visual impact to scenic and wilderness quality in the mountainous portion of the corridor can be expected.

Land Use and Resources: There will be no impacts on forestry and agriculture throughout this alternative. There will be no impacts on mineral or fossil fuel resources.

Impacts of Alternative Nenana-5

Soils: The soils from Watana Damsite to Wells Creek will be very vulnerable to permafrost degradation and frost heaving. The vegetative mat must be preserved, and construction activity must be planned to minimize disruption of the soil. Erosion caused by permafrost degradation and access road construction will have adverse impacts on water quality in the clearwater streams encountered.

Fording of streams in this segment, given the sensitive soil conditions, could result in extensive bank erosion. To minimize this and to ensure the integrity of the transmission line, the corridor will avoid river crossings when possible.

From Wells Creek to upper Wood River the soils are rocky, thin soils and bedrock, and as such are well suited generally for tower foundations. Access road construction will be hampered by steep slopes, bedrock, and talus encountered by this corridor. Erosion will generally be low, although on thin soils or unstable slopes erosion will be severe unless corrective measures are employed. Permafrost can be assumed to be continuous, but will not usually be of concern to tower location unless the soil is ice-rich. This condition is assumed to be restricted to valley floors.

The Wood River valley and Tanana River valley present problems with locating well drained soils. Large areas of poorly drained peats with continuous shallow permafrost will result in potential severe impacts such as permafrost degradation, rutting and scarring of the surface, bank erosion where clearwater streams are forded, and erosion caused by access road construction. The necessary clearing will also greatly add to erosion and siltation. Preventive and corrective measures will need to be used to minimize these impacts.

Vegetation: This corridor will require up to 1,369 acres of clearing, 74 acres less than Nenana-1. Actual acres cleared will probably be less than this figure since the entire right-of-way need not be cleared. The majority of the clearing will be along the Tanana River valley and lower Wood River in the bottomland spruce-poplar and upland spruce-hardwood ecosystems. Along the greater part of the corridor the access road can be incorporated into the clearing due to level terrain.

The most immediate effect of clearing will be the destruction of the cleared vegetation. Downed timber and slash must be disposed of by open burning or chipping when possible to prevent infestation of standing stocks of bottomland spruce-poplar with spruce beetle (Dendroctonus rufipennis) and the accumulation of fuel for wildfire. Non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly in the bottomland spruce-poplar ecosystem.

Destruction of the vegetative mat in tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrence of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Some disruption of the soil from clearing is to be expected. Increased erosion because of this, and enhanced by the lack of cover, will result. If vegetation is cleared up to river banks on stream crossings, this may result in additional sedimentation.

Wildlife: There will be loss of individual smaller animals and displacement of others; however, this is a temporary setback. High reproductive rates of small mammals and re-invasion will amend this impact.

A permanent habitat modification will result from the clearing and maintenance. A corridor of brush will be maintained through otherwise forested land. Animals dependent upon climax forest, such as squirrels, will suffer some habitat loss. Animals dependent upon brush and forbs for browse will gain.

The large concentration of moose along the lower Wood River and the Tanana River will benefit from the regrowth of brush into cleared areas. Dall sheep and caribou in the mountainous areas will suffer some loss of forage to the roadbed and tower bases. Excessive fire will adversely affect the forage for these last two game animals since they are dependent upon climax vegetation which has a slow regrowth rate. Moose will benefit from fires, up to a point. Excessive fires may trigger erosion which would degrade, rather than enhance, browse for moose.

Construction activity may cause avoidance of the corridor by animals; however, this is a temporary impact. Operation and maintenance will not affect the animals' occupation of the corridor.

Increased access afforded by the service road may increase hunting pressure on Dall sheep, caribou, and moose. The degree of this impact is dependent upon the desirability of this corridor for hunting, and access and hunting regulations imposed by the land managing agencies.

Recreation: This corridor does not traverse any Federal or State parks or recreation areas. The corridor will provide access to an area previously accessible only by air or foot. In some cases, access is presently possible with all-terrain vehicles. Increased access will impact game animal populations somewhat. The actual impact will depend upon the desirability of the area for hunting, and access and hunting regulations imposed by the land managing agencies.

Cultural Resources: This alternative approaches no National Historic or Archeological sites. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: This alternative traverses areas of low to high scenic quality. In terms of viewer contacts, this corridor will have little impact since it will not be visible from transportation routes for most of its length. Disregarding viewers, high visual impact to scenic and wilderness quality in the mountainous portion of the corridor can be expected.

Land Use and Resources: There will be no impacts on forestry and agriculture throughout this alternative. There will be no impacts on mineral or fossil fuel resources.

Impacts of Alternative Matanuska-1

Soils: From Devil Canyon to Vee Damsite, some problems related to poorly drained woils will be encountered. Generally, erosion potential along this segment will be low to moderate. Permafrost degradation potential is low. The relatively level nature of the terrain will facilitate construction of an access road without undue erosional problems. Several clearwater streams will need crossing. Sedimentation may occur from these crossings, but since they will be crossed close to their confluences with the silt-laden Susitna, this impact will be low.

From Vee Damsite to Slide Mountain the potential for permafrost degradation is very high. The poorly drained fine-grain soils encountered are very vulnerable to frost heaving, which will entail much maintenance of the line and road. The potential for scarring and rutting of the surface is high, and the subsequent erosion may cause significant sedimentation in the many clearwater streams in this area.

From Slide Mountain to Palmer, the corridor encounters less sensitive soils. Once over Tahneta Pass permafrost becomes increasingly discontinuous, and well drained soils predominate. Erosion potential is low to moderate and construction of an access road should present no undue erosional impacts.

Steep slopes in the upper Matanuska Valley may present some erosional problems, but the slopes are generally stable. Thin soils are also common, and potential for denudation of slopes below an access road cut exists, but should be easily preventable.

In the lower Matanuska Valley soils susceptible to water erosion are encountered, and location of towers and road will have to be planned not only to prevent bank cutting, but also to avoid a threat to the integrity of the line. Since this area is also the State's only major agricultural area, extensive care should be taken to avoid adversely affecting good quality, arable soils.

From Palmer to Point MacKenzie large areas of poorly drained soils will again necessitate great care in location of the transmission line. Although permafrost is absent, scarring of the soft peat soils is still a possibility, and the subsequent sedimentation of clearwater streams will have an adverse impact on aquatic life. The heavier clearing necessary in this area will also contribute somewhat to sedimentation; to what degree is dependent upon the care exercised in minimizing disruption of the soil.

Vegetation: If a 345 kv transmission system is constructed, this alternative could require up to 2,817 acres of clearing, 510 acres more than Susitna-1. If a 230 kv system is used, up to 2,514 acres of clearing will be necessary, 454 acres more than a similar system along Susitna-1. The majority of this clearing will be in the lower Matanuska Valley and along the north shore of Cook Inlet to Point MacKenzie. Very little clearing will be required along the portion from Vee Damsite to the Little Nelchina River. Actual acres of clearing will probably be less than the above figures since the entire width of the right-of-way need not be cleared. The terrain is generally level; so the access road can be incorporated into the line clearing without additional clearing.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain, mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires, and to reduce potential infestation of healthy bottomland spruce-poplar by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber, chipping, or by burning. Although burning will reduce air quality temporarily, it is more economical and less damaging than the alternatives; so, non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly on the bottomland spruce-poplar ecosystem.

Regrowth rates along this corridor are fast enough, particularly in the southern portion, to warrant periodic suppression of tall growing trees which pose a hazard to the transmission line. The preferred method along this corridor is manual application of a suitable herbicide. The amount of clearing to be maintained, the modest regrowth rates, and high cost of labor make this alternative preferrable in this corridor over aerial application of herbicides on the one hand, or hand cutting of individual trees on the other. If proper application techniques are adhered to (see Mitigating Measures), there will be no other impacts other than the maintenance of a sub-climax vegetation. Accidental overspraying or wind drift, or improper dilution, resulting in unnecessary destruction of vegetation and spraying of water bodies resulting in habitat destruction for aquatic life will not occur.

Sections needing vegetation suppression occur in the bottomland spruce-poplar, lowland spruce-hardwood, and upland spruce-hardwood forests, particularly in the bottomland spruce-poplar. Muskeg-bog areas, which comprise a significant proportion of the ecosystems crossed by this corridor will need little clearing and no vegetation suppression. Lowland spruce-hardwood areas will not need to be maintained as often as bottomland spruce-poplar.

In the moist tundra ecosystems encountered between Vee Damsite and the Little Nelchina River, destruction of vegetation will be limited to those areas directly occupied by the roadbed and the tower bases. This will be a permanent impact, although some revegetation of tower bases can be expected.

Destruction of the vegetative mat in the tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrence of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Wildlife: Alteration of vegetation patterns will affect wildlife. This corridor traverses many areas of moose concentration, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase nearer the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

Animals dependent upon climactic forest such as squirrels will suffer loss and displacement. However, their faster reproductive rates will allow their populations to adapt rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover, this will be limited. In any event, this impact should be low in this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant.

Areas requiring clearing coincide with moose populations. The resulting brush will be to their benefit. Caribou on the upland between the Susitna and Little Nelchina Rivers will suffer some direct loss of forage from the vegetation covered by the roadbed and tower bases. Of more importance to caribou habitat is the potential overburning of key winter browse, and the subsequent reduction of winter range. Since the Nelchina caribou herd has undergone drastic reductions in population (from an estimated 61,000 in the late 1960's to an estimated 4,000 to 5,000 presently) any adverse impact on caribou habitat can be considered serious. The access road will seriously affect hunting success unless hunting is further restricted in this area. There will be only slight impact on Dall sheep range in Tahneta Pass.

Recreation: This corridor approaches no State or Federal park or recreation area. However, areas with a high recreational use are encroached upon. The Lake Louise area is a complex of interconnected lakes set upon a gentle, rolling uplands, and receives high use for vacationing, fishing, and camping. Lake Louise itself lies approximately 10 miles east of this alternative corridor. Increased access and visibility of transmission structures will have impacts upon the recreational use. Since the area is served by only one road to the Glenn Highway, an access road would increase access to the area. This may be perceived as an adverse impact by people already owning or leasing sites along the lakes who value the relative solitude, and may be perceived as beneficial by fishermen, hunters, and others wanting access to cabin sites on these lakes.

From Devil Canyon to Slide Mountain this corridor will traverse areas previously accessible only by foot or air. The impact of an access road has been discussed above. For access to the north of Lake Louise, increased access will allow greater use of this upland area. For hunters particularly, the increased access may be perceived as desirable. Access will be controlled by the land managing agency having jurisdiction over these areas.

Cultural Resources: This corridor will approach the sites of the Independence Mines and Knik Village, both National Historical Sites. The corridor will avoid the Independence Mines by at least 8 miles; so no impact on this site is anticipated. The Knik site will be approached up to 3 to 5 miles; however, impact on this site will be low to none.

If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or tower will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: There will be a medium to high impact on scenic quality of the Tahneta Pass-upper Matanuska Valley area. High existing scenic quality, large numbers of viewers along the Glenn Highway, and some difficulty in concealment of a transmission line contribute to this impact. Development of the lower Matanuska Valley, which has already affected the intactness of that area, will lessen visual impact. The opportunities for concealment are greater also in the lower valley. Low numbers of viewer contacts and ease of concealment will greatly mitigate visual impact from Palmer to Point MacKenzie. Visual impact here is low to medium.

Visual impact from Vee Damsite to Slide Mountain is low. This is a factor of low viewer contacts, low to medium existing scenic quality, and toward Slide Mountain some measure of concealment.

Land Use and Resources: A low impact is expected on agriculture on the Matanuska. The final route can avoid presently developed land and high quality undeveloped land. Even if land in production were to be crossed, only the land directly occupied by the tower bases would be rendered unfarmable. Much of the agricultural land is devoted to dairying and hay. There would be a very low impact on these uses. Truck farming would be impacted more than dairying or hay since the patterns of row crops would be affected by tower locations.

No significant impacts are expected on potential forestry along this alternative, nor are any significant impacts expected on minerals extraction.

Social: Some socio-economic impacts can be expected for Palmer, Wasilla, and the several small communities along the north shore of Cook Inlet. Skilled labor will most likely not be drawn from these communities, although it is possible that unskilled labor from these communities might be employed on the construction phase. Local services such as food and lodging should experience an increase in business, but this will be a temporary impact, and due to the relatively small amount of workers needed and the shifting aspect of the construction, an insignificant impact, also.

Easements will need to be purchased over privately owned lands. This will give a lump sum payment, which will be a positive impact upon the land owner. Future rise in land prices and assessed taxes due to encroaching residential development will adversely impact land owners who have easements on their land. They will pay tax on land they cannot develop, at rates far beyond the rates for undeveloped land. In cases where this may occur, some arrangement such as an increased lump sum payment or annual payments equal to the difference in tax rates should be made.

Impacts of Alternative Matanuska-2

Soils: Impacts on soils from Slide Mountain to Point MacKenzie are identical to those described under impacts on soils of alternative corridor Matanuska-1.

Throughout the entire segment from Watana Damsite to Slide Mountain by way of Glennallen, the potential for permafrost degradation is very high. The poorly drained fine-grain soils encountered are very vulnerable to frost heaving, which will entail much maintenance of the line and road. The potential for scarring and rutting of the surface is high, and the subsequent erosion may cause significant sedimentation in the many clearwater streams in this area.

Particularly sensitive is the Gulkana and its tributaries. The corridor parallels this system for approximately 50 miles, and multiple crossings will have cumulative effect on sedimentation.

Vegetation: The Matanuska-2 alternative could require up to 3,869 acres of clearing if a 345 kv system is constructed. This is 1,561 acres more than the proposed Susitna-1 corridor. If a 230 kv system is used, up to 3,454 acres will need clearing, 1,394 acres more than Susitna-1. Actual acreage of clearing will probably be less than these figures since not all of the right-of-way need be cleared, and the terrain is level enough so that the access road can be incorporated into the line clearing.

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain, mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes, hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

To reduce available fuel for forest fires, and to reduce potential infestation of healthy bottomland spruce-poplar by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber, by chipping, or by burning. Although burning will reduce air quality temporarily, it is more economical and less damaging than the alternatives, so non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly on the bottomland spruce-poplar ecosystem. (See Mitigating Measures.)

In the moist tundra ecosystem crossed from Watana Damsite to within 10 or 20 miles of Paxson, destruction of vegetation will be limited to those areas directly occupied by the roadbed and the tower bases. This will be a permanent impact, although some revegetation of tower bases can be expected.

Destruction of the vegetative mat in tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrence of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Wildlife: Alteration of vegetation patterns will affect wildlife. This corridor traverses many areas of moose concentration, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase nearer the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

Areas requiring clearing coincide with moose populations. The resulting brush will be to their benefit. Caribou on the uplands between the Susitna and Little Nelchina Rivers will suffer some direct loss of forage from the vegetation covered by the roadbed and tower bases. Of more importance to caribou habitat is the potential overburning of key winter browse, and the subsequent reduction in winter range. Due to the drastic reduction in the population of the Nelchina herd, (from an estimated 61,000 in the late 1960's to an estimated 4,000 to 5,000 in 1974) any adverse impact on caribou is a serious impact. Increased access will be a serious adverse impact unless hunting is further restricted in this area.

Animals dependent upon climactic forest such as squirrels will suffer loss and displacement However, their fast reproduction rates will allow their populations to adapt rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover, this will be limited. In any event, this impact should be low in this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed.

Recreation: This corridor approaches no State or Federal park or recreation area. However, areas with a high recreational use are encroached upon. The Lake Louise area is a complex of interconnected lakes set upon a gentle, rolling uplands, and receives high use for vacationing, fishing, and camping. Lake Louise lies approximately 35 miles to the west. Since the corridor will parallel an existing highway, it is unlikely that it will contribute greatly to increased access to this lake complex.

Except for the portion from Watana Damsite to Denali Damsite, the corridor will parallel existing highway. Threfore, it is not expected that the corridor will provide access to significantly large areas.

Cultural Resources: Apart from Independence Mines and the Knik site discussed under alternative Matanuska-1, the only National Archeological site is the Tangle Lakes Archeological District west of Paxson. Careful examination of the final route will minimize any chance of disruption of archeological sites within this district. A National Historical Site, Sourdough Lodge, will not be approached enough to be affected. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: Impact to scenic quality from Denali Damsite to Paxson will be high. Large numbers of viewer contacts, little opportunity for concealment, and areas of high existing scenic quality are factors in this high impact. From Watana to Denali Damsites, visual impact is low. From Paxson to Slide Mountain visual impact will range from low to moderate.

For the rest of this alternative, visual impacts are as described for alternative Matanuska-1.

Land Use and Resources: Little or no impact is expected on agriculture, forestry, or mineral extraction.

This corridor will parallel the right-of-way of the Alyeska Pipeline and the Richardson Highway. It will, by doing so, reinforce the existence of a utility corridor and subsequently, the location of future rights-of-way. Some savings of total width of this corridor could be achieved by sharing of rights-of-way. (See Alternatives to the Proposed Action.)

Social: Socio-economic impacts will be identical to those discussed for alternative Matanuska-1, with the exception of two additional communities, Glennallen and Paxson. Since the corridor will run so close to both, it is very likely that they will receive impacts upon their services such as lodging and food. This is a temporary impact, and not very significant. Some local labor may be employed during construction, but this will probably be unlikely.

Easements will need to be purchased where private land must unavoidably be crossed. This will result in the land owner receiving a lump sum payment, and will provide some influx of capital to these areas.

Impacts of the Delta Alternative

Soil: This alternative crosses significantly large areas of soils having moderate to high erosion potential. There are two sensitive soil areas: 1) The poorly drained, ice-rich permafrost found throughout the entire length of the route. This soil is vulnerable to permafrost degradation, frost heaving, and rutting and scarring of the top soil. 2) The second sensitive soil type is the fine-grain soils, generally well drained upland soils, found between Shaw Creek and Fairbanks. This soil is vulnerable to gulleying, unstable slopes, and wind erosion.

Erosion from either of these two soil types may cause sedimentation in the many clearwater streams that are tributaries to the Tanana River. Generally, these clearwater tributaries are limited to those draining the northeast portion of the Tanana River valley in this area. Tributaries of the Tanana from the Alaska Range are sediment laden and will not be significantly impacted from erosion.

Local problem areas will be encountered. North of Summit Lake, in Isabel Pass, is an area of thixotropic soils which become plastic under seismic shock. Unless this soil can be feasibly circumvented, transmission towers in this area will be under higher than normal seismic risk. Through the Isabel Pass, rocky soils interspersed with bedrock and talus will present problems in placing of tower foundations and access road. Excessive cutting and filling for an access road through this area, in conjunction with thin soils or unstable slopes, can cause severe erosion.

A large, extremely marshy area around the Shaw Creek confluence will be encountered. Tower foundations will need special attention and the access road will need special design. Frost heaving will be severe in this marshy soil.

Vegetation: The Delta alternative could require up to 1,737 acres of clearing, 288 acres more than Nenana-1. The actual acreage cleared will probably be less than these figures since the entire width of the right-of-way need not be cleared. In areas where clearing is required, the terrain is level enough to permit the access road to be incorporated into the line clearing.

The majority of the clearing will be done in the upland spruce-hardwood and bottomland spruce-poplar along the lower Delta River and the Tanana River.

To reduce available fuel for forest fires, and to reduce potential infestation of healthy bottomland spruce-poplar by spruce beetles (Dendroctonus rufipennis) and ips beetles, slash must be disposed of. This can be either by sale of merchantable timber, by chipping, or by burning. Although burning will reduce air quality temporarily, it is more economical and less damaging than the alternatives, so non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly in the bottomland spruce-poplar ecosystem. (See Mitigating Measures.)

The immediate effect of this clearing will be the destruction of the vegetation. The much more significant impact will be upon erosion and wildlife habitats. In hilly terrain, mechanical clearing methods such as bulldozing will cause considerable disruption of the soil and subsequent erosion and stream sedimentation. The use of brush blades or rotary cutters will reduce this effect. On steep slopes, hand clearing will mitigate the otherwise heavy erosion potential likely with mechanical clearing.

In the alpine and moist tundra ecosystems found from Watana Damsite through Isabel Pass and the Alaska Range, destruction of vegetation will be limited to those areas directly occupied by the roadbed and the tower bases. This will be a permanent impact, although some revegetation of tower bases can be expected.

Destruction of the vegetative mat in tundra areas will result in long lasting scars unless corrective and preventive measures are taken. This scarring could lead to subsequent degradation of ice-rich permafrost and erosion.

Fires resulting from construction and operation, unless suppressed quickly, will result in extensive destruction of vegetation. These ecosystems are adapted to natural wildfires, and unless the occurrence of man-caused fires is very high, they should recuperate as quickly as they would under normal circumstances.

Wildlife: The areas requiring the most clearing coincide with many areas of moose concentration, and moose should benefit from the introduction of brush resulting from the regrowth on the clearing. Since the clearing must be maintained, this brush area will last for the life of the line. Most brush areas are in transition, changing from the brush phase to some other phase nearer the climactic phase. The brush in a transmission clearing can be counted as a more permanent source of browse.

The large numbers of caribou in the Nelchina herd south of the Alaska Range will suffer some direct loss of forage from the vegetation covered by the roadbed and tower bases. Of more importance to caribou habitat is the potential overburning of key winter browse, and the subsequent reduction in winter range. Due to the drastic reduction in the population of the Nelchina herd, (from an estimated 61,000 in the 1960's to 4,000 to 5,000 in 1974) any adverse impact is a serious impact. Increased access will seriously affect the herd unless hunting is further restricted. There will be only slight impact on Dall sheep range in Isabel Pass and the canyon of the Delta River.

Animals dependent upon climactic forest such as squirrels will suffer loss and displacement. However, their faster reproductive rates will allow their population to adapt rapidly.

Most animals will benefit from the edge environment, offering both forage and cover from the adjacent forest and brush. Initially, animal movements may occur along the right-of-way, but as the brush grows into a dense cover this will be limited. In any event, this impact should be low on this corridor.

Construction itself will affect wildlife. Larger mammals may temporarily leave the area to return after the construction activity. Smaller animals will suffer loss of individuals, but should recuperate rapidly once construction is completed. The density of forest in this corridor will allow animals to move only a short distance to avoid contact with construction activities.

Vegetation suppression, by whatever method, will periodically remove cover from along the right-of-way. However, due to the surrounding cover of the uncleared forests, this impact will be insignificant.

Recreation: This corridor does not infringe upon any Federal or State park or recreation area. Since the Delta alternative parallels existing highways and the Alyeska Pipeline, it will not provide new access to any significantly large area. Use of the access road is dependent upon regulations imposed by the landowners or land managing agency.

Cultural Resources: For the segment from Watana Damsite to Paxson the impacts are as described under impacts of alternative Matanuska-2. From Paxson to Fairbanks there are no National Archeological or Historical Sites. If the final survey discloses an unsuspected archeological site along the right-of-way, the location of the line or towers will be altered to avoid damage to such sites. Inadvertent damage to an archeological site will reduce its historical value. At the same time, discovery of an archeological site during survey or construction will be a beneficial aspect.

Scenic Resources: This corridor will have visual impacts ranging from high along the Denali Highway and through the Isabel Pass-Alaska Range area, moderate from Donnelly Dome to the Salcha River, and to low from the Salcha River to Fairbanks. Since nearly the entire corridor is exposed to viewers from the Denali and Richardson Highways, the variables are the existing scenic quality and the opportunities for concealment. Along this alternative, generally the higher the existing scenic quality, the less the opportunity for concealment.

Land Use and Resources: No impacts are expected on minerals extraction. The area around Big Delta and Delta Junction is a potentially major agricultural area, particularly in grain crops such as barley. Crossing of good quality arable land will result in the removal from production of the land occupied by the tower bases. Row crops will be more affected than field crops in that patterns of tilling and harvesting will be more disrupted by tower locations.

Along the lower Delta River and the Tanana River there is potential for forestry, particularly in the bottomland spruce-poplar ecosystems. The Delta alternative will have little effect on forestry, apart from minimal use as logging roads or firebreaks. Merchantable timber from clearing operations can be disposed of by sale. The proximity of a highway and river will facilitate salvage of logs.

Paralleling of the Alyeska Pipeline and the Richardson Highway will reinforce the utility corridor along the Delta and Tanana Rivers, and will affect location of future rights-of-way. the total width of this utility corridor can be reduced by sharing of rights-of-way. (See Alternatives to the Proposed Action.)

Social: The towns of Paxson, Delta Junction and Big Delta will benefit from use of services such as food and lodging by construction workers. It is unlikely that much of the labor needed for construction will be drawn from the smaller communities.

Logging of timber and clearing contracts will affect towns along the Tanana River by providing jobs and capital from sales of timber. This will be a short-lived impact, however.

Some easements across private land may need to be purchased. The majority of the alternative can be routed along the utility corridor along the Alyeska Pipeline. Purchases of easement will provide a lump sum influx of capital to the affected land owners. This influx is temporary, unless arrangements are made for yearly payments.

Comparison of Impacts of Corridors

From the preceding descriptions of potential impacts of the various alternative corridors, comparisons can be drawn to rank these alternatives as to their degree of cumulative impact. Several assumptions will be used in these comparisons, and from these comparisons the proposed corridors were selected.

The first assumption to be made is that other factors being equal, cumulative impacts are proportional to corridor length. In other words, a 100 mile corridor will have twice the cumulative impact a 50 mile corridor crossing similar terrain and ecosystems would have. If varying conditions exist, this assumption is not necessarily valid; a 100 mile corridor crossing stable soils may incur less impact than a 50 mile corridor over ice-rich permafrost.

The second assumption is that joint use and paralleling of existing rights-of-way is preferable to pioneering of a new corridor because of the secondary impacts associated with new corridors.

Against this assumption is the assumption that transmission systems always cause an adverse visual impact of varying degree, and that transmission systems should be screened as much as possible from major surface transportation routes. Thus a transmission line ideally should share or parallel transportation rights-of-way and yet not be seen from them; this is a condition rarely achieved.

The fourth assumption is that a transmission corridor should be located to anticipate future needs, and so reduce potential proliferation of future transmission corridors. Practically, this will favor corridors that approach present and potential communities that may require interconnection.

The fifth assumption is that the corridor should fulfill its requirements as economically as possible while keeping environmental impacts to a minimum. This is an extension of the first, second, and fourth assumptions.

Using these assumptions as broad categories in conjunction with environmental criteria, the twelve corridors can be summarized and ranked in the following table:

Corridor Analysis - Project Power to Anchorage/Cook Inlet Area

Analysis Factor:	Susitna Corridors S - 1	Susitna Corridors S - 2	Susitna Corridors S - 3	Susitna Corridors S - 4	Matanuska Corridors M - 1	Matanuska Corridors M - 2
Length, miles	136	140	129	147	258	385
Max. elevation, feet	2,100	2,100	3,800	2,200	3,000	4,000
% of joint or parallel use	75	75	39	35	52	90
Cost x $1,000	92,650	94,986	93,712	96,072	153,187	224,427
Ability to accommodate future needs	1	1	3	3	4	2
Ranking	1	1	2	1	3	4
Environmental Impacts						
Soils	1	2	1	1	2	2
Vegetation	2	3	1	3	4	5
Wildlife	1	2	3	3	4	3
Existing developments	3	3	2	1	3	3
Scenic quality/recreation:						
Developed areas	3	3	2	1	3	3
Remote areas	1	2	3	4	4	3
Ranking	1	3	1	3	4	4

Corridor Analysis - Project Power to Fairbanks/Tanana Area

Analysis Factor:	Nenana Corridors					Delta Corridor
	N - 1	N - 2	N - 3	N - 4	N - 5	D
Length, miles	198	220	231	223	212	280
Max. elevation, feet	2,400	4,300	4,000	4,000	4,300	4,000
% of joint or parallel use	100%	38%	78%	43%	0%	86%
Cost x $1,000	85,382	107,090	106,272	95,648	96,572	122,475
Ability to accommodate future needs	1	4	3	4	5	2
Ranking	1	3	3	3	4	3
Environmental Impacts						
Soils	1	3	2	2	3	3
Vegetation	2	2	3	2	1	3
Existing developments	3	2	2	2	1	2
Scenic quality/recreation:						
Developed areas	3	2	2	1	1	3
Remote areas	1	3	2	2	3	2
Ranking	1	3	3	2	1	3

Combining the information on this table with the more detailed descriptions of potential environmental impacts of the corridors in pages 34 to 74, a brief discussion of each corridor and its relative suitability follows:

Susitna-1

Of the possible corridors from the Upper Susitna Project to the Anchorage area, the Susitna-1 corridor is the second shortest, and one of the closest adherents to existing corridors. Because of the fairly heavy to moderate forest density, the clearing can be screened from the parallel Alaska Railroad and Anchorage-Fairbanks Highway. Of the six corridors leading to the Anchorage area, this is the cheapest to construct.

Some of the advantages of this corridor are its directness and its proximity to small communities which may eventually require a direct tap. It avoids the Denali State Park and consequential scenic impacts as seen from the highway, and avoids unnecessary crossings of the Susitna River.

The disadvantages of this corridor are: the additional access provided to the area between Talkeetna and Gold Creek, which is presently served by flag stops on the Railroad; the new access provided to the area between Nancy Lake and Point MacKenzie; and the possible interference with recreation in the Nancy Lake Recreation Area.

Susitna-2

This corridor is slightly longer than Susitna-1, more expensive, and will interfere with recreation in the Denali State Park. Concealability of the line from transportation routes is equal to Susitna-1, as is its ability to incorporate future electrical needs of communities enroute. Interference with the Nancy Lake Recreation Area and the new access provided to Point MacKenzie is similar to Susitna-1.

The major disadvantage of this corridor will be the interference with the Denali State Park; it would practically render the Park area to the east of the Highway uesless for hiking trails, since trails of any length over five miles would cross the right-of-way. For this reason, it is not preferred over Susitna-1.

Susitna-3

This is the shortest of the corridors, and the second to the cheapest corridor to Anchorage. It avoids visibility from transportation routes by striking to the northeast through relatively inaccessible country. Thus, it is less able to accommodate new taps along the stretch from Talkeetna to Gold Creek. The proximity to Nancy Lake Recreation Area and the access to Point MacKenzie are similar to Susitna-1.

This corridor has two serious disadvantages: First, it will pioneer a considerable area of land, reducing wilderness values and permitting problems with increased access. Secondly, it will be more vulnerable to weather and reliability will be reduced. For these two reasons, it is not favored over Susitna-1.

Susitna-4

This corridor is considerably longer and more expensive than Susitna-1; only 33% of its length follows existing corridors, since it avoids public transportation routes by leading northeast to Devil Canyon from Talkeetna. It is not as able to handle new loads from Talkeetna to Gold Creek as Susitna-1; the proximity to the Nancy Lake Recreation Area and the increased access to Point MacKenzie are similar to Susitna-1.

The large area of new access provided, with its attendant problems, combined with recreational use of the Stephan Lake area reduce the value of this corridor. Because of this and its higher cost, it is not preferred over Susitna-1.

Matanuska-1

This corridor is almost twice as long as Susitna-1, and about 60% more expensive. Half of its length parallels existing corridors; where it does follow these corridors, its concealability varies from low to high. It is poorly suited to accommodate future electrical needs.

There are several major environmental objections to this corridor. First, it would open up a very large area of previously inaccessible (except by air) area. This area is unique in many ways: first, it is a considerable part of the Nelchina caribou range, and since this herd has suffered major declines recently, any impact on their range will be adverse. Secondly, this area has a high recreational use, such as fly-in hunting, fishing, and cabins; increased access may reduce wilderness values for this sort of recreation. Thirdly, this is a large area of continuous ice-rich permafrost. These objections, combined with its length and cost, rule out this alternative.

Matanuska-2

This corridor is almost three times longer than Susitna-1 and almost 150% more in cost. However, most of its length parallels existing corridors; visibility from transportation routes would be medium to high for much of its length. It would be well-suited to the interconnection of the CVEA system.

Since it follows existing corridors for most of its length, the new-access problem is rather low for this alternative. The major environmental objection to this corridor will be the large area of ice-rich permafrost to be crossed, and visibility in scenic areas, as in Tahneta Pass and the Upper Matanuska Valley. However, its length and cost are inordinately high, so this corridor is not recommended at this time.

Nenana-1

The Nenana-1 corridor is the shortest and cheapest corridor connecting the Upper Susitna Project to Fairbanks. It would parallel or use existing rights-of-way for its entire length, and its ability to accommodate future electrical needs are very good.

The main objection to this corridor would be the lack of concealment from south of Broad Pass to Healy; varying degrees of visual impact along this stretch could be expected. Although not entering the Mount McKinley National Park, it would be visible along the Anchorage-Fairbanks Highway in the vicinity of the Park. No other major environmental problems are anticipated. To further reduce impact, no access road is planned from Healy south to the Project area. This modification would apply not only to this corridor, but also to the Cantwell-Gold Creek sections of Nenana-2 and Nenana-3.

Nenana-2

Although not much longer or more expensive than Nenana-1, this corridor would provide access to a very large area; only 38% of its length follows existing corridors. Those sections paralleling the Anchorage-Fairbanks Highway/Alaska Railroad corridor would be rather visible.

The increased access is a major environmental objection; the major recreational use of this access road would be for hunting, and wilderness quality of this area would be irreversibly damaged. Another major objection is the necessity of crossing several high passes in the Alaska Range; reliability would be less, not only because of harsher conditions, but also to uncertainty of access for repairs. This corridor is less suitable than Nenana-1.

Nenana-3

This corridor is more expensive and longer than Nenana-1. It parallels existing rights-of-way for more than 75% of its length, circumventing the Nenana canyon area by way of two other passes in the Alaska Range. From the Project to Cantwell, it would be rather visible. It is much better suited to connect existing and potential communities to the interconnected system than Nenana-2, but will not be able to be tapped by McKinley Park.

A significant area of mountainous terrain will be opened up by this corridor, unless helicopter construction is used. One high pass will need to be crossed; the harsh conditions will reduce reliability of operation and access. This corridor is not preferred over Nenana-1.

Nenana-4

Slightly longer and more expensive than Nenana-1, this corridor would not be seen from transportation routes from the Project area north to Healy. Less than half of this corridor parallels existing rights-of-way, and it would be poorly suited to accommodate future electrical needs of existing or potential communities.

Not only would this corridor have the same objections as that of Nenana-3, it also would provide access to the area immediately north of Watana damsite to the Denali Highway, dividing what is now a fairly large wilderness area. This area can be expected to provide unsuitable soils, much of it ice-rich permafrost. Nenana-4 is not preferred over Nenana-1.

Nenana-5

This corridor is unique in that its whole length pioneers a new corridor; no existing rights-of-way are paralleled. Yet, its length and cost are not much greater than Nenana-1. It would be very poorly suited to accommodate future electrical needs of existing and potential communities.

This corridor combines the objections of Nenana-2 and Nenana-4, and its only advantage would be its concealment from transportation routes. Thus, this corridor is not recommended.

Delta

The Delta corridor is twice as long and 50% more expensive than Nenana-1. Most of it parallels existing rights-of-way, and for many stretches, would be highly visible from the Denali and Richardson Highways. It has a fair suitability for accommodating future electrical needs of existing or potential communities. In addition, it can serve to power pipeline pumping stations and connect the CVEA and GVEA systems.

The major environmental objections to this line are: there is a large area of poor soils to be crossed along the Denali Highway and through Isabel Pass; the line would also be highly visible in these two areas. This corridor infringes on the Nelchina caribou range. Since the Nelchina herd has suffered such dramatic losses in the past ten years, any impact on their range should be considered adverse. The only Endangered Species in Alaska, the Peregrine falcon, would be affected in its habitat along the Salcha Bluffs. A large archeological district would have to be crossed west of Paxson. These objections, combined with length and cost, rule against this alternative.

The selection of the Nenana-1 and Susitna-1 as the proposed corridors does not disavow the impacts associated with them; it only selects these two as the most economically desirable and the least environmentally objectionable alternatives. Lessening, or mitigation, of the impacts of these two corridors is discussed in the following section.

MITIGATION OF IMPACTS

Most mitigating measures are basically standard practices stringently enforced. If basic applicable regulations issued by the Federal, State, and local governments regarding environment quality are adhered to, most impacts affecting air and water quality will be minimized. Application of practices and guidelines such as those issued in Environmental Criteria for Electric Transmission Systems, a joint Department of the Interior, Department of Agriculture publication, will reduce visual and environmental impacts.

Consultation with agencies proficient in certain areas of concern, such as the Soil Conservation Service and the State Department of Fish and Game, will provide further guidance on mitigation of impacts.

More specific mitigating measures are discussed below. It must be remembered that many of these are standard practices intended not only to minimize damage to the environment, but also to protect the integrity of the transmission line.

Experience gained from construction and maintenance of other transmission systems in Alaska has shown that most environmental impacts from transmission lines can be avoided. Golden Valley Electric Association and Chugach Electric Association have constructed and operated several lines without access roads, on poor soils, and under harsh climatic conditions.

Except for visual impact, most environmental impacts caused by a transmission system are far less than many transportation and communication systems; particularly if it is an overhead system. The majority of the impacts are due to the access roads; if the access road can be omitted, a large portion of the potential impacts will be eliminated.

The following mitigative procedures will assume the existence of an access road and its potential impacts; it must be remembered that access roads will not be used where they are shown to be incompatible with the environment.

Soils

Since it is expected that most damage to soils will occur during the construction phase, the construction schedule can be arranged so that considerable amounts of the work, particularly those requiring the use of an access road, such as delivery of materials, can be done in winter and spring, when the ground is least vulnerable to physical disturbances.

However, winter road use will be dependent upon snow depth and surface conditions; winter use can affect surface vegetation through destruction of surface plants, or over-compaction of snow.

Temporary roads will be avoided as much as possible; access roads will be built to a standard applicable to the expected use. If so designated by the State Department of Highways, some sections of access roads will be built to secondary road standards.

Not all sections of the line will require an access road; particularly sensitive areas may be protected by the use of helicopter construction and maintenance, or the use of winter access roads and helicopter maintenance. It should be recognized, however, that dependence on aerial methods leaves the construction and/or maintenance program more vulnerable to weather conditions. One major section will be constructed without access roads from Devil Canyon to Healy.

For ground work, roads must be adequately constructed to avoid erosion, slope instability, degradation of the permafrost, and alteration of drainage. Gravel or other insulating material should underlay permanent access roads on permafrost area; culverts and bridges where necessary should be placed to avoid disruption of drainage and possible icing conditions. Slopes on cuts and fills should be of proper gradient and revegetated as soon as possible to prevent erosion and slumping. Revegetation will be done with species recommended in A Vegetative Guide for Alaska published by the Soil Conservation Service.

For ground work off of the access road, or where no access road will be provided, machinery compatible to the surface should be used. For shallow permafrost areas, soft muskeg and bogs, and highly erosive soils, machinery with low-pressure treads or tires shall be used to avoid scarring the vegetative mat and incurring subsequent erosion.

On sensitive soils, such as ice-rich soils with a shallow permafrost table, disturbed soil will be protected with an organic insulating mulch, such as straw, or when available, chipped slash from the clearing. Revegetation with appropriate cover plants will immediately follow construction. To reduce the likelihood of disturbance of marshy soils, mats of slash, logs, or other materials will be used.

On erodable slopes, no bulldozing will be done on slopes greater than 35%. All cuts and fills shall be angled back sufficiently to minimize slumping and immediately seeded with appropriate plants. Sodding or fabric mats may need to be used in some cases to minimize erosion until revegetation can control slope erosion. Culverts and water breaks will be placed to reduce water flow over the bare roadbed. No machine clearing will be permitted within 100 feet of any streambed.

To protect the integrity of structures in extremely marshy soils or soils with a shallow ice-rich, permafrost table, and to minimize use of the access road for maintenance of tower footings on these soils, heat transfer devices may be used if necessary to keep tower footings and guys frozen into place. This is especially important in those stretches not having an access road. Keeping poorly drained soils and the shallow active zone around tower bases permanently frozen, eliminates frost-heaving of anchors and settling of foundations due to changes in the permafrost. There are several types of these devices in use; their use is widespread along the Alyeska Pipeline where elevated sections of pipe are vulnerable to settling.

A good discussion of several types of these devices is found in the article "Settling a Problem of Settling", in the Northern Engineer, Vol. 7, no. 1.

The basic principle of these devices is that of "pumping" heat from the soil to the air. Year-round operation would require an actual pump to keep coolant flowing, but several types use no pump, relying instead upon the difference between soil and ambient air temperatures in winter and one-way flow of coolant to retard heat transfer to the soil in summer. These heat-transfer devices may provide the best available solution to the problem of suitable footings and anchors for structures in muskeg.

Fire control will be quick and efficient to limit fires to small areas. Fire control methods and machinery should not ultimately cause more damage than the fires themselves; soil disruption by fire control must not aggravate soil disturbance already caused by a fire. Aerial control and ground vehicles with low-pressure treads will be used where needed.

Crews will be instructed on fire safety. Extinguishing tools will be on hand; machinery will be suitably maintained to minimize sparking. Work will go on a special basis during high-risk periods. The permanent access road can double as a fire break and a fire-control road for continuing wildfire management.

On unbridged stream crossings, gravel fords will be constructed where the bottom is not already gravel. No trees shall be felled or yarded across streams. No waste material will be dumped into streams or abandoned on their flood plains. Towers will be located well away from streams, not only to reduce the potential for erosion, but also for their own safety.

Vegetation

Only the necessary vegetation will be cleared to minimize impact and cost. Photogrammetric identification of clearing zones will be used; this technique, already in use by Bonneville Power Administration, uses a combination of factors, including spacing of towers, line sag, topography, profiles, and growth rates to determine exactly which trees need to be eliminated in a forested area. Designation of the minimum safe clearing will be in keeping with the National Electric Safety Code.

Clearing will be with brush blades on bulldozers on frozen ground, as well as with rotary cutting or hand clearing to reduce unnecessary disruption of vegetation. No bulldozing will be permitted on slopes greater than 35%. Clearing on steep slopes will be by hand; stumps and roots will be allowed to remain to help keep slopes stable.

Slash will be immediately chipped to provide erosion control where necessary or burned to avoid potential insect epidemics and to reduce fire hazard. Non-merchantable timber will be burned if an access road is present. With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing. Beetle infestation will be of concern mainly on the bottomland spruce-poplar ecosystem. Disturbed areas will be graded back to merge with the contours of the land, and fertilized or revegetated if necessary to provide a ground cover. In many cases, chipping of brush, a very suitable method of reducing soil erosion in the clearing, will also provide some increase of insulation in areas of shallow permafrost. Fire hazard will be low, since the chips will usually be in wet soils in these conditions.

Revegetation of cleared areas can be with plant species that will enhance habitat for animals, yet can successfully dominate taller-growing species. Typical of these species are grasses and legumes. Revegetation will be carried out in accordance with A Vegetative Guide for Alaska presently used by the State Department of Highways.

Those sections of clearing needing periodic maintenance to keep down tall-growing trees will be cleared in such a way as to minimize further soil disruption. If mechanical methods are used, selective cutting is preferable over brush hogs or brush blades on tractors, which not only can be destructive to the soil, but inefficient, also, in that little selective cutting is possible. If herbicidal control is to be used, proper application methods and proper herbicide methods will be used. Aerial application will not be used; manual application is not only very selective, but accidental misapplication is less likely to occur. Herbicides will not be applied next to streams or lakes; a buffer strip will be left untreated adjacent to water bodies. Application will be of a coverage and dilution appropriate to the vegetation being treated.

Fire control will be as discussed in the preceding section on soils.

Wildlife

A policy of minimal clearing of vegetation should have the least impact upon wildlife in terms of destruction of habitat. Avoidance of unique habitat, or habitat of rare and endangered species will minimize impact on these important, but usually localized, areas. Seasonal scheduling of construction will minimize contacts with migrating mammals, although this may conflict with winter construction in areas used by wintering caribou or moose.

Any access roads will be designed to minimize river crossings, which should reduce sedimentation caused by fording machinery. Where possible, drainage will be preserved through proper placing of culverts and bridges. Borrow pits will be located to avoid sedimentation of clearwater streams and lakes and subsequent impacts on aquatic ecosystems. Spills of fuel, oil, and other chemicals will be avoided, particularly if streams or lakes may be affected. Herbicides, if used, will be applied properly.

Wildfire control will be as discussed in the section on soils.

Harassment of wildlife by ground vehicles, planes, or helicopters, either deliberate or inadvertant, will be minimized by strict enforcement of vehicle use and aircraft use by either the contractors or the supervisors during construction and maintenance. Hunting and trapping activities of work crews will be controlled. The Alyeska Pipeline camps restrict firearms possession to control hunting and harassment, as well as accidental shootings. The Alyeska Pipeline camp and construction areas have also been closed to hunting and fishing by the Alaska State Department of Fish and Game. Similar controls will be employed for transmission line work.

Increased exposure of wildlife to hunting or trapping because of the increased access of a service road can be controlled to a degree, if deemed necessary by game management agencies. Access roadheads can be barricaded or concealed, breaks can be designed on the access road to limit use by standard four-wheel drive vehicles, and the road can be posted.

However, it is not expected that such access-control measures will entirely succeed. In most areas, Alaska Power Administration favors multiple-use of the right-of-way; final regulation of access will be at the discretion of the land owner or land-managing agency.

Existing Developments-Social

To avoid preemption of private lands, the final route will be flexible enough to circumvent small blocks of private land. Larger privately owned sections will entail a purchase of easement. All of the alternative corridors can avoid communities en route. Sections of the line deemed hazardous by the FAA will be adequately marked as outlined in Part 77, FAA regulations "Objects Affecting Navigable Air Space".

Effects of audible noise and electromagnetic interference are minimized by the distance between the majority of the corridor and residences, especially residences with radio and/or television reception. Avoidance of communities for the most part will eliminate the nuisances of noise and interference. Paralleling communication lines vulnerable to reduced interference can be re-routed to minimize the distance along which transmission and communication lines closely parallel. The magnitude of induce voltage is inversely proportional to the square of the separating distance, so doubling the distance between the transmission line and communication lines would reduce induced interference to a quarter.

Camps will be provided for transmission line workers; these and all material dumps and construction areas will be located away from small communities; such precautions will not be needed for the larger towns of Anchorage and Fairbanks. The camps will be temporary, and will be removed as the construction phase in their vicinity is completed; the land occupied by the camps will either revert to their former use or used for other purposes.

Depending upon the ability of the community to absorb an influx of people, the camps will provide for entertainment, food, and lodging. This will minimize the strain on such services in the communities, at the same time, allowing local merchants to profit from these services.

Scenic Quality-Recreation

The obtrusiveness of a transmission line can be lessened by proper design and location. In forested areas, placing the clearing far enough from a parallel highway or railroad is sufficient to conceal the transmission line. In areas having shorter trees, using the topography to conceal a line behind ridges, in swales, and along breaks in slopes will help to lessen its visibility. In completely open areas, the only alternatives are using a combination of topography and distance to conceal a line, or to keep it close to the road if it cannot be concealed. By keeping an obvious line next to a road, one can walk under the line to get an unobstructed view of scenery on the other side; merely keeping an unconcealable line a short distance from a parallel road does not lessen its obtrusiveness, and it precludes getting a clear view of scenery beyond.

Other techniques of concealing or mitigating the presence of a line are to avoid clear-cuts for clearings, but instead, to feather back the break between original forest and clearing; use of photogrammetric selective clearing will ease the abrupt appearance of clearings. Where road crossings are necessary, it is best to cross at less than right angles and to leave a buffer strip of original vegetation to mask the right-of-way. This might involve using taller than usual towers on either side of the highway to provide the additional clearance. Placing lines on ridges silhouettes them, and will be avoided; ridge crossings are best put in notches or low spots.

Whenever possible, existing rights-of-way should be shared or paralleled to avoid the problems associated with pioneering a corridor in inaccessible areas. Trails in these "inaccessible" areas should,however, be avoided; preserving wilderness quality entails sharing or paralleling all rights-of-way except trails, and from these, lines should be shielded as much as possible.

Cultural Resources

There are known and potential archaeological and historical sites along the proposed corridors. To minimize possible vandalism or disturbance, no sites other than those on the National Register shall be located either on a map or on the narrative of this assessment. To preserve the integrity of these known and potential sites, a pre-construction archaeological survey of the corridors will be carried out, and the final transmission route will be adjusted to minimize disruption. Inadvertent discovery of an unsuspected site at a later stage will entail either the minor relocation of a segment of the transmission line, or the salvage of the site as prescribed by Executive Order 11593 and P. L. 93-291.

For sites already disturbed, such as those uncovered during excavation, accurate records of the site will be prepared; the site will be studied to determine its significance and the extent of disturbance. All photographs, drawings, and descriptions will be filed with the Library of Congress as part of the Historic American Buildings Survey or the Historic American Engineering Record. If the site is of such significance to warrant more detailed study, construction work shall be temporarily halted on the vicinity of the site; if necessary, a minor relocation can be arranged to prevent further disruption of very important sites.

ADVERSE ENVIRONMENTAL IMPACTS

All generation of power will create adverse impacts, all transmission of power will create adverse impacts; all generation sites, except for local generation, need a transmission system. The degree of adverse impact of a transmission line will vary with its length, the character of the terrain, and the care exercised in design, construction, operation, and maintenance.

Adherence to regulations and guidelines issued by the National Environmental Policy Act of 1969, the Water Quality Act, and relevant State and local agencies and application of mitigating measures as outlined in the preceding section will reduce unavoidable detrimental impacts to a considerable degree. Experience in construction and maintenance of the more recent transmission lines of Alaskan utilities has shown that most adverse impacts can be avoided or mitigated. The Healy-Fairbanks and the Beluga-Point MacKenzie transmission lines have been successful in crossing a wide variety of ecosystems with little damage. These lines have used winter and helicopter construction in addition to conventional vehicle access roads. The use of the experience gained in these projects will reduce the degree of adverse impacts considerably. However, some unavoidable impacts are inevitable. These impacts are of two kinds: Those resulting from the construction activities, and those inherent in the existence of a transmission line.

Unavoidable impacts due to construction activities are usually temporary; these include effects such as disruption of the surface vegetation and subsequent erosion on slopes; disruption of animal habitat due to human presence; and loss of vegetation due to clearing. The degree of these impacts will depend upon the mitigation measures taken, timing of the construction phase, and ecological factors; these impacts will lessen or cease after constructtion, as regrowth of vegetation and reinvasion of fauna occurs.

Unavoidable impacts of a more permanent nature associated with maintenance and operation of the transmission line include modification of habitat due to a maintained clearing; increased access and subsequent impacts of increased access; influence on existing and future land use; influences on existing and future utility corridors; and very importantly, impacts on scenic quality.

The maintenance of a clearing through forested areas will have impacts on wildlife for the life of the transmission lines. Animals dependent upon successional vegetation for browse, such as moose and snowshoe hare, will benefit by the introduction of brush into an otherwise forested area. Animals dependent upon climax forest for habitat, such as red squirrel, will suffer a reduction of habitat. In general, both of these impacts will be insignificant due to the small ratio of affected land to the area of unaffected forest traversed by a transmission route.

Increased access due to the existence of a transmission line will depend upon the type of access used to the line, the degree of present accessibility, the area of inaccessible land opened up, and the attraction for activities other than line maintenance.

Some sections of the line will have no access road; some will be serviced by temporary construction roads or winter roads; some sections will be serviced by an access road suitable for four-wheel drive vehicles. Thus, access will be effectively denied to vehicles unable to negotiate a road of this standard, and in many areas, to all vehicles except all-terrain vehicles or aircraft.

If the area is already suitably served by an existing road of higher standards, it would be expected that a transmission line access road will not appreciably affect the existing access. Also, it would be expected that large areas opened up by a new access road would receive more impacts than smaller areas; however, it can also be reasoned that larger areas can absorb the greater impacts of increased access more easily than smaller areas. If other factors are considered equal, impacts of increased access will depend upon the area's attractiveness for hunting, packing, camping, and sightseeing.

Alaska Power Administration presently favors multiple-use of transmission rights-of-way. Since most of the rights-of-way will be easements on State and private lands, and lands managed by other agencies, determination of access will be left to the land owners or managers.

There will be an unavoidable impact on present and future land use; the degree of this impact is a function of the existing use and the potential uses of not only the land occupied by the transmission line, but also the adjacent lands. Presently, there is little agriculture or forestry along the alternative corridors; residential areas are largely limited to the Anchorage-Palmer and Fairbanks areas.

However, future patterns of land use will change; agricultural patterns adjacent to a transmission line will be affected somewhat, depending on the crop and the method of agriculture. Since the transmission line will probably predate agricultural land use along the corridor, this impact will be slight, and probably beneficial, since a right-of-way would provide cleared land at little or no expense to the farmer. Irrigation and tilling methods will have to adapt themselves to the spacing of the towers; land occupied by the tower bases will be unusable, but this land is a small fraction of the right-of-way.

Forestry is presently limited by physical, economic, and ownership factors. Present forestry areas can easily be circumvented; potential areas may benefit from the existing access road of the transmission line not only for logging, but also for fire control. The existence of a transmission corridor in general will have a minimal impact on forestry.

Present residential areas will be unaffected by any of the alternative corridors; potential residential areas adjacent to an existing transmission line will accommodate themselves to its presence. The voltage of the transmission line precludes direct service to small communities; these will have to be served by lower voltage distribution lines, emanating from existing or future major substations. The potential for service to small communities is a significant impact in that these communities may strongly desire to tap the transmission line; if they are serviced by the transmission line, they will essentially become part of the interconnected system. Since the cost of power will most likely decrease in these communities after interconnection, some local growth can be expanded, depending on what degree the availability and cost of power was a limiting factor to growth.

The existence of a transmission corridor may tend to attract future corridors; to a considerable extent, this is a beneficial impact in that it is more economical for rights-of-way to be shared or to be adjacent; there is a lessened likelihood of large areas of wilderness to be cut into a multitude of smaller areas by redundant rights-of-way; and the possibility exists for "symbiotic" use of a right-of-way by two different types of utilities. Examples are the use of access roads for transportation and the electrification of railroads and pipelines. In corridors limited by physical and/or land-use constraints, such as the Nenana Canyon through the Alaska Range, proliferation of rights-of-way will lead to congestion; in cases such as this, it is most desirable to set a future pattern by attempting to utilize existing corridors to minimize potential congestion.

One of the most significant unavoidable adverse impacts will be upon scenic quality. A transmission line will always cause a detrimental impact; the degree of this impact is determined by the visibility and obtrusiveness of the transmission line as seen by the majority of the viewers. Since most of the viewers of the alternative corridors will be on the existing transportation routes, it is inferred that increased visibility and obtrusiveness from

However, it is impossible to hide any line from all viewers from all directions. Any transmission line is easily visible from the air; placing a line away from a road to hide it from motorists will not conceal it from hunters, hikers, and campers, to whom the line may be especially obtrusive. This dilemma becomes more severe in open country, particularly in scenic surrounds.

In summary, adverse environmental impacts will be:

- clearing of vegetation from as much as 3747 acres.
- subsequent periodic control of the regrowth on the clearing created.
- permanent removal of vegetation from tower bases, access roads, and any future substations to be added to the system.
- impacts to soil from construction and maintenance operations.
- impacts to fisheries in clearwater streams affected by construction and maintenance.
- impacts to wildlife, both beneficial and adverse, stemming from the above effects of construction and maintenance.
- visual impacts to scenic andrecreational resources from Talkeetna north to Healy.
- effects on air quality due to burning of slash resulting from clearing operations.

RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

The transmission line can be assumed to have a very long life; as long as loads are expected to increase, as they are, and as long as the Upper Susitna project is a viable source of power, the transmission route can be considered operative. Individual components will be replaced, and it is foreseeable that the line itself may be upgraded to higher voltages and capacity, but it will still be essentially the same transmission system.

The bulk of the impacts on the environment of the line will be encountered during the relatively short construction phase. Of the long-term effects, some would terminate immediately or shortly after the retirement of the line. Some of these effects would be those springing from access road maintenance, vegetation control, noise and electromagnetic interference, (see **Exhibit** I "Hazards") and visual impact. Other impacts will be "imprinted" into the environment. Wildlife patterns may have been affected by continual hunting or habitat modification; these patterns will linger for a considerable time after a possible removal of the line. Vegetation patterns, altered by continual maintenance or introduction of grasses or other nonnative plants, may continue for a very long time. Unchecked regrowth of the clearing will eventually result in successional vegetation closer to the stage of the surrounding forests; this regrowth will entail habitat modifications opposite to those caused by the original clearing, but of course over a much longer time period.

The above assumes that the transmission right-of-way will retain its original function for the life of the project. However, this right-of-way may influence land use patterns that, like vegetation patterns, will linger after the term of the actual transmission line. The right-of-way may assume the function of a transportation route; this transportation route may eventually have more impact than the original transmission line and even outlive the line. Other rights-of-way may be routed adjacent to the transmission line, thus setting a regional pattern of corridors that again may outlive the lifetimes of the original utilities. A transmission line which presently pioneers a right-of-way into undeveloped areas may imprint a pattern, which although it might shift and fluctuate somewhat, will determine future land use and transportation and transmission networks for that area far beyond its own lifetime. This effect is similar for other rights-of-way which pioneer large undeveloped areas. A good example of this is the Alaska Railroad, which is now paralleled by distribution and transmission lines and a highway, and which resulted in the creation of several small communities along its length.

Another effect on the long-term productivity of the area by the transmission corridor would spring from the interconnection of the electric power grids of the two largest population centers in the State. Interconnection would enable use of the cheapest generation and the maintenance of smaller reserve capacity, while at the same time resulting in greater reliability for both systems. Interconnection would assume an importance nearly as great as the function of delivery of Upper Susitna power.

New population centers arising in the Railbelt area would be aided by proximity to this interconnected system. The growth of energy-intensive heavy industry along the corridor due to the availability of power is presently unlikely; this is due to the high transportation and labor costs of the area, which would outweigh the advantage of the availability of relatively cheap power. The construction of an interconnected power system for the Railbelt is a response to the increased demand for electric power. In itself, the availability of power is not enough to induce growth of an area; other factors, some of which are intra- and inter-regional transportation, the availability of labor, the existence of a market for manufactured goods, produce, and/or raw materials, must exist also to spur regional growth. These other factors are probably more responsible for growth than the availability of power.

There are no important potential hydro powersites close to the alternative corridors except the Wood Canyon site. The viability of this project may be enhanced by the existence of the transmission route which follows the Richardson Highway route. However, other factors such as large size of the potential project and environmental impacts of the Wood Canyon project reduce the probability of this project being spurred on by the existence of an alternative corridor.

The proposed Healy-McKinley Park 25 kv distribution line may be affected by the Nenana-1 corridor. The distribution line will add another right-of-way to a narrow canyon already occupied by two transportation lines. The construction of a transmission line could remove the necessity of part of this distribution line; a tap at McKinley Park could serve this area with power from the Upper Susitna Project. However, it has yet to be determined if the cost of a low-load tap at McKinley Park will prove more economical than an extension of a distribution line from Healy.

The proposed 230 kv CEA transmission line from Point MacKenzie around Knik Arm may provide another means of connection of the Susitna-1 corridor to the Anchorage area in conjunction with the existing submarine cables at Point MacKenzie.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The materials directly used in the construction of the transmission line and access roads will be irretrievably committed for the life of the transmission line. These materials include the aluminum and steel in the towers, aluminum and steel in the cables and guys, insulators, steel culverts, gravel and concrete. Of these, aluminum and steel have scrap value and can be recycled. Maintenance vehicles will be irretrievably committed, since their resale value after full use can be expected to be low. The fuel expended on construction and maintenance is irretrievably committed, as are other chemicals, such as paint, if steel towers are to be coated, and herbicides, if chemical control of vegetation is used.

The land occupied by the right-of-way is irreversibly committed for the life of the project, although it can revert to its original use or some other use after retirement of the line. This land can, for the most part be used for other activities, such as recreation, access, or agriculture. This is, however, at the discretion of the landowner or land-managing agency. Land use patterns may be permanently affected by the pattern originated by the transmission corridor, with effects outliving the original transmission line.

Irreversible ecological changes may result, depending upon the amount of clearing or large-scale change imposed upon an area by a right-of-way. Most of these changes, such as the maintenance of successional vegetation in an otherwise climatic forest, will eventually revert to their original condition, after retirement of the transmission line, although this may take a considerable period of time.

Mineral extraction may be affected by the location of the transmission line; such effects probably will last for the lifetime of the line, unless the line is later re-routed around ore bodies. This would not be practical for low unit-value minerals, such as sand and gravel.

Inadvertant disruption of undetected archeological sites would result in irreversible damage to such sites, reducing the amount of information obtainable and their historical or archeological value. Discovery of unharmed sites during construction will be a beneficial effect, however. All sites discovered during construction will be salvaged as prescribed by Executive Order 11593 and Public Law 93-291, an amendment to the Reservoir Salvage Act of 1960.

The labor spent in construction, operation, and maintenance of the transmission line is irreversibly committed, as are the secondary effects of the increased employment afforded.

MATERIALS AND LAND COMMITTED

Proposed System Plan	Length miles	Conductors 1/ Ton	Structures 2/ Ton	ROW 3/ acres	Maximum Clearing 4/ acres
Susitna-1: 345-kv - DC	136	4,624	13,668	2,308	2,308
Susitna-1: 345-kv - PSC		4,624	16,684	4,616	4,616
Susitna-2: 345-kv - DC	140	4,760	14,070	2,376	2,376
Susitna-2: 345-kv - PSC		4,760	17,360	4,752	4,752
Susitna-3: 345-kv - DC	129	4,556	13,467	2,274	1,900
Susitna-3: 345-kv - PSC		4,556	15,996	4,548	3,800
Susitna-4: 345-kv - DC	147	5,066	14,975	2,529	2,257
Susitna-4: 345-kv - PSC		5,066	18,226	5,058	4,514
Matanuska-1: 345-kv - DC	258	9,010	26,633	4,497	2,817
Matanuska-1: 345-kv - PSC		9,010	31,992	8,994	5,634
Matanuska-2: 345-kv - DC	385	13,056	38,592	6,516	3,869
Matanuska-2: 345-kv - PSC		13,056	47,740	13,032	7,738
Nenana-1: 230-kv - DC	198	5,108	10,692	3,000	1,439
Nenana-1: 230-kv - PSC		5,108	13,144	6,000	2,878
Nenana-2: 230-kv - DC	220	5,676	11,880	3,333	1,500
Nenana-2: 230-kv - PSC		5,676	14,508	6,666	3,000
Nenana-3: 230-kv - DC	231	5,960	12,474	3,450	1,318
Nenana-3: 230-kv - PSC		5,960	15,190	6,900	2,636
Nenana-4: 230-kv - DC	223	5,753	12,042	3,378	1,182
Nenana-4: 230-kv - PSC		5,753	13,826	6,756	2,364
Nenana-5: 230-kv - DC	212	5,470	11,448	3,212	1,364
Nenana-5: 230-kv - PSC		5,470	13,144	6,424	2,728
Delta: 230-kv - DC	280	7,224	15,120	4,242	1,727
Delta: 230-kv - PSC		7,224	17,360	8,484	3,454

1/ Assumes Rail and Pheasant conductors; can be 10% greater in rough terrain.

2/ Assumes steel free-standing tower; can be 10% greater in rough terrain.

3/ Assumes R.O.W. width of 140' for 345 kv, and 125' for 230 kv.

4/ Assumes total clearing for full width of right-of-way.

DC=Double Circuit; SC=Single Circuit; PSC=Parallel Single Circuit

MATERIALS AND LAND COMMITTED

Alternate System Plan	Length miles	Conductors 1/ Ton	Structures 2/ Ton	ROW 3/ acres	Maximum Clearing 4/ acres
Susitna-1: 230-kv - DC	136	3,509	7,344	2,060	2,060
Susitna-1: 230-kv - PSC		3,509	8,432	4,120	4,120
Susitna-2: 230-kv - DC	140	3,612	7,560	2,121	2,121
Susitna-2: 230-kv - PSC		3,612	8,680	4,242	4,242
Susitna-3: 230-kv - DC	129	3,457	7,236	2,030	1,697
Susitna-3: 230-kv - PSC		3,457	7,998	4,060	3,394
Susitna-4: 230-kv - DC	147	3,844	8,046	2,257	2,015
Susitna-4: 230-kv - PSC		3,844	9,114	4,514	4,030
Matanuska-1: 230-kv - DC	258	6,837	14,310	4,015	2,515
Matanuska-1: 230-kv - PSC		6,837	15,996	8,030	5,030
Matanuska-2: 230-kv - DC	385	9,907	20,736	5,818	3,454
Matanuska-2: 230-kv - PSC		9,907	23,870	11,636	6,908
Nenana-1: 230-kv - SC	198	2,254	6,138	3,000	1,439
Nenana-2: 230-kv - SC	220	2,838	6,820	3,333	1,500
Nenana-3: 230-kv - SC	231	2,980	7,161	3,450	1,318
Nenana-4: 230-kv - SC	223	2,876	6,913	3,378	1,182
Nenana-5: 230-kv - SC	212	2,735	6,572	3,212	1,364
Delta: 230-kv - SC	280	3,612	8,680	4,242	1,727

1/ Assumes Rail and Pheasant conductors; can be 10% greater in rough terrain.

2/ Assumes steel free-standing tower; can be 10% greater in rough terrain.

3/ Assumes R.O.W. width of 140' for 345 kv, and 125' for 230 kv.

4/ Assumes total clearing for full width of right-of-way.

DC=Double Circuit; SC=Single Circuit; PSC=Parallel Single Circuit

OTHER ALTERNATIVES TO THE PROPOSED ACTION

Alternative corridors have already been discussed and compared on the previous sections and on the matrixes in the appendix. In this section, alternatives to basic assumptions of the proposed transmission line will be discussed along with the alternative of non-construction.

Sharing of Rights-of-Way

The assumption is made in the proposed and the alternative corridors that an entirely new right-of-way will need to be obtained for the entire corridor. Sharing right-of-way with another utility (not necessarily electrical) may obviate many potential impacts in that access may already exist, reducing construction activity somewhat, and that pioneering of new corridors, with attendant problems, is no longer necessary.

The proposed transmission corridor could adjoin or share the rights-of-way of five types of systems: other electrical transmission, communication, pipelines, railroads, and highways. Although the benefit in each case is a savings in total land use, the adverse impacts upon these five systems vary. Electrical transmission systems that are jointly using one right-of-way will suffer a reduction in reliability, in that a catastrophe affecting one line, such as seismic activity, is very likely to affect the other. Safety during maintenance will decrease somewhat.

Joint use of an existing communiciation right-of-way will entail possible damage to the existing system during construction of the transmission line. Steady state noise may be induced into the communication line; the communication line will also be more vulnerable to fault and lightning damage. In the case of buried communication cables, erosion will occur unless corrective measures are used.

Pipelines are subjected to corrosion risk also. The hazards of construction damage, shock and fires or explosion will exist.

Railroads will be subjected to shock and fire hazards. Communications may suffer interference, and in the case of electric signals, induced current may cause false control signals.

Along highways, transmission lines can contribute to radio and audible noise, and in the case of accidents, can cause a fire and shock hazard.

In the case of joint use of railroad and highway rights-of-way, the risk of accidents on these systems affecting the integrity of the transmission system must also be considered.

The above risks are considered with no compensation or mitigation. For instance, corrosion of cables can be controlled, as can induced currents. Proper construction techniques will greatly minimize risk of damage. Effects such as audible noise and resulting risks of fire and explosion from accidents cannot be resolved with joint right-of-way use. However, the use of a buffer strip between right-of-way will not entail a savings in land; in the case of adjoining or partial overlap of rights-of-ways requiring clearing through forest, the use of a buffer of standing trees will realize no savings in clearing.

Not all rights-of-ways are visually compatible; for instance, sharing of right-of-way with a major highway or trail systems will cause an unacceptable scenic impact. For highways, this incompatibility must be weighed against the additional scenic visual impact of viewing the parallel, but separate rights-of-way. However, utilities not directly involving human transportation or those in commercial or industrial surroundings are suited for right-of-way sharing particularly if the utility is an existing transmission line.

On the proposed corridor to Fairbanks, the Golden Valley Electric Association owns a 138 kv transmission line from Healy to Ester. It is possible to combine this line with the proposed 230 kv double-circuit line from Devil Canyon by upgrading the proposed line to 345 kv double-circuit and adding enough width to make a 140 foot wide right-of-way. This would be a more efficient use of the land, along with the elimination of redundancy of parallel transmission lines.

Another existing right-of-way which could be shared is that of the Alyeska Pipeline. This is a right-of-way with an existing road for nearly its entire length; use of this utility would, however, entail a longer transmission line. The pumping stations along the pipeline are planned to operate with a portion of the transported oil; however, if the stations were to be electrically operated, they could draw power from an adjacent distribution line which taps the transmission line. Extra width will need to be obtained for the right-of-way if the transmission line were to follow the pipeline. The feasibility of having individual taps to serve the pumping stations is low, due to the inordinate expense involved.

One utility right-of-way closely follows the proposed transmission corridor for nearly its entire length. This is the Alaska Railroad, owned by the Federal Government and operated by the Department of Transportation.

Presently, the railroad is operated by diesel motors; if electric motors were to be used, power could be tapped from an adjacent powerline. However, due to a relatively narrow right-of-way which a transmission line could not simultaneously occupy, the right-of-way would need to be doubled on width, creating, in effect, two immediately adjacent right-of-ways. Thus, there would not be the savings of right-of-way as the previous two cases. The Alaska Railroad carries mainly freight; in 1973, the railroad operated over 1800 freight cars and 54 passenger cars. There will be some objection on the part of the passenger component to the extreme closeness of a major transmission line for 250 miles; however, this is much less of an impact than if the line were to closely parallel the Anchorage-Fairbanks highway for the same distance.

T.Y. Lin (in the Northern Engineer, Vol. 5, No. 4) proposes the construction of Integrated Pipeline Transportation, a coalescence of separate but parallel transportation corridors into one integrated structure to minimize environmental impacts, economize on construction, and increase efficiency of service and maintenance. It is possible to integrate transmission lines into such a transportation system, and would result in the best use of the land and the least impacts. However, the presence of several existing transportation routes preclude construction of such integrated transportation systems; they are most feasible in opening up new corridors of significant length, and this situation is not foreseeable in the Railbelt. Also, a transmission line integrated into such a system would require technology similar to that required by an underground cable, the next alternative to be discussed.

Underground Transmission Systems

This discussion will limit itself to the present technology of transmission systems; potential capabilities will be discussed at the end of this section. Much of this material is abstracted from the Bonneville Power Administration's draft Fiscal Year 1976 Proposed Program Environmental Impact Statement.

Underground transmissions have been found to be practical in two types of situations; one in which the costs of an underground system are less than an overhead one, such as in areas of very high right-of-way costs or where a large savings in line length is possible, such as with submarine cables. The other situation is that in which an underground system has high suitability, such as entry to substations in congested areas or eliminating the hazards of critical crossings, such as other transmission systems, and to eliminate hazards to aircraft near airports.

Neither of these two general situations exists for any appreciable length along the proposed corridor or any of the alternatives. Although underground lines will almost eliminate some impacts, such as visual impacts, they will produce other impacts not normally associated with overhead systems.

In some cases, the use of underground transmission can be justified to reduce visual impacts where these impacts are judged to be greater than the adverse impacts of undergrounding. Such a situation is typical in those highly scenic areas where the transmission structures would either be silhouetted, highly visible, or highly obtrusive, yet where the access road and trenching scar of an underground cable would not be overly visible. This sort of situation will rule out canyons and other high-relief areas, but will favor relatively flat land.

The greatest visual difference between underground and overhead transmission is obviously the lack of the transmission structures. However, an underground system in all cases will require not only an access and construction road, but also a trench which will be visible for quite some time after construction. Overhead systems, however, can be built without the need for an access or construction road, and the only excavation needed will be for the tower foundations spaced out at a rate of four or five to a mile.

If the location, design, and construction of an overhead system are properly specified, the access road and clearing will be as visible, and usually more visible, than the structures themselves. Where clearing is not needed, the most visible component will then be the access road, and as indicated, even this need not be constructed for an overhead system. In contrast, an underground system will always need a clearing in any area and will always need a construction road. Thus, an underground system in rolling or steep terrain may well be more visible than an overhead system in these situations. For this reason, coupled with the seismic risk to be discussed below, it is not recommended that the section of corridor through the Alaska Range be underground.

A major factor in the use of underground systems is the cost. Transmission systems are usually designed to meet given requirements for the least cost; in almost all situations, overhead lines will meet system requirements at a lower cost than underground cables. The A. D. Little Report to the Electric Research Council (October 1971) states that underground transmission costs can be as high as ten times greater than overhead systems, and in the case of compressed gas cable systems, up to 20 times.

Underground systems generally involve higher materials cost for the cable and for associated materials such as insulating backfill or protective sheeting. Installation is more complicated, involving excavation and backfilling and labor use is higher than for overhead systems. Splicing of a 345 kv cable can take eight or more full workdays and must be performed in specially constructed air-conditioned rooms, ("Underground Power Transmission", P.H. Rose, Science, Vol. 170, Oct. 1970).

Theoretically, overhead systems have more outages than underground systems since they are exposed to weather, vandalism, and accidents; however, unless damage is exceptionally severe, including failure of one or more towers, or access is restricted by weather, these outages are of short duration. Faults in underground cables may result in long-term outages up to several weeks; this results from the difficulty in location of the fault, the time involved in excavation and backfilling, and the time needed to replace the faulted section by splicing in a new section. Frozen ground, which persists for five or six months, will retard repair efforts more than usual.

In seismically active areas, such as can be found in the railbelt, the reliability of underground cables must be questioned. Slicing of the cable can result from settling or slumping of the soil; oil-filled or compress-gas filled cables may rupture during soil movement. Other agents can cause faulting, such as rodents, corrosion, and subsequent excavation. Location and correction of faults in a cable following quakes may involve considerable time and effort as opposed to the location of faults in an overhead system. Overhead transmission lines have more inherent resiliency than underground cables, and faults are more accessible and easier to locate.

Environmental impacts of an underground cable can be quite significant in that a continuous trench is required and an access road is mandatory for the construction vehicles and the laying of the cable. The backfilled trench may cause erosional problems, particularly if the trench cuts up or down slopes. A cleared right-of-way must be provided for maintenance vehicles needed to unearth a faulted line; however, this clearing need not be as wide as for an overhead system. Repairs will involve re-excavation, with attendant impacts due to potential erosion. An underground cable in use will continuously give off heat; this can be very serious in ice-rich permafrost areas, which occur in all of the alternative corridors. Insulating backfill will retard but not eliminate this heat flow; heat-transfer devices will be necessary to prevent excessive slumping and settling of ice-rich areas traversed by an underground cable.

Generated heat will also affect the growth of vegetation, but this does not appear to be a significant impact.

Due to the expense and difficulty of installation, underground cables are rather inflexible with regards to changing power needs. The addition of another circuit or the addition of taps for local communities is very difficult in comparison to overhead systems, where the addition of an additional circuit will not require another right-of-way, and the addition of a tap will not involve the excavation of the cable, splicing, and terminal facilities for the oil or pressurized gas insulation.

On hilly terrain, unreinforced low-pressure, oil-filled cable is subject to possible rupture due to the increased oil pressure at the low points of cables. Reinforcing and pressure compensation devices are necessary in this type of cable over hilly ground.

High-pressure oil-filled pipe cable requires a continuous high pressure maintained by pumps. This type of underground system is also subject to pressure differentials due to elevation changes.

Cables filled with nitrogen or SF6 gas contain conductors wrapped with oil-impregnated paper; on hilly terrain, this oil will seep to the lower ends, and so this cable is only suited for level terrain.

Cables insulated with solid insulation, such as cross-linked polyethylene are subject to manufacturing flaws, such as small voids, which can later develop into electrical faults; the probability of faults is proportional to the voltage. Usage is usually limited to 138 kv or lower.

A major disadvantage of underground systems is the carrying capacity dictated by capacitive reactance. Capacitive reactance is inherent in the cable construction, and results in a charging current which decreases the usable power that can be transmitted. The power loss in an underground cable is 25 to 30 times greater than for an overhead system. If a cable exceeds a certain length, its transmission capacity becomes zero. For a cable of 115 kv, this length is about 45 miles; for a 230 kv cable the length is about 35 miles. In other words, for a 230 kv cable 35 miles long, the loss is equal to the input power.

To overcome capacitive reactance losses, and thus lengthen the critical length of an underground cable, shunt reactors must be installed at periodic intervals along the cable. These shunt reactors are preferrably located above ground for access and heat dissipation, and are basically equivalent to a series of miniature substations with the attendant similar environmental impacts, high reduction in reliability, and additional costs.

Research to improve the underground transmission technology is carried on by the Department of the Interior through the Office of the Assistant Secretary for Energy and Minerals, and by private industry through the Electric Power Research Institute; private industry is making by far the greater contribution, spending $14 million during fiscal year 1974 in efforts to advance underground transmission technology.

One result of recent efforts is the Compressed Gas Insulated Bus (CGIB). Although still 10 to 20 times more expensive than overhead transmission and of untested reliability, this sytem can handle 500 kv with a critical length of up to 200 miles, a tenfold improvement over previous critical lengths for this voltage. The potential advantages of such a system include reduced visual impact, no audible noise as electromagnetic interference, small volume, simplicity of maintenance, and power handling capability approaching that for overhead systems. Bonneville Power Administration plans to operate a length of prototype 500 kv CGIB near Ellensburg, Washington starting the summer of 1974 to accumulate experience with this system. Eventually, underground cables may be expected to equal overhead systems in performance and overall reliability; however, since most of the cost of an underground system is attributable to labor, the cost differential between the two systems is not expected to decrease significantly.

APA will not recommend underground construction for this project. The present technology for underground transmission is not sufficiently advanced to assure reliability of service for a regional intertie. APA intends to follow continuing developments in undergrounding technology, but there is no indication that the disadvantages of undergrounding will be solved in the near future.

Direct Current Transmission

Direct current transmission has been used in several countries for bulk transmission of power over long distances. Due to the higher costs of conversion, this type of transmission is usually used for distances of 500 to 1,000 miles between converter stations. If no itermediate taps are planned between the generation site and Anchorage and Fairbanks, then the 136 mile and 198 mile lengths of the proposed corridors are considerably shorter than the economical distances. Intermediate taps to serve presently unconnected town and future population centers along these corridors would require converter stations and even shorter transmission lengths.

Environmental impacts of d-c transmission systems are generally the same as for a-c systems, except that d-c systems require only two conductors instead of three, and thus would require a slightly narrower right-of-way. For underground transmission, the use of direct current will obviate losses from capacitive reactance, and in this way, enhance the viability of undergrounding while imposing the additional costs of converters at each end of the cable. The use of d-c in underground systems will not lower the installed cost per cable, nor will it enhance reliability. The need for only two cables will lower the total cost versus a-c transmission, and if one cable is faulted, the other can function at half-capacity with proper grounding.

The limitations of d-c transmission presently are great enough so that it cannot be recommended for the Upper Susitna River Project. However, technological advances may eventually provide a cheaper alternative to the present converters, and thus provide the flexibility possessed by the a-c system.

Alternative System Plans

Alternative Voltages:

The proposed system plan specifies a 345 kv double circuit line from the generation site to Anchorage and a 230 kv double circuit line from the generation site to Fairbanks. The "Transmission Report" discusses an alternative system plan with a 230 kv double circuit line to Anchorage and a 230 kv single circuit line to Fairbanks. For design details, refer to the "Transmission Report".

The right-of-way width for 230 kv is 125 feet; for 345 kv it is 140 feet. Double and single circuit lines of the same voltage require identical widths. The structures needed for 345 kv are slightly larger than those for 230 kv, and in some cases, may be more visible, but this is unlikely.

The environmental impacts of this alternative voltage will be essentially identical to the proposed one. There will be some major differences, however, in the amount of right-of-way and clearing for all the alternative corridors from the generation site to Anchorage, and in the amounts of materials committed for all the alternative corridors.

Double Circuits: Stacked or Parallel Single Circuits: Both of the above alternative voltages will call for double circuits to Anchorage, and one will require a double circuit to Fairbanks. In the Description of the Proposed Action section, the use of stacked double circuits was premised. In this arrangement of circuits, both circuits occupy the same right-of-way and are supported by the same towers, such as shown in Figure 2. However, another arrangement of circuits will be proposed for those segments of the corridor requiring added reliability. Since the proposed project will be a regional intertie, there is concern for reliability by the utilities serving the Anchorage and Fairbanks areas and consulted agencies such as Bonneville Power Administration and the Bureau of Reclamation. Because of this concern, most of the proposed corridor will require a more reliable arrangement of circuits than the stacked double circuit.

This alternative arrangement of circuits for either voltage plan will call for two parallel single circuits instead of a stacked double circuit. This will not affect the system plan, as in either method, a double circuit will be provided where needed. However, a parallel single circuit will require up to twice the acreage and clearing of a stacked double circuit, which requires no more acreage or clearing than a single circuit. The major advantage of such a method will be the extra reliability provided by a redundant transmission line; outages from dropped towers or dropped conductors shorting another circuit are eliminated. The visibility of a parallel single circuit line will be different than a stacked double circuit; the towers are shorter than double circuit towers, but the number of structures per mile is twice as much. In addition, the clearing is twice as wide.

The extra reliability of a redundant transmission line may not be necessary for the entire length of a corridor, but only in those areas of high risk from winds, slides, or seismic activity. In the table on pages 108-109, the materials and land committed for each alternative corridor and both alternative system plans are presented. For each double circuit system, the equivalent material and land for the parallel single circuit system is presented also. It must be remembered that in this table, it assumed for the parallel single circuit system that the entire corridor will use this system, the actual materials and lands committed will probably be less.

Common or Divided Right-of-way for Parallel Single Circuits: When two parallel single circuits are used, they can be located either on a common right-of-way of a width up to twice the width required for a single circuit, or they can be located along two totally separate rights-of-way.

The advantages of a common right-of-way are economy of construction and maintenance in that only one access road need be built and maintained; and a better use of the land in that unusuable strips of land between rights-of-way will be minimized. Problems related to increased access will be less with a common access road than with duplicate access roads.

The reliability of parallel single circuits will be increased if separate rights-of-way are used on the theory that natural disasters affecting one circuit will probably affect the other one immediately adjacent to it. Separation of the two circuits will increase the chance of survival of at least one of the circuits. In this case, the distance of separation is understood to be on the order of up to several miles; both circuits would remain the same corridor. An additional advantage of separate rights-of-way will be flexibility for local service for communities enroute, and for local service, assuming it is decided that a community in the vicinity of the corridor of a 345 kv double circuit line will be connected to the transmission system. If two parallel single circuits are used, one right-of-way can be routed to provide a closer approach to the community, reducing the length of distribution line. The use of parallel single circuits for connection to the Anchorage area will be discussed under Alternative Endpoints.

A common right-of-way may in some instances require only half the clearing required of separate rights-of-way; in most cases, however, the amounts of clearing will be nearly equal. Both will require the same amounts of material and labor in construction. If two parallel single circuits are used, both common and separate rights-of-way may be used. In stretches of high risk of catastrophic failure, such as slide and seismic areas, separate rights-of-way are preferrable. In areas of low risk of natural disaster, economy of construction and maintenance would indicate a common right-of-way.

The cost of parallel single circuit construction on a common right-of-way is included in the "Transmission Report." Later design studies will go into greater detail on the problem of reliability.

Additional Transmission Lines Along Other Corridors: Another alternative is the construction of transmission lines along the Matanuska-1 or Matanuska-2 and the Delta corridors in conjunction with the proposed system. These corridors would not necessarily be constructed at the same time nor same voltages or capacities as the proposed system. The main advantage of such a system would be the increased reliability of redundant lines, and the interconnection of communities along the Glenn and Richardson Highways, the Copper Valley Electric Association and the interconnected system produced by the proposed system plan.

The environmental impacts of these additional corridors would essentially be the same as those outlined for Matanuska-1 and Matanuska-2 and the Delta corridors. However, the amounts of right-of-way, clearing, and materials committed will depend upon the voltage and capacities of these additional corridors. For details, refer to the "Transmission Report."

Alternative Methods of Construction and Maintenance

Access Roads versus Helicopter Construction: It is proposed to build permanent access roads for the length of both the proposed Susitna-1 and Nenana-1 corridors with the exception of unsuitable areas. These areas will be constructed by helicopter access. Where an access road is used, it will be broken at major stream crossings, stretches of poor soil or broken terrain, or where it would result in excessive visual degradation. The major sections of the access road will tie into existing transportation corridors. These breaks in the access road will also serve to limit access.

The advantages of an access road over helicopter access are: less expense per mile over most terrain; ease in transportation of machinery and materials, tower erection, stringing of conductors, and removal of merchantable timber; more reliability of access for maintenance and inspection; and multiple-use of corridor.

Disadvantages of an access road are: increased maintenance problems; unauthorized use of access road; potential increase in erosion and sedimentation; increased visibility, and more clearing required with subsequent impacts.

Since neither alternative method is suitable for the entire length of the proposed corridor, the proposed method of access is that which was judged to be most suitable to the location.

Winter Access versus Year-Round Access: Transportation of materials and machinery and construction during winter would eliminate many impacts related to access road construction and tower erection. With total winter construction, the access road would not be necessary.

Winter road use will depend upon the topography, snow depths, soil moisture content, vegetation cover, and loaded vehicle weights. Two major abuses of winter roads are their use over insufficient snow cover, especially with vehicles of high surface loading, which can destroy the vegetative cover; and the over-compaction of snow caused by high surface loadings in deeper snow, which results in loss of insulation for surface vegetation and a more tenacious spring snowpack on the track area.

Disadvantages of winter access and construction are: the construction season would be rather limited; conditions will be harsh on men and machinery; snow and frozen ground may interfere with excavation and placement of tower footings; the lack of an access road will affect the reliability of maintenance access, and will eliminate any multiple-use of the clearing.

Considering the site of this project, it is necessary to use as much of the year as possible in order to complete construction within a reasonable time. Also, given some of the weather conditions and the length of the corridors, reliability of access is imperative, especially since there is no proposed back-up transmission line in case of a fault. Thus, whenever possible, year-round construction will be used. As outlined above, access roads will be used whenever indicated.

Alternative Methods of Clearing: Presently, some of the clearing methods used by the utilities are as simple as bulldozing over any and all trees within a set distance from the centerline of the right-of-way, insuring enough width for an access road, ease of construction, and clearance between falling trees and the conductors. This method is fairly direct, involving little discretion between what is cleared, and actually what is minimally necessary for construction and maintenance. However, this method also results in excessive disturbance of the soil and unnecessary destruction of vegetation.

Considerably cheaper and less environmentally damaging, the technique of only clearing that vegetation necessary for construction and maintenance is recommended. Instead of toppling trees with a bulldozer, selective cutting is used, allowing stumps to remain.

There are three methods of disposal of cleared vegetation: sales of merchantable timber, burning, or chipping. All three alternative methods will be used where applicable.

With no access road, machinery cannot be brought in for stacking, burning, or chipping, and downed timber will be left along the clearing.

Sale of timber will require an access road; some of the timber can be used in road construction in timber bridges and corduroy in muskeg. Also in this category is the offering of timber to any who wish to remove it for firewood; this will only be significant near settled areas, and any timber not disposed of in this way after a few months will be disposed of in other ways.

If no access road is to be used, then open burning is the only available method of disposal. A temporary decline in air quality is inevitable, and open burning, in any case, will be subject to local ordinances of the affected boroughs.

Forced-draft burning will considerably reduce particulates, but will require an access road for the large tub burners. In any case where burning is allowable, where an access road will be built, and where chipping is not necessary, forced-draft burning will be used.

In areas where large-scale burning is prohibited, or where chipping is more suitable, then slash and unsalable timber will be chipped. Although most expensive and time consuming of the three methods, chipping in many instances is preferable. Where permafrost degradation is likely, where the surface mat of vegetation has been seriously disturbed or destroyed, or on potentially erosive soils, the use of chips as a protective humus is indicated. Chips will provide a measure of insulation over ice-rich frozen soils, some protection for bare soils, and although decomposition rates are slow, an organic mulch to aid revegetation.

Since the chips will lie on the ground, and usually be somewhat wet, they will present less of a fire hazard than unchipped slash.

A fourth method of disposal is to stack slash and allow it to naturally decompose. Although this will provide a temporary habitat for small mammals, it will also provide good habitat for destructive insects, provide fuel for fires, and reduce the value of the clearing as a firebreak. Thus, this option is not recommended in the ecosystems of moderate and dense forests, specifically the bottomland spruce-poplar and dense upland spruce-hardwood ecosystems.

Alternative Methods of Clearing Maintenance: In areas of fast regrowth, some periodic suppression of tall plants is necessary. There are three major alternative methods: aerial application of herbicide, manual application of herbicide, and physical cutting of trees and brush.

Aerial spraying involves the coverage of large areas with herbicides sprayed from an airplane, or more frequently, a helicopter. Due to the non-selective nature of application and the risk of accidental overspraying, spraying of water bodies, and improper concentrations, this method will not be used.

Manual application of herbicides involves the spraying of target trees, dispersal of pellets at the base of target trees, or selective spraying of thicket of brush. It is relatively safe from the risks associated with aerial spraying, and also much more selective. It can be carried out during routine ground inspections or during scheduled programs of brush suppression.

Physical cutting involves the identification and destruction of danger trees and the periodic suppression of brush. Chain saws, brush axes, and motorized rotary axes can be used for this. The labor expended is greater than for manual application of herbicide, but is safe for use adjacent to water bodies. If large areas of brush are cut, the slash must be burned or chipped. Small amounts of slash widely dispersed will not pose an insect or fire hazard.

The proposed method of control is the manual application of herbicides with cutting in sensitive areas; aerial spraying is not proposed.

Alternative Endpoints:

For this feasibility study, it was necessary to assume endpoints to allow determination costs, clearing, etc. This in no way will finally define the endpoints of the actual transmission, just as the location of a corridor does not attempt to locate the actual placement of a transmission line within that corridor. The actual endpoints will be determined in the final design studies.

The choice of endpoints of the Nenana and Delta alternative corridors is relatively limited to those already postulated--Ester and Fairbanks. Unless new substations were to be built, these are the only two feasible choices.

The Anchorage area will need additional transmission capacity, whether the proposed transmission system is built or not. However, there are serious problems in supplying power to Anchorage. Presently, power is brought into Anchorage through the submarine cables at Point MacKenzie from the northeast via the APA 115 kv line, and from the south, which will not be of concern in this discussion. The two supplies to Anchorage via Point MacKenzie and the APA line overcome the barrier of Knik Arm in two ways: a direct crossing, and an end-run around the north of the Arm. Although most direct, the submarine cables are not as reliable as an overhead system; this was brought out in the failure of the cables caused by a dragging ship's anchor in the winter of 1974-75.

Point MacKenzie is far closer to the main load center at Anchorage than Palmer; the transmission corridor will cross relatively less developed land to approach Anchorage via Point MacKenzie than via Palmer. Power would be marketed directly to Chugach Electric Association, and wheeled over their system to Anchorage Municipal Light and Power, Homer Electric Association, Matanuska Electric Association, and the Seward Electric System.

Another possible method for connection to Anchorage, utilizing the Point MacKenzie endpoint would be the overhead crossing of Knik Arm. Placing the towers on piers across a relatively shallow section of Knik Arm would allow a more direct connection to Anchorage, avoiding both the submarine cables and the more circuitous route around the Arm. However, visibility would be high for this line, possible interference with marine and air traffic may result, and there is a possible risk of damage by pack ice to the towers.

CEA presently operates a 138 kv line from the Beluga gas turbine generation site to Point MacKenzie, designed for upgrading to 230 kv, and has proposed an extension around Knik Arm which will eventually tie into Anchorage by way of Reed Substation. An endpoint for Susitna-1 at Point MacKenzie could use this proposed line as an alternate connection to Anchorage along with the submarine cables. This would, however, be dependent upon authorization for the construction of the extension.

Delivery to the existing APA system at Palmer would avoid the limitations and risk of the submarine crossing of Knik Arm, but would involve more crossing of privately owned land. Power would be marketed directly to

Anchorage Municipal Light and Power and Chugach Electric Association. Power would be wheeled over the CEA system to HEA, SES, and MEA.

The environmental assessment for the Susitna corridor with an endpoint at Palmer would be substantially the same as that for the proposed system. Mileage, clearing, and other impacts would remain virtually the same. If the corridor were to be routed along the uplands north of the Anchorage-Fairbanks Highway, somewhat better soils would be encountered, and more privately owned land and farms would be crossed.

For the Matanuska alternative corridors, there would be more substantive differences: the corridor would be about 45 miles shorter, and would involve up to 764 acres less of right-of-way and clearing. Also, less materials would be used, and less labor expended by utilizing the Palmer endpoint.

The use of separate rights-of-way for parallel single circuits would enable the utilization of two separate endpoints chosen to maximize ease of access to Anchorage while retaining a high degree of reliability. As an example, one circuit could terminate at the Point MacKenzie cable terminal, the other could deliver power via the APA system near Palmer. Other possible combinations could be devised with endpoints of Palmer, a potential causeway across Knik Arm, and the projected Beluga extension around Knik Arm.

Another variation on endpoints would be the upgrading of the existing 115 kv APA line from Palmer to Eklutna to Anchorage. Either a single circuit or both circuits from the Upper Susitna project could be built upon this right-of-way if additional capacity was added to handle the output of the Eklutna powerplant.

The final decision on endpoints will be made in later design studies, and will be dependent upon the evolution of the existing transmission systems in the time until the final design studies.

Alternative Local Service

Along the proposed corridors are several communities not presently served by the larger utilities. These communities depend upon local diesel generation for electrical power, and not all members of these communities can afford the high cost of local generation. These communities will eventually be served with Upper Susitna power, either by a direct tap from the proposed transmission line or indirectly by extensions of existing distribution systems.

Size of the load, length and cost of the necessary distribution system extension, and distance from other presently unserved communities will determine which of these two methods will serve a community.

A community, or cluster of communities, relatively distant from existing distribution systems, yet close to the transmission system, and having an expected load of five to ten megawatts, will be likely to tap directly from the transmission line. However, a distribution system will still be necessary to deliver power from the substation to the community.

Communities with expected low loads may not justify the expense of a substation for a direct tap; these communities will have to wait for an extension of existing distribution.

No Action (Non-construction)

In discussing the alternative of non-construction of the proposed transmission line, the viability of the Upper Susitna hydroelectric project must be considered, since the primary purpose of the transmission line will be to deliver the generated power to the major centers in the Railbelt. In essence, non-construction of the transmission line implies non-construction of the Upper Susitna powersites.

No action will mean that the potential power of the Upper Susitna will not be made available to the Railbelt area. Since use of power is projected to increase, alternate sources of power will have to be used. If present plants are upgraded, this will result in the increased use of fossil fuels such as coal and gas. It is not likely that costs of fossil fuels will remain the same, and they will almost certainly not decrease. Development of large-scale hydro projects will probably be beyond the capability of the present utilities, so fossil fuels will be used for a relatively low-priority use whereas a renewable resource, water power, will go untapped.

If additional power sites are required to satisfy energy needs, as they probably will be, then they will require their own transmission systems to deliver their power. Thus, non-development of the Upper Susitna and its transmission system will not halt further construction of transmission systems by other agencies or utilities, and if new powersites tend to be small-scale due to inability of utilities to develop large hydro sites, then more transmission lines may result than if the Upper Susitna were to be developed.

Another effect of non-construction will be to preserve the insular and disconnected character of the utility systems presently serving the Railbelt. A transmission line to be built with the main purpose of interconnection would not be likely in the near future, and the duplication and waste of the present situation will be prolonged.

ACKNOWLEDGEMENTS

In preparing this Environmental Assessment, the Alaska Power Administration has worked in close coordination with the Alaska District Corps of Engineers. This report was circulated in preliminary draft and draft editions to interested Federal and State agencies, boroughs, utilities, and groups for comment and information, many of which provided valuable assistance.

Comments and advice have been given by the following agencies, utilities, and groups:

Bonneville Power Administration
Bureau of Land Management
Bureau of Reclamation
U.S. Forest Service, Alaska Region
National Park Service
Fish and Wildlife Service
National Weather Service

State of Alaska:
- Department of Environmental Conservation
- Department of Community and Regional Affairs
- Department of Natural Resources - Division of Parks
- Department of Fish and Game
- Department of Highways

Fairbanks North Star Borough
Anchorage Municipal Light and Power Department
Chugach Electric Association
Golden Valley Electric Association
Homer Electric Association
Matanuska Electric Association
Geophysical Institute, University of Alaska
Commonwealth Associates, Inc.

In addition, many individuals have contributed valuable informal comments.

Bibliography

Underground Power Transmission, A.D. Little Report to the Electric Research Council, October 16, 1971.

Alaska Regional Profiles: South-Central Region, the Arctic Environmental Information and Data Center; The University of Alaska and the Office of the Governor, State of Alaska 1974.

Multimodal Transportation & Corridors in Alaska: A Preliminary Conceptual Analysis. U. S. Department of Interior, Bureau of Land Management, October 1974. 2 Volumes.

The Need for a National System of Transportation and Utility Corridors Across Federal Lands: A Study Report (Draft). U. S. Department of Interior, Bureau of Land Management, July 1975. 2 Volumes.

Environmental Effects of Herbicides Research Project, K. L. Carvell, Edison Electric Institute, New York; EEI Project RP103.

The 1970 Nation Power Survey, Federal Power Commission; printed by Government Printing Office, Washington, D.C., December 1971, Part IV.

EHV Transmission Line Reference Book, written and edited by Project EHV, General Electric Company; published 1968 by Edison Electric Institue.

Measuring the Social Attitudes and Aesthetic and Economic Considerations Which Influence Transmission Line Routing, P.L. Hendrickson, et al; Battelle Pacific Northwest Laboratories, Richland, WA; July 1974, NWL-1837: UC-11.

Environmental Atlas of Alaska; P. R. Johnson and C. W. Hartman; University of Alaska, College, Alaska, 1969.

Muskeg Engineering Handbook, edited by I.C. MacFarlane; by the Muskeg Subcommittee of the NRC - Associate Committee on Geotechnical Research; University of Toronto Press, 1969.

55 Ways to the Wilderness in Southcentral Alaska; Nienhauser, Simmerman, Van der Laan; Mountaineering Club of Alaska and The Mountaineers; Seattle, June 1972.

Oregon Weed Control Handbook, Oregon State University Extension Service, Corvallis, April 1973.

Resources of Alaska: A Regional Summary, the Resource Planning Team, Joint Federal-State Land Use Planning Commission for Alaska, July 1974.

A Vegetative Guide for Alaska , prepared by the Soil Conservation Service et al; published by the Department of Agriculture, Portland, 1972.

Environmental Criteria for Electric Transmission Systems, USDA, USDI; U.S. Government Printing Office, Washington, D.C. 1970.

B. H. Baker, "Did Beetles Do That?", Alaska Magazine, July 1974, p.48.

A. E. Caswell, C. V. Nazare, R. J. Berger, J. C. Tossi of Commonwealth Associates, Inc., "Geology is Critical in Routing EHV Transmission Lines", Electrical World, December 1974, p. 54 ff.

J. A. Heginbottom, "Permafrost and Ground Stability", Northern Engineer, Vol. 6, No. 4, Winter 74-75, p.4.

Proposed Mt.McKinley National Park Additions, Alaska: Environmental Statement; Alaska Planning Group vs. Department of Interior, October 1974.

General Construction and Maintenance Program: : Environmental Statement prepared by Bonneville Power Administration, August 1974.

Gas Pipeline Draft EIS; Department of the Interior, Bureau of Land Management, January 1975.

Herbicide Use on National Forests of Alaska: Environmental Impact Statement prepared by U.S. Forest Service, Region 10, May 1975.

Proposed Electric Distribution Line Extension to McKinley Park: Draft EIS; prepared by Department of Interior, National Park Service, Pacific Northwest Region. Received November 1975.

Environmental Analysis of Proposed 230 kv Transmission Line from Teeland Substation to Reed Substation; Chugach Electric Association, January 1975.

Draft Environmental Impact Statement for the Cantwell-McKinley Park section of the Anchorage-Fairbanks Highway; Department of Highways State of Alaska, August 1971.

"Preservation of Historic Places", Federal Register, Vol. 40, No. 24, February 7, 1975.

"Threatened or Endangered Fauna or Flora", Federal Register, Vol. 40, No. 127, July 1, 1975.

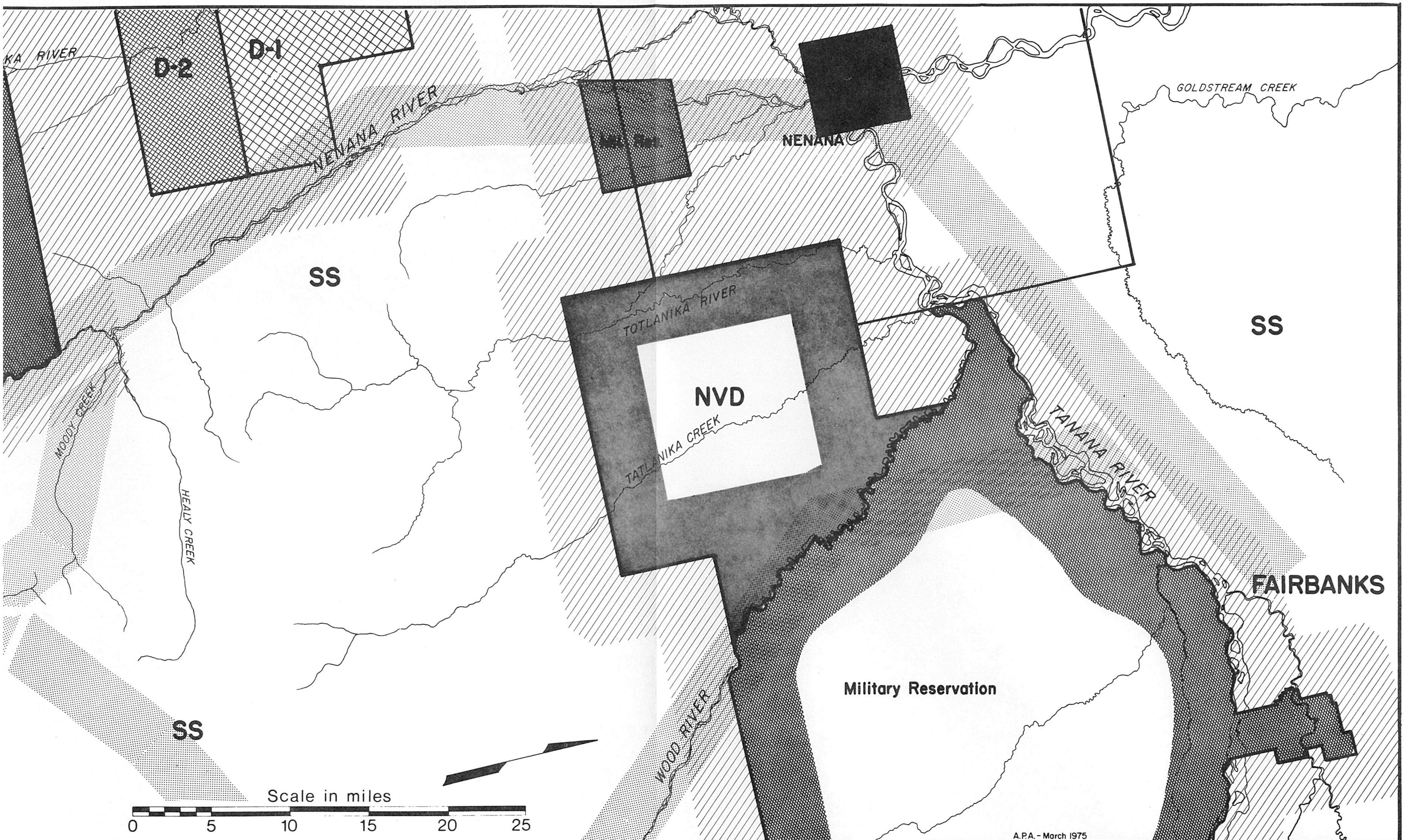
"National Register of Natural Landmarks", Federal Register, Vol. 40, No. 87, May 5, 1975, p. 19503 ff.

"Discussion of Undergrounding Alternatives in Environmental Supplements", draft position paper prepared by Bonneville Power Administration, February 1975.

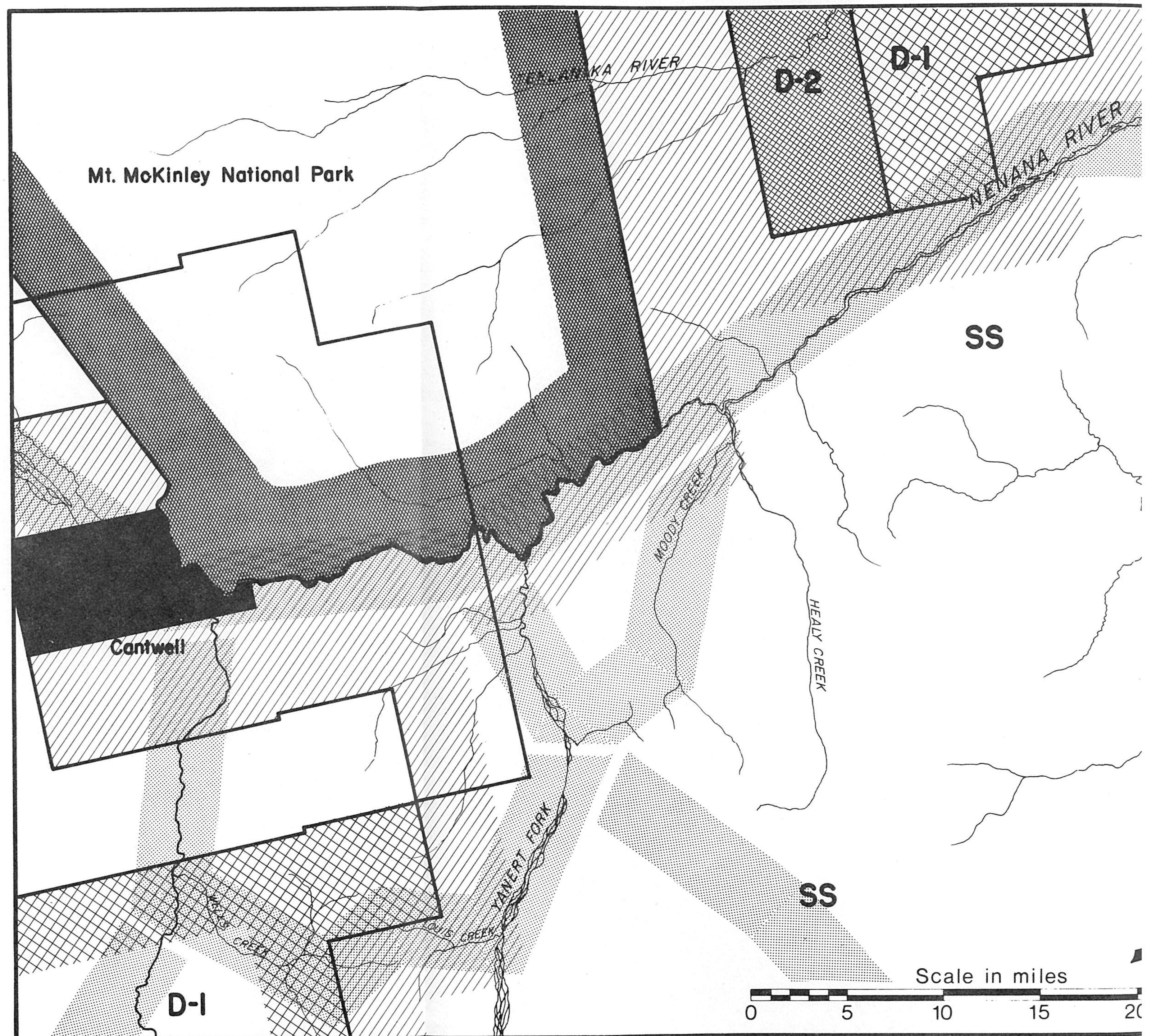
PHYSICAL AND SOCIAL CHARACTERISTICS

OF THE ENVIRONMENT

APPENDIX I
EXHIBIT I-1



LAND STATUS: CANTWELL-FAIRBANKS


Mt. McKinley National Park
KA RIVER
D-2
D-1
NENANA RIVER
SS
Cantwell
MOODY CREEK
HEALY CREEK
YANERT FORK
SS
D-1
Scale in miles
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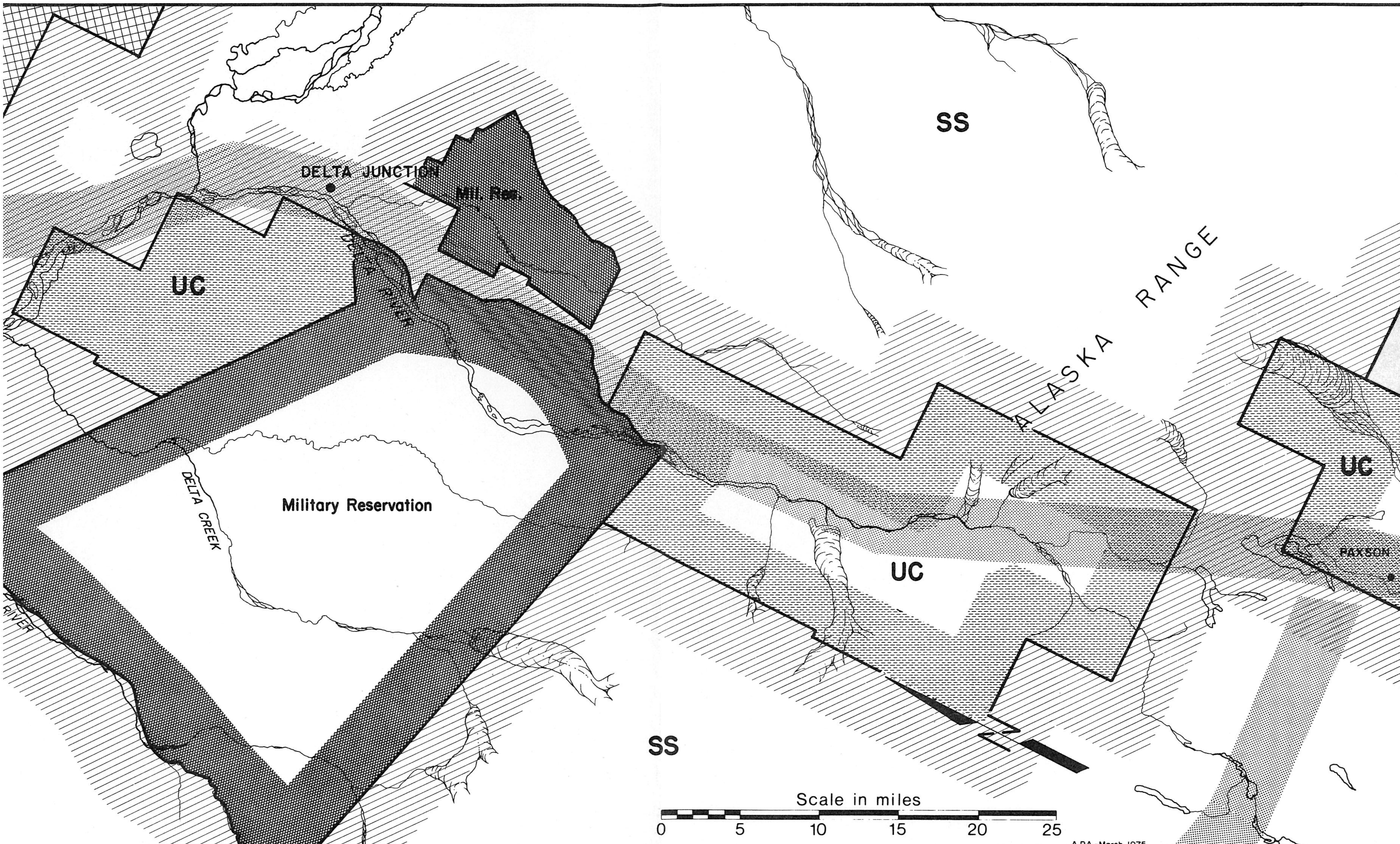
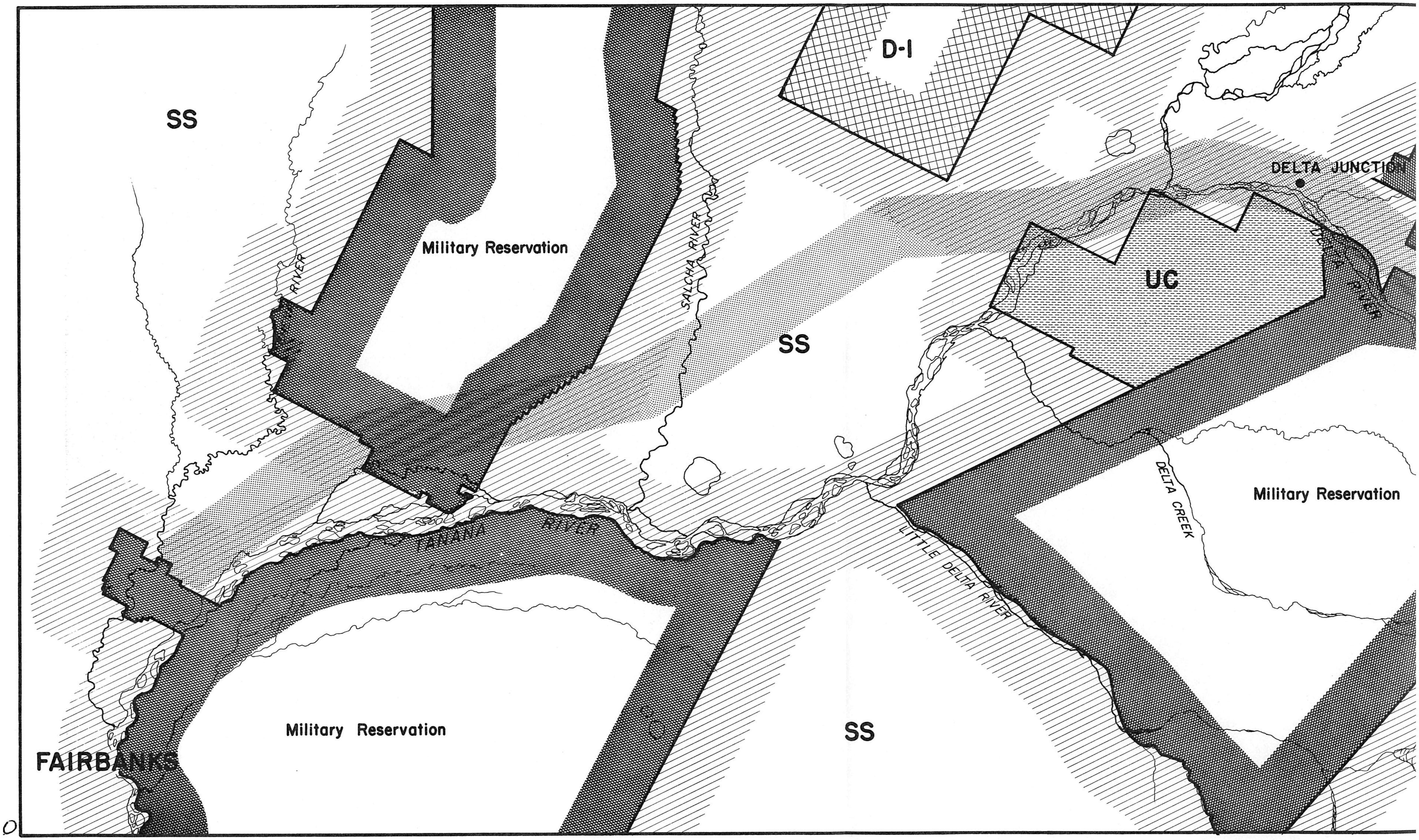
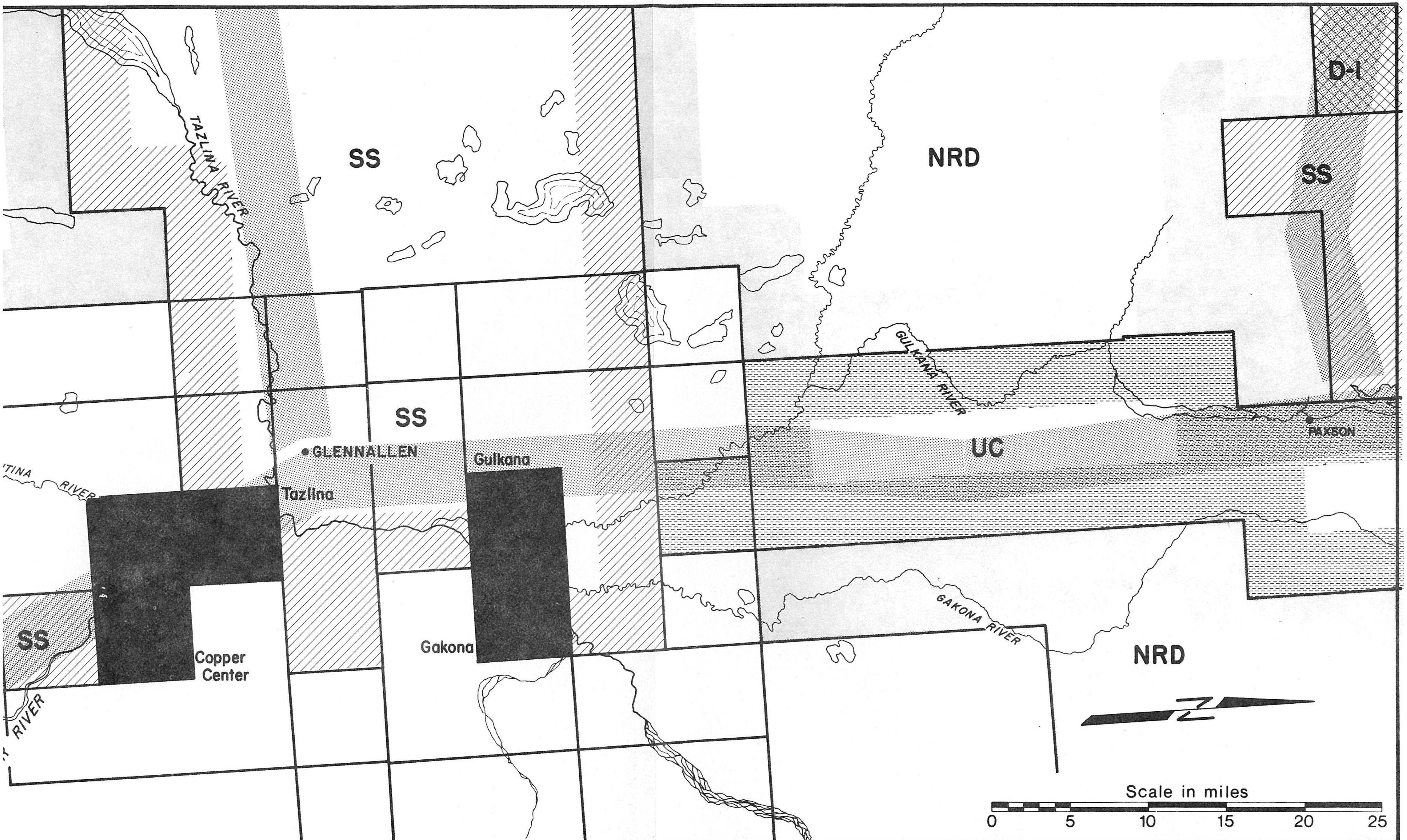
5
10
15



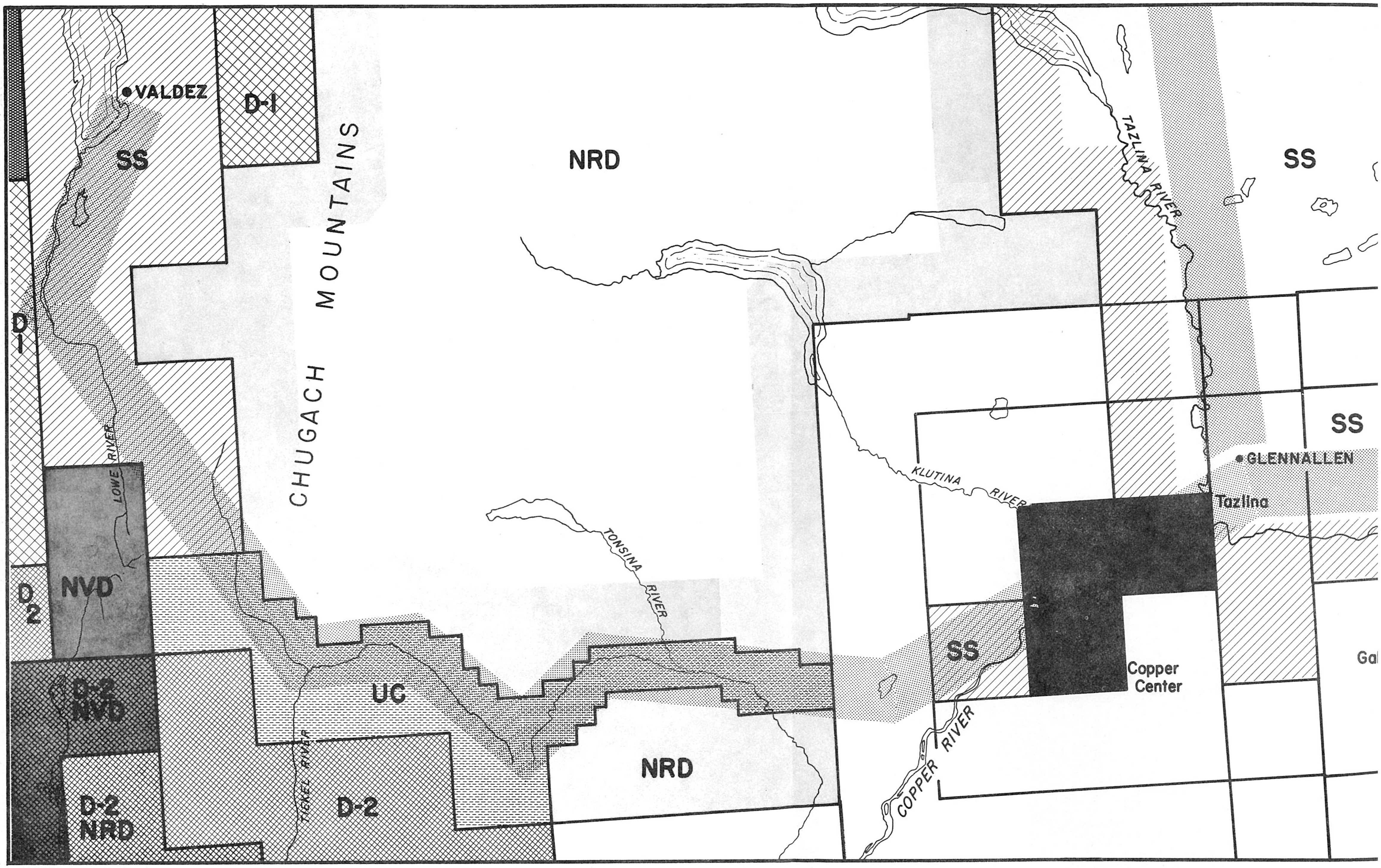
LAND STATUS: FAIRBANKS-PAXSON



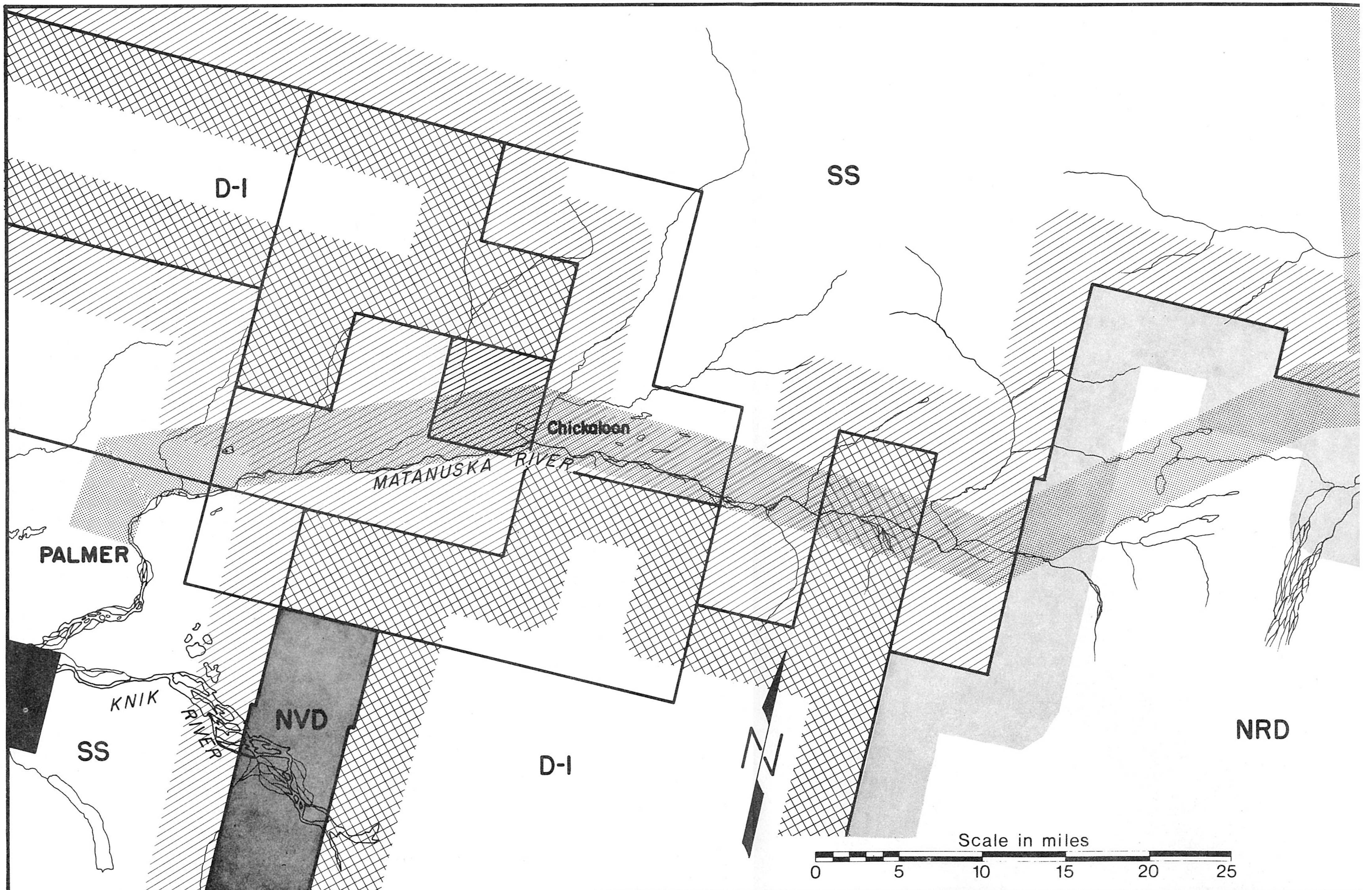
SS
D-I
Military Reservation
SALCHA RIVER
RIVER
SS
DELTA JUNCTION
UC
TANANA RIVER
DELTA CREEK
Military Reservation
LITTLE DELTA RIVER
Military Reservation
SS
FAIRBANKS



LAND STATUS : VALDEZ-PAXSON


VALDEZ
D-I
SS
NRD
CHUGACH MOUNTAINS
TAZLINA RIVER
SS
D I
LOWE RIVER
SS
GLENNALLEN
KLUTINA RIVER
Tazlina
TONSINA RIVER
D 2
NVD
SS
Copper Center
D-2 NVD
UC
NRD
TIEKEL RIVER
COPPER RIVER
D-2
D-2 NRD

LAND STATUS: PALMER-GLENNALLEN


D-I
SS
Chickaloon
MATANUSKA RIVER
PALMER
KNIK RIVER
NVD
SS
D-I
N
NRD
Scale in miles
0 5 10 15 20 25

PHOTOGRAPHS

APPENDIX I
EXHIBIT I-3

EXHIBIT I-3

Photographs

The following photographs depict typical views and critical points along the proposed corridors and their alternatives:

Photos 1 - 4 are illustrations of Corridor Susitna-1

Photos 5 - 25 are illustrations of Corridor Nenana-1

Photos 26 - 28 are illustrations of Corridor Susitna-2

Photos 29 - 30 are illustrations of Corridor Susitna-3, 4

Photos 31 - 40 are illustrations of Nenana-2, 3, 4, 5

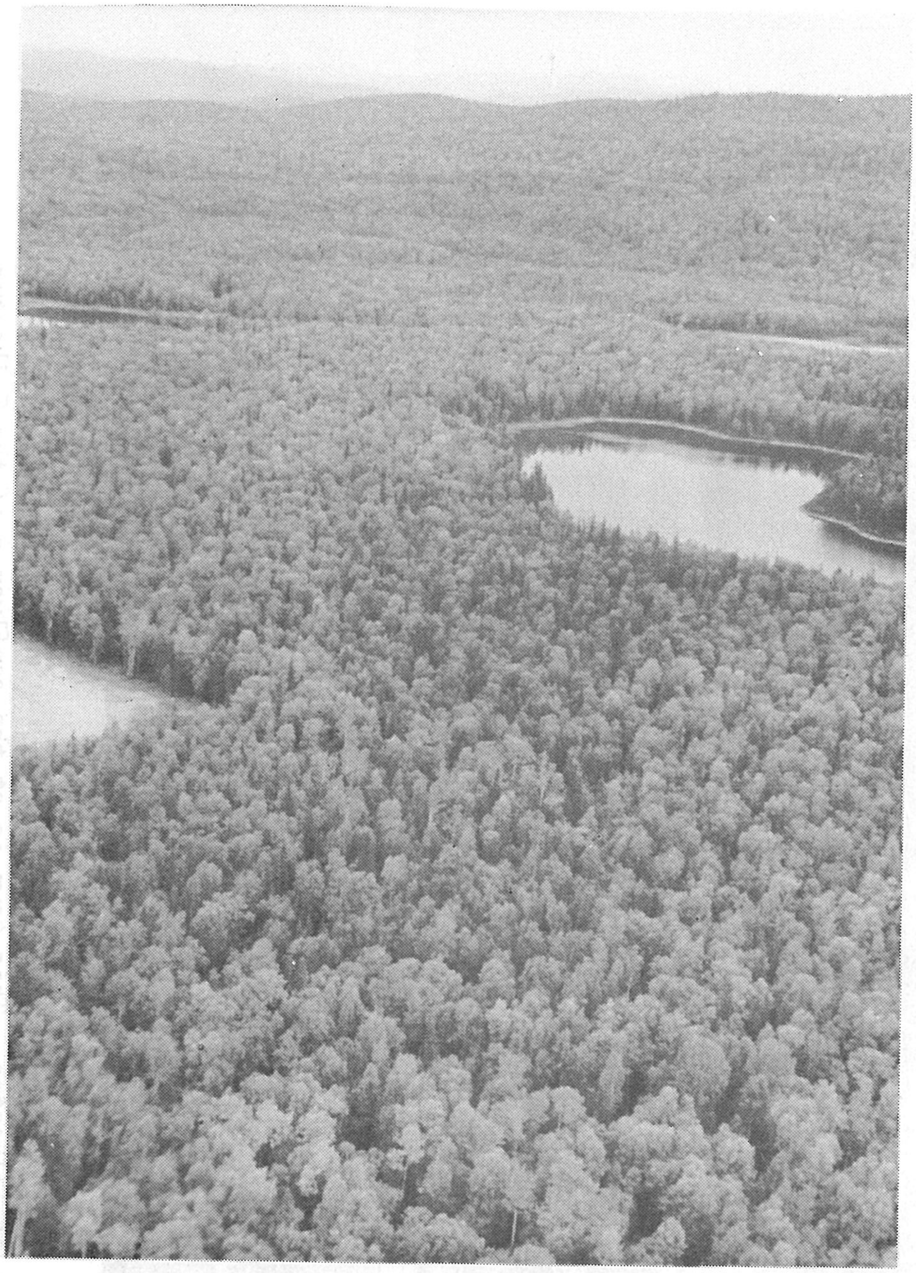
Photos 41 - 56 are illustrations of Matanuska-1, 2

Photos 57 - 69 are illustrations of Delta Corridor

All photographs in this appendix were taken by APA personnel. The majority were taken in September of 1974.

Lower Susitna River Valley. This area is characterized by extensive muskegs, intermingled with bottomland spruce-poplar forests. Permafrost is absent or discontinuous in this area, although the soils are generally poorly drained.

Susitna River Valley. Lakes are prevalent and associated with muskegs, which succeed them in formation. Muskegs are succeeded in turn by forests dependent upon well-drained soils. The three stages of succession are shown here.

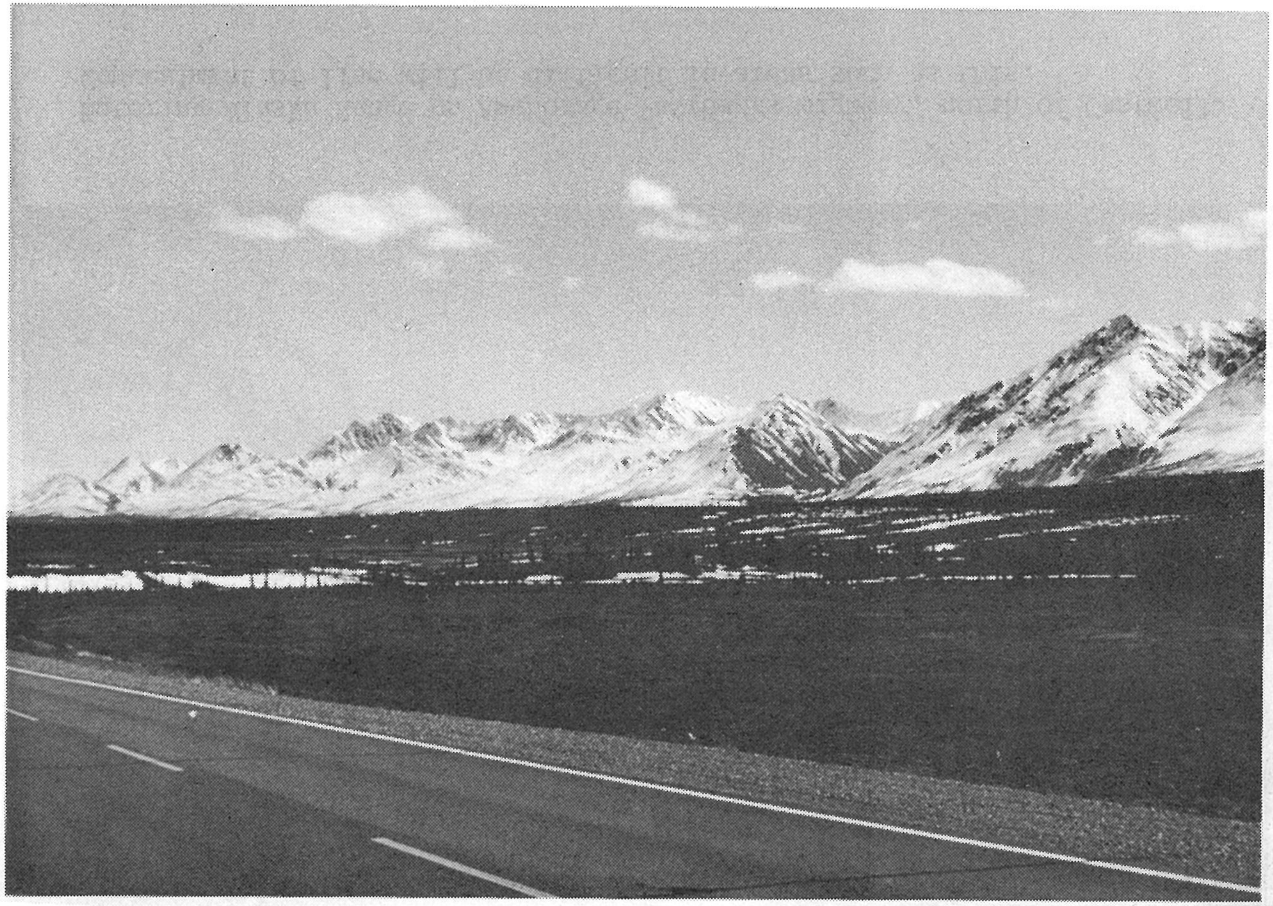


Susitna River Valley near Talkeetna. As the terrain becomes more rolling, the relative amount of muskeg becomes less.

Town of Talkeetna. This town is at the confluence of the Talkeetna, Susitna, and Chulitna Rivers. The Alaska Railroad can be seen crossing the Talkeetna River near the right edge of the picture.

Summit Lake at Broad Pass. Broad Pass is an aptly named feature; a structurally-controlled depression in an otherwise mountainous area. It is the divide for tributaries of the Chulitna and Nenana Rivers.

Alaska Range from Anchorage-Fairbanks Highway near Broad Pass, late spring. Vegetation biome is lowland spruce-hardwood. Soils here are basically glacial deposits.

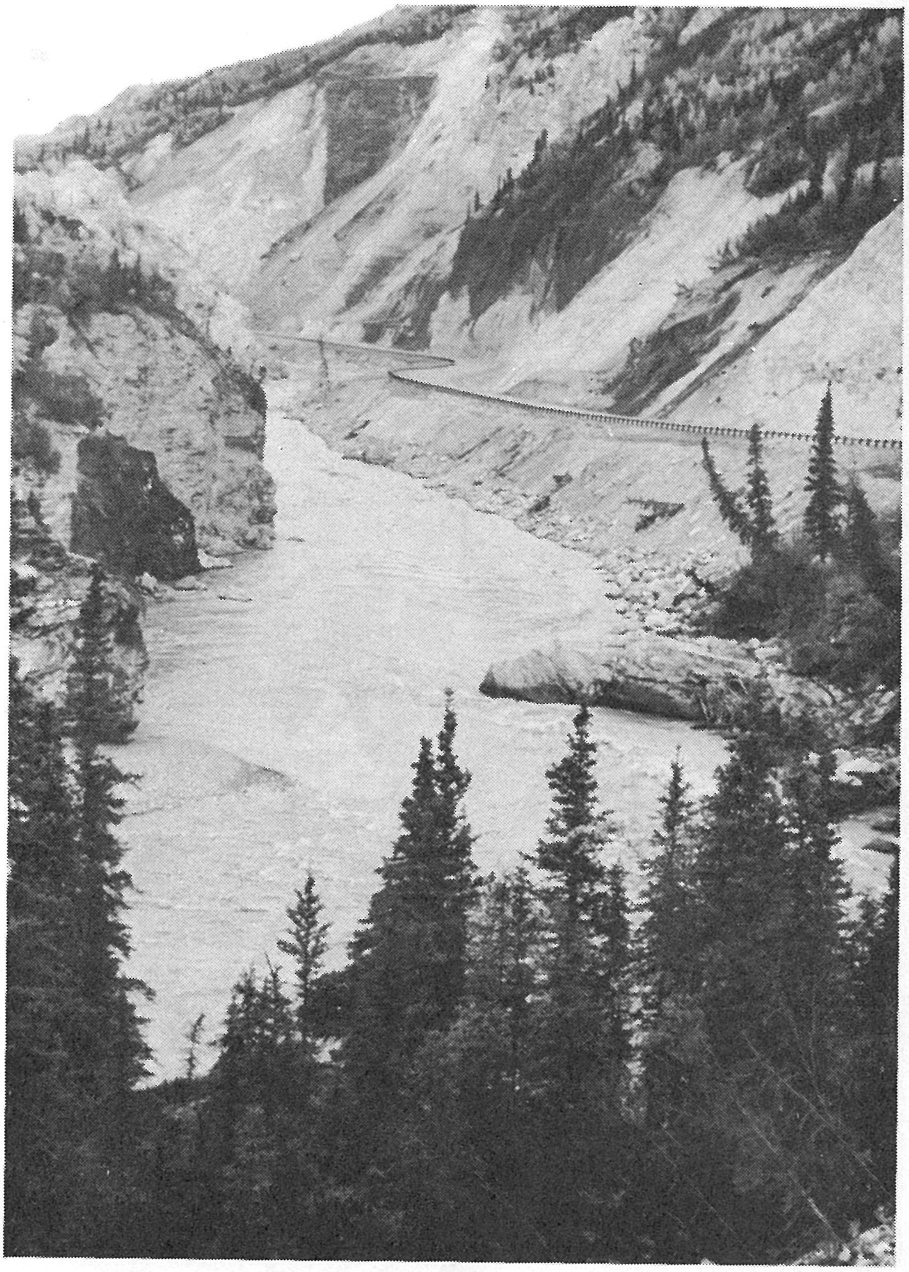


Alaska Range from Anchorage-Fairbanks Highway near Broad Pass. Soil here is poorly drained; trees visible are black spruce.

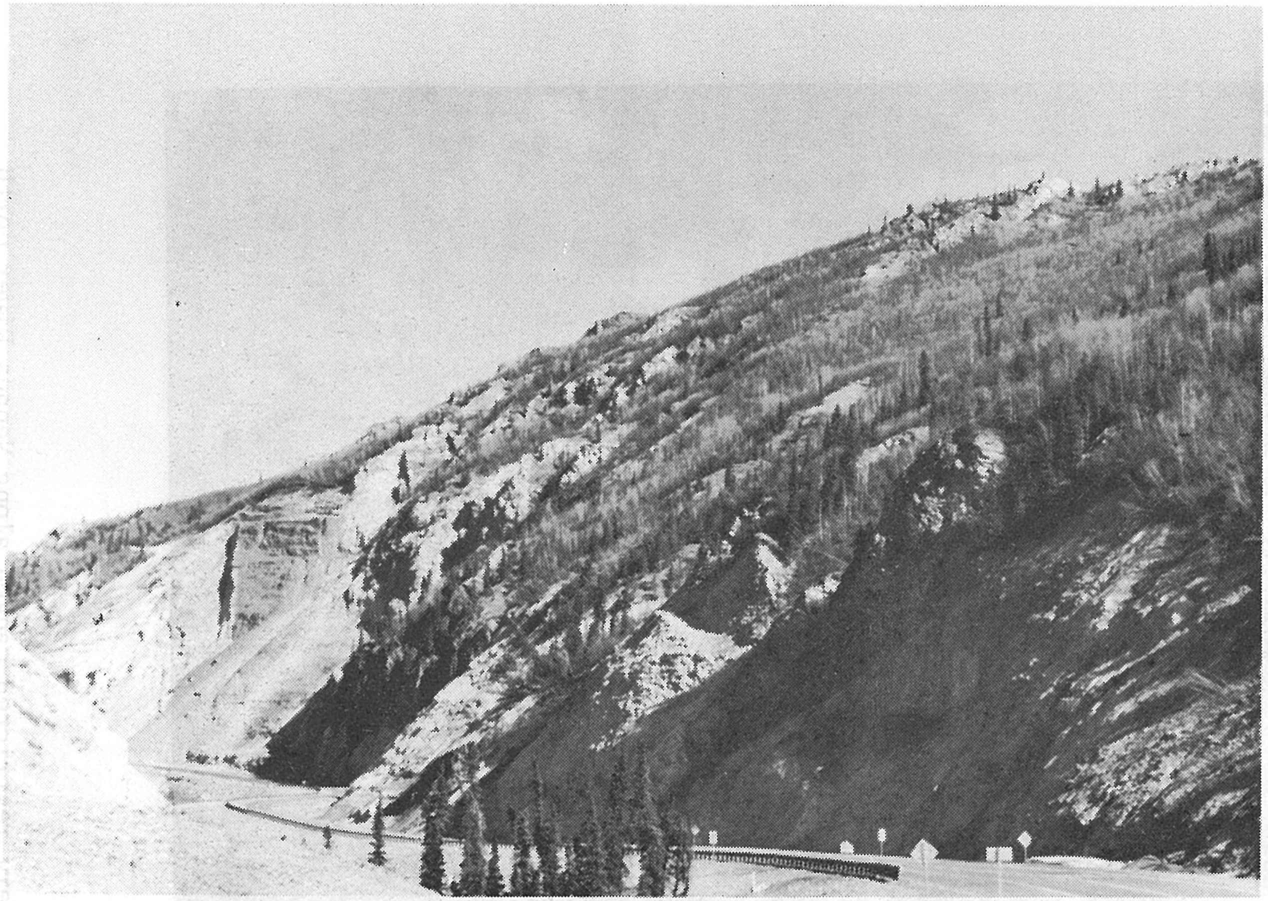
Entering Alaska Range on Anchorage-Fairbanks Highway, north of Cantwell. Concealment of line will be difficult in areas such as this.

Looking south along Nenana River to Upper Nenana Canyon. The Anchorage-Fairbanks Highway parallels the left bank. Mount McKinley National Park and the Alaska Railroad are on the right bank of the river.

Nenana River and Sugar Mountain, seen from Anchorage-Fairbanks Highway near Yanert. Yanert Fork enters Nenana River near right-hand edge of photo. Visible also is communication line for Alaska Railroad.



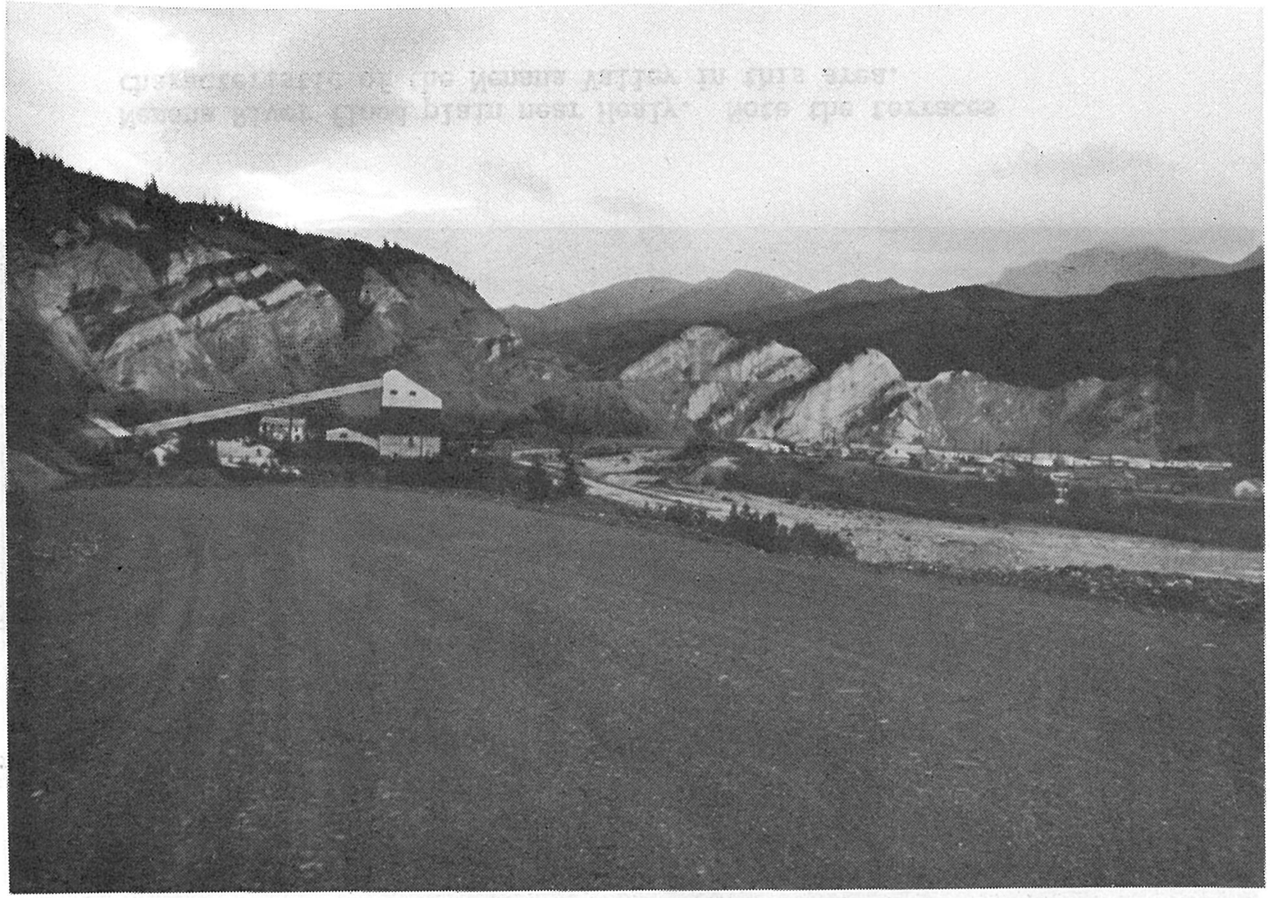
Very restricted canyon along Nenana River north of McKinley Park. Alaska Railroad is off left-hand edge of photo. Land left of river is within Mount McKinley National Park.



Another view of canyon on Nenana River.

Nenana River valley in vicinity of Moody bridge on Anchorage-Fairbanks Highway.

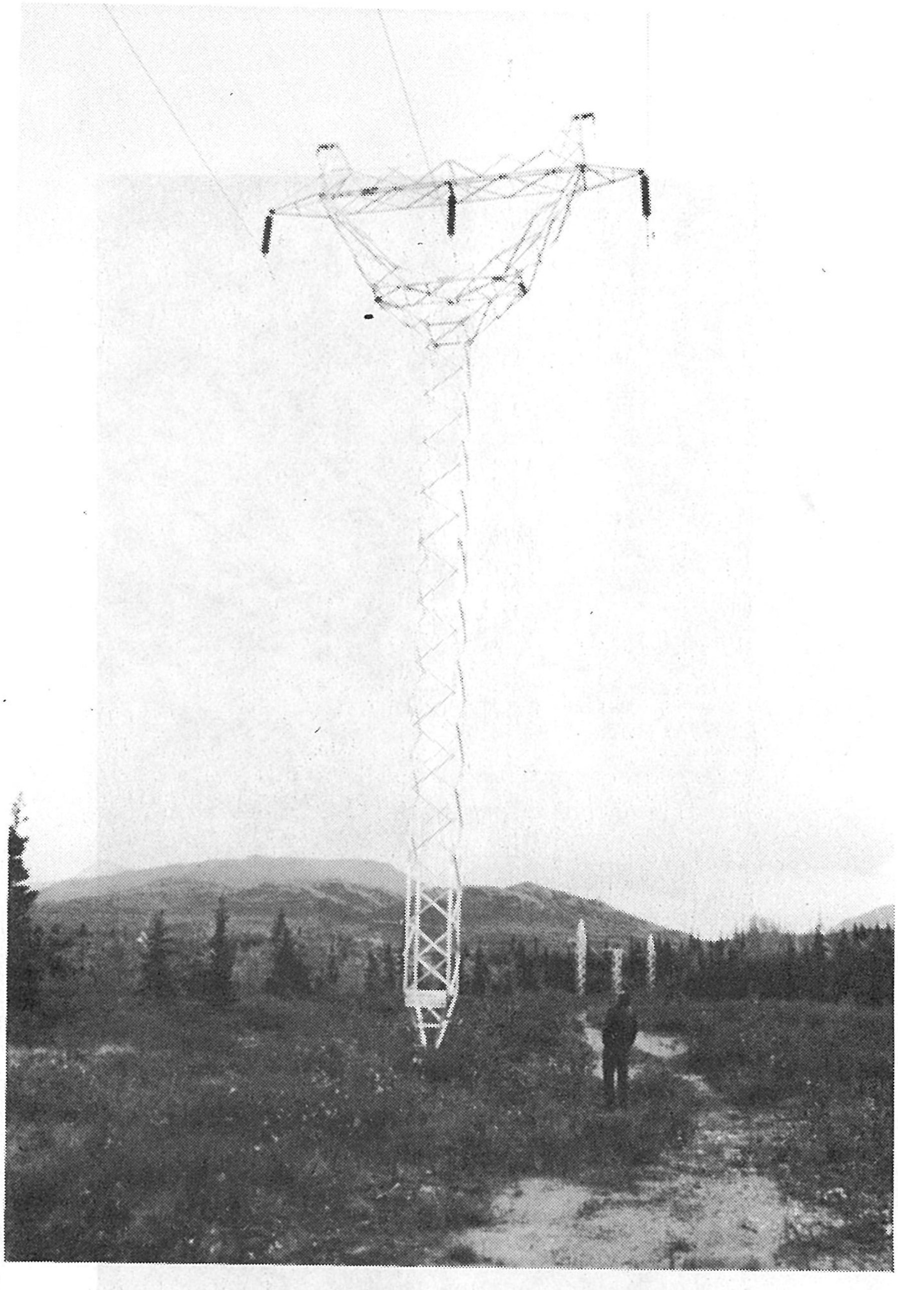
Alaska Railroad north of McKinley Park.



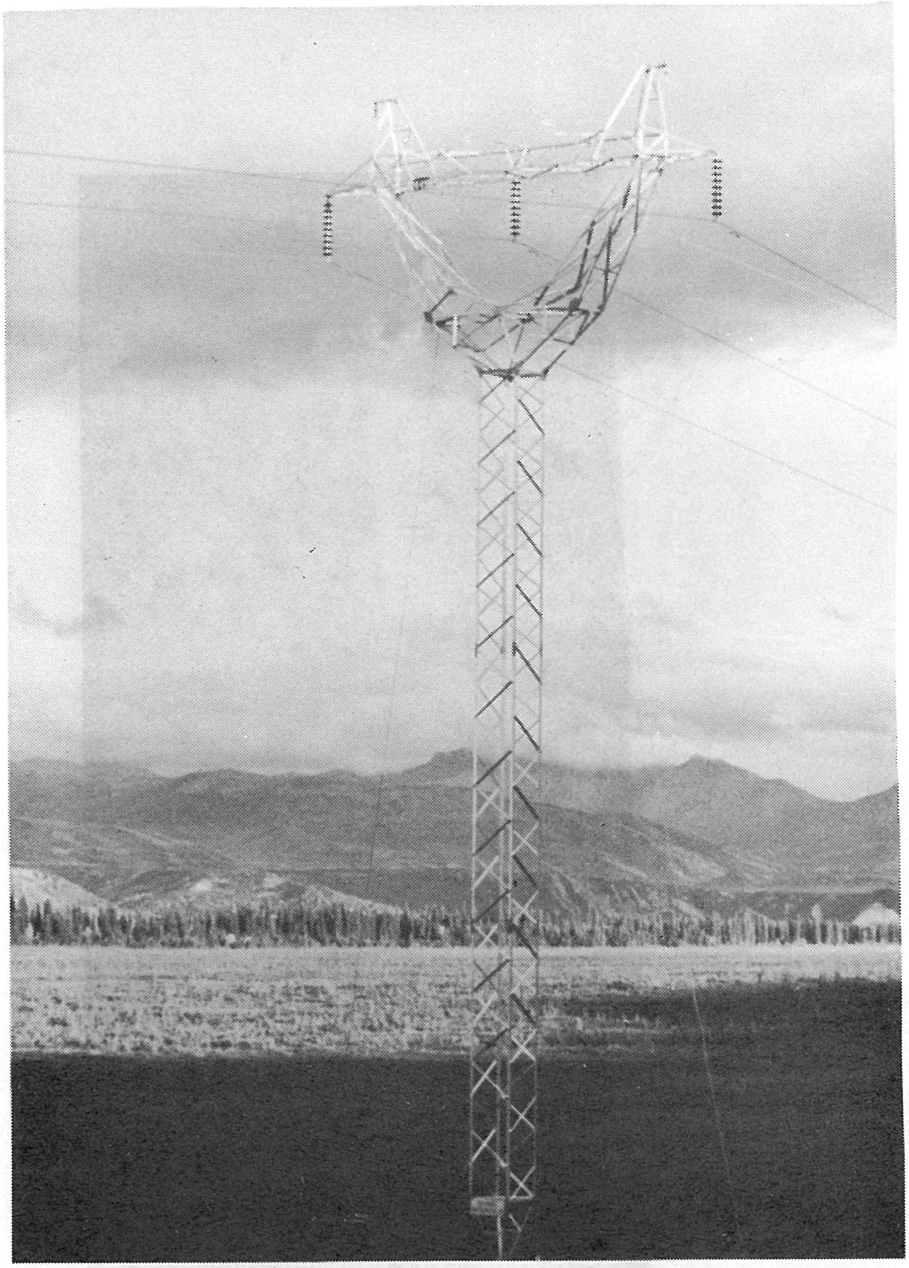
Usibelli Coal Mines near Healy. Note the seams of coal in the scarp. This coal is the fuel for the Healy steamplant.

Nenana River flood plain near Healy. Note the terraces characteristic of the Nenana Valley in this area.

138 KV Healy transmission line. Looking south from Anchorage-Fairbanks Highway towards Healy.

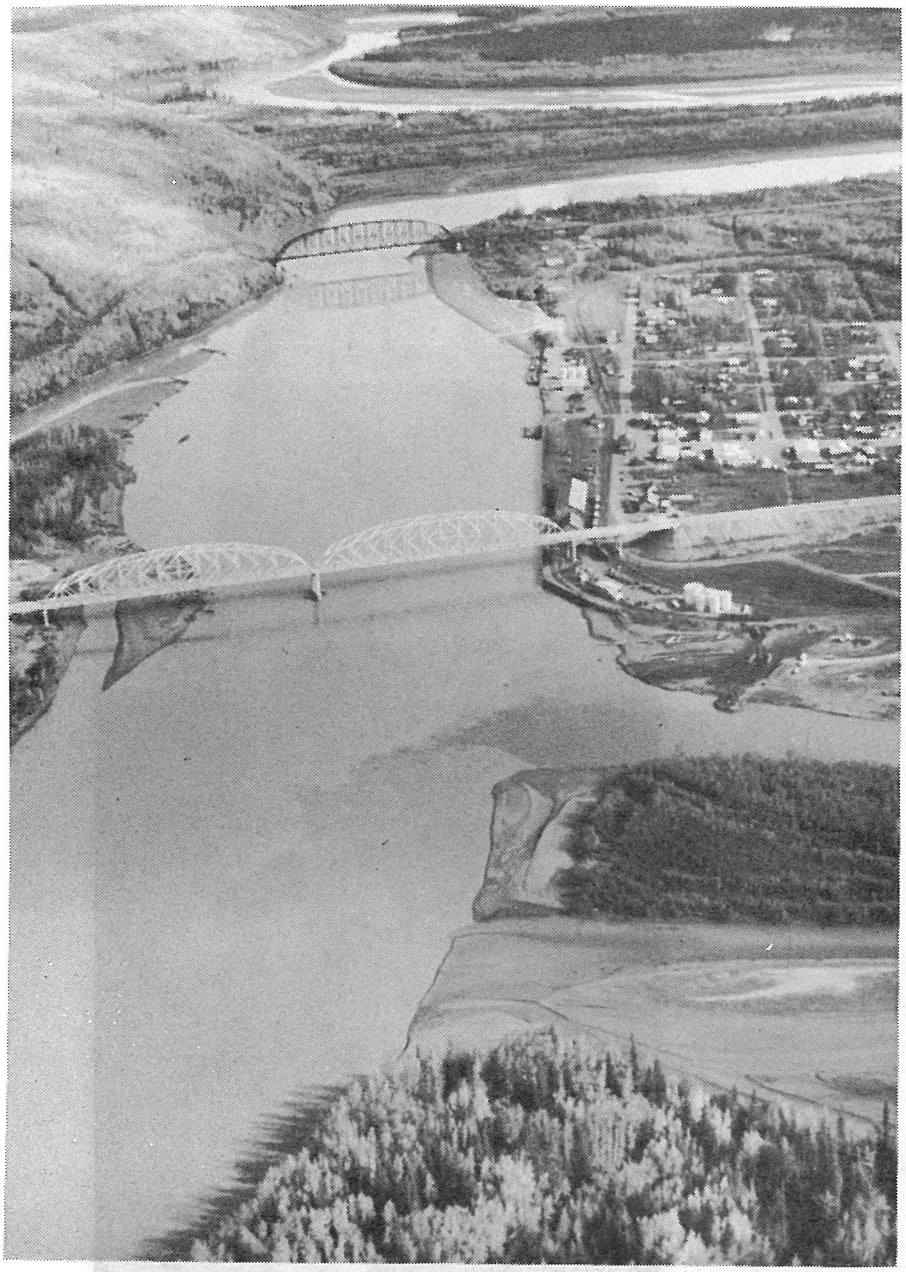


Guyed tangent tower in foreground; guyed dead-end towers in background; Healy 138 KV transmission line.



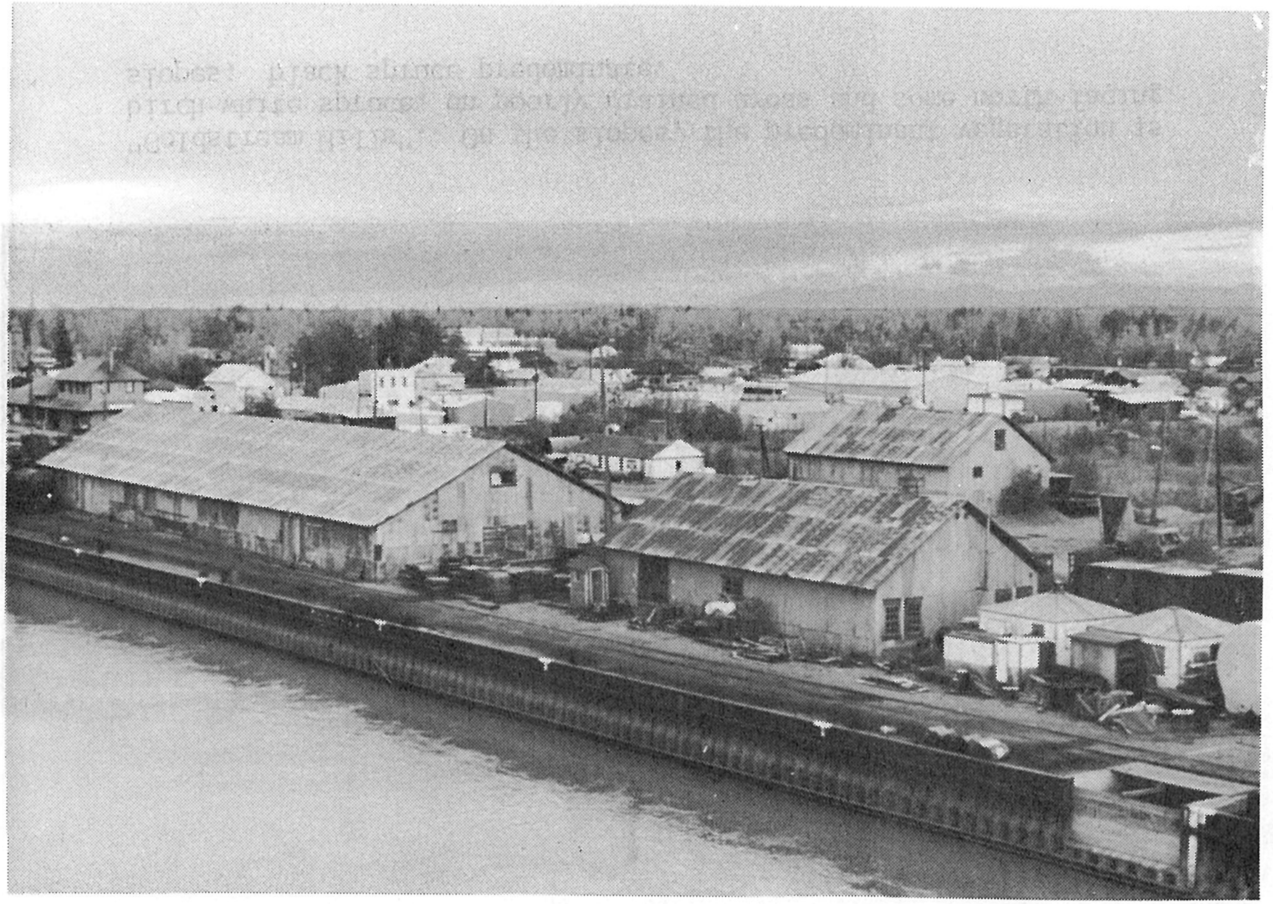
Guyed 138 KV tower on the Healy transmission line.

Nenana River valley, looking south to Alaska Range. Terraces are fairly evident along right background.

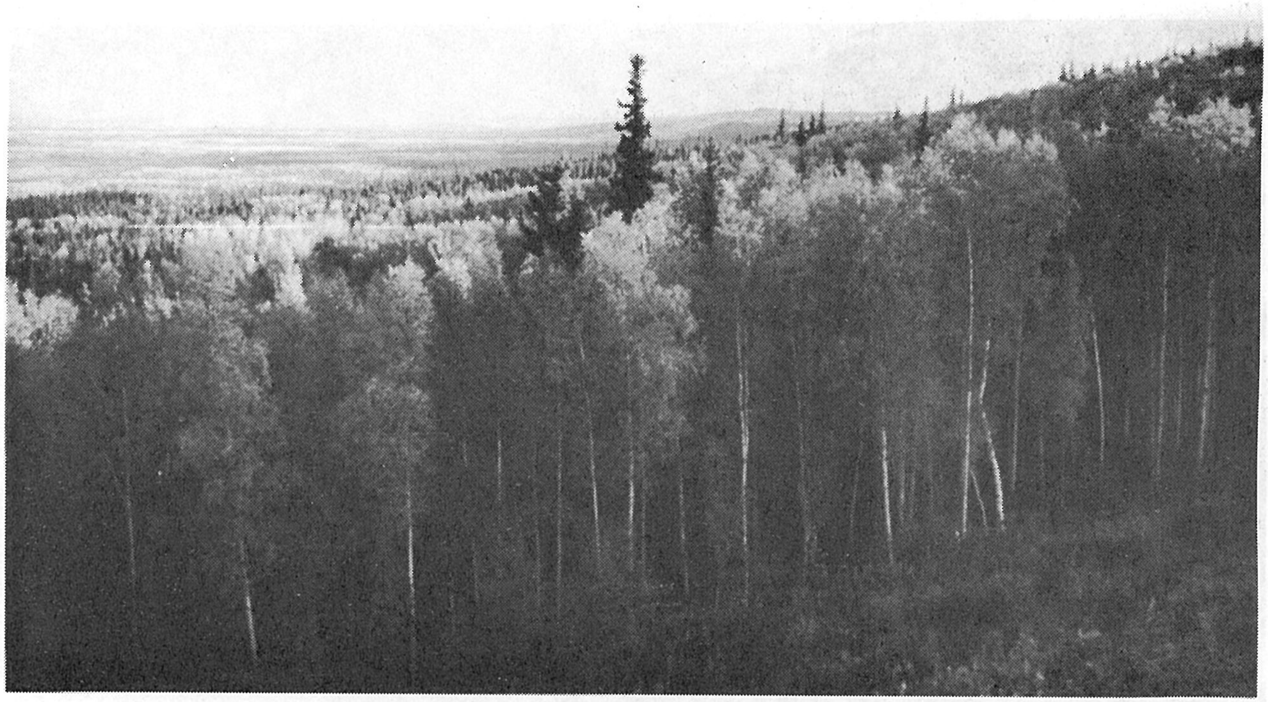


Town of Nenana, at confluence of Tanana River and Nenana River, which flows in from lower right. Double-span bridge is for the Anchorage-Fairbanks Highway; single-span bridge is for Alaska Railroad.

Alaska Railroad siding along Tanana River at Nenana. Large free-standing tower is part of river crossing of Healy 138 KV transmission line.



Town of Nenana; frontage on Tanana River. Nenana handles considerable river traffic on the Tanana River.

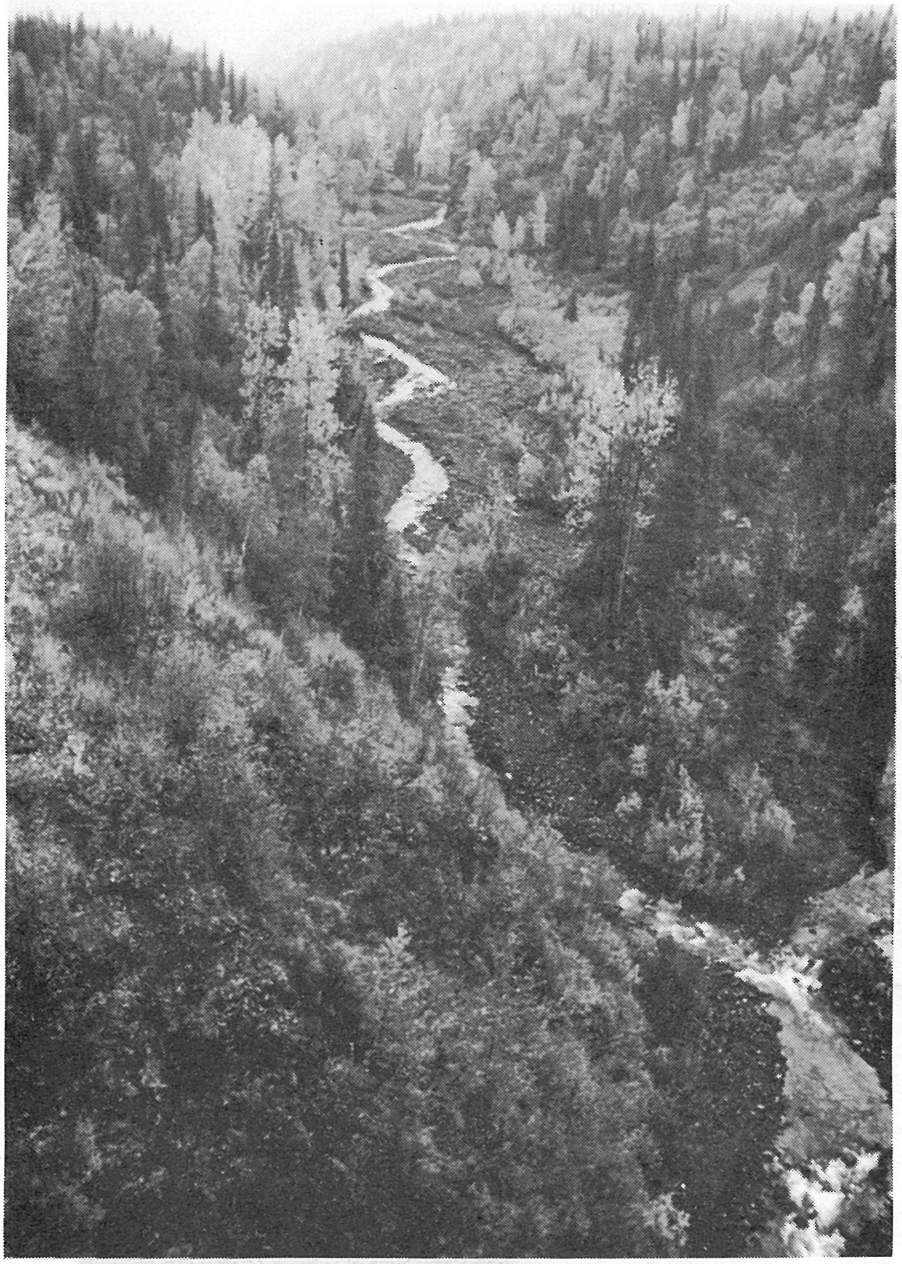


"Goldstream Hills". On the slopes, the predominant vegetation is birch-white spruce, on poorly drained areas and some north-facing slopes; black spruce predominate.

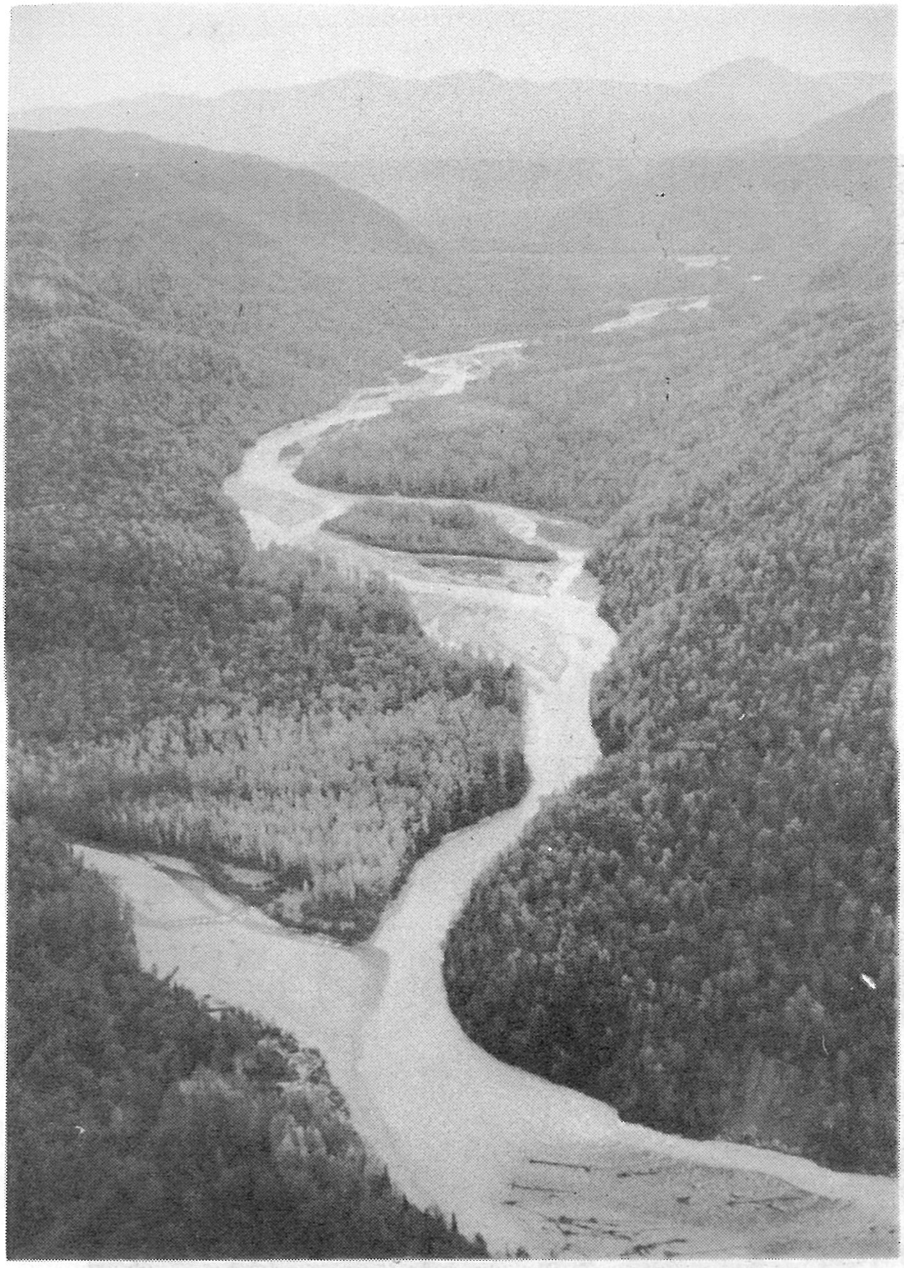
View to the west from the "Goldstream Hills". These hills flank the north bank of the Tanana River; the Anchorage-Fairbanks Highway enters them immediately across the river from Nenana, and follows their crest to Ester and Fairbanks.

Clearing for Matanuska Electric Association (MEA) distribution line. Vegetation is predominantly poplar and spruce. Clearing was done by uprooting trees with a bulldozer.

Near Honolulu on the Anchorage-Fairbanks Highway. Biomes shown on low brush muskeg in foreground and upland spruce-hardwood in background. Black spruce in foreground are associated with poorly drained soils and/or shallow permafrost tables.

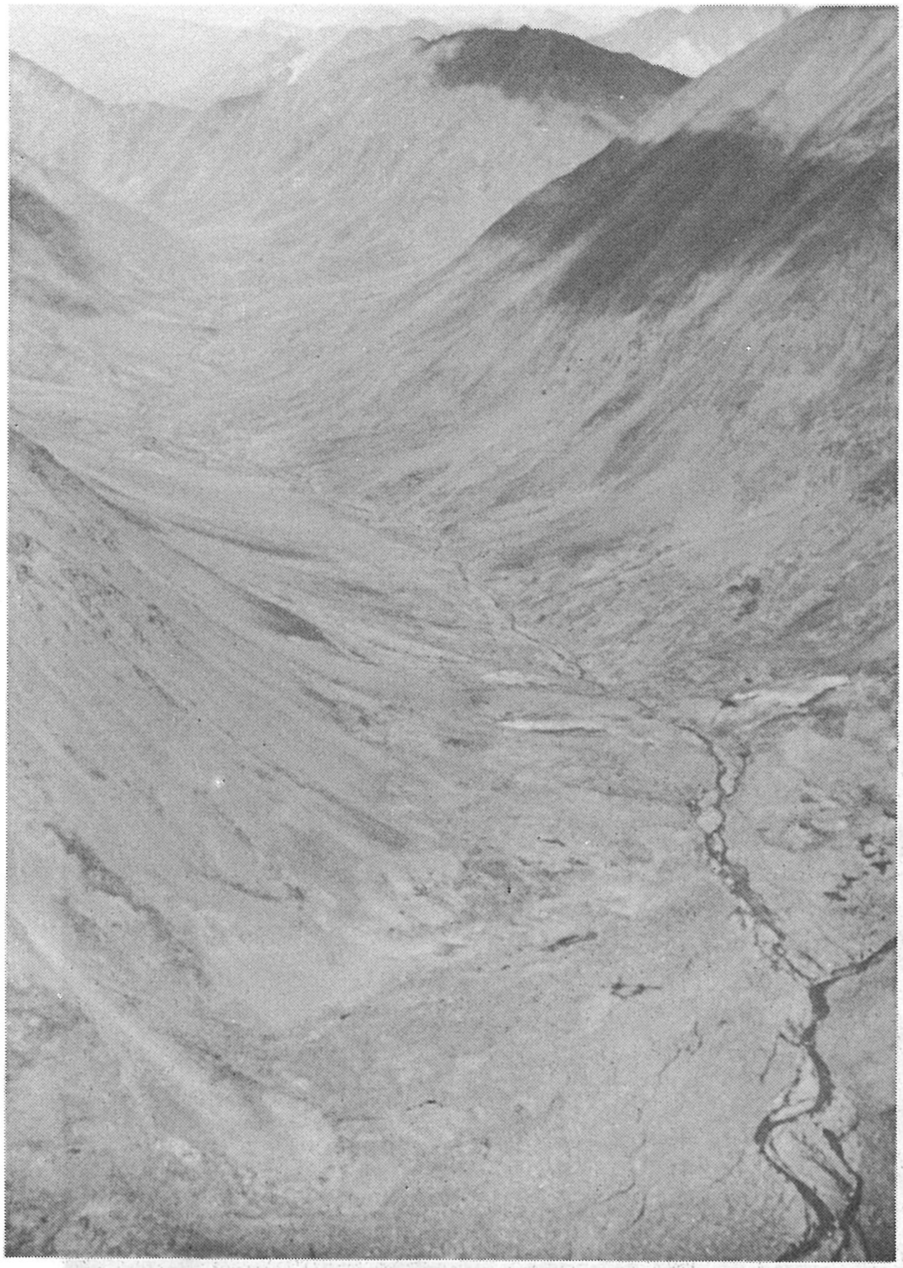


Little Coal Creek in Denali State Park. Vegetative biome is classified as upland spruce-hardwood. Streams in this area are incised into a relatively gentle plain.



Talkeetna River near town of Talkeetna. This photo shows the density and conformity of the forest of the lower Susitna Valley in the Talkeetna area.

Detail of bottomland forest near Talkeetna. Predominant trees are poplar and white spruce with considerable brush understory. This forest type can easily conceal a transmission clearing.



Upper Wells Creek, approaching pass to Louis Creek. Biome is alpine tundra.

Wells Creek Pass as seen from Louis Creek side.

Moody Pass from Yanert Fork to Moody Creek, which is visible in the upper left. This pass is relatively low (2900') and wide, but soils are poorly drained and subject to permafrost.

Lower Moody Creek. This is a well-dissected area, covered with upland spruce-hardwood. Routing of transmission may prove difficult in this stretch.

Lower Moody Creek at confluence with Healy Creek (top of photo). Unstable slopes are evident.

Looking north from western end of Denali Highway. Typical low brush and muskeg biomes. Trees are black spruce.

Aerial view looking west along Denali Highway and Nenana River to Cantwell. Note that forests are limited to the terrace slopes and levees of the river channel.

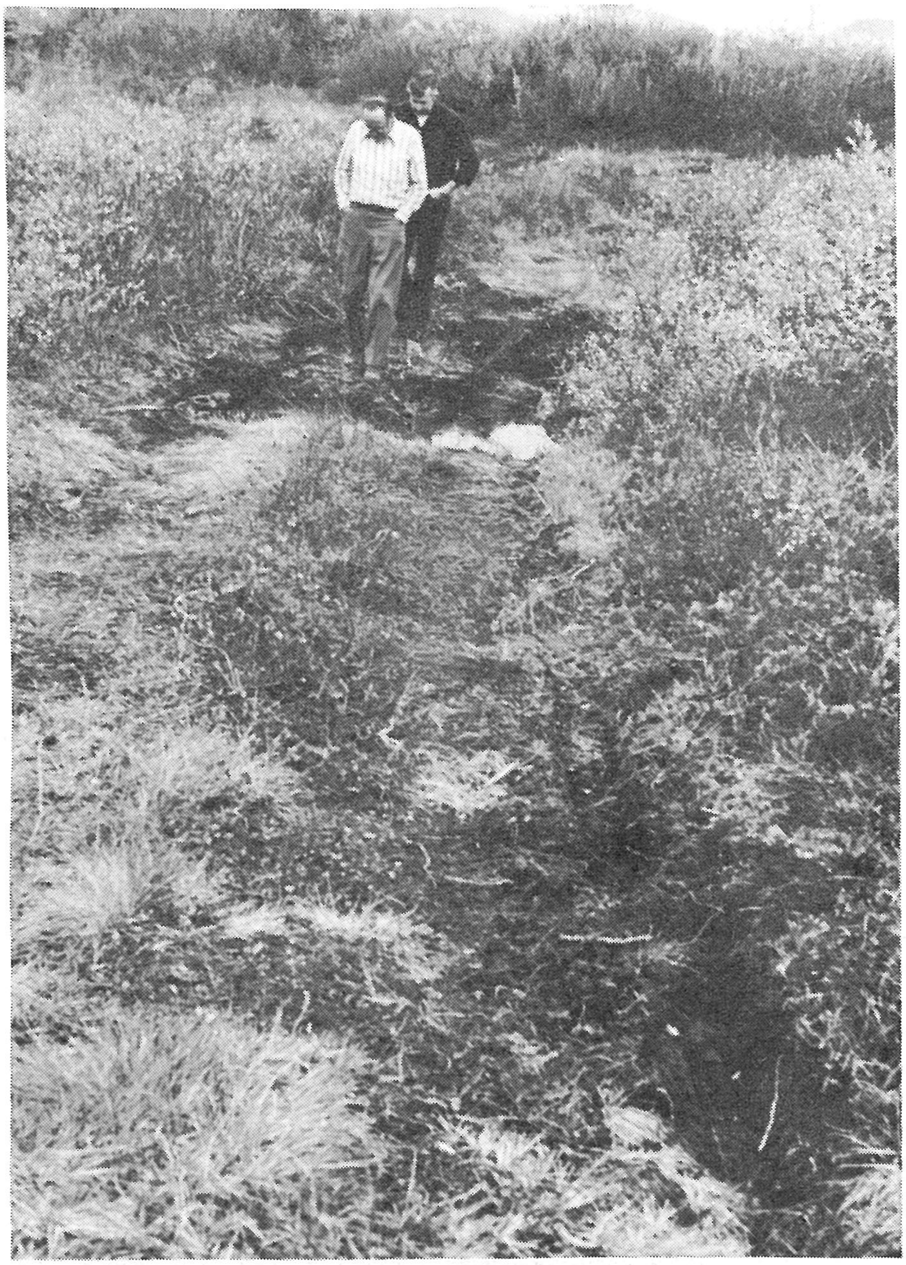
Surface view of area typical of that shown in photo above; in this case, the Nenana River is in the vicinity of the Wells Creek confluence. The lowland spruce-hardwood is limited to the terrace slope and river bottom.

Looking west up the Nenana River and Denali Highway. The sources of both the Nenana and Susitna Rivers are in the Alaska Range visible in the upper left. In the upper left also is the divide between these two rivers, a wide, poorly-drained area called Monahan Flat.

Susitna River between Watana and Vee damsites. Heavier vegetation, in this case upland spruce-hardwood forest, is limited to the valley slopes, the vegetative biome on the upper plateaus is generally moist tundra, muskeg, and alpine tundra.

Susitna River at Vee damsite. This demonstrates the typically incised character of the Upper Susitna from Devil Canyon to the Tyone River. Note that heavier vegetation is limited to slopes and creek valleys.

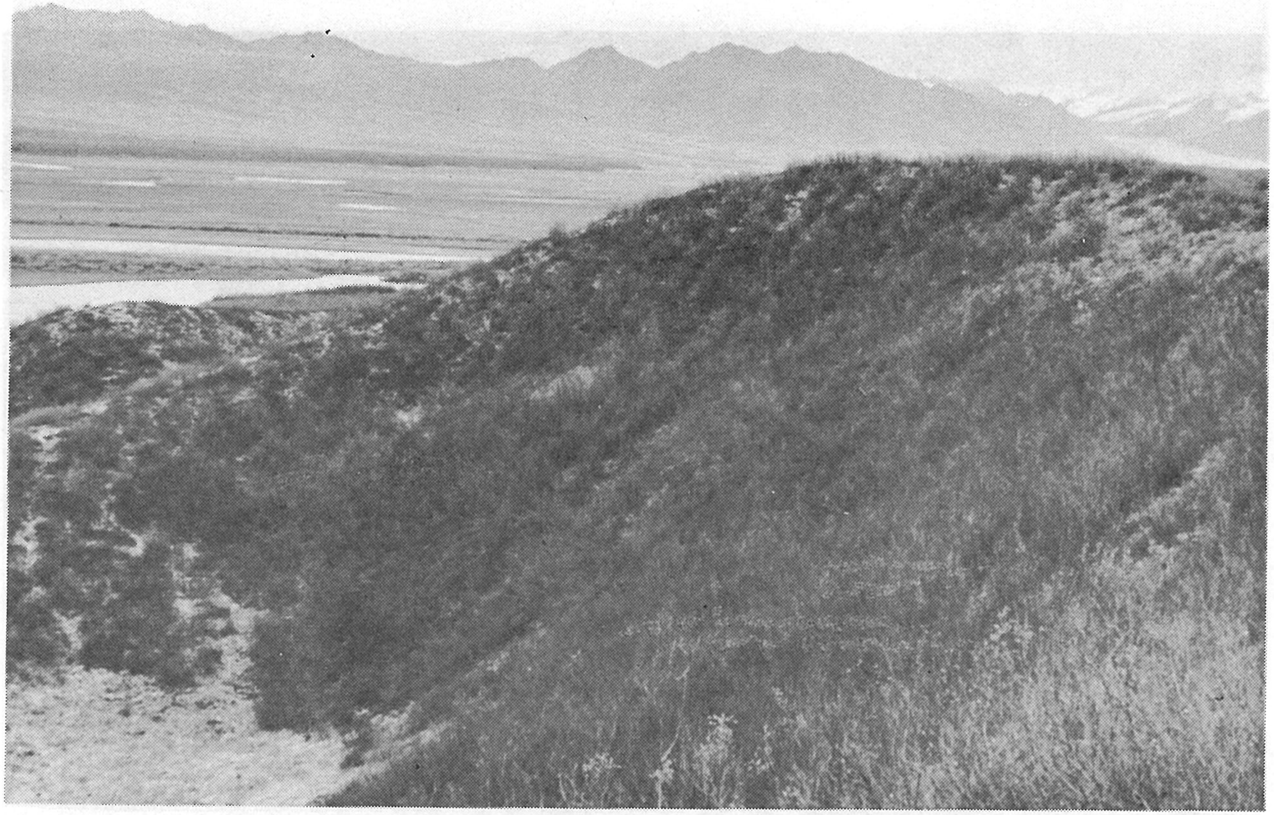
Moist tundra near Butte Lake; looking north to Monahan Flats and Alaska Range. ATV tracks are visible in the foreground; these tracks start from the Denali Highway, which crosses the flats in the background.



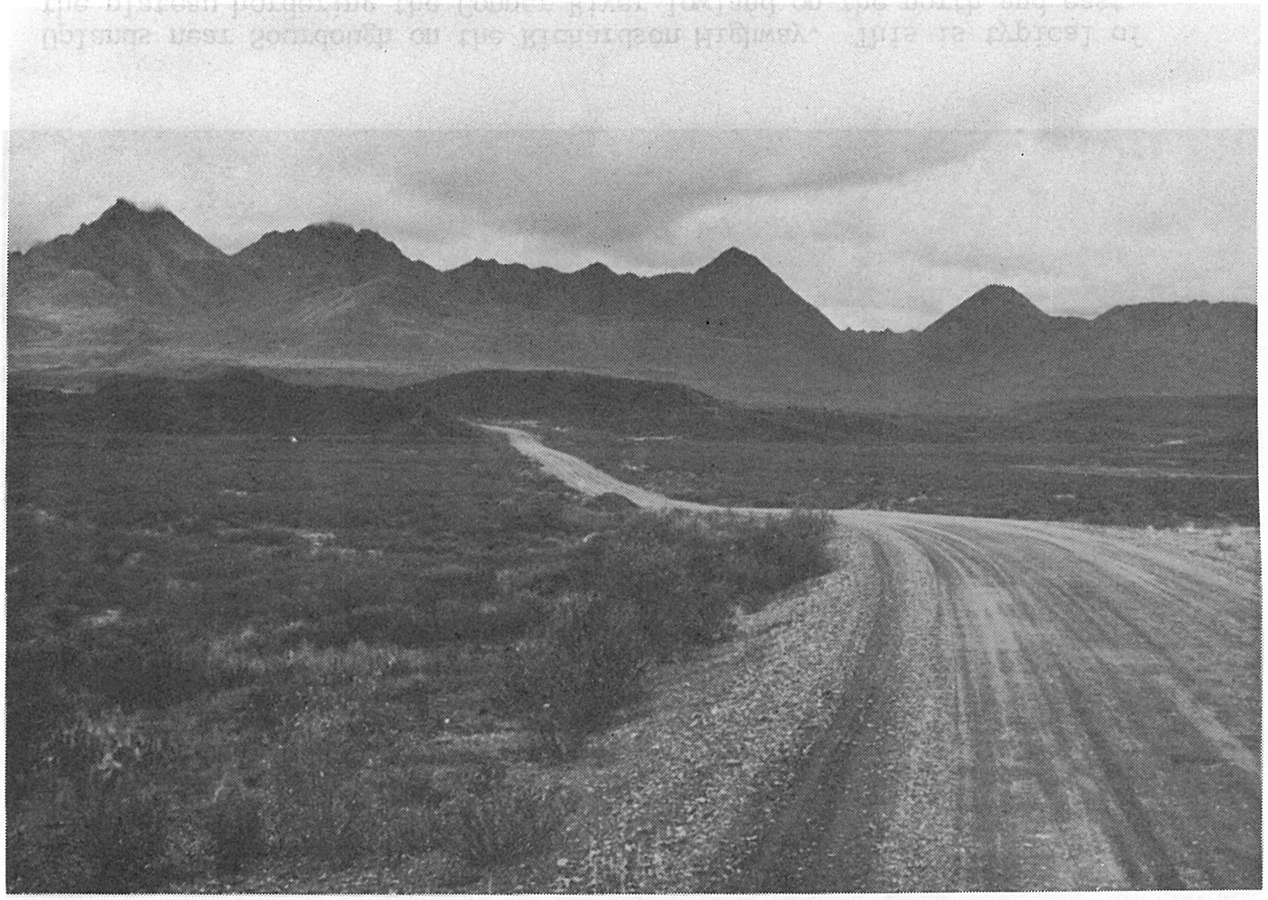
ATV tracks leading from Denali Highway. This photo shows typical moist tundra vegetation with low-growing brush, peaty soil, and poor drainage.

Susitna River above Denali damsite, looking west. The few spruce to be found are limited to the river bottom.

Impoundment area of Denali damsite. The Susitna here is a meandery, aggrading river, the surrounding land is very poorly drained and underlain by fairly continuous permafrost.



Maclaren River, looking north to the Clearwater Mountains. The foreground knob is part of a morainal ridge. These morainal features are reltaively well-drained, whereas the flat low-lying lands are poorly drained with shallow permafrost tables.

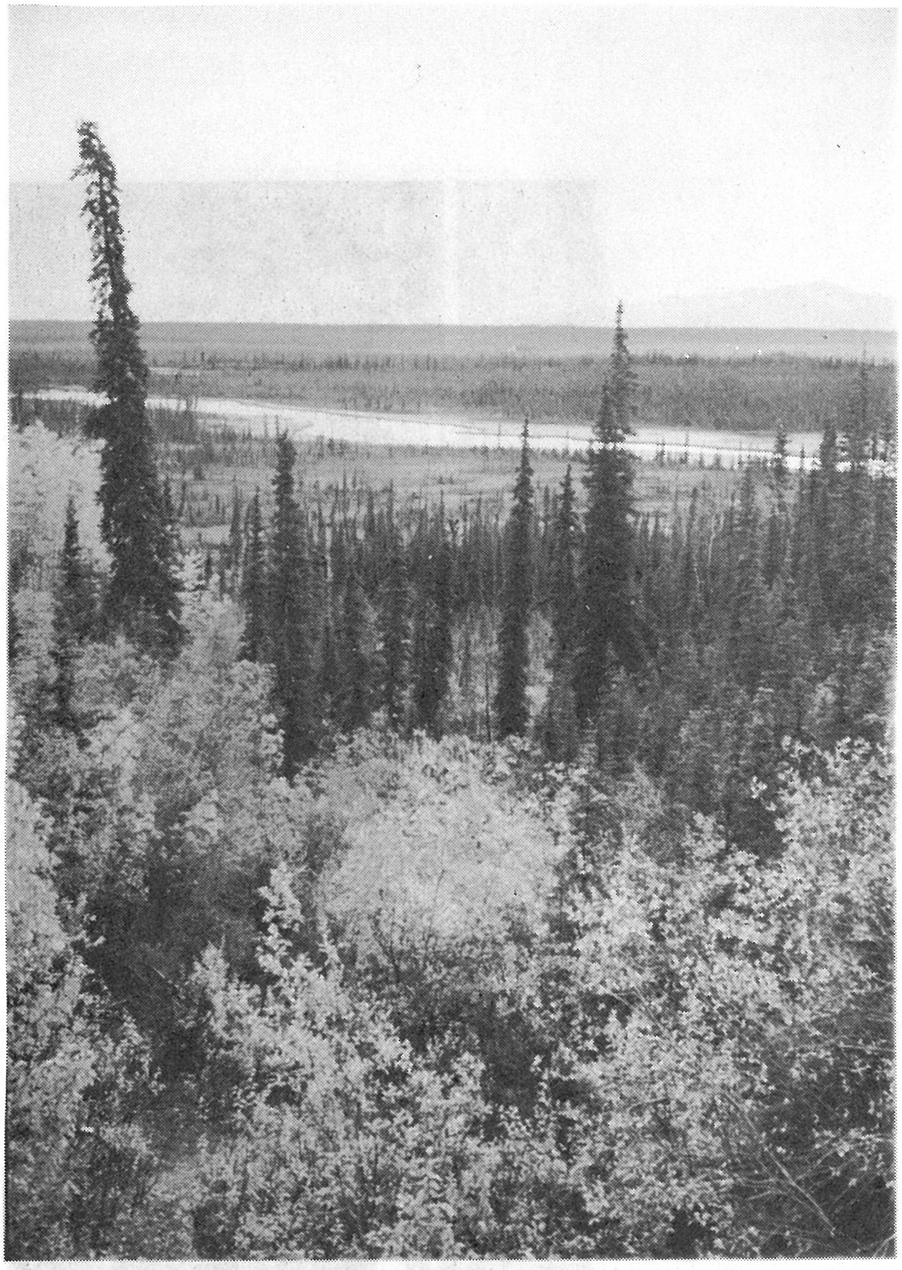


Looking north along the Denali Highway to the Amphitheater Mountains. Morainal ridges run across the middle of the photo. The biome along most of the eastern half of the Denali Highway is moist tundra.

Uplands near Sourdough on the Richardson Highway. This is typical of the plateau bordering the Copper River lowland on the north and east. Poorly drained, it supports many lakes, the largest of them in the Lake Louise complex.

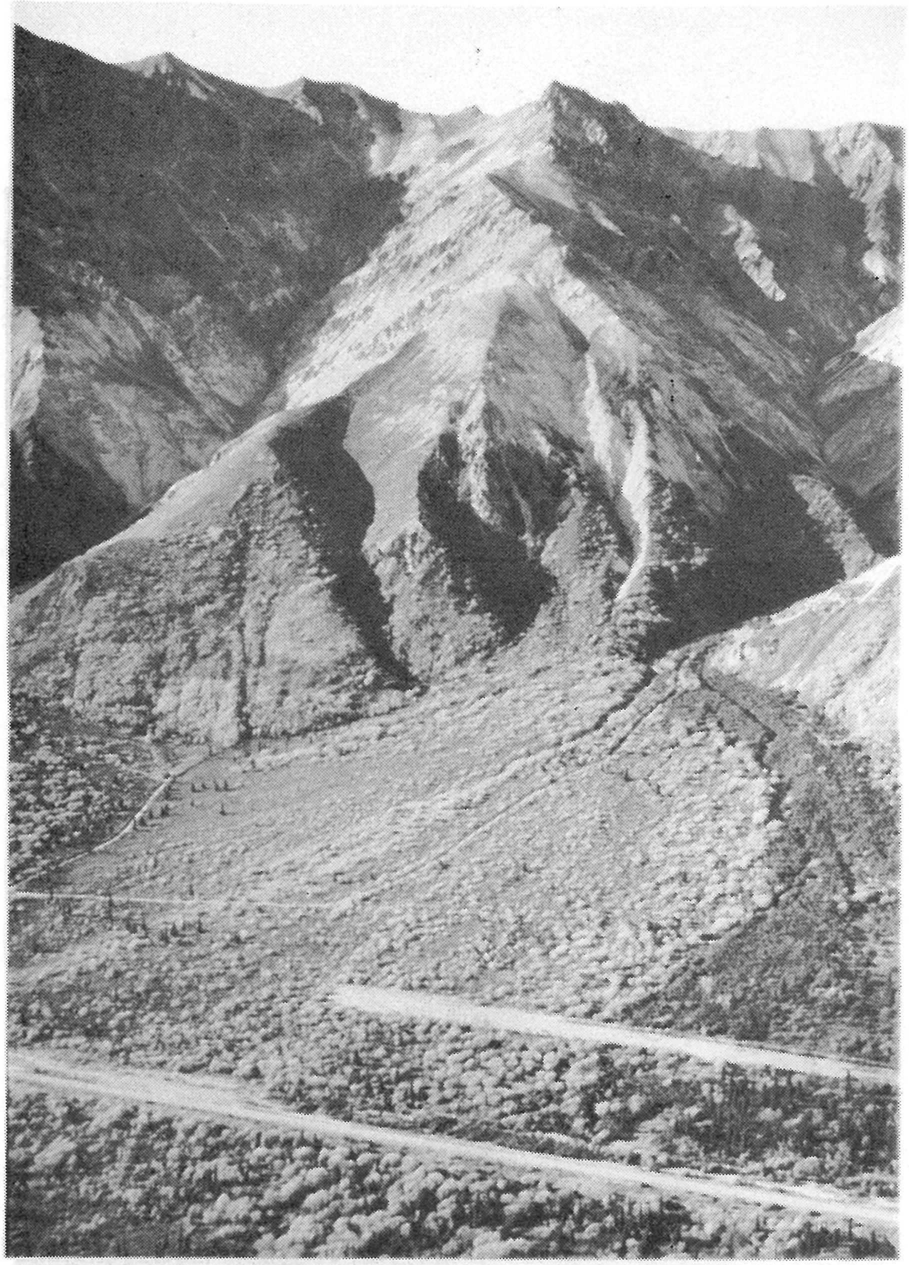
The Lake Louise plateau. Biomes are predominantly lowland spruce-hardwood and muskeg. These uplands are underlain by continuous permafrost.

The Copper River lowlands, a large basin underlain by permafrost.

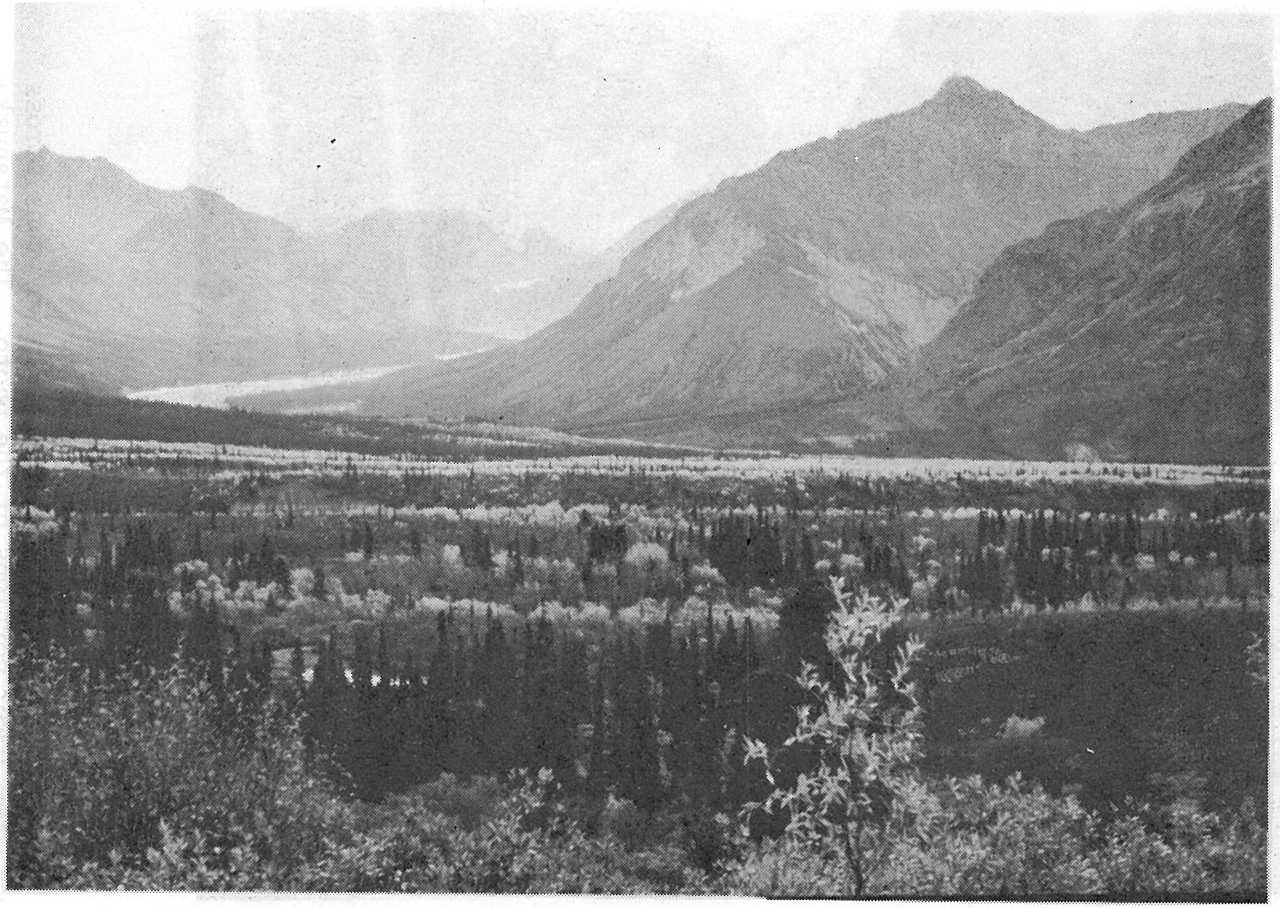


Tazlina River as seen from the Glenn Highway.

Tahneta Pass area between the Tazlina and Matanuska River drainages. Lakes and muskegs are indicative of poor drainage. The mountains are part of the Chugach Range.

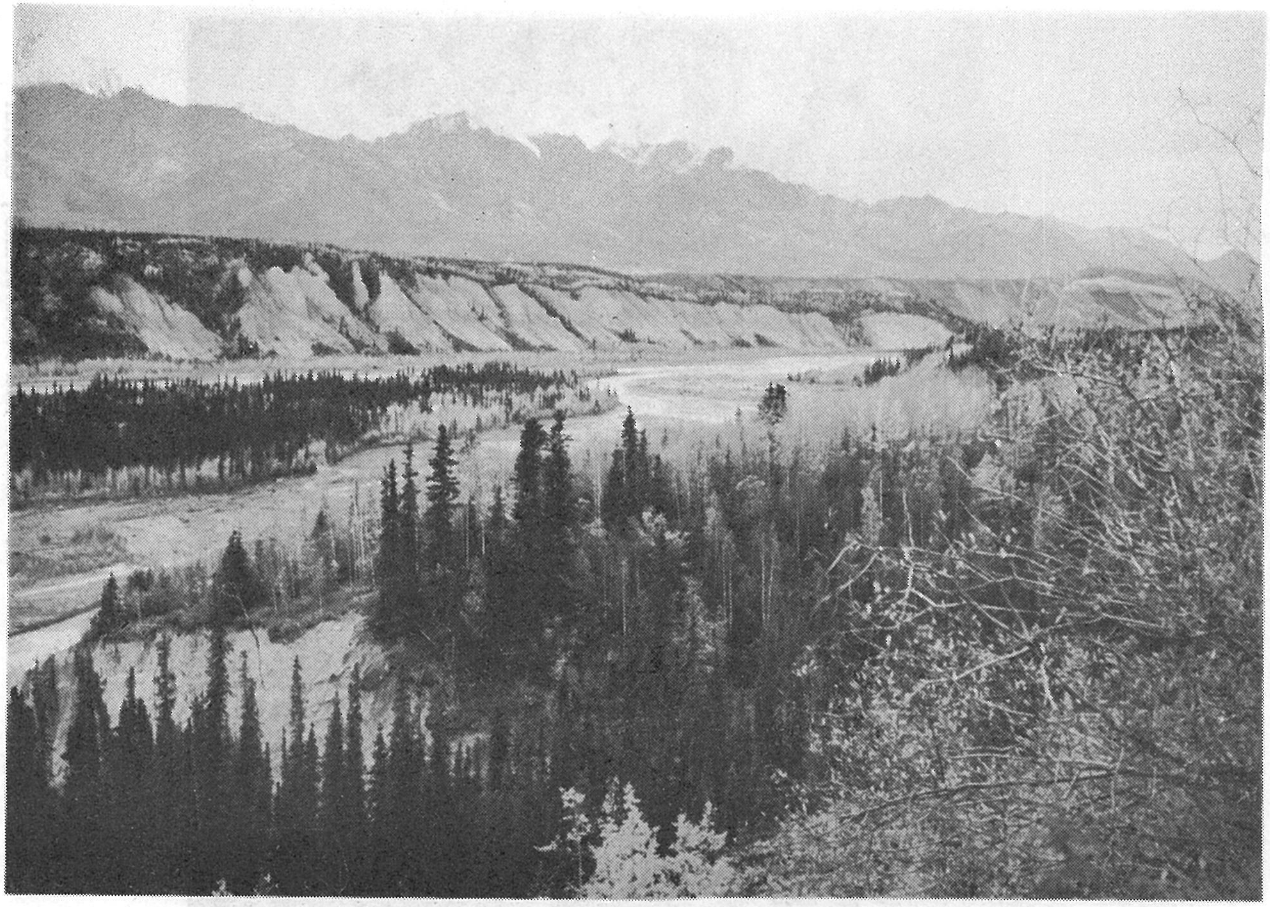


Talkeetna Mountains; Glenn Highway runs across the lower portions of the photo. The Matanuska valley is bordered on the north by the Talkeetna Range, on the south by the Chugach.



Howell Glacier and the Chugach Range. The Matanuska River flows in an incised channel across the middle of the photo.

Caribou Creek and the Talkeetna Mountains; Glenn Highway on lower portion of photo. This tributary of the Matanuska River typifies the incised character of many rivers eroding through glacial debris and loess, such as the Matanuska, Copper, Gulkana, and upper Nenana Rivers.



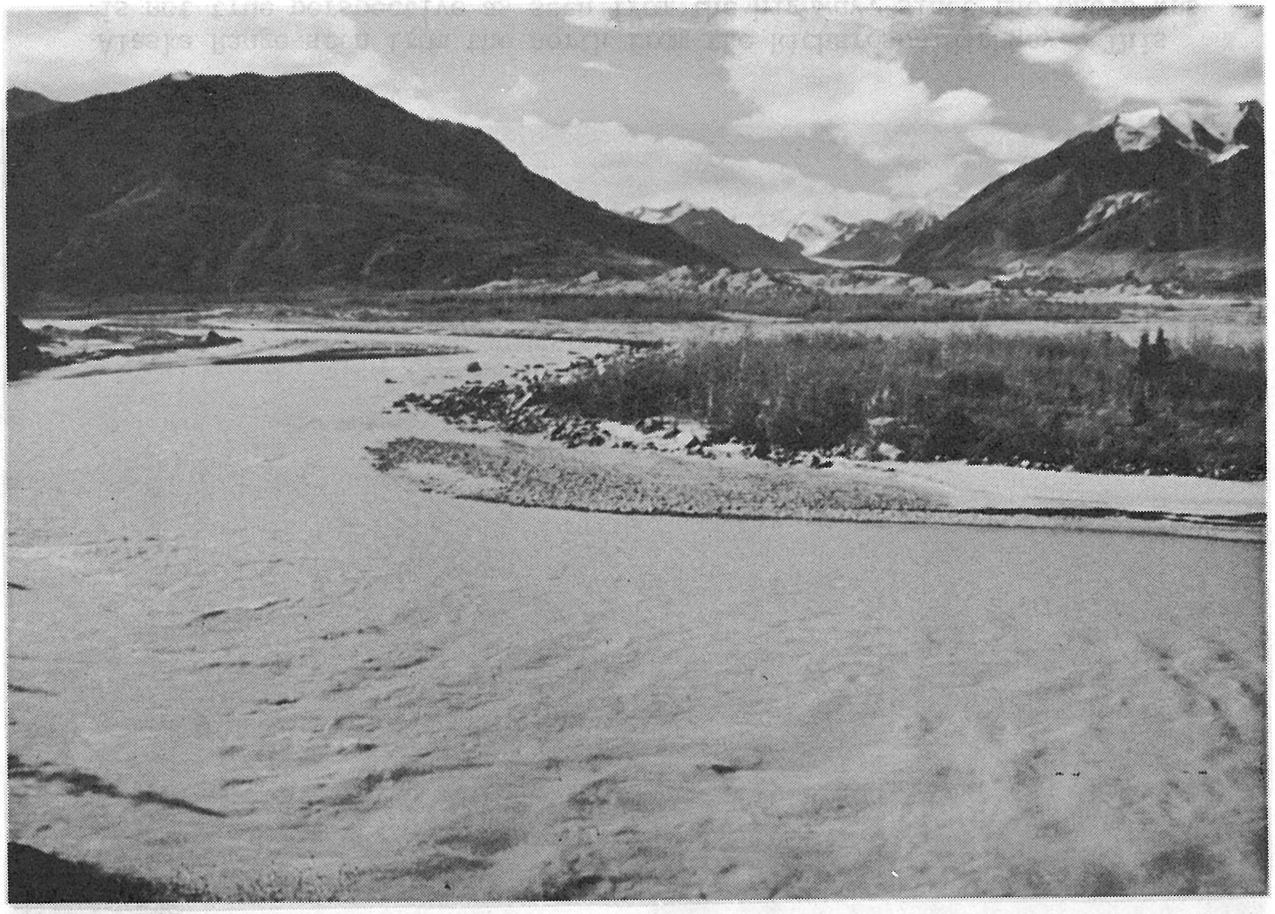
Matanuska River and Chugach Range. The Matanuska River has a braiding channel due to the high silt load from the Howell and Matanuska Glacier, and the glacial tributaries entering from the Chugach Range.

Looking north by Paxson Lake on the Richardson Highway to the Alaska Range. Paxson Lake is an important part of the fisheries of the Gulkana River.

Summit Lake and the Alaska Range. Summit Lake is drained by the Gulkana River and is just south of Isabel Pass.

Isabel Pass, looking north to Rainbow Ridge. The Richardson Highway, the Delta River, and the Alyeska Pipeline cross the photo at the base of Rainbow Ridge.

Rainbow Ridge, as seen from the south. The Richardson Highway crosses under the ridge from right to left. The slope of the ridge is a series of adjoining talus cones some of which are unstable.

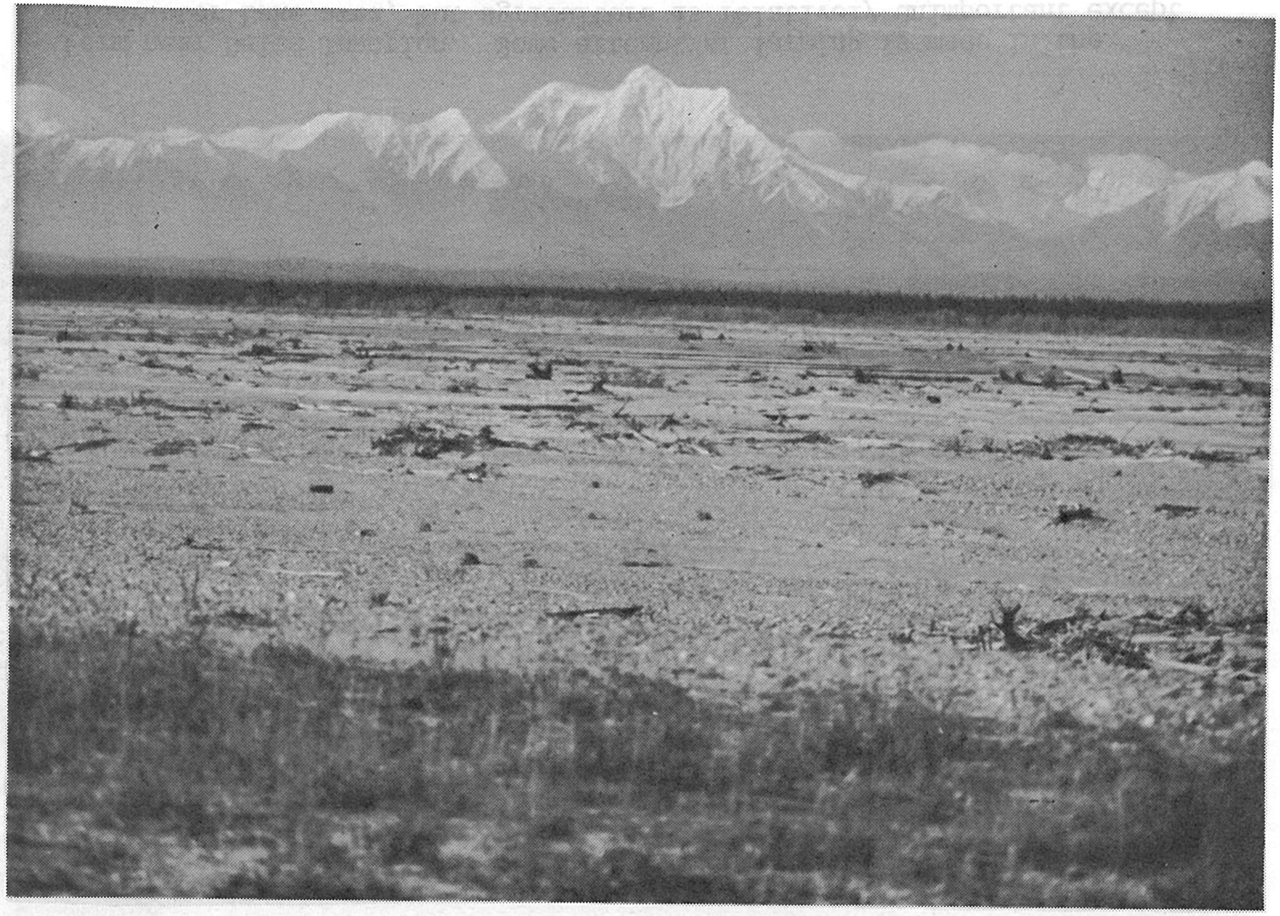


Delta River by Black Rapids Glacier. The glacier is partially visible in the upper center of the photo. The Delta River carries considerable glacial silt, resulting in aggradation and braiding of the channel.

Alaska Range seen from the north from the Richardson Highway. This is not true perspective as seen from the highway, since the photo was taken with a telephoto lens.

The Alaska Range seen from the Richardson Highway near Donnelly Dome, looking south. The dust is from the channel of the Delta River, which is extremely undersized for its channel.

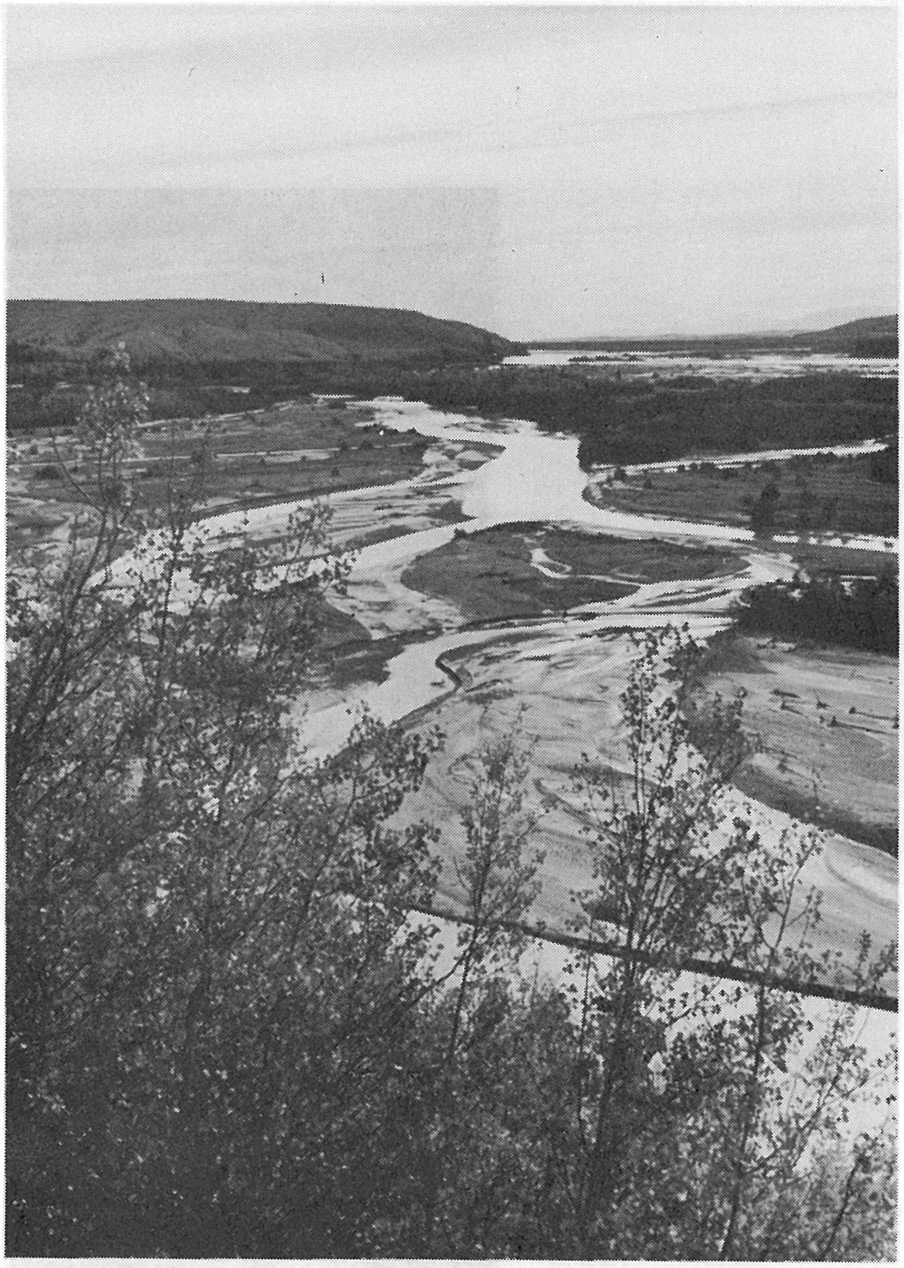
Another view of the Delta River as seen from near Donnelly Dome.
Again, the blowing dust from the channel is evident.



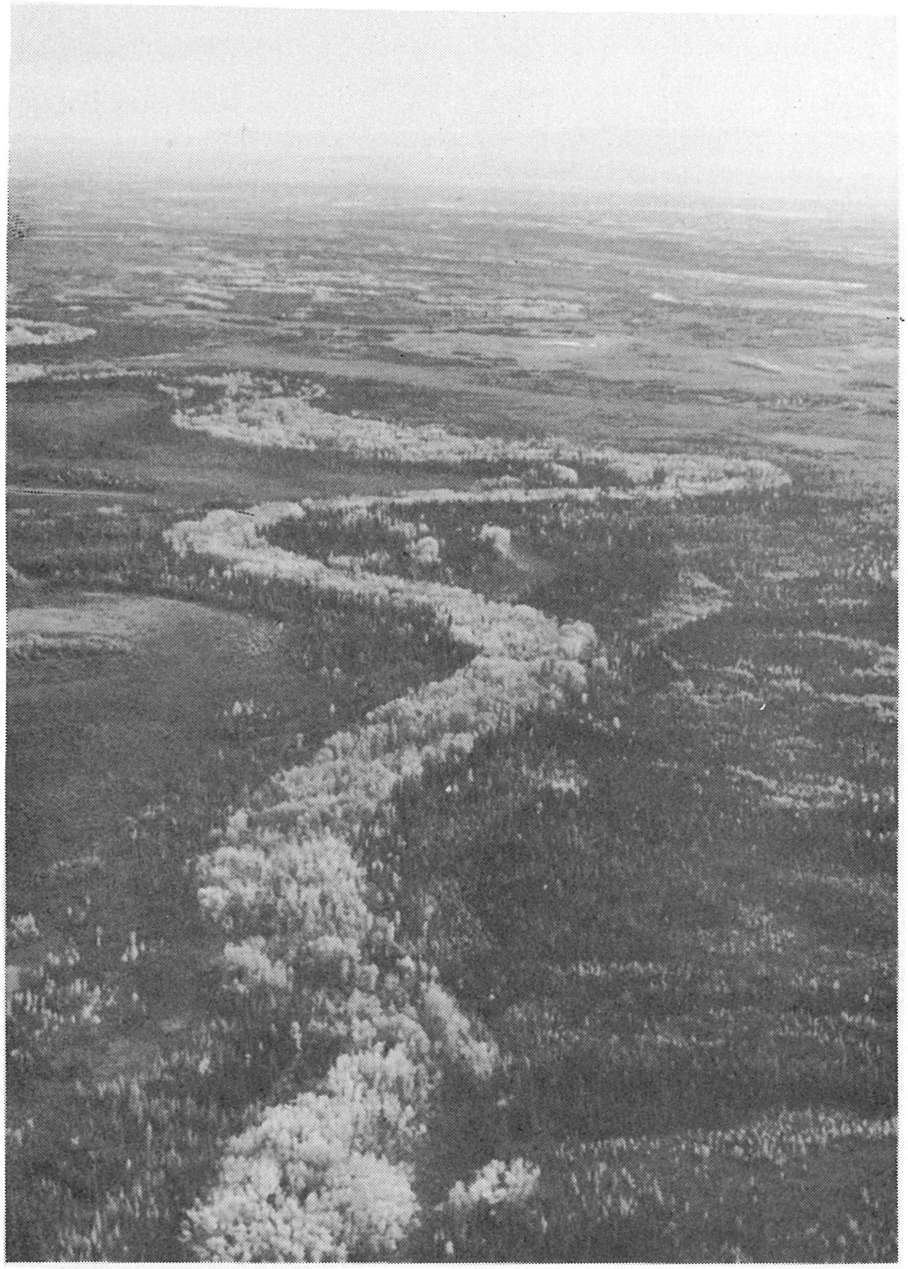
Alaska Range from Big Delta, taken with telephoto, In the foreground is the Delta River channel, which near here joins the Tanana River.

Farm near Delta Junction. Some attempt at farming is made in the Clearwater Lake area, but agriculture is relatively unimportant except for the lower Matanuska Valley area.

Silhouetted notch on a clearing for a GVEA distribution line.



Looking up the Tanana River across the confluence of Shaw Creek. The braiding of channels characteristic of the Delta and Tanana Rivers is evident.



The Tanana River flood plain. This area is extremely flat and poorly drained. Three types of biome are represented in this picture: muskeg, lowland spruce-hardwood, and bottomland spruce-poplar. The dark forests are mainly black spruce. The sinuous lighter forest is white spruce, aspen and birch. This forest type prefers well-drained soils, and so is found on old levees of existing and extinct channels.

GLOSSARY

Appendix I
EXHIBIT I-4

GLOSSARY - EXHIBIT I-4

1. Brush blades, brush hogs: Devices mounted on tractors or bulldozers which cut and clear brush with less soil disturbance than the methods of uprooting with the standard blade or shovel.

2. Chipping: Method of disposal of cleared brush and slash by mechanical cutting into suitably small chips, which are then either dispersed or hauled away.

3. Climax: A stable condition achieved by a community of plants and animals resulting in successful adjustment to its environment. The stability involved is of a long-term nature; short-term fluctuations are to be expected. In this way, a climax stage of development can be considered dynamically stable rather than static. See Succession.

4. Conductor: The part of the transmission system which actually transmits power. In overhead systems, this is an uninsulated cable, generally of aluminum and steel, connected to the towers by way of insulators. In underground systems, the conductor is generally aluminum cable insulated with oil-impregnated paper, oil, or plastic. This cable is often wrapped in a protective sheath. In overhead systems, there can be multiple conductors per phase. Single conductors are called simplex; double conductors are called duplex. Larger numbers of cables per phase can be used, the resulting combination called conductor bundles.

5. Corridor: A generalized route. A strip of land of variable width joining two end points. In this assessment, corridors are not defined in width and final location. A more specific linear location is the Route.

6. Danger Tree: Any tree which threatens the safety of a transmission system. Several factors determine danger trees: voltage of line, height of line above ground, height of tree, growth rate of tree, and distance of tree to center line. These trees must be periodically identified and removed.

7. Ecosysem: The complex of a community and its environment functioning as an ecological unit in nature.

8. Electromagnetic Interference (EMI): Interference with radio and television produced by corona losses from transmission lines. EMI is a function of many factors, among them the voltage of the line, the configuration, site, height and age of the conductors, and atmospheric conditions.

9. Fault: In the transmission sense, a condition of either open or short circuiting can be caused by defects, lightning, grounding or connecting of phases, dropping of overhead cable, or break in insulation in underground cable. In the geologic sense, a fracture in the crust, along which displacement has occurred.

10. Free-standing Towers: A transmission tower design needing no support from guyed cables. This design generally has four legs, and is usually of steel lattice construction. See Guyed Tower.

11. Generation Site: Any power site, without regard to method of generation. Generation sites are one end to transmission lines. In this assessment, the generation sites are the potential power sites on the Upper Susitna River.

12. Guyed Tower: A transmission tower supported by two or more guyed cables and pivoting on one or two points. Generally lighter than free-standing towers, they are more suited to helicopter construction. See Free-standing Towers.

13. Habitat: The particular area in which a plant or animal lives. In general, any area possessing those conditions necessary to support a population of a particular plant or animal.

14. Herbicide: A variety of pesticide which affects plants. Herbicides can be general or specific in action, and of various potencies and duration.

15. Interconnection: The connection of two or more independent power systems with tie lines. Besides an increase in total reliability, the opportunity exists for one system to sell surplus power to another, which can result in greater efficiency of generation.

16. Load Center: A point at which the load of a given area is concentrated. For example, the Anchorage load center, as referred to in this assessment, covers the load included in the CEA, AML&P, HEA, SES, and MEA systems. The load center is assumed to be the receiving end of a transmission line. See Generation Site.

17. Permafrost: Permafrost is a condition resulting whenever soil or rock has been subjected to an annual average temperature of less than $0^{\circ}C$ for more than two years. Ice-rich permafrost is permanently frozen soil with a high moisture content. Permafrost table is the level beneath the soil surface which remains frozen through summer.

18. Right-of-way (ROW): A right-of-way is a strip of land dedicated for use of some utility, such as transportation or transmission. The land within a ROW is sometimes an easement, not involvingthe purchase of the land, or can be owned by the utility. The right-of-way width for a transmission line is generally less than 200 feet wide. Clearing width and right-of-way width should not be confused; clearing width, if clearing is needed at all, is almost always less than the right-of-way width.

19. Route: A definite location of a ROW, as opposed to a corridor.

20. Seismic: Pertaining to, subject to, of the nature of, or caused by an earthquake.

21. Substation: A facility at a junction of transmission lines or at the point of distribution to a load center. A substation functions to switch power and raise or lower voltage. See Tap.

22. Succession: A process by which a community of plants and animals achieves a stable adjustment to its environment; a successional stage is a transition culminating in a stable climax stage, providing the process is allowed to continue. However, due to natural and human causes, a community will often never reach a climax stage, the successional stages being maintained by fire, logging, grazing, agriculture or other reasons.

23. System Plan: A plan of transmission from generation site to load center which is a combination of two factors: the corridor location and the voltage and capacity of the transmission line.

24. Tap: A drawing of power from a transmission line, particularly at a point between the generation site and the main load center. Each tap will involve a substation.

25. Utility Corridors: A concept of concentrating generally parallel rights-of-way, even to the point of sharing of rights-of-way. The rights-of-way can be for various utilities, such as pipelines, railroads, transmission lines, and highways.

26. Sedimentation: The introduction into a stream or lake of sediment not normally associated with that water body. Although sometimes caused by natural agents, such as slides or erosion triggered by fires, it is more often a result of man's activities, such as logging and farming.