Feasibility Study

Copper Valley Intertie

State of Alaska, Department of Community and Regional Affairs, Division of Energy

Volume 1

April 1994

R·W·BECK

Section I
SUMMARY AND CONCLUSIONS

Section II
INTRODUCTION

Section III
ROUTE SELECTION

Section III
ROUTE SELECTION *(continued)*

Section IV
FEASIBILITY DESIGN - TRANSMISSION LINE

Section IV
FEASIBILITY DESIGN - TRANSMISSION LINE *(continued)*

Section IV
FEASIBILITY DESIGN - TRANSMISSION LINE *(continued)*

Section V
FEASIBILITY DESIGN - SUBSTATIONS

Section VI
PROJECT COST ESTIMATES

Section VI
PROJECT COST ESTIMATES *(continued)*

Section VII
PROJECT SCHEDULE

Section VIII
ELECTRIC LOAD FORECAST

Section VIII
ELECTRIC LOAD FORECAST *(continued)*

Section IX
POWER SUPPLY EVALUATION

Section IX
POWER SUPPLY EVALUATION *(continued)*

Section X
EVALUATION OF ALTERNATIVE POWER SUPPLY PLANS AND ECONOMIC ANALYSIS

(PROVIDED AS A SEPARATE BOUND DOCUMENT.) VOLUME 2

(PROVIDED AS A SEPARATE BOUND DOCUMENT.) VOLUME 3

SUMMARY AND CONCLUSIONS

A. INTRODUCTION

In 1992, the Copper Valley Electric Association (CVEA), a rural electric cooperative that serves the Glennallen and Valdez areas, prepared a screening level cost estimate for a 138-kV transmission line between Sutton and Glennallen (the "Intertie"). Following development of its cost estimate, CVEA prepared an economic analysis showing that the Intertie could provide economic benefits to the electric customers of CVEA. At that time CVEA requested that the Alaska Energy Authority (Authority) conduct a feasibility study of the Intertie that would conform with statutory requirements for proposed Authority projects. R. W. Beck and Associates was retained by the Authority in January 1993 to perform the feasibility study, the results of which are presented in this report. As a result of State legislation that took effect in August 1993, oversight responsibility for this study was transferred from the Authority to the Department of Community and Regional Affairs, Division of Energy (Division).

In May 1993, the State Legislature appropriated $35 million for payment as a zero-interest, 50-year loan to the participating utilities for design and construction of the Intertie. According to this legislation, the appropriation "is contingent upon the completion of a feasibility study and finance plan satisfactory to the Department of Community and Regional Affairs as set out in former AS 44.83.181." The referenced statute requires that a feasibility study include "a comparative analysis of all reasonable alternatives to construction of the proposed project." The associated regulations further specify that the comparison of alternatives must be conducted with respect to economic, environmental, and technical factors; and that the present value of future costs to meet long-term power requirements in the region must be estimated for each plan and compared. The overall methodology of this feasibility study is dictated by these statutory and regulatory requirements.

CVEA presently sells electric power to approximately 3,000 member-customers in its service territory which includes Valdez, Glennallen and other communities in the Copper River Valley area. CVEA maintains two offices and two power plants, one each in Valdez and Glennallen. The primary source of power supply for CVEA is hydroelectric generation from the 12-megawatt (MW) Solomon Gulch Hydroelectric Project (the "Solomon Gulch Project"), located near Valdez and owned by the State. The full generating capability of the Solomon Gulch Project is sold to CVEA pursuant to a long-term power sales agreement. Since the Solomon Gulch Project does not have the capability to provide all the power needs of CVEA's customers, power generated by diesel generators located in both Valdez and Glennallen is used to supplement the output of the Solomon Gulch Project.

In calendar year 1992, CVEA sold 54,602 megawatt-hours (MWh) of electric energy to its customers. Of this amount 27%, 71%, and 2% was sold to CVEA's residential, commercial and public building customer classes, respectively. CVEA's peak demand in 1992 was 10.9 MW. CVEA's total energy requirements in 1992 were 62,481 MWh, of which 40,880 MWh was supplied by the Solomon Gulch Project and 21,601 MWh was supplied by diesel generators. Beginning in January 1993, CVEA began supplying power to the Petro Star refinery, a new industrial facility in Valdez that produces refined fuels from oil extracted from the Trans-Alaska pipeline. The Petro Star refinery is CVEA's largest customer. During August 1993, Petro Star purchased 1,165 MWh of electric energy from CVEA and had a peak demand of 1,790 kW. Total energy needs for Petro Star for calendar year 1993 are estimated to be 12,200 MWh.

The Intertie would connect the electric system of CVEA directly to the electric system of the Matanuska Electric Association (MEA) and indirectly, through MEA's transmission system, to the electric systems of Alaska's Railbelt utilities. It is expected that with the Intertie, CVEA would purchase power generated at gas-fired generating plants by either the Chugach Electric Association (CEA) or Anchorage Municipal Light and Power, utilities located in the Anchorage area. Power purchased from the Anchorage area utilities would be used by CVEA to offset diesel generation in Glennallen and Valdez. CVEA is presently an isolated electric system with no interconnections to any other electric utilities.

B. PURPOSE OF STUDY

This feasibility study is intended to define the design and routing criteria and estimated costs related to development of the Intertie, to provide a feasibility level environmental analysis, and to assess the costs of the Intertie as compared to other resource alternatives. The feasibility study includes the following principal tasks:

1. Review the Intertie route options defined in previous studies and identify other possible routing alternatives and define preferred alternatives.

2. Develop a feasibility level design of the Intertie.

3. Develop a construction cost estimate and construction schedule for the Intertie.

4. Develop an estimate of annual operations and maintenance costs for the Intertie.

5. Conduct a review of the environmental factors related to the Intertie. Meet with and solicit input from various governmental and public agencies concerning environmental and other institutional constraints which may affect construction of the Intertie.

6. Conduct public meetings at Sutton, Glennallen and other affected communities to obtain comment concerning the Intertie from the general public.

7. Prepare an environmental report which can serve as the basis for subsequent environmental studies.

8. Compare significant environmental impacts estimated for the most competitive alternatives.

9. Conduct an electric system analysis of the electric systems of CVEA and the Railbelt utilities to determine the effects on system stability and performance resulting from interconnected operation if the Intertie were constructed.

10. Prepare a forecast of CVEA's electric power requirements for the next twenty years.

11. Review and define the costs and operating characteristics of alternative power supply options, including conservation, that may be available to CVEA in the future.

12. Conduct an economic analysis comparing the life-cycle costs and benefits of the Intertie to those of alternative resource scenarios.

13. Prepare a draft report summarizing the findings of the feasibility study.

14. Conduct a final set of public meetings to present the findings of the feasibility study and solicit public comment.

15. Prepare a final report following the receipt of comments on the draft report from the Division and others.

C. STUDY METHODOLOGY

The feasibility study was conducted as an independent study of the Intertie and its identified alternatives and involved the efforts of several engineering, environmental, public policy and economic specialists. R. W. Beck developed the Intertie route alternatives, preliminary design, cost estimate and construction schedule, and also prepared the electric load forecast, the evaluation of alternative power supply options and the economic analysis. Dames & Moore, Inc. of Anchorage conducted an environmental analysis and prepared an environmental report which is included as an appendix to this report. Following review of the draft feasibility study, the environmental analysis was supplemented by R.W. Beck. Power Technologies, Inc. conducted the electric system analysis and provided a report which is also included as an appendix. Both the environmental review and the electric system analysis were used as input to the feasibility level design and cost estimate of the Intertie. In addition, comments received during the public meetings and written comments received from the general public during the course of the feasibility study were reviewed and considered in the development of the analysis. Written comments and transcripts of formal public testimony received during the course of the study are also included as an appendix.

Alternative design and routing criteria for the Intertie were gathered from previous studies and new investigations. These criteria were evaluated based on past experience with similar projects in Alaska and elsewhere. Discussions were held with utility and Authority engineers to solicit input with regard to the basic design and routing criteria. Both the environmental review and the electric system analysis relied upon the routing and design characteristics of the Intertie as part of the basis for their analysis. The electric load forecast that was prepared as part of the feasibility study used a model that was developed to relate energy usage in the CVEA service territory to projected future changes in population, employment, income and other factors.

The review of power supply alternatives available to CVEA was conducted using, for the most part, information developed by others in previous studies. An independent review of a proposed coal-fired generating project was conducted as part of the feasibility study. The economic analysis that was conducted for the feasibility study projected the comparable costs of power supply for CVEA for the various resource alternatives over the expected lifetime of the Intertie and then accumulated the present value of these costs. This method of economic analysis was employed by the Authority for many years in its evaluation of generation and transmission projects throughout the State and is a standard approach for electric utility least cost planning analyses.

Specific descriptions of the methodology incorporated in the various components of the feasibility study are included throughout the sections of the report. Assumptions used throughout the study are also identified in the applicable sections of the report.

Significant effort was extended to gather and incorporate input from local communities, utilities and State and Federal agencies that will be affected by the Intertie. Advertised public meetings were held in Sutton, Glennallen, Chickaloon, the Glacier View area, and Valdez to introduce the general characteristics of the Intertie and obtain comment. A meeting was held with various State and Federal agencies for additional comment and input. Discussions were held with staff members of CVEA and MEA and a design criteria review meeting was conducted with the Authority, CVEA and other local utility and engineering representatives to obtain input. Historical operating and other technical data was received from CVEA and used in the development of the overall analysis.

D. PROJECT DESCRIPTION

1. Route

The Intertie would interconnect the Railbelt electric system at Sutton to the electric system of CVEA at Glennallen and would traverse a distance of approximately 135 miles. Initially, two route alternatives were considered, one relatively close to the Glenn Highway and one farther north. These two routes were both identified in previous studies with the northern route having been proposed by a citizen's group as an alternative to a proposed transmission line near the Glenn Highway. The two initial route alternatives evolved into four route alternatives after several new route segments were identified as part of this feasibility study. The four routes, identified in this study as Route Alternatives A, B, C and D, were compared and an "apparent preferred route" alternative was identified. The route identification and comparison process entailed review of previous studies for transmission lines in the same area, ground and aerial reconnaissance, review of public comment, and the compilation of information on property ownership, wildlife habitat, forest cover and other environmental characteristics affecting route alignments. The apparent preferred route and the other alternative route segments are shown in Figure III-1 and are identified by route segment.

All route alternatives were, to the extent possible, sited to minimize visual impact and to avoid private and, to a lesser extent, native-owned lands. The transmission line was also routed at least 600 feet from known occupied structures in response to public concerns over magnetic fields. At 600 feet from the transmission line, the magnetic field from the line under maximum electrical loading is less than 0.1 milligauss, well below typical ambient field levels within housing units.

A set of evaluation criteria was established and applied with a route evaluation matrix procedure to determine the relative advantages and disadvantages of each route. The evaluation process that was conducted was limited and was not intended to take the place of a formal assessment of the various route options that will be prepared further into the development process. Our limited evaluation procedure considered four categories: environmental, land use, construction and technical issues, and estimated cost. Specific objective criteria in each category were developed and measured. Examples of the criteria are the number of anadromous streams crossed by the transmission line, the distance traversed in wetlands and the unit cost per mile.

An apparent preferred route, Route Alternative D, was identified. This route alternative is shown in bold on the base maps at the end of Section III of this report. It proceeds from Sutton to Simpson Cabin on Boulder Creek, then along the southern flank of Anthracite Ridge to a point west of the Victory Road area. Route Alternative D would pass north of Strelshla Mountain and continue up Hicks Creek, Alfred Creek and Crooked Creek before turning east into the Copper River Basin. The route continues in a general easterly direction from Crooked Creek remaining from two to six miles north of the Glenn Highway until it turns south and crosses the highway approximately five miles west of Glennallen.

The apparent preferred route alternative would not be visible to travelers along the Glenn Highway except possibly for short distances where the transmission line crosses Granite Creek, near Strelshla Mountain and where the transmission line crosses the Glenn Highway approximately five miles west of Glennallen. Brief glimpses of the Intertie may be possible from the Glenn Highway between Chickaloon and Victory Road depending on the perspective of the viewer. The apparent preferred route alternative avoids to a significant extent the Matanuska Valley Moose Range (MVMR), privately-owned land, native lands and unpatented mining claims. The apparent preferred route alternative is only marginally longer than the shortest route alternative and not significantly different in cost.

Route Alternative A differs from the "apparent preferred route" by going up Boulder Creek and across Chitna Pass rather than traversing the southern flank of Anthracite Ridge to Strelshla Mountain and on into the Hicks Creek area. Significant public comment was received from residents in this general area indicating a preference for the Boulder Creek route rather than the Anthracite Ridge route. On the basis of this apparent expression of community preference, it is recommended that additional consideration be given to Route Alternative A as well as Route Alternative D in any future route selection process for the Intertie.

2. Design and Estimated Cost

The Intertie is presently configured as a 138-kilovolt (kV) single circuit transmission line originating at a new substation to be located approximately 0.7 mile west of Sutton and terminating at the Pump Station No. 11 Substation in Glennallen. Improvements and additions will be needed at the Pump Station No. 11 Substation to accommodate the Intertie. No consideration was given in the preliminary design of the Intertie included in this study for future use of the Intertie as a 230-kV link in a second transmission interconnection between Anchorage and Fairbanks. To upgrade the Intertie for this purpose would require essentially dismantling the 138-kV line, constructing a new 230-kV line, and probable acquisition of additional right-of-way.

Seven types of transmission tangent structures (the structures that support the transmission line along straight runs) were investigated for the Intertie. These included self-supporting single steel and wood poles, self-supporting steel and wood H-frame structures, both braced and unbraced, and the guyed steel X-frame structure commonly used in Alaska. Detailed engineering computations were performed for three conductor options and four loading zones which differentiate primarily between the ice and wind conditions which will affect the Intertie along its route. The higher the number of the loading zone, the more significant the ice and wind loading conditions and, consequently, the stronger the structures must be. Based on evaluation of the seven structure types which we reviewed, self-supporting steel H-frames were selected as the lowest cost tangent structure for the Intertie. These structures would be made of self-weathering steel which would appear a dull, reddish-brown in color, similar in appearance to wood H-frame structures. Structure heights would be approximately 60-85 ft above ground and structures would be approximately 1,100 ft apart.

The right-of-way for the Intertie would be typically 100-125 ft wide with a cleared swath of 50-75 ft immediately below the transmission line with the width of the clearcut depending on adjacent forest cover height. A primitive trail would be grubbed along the right-of-way where terrain permits for moving equipment. Although existing access to the right-of-way that may be usable for construction purposes is limited to seven known locations, a more detailed plan for right-of-way access will be prepared during the right-of-way acquisition phase of Intertie development. Potential access points along existing roads, tractor trails, and trails are indicated on the maps at the end of Section III. Construction methods are expected to employ a combination of helicopters and ground equipment.

A detailed cost estimating model was prepared to estimate the cost of construction and materials for the different Intertie route alternatives and design alternatives. Costs for the substation additions and improvements, right-of-way acquisition and clearing, engineering and construction management, permitting, and owner's costs were developed separately. The estimated costs as developed with the cost estimation model for the direct construction cost of the Intertie on a cost per mile basis are shown in Table I-1. The total estimated development cost of the Intertie is shown by major classification in Table I-2. Generally, the lowest unit cost option for each loading zone was applied to the different lengths in each zone to compare the four route alternatives and the costs for the route alternatives varied between $47,604,000 and $49,607,000. The total estimated cost for the apparent preferred route alternative is $47,604,000 in 1993 dollars as shown in detail in Table I-2.

Table I-1
Unit Cost Estimate Comparison
Transmission Line Construction Only
(Thousands of 1993 Dollars per Mile)(1)(2)(3)

	LOADING ZONE 1			*LOADING ZONE 2*			*LOADING ZONE 3*			*LOADING ZONE 4*	
Options \ *Conductor*	***Dove***	***Teal***	***T2Linnet***	***Dove***	***Teal***	***T2Linnet***	***Dove***	***Teal***	***T2Linnet***	***Teal***	***37#9AW***
Single Steel Pole	238	239	234								
Single Wood Pole	294	276	314								
Guyed Steel X-Frame	253	247	251	272	270	267	293	292	292	475	430
Steel Unbraced H-Frame	240	227	237	229	223	237	266	245	248	467	391
Steel Braced H-Frame	259	235	257				283	271	258	468	377
Wood Unbraced H-Frame				230	238	235					
Wood Braced H-Frame	247	252	245				278	255	267		

(1) Includes mobilization/demobilization @ 5%, material contingency @ 10%, installation contingency @ 20%.
(2) Does not include right-of-way clearing costs.
(3) Unit costs based on Route Alternative D. *Shaded areas were not estimated.

3. Schedule

A preliminary schedule for total project implementation was prepared as part of the feasibility study. This schedule anticipates that environmental studies would be undertaken beginning in September 1994. The schedule further expects completion of the Intertie in late 1998 with environmental work, permitting, and right-of-way acquisition occurring through spring 1996; engineering from 1995 to 1996; and construction including right-of-way clearing, from mid-1996 to fall 1998. If an Environmental Impact Statement is determined to be required, the schedule may be delayed.

Table I-2
Intertie Cost Estimate Summary
Apparent Preferred Route Alternative D
(1993 Dollars)

									cost/mile
	A.1	Structures						$7,717,699	$57,599
	A.2	Foundations						$7,598,190	$56,707
	A.3	Guys and Anchors						$1,226,521	$9,154
	A.4	Framing						$2,642,195	$19,719
	A.5	Conductor						$6,503,487	$48,537
	A.6	Right-of-Way Clearing						$2,792,960	$20,845
	A.7	Mobilization						$1,284,405	$9,586
	A.8	Contingencies on Transmission Construction						$4,347,472	$32,446
	Subtotal Transmission Line Construction						*$34,112,928*		
	Labor	*135786.9* hours	Total Per Mile Cost				*$254,593*		
B.	**Substations**								
	B.1	New Sutton Substation						$1,824,316	
	B.2	Pump Station No. 11 Sub						$1,793,903	
C.	**Engineering Services**								
	C.1	Surveying			10000 per mile			$1,339,900	
	C.2	Geotechnical Investigation						$700,000	
	C.3	Meteorological Study						$35,000	
	C.4	Transmission Line						$912,500	
	C.5	Substation						$350,500	
D.	**Environmental Services, Right-of-Way Acquisition and Permitting**								
	D.1	Cultural Resource Survey		Included in D.3				$0	
	D.2	Raptor Survey		Included in D.3				$0	
	D.3	NEPA Process/EIS						$1,300,000	
	D.4	Visual Modeling Study						$40,000	
	D.5	Permits							
		D.5.a	ADNR/ASDOT-PF					$20,000	
		D.5.b	ADF&G					$10,000	
		D.5.c	BLM					$5,000	
		D.5.d	Mat-Su Conditonal Use Permits					$10,000	
		D.5.e	Corps Section 404 Permit/ADEC					$20,000	
	D.6	Right-of-Way Acquisition		miles	acres	cost/ac			
		D.6.a	Private Lands	0.0	0	1000		$0	
		D.6.b	Native Lands	16.3	246	1000		$246,000	
		D.6.c	State Lands	98.0	1477	0		$0	
		D.6.d	Federal Lands	8.3	125	0		$0	
		D.6.e	State/MH Lands	12.1	182	1000		$182,000	
		D.6.f	Mat-Su Borough	1.0	15	1000		$15,000	
		D.6.g	Native-Selected lands	3.0	45	1000		$45,000	
		D.6.h	Mining Claims	125	na	1000		$125,000	
		D.6.I	ROW Agent					$100,000	
SUBTOTAL >>>								$43,187,048	
E.	**Construction Management**			5%				$2,159,352	
F.	**Owner Costs** (Applied to items A-E)			3%				$1,360,392	
G.	**Contingency on Non-Construction Costs** (items C,D,E, and F)			10%				$897,564	
H.	**Total Project Development Cost Estimate**							$47,604,356	

4. Impacts on Railbelt and CVEA Electric Systems

Electric system studies were performed by Power Technologies, Inc. to determine the impacts on operation of the potentially interconnected electric systems of the Railbelt utilities and CVEA. These studies included steady state load flow modeling, switching studies, and transient stability analysis with a maximum electrical load of 10 MW over the Intertie. Supplemental computations were performed to identify the maximum reliable power transfer limit over the Intertie.

The system studies determined that the Intertie is conditionally feasible from the standpoint of its impacts on the Railbelt and CVEA electric systems. A 10 megavolt-ampere reactive (MVAR) unswitched shunt reactor was indicated as necessary for line energization and control of voltage under light load conditions and has been included in the Intertie cost estimate. The supplemental computations showed that power transfers above about 15 MW over the Intertie would exceed transfer limits under single contingency outage conditions on the Railbelt electric system. At this transfer level and above, an outage of certain components in the Railbelt system would cause unacceptable voltage reductions for CVEA and MEA.

If only the CVEA system load grows, the Intertie system intact transfer limit is 27 MW, limited by low voltage conditions on the southern CVEA system that would exist above that transfer amount. If MEA and CVEA loads grow at the same rate, the Intertie system intact transfer limit is 23.7 MW, limited by low voltage conditions on the MEA system. Under single contingency outage conditions on the Railbelt system, the transfer limit drops to 13.7 MW or 14.9 MW depending on the specific outage condition, limited by low voltage or thermal constraints on the MEA system. These limits assume that shunt reactors are disconnected, allowing full reactive voltage support for the MEA system from the Intertie line capacitance. With the reactors connected the transfer limit would be lower.

Assuming that no improvements are made to the existing Railbelt transmission system, transmission of power at the identified 23.7 MW steady state transfer limit would risk voltage collapse in the Railbelt if one of the primary single contingency outage events were to occur on the Railbelt system. The studies indicated that a static VAR compensator (SVC) system would be desirable to dampen possible severe voltage fluctuations due to minor load changes on the CVEA system and to allow reliable transfers of power above the single contingency limit of approximately 15 MW. Alternatively, CVEA could elect to sever the Intertie for the condition of a 15 MW transfer and a single contingency outage on the Railbelt system. CVEA would have to support its load with a mix of internal generation resources and possibly load-shedding. For this reason we have included the costs of CVEA diesel generation to supply the equivalent Intertie import load based on 98% availability of the Intertie. The estimated cost of the Intertie provided herein includes the cost of a shunt reactor but does not include the cost of a SVC system since CVEA can choose to operate the Intertie in such a way that it is disconnected from the Railbelt above a certain transfer limit and a single contingency outage condition on the Railbelt. CVEA has indicated that it is willing to operate the Intertie in this manner.

E. ECONOMIC ANALYSIS

1. Load Forecast

A twenty-year forecast of CVEA's power requirements was included as part of the feasibility analysis to assess the future need for electric power in CVEA's Valdez and Copper River service areas. The forecasting effort included the development of econometric models to relate electricity requirements to population, employment, income and other factors. The power requirements of CVEA's fifteen largest commercial customers were forecasted separately based on historical trends in power usage and expected economic trends as well as anticipated changes in power requirements provided by the individual customers. Previous studies of the area's economy were reviewed and interviews with area planners, business managers and civic leaders were conducted.

The economy of the Valdez and Copper River Valley areas is predominantly influenced by the petroleum industry, seafood processing, tourism and state and federal spending. Estimated population in Valdez has increased from 3,079 in 1980 to an estimated 4,326 in 1992, a 2.9% average annual rate of growth. Population in the Copper River Valley has increased from 2,721 to an estimated 2,832 over the same period, a 0.3% average annual rate of growth. CVEA's largest commercial customers include the Petro Star refinery in Valdez, the Alyeska Pipeline Service Company and three seafood processors located in Valdez. The Petro Star refinery began commercial operation at the beginning of 1993 and has indicated that it expects to expand its operation and power requirements in the future. CVEA does not sell power to the Alyeska terminal facility in Valdez but does sell power to several remote valve and control locations along the trans-Alaska pipeline and to the pipeline's Pump Station No. 12.

Four load forecast scenarios were defined and alternative assumptions were made for each scenario. The variations among scenarios are mainly due to alternative assumptions in three areas: future operation of the Trans-Alaska oil pipeline and possible construction of a natural gas pipeline, future operation and expansion of the Petro Star Valdez refinery, and underlying population and employment projections for the Valdez and Copper River areas. Two oil price scenarios have been defined as well: a "low" price scenario corresponding to the Alaska Department of Revenue middle case presented in their Fall 1993 forecast, with oil prices reaching approximately $21 per barrel in 1992 dollars by 2010; and a "high" price scenario based on the idea that oil prices will increase to $29-30 per barrel in 1992 dollars by 2010. In an effort to define internally consistent scenarios, the "low" oil price is assumed in this study to be associated with the low and medium-low load forecasts, while the "high" oil price is assumed to be associated with the medium-high and high load forecasts.

For the underlying rate of growth in population and employment for the medium growth scenario, the average of two recent projections was used: one developed by the Alaska Department of Labor and the other by the City of Valdez in its 1991 Comprehensive Development Plan. Alternative low and high population and employment projections were derived from review of these reports, review of historical trends and other explicit assumptions on industrial employment.

The high load growth scenario assumes that sufficient additional production is maintained at the North Slope to allow the Trans-Alaska oil pipeline to continue to function throughout the 50-year analysis period, and that the Petro Star Valdez refinery continues to operate throughout the 50-year period as well. Refinery throughput is assumed to increase from the present level of 30,000 barrels per day to 55,000 barrels per day. In addition, it is assumed in the high case that a natural gas pipeline is constructed from the North Slope to a Valdez terminal facility, and that construction of the gas pipeline begins in 2005 with operation beginning in 2009. Average annual population growth in Valdez from 1993 to 2013 is assumed at 2.53% exclusive of growth attributable to the natural gas pipeline, while average annual population growth in the Copper River area is assumed at 1.20%.

The medium-high load growth scenario also assumes that sufficient additional production is maintained at the North Slope to allow the Trans-Alaska oil pipeline to continue to function throughout the

50-year analysis period. Throughput at the Petro Star Valdez refinery is assumed to expand to 50,000 barrels per day, and the refinery is assumed to continue operation throughout the 50-year analysis period as well. No gas pipeline is assumed to be constructed into Valdez in this scenario. Average annual population growth in Valdez from 1993 to 2013 is assumed at 1.47%, while average annual population growth in the Copper River area is assumed at 0.90%.

The medium-low load growth scenario assumes that declining oil production at the North Slope causes the Trans-Alaska oil pipeline to discontinue operation in 2018. This scenario also assumes that other industrial development in Valdez (for example, construction by that time of a natural gas pipeline) will compensate for the loss of the oil terminal in terms of the overall economic impact on the city and the direct impact on electric utility requirements. However, although throughput at the Petro Star refinery is again assumed to increase over the next few years to 50,000 barrels per day in this scenario, loss of oil pipeline operations in 2018 causes the refinery to close in the same year. The net result is that the medium-high and medium-low scenarios are defined to differ in two major ways: the Petro Star Valdez refinery discontinues operation in 2018 in the medium-low case consistent with shut-down of the oil pipeline, and the "Low" oil price is used in the analysis in conjunction with the medium-low load forecast while the "High" oil price is used in conjunction with the medium-high load forecast.

The low load growth scenario assumes that the oil pipeline and terminal shuts down in 2013. Throughput at the Petro Star Valdez refinery expands to 40,000 barrels per day in the near term, but the refinery also shuts down in 2013 consistent with closure of pipeline operations. No natural gas pipeline is built. Average annual population growth in Valdez from 1993 to 2013 is assumed at -0.96%, while average annual population growth in the Copper River area is assumed at 0.54%.

Table I-3 and Figure I-1 show the historical and projected total energy requirements for CVEA for the four alternative load forecast scenarios. Table I-3 also shows the compounded annual growth rates for selected time periods. The significant growth between 1992 and 1997 in all cases is attributed primarily to Petro Star. Figure I-2 shows the historical and projected energy sales by customer class for the medium-high and medium-low load growth scenarios. As can be seen in Figure I-2, energy sales to the Petro Star refinery are projected to be a significant portion of CVEA's total energy sales in the future. In 1994, it is expected that energy sales to Petro Star will represent 20% of CVEA's total energy sales in that year. By 2000, energy sales to Petro Star are projected to be approximately 22,500 MWh for the medium-high and the medium-low scenarios, representing 26% of CVEA's forecasted total energy sales in that year.

For the purposes of the economic analysis, the results of the 20-year load forecast were extended to 2018. Beyond 2018, CVEA loads were assumed to remain constant. Figure I-1 shows the projected total energy requirements for each of the load forecast scenarios through 2025.

Table I-3
Historical and Projected
CVEA Energy Requirements (MWh)

Fiscal Year	High Case	Medium-High Case(1)	Medium-Low Case(1)	Low Case
1980	43,982	43,982	43,982	43,982
1985	50,500	50,500	50,500	50,500
1992	59,227	59,227	59,227	59,227
1997	95,107	88,141	88,141	79,215
2002	104,492	92,400	92,400	77,734
2013	126,369	99,453	99,453	49,360
Compounded Annual Growth Rates:				
1980-1992	2.5%	2.5%	2.5%	2.5%
1988-1992	4.7%	4.7%	4.7%	4.7%
1992-1997	9.8%	8.3%	8.3%	6.0%
1997-2002	1.9%	1.0%	1.0%	-0.4%
2002-2013	1.7%	0.7%	0.7%	-4.0%
1992-2013	3.7%	2.5%	2.5%	-0.9%

(1) The medium-high and medium-low case scenarios vary only in the assumed level of power sales to the Petro Star refinery beginning in 2018.

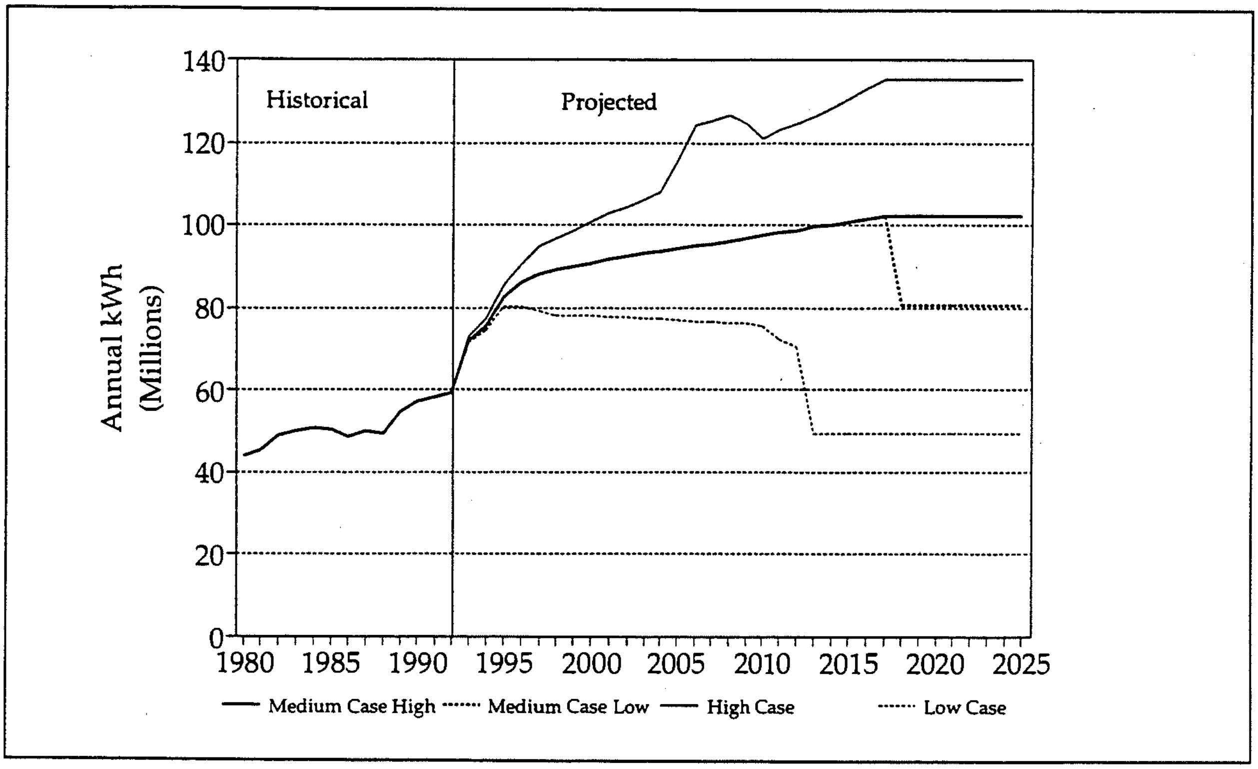


Figure I-1: Historical and Projected Energy Requirements

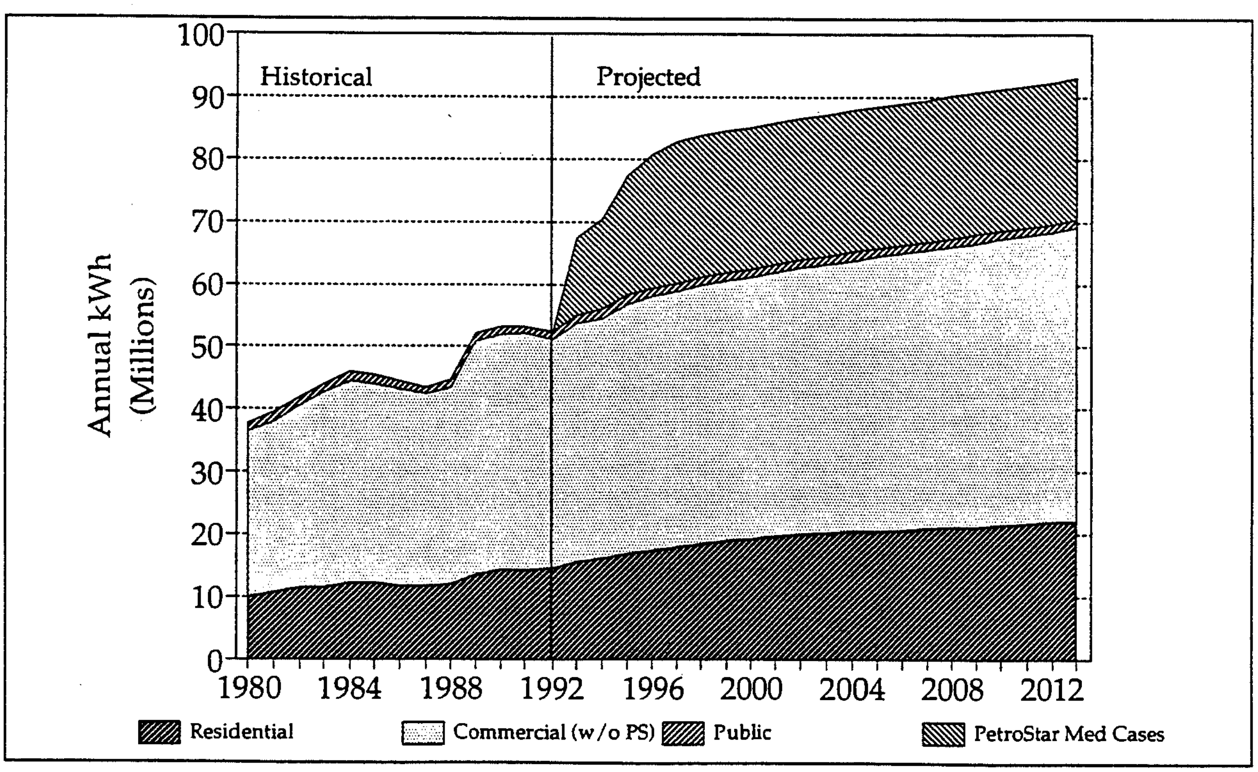


Figure I-2: Historical and Projected Energy Sales by Customer Class - Medium Load Growth Scenario

The authors of this report have not attempted to attach any probability estimates to factors like the prospects for continued oil pipeline operations after 2018, or to related factors such as the long-term oil price and prospects for major additions to North Slope oil production, or to the long-term likelihood of building a natural gas pipeline into Valdez. These are major uncertainties that continue to be debated by informed observers and participants, and which we cannot begin to resolve within an intertie feasibility study. Consequently, this study does not identify any one of the four scenarios as the "expected case" or "most likely case," but rather presents the analytical results for each case for consideration and judgment by Alaska decision-makers. During the preparation of the load forecast we have focused on identified developments and avoided reliance on general attitudes with regard to unspecified growth in the region, which is consistent with industry practice for feasibility or investment analysis.

2. Comparison of Alternatives -- Present Value of Future Costs

The economic analysis determines the cumulative present value of the costs associated with the various power supply scenarios that have been developed as part of the feasibility study over the expected economic life of the Intertie. Although real escalation in oil prices over time are included, costs included in the analysis have no inflation applied in the future. The cumulative present value is calculated using an inflation free discount rate of 4.5% as presently defined by the Division. Consistent with previous feasibility studies conducted by the State under AS 44.83.181, this analysis compares long-term resource costs that would be borne by Alaskans under each scenario, including any costs that may be paid by State government.

Each power supply scenario defined in the study provides similar levels of electric capacity and identical levels of energy to CVEA over the analysis period; however, the costs for this power supply will vary for each case. The analysis period is the economic lifetime of the Intertie, an assumed 50-year period beginning in 1999, the expected initial year of operation of the Intertie. Costs included in the analysis are capital and operation and maintenance costs of new generation and transmission additions, including the Intertie, and operation, maintenance and fuel costs of new and existing diesel generators. Excluded from the analysis are certain fixed operating and capital costs related to CVEA's existing generation plant and the cost of power purchased by CVEA from the Solomon Gulch Project. These excluded costs do not affect the outcome of the economic analysis because they will be incurred no matter what case is being evaluated.

The economic analysis begins with the definition of the alternative power supply scenarios. Each of the power supply scenarios takes into account the projected energy and capacity needs of CVEA over the analysis period and each scenario provides for necessary backup generation. It is assumed that CVEA will continue to maintain adequate generation capacity in both Glennallen and Valdez to supply local power requirements in the event that either the existing Glennallen to Valdez transmission line or the Intertie are forced out of service. The economic analysis provides a means for determining the least cost long-term resource alternative.

Three of the power supply scenarios specify that a new relatively large single generating plant is to be constructed in or near the CVEA service territory. The All Diesel scenario assumes that diesel generators will be installed by CVEA on an as needed basis and that existing diesel generators will be replaced rather than overhauled during the study period. An evaluation of several energy conservation measures that could be implemented by CVEA to reduce the power needs of its customers was conducted as part of the analysis. For all cases, new diesel generators are specified to be added if installed resources are insufficient to meet CVEA's power requirements. A detailed evaluation of the need for and timing of new diesel generators was conducted for each of the power supply and load forecast scenarios. The power supply scenarios included in the analysis are described briefly in Table I-4.

Table I-4
Description of Power Supply Scenarios

Scenario	Description
All Diesel Case	2,150 kW diesel generators are added at times as needed in both Glennallen and Valdez.
Intertie Case	The Intertie is constructed and begins operation in 1999. CVEA purchases power generated using natural gas by Anchorage area utilities.
Allison Lake Case	The 3,145 kW Allison Lake hydroelectric project (tunnel alternative) is constructed near Valdez and begins operation in 2000.
Silver Lake Case	The 15,000 kW Silver Lake hydroelectric project is constructed 15 miles southwest of Valdez and begins operation in 2001.
Valdez Coal Case	A 22,000-kW coal fired generation and district heating facility is constructed in Valdez and begins operation in 1998.
Conservation Case	Applicable conservation measures are undertaken by CVEA beginning in 1994 to reduce power requirements. To the extent the measures are expected to be insufficient to supply all requirements, diesel generators are added.

For each power supply scenario, the power supply cost is estimated in each year of the 50-year analysis period, and then discounted to 1993. The sum of these discounted annual costs provides the cumulative present value for each scenario, a value that is suitable for comparing the long-term costs of the alternatives.

The economic analysis has been performed for alternative fuel cost and load growth assumptions to determine the effect of changing these assumptions on the results of the analysis.

Table I-5 provides a comparison of the cumulative present value for various cases and assumptions. As can be seen in this table, the lowest cost alternative for the high load growth scenario is the Intertie Case. For the medium-high and medium-low load growth scenarios, the Allison Lake Case becomes the lowest cost alternative. For the low load growth scenario, the All Diesel Case becomes the lowest cost alternative followed next by Allison Lake and then by the Intertie. Note that Table I-5 also shows benefit-cost ratios for each alternative and each scenario. In each case, the benefit-cost ratio is defined as the present value of future cost for the diesel alternative divided by the present value of future cost for the specified non-diesel alternative. A benefit/cost ratio greater than 1.0 indicates that the benefits exceed the costs for a specific alternative.

Table I-5
Summary of Economic Analysis Results
Cumulative Present Value of Comparable System Costs and Benefit/Cost Ratios(1)
($000)

Load Forecast and Fuel Price Escalation Scenario	Power Supply Scenario					
	All Diesel	Intertie	Allison Lake	Silver Lake A	Coal Facility	Conservation
Medium-High Load Growth (2)						
High Fuel Price Escalation	$84,771	$72,604	$71,989	$74,929	$76,567	$84,098
Benefit/Cost Ratio	1.0	1.2	1.2	1.1	1.1	1.0
Medium-Low Load Growth(3)						
Low Fuel Price Escalation	67,853	63,415	60,596	70,508	77,062	67,777
Benefit/Cost Ratio	1.0	1.1	1.1	1.0	0.9	1.0
High Load Growth(4)						
High Fuel Price Escalation	121,562	91,227	108,298	108,376	98,898	120,690
Benefit/Cost Ratio	1.0	1.3	1.1	1.1	1.2	1.0
Low Load Growth(5)						
Low Fuel Price Escalation	39,565	50,042	44,808	63,462	61,432	39,775
Benefit/Cost Ratio	1.0	0.8	0.9	0.6	0.6	1.0

(1) Benefit/cost ratios are calculated as the cumulative present value of the All Diesel case divided by the cumulative present value of the specific alternative.
(2) Assumes medium population growth in CVEA's service territory and operation of the Trans-Alaska oil pipeline and Petro Star refinery through the end of the study period.
(3) Assumes medium population growth in CVEA's service territory, shut down of the Trans-Alaska oil pipeline and Petro Star refinery in 2018. New industrial activity with comparable power requirements on CVEA to the oil pipeline continues through the remainder of the study period.
(4) Assumes high population growth in CVEA's service territory, operation of the Trans-Alaska oil pipeline and Petro Star refinery through the end of the study period and construction of a North Slope natural gas pipeline.
(5) Assumes low population growth in the CVEA service territory, limited expansion of Petro Star refinery, and closure of the Trans-Alaska oil pipeline and the Petro Star refinery in 2013.

3. Comparison of Alternatives -- Cost of Power

AS 44.83.181 and associated regulations require not only a comparison of the present value of long-term resource costs but also a comparison of the "cost of power" for each alternative under "hypothetical financing conditions." "Cost of power" is herein assumed to mean the annual nominal wholesale cost per kWh to Copper Valley Electric Association of generating and/or purchasing power delivered to the CVEA distribution system under each power supply scenario under hypothetical financing conditions, excluding costs that are common to all scenarios such as the purchase of Solomon Gulch energy, or depreciation of existing equipment.

The hypothetical financing conditions assumed for this analysis are as follows:

a. The $35 million, zero interest, 50-year loan is used to finance the Intertie.

b. While additional legislative action would be needed to use the $35 million appropriation for a project other than the Intertie, cases have been developed for illustrative purposes whereby the $35 million, zero interest loan is used to finance the other capital intensive alternatives as well. The term of the loan is reduced to 30 years for the proposed coal plant to correspond with its estimated economic life. The full 50-year term is assumed to apply to Allison Lake. Diesel generators are not assumed to be financed with State loans in any scenario.

c. All supplemental financing is assumed to occur at 7.5 percent interest and with repayment terms of 30 years for the Intertie and the hydroelectric projects, 20 years for diesel generators and 25 years for the coal project.

d. Costs are shown in nominal dollars based on an assumed 3.5 percent annual inflation rate.

A variant of the Allison Lake "cost of power" estimate is also presented based on the possibility that additional energy generated by the existing Solomon Gulch turbines due to the provision of additional water from Allison Lake will be assessed an additional wholesale charge of over 6.4 cents per kWh corresponding to the wholesale power rate for the Four Dam Pool.

Table I-6
Estimated Cost of Power
(nominal cents/kWh)

	Load Forecast/Fuel Forecast Scenario(1)							
	High		Medium-High		Medium-Low		Low	
Resource Option	2000	2010	2000	2010	2000	2010	2000	2010
ALL DIESEL (2)	11.7	17.1	12.6	17.7	12.0	15.5	10.6	14.6
INTERTIE (3)	9.5	11.1	10.7	12.2	10.3	11.0	12.0	13.6
ALLISON LAKE								
State Loan (4)								
With Payment for Additional Solomon Gulch Energy (5)	10.1	13.6	10.1	12.5	9.9	11.6	9.2	10.4
Without Payment for Solomon Gulch Energy (6)	8.1	12.0	7.6	10.0	7.4	9.0	6.0	6.4
No State Loan (7)								
With Payment for Additional Solomon Gulch Energy (5)	16.4	18.1	18.0	19.3	17.8	18.3	19.5	21.3
Without Payment for Solomon Gulch Energy (6)	14.4	16.4	15.5	16.7	15.3	15.8	16.3	17.3
SILVER LAKE (8)								
State Loan (9)	10.0	11.8	11.2	10.3	11.2	10.3	13.5	14.0
No State Loan (10)	17.0	16.9	20.1	18.1	20.1	18.0	25.4	26.5
VALDEZ COAL PROJECT								
State Loan (11)	10.3	11.3	11.3	11.8	14.1	15.2	16.9	20.3
No State Loan (12)	15.2	14.6	17.3	16.9	17.7	18.3	21.6	25.3

(1) The high and medium load forecast scenarios assume the high fuel price scenario while the low and medium-low load forecast scenarios assume the low fuel price scenario.

(2) Assumes new diesel generating units are financed with revenue bonds. Includes estimated costs of new fuel storage system and switchyard improvements in 1999.

(3) Assumes capital cost of Intertie is financed with $35.0 million zero-interest state loan and $21.3 million of supplemental debt. Includes cost of power purchased from Anchorage utilities and estimated charges of 0.2 cent per kWh (1993 dollars) for transmission over MEA and CEA transmission lines.

(4) Assumes $35.0 million state loan is applied towards construction costs. Remaining capital costs of $2.5 million assumed to be financed with supplemental debt. It is assumed that the project comes on-line in 2000.

(Footnotes continued on following page.)

(5) Includes payments of 6.4 cents per kWh (pursuant to Four Dam Pool Power Sales Agreement) for additional energy generated at the Solomon Gulch Project resulting from water released into the Solomon Gulch reservoir from Allison Lake. Debt service component of 4.0 cents per kWh is held constant whereas O&M component is adjusted annually for inflation.
(6) Assumes additional power generated at the Solomon Gulch Project does not require any additional payment.
(7) Assumes Allison Lake Project is financed with $46.6 million of debt financing and no state loan is made available.
(8) Cost of power shown in the year 2000 column is for 2001, the first year of operation of the Silver Lake Project.
(9) Assumes $35.0 million state loan is applied towards construction costs. Remaining capital costs of $33.1 million assumed to be financed with supplemental debt.
(10) Assumes project is financed with $82.5 million of debt financing and that no state loan is made available.
(11) Assumes Coal Project is financed with $35.0 million zero-interest state loan and $6.5 million of supplemental debt.
(12) Assumes Coal Project is financed with $47.4 million of debt financing and that no state loan is made available.

F. ENVIRONMENTAL REVIEW

An environmental review of the Intertie was conducted as part of the feasibility study. Appendix K contains the full "Copper Valley Intertie Project Environmental Analysis" report prepared by Dames & Moore. This report presents available environmental information and issues of public concern expressed for the two primary proposed route alternatives - a southern route and a northern route. The northern route is generally located farther away from the Glenn Highway than the southern route. Two sets of five public meetings were held in the development of the draft feasibility study and a meeting with State and federal agencies was held to identify issues to be considered during the feasibility study. A third set of five public meetings was held after issuance of the draft report. Public and agency comments were taken into consideration, where practical, during the route selection process. The findings of the environmental review are summarized in the following paragraphs.

All route alternatives for the Intertie generally parallel the Glenn Highway at some distance and pass through the Matanuska River Valley, tributary river valleys, and the Copper River Basin. The Intertie corridor can be divided into two nearly equal but distinct sections, east and west of Eureka. West of Eureka in the Matanuska River Valley, Intertie route alternatives would encounter or be near comparatively dense forests, extensive trail systems with known historical importance, and higher concentrations of population and variable land ownership. East of Eureka, extensive wetlands and stunted forests of black spruce will be crossed and land is held principally by state and Native interests.

The environmental impacts associated with the two route alternatives are similar. The most significant impacts are likely to be visual impacts and potential impacts on recreation in the immediate area near the Intertie, i.e., backpackers, rafters, skiers and snowmobilers using trails in the back country. The southern route (Route Alternative B) affords visibility from the Glenn Highway more often than does the northern route alternative (Route Alternative A). The northern alternative may reduce the visual and recreation impacts to some degree by decreasing the number of people impacted (fewer people use the back country trails than the Glenn Highway).

Major wildlife within the Intertie corridor include moose, caribou, Dall sheep, black bear, brown bear, trumpeter swans, various waterfowl species, and anadromous fish species. The Intertie route alternatives are all constrained by topography and practical routing considerations to pass through or near wildlife habitat along the corridor.

Impacts to wetlands and other wildlife habitats for either alternative are expected to be minimal. Care taken during construction and operation to use Best Management Practices and minimize clearing of natural vegetation will reduce the likelihood of significant permanent impacts to these habitats.

Project impacts to wildlife will be minimized by employing protective measures such as timing construction activities specifically to avoid disruption to nesting swans, or other species during sensitive time periods. Limiting the number of new access roads to be constructed will minimize increased pressure on wildlife.

Public meetings and written public comment revealed significant concerns regarding effects on quality of life and tourism, and health risks associated with electric and magnetic fields (EMFs) if the Intertie is constructed. Quality of life issues are based on subjective criteria and are hard to quantify. Visual impacts which may negatively affect recreational experiences in the vicinity of the Intertie, may not necessarily reduce the number of tourists who come to the area for the scenic views. Research on the relationship of EMFs to any specific disease has not been conclusive. However, as a precautionary measure, the route alignments were established well away from known occupied structures.

A significant criticism of the draft feasibility study expressed in the public meetings was that no estimate was included for the value of the Intertie's expected environmental impacts, suggesting that these impacts are accorded zero value for purposes of the feasibility assessment. An implication of zero value was not intended, however, and an effort was therefore made prior to issuance of this final report to examine methods that have been used in other studies to place values on environmental impacts and to determine the applicability of these methods to the Intertie case. While potentially useful material was turned up in this effort and is summarized in a new environmental supplement in Appendix M, we were not able to come up with defensible estimates of the value of Intertie environmental impacts within our time and budget constraints.

A limited qualitative comparison of the potential for environmental impact in major impact categories has been conducted, however, for the most competitive resource alternatives considered in the study. This comparison is included in the Supplement to the Environmental Review. In addition, the environmental review from the 1992 Allison Lake Reconnaissance Study, conducted for the Alaska Energy Authority by HDR Engineering, Inc., is also included in Appendix F.

Finally, as evidenced by the public comments included in Appendix Q and the transcripts of public testimony included in Appendix P, it should be acknowledged that there is a considerable level of public resistance to construction of the Intertie on environmental grounds, concentrated among people living west of the Copper Valley Electric Association service territory.

INTRODUCTION

A. BACKGROUND

In 1989, the Alaska Energy Authority (Authority) conducted a reconnaissance study of a 230-kilovolt (kV) transmission interconnection between the electric systems of the Anchorage area and the Fairbanks area that was to have passed through the Matanuska Valley, continue on to Glennallen and then turn north to Delta Junction. This transmission line, referred to as the Northeast Intertie, was to have been used primarily to provide an additional transmission interconnection between Anchorage and Fairbanks. The Northeast Intertie was not judged economically feasible and no further action was taken towards its development by the Authority following completion of the study. In 1992, the Copper Valley Electric Association (CVEA), a rural electric cooperative that serves the Glennallen and Valdez areas, prepared a screening level cost estimate for a 138-kV transmission line between Sutton and Glennallen (the "Intertie"). This transmission line, as anticipated by CVEA, was to have generally followed one of two routes which were originally identified in connection with the study of the Northeast Intertie. Following completion of its cost estimate, CVEA prepared an economic analysis showing that the Intertie could provide economic benefits to the electric customers of CVEA.

After completion of its cost estimate and economic analysis, CVEA requested that the Authority conduct a feasibility study of the Intertie that would conform with statutory requirements for proposed Authority projects. R. W. Beck and Associates was retained by the Authority in January 1993 to perform the feasibility study, the results of which are presented in this report. As a result of State legislation that took effect in August 1993, oversight responsibility for this study was transferred from the Authority to the Department of Community and Regional Affairs, Division of Energy (Division).

CVEA presently sells electric power to approximately 3,000 member-customers in its service territory which includes Valdez, Glennallen and other communities in the Copper River Valley area. CVEA maintains two offices and two power plants, one each in Valdez and Glennallen. The primary source of power supply for CVEA is hydroelectric generation from the 12-megawatt (MW) Solomon Gulch Hydroelectric Project (the "Solomon Gulch Project"), owned by the State. The full generating capability of the Solomon Gulch Project is sold to CVEA pursuant to a long-term power sales agreement. Since the Solomon Gulch Project does not have the capability to provide all the power needs of CVEA's customers, power generated by diesel generators located in both Valdez and Glennallen is used to supplement the output of the Solomon Gulch Project. In calendar year 1992, CVEA sold 54,602 MWh of electric energy to its customers. Of this amount 27%, 71%, and 2% was sold to CVEA's residential, commercial and public building customer classes, respectively. CVEA's peak demand in 1992 was 10.9 MW.

Beginning in January 1993, CVEA began supplying power to the Petro Star refinery, a new industrial facility in Valdez that produces refined fuels from oil extracted from the Trans-Alaska pipeline. The Petro Star refinery is CVEA's largest customer. During August 1993, Petro Star purchased 1,165 MWh of electric energy from CVEA and had a peak demand of 1,790 kW. Total energy needs for Petro Star for calendar year 1993 are estimated to be 12,200 MWh. It is expected that Petro Star's power requirements will increase in the near future as the refinery continues to expand its operating levels.

The Intertie will connect the electric system of CVEA directly to the electric system of the Matanuska Electric Association (MEA) and indirectly, through MEA's transmission system, to the electric systems of Alaska's Railbelt utilities. It is expected that with the Intertie, CVEA will purchase power generated with gas-fired generating plants by either the Chugach Electric Association (CEA) or Anchorage Municipal Light and Power, utilities located in the Anchorage area. CVEA is presently an isolated electric system with no interconnections to any other electric utilities.

B. PURPOSE OF STUDY

This feasibility study is intended to define the design and routing criteria and estimated costs related to development of the Intertie, to provide a feasibility level environmental analysis, and to assess the costs of the Intertie as compared to other resource alternatives. The feasibility study includes the following principal tasks:

1. Review the Intertie route options defined in previous studies and identify other possible routing alternatives and define preferred alternatives.

2. Develop a feasibility level design of the Intertie.

3. Develop a construction cost estimate and construction schedule for the Intertie.

4. Develop an estimate of annual operations and maintenance costs for the Intertie.

5. Conduct a review of the environmental factors related to the Intertie. Meet with and solicit input from various governmental and public agencies concerning environmental and other institutional constraints which may affect construction of the Intertie.

6. Conduct public meetings at Sutton, Glennallen and other affected communities to obtain comment concerning the Intertie from the general public.

7. Prepare an environmental report which can serve as the basis for subsequent environmental studies.

8. Conduct an electric system analysis of the electric systems of CVEA and the Railbelt utilities to determine the effects on system stability and performance resulting from interconnected operation if the Intertie were constructed.

9. Prepare a forecast of CVEA's electric power requirements for the next twenty years.

10. Review and define the costs and operating characteristics of alternative power supply options, including conservation, that may be available to CVEA in the future.

11. Conduct an economic analysis comparing the life-cycle costs and benefits of the Intertie to those of alternative resource scenarios.

12. Prepare a draft report summarizing the findings of the feasibility study.

13. Conduct a final set of public meetings to present the findings of the feasibility study and solicit public comment.

14. Prepare a final report following the receipt of comments on the draft report from the Authority and others.

C. STUDY METHODOLOGY

The feasibility study was conducted as an independent study of the Intertie and its identified alternatives and involved the efforts of several engineering, environmental, public policy and economic specialists. R. W. Beck and Associates developed the Intertie route alternatives, preliminary design, cost estimate and construction schedule. R. W. Beck also prepared the electric load forecast, the evaluation of alternative power supply options and the economic analysis. Dames & Moore, Inc. of Anchorage conducted the environmental analysis and prepared the environmental report which is included as a separately bound appendix to this report. Power Technologies, Inc. conducted the electric system analysis and provided a report which is also included in a separately bound appendix. Both the environmental review and the electric system analysis were used as input to the feasibility level design and cost estimate of the Intertie. In addition, comments received during the public meetings and written comments received from the general public during the course of the feasibility study were reviewed and considered in the development of the analysis. Written comments and transcripts of formal public testimony received during the course of the study are also included as an appendix to this report.

Alternative design and routing criteria for the Intertie were gathered from previous studies and new investigations. These criteria were evaluated based on past experience with similar projects in Alaska and elsewhere. Discussions were held with utility and Authority engineers to solicit input with regard to the basic design and routing criteria. Both the environmental review and the electric system analysis relied upon the initial routing and design characteristics of the Intertie as part of the basis for their analysis. The electric load forecast that was prepared for CVEA as part of the feasibility study used a model that was developed to relate energy usage in the CVEA service territory to projected future changes in population, employment, income and other factors.

The review of power supply alternatives available to CVEA was conducted using, for the most part, information developed by others in previous studies. An independent review of a proposed coal-fired generating project was conducted as part of the feasibility study. The economic analysis that was conducted for the feasibility study projected the comparable costs of power supply for CVEA for the various resource alternatives over the expected lifetime of the Intertie and then accumulated the present value of these costs. This method of economic analysis has been employed by the Authority for many years in its evaluation of generation and transmission projects throughout the State and is a standard approach for electric utility least cost planning analyses.

Specific descriptions of the methodology incorporated in the various components of the feasibility study are included throughout the sections of the report. Assumptions used throughout the study are also identified in the applicable sections of the report.

Significant effort was extended to gather and incorporate input from local communities, utilities and State and Federal agencies that will be affected by the Intertie. Advertised public meetings were held in Sutton, Glennallen, Chickaloon, the Glacier View area, and Valdez to introduce the general characteristics of the Intertie and obtain comment. A meeting was held with various State and Federal agencies for additional comment and input. Discussions were held with staff members of CVEA and MEA and a design criteria review meeting was conducted with the Authority, CVEA and other local utility and engineering representatives to obtain input. Historical operating and other technical data was received from CVEA and used in the development of the overall analysis.

D. FORMAT OF REPORT

This report includes the description of the work undertaken, discussion of evaluations conducted and a summary of the findings for the various components of the feasibility study. Sections III provides an overview of the route alternatives evaluated. The apparent preferred route alternative is identified at the end of Section III. Section IV discusses the conceptual design parameters that determine the basis for the preliminary design of the transmission lines and Section V provides the basis for and preliminary design of the substation components of the Intertie. This section also discusses the design alternatives considered and their evaluation. The cost estimate for the Intertie is presented in Section VI.

The various design and route alternatives considered as part of the feasibility study all have different costs associated with them. In addition to the cost of the apparent preferred alternative, Section VI identifies the estimated cost of several of the alternatives for comparison. A comparison of the costs of similar projects in Alaska is also shown in Section VI. A practical schedule for Intertie development through construction and the basis for this schedule is shown in Section VII.

The electric load forecast for CVEA is provided in Section VIII and the evaluation of alternative power supply options for CVEA is described in Section IX. Alternative power supply plans, their evaluation and the economic analysis are described in Section X. The overall results of the economic analysis are shown at the end of Section X.

Several appendices are provided with this report. Principal among these are Appendix N, the environmental report prepared by Dames & Moore, and Appendix O, the electric system analysis prepared by Power Technologies, Inc. The Dames & Moore report includes the summaries of the initial public meetings conducted as part of the feasibility study and also includes copies of the letters and other comment forms sent in by the general public during the course of the study. A separate appendix is attached to present the written comments received in response to the draft feasibility study. Appendices N and O are bound together in a separate volume but their principal conclusions are summarized in the body of this report, primarily in Sections III and IV as they pertain to routing and design criteria, respectively. A significant amount of written public comment concerning this feasibility study and the Intertie in general was received during the course of the study effort. Comments received prior to the release of the draft feasibility study report are included in Appendix N. Comments received after the release of the draft feasibility study are included as Appendix Q, which is bound in Volume III. Also included in Volume III is Appendix P which provides transcripts of formal public testimony received at the third and final set of public meetings conducted as part of the feasibility study.

ROUTE SELECTION

A. BACKGROUND

The following previous studies [1,2,6] have investigated transmission line routes in the Palmer/Sutton to Glennallen corridor.

1. Cordova Power Supply Study

In 1982-1985 the Cordova Power Supply Project [6] included study of a 230-kV transmission line with a link from Palmer to Glennallen. The route chosen for study basically followed and was adjacent to the Glenn Highway for its entire distance. It passed to the south of Sheep Mountain.

2. Northeast Transmission Intertie Project

In 1989, the Railbelt Intertie Reconnaissance Study, Northeast Transmission Intertie Project [2] looked at several route options for a 230-kV line between Sutton and Glennallen as part of the Railbelt interconnection to Delta Junction.

Two route alternatives, Northwest and Southeast, were identified for evaluation, both following the Glenn Highway corridor from Sutton to Glennallen. The route alternatives were evaluated based on the feasibility of obtaining right-of-way, the absence of environmental obstacles to construction, a reasonable schedule for permitting, and cost of construction. A suggested route for the entire 230-kV Intertie combined elements of the Northwest and Southeast alternatives. The suggested route followed the Northwest alternative from Sutton to Glennallen and was favored over the Southeast alternative because of perceived land acquisition difficulties, permitting, no crossings of the Glenn Highway and lower cost of right-of-way.

The suggested route in [2] would originate at an expanded O'Neill Substation and proceed directly northeast to the bench on the south side of Little Granite Creek, following the Chickaloon Trail. The route passed about 0.5 mile north of Chickaloon and continued parallel to and 0.25 mile to 0.5 mile north of the Glenn Highway to about 1 mile west of Caribou Creek. The route then followed Caribou Creek and Squaw Creek to Tahneta Lake, whereupon it resumed its course parallel to and about 0.25 mile to 0.5 mile north of the highway, skirting the south flank of Slide Mountain. The route passed north of Snowshoe Lake and proceeded in staircase fashion in a general northeast direction to a crossing of Lake Louise Road about 0.3 mile north of the intersection with the Glenn Highway. The route continued in a northeast direction over Tolsona Mountain and north of Moose Lake before dipping south slightly and resuming a route parallel to and about 1 mile north of the Glenn Highway all the way to Glennallen where it crossed the highway to reach Pump Station 11 Substation.

The Southeast route alternative in this area basically ran parallel to and south of the Northwest alternative from Sutton to about Mile 80, staying within 0.5 mile north of the highway. At Mile 80 the route crossed to the south of the highway. Except for a few route deviations, the Southeast route alternative remained 0.25 mile to 1.0 mile south of the highway from Mile 80 all the way to Glennallen, passing Sheep Mountain on the south side. This alternative was deemed too visually intrusive and was abandoned.

During the preparation of the study, the Northeast Intertie Concerned Residents (NEICR) group formed to oppose the selection of routes through the Matanuska Valley. They proposed an alternative route which followed Boulder Creek over Chitna Pass to Caribou Creek then via Alfred Creek to Tahneta Pass where it rejoined the suggested route. This NEICR alternative was not evaluated thoroughly in [2].

The Matanuska-Susitna Borough passed Resolution 89-113 stating among other preferences that no route alternatives on the south side of the Matanuska River or along the Glenn Highway be considered due to the negative impact such routes would have to the high scenic quality of the valley and related tourism.

Significant public comment was offered during [2] and, since it applies to the same proposed corridor, was reviewed in conjunction with the present study.

3. Sutton to Glennallen 138-kV Transmission Intertie Project[1]

In 1992, CVEA commissioned a narrowly-focused screening study to conceptually design and estimate the cost of a 138 kV Intertie. For the purposes of their study, the authors selected a modified version of the suggested route proposed in [2], i.e., the Northwest route alternative.

The study adopted several modifications to the route. A northerly departure from O'Neill Substation for about one mile was selected to avoid passing near the Sutton School and other community use areas. A route passing about one mile farther north of Chickaloon and proceeding north of Bonnie and Rush Lakes to the vicinity of Simpson Cabin was chosen to set the line farther back from the Glenn Highway and high recreation use areas. The former route segment up Caribou Creek was abandoned and a route following Pinochle, Hicks, Caribou and Squaw Creeks was adopted to avoid the rugged terrain of lower Caribou Creek. The route from Tahneta Pass to where the Glenn Highway turns east was generally moved farther back from the highway to better conceal the line and lessen visual impact. A straight route across the south side of Slide Mountain, more distant from the highway was chosen. The route from Slide Mountain into Glennallen, except for a few minor route shifts, remained unchanged from the suggested route in [2].

The route modifications made in [1] were in partial response to public comment made during the preparation of [2].

The scope of work for this feasibility study directed the initial consideration and comparison of two route alternatives, one close to the Glenn Highway and one distant from the highway. The modified route selected in [1] was chosen as the starting point for the route alternative close to the highway and the NEICR-proposed route in [2] was chosen as the starting point for the route alternative distant from the highway.

B. METHODOLOGY

1. General

The process of route selection requires the input of several sources of information to make reasonable routing decisions. These sources include public comment in written form and at public meetings, local government consultation, agencies charged with stewardship of lands and the protection of the environment, land owners along the corridor, experienced line designers in Alaska, the interconnecting utilities and relevant literature.

The route selection process in [1,2] was reviewed as well as the public comment in [2]. Routing information for the Cordova Intertie, developed in [6], was furnished by CVEA. Matanuska Electric Association (MEA) and CVEA furnished detailed layouts for their respective distribution lines serving the Glenn Highway Corridor.

In April 1993, discussions were held between the Authority and staff of the Matanuska-Susitna Borough Planning Commission during which additional route segment alternatives were defined for the Sutton and Chickaloon areas. Also in April, the Engineering Manager for CVEA, Mr. Mike Easley, conducted a helicopter overflight of the preliminary route alternatives and recorded his observations on a set of maps. On April 20-21, the Authority and CVEA personnel met with R. W. Beck to discuss these possible route modifications.

Several route modifications were adopted as a result of these discussions. These preliminary routes and modifications were then mapped and constituted the initial base maps. Copies of these initial base maps were made available to attendees at a second set of public meetings at the same locations as the first set of meetings during the week of June 21-25, 1993. These initial base maps and the routes shown thereon were modified slightly to (1) delete route Segment 4-5 on Map 2 and move it farther north, (2) delete route Segment 5-6 on Map 3 on the south side of Strelshla Mountain and move it north of the mountain, (3) show minor route enhancements for future consideration, and (4) clearly delineate Route Alternative D, the apparent preferred alternative. The modified maps 1-11 are included at the end of this section. However, it is important to note that further minor route modifications can be expected to fine tune exact line layout in final design if the Intertie is pursued.

To support the process of route selection we obtained complete topographic mapping of the corridor as well as color infrared stereo aerial photography; small scale color aerial photography was also obtained for Sutton. Together with the fixed photography and video documentation obtained in the fixed wing flyovers, these tools provided a detailed picture of the routing options. Overlays showing possible route alternatives were prepared for the aerial photography and used to depict route adjustments on the base maps.

2. Public Meetings

Five public meetings were held in March-April 1993 at Sutton, Chickaloon, Glennallen, Glacier View School and Valdez to inform the public that a feasibility study was starting on the Copper Valley Intertie and to solicit preliminary comments. The initial route alternatives were presented on display boards and reduced copies of the maps were handed out with comment sheets. Full transcripts of each meeting were prepared from recorded proceedings and a summary of the meetings prepared for distribution. A second set of public meetings was held in late June 1993, at the same locations as the first set of meetings, to discuss recent legislation affecting the Intertie and progress on the feasibility study. See the Environmental Analysis in Volume 2 (Appendix N) and its Appendices A and B for a complete presentation of public meetings and comment. We address major comments on routing issues in this section, Part C.

An agency meeting was held at the offices of Dames & Moore on March 17, 1993. In attendance were representatives of the Matanuska-Susitna Borough, U.S. Fish and Wildlife, the Alaska Department of Environmental Conservation, the Alaska Department of Fish and Game, the US Army Corps of Engineers, the Alaska State Office of History and Archaeology, Dames & Moore and R. W. Beck. Invitees not attending included the U.S. Environmental Protection Agency and the Bureau of Land Management. This was a round table discussion of agency requirements and preferences related to mitigating environmental impacts, construction activities, field surveys and permitting. A consensus opinion emerged that winter construction would minimize damage to wetlands, habitat and cultural resources and would facilitate permitting. The need to design any line for raptor protection in accordance with methods recognized in [12] and to limit bird strikes was reinforced. The extensive network of Chickaloon-Knik-Nelchina (CKN) historic trails will require ground surveys of the cultural resource prior to construction.

Most public written comments were received by late May, reviewed and key points extracted. Volume 2, Appendix B, contains copies of all written comments received by the project team.

3. Route Reconnaissance Flyovers

Four overflights of the route corridor were undertaken. A three-hour, fixed-wing, winter flyover on the various route alternatives was performed on March 16,1993 with a transmission line design engineer from R. W. Beck, a geotechnical engineer and a visual quality specialist from Dames & Moore, and the Director of Facilities Operations and Engineering from the Authority. Outstanding weather allowed good visual documentation of most of the routes. The flyover was conducted over Matanuska Valley, Boulder Creek, Chitna Pass, Alfred Creek, Squaw Creek, Caribou Creek, Hicks Creek and both north and south of the Glenn Highway east of Tahneta Pass. We investigated the south bank of the Matanuska River as suggested in one of the public meetings. No recent or active avalanches were spotted although the potential for avalanches is known to exist. Particular attention was paid to the ruggedness of terrain on the back country routes. The high level and wide extent of snowmobiling was noted.

In addition to the fixed wing winter flyover, three helicopter flights were taken. The first helicopter flight was undertaken by CVEA on April 13 with only the CVEA engineering manager attending. Several route modifications were identified and conveyed to the project team on April 20-21. Generally this overflight resulted in pushing route alternatives farther north and in crossing the Glenn Highway farther to the west. A second helicopter flyover took place on June 11 with the general manager of CVEA, the manager of engineering for CVEA, an ADNR geologist, an Authority engineer, and a transmission line engineer from Power Engineers attending. This flyover included reconnaissance of Chitna Pass and the Strelshla Mountain rock glacier (Victory Road area). Two route modifications were proposed around the area of Simpson Cabin and Strelshla Mountain. Observations included that Chitna Pass and an alternative route around Strelshla Mountain appeared more constructible and reliable than previously thought. These observations were conveyed to the project team on June 14 in a meeting in Seattle. The final flyover took place on June 25 with the R. W. Beck transmission line engineer, ADNR geologist, Authority engineer, a local experienced transmission line contractor, and the Authority project manager. The objectives of this flyover were to confirm the observations regarding Chitna Pass and Strelshla Mountain, confirm the advantages of certain route modifications, review terrain and forest cover, and to gain the benefit of a line contractor's perspective on construction methods and costs. Final route modifications were identified following this flyover.

4. Ground Reconnaissance

Limited winter ground reconnaissance was performed on the route corridor separately by the R. W. Beck transmission line engineer and the Dames & Moore visual quality specialist in March 1993. This consisted chiefly of photographing the corridor along the Glenn Highway, Victory Road, Lake Louise Road and Lake Tolsona Road and noting the level of potential visibility of the initial route alternatives from the roadways. It was not possible to schedule any cross-country exploration of the routes at this time. Areas of potential high visibility for the initial route alternatives were noted in the areas of Slide Mountain, Tahneta Pass, and above Victory Road on the banks of Strelshla Mountain.

Some findings of this ground reconnaissance were that a line along a route north of the Glenn Highway between Sutton and Victory Road would not be visible to travelers along the Glenn Highway, except perhaps from a view of Strelshla Mountain to travelers heading east on the Glenn Highway just before Victory Road and at the crossing with Granite Creek; that a route on the south bank of the Matanuska River would be highly visible and would require long river crossings to exit Sutton and avoid undesirable construction on steep slopes in at least two locations; that a line along the initial routes in the vicinity of the Lake Louise Road scenic overlook would be highly visible and should be rerouted to mitigate this impact; and that a line north of the Glenn Highway and east of Tahneta Pass would not be visible from the Glenn Highway for the great majority of the initial routes. Areas of potentially high visibility included the south flank of Slide Mountain, Old Man Creek near Eureka and Tahneta Pass, Lake Louise Road, and possibly a few high vantage points along the Glenn Highway with views of the initial routes in the distance.

In conjunction with the second set of public meetings in June 1993, further ground review was undertaken. Areas reviewed by car included Sutton, Chickaloon, Bonnie Lake, and Lake Louise Road. In addition on June 23, the owner of Eureka Lodge and the R. W. Beck transmission line engineer traveled a 50-mile circuit on all-terrain vehicles (ATVs) in the areas of Old Man Creek, Crooked Creek, Pass Creek, Belanger Pass and Squaw Creek. This ATV tour revealed the wide extent of muskeg in low lying areas around Old Man Creek and Crooked Creek and the availability of elevation contours to either hide the line in the Old Man Creek valley or to site the line in reasonably stable and solid soil conditions above the creek beds. Extensive muskeg situations must still be assumed and winter construction in these areas is prudent from the standpoint of construction ease and minimizing damage to the wetlands. Numerous mining claims, both active and abandoned, were noted in the area. Caribou herds were present.

5. Route Selection Methodology

As a means of preliminary comparison, we first established several objective criteria and weights to apply to the various route segments. The criteria fall into the categories of environmental, land use, construction/technical and financial. These criteria, their weights and units of measure are presented in Appendix A. Each route segment shown on the base maps was measured for its impact in each criterion. Four preliminary route alternatives were developed from among the numerous route segments; they varied in length from 133 miles to 136 miles. A scoring system was used to develop a rating for each route alternative in each of the four categories and this rating served as the first basis of comparison. The sensitivity of the ratings to differences in weights was briefly investigated.

In the remainder of this section we discuss key public comments as they affect route selection, route selection criteria, individual route segments, the route alternatives and route evaluation.

C. PUBLIC COMMENT SUMMARY

The body of public comment that a proposed Intertie in this corridor has engendered is significant and reflects strong feelings about the possible impacts a line might have on the quality of life in the area. The public and their representative organizations have expressed the deepest concerns over the issues of negative visual impact, effects on the tourist industry, recreational experience and quality of life in the area, the perceived risk of health effects from electric and magnetic fields, the effect on property values and the possibility that private land would be taken for right-of-way, and the completeness of the feasibility study in terms of considering all options for increasing local generation on the Copper Valley system. See Appendices N and Q of this report for a detailed presentation of the public comment. We have attempted to address these concerns in the selection and comparison of route alternatives, as discussed below. We also include discussion of the Mental Health Trust lands.

1. Visual Impacts

The issue of visual impact was framed in the dual sense of reducing opportunities for wilderness experiences and reducing the appeal for tourism which forms a major part of the local economy. It is recognized that a line along any of the route alternatives will be visible for some of its length to some people. The objective is to keep the extent of visual intrusion and the number of people exposed to the impact to a minimum.

Depending on the route segment, a line might be visible to travelers on the Glenn Highway or other major roads, by users of the back country trail system, and by aircraft. Efforts were made to route line segments away from known occupied structures, where frequent visual impact is predictable. Within back country valleys it is not possible to hide lines for most of their routes. A line would be visible in these areas to those traveling above the banks of the rivers and creeks, while anyone rafting or kayaking the creeks themselves or using trails following the creek bed may or may not see the line. We made an effort to select route alternatives up and out of the creek beds and to limit creek crossings.

We made the following major adjustments in the conceptual design to lessen visual impact. In Sutton, instead of adopting the course of upgrading the MEA O'Neill Substation, it is proposed to build a new substation on Mat-Su Borough land about 0.7 mile west of O'Neill which will reduce the visual impact of both the substation and the Intertie getaway route. We rejected the siting of a line on the south bank of the Matanuska River due to the high visual impact. Route alternatives were selected to go over and north of Slide Mountain instead of along its exposed southern flank. In the area of Old Man Creek the route alternatives were moved farther away from the Glenn Highway to possibly reduce their visibility; the effectiveness of this change needs to be verified. In the area of Chickaloon the routes were moved north of Boulder Creek and closer to Anthracite Ridge.

A route modification around Knob Hill would lessen or eliminate the visual impact from the mouth of Granite Creek. It would also lessen the potential hazard to hang-gliders taking off from a sharp knob just north of Little Granite Creek.

In the area of Victory Road a route modification was identified to pass north of and around Strelshla Mountain, but at a substantial cost increase.

2. EMF Effects

It has been suggested that design of any Intertie adopt the criterion for siting route alternatives such that field strengths in occupied structures or other public places would be measurably no greater under Intertie maximum loading than they would be without the Intertie. The practical application of this criterion is complicated by the fact that it is not possible to design for a zero field increase at any distance. However, an arbitrary criterion that the field increase be no greater than the smallest reading possible by an EMDEXC meter (i.e., 0.1 milligauss magnetic field) would dictate that the line be situated approximately 600 ft from homes and public places. It would be impractical to acquire a right-of-way of this width, and there is no means for the operating utility to control development around the line. Homes and other public use areas may be developed inside this 1,200 ft band but outside the 100 ft to 125 ft right-of-way and the fields, while still very low, would increase as distance from the line decreases.

Matanuska-Susitna Borough Assembly Resolution 93-035 requests "assessment of EMF hazards at the O'Neill Substation" and relocation of the substation "to mitigate EMF health hazards". We have relocated the Intertie connection in Sutton to a new substation on Borough property about 0.7 mile west of O'Neill Substation. This moves the new substation and getaway line routes away from populated areas of Sutton, but it does not diminish any effects associated with O'Neill Substation which would remain.

To address these concerns we adopted the initial criterion that the line be sited 600 ft from homes and other occupied structures wherever possible. Where this is not possible, alternative line designs can be used in final design to reduce fields. The only area identified where the separation of 600 ft is not attained by the study route alignments is in Sutton near Eska Mine where the shown route passes about 400 ft from a mine complex building. Phone discussions with two Sutton residents indicated that the building is an occupied residence. The route shown on the maps at the end of this section can and would be modified slightly to obtain the stipulated 600 ft separation. The proposed new substation west of the existing O'Neill Substation will distance the line from existing homes in Sutton and result in lower field strengths.

Volume 2, Appendix N, Chapters 2.12 and 3.2 discusses the issue of EMF in more detail, covering the current status and findings of epidemiological research, law and regulations limiting field strengths, expected field strengths of the proposed Intertie and comparison to field strengths generated by typical lines and appliances. We also discuss means which can be taken to reduce the field strengths where necessary. It should be noted that the Intertie initial loading estimated at 15 MVA would generate maximum 60 Hz magnetic fields on the order of 0.03 milligauss at a distance of 600 ft from the line while the ultimate design loading of 40 MVA would yield fields on the order of 0.09 milligauss at 600 ft, well below typical ambient fields.

3. Right-of-Way and Land Ownership

We have researched and mapped land status for the entire corridor and all route segment alternatives (see Volume 2). We selected route alternatives in the Sutton-Chickaloon area to avoid private property and native lands wherever practical. Right-of-way for the route alternatives considered in this study occupies a maximum of 0.25 mile of private land (not counting unpatented mining claims) and 21.25 miles of Native and Native-selected lands. The new proposed substation in Sutton was located so as to minimize conflicts with private property. The sole crossing of the Glenn Highway was relocated westward to avoid crossing in Glennallen itself. Generally the route alternatives were moved farther from the Glenn Highway which has the dual effect of making the line less visible from the highway and avoiding private properties along the Glenn Highway.

Numerous unpatented mining claims along Boulder Creek, Chitna Pass, Caribou Creek, Alfred Creek, Squaw Creek, Crooked Creek, and other areas in the Talkeetna Mountains are known to exist. Index maps from the Alaska Division of Mines were provided to the study team by MEA with the assistance of Land Field Services. These maps clearly indicate extensive claims but further research at the Division of Mines is required to determine the exact number and extent of claims. The claimants will have to be treated as private landowners for the purposes of obtaining a right-of-way easement.

The potential of increased access to and along the right-of-way, especially by off-road vehicles, was voiced often as a public concern. Anxiety was expressed over a number of adverse impacts due to increased vehicular traffic to the back country, including increased hunting pressure, noise, abandoned campfires and the danger of wildfires, and higher use of and damage to the trail system. Access to the right-of-way is discussed in further detail in Section IV-7 (b).

4. State Mental Health Trust Lands

Approximately 13 miles of the route alternative rights-of-way are located on State Mental Health Trust lands. State Mental Health Trust lands were granted to the state by the federal government prior to statehood to generate revenue to support Alaska's mental health program (Mental Health Enabling Act of 1956). In 1978 the legislature waived the trust status of these lands and some lands were leased for oil and gas development, sold to individuals or transferred to municipalities. In the 1980's mental health advocates sued the state (Weiss vs. State of Alaska, 1982) and the state was ordered to "reconstitute" as nearly as possible the holdings which comprised the trust when the 1978 law became effective.

At this time, no settlement between the State of Alaska and mental health interests has been reached. Pending final settlement, in 1990 an injunction was placed on all activities and conveyances to title to the original Mental Health Trust lands. The 1991 Mental Health Trust Lands Settlement Act is a proposal from the Hickel Administration, which has been signed into law, to settle the issue of mental health trust lands. It would reconstitute the Mental Health Trust with all unencumbered lands from the original trust and provide replacement land in exchange for lands conveyed out of the trust. This law however, will not take effect until the original 1982 case is dismissed and the expiration of time for appeal. In the interim, the 1990 injunction applies.

Mental Health Trust lands depicted on land status maps in Section 2.7 of Appendix N originated from ADNR Division of Lands status plats. Mental Health Trust lands shown on these status plats are part of the original trust and are managed by ADNR in accordance with the original mandate for these lands. Lands which were conveyed out of the trust after the 1978 law would appear as belonging to the third party interests to whom they were conveyed. Mental Health interests, as part of the ongoing litigation, have been asked to select state lands to reconstitute the trust. Based on discussions with ADNR Division of Lands staff, we understand that a confidential priority list of selected lands ("hypothecated lands") has been prepared and is under review by the parties. These same discussions indicated that, based on experience, situating right-of-way on known Mental Health Trust lands would not hinder development of the Intertie, as long as standard right-of-way permitting procedures are followed and a use fee is negotiated that reflects the fair market value of the lands in question. It is not possible at this time to identify state lands selected to reconstitute the Mental Health lands and, in the course of standard permitting procedures for occupancy of state lands, ADNR would consult with Mental health interests in drawing up right-of-way easement agreement. In legal terms, concurrence of the plaintiff's mental health interests for the right-of-way would be sought and with concurrence the 1990 injunction would be modified to grant the right-of-way easement. This would require court approval.

According to ADNR staff, right-of-way occupancy of mental health lands would not constitute an obstacle to development of the Intertie. Mental Health interests have in the past demonstrated a willingness to negotiate use fees that would return an equitable percentage of fair market value of the land in question. The period for obtaining an easement in Mental Health Trust lands is estimated to be one to two months longer than for other state lands due to the 2-3 week court review and approval cycle and consultation with Mental Health interests. There is a reasonable expectation that the rental fee for the right-of-way on state non-Mental Health Trust lands would be waived since CVEA is a non-profit utility covered under Statute AS 38-05-810-F. However, it is not clear that such a waiver would be granted for right-of-way on Mental Health Trust lands. The governing statute only allows and does not obligate ADNR to grant waivers. Whether to grant a waiver, and, if not, what level of fee is appropriate, are ADNR administrative decisions. Typical use fees can be on the order of $100/acre-year.

D. INTERTIE CORRIDOR CHARACTERISTICS

1. Soil Conditions

A detailed description of the complex geology and soil conditions expected within the corridor is given in Volume 2, Appendix N, Chapter 2.2. General soil conditions as they might affect routing are summarized below.

West of Syncline Mountain, i.e., between Sutton and Eureka, soils will be predominantly glacial, alluvial and colluvial. Glacial and alluvial soils are expected to dominate in the Matanuska Valley at lower elevations, Boulder Creek Valley, Hicks Creek Valley and the lower reaches of Caribou and Squaw Creeks. Colluvial soils will be found on the broader valley sides of Caribou and Squaw Creeks and along narrow valley walls.

East of Syncline Mountain, i.e., from Eureka to Glennallen, glacial and lacustrian soils will dominate, with occasional colluvial deposits. Along the Tolsona Creek and Tazlina River drainages, alluvial soils will likely be encountered.

No permafrost is expected in Matanuska Valley. Colluvial soils may be frozen at protected higher elevations, discontinuously frozen on lower northern exposures, or sporadically frozen on southern exposures. Soils east of Syncline Mountain will generally be frozen. Typical active layer thickness near Glennallen is reported to be 3 ft to 7 ft. Stunted black spruce forest is an indication of permafrost.

2. Wetlands

A detailed description of wetlands and vegetation is given in Volume 2, Appendix N, Chapter 2.3. A summary of this discussion is given here as it affects routing.

Palustrine, lacustrine and riverine wetlands are common within the corridor. West of Syncline Mountain, riverine wetlands dominate and will affect routing where the line would cross or parallel creeks and streams. Palustrine wetlands, consisting mostly of saturated shrub bogs (muskeg), forested wetlands, and seasonally flooded shrub wetlands, are extensive east of Syncline Mountain in the areas of low relief of the Copper River Basin east of Slide Mountain. These palustrine wetlands are the result of poor drainage caused by the extensive permafrost. Saturated black spruce bog is a common type in the Copper River Basin.

Because of the extensive nature of the wetlands, to avoid construction in them would be impractical. Measures will have to be taken to limit disruption of wetland habitat and to restore damaged wetlands in accordance with guidelines and permit stipulations of the permitting agencies. In the Matanuska Valley Moose Range (MVMR), wetland buffers of 100 ft landward of the wetland are required in general, with a 200 ft buffer along anadromous stream wetland. ADNR prefers that no utility line parallel a wetland, but access to wetlands for utility construction and maintenance is allowable subject to ADNR approval. To minimize wetland damage, winter construction using driven-pile foundations would be used.

3. Forest Cover

The lower elevations of the Matanuska Valley and tributary valleys contain mixed sporadically heavy forests of black cottonwood, white spruce, black spruce, balsam poplar, quaking aspen willow, thinleaf alder, and dwarf birch. Higher elevation route segments in the Talkeetna Mountains (e.g., Chitna Pass, Caribou Creek, Alfred Creek) and the Tahneta Pass area are essentially barren with only occasional and mostly riparian tree cover.

From Old Man Creek to Glennallen, black spruce forests dominate. Stunted black spruce cover is indicative of permafrost.

No significant forests of commercial value occur along the corridor and removal of merchantable timber is assumed not to be required. However, state regulations (Sec. 41.17.082) do require the removal of commercial timber if is determined that it is economically feasible to do so. Such a determination would be made by ADNR Division of Forestry during permitting. In its review comments of the Draft Report, ADNR indicated that some commercial stands may be found in the last 10-15 miles of the line route. Special treatment of cleared spruce (other than black spruce) is required by regulation (11 AAC 95.195, Clearing of Spruce trees) to limit spread of the bark beetle infestation. Allowable treatments include controlled burning, chipping and spreading, or repeated passes by a roller crusher. ADNR personnel indicated that special treatment of black spruce was less critical than for white spruce and that it would be reasonable to assume no special treatment of the black spruce. However, to the extent black and white spruce stands cannot be distinguished or treated separately, ADNR would prefer to apply required white spruce treatment to black spruce as well.

4. Wildlife Habitat

A complete discussion of the wildlife habitat along the corridor is contained in Volume 2, Appendix N, Chapter 2.6.5.

With few exceptions, it is not practical to route around the bear, caribou, Dall sheep and moose concentrations in the Talkeetna Mountains and Matanuska Valley. Construction activities will be timed to mitigate impacts. See Section VI, Project Schedule.

Waterfowl and raptor nesting sites can be avoided by detailed route modifications. This especially affects trumpeter swan nesting areas near Mud Lake, Moose Lake, and Lake Louise Road. Raptor nests are possible, but have not been surveyed yet. Again, route modifications can avoid such sites and maintain required buffers (e.g., 330 ft to an eagle or peregrine falcon nest). If they exist along the route, it is probable raptors would nest in the Matanuska Valley. The project could be delayed if maintaining the required buffers forced a realignment and location of the line on another property parcel. To avoid this possibility, it is recommended that a raptor survey be undertaken before right-of-way permitting and acquisition activities.

While nesting sites can be avoided, this is not true of migration patterns. Special designs will have to be implemented to limit trumpeter swan-line strikes. This would include marking the wires with spiral dampers, aerial marker balls, or strobe lights and limiting the height of structures. Because most waterfowl activity occurs in an area east of Eureka where tree height is approximately 40 ft maximum, it will not be possible to keep wires at or below tree height without incurring the exorbitant cost of very short spans.

E. ROUTE SELECTION CRITERIA

Several practical criteria guided the selection of route alternatives as listed below. To the maximum extent possible, without clearly jeopardizing technical or economic feasibility:

1. Avoid siting the line right-of-way on private, native or native-selected lands;
2. Site the line at least 600 ft from known occupied structures (e.g., homes, schools, businesses) to limit magnetic field levels due to the Intertie to below 0.1 milligauss.
3. Avoid creek or river crossings and siting line in flood plain;
4. Avoid slopes between 25-45 percent and obvious signs of avalanche chutes or unstable soil;
5. Site the route so as to mitigate visual impacts from the Glenn Highway and other high-use traveled ways;
6. Conform with constructive recommendations from the public consistent with other selection criteria;
7. Avoid high elevations which are typically associated with severe microclimate loading conditions;
8. Avoid direct conflicts with the CKN Trail system which, in addition to high public use, may be designated a part of the national trail system; and
9. Avoid known wildlife nesting areas, habitat, and migratory paths.

F. DESCRIPTION OF ROUTE SEGMENTS

The feasibility study resulted in the identification of several route segment alternatives throughout the Intertie corridor for comparison. Combinations of these segment alternatives yielded two basic complete route alternatives for comparison: Route Alternative A, the Northern Route, generally the most distant from the Glenn Highway and Route Alternative B, the Southern Route, generally closest to the Glenn Highway. Two other route alternatives were investigated. Route Alternative C, similar to Route Alternative B, except that it follows Hick's Creek to Squaw Creek, and Route Alternative D, which is the same as Route Alternative C from Sutton to the headwaters of Hicks Creek, but then takes Alfred Creek and follows the same segments as Route Alternative A to Glennallen. Route Alternative D emerged from the preliminary route evaluation process as the apparent preferred route alternative as discussed at the end of this section.

Maps 1-11 at the end of this section show the various route segments and Table III-1 gives a tabulation of the segments comprising each route alternative and loading zones for each route segment. Land status maps are found in the Environmental Analysis in Volume 2, Appendix N, Section 2.7. Each route segment is discussed individually below.

Table III-1
Segment Data Tabulation and Route Alternatives

Segment		All	Length	Minimum	Maximum	Loading	Route Alt A		Route Alt B		Route Alt C		Route Alt D	
start	end	Segments	(miles)	Elevation	Elevation	Zone	Segment	miles	Segment	miles	Segment	miles	Segment	miles
1	2	1-2	5.56	655	1100	1	1-2	5.56	1-2	5.56	1-2	5.56	1-2	5.56
2	3	2-3	11.36	1100	1900	1	2-3	11.36		0.00		0.00	2-3	11.36
2	31	2-31	6.58	800	1125	1		0.00	2-31	6.58	2-31	6.58		0.00
3	4	3-4	6.68	1100	2200	1	3-4	6.68	3-4	6.68	3-4	6.68	3-4	6.68
4	4A	4-4A	2.92	2200	2800	1	4-4A	2.92	4-4A	2.92	4-4A	2.92	4-4A	2.92
4A	5	4A-5	5.24	2200	3000	1		0.00	4A-5	5.24	4A-5	5.24	4A-5	5.24
5	5A	5-5A	2.69	2900	3100	1		0.00	5-5A	2.69	5-5A	2.69	5-5A	2.69
5A	5B	5A-5B	2.01	3100	4800	4		0.00	5A-5B	2.01	5A-5B	2.01	5A-5B	2.01
5B	5C	5B-5C	2.28	2500	4800	4		0.00	5B-5C	2.28	5B-5C	2.28	5B-5C	2.28
4A	7	4A-7	10.61	2200	3400	3	4A-7	10.61		0.00		0.00		0.00
7	7A	7-7A	9.27	3400	4900	4	7-7A	9.27		0.00		0.00		0.00
5C	6	5C-6	2.34	2900	3000	1		0.00	5C-6	2.34	5C-6	2.34	5C-6	2.34
6	8	6-8	8.73	2830	3500	3		0.00		0.00	6-8	8.73	6-8	8.73
6	9	6-9	4.71	2200	3400	1		0.00	6-9	4.71		0.00		0.00
7A	8	7A-8	3.25	3200	4900	3	7A-8	3.25		0.00		0.00		0.00
8	10	8-10	1.44	2600	2800	3	8-10	1.44		0.00	8-10	1.44	8-10	1.44
9	11	9-11	7.37	2200	3000	3		0.00	9-11	7.37		0.00		0.00
10	11	10-11	4.25	2500	2600	3		0.00		0.00	10-11	4.25		0.00
10	15	10-15	12.61	2600	4300	3	10-15	12.61		0.00		0.00	10-15	12.61
11	12	11-12	4.74	2500	2900	3		0.00	11-12	4.74	11-12	4.74		0.00
12	13	12-13	3.14	2700	3000	2		0.00	12-13	3.14	12-13	3.14		0.00
13	14	13-14	3.3	3200	4000	3		0.00	13-14	3.30	13-14	3.30		0.00
14	15	14-15	1.91	3400	3700	3		0.00		0.00	14-15	1.91		0.00
14	16	14-16	6.2	3200	3500	3		0.00	14-16	6.20		0.00		0.00
15	16	15-16	4.57	3200	4400	3		0.00		0.00	15-16	4.57		0.00
15	17	15-17	6.26	3500	3800	3	15-17	6.26		0.00		0.00	15-17	6.26
17	17A	17-17A	3.2	3300	3900	3	17-17A	3.20		0.00		0.00	17-17A	3.20
16	18	16-18	5.89	2950	3200	2		0.00	16-18	5.89	16-18	5.89		0.00
17A	19	17A-19	5.86	2600	3900	2	17A-19	5.86		0.00		0.00	17A-19	5.86
18	18A	18-18A	3	2600	3300	2		0.00	18-18A	3.00	18-18A	3.00		0.00
18A	18B	18A-18B	4.45	3300	3850	3		0.00	18A-18B	4.45	18A-18B	4.45		0.00
18B	21	18B-21	6.3	2350	3800	2		0.00	18B-21	6.30	18B-21	6.30		0.00
19	20	19-20	12.13	2300	3365	2	19-20	12.13		0.00		0.00	19-20	12.13
20	22	20-22	4.99	2250	2725	2	20-22	4.99		0.00		0.00	20-22	4.99
21	23	21-23	5.19	2200	2317	2		0.00	21-23	5.19	21-23	5.19		0.00
22	26	22-26	13.56	2400	3107	2	22-26	13.56		0.00		0.00	22-26	13.56
23	24	23-24	6.02	2317	2660	2		0.00	23-24	6.02	23-24	6.02		0.00
24	25	24-25	4.88	2660	3000	2		0.00	24-25	4.88	24-25	4.88		0.00
25	26	25-26	2.27	2400	2850	2		0.00	25-26	2.27	25-26	2.27		0.00
26	27	26-27	7.97	2000	2200	2	26-27	7.97	26-27	7.97	26-27	7.97	26-27	7.97
27	28	27-28	6.44	1720	2100	2	27-28	6.44		0.00		0.00	27-28	6.44
27	29	27-29	9.05	1682	2172	2		0.00	27-29	9.05	27-29	9.05		0.00
28	29	28-29	2.6	1682	1720	2	28-29	2.60		0.00		0.00	28-29	2.60
29	30	29-30	7.7	1400	1682	2	29-30	7.70	29-30	7.70	29-30	7.70	29-30	7.70
31	3	31-3	5.89	1100	1900	1		0.00	31-3	5.89	31-3	5.89		0.00
TOTAL LENGTHS OF ROUTE ALTERNATIVES (miles)>>>>>								134.41		134.37		136.99		134.57

Segment 1-2 (length 5.56 miles)

The segment originates at a new substation on Mat-Su Borough property about 0.7 mile west of the existing MEA O'Neill Substation along the alignment of the existing MEA O'Neill Tap 115 kV transmission line. The route proceeds essentially due north from the substation through rolling, densely-forested hills to a crossing of Jonesville Road at a point just south of the mines and beyond current residential areas of Sutton. About 1.5 miles north of the new substation Segment 1-2 would turn east for a crossing of Granite Creek at segment mile 4.2 after which the segment occupies high ground on the bench above the Matanuska River bed and the Glenn Highway. This crossing has been moved north to avoid settled areas and private property of Sutton.

The present location on Granite Creek will likely require a long span crossing (estimated at 1,500 ft to 2,000 ft) and may be subject to higher, channeled wind loadings than the former crossing farther downstream. This segment will not be visible from the Glenn Highway due to the hilly terrain, dense forest, and distance from the highway, except from a viewpoint at the Glenn Highway crossing of Granite Creek. The crossing of Jonesville Road will be visible. East of Granite Creek the route segment has been located north of Little Granite Creek to avoid homes and private property in the area.

The line passes within about 400 ft of a building at the Eska mine complex and discussions with Sutton residents indicate it is an occupied residence. A minor route modification would be made to obtain the target 600 ft separation.

Segment 1-2 crosses wetlands about 0.5 mile in extent as it parallels Eska and Little Granite Creeks. It is estimated that wetlands around Granite Creek can be spanned, but the others must be traversed and may require winter construction and pile foundations. Segment 1-2 passes about 0.5 mile south of a Dall sheep mineral lick, an important summer habitat. In winter, Dall sheep congregate on south-facing slopes between Granite Creek and Kings River. This segment crosses one and parallels two anadromous streams and is located in the MVMR which will require special wetland/stream buffer zones. Sections along Eska and Little Granite Creeks may have to be rerouted to address ADNR concerns.

A knob just north of Little Granite Creek is used as a take-off point for hang-gliding and the routing of Segment 1-2 must consider the conflicts a line would create. Curtailment of hang-gliding activities for safety reasons would be considered in land use impacts. Depending on the extent that Granite Creek is used by private aircraft, a long span crossing may be considered an obstruction hazard and will have to appropriately marked and identified for local pilots. A landing strip is shown on Map 1 about 0.5 mile west of the route.

A possible route modification north of Knob Hill would mitigate both visibility of the line from Granite Creek and interference with hang-gliding activities, but with a penalty of adding 1.85 miles to the line at a cost of about $500,000. This route modification would pass through Dall sheep habitat near node 2.

An alternative substation site about 0.3 mile up a private road at Mile 60 of the Glenn Highway should be investigated since aerial photos indicate more level terrain is possible there. The substation would be fed by a single circuit line from the tap of the O'Neill tap line. Final routing of this segment would have to consider land use impacts to the strip mining operations and impacts of the mines on line design (e.g., blasting operations, excavation and stockpiling).

This segment lies on 1.5 miles Native land (Cook Inlet Regional Incorporated, "CIRI"), 2.8 miles state land, 1.1 miles of Mat-Su Borough land and 0.5 mile of State Mental Health Trust lands.

Segment 2-3 (length 11.36 miles)

The segment travels in a northeast direction up the west side of Young Creek to Chain Lakes at segment mile 7.0 where it heads east, crossing Kings River at segment mile 8.7.

Aerial photos indicate bare rock and or landslide activity at about segment mile 2.35 and mile 5.5 on the slopes of Red Mountain which were investigated closely during the summer flyover and ground review. Alternative paths around these areas are shown on the base maps as dashed lines.

This segment routing was selected to further hide the line from the Glenn Highway travelers and users of the Chickaloon Trail and to avoid impacts to private and native lands. It avoids the Chickaloon Trail, being no closer than about 1.5 miles from the trail. Since the segment is located higher up the mountain sides it is possible that the line would be more visible from a few vantage points along the highway than the Segments 2-31 and 31-3 hidden on the bench above the Glenn Highway or in the Kings River Valley. This should be evaluated in the preliminary design phase with the aid of a visual simulation model.

A long span crossing (estimated at 1,500 ft-1,750 ft) of the Kings River would be required. Depending on the extent that Kings River is used by private aircraft, a long span crossing may be considered an obstruction hazard and will have to be appropriately marked and identified for local pilots.

Segment 2-3 skirts the southeast facing slopes of Red Mountain which are a prime winter habitat for Dall sheep. It also passes about 0.5 mile from a mineral lick. Segment 2-3 traverses wetlands near node 2 and will span wetlands at Kings River. Segment 2-3 essentially lies entirely outside the MVMR.

This segment is located on 3.0 miles Native-selected state lands (CIRI, subsurface, Chickaloon Moose Creek Native Association, "CMCNA", surface claims), 3.3 miles state land, and 4.8 miles of State Mental Health Trust lands.

Segment 2-31-3 (length 12.47 miles)

This segment combination is located directly on the bench above the Glenn Highway heading east to segment mile 2.6 where is turns north across a wide gully at segment mile 2.8, then east again across Kings River and the Chickaloon Trail at segment mile 4.7, with a final northeast run about 0.25 mile east of and parallel to the river and trail to node 31. From here the route heads north across the Chickaloon Trail at segment mile 8.3, then east-northeast above the trail system.

The segment would not be visible to travelers of the Glenn Highway but would be visible in spots to users of Kings River, Chickaloon Trail, Fish Lake and Drill Lake as well as residents in this area. Because of the relative proximity to the trail system and river, there appears to be an increased potential for cultural resource conflicts on this segment compared to Segment 2-3.

Segment 2-31-3 lies almost entirely within the MVMR and passes through three stretches of wetlands. It crosses and parallels Kings River, an anadromous stream.

This segment is located on 0.25 miles of private land, 0.75 mile of Native land (CIRI, subsurface rights, CMCNA, surface rights), 6.5 miles state land, and 4.35 miles of State Mental Health Trust lands.

Segment 3-4 (length 6.68 miles)

This segment heads in an east-northeast direction, crossing California Creek at segment mile 0.4 and the Chickaloon River/Trail at segment mile 3.6. It proceeds on the north side of and parallel to Boulder

Creek where the terrain is relatively flat. The CKN Trail is located on the south side of Boulder Creek and another trail from Simpson Cabin to Chickaloon River parallels this segment on the north side at generally higher elevation.

This segment will not be visible from the Glenn Highway but will be visible to users of the Chickaloon River, Boulder Creek and other trails in the area. The routing of this segment was moved north of Boulder Creek away from the recreational use area around Bonnie and Rush Lakes and the CKN Trail system. Higher, channeled wind loading should be expected out of Chickaloon River transverse to the line.

Segment 3-4 passes through wetlands near node 3, at Chickaloon River and at node 4. Except for about 1 mile at the beginning, this segment lies outside the MVMR. It crosses Chickaloon River, an anadromous stream, and parallels Boulder Creek at a distance of 0.25 mile approximately and high above the creek bed.

This segment is located entirely on State Mental Health Trust lands.

At this point two major alternatives begin: one up Boulder Creek and the other continuing along Anthracite Ridge to Hicks Creek. The latter will be discussed first.

Segment 4-4A (length 2.92 miles)

Node 4A was introduced for convenience after old Segment 4-5 was eliminated from consideration. The combination of Segments 4-4A and 4A-5 replaces Segment 4-5, which crossed the CKN trail twice, had a fairly visible span within the viewshed of Rush Lake, and would disrupt views to the south from the CKN Trail.

Segment 4-4A heads northeast to a point about 0.7 mile north of Simpson Cabin. It crosses a trail at about segment mile 0.8. Elevations range from 2,200 ft at node 4 to 2,500 ft at node 4A. The segment lies north of Boulder Creek and might be visible to CKN Trail users.

This segment lies entirely outside the MVMR and encounters wetland areas in the last 0.7 mile.

This segment lies in 1.8 mile of State Mental Health Trust lands and 1.1 miles of state land. The segment passes to the north of a Native-selected parcel in the vicinity of Simpson Cabin.

Segment 4A-5 (length 5.24 miles)

This segment crosses Boulder Creek above Simpson Cabin and proceeds southeast to Node 5. It is located north of the CKN Trail and does not cross the trail at any point. Although it would be visible at points to users of the CKN Trail, this segment's location on the southern flank of Anthracite Ridge would not disrupt the direct southern viewshed from the trail.

Elevations range from 2,500 ft to over 3,500 ft with most of the segment lying below the 3,000 ft contour. The segment would be on mostly open or sparsely wooded land and might be visible from points along the Glenn Highway.

This segment lies outside the MVMR and entirely on state lands. The segment crosses Boulder Creek, an anadromous stream.

Segment 5-5A-5B-5C-6 (length 9.32 miles)

Segment 5-5A-5B-5C-6, which passes north of Strelshla Mountain, was selected to replace Segment 5-6 which passed south of Strelshla Mountain. Segment 5-6 was abandoned due to its potential for high visibility from the Glenn Highway and to residents of the Victory Road, Index Lake area. The new segment also avoids the two-lobed, active rock glacier which could have exposed about 1 mile of Segment 5-6 to falling or moving rock and debris. An ADNR study of the rock glacier's southwest trending lobe showed it moved 26 ft in the two-year study period.

This new segment might be visible at some points along the Glenn Highway, but not to the same extent as the former route segment.

This new segment is slightly shorter than the old Segment 5-6, but places 4.0 miles of this segment in the severe Loading Zone 4. This would require all-helicopter construction and represents a higher cost for the project.

Segment 5-5A-5B-5C-6 lies outside the MVMR. It is located entirely on 9.32 miles of state land.

Segment 6-9 (length 4.71 miles)

This segment heads in a southeasterly direction crossing from the Hicks Creek to the Pinochle Creek drainage. It crosses the CKN Trail at segment mile 1.2 and then turns east at segment mile 1.8 where it begins to generally parallel Dan Creek on the north side. The terrain is relatively flat for the entire segment length, varying between 3,000 ft and 2,500 ft, except in the vicinity of the trail, where the route drops from elevation 3,000 ft to 2,200 ft in just under one mile.

The portion of the route between Hicks Creek and Pinochle Creek drainages will be visible to users of the Pinochle trail. Travelers along the Glenn Highway may be able to view portions of the route from segment mile 1 to mile 3 depending on forest cover and season.

Segment 6-9 passes to the south of caribou winter/summer habitat in the Fortress Ridge area and to the north of the MVMR. It passes through a 1 mile stretch of wetlands as it parallels Dan Creek.

This segment is located entirely on Native land (CIRI).

Segment 9-11 (length 7.37 miles)

This segment extends from Dan Creek to Squaw Creek heading in a northeasterly direction, parallel to Caribou Creek for its entire length. For the first five miles the segment is routed on the west side of Caribou Creek, along the eastern flank of Fortress Ridge, where the terrain stays relatively flat at about elevation 2,500 ft. At segment mile 5 the route would cross to relatively level and open terrain on the east side of Caribou Creek. Sparse forest cover and open terrain make hiding the line difficult. The route segment would be visible by users of Dan Creek and the Squaw Creek trail. It may also be visible to users of Caribou Creek downstream of the Glenn Highway crossing. The route segment would not be visible to travelers on the Glenn Highway. See comments regarding unpatented mining claims in Segment S 4-7.

Two long span crossings (estimated at 1,500 ft) of Fortress Creek at mile 3.5 and Caribou Creek at mile 4.8 would be required.

Segment 9-11 lies entirely outside the MVMR and this point represents the easternmost extent of the MVMR. The segment parallels Caribou Creek, an anadromous stream, high above the creek bed. Wetlands along Fortress Creek and Caribou Creek would be spanned or avoided by the recommended route modification shown in dashed lines on Map 3. It is not expected that this segment would affect caribou concentrations on Fortress Ridge or Dall sheep on Sheep Mountain.

This segment passes about 0.5 mile north of the Caribou Creek Recreational Mining Area on the lower stretch of the creek. It is possible that a small section of Segment 9-11 would be visible to users of this area.

This segment is located on 0.7 mile of Native land (CIRI) and 6.7 miles state land.

Segment 4A-7 (length 10.61 miles)

This segment begins one of two major route alternatives, the other being Segment 4A-5, discussed earlier. The segment heads in a northeasterly direction, staying entirely within the Boulder Creek canyon bottom area where it would cross the creek several times to avoid steep slopes or unstable soil conditions. Terrain is extremely flat along the creek bottom. The line may be visible from the CKN Trail up until segment mile 3. The line on this segment would be visible for its entire length to users of the Boulder Creek trail.

Segment 4A-7 will encounter significant stretches of wetlands totaling about 4 miles along Boulder Creek. Final route layout would attempt to avoid wetland and potential landslide areas but it will probably not be possible to avoid traversing some wetlands parallel to Boulder Creek.

Numerous unpatented mining claims appear on Division of Mine records in Fairbanks. These would be treated the same as private land owners. The exact number of claims is not known but it is estimated that a total of 100 to 200 claims along Boulder Creek, Caribou Creek, Squaw Creek, Alfred Creek and in Chitna Pass may exist.

This segment is located entirely on state land (10.61 miles).

Segment 7-7A-8 (length 12.52 miles)

This segment heads northeast, crossing Chitna Pass (elevation 4,800 ft) at segment mile 4 and then heads southeast, paralleling Chitna Creek and Caribou Creek as they descend to elevation 2,900 ft at the end of the segment. This segment will not be visible from Glenn Highway but will be visible to users of the Boulder/Caribou Creek trails in the area. See comments regarding unpatented mining claims in the previous section.

Segment 7-8 lies 75% in Loading Zone 4, the most extreme loading zone. It passes through wetlands near node 7, along Chitna Creek and at the confluence of Caribou and Chitna Creeks. Dall sheep habitat is located in the vicinity of Chitna Creek to the south.

This segment is located entirely on state land (12.5 miles).

Segment 8-10 (length 1.44 miles)

This short segment heads southeast, paralleling Caribou Creek, connecting route segments emerging from Chitna Pass or Hicks Creek valley with the Alfred Creek and Squaw Creek route segments. This segment will not be visible from the Glenn Highway but will be visible to users of the Caribou Creek trail. A suggested route modification would push node 8 southwest approximately 1 mile to remove the line from the Caribou Creek bed as shown and allow it to take a more direct, flatter and less visible route from Hicks Creek to Squaw Creek. See comments regarding unpatented mining claims under Segment S 4A-7.

As shown on Map 5, Segment 8-10 lies in wetland areas along Caribou Creek. The suggested route modification would place the line at higher elevations and probably out of the wetland areas.

This segment is located entirely on state land (1.4 miles).

Segment 6-8 (length 8.73 miles)

This segment heads in a northeasterly direction up the west side of Hicks Creek Valley, passing west of Hicks Lake at segment mile 4.5, paralleling Divide Creek for one mile starting at segment mile 6.3, and ending at Caribou Creek. A suggested route modification would move node 8 southwest approximately 1 mile so as to take a more direct route to Alfred or Squaw Creeks. The terrain is relatively flat, beginning at elevation 3,000 ft, rising to 3,500 ft at Hicks Lake, and falling back to 3,000 ft at segment end. This segment will not be visible from the Glenn Highway but will be visible to users of the Hicks Creek trail, with a short portion visible to Caribou Creek trail users.

Segment 6-8 passes through wetlands near node 6 and adjacent to Divide Creek. The suggested route modification discussed under Segment 8-10 would probably avoid the wetlands on Divide Creek.

This segment is located on 0.7 mile of Native land (CIRI) and 8.0 miles of state land.

Segment 10-11 (length 4.25 miles)

This segment heads southeast, paralleling Caribou Creek either on the west or east side. If a route along the north side of Squaw Creek is selected, parallel to the existing road/trail, the preferred crossing of Caribou Creek would be just south of Alfred Creek and route Segment S10-11 would be on the east side of Caribou Creek. If a route on the south side of Squaw Creek is selected, the preferred crossing of Caribou Creek would be south of the confluence of Squaw and Caribou Creeks and S 10-11 would be located on the west side of Caribou Creek. This segment will not be visible from the Glenn Highway but will be visible to users of the Caribou Creek and Squaw Creek trails. See comments regarding unpatented mining claims under Segment S 4A-7.

Segment 10-11 would not apparently be located in any wetlands if routing follows the suggested route modifications discussed above. All route segment alternatives in this area are located on the lower elevation slopes of Syncline Mountain which is habitat to Dall sheep.

This segment is located entirely on state land (4.25 miles).

Segment 10-15 (length 12.61 miles)

This segment begins in the Caribou Creek Valley (elevation 2,600 ft) and heads northeast up the Alfred Creek valley, which turns due east at segment mile 4, and continues up Alfred Creek to segment mile 8, where the route heads up the Pass Creek valley, also in an easterly direction. The segment follows the Pass Creek valley to the end where it crosses just north of Belanger Pass at elevation 4,300 ft and then begins a one mile descent into the Crooked Creek drainage, elevation 3,700 ft.

This segment will not be visible from the Glenn Highway but will be visible to users of the trail along portions of Caribou Creek and most of Alfred and Pass Creeks, with a short portion visible to Crooked Creek trail users. See comments regarding unpatented mining claims under Segment S 4A-7.

Segment 10-15, as shown, passes through wetlands adjacent to Alfred Creek near Wood and Papoose Creeks. It should be possible to avoid these wetlands by siting the line on the south bank bench of Alfred Creek.

This segment is located on 4.8 miles of state land and 7.8 miles federal land.

Segment 11-12 (length 4.74 miles)

This segment begins at the confluence of the Caribou and Squaw Creeks, heading east along Squaw Creek on either the north or south side. If Segment S 9-11 heading north up Caribou Creek is selected, Segment S 11-12 will be south of Squaw Creek for most of its distance; if S 10-11 coming from the north is selected then S 11-12 may be located north of Squaw Creek. The south side of Squaw Creek is characterized by open terrain but relatively poor access and the possibility of discontinuous permafrost in colluvial soils on the northern exposure, while the north side route is located generally parallel to the existing road but is densely forested. This segment will not be visible from the Glenn Highway but will be visible to users of the Squaw Creek trail. See comments regarding unpatented mining claims under Segment S 4A-7.

Segment 11-12, if located north of Squaw Creek, will pass through about 1 mile of wetlands between Caribou Creek and Inoceramus Creek. The southern alignment would avoid these wetlands.

This segment is located entirely on state land (4.7 miles).

Segment 12-13 (length 3.14 miles)

This segment begins on the south side of Squaw Creek and runs north, crossing the creek and then turning northeast at segment mile 0.4 up the north side of Squaw Creek valley in relatively level and open terrain. Total elevation gain across the segment is only 300 ft. The precise crossing point of Squaw Creek must be selected to take maximum advantage of terrain elevation differences and likely would be shifted slightly from the location shown on Map 5 in final design. This segment will be visible to users of the Squaw Creek trail and a majority will probably be visible from the Glenn Highway.

Segment 12-13, as shown, crosses wetlands at the crossing of Squaw Creek about 1 mile below Squaw Lake. Lack of elevation contours a this point make spanning the wetlands impractical. A crossing point farther to the west would appear to offer more favorable terrain for avoiding wetlands adjacent to Squaw Creek. However, passing to the north side of Squaw Creek farther west would still require traversing the wetlands near node 12.

This segment is located entirely on state land (3.1 miles).

Segment 13-14 (length 3.3 miles)

This segment loops around a topographic "bowl" at the end of Martin Road and at the point of egress of Belanger Pass in an effort to avoid a number of cabins and private parcels . This segment (beginning elevation 3,200 ft) heads due north reaching elevation 4,000 ft, starts a gradual descent as it turns northeast at segment mile 1.1 reaching elevation 3800 ft, turns due east at segment mile 2.1, and turns southeast at segment mile 2.7 ending at elevation 3,400 ft. The majority of this segment would be visible to users of the Pass Creek and Crooked Creek trails as they descend into the bowl and would be visible, although at a distance of 2 to 2.5 miles from the Glenn Highway. Based on ground reconnaissance it appears that the line would not be highly visible to occupants of the few cabins off Martin Road since they are located beneath an elevation bench at the lip of the bowl. According to the local lodge owner, there are currently only one or two permanent residents in the group of cabins.

Segment 13-14 passes through about 0.5 mile of unspanable wetlands.

This segment is located on 2.5 miles of state land and 0.8 mile of federal land.

Segment 14-15 (length 1.91 miles)

This segment connects the route alternative emerging from Squaw Creek with that emerging from Alfred Creek. It heads in a northeasterly direction up the Crooked Creek valley, paralleling the trail and creek to the west; ground reconnaissance indicates that a location on the east side is preferable due to favorable, open terrain on high ground. Total elevation gain across the segment is only about 300 ft. The first half-mile of this segment will be visible at a distance of 2 to 2.5 miles from the Glenn Highway, but the entire segment will be visible to users of the Crooked Creek trail.

Segment 14-15 traverses no wetlands.

This segment is located entirely on federal land (1.9 miles).

Segment 14-16 (length 6.2 miles)

This segment follows Old Man Creek beginning north of Startup Lakes. From ground reconnaissance it appears possible to site this line segment on the slopes of the west side of the creek achieving the objectives of mitigating visibility and having relatively dry foundation conditions. This line segment would be potentially highly visible to travelers along the Glenn Highway and visual simulation is recommended to site the line segment out of view to the maximum extent possible. It would be difficult to hide the line segment as it enters and emerges from the Old Man Creek drainage. Users of the numerous snowmobile and ATV trails in the area would see the line.

Segment 14-16 traverses about 0.5 mile of wetland near node 16. It passes to the south of caribou winter range. It is likely that much of the construction in this segment would take place in winter leading to possible conflicts.

This segment is located entirely on federal land (6.2 miles).

Segment 15-16 (length 4.57 miles)

This segment begins in the Crooked Creek valley and heads northeast to segment mile 0.8, then turns due east to climb over a high, unnamed ridge to segment mile 3.3, then turns northeast to the end of the segment. The segment begins at elevation 3,600 ft and in 2 miles reaches 4400 ft at the top of the ridge, after which it begins a gradual descent to 3,200 ft at the end of the segment. Severe loading conditions can be expected on top of the ridge.

Approximately one mile of the segment, as it descends from the top of the ridge in open terrain, would be visible to travelers along the Glenn Highway, with medium density forest cover and a small knoll between the end of the route and the highway partially hiding the last part from view. The first two miles of this segment which climbs to the top of the ridge will be visible only to users of the Crooked Creek trail.

Segment 15-16 passes through about 0.5 mile of wetlands near node 16. It is about 1 mile closer to the caribou winter range than Segment 14-16.

This segment is located entirely on federal land (4.6 miles).

Segment 15-17 (length 6.26 miles)

This segment heads in a northerly direction up the Crooked Creek valley, paralleling the trail and creek to the east on high ground. The route would cross six small, intermittent streams that feed into Crooked Creek. The creek bed itself is extremely wet terrain, but achieving high ground on eastern slopes will improve construction conditions. The route segment would be located at elevations generally above 3,500 ft reaching 4,000 ft in some locations. This segment will not be visible from Glenn Highway but will be visible to users of the Crooked Creek trail.

Segment 15-17 passes through wetlands near node 15 for less than about 0.5 mile. It appears possible to avoid these wetlands by following Segment 15-16 for about 0.5 mile to its first point of intersection (PI) then heading north on higher ground.

This segment is located on 0.7 mile of state land and 5.6 miles of federal land.

Segment 16-18 (length 5.89 miles)

This segment crosses the Old Man Creek drainage heading in a general northeast direction. Terrain is level with significant muskeg expected. The segment begins at approximate elevation 3,200 ft and drops steadily to elevation 2,900 ft plus. Depending on perspective the segment would be visible in certain locations to travelers on the Glenn Highway, but at a distance of more than 1.5 miles.

Segment 16-18 passes through wetlands for a stretch of about 1 mile just beyond node 16. It may be possible to avoid these wetlands by moving the line to higher ground, but at the cost of potentially greater visibility from the Glenn Highway. The segment also passes through a 1 mile stretch of wetlands just prior to node 18. Rerouting to avoid these wetlands appears impractical. This segment passes through the southern fringes of caribou winter range.

This segment is located on 5.6 miles of state land and 0.3 mile federal land.

Segment 17-17A-19 (length 9.06 miles)

This segment crosses the Little Nelchina River drainage heading due east from the Crooked Creek valley and crossing Old Man Creek at segment mile 6.0 and the Little Nelchina River at segment mile 8.3. The route would also cross several small, intermittent streams, ponds and lakes. Terrain is flat along the entire segment with significant areas of muskeg anticipated. The segment begins at elevation 3,700 ft, crosses a ridge at elevation 3,900 ft plus before dropping gradually to the river bed at elevation 2,700 ft and starting the climb up Slide Mountain. This segment will not be visible from Glenn Highway but will be partially visible to users of the Crooked Creek trail. A possible route modification would take a more direct route from a point approximately 1.5 miles south on Segment S 15-17 to the PI at segment mile 3.8 on S 17-17A-19. This modification is not shown on the base maps.

Segment 17-17A-19 traverses about 4 miles of wetlands. It does not appear practical to route around these wetlands. Winter construction would be required. This segment passes through caribou winter range which may create construction conflicts.

This segment is located entirely on state land (9.1 miles).

Segment 18-18A-18B-21 (length 13.75 miles)

This segment crosses the Little Nelchina River and Slide Mountain. It heads due east and crosses the Little Nelchina River at segment mile 1.3, turns northeast at segment mile 6.1, crosses Cache Creek several times over 3 miles, turns due east at segment mile 10.8 at a point north of Snowshoe Lake, and turns due north at segment mile 13.2 around Lila Lake. The route would also cross several small, intermittent streams, ponds and lakes. Possible route modifications include (1) removing the 90 degree jog around Lila Lake by taking a direct route from segment mile 10.8 to node 21, (2) locating the final route to the south of Cache Creek on the east side of Slide Mountain, and (3) connecting from segment mile 10.8 to node 20 on the more northerly route. Terrain is flat along the entire segment. The segment starts at elevation 2,900 dropping to elevation 2,700 ft in the Little Nelchina River bed, climbing steadily over the next 3.5 miles to a high point on Slide Mountain at elevation 3,800 ft, then dropping gradually to elevation 2,350 ft near Lila Lake. This segment will probably be visible from some perspectives along the Glenn Highway as it descends the east slope of Slide Mountain, albeit at a distance of some 2 to 3 miles.

Segment 18-18A-18B-21 encounters a solid 4.5-5.0 mile stretch of unavoidable wetlands on the east side of Slide Mountain. It passes through a dispersed waterfowl nesting area above Snowshoe Lake and trumpeter swan nesting areas around Lila Lake. Special mitigation measures will be required to limit waterfowl-line strikes. These measures may include limiting structure and wire height at a significant cost penalty, or marking wires with marker balls or special damper-like devices. Suggested route modification (1) would eliminate a parallel of Lila Lake and give a greater wetland buffer.

Segment 18-18A-18B-21 passes about 1.5 miles north of the seaplane base at Snowshoe Lake. This should not pose an obstruction to air navigation but still may have to be marked.

This segment is located entirely on state land (13.8 miles).

Segment 19-20 (length 12.13 miles)

This segment crosses Slide Mountain approximately 3 miles farther north than Segment S 18-18A-18B-21. It begins 0.75 mile east of the Little Nelchina River and heads northeast for 3.5 miles at approximately constant elevation 2,950 ft. It then turns due east climbing over the back side of Slide Mountain reaching a high point of elevation 3,400 ft just north of benchmark VABM Ben at segment mile 5.4 and crossing a knoll at elevation 3,200 ft at segment mile 7.1 near VABM Cat. At segment mile 8 approximately the route begins a 4-mile traverse of flat terrain at elevation 2,600 ft-2,400 ft to its end point about 0.5 mile west of Nickoli Lake. The route would cross several small, intermittent streams, ponds and lakes. Possible route modifications include routing around the knoll at segment mile 7.1. This segment will probably not be visible from the Glenn Highway due to the distance from the highway and its location behind Slide Mountain.

Segment 19-20 encounters a solid 3.5 mile stretch of wetlands on the east side of Slide Mountain, again apparently unavoidable. It passes through a dispersed waterfowl nesting area. Both Segments 18-18A-18B-21 and 19-20 pass south of a moose fall rutting area southwest of Old Man Lake and a trumpeter swan nesting area on Old Man Lake.

This segment is located entirely on state land (12.1 miles)

Segment 20-22 (length 4.99 miles)

This segment begins 0.5 mile west of Nickoli Lake and heads northeast, 0.25 mile north of Nickoli Lake, to the end of the segment. The route crosses an unnamed trail at segment mile 0.6, and Mendeltna Creek at mile 1.5. Terrain is flat along the entire segment ranging from elevation 2,400 ft at the beginning of the segment to elevation 2,700 ft at the end. The route segment parallels the Mendeltna Creek road to the east for about 1.5 miles before crossing the road at segment mile 4.5. This route segment is markedly less visible from the scenic overlook on Lake Louise Road and to travelers on Lake Louise Road than route segments farther to the south. This segment will probably not be visible from the Glenn Highway but will be visible to travelers on Mendeltna Creek Road and portions of Lake Louise Road. The segment right-of-way may be oriented along the direct line of view of the valley and mountains to the south for travelers on certain portions of Mendeltna Creek Road.

Segment 20-22 is almost entirely located in wetland areas. It crosses Mendeltna Creek, an anadromous stream, and passes through a waterfowl spring/fall concentration area. Special mitigation measures would be required to limit impacts to waterfowl as mentioned under Segment 18-18A-18B-21. Segment 20-22 also passes through a moose calving area active in spring and summer months. Although most construction work occurs in winter, stringing operations would take place in summer and could pose a conflict.

This segment is located entirely on state land (5.0 mile).

Segment 21-23 (length 5.19 miles)

This segment begins one-half mile west of Nickoli Lake and heads due east, passing south of the lake, until segment mile 3.4 where it turns northeast to the end of the segment. The route crosses an unnamed trail at segment mile 0.5, 0.7 and 1.3, and Mendeltna Creek at mile 2.3. The route as shown would also cross several small, intermittent lakes and ponds. Terrain is relatively flat along the entire segment with elevations between 2,400 ft and 2,700 ft generally. This segment will probably not be visible from the Glenn Highway but may be visible from some vantage points on Lake Louise Road. Possible route modifications include taking a more direct route from a point south of Nickoli Lake to node 23 and final layout to avoid crossing lakes.

Segment 21-23 passes through extensive, but discontinuous wetlands for an estimated 80% of its length. It passes through a known waterfowl spring/fall concentration area and trumpeter swan nesting area around Lila Lake. It crosses Mendeltna Creek, an anadromous stream. Segment 21-23 also skirts the southern end of Nickoli Lake and may be subject to special buffer requirements. Special mitigation measures will be required to limit impacts to waterfowl as mentioned under Segment 18-18A-18B-21.

This segment is located entirely on state land (5.2 miles).

Segment 23-24 (length 6.02 miles)

This segment generally parallels the Glenn Highway on the north side at a distance of 1-1.5 miles and is located on the lip of an expansive plateau. The segment heads northeast through segment mile 5.8, where it turns almost due north for a short distance to the end of the segment. The route crosses Lake Louise Road at segment mile 4.1, just south of Crater Lake and a scenic overlook with a view shed of the Chugach Mountains to the south and southwest. As shown it would cross an unnamed creek at mile 5.6 and several small, intermittent lakes and ponds. Terrain is undulating but relatively level along the entire segment, ranging in elevation from 2,300 ft to 2,700 ft. This segment will probably be highly visible from the Glenn Highway due to its location on the lip of the plateau to the north of the highway and to travelers on Lake Louise Road. Visual impact to the view shed to the south from points on Lake Louise Road is expected to be high and difficult to mitigate. Possible route modifications include (1) final layout to avoid crossing lakes, (2) shifting the route segment north in an effort to mitigate visual impacts, and (3) eliminating the jog at the end of the segment.

Segment 23-24 passes through extensive but discontinuous wetlands for most of its length. It is located in a dispersed waterfowl nesting area. Route modifications mentioned are not expected to avoid these potential impacts.

This segment is located entirely on state land (6.0 miles).

Segment 24-25 (length 4.88 miles)

This segment heads northeast to the eastern lip of the plateau across flat terrain at elevation 2,700 approximately. Possible route modifications include (1) final layout to avoid crossing lakes, (2) taking a direct route from a point near segment mile 2-3 to segment mile 11 on S 22-26. The route as shown crosses several unnamed creeks and ponds. This segment will probably not be visible from the Glenn Highway, except perhaps the last section near node 25. Visual impact would be mitigated by adopting possible route modification (2).

Segment 24-25 passes through two areas of wetlands each about 0.5 mile long. It does not appear practical to avoid these by any minor reroute. This segment is closer to the Glenn Highway than Segment 22-26 but farther away from caribou winter range.

The combination of wetlands and caribou winter range may create construction conflicts.

This segment is situated entirely on state land (4.88 miles).

Segment 25-26 (length 2.27 miles)

As shown this segment heads due north along the east slope of the plateau at elevation 2700 through segment mile 1.0, where it turns due east through segment mile 2.0, and northeast to the end of the segment at elevation 2400. The route crosses Little Woods Creek at segment mile 1.3. Possible route modifications include (1) moving the first 1.0-mile leg farther to the west to lessen potential visibility, (2) adopt possible route modification (2) for Segment S 24-25 removing the 90 degree turns. As shown, this segment will probably be visible from the Glenn Highway , at least for the first 1.0-mile, and may be visible for parts of its entire length from certain points on the Glenn Highway. This visual impact would be mitigated by adopting possible route modification (1) or (2).

Segment 25-26 is located almost entirely in wetland areas and in the vicinity of caribou winter range, again with the potential of construction conflicts.

This segment is located entirely on state land (2.3 miles).

Segment 26-27 (length 7.97 miles)

This segment generally proceeds eastward, paralleling the Glenn Highway at a distance of 2.5 to 3.0 miles. It passes about 0.3 mile north of Moose Lake before crossing Tolsana Creek, an anadromous stream, at approximately segment mile 3.7. Terrain is very flat along the entire segment starting at elevation 2500 but spending most of its length at elevation 2100-2200. This segment will not be visible from the Glenn Highway, situated as it is for most of its length 3 miles north of the highway in forested lands.

The alignment of this segment passes to the north and east of Mud Lake, a trumpeter swan nesting area, at a distance of about 0.3 mile. Special mitigation measures will be required to limit impacts to the trumpeter swans during nesting and as they fly into and out of the lake area. A possible route modification would extend Segment 26-27 eastward to a point directly north of node 28 to avoid encircling Mud Lake.

Segment 26-27 lies entirely on state lands (7.97 miles). It passes through about 3 miles of wetlands and south of caribou winter range with the potential for construction conflicts.

Segment 22-26 (length 13.56 miles)

This segment climbs, traverses and descends the plateau between the Mendeltna and Tolsona Creeks. It heads due east starting at elevation 2,700 ft, paralleling Mendeltna Creek Road on the north side for 1.3 miles where it passes to the south side of the road before crossing Lake Louise Road at segment mile 2.0 at elevation 3,100. The route segment then traverses the plateau over relatively flat terrain, elevation 2,800-3,100, containing many small lakes and ponds. At approximate segment mile 11.0 the route segment descends to elevation 2,500 ft. Possible route modifications include (1) final layout to avoid crossing lakes, (2) keeping the line segment north of Mendeltna Creek Road for the entire length of parallel to avoid adverse impact to view shed of Chugach Mountains, and (3) routing to further mitigate visual impacts to travelers on Lake Louise Road. This segment will probably not be visible from the Glenn Highway but will be visible to travelers on Mendeltna Creek Road and portions of Lake Louise Road.

Segment 22-26 is located south of caribou summer and winter range, passes through a dispersed waterfowl nesting area, and runs just north of a trumpeter swan nesting area. Segment 22-26 is located in wetlands for about 50% of its length. Special mitigation measures will be required to limit impacts to waterfowl as mentioned under Segment 18-18A-18B-21.

This segment is located entirely on state land (13.6 miles).

Segment 27-28 (length 6.44 miles)

This segment heads due east descending into the Copper River basin, running parallel to and 1.5 miles north of the Glenn Highway, through the end of the segment. Terrain is very flat along the entire segment starting at elevation 2,100 ft and gradually dropping to elevation 1,700 ft approximately. This segment will probably not be visible from the Glenn Highway due to its distance from the highway and relatively heavy, though stunted forest cover.

Segment 27-28 crosses about 5 miles of wetlands and at node 27 lies in a trumpeter swan nesting area. Special mitigation measures will be required to limit impacts to waterfowl as mentioned under Segment 18-18A-18B-21.

This segment is located on 5.0 miles of Native land (Tazlina Village Corporation surface rights, Ahtna Regional Corporation subsurface rights) and 1.4 miles of state land.

Segment 27-29 (length 9.05 miles)

This segment crosses the Glenn Highway and parallels the Tazlina River on the north side. The segment heads due south through segment mile 2.5, where it turns southeast through segment mile 3.2, and east to the end of the segment. The route crosses the Glenn Highway at segment mile 1.5, which is approximately highway mile 174.5. The route also essentially parallels the Tazlina River trail (and crosses it twice) from about segment mile 5.1 to the end of the segment. Terrain is very flat along the entire segment, dropping gradually from elevation 2,100 ft to elevation 1,700 ft. The portion of this segment parallel to the Tazlina River will probably not be visible from the Glenn Highway due to its distance from the highway and relatively heavy forest cover. The highway crossing ,as shown, occurs in open lands and because the line structures will be significantly taller than any surrounding vegetation the right-of-way and line will be highly visible from a section of the Glenn Highway either side of the crossing. It is not expected that the crossing would impair views of the Wrangell Mountains to the east from the Glenn Highway.

This segment passes through about 7.5 miles of wetlands which appear unavoidable. The extent of wetlands crossed by Segment 27-29 is slightly more than that crossed by Segments 27-28, 28-29. The segment parallels the Tazlina River, an anadromous stream, at a distance of 0.3 to 1.5 miles approximately. Some commercial stands of timber may be encountered according to ADNR.

This segment is located on 4.7 miles of Native land (Tazlina Village Corporation surface rights, Ahtna Regional Corporation subsurface rights) and 4.4 miles of state land.

Segment 28-29 (length 2.6 miles)

This segment crosses the Glenn Highway about 6 miles farther east than S 27-29. It heads due south through the end of the segment. The route crosses the Glenn Highway at segment mile 1.5, which is approximately highway mile 181. Terrain is very flat along the entire segment at almost constant elevation 1700. The majority of this segment as shown will probably be visible from the Glenn Highway due to the highway crossing in open terrain and the fact that structures will be much taller than surrounding vegetation. Possible route modifications include (1) shifting this segment west about 0.5 mile to forested lands. This would allow hiding the right-of-way by maintaining a corridor of tree growth adjacent to the highway and it might assist in hiding the line at some distance from the highway. However, this will also increase clearing costs. Some commercial stands of timber may be encountered according to ADNR.

This segment crosses about 2.0 miles of wetlands.

This segment is located entirely on Native land (Tazlina Village Corporation surface rights, Ahtna Regional Corporation subsurface rights) (2.6 miles).

Segment 29-30 (length 7.70 miles)

This segment terminates at the existing Pump Station No. 11 Substation adjacent to the Aleyeska Pipeline in Glennallen and is common to all route alternatives. This segment heads east through segment mile 7.1, where it turns northwest to parallel the existing Glennallen-Valdez 138-kV line and then into the substation. The route as shown crosses the Tazlina River trail four times. an unnamed creek at segment mile 3.5, and Moose Creek just before turning northwest towards the substation. At about segment mile 4.7 it passes about 0.25 miles south of a private parcel but available aerial photography shows no homes exist on the parcel. Terrain is very flat along the entire segment starting at elevation 1700 and dropping gradually to elevation 1400 approximately. Possible route modifications include (1) routing slightly farther north of the Tazlina River bank at the bend in the river at segment mile 1.7 and (2) taking a more direct route into the substation rather than paralleling the existing line. The majority of this segment will not be visible from the Glenn Highway due to fairly heavy forest cover and its distance from the highway. It may be visible at a distance of 1-1.5 miles from high viewpoints north of the Glenn Highway in Glennallen.

It is estimated that this segment crosses 2 miles of wetlands. The segment parallels the Tazlina River, an anadromous stream, at a distance of 0.25 to 1.5 miles and high above the riverbed. Some commercial stands of timber may be encountered according to ADNR.

This segment is located entirely on 7.7 miles of Native land (Tazlina Village Corporation surface rights, Ahtna Regional Corporation subsurface rights).

G. DESCRIPTION OF ROUTE ALTERNATIVES

As discussed earlier, four route alternatives were identified for comparison. They are all combinations of the route segments described above. In Table III-1 (on page III-13 of this Section), elevation, loading zone and length data for these four route alternatives are tabulated.

1. Route Alternative A, The Northern Route

Route Alternative A generally follows route segments located farthest from the Glenn Highway and with a length of 134.4 miles is only slightly longer than Route Alternative B. In common with the other alternatives, Route Alternative A shares Segment 1-2 in the Sutton area before following Segment 2-3 up Young Creek to Chain Lakes and 3-4 to the Chickaloon vicinity. It then takes Segments 4-7, 7-8, 8-10, and 10-15 up Boulder Creek, over Chitna Pass into the Caribou Creek drainage, and then along Alfred Creek , emerging from the divide at Pass Creek on the east side of Syncline Mountain. At this point Route Alternative A follows Segment 15-17 north up Crooked Creek to about Cottonwood Creek before heading east and north of Slide Mountain on Segments 17-19 and 19-20. This alternative then would take Segments 20-22, 22-26 eastward staying a minimum of 2.5 miles north of the Glenn Highway. This alternative crosses Lake Louise Road at approximately mile 6 of the road. Segment 26-27 north of Moose Lake and Mud Lake is common to all route alternatives. The final approach to Glennallen is made along Segments 27-28, 28-29 and 29-30, crossing to the south of the Glenn Highway near mile 181 to follow the north bank of the Tazlina River.

2. Route Alternative B, The Southern Route

Route Alternative B is 134.4 miles long and generally is the closest to the Glenn Highway, although still a considerable distance from the highway. In common with the other alternatives, Route Alternative B shares Segment 1-2 in the Sutton area before following Segments 2-31-3 and 3-4 to the Chickaloon vicinity. It then skirts the south slope of Anthracite Ridge following Segment 4-4A-5 and then 5-5A-5B-5C-6 around Strelshla Mountain and up Hicks Creek. At this point Route Alternative B follows Segment 6-9 down Pinochle Creek, around the south side of Fortress Ridge and along Dan Creek before heading up Caribou Creek on Segment 9-11. It passes up Squaw Creek on Segment 11-12 and Old Man Creek on Segments 12-13, 13-14,14-16 and 16-18. Following Segments 18-21, 21-23, 23-24, 24-25, 25-26 and 26-27 this alternative passes over Slide Mountain and south of Nickoli Lake, crossing Lake Louise Road about 1 mile from the Glenn Highway intersection and passing north of Moose and Mud Lakes. The final approach to Glennallen is made along Segments 27-29 and 29-30, crossing to the south of the Glenn Highway near mile 174 to follow the north bank of the Tazlina River.

3. Route Alternative C

Route Alternative C, 137.0 miles long, follows Route Alternative B (closest to road) from Sutton to the Victory Road area. It differs from other alternatives in taking Segment 6-8 up the west side of Hicks Creek. It then takes Segments 8-10 and 10-11 down Caribou Creek, Segment 11-12 along Squaw Creek, and Segments 12-13 and 13-14 up to Belanger Pass. At this point Route Alternative C takes Segment 14-15 into the Crooked Creek drainage and Segment 15-16 parallel to Old Man Creek. From this point this alternative follows the same Segments as Route Alternative B.

4. Route Alternative D

Route Alternative D, 134.6 miles long, is identical to Route Alternative A except that from node 4 to node 8 it passes south of Anthracite Ridge and up Hicks Creek, where Route Alternative A goes up Boulder Creek and over Chitna Pass.

H. ROUTE ALTERNATIVE COMPARISON

This exercise of route comparison is not intended to take the place of a formal impact assessment as may be required by NEPA regulations for an Environmental Assessment. The evaluation of various route alternatives which follows reflects the sole judgment of the R. W. Beck project engineering staff, based on information compiled during the study. The methodology using measurable objective route evaluation criteria, described below, was adopted to systematically compare route alternatives. The selection of evaluation criteria and their weights was based on the engineers' judgment.

1. Methodology

As a first step in developing a preferred route selection, four route alternatives were compared using a scoring system based on criteria in the categories of environmental concerns, land use impacts, construction and technical concerns, and construction cost. A unit of objective measure (e.g., "each 1000-foot segment in steep terrain counts as one unit of measure" or " each highway crossing counts as one unit of measure") and a subjective weight (0-5) was assigned to each criterion to reflect its perceived importance; public comment was a major factor in selecting weights. For each route segment and for each criterion in the four categories of comparison the product of the measured impact and the criterion weight was determined. The total impact for each criterion over all route segments was summed for each route alternative and normalized to the lowest value sum among the four route alternatives. A summary table of this preliminary comparison is included as Table S-1 in Appendix A.

A description of the four comparison categories and their several criteria and weights is found in Appendix A. Also included is a sample set of the evaluation matrices for all four route alternatives.

Some criteria which were not explicitly addressed include wildlife habitat, environmental concerns expressed by the general public, and unpatented mining claims (land use and financial). Inclusion of these, and perhaps other criteria, might alter findings.

2. A First Comparison

Table III-2 gives one comparison of the route alternatives by uniform weighting of the four categories, i.e., environmental, land use, construction/technical, and financial. Individual criteria weights are as in the attached description; no sensitivity analysis was performed on these weights.

Table III-2 is based on applying equal weighting to each of the four categories.

Table III-2
Preliminary Comparison of Impacts
Uniform Category Weights

Route	Category				Overall
Alternative	**Environmental**	**Land Use***	**Construction**	**Financial***	**Rank**
A	Low+	Medium	High	Medium+	3
B	Medium+	Medium	Low	Medium	2
C	High	Medium+	Low+	Medium+	4
D	Low	Medium	Medium	Medium	1

* Weighted indices are essentially equivalent.

3. Sensitivity Analysis

By applying different weights to the four evaluation categories we attempt to predict how the initial ranking of route alternative might change with perspective. Specifically, we assigned a normal weight of 2 to three categories and a high weight of 5 to the other remaining category. The results of this are shown in Table III-3.

Table III-3
Route Alternative Comparison
Sensitivity Analysis

Route Alternative	High Environmental	High Land Use	High Construction	High Financial
A	2	3	4	3
B	3	2	1	1*
C	4	4	3	4
D	1	1	2	1*

* Indicates ranking is essentially the same.

4. Route Alternative Comparison

a. Route Alternative A

(1) Advantages

Route Alternative A is consistently farthest from the Glenn Highway, would have the least visual impact on highway travelers, has relatively low conflict with the MVMR, avoids native lands in Segment 2-31-3, would have the least visual impact to users of the CKN Trail system in the Matanuska Valley, and has the least length (with Alternatives B and D) in the Chickaloon Special Land Use District ("CSLUD"). Route Alternative A is preferred by Glacier View area residents (Glacier View Community Council, "GVCC," Resolution dated April 7, 1993, Appendix C, Volume 2).

(2) Disadvantages

Route Alternative A would have a high visual impact to users of Boulder Creek, Chitna Pass and Alfred Creek; would be more isolated and expensive to operate and maintain; and would entail dealing with numerous unpatented mining claims.

b. Route Alternative B

(1) Advantages

Route Alternative B avoids the back country areas of Boulder Creek, Chitna Pass, Alfred Creek, etc. and the numerous unpatented mining claims found there.

(2) Disadvantages

Route Alternative B is consistently closest to the Glenn Highway, although at a distance of one to four miles, and will have the highest overall potential for visual impacts to users of the highway. This alternative has the greatest length (with Alternative C) in the MVMR and the CSLUD with the highest potential impacts to these areas. Route Alternative B is opposed by the GVCC. The route has about 4.0 miles in the severe Loading Zone 4, as it passes north of Strelshla Mountain. Route Alternative B is estimated to have the second highest cost.

c. Route Alternative C

(1) Advantages

Route Alternative C shares the advantages of Route Alternative B. It heads up Hicks Creek, rather than following Dan Creek and Caribou Creek as does Alternative B, and therefore would have fewer impacts on the Matanuska Valley.

(2) Disadvantages

Route Alternative C shares the disadvantages of Route Alternative B, except that it would occupy about 6 miles less in the Matanuska Valley. It would use Hicks Creek, a well-used hiking corridor, to the back country. It is the longest route alternative and its estimated construction cost is the highest.

d. Route Alternative D

(1) Advantages

Route Alternative D shares most of the advantages of Route Alternative A except in the area of Anthracite Ridge, where Alternative A passes up Boulder Creek and over Chitna Pass as opposed to Alternative D which passes south of Anthracite Ridge and up Hicks Creek. Route Alternative D was evaluated to have the least estimated development cost.

(2) Disadvantages

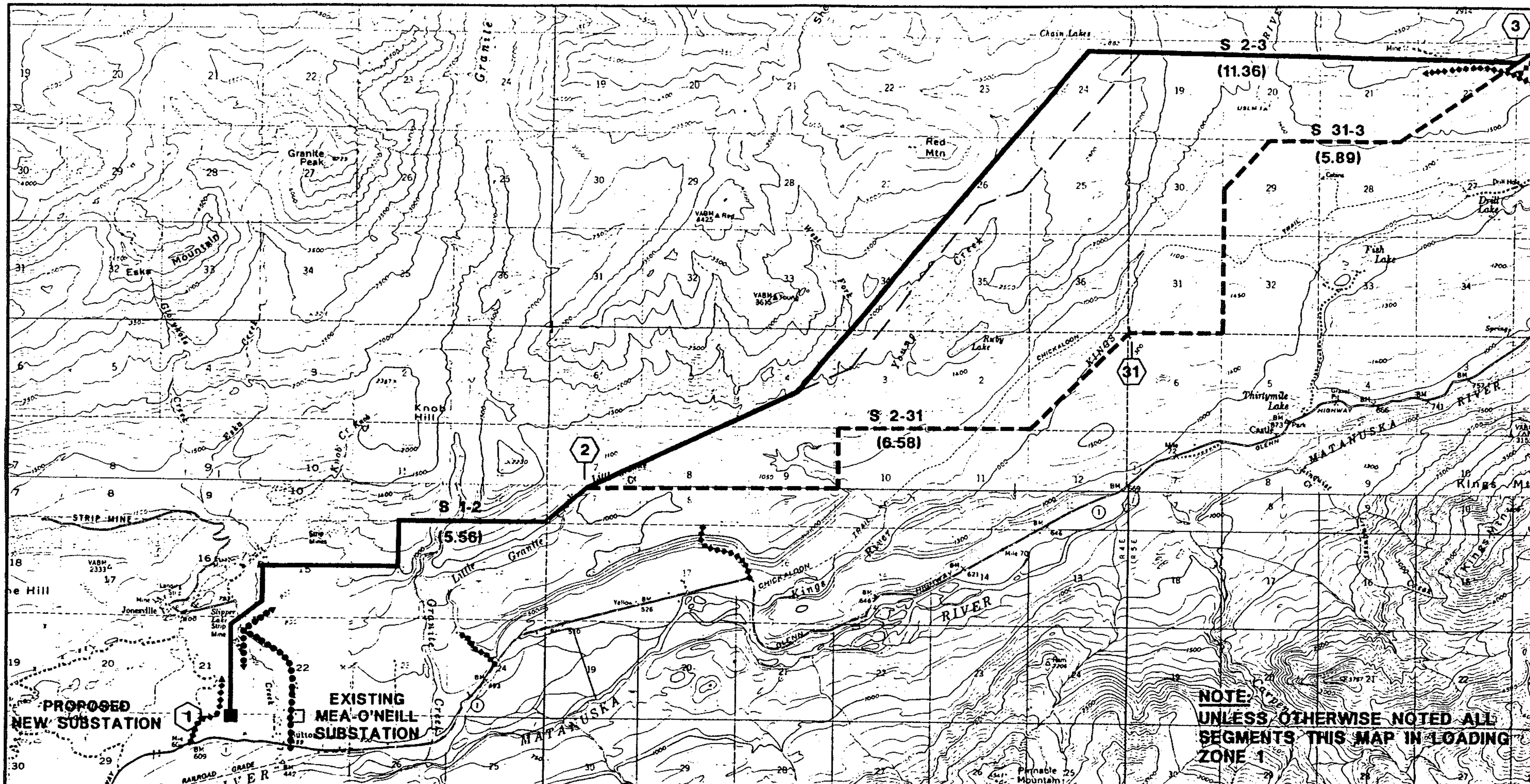
Route Alternative D shares the disadvantages of Route Alternative A, except that it is located south of Anthracite Ridge from Boulder Creek to Strelshla Mountain and will have greater impacts to users and resources of the CKN Trail system in the area.

5. Apparent Preferred Route Alternative

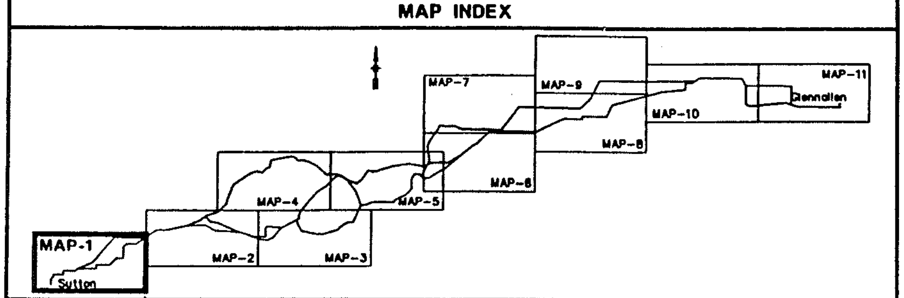
This feasibility study stopped short of selecting a preferred route. The foregoing route alternative comparison must be expanded to a full-scale and systematic impact assessment which would consider the magnitude, geographic extent, duration and frequency, and likelihood of impacts. This evaluation would take place during the environmental assessment phase and would follow Council on Environmental Quality guidelines for determining the significance of impacts. However, for the purposes of focusing the feasibility study, we do discuss an apparent preferred route alternative below.

Based on the preliminary comparisons discussed above and Tables III-2 and III-3, Route Alternative D emerges as the apparent preferred route alternative for an Intertie. Although Route Alternative D appears to be preferred, the other route alternatives are competitive. Additional minor route adjustments must be anticipated for any route alternative in response to detailed information on land ownership and input from permitting agencies or other interested parties.

Route Alternative A differs from the "apparent preferred route" by going up Boulder Creek and across Chitna Pass rather than traversing the southern flank of Anthracite Ridge to Strelshla Mountain and on into the Hicks Creek area. Significant public comment was received from residents in this general area indicating a preference for the Boulder Creek route rather than the Anthracite Ridge route. On the basis of this apparent expression of community preference, it is recommended that additional consideration be given to Route Alternative A as well as Route Alternative D in any future route selection process for the Intertie.



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.56)
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

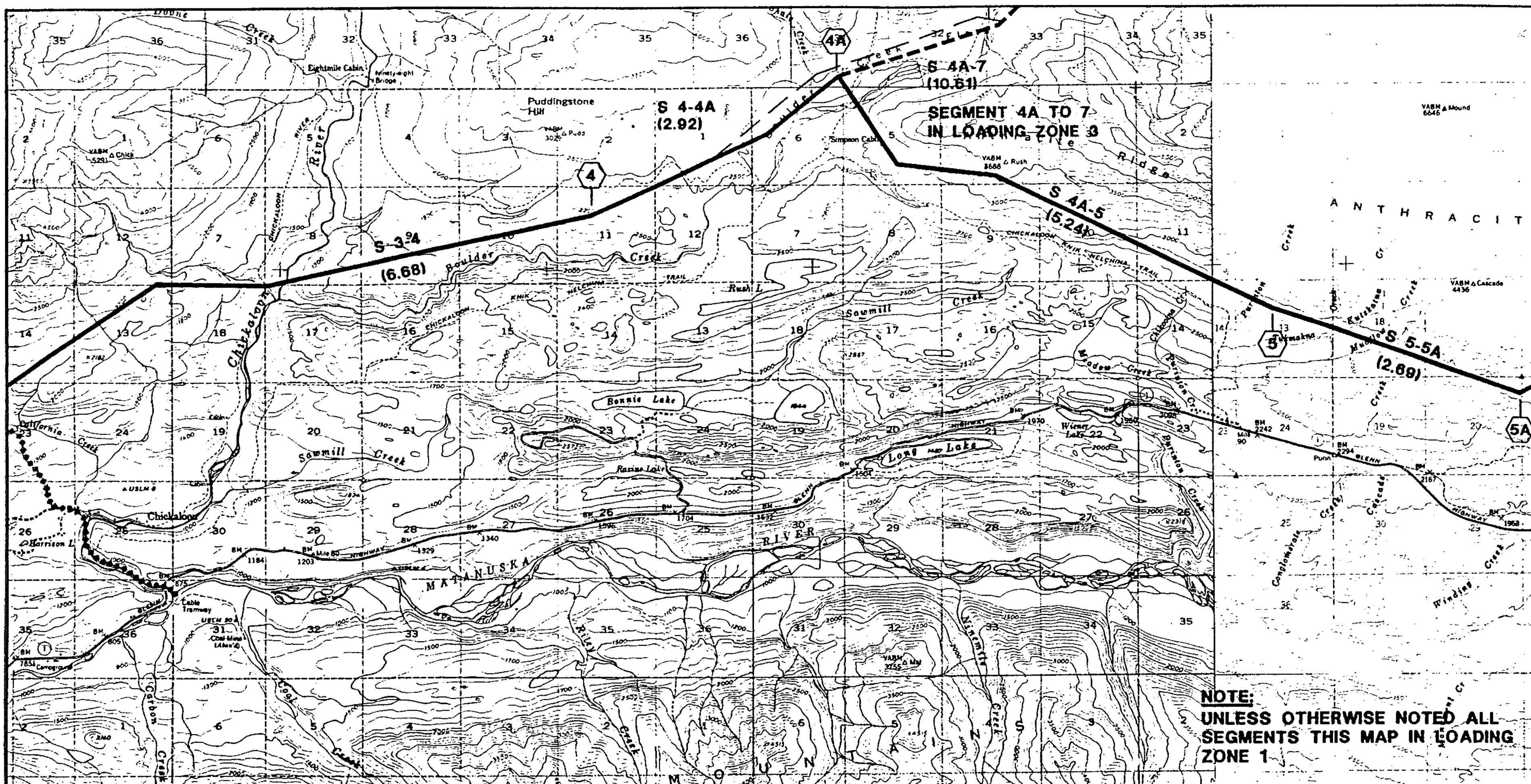
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES

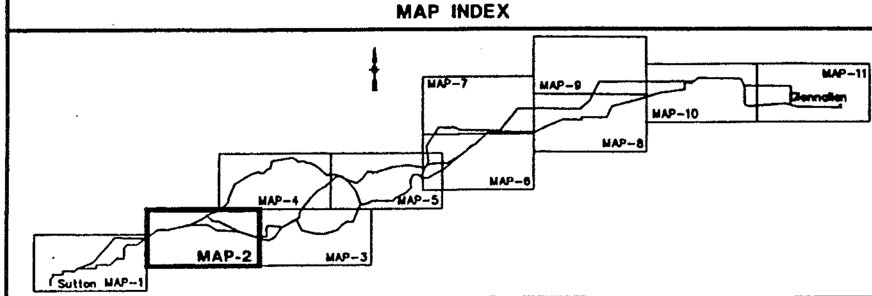
MAP-1 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.56)
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

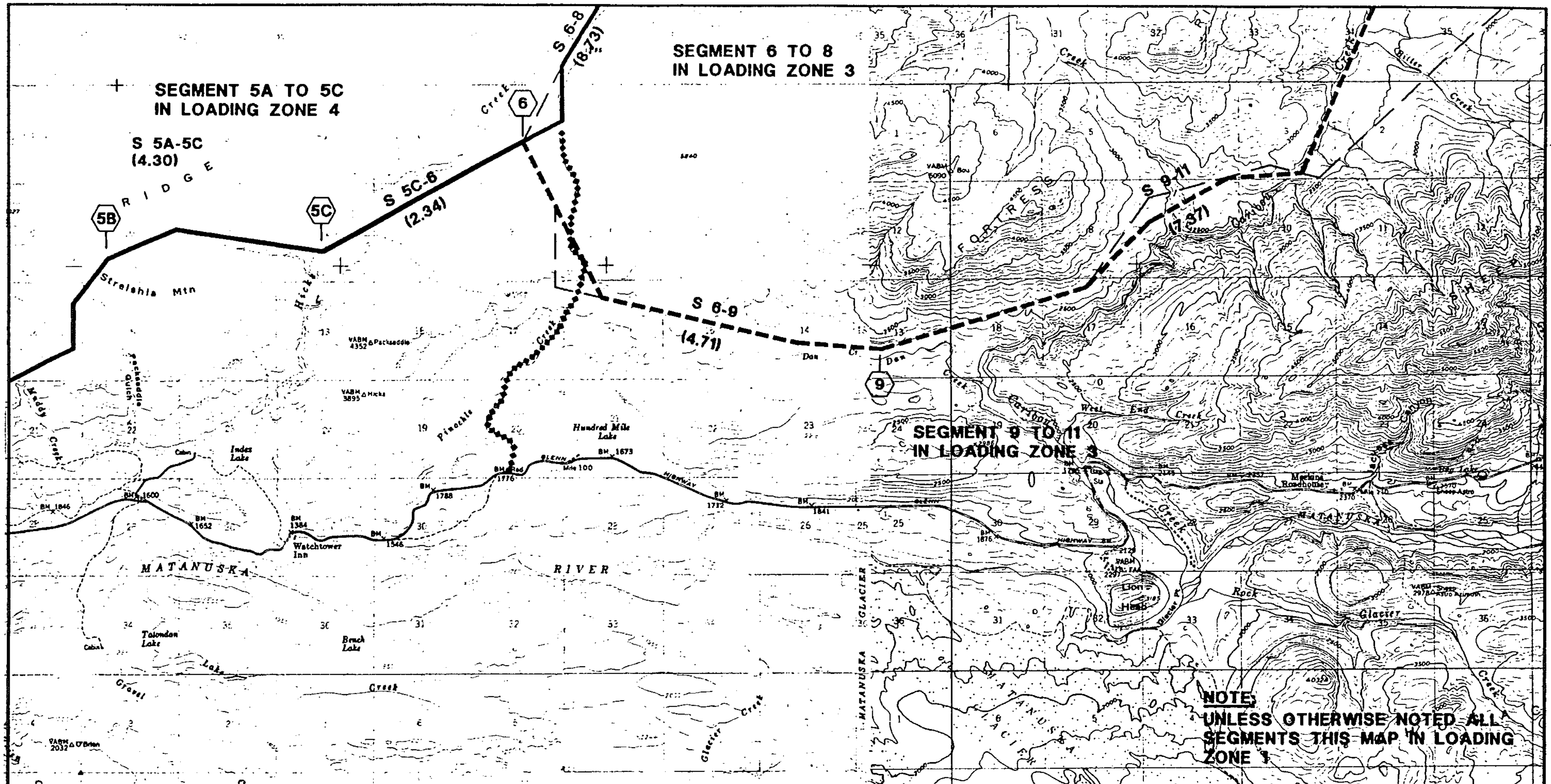
SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

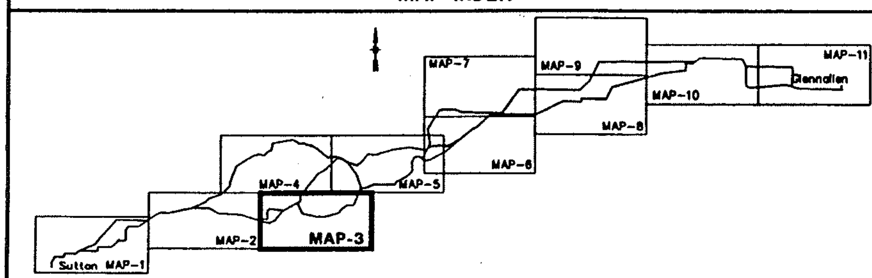
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES
MAP-2 OF 11 MAPS
APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- (1) S 1-2 (5.56) (2): SEGMENT DESIGNATION S1-2, I.e. BETWEEN POINTS 1 AND 2; MILEAGE BETWEEN POINTS IN ( )
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

N

0 — 1 MILE

SCALE: 1:63,360

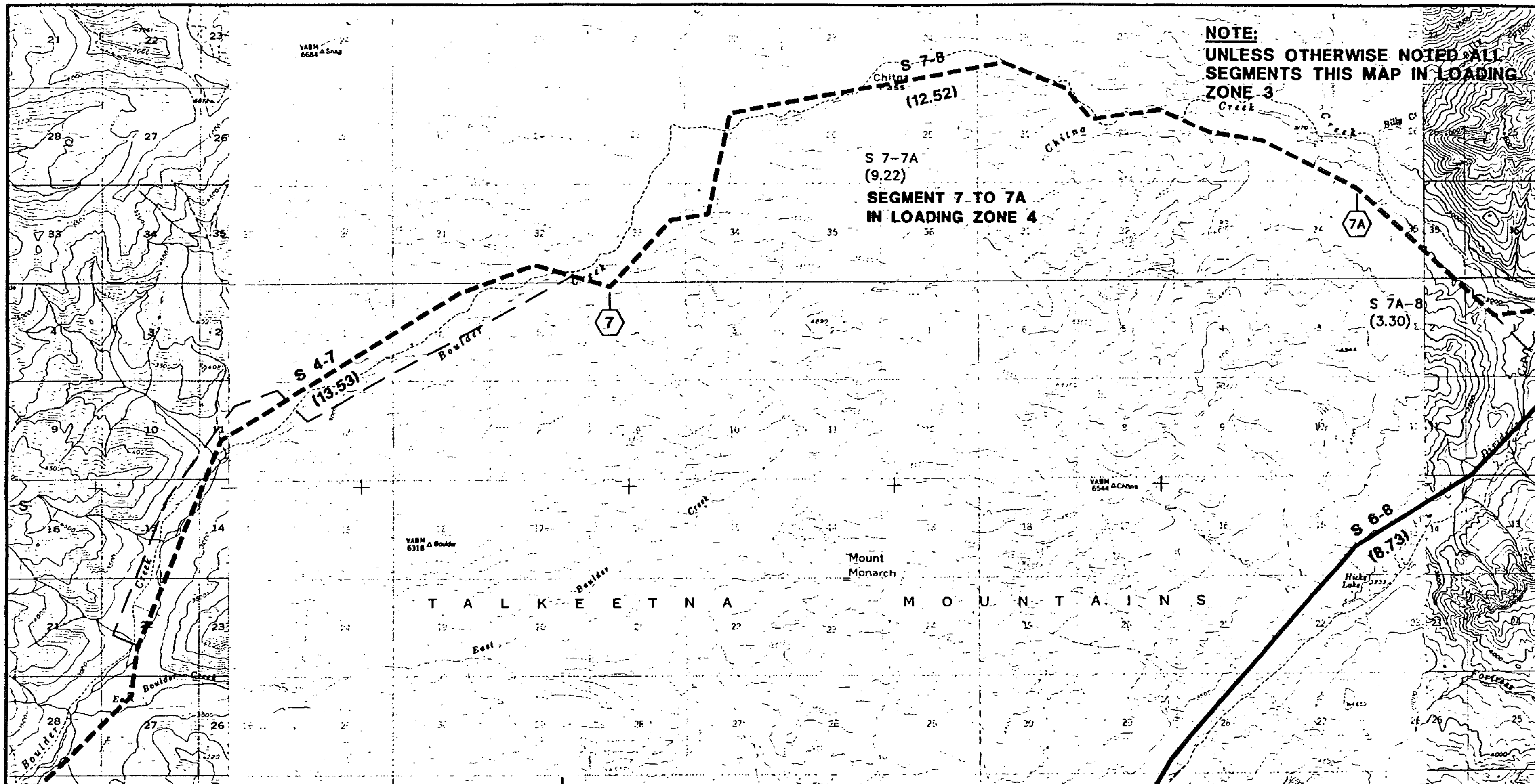
ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

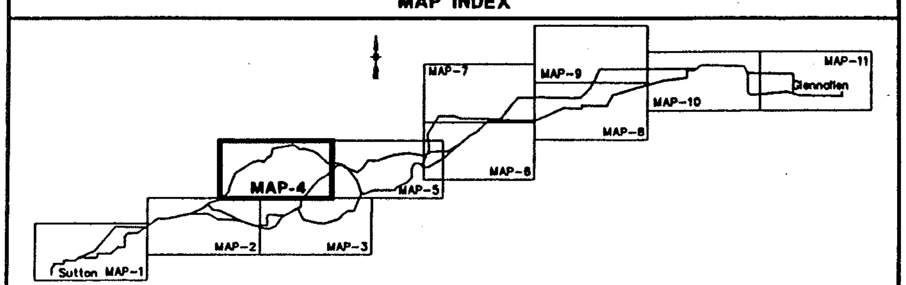
STUDY ROUTE ALTERNATIVES MAP-3 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- ROUTE MODIFICATIONS POSSIBLE
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.56)

0 — 1 MILE

SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

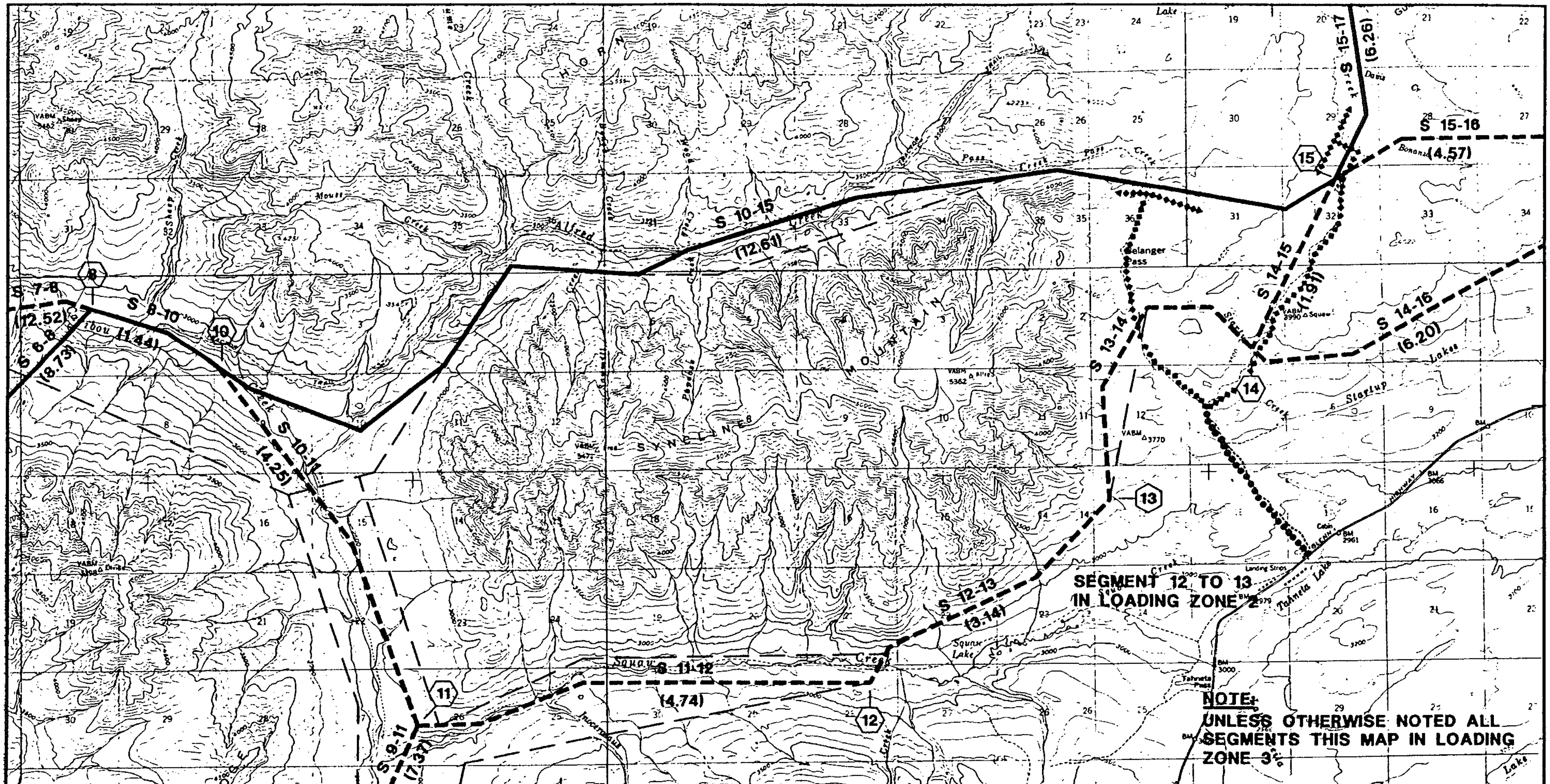
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES

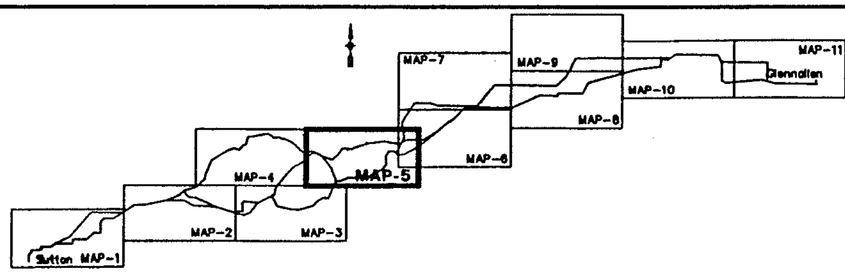
MAP-4 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, I.e. BETWEEN POINTS 1 AND 2 (S 1-2, (6.56))
- MILEAGE BETWEEN POINTS IN ( )
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

SCALE: 1:63,360

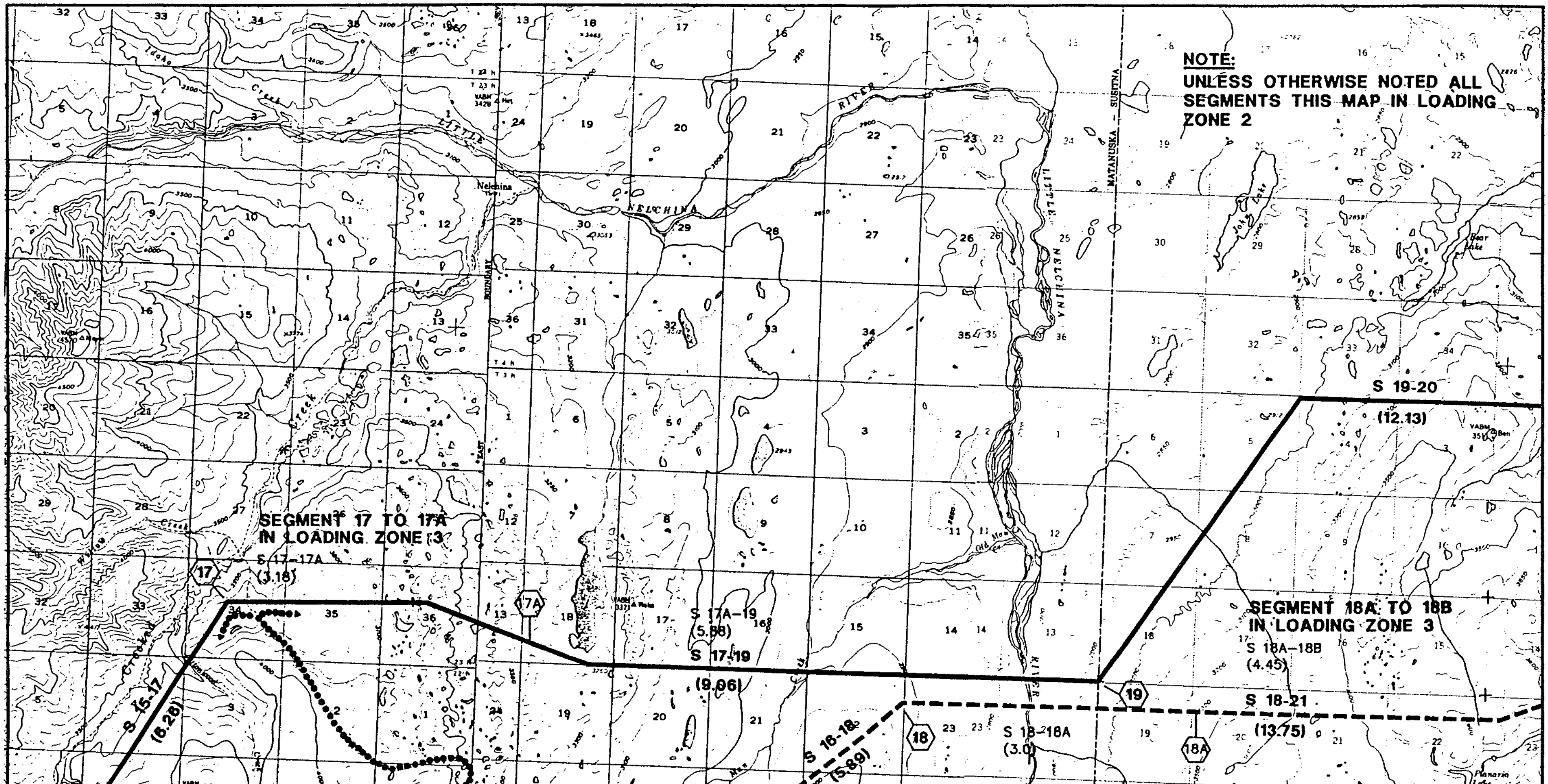
ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

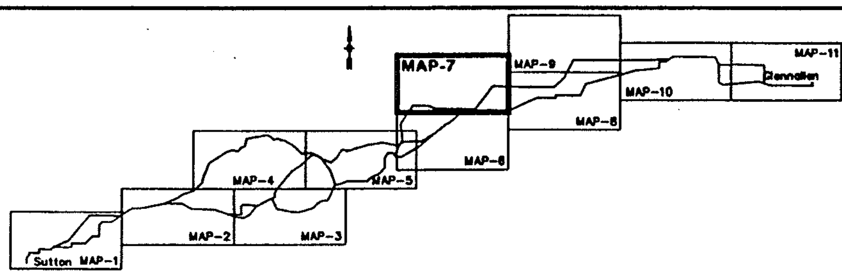
STUDY ROUTE ALTERNATIVES MAP-5 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.86)
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

SCALE: 1:63,360

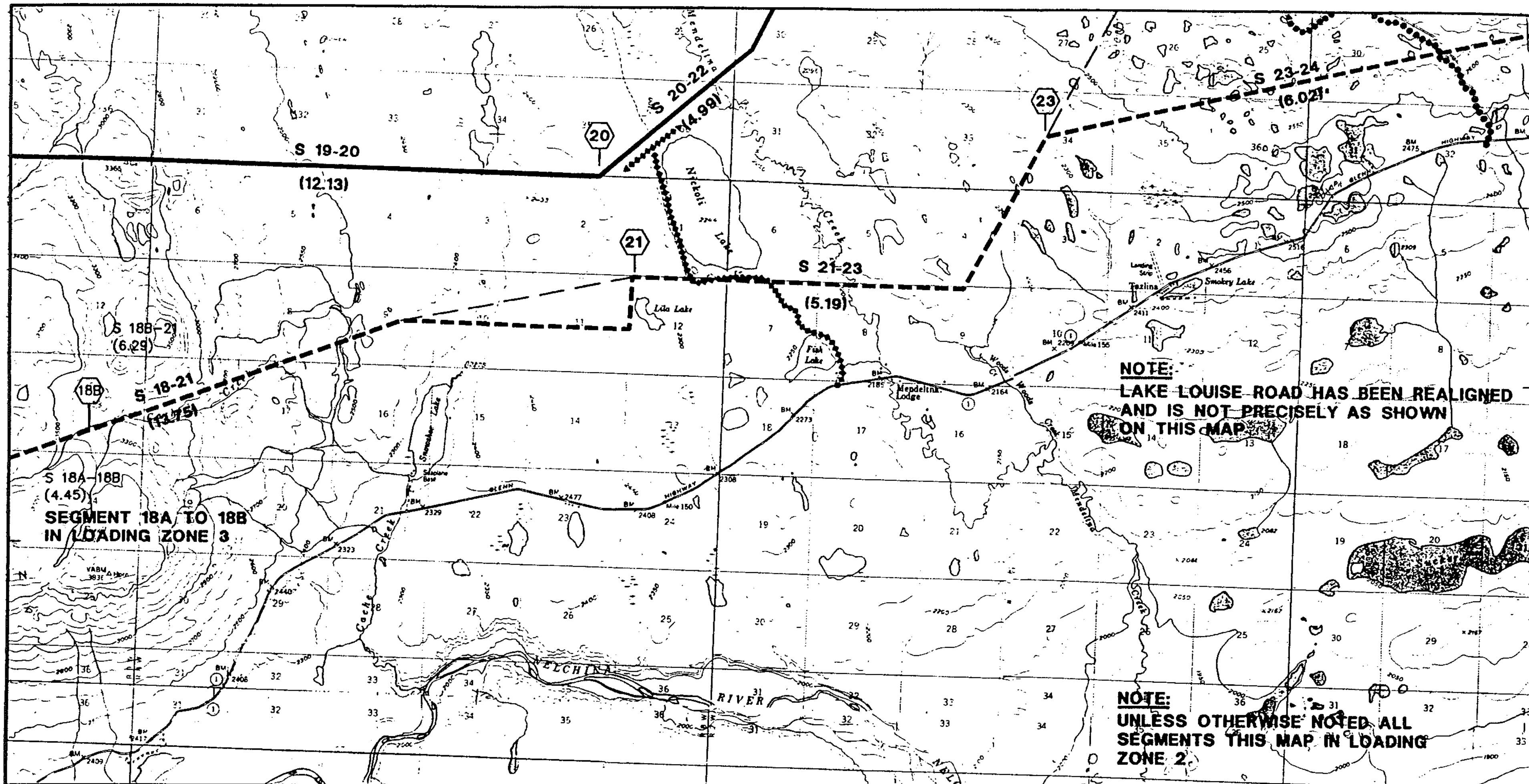
ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

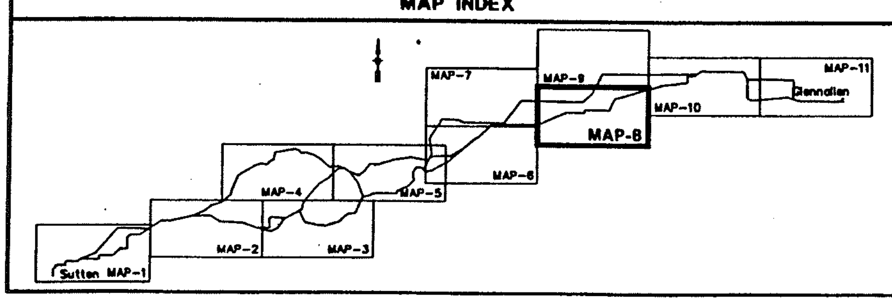
STUDY ROUTE ALTERNATIVES MAP-7 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.66)
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

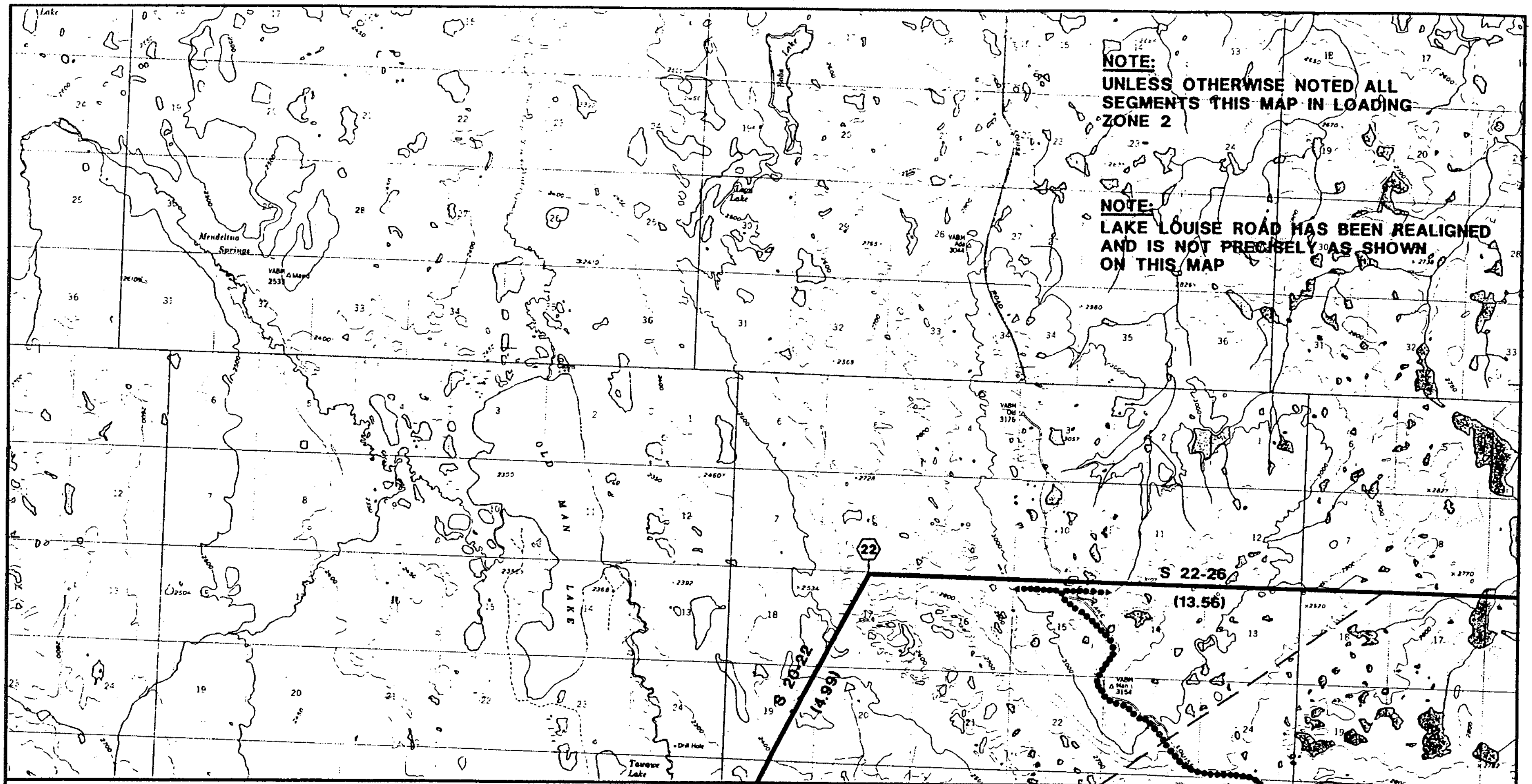
SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

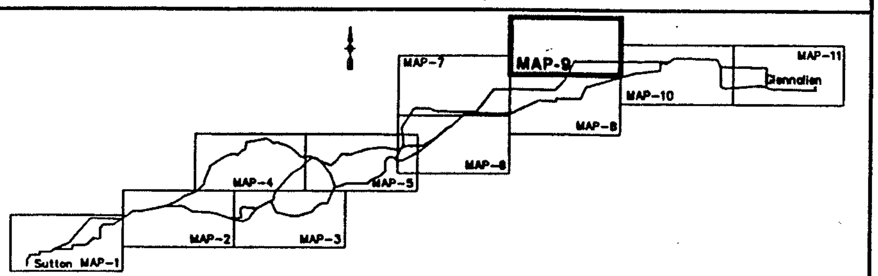
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES
MAP-8 OF 11 MAPS
APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2 (S 1-2)
- MILEAGE BETWEEN POINTS IN ( ) (5.56)
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

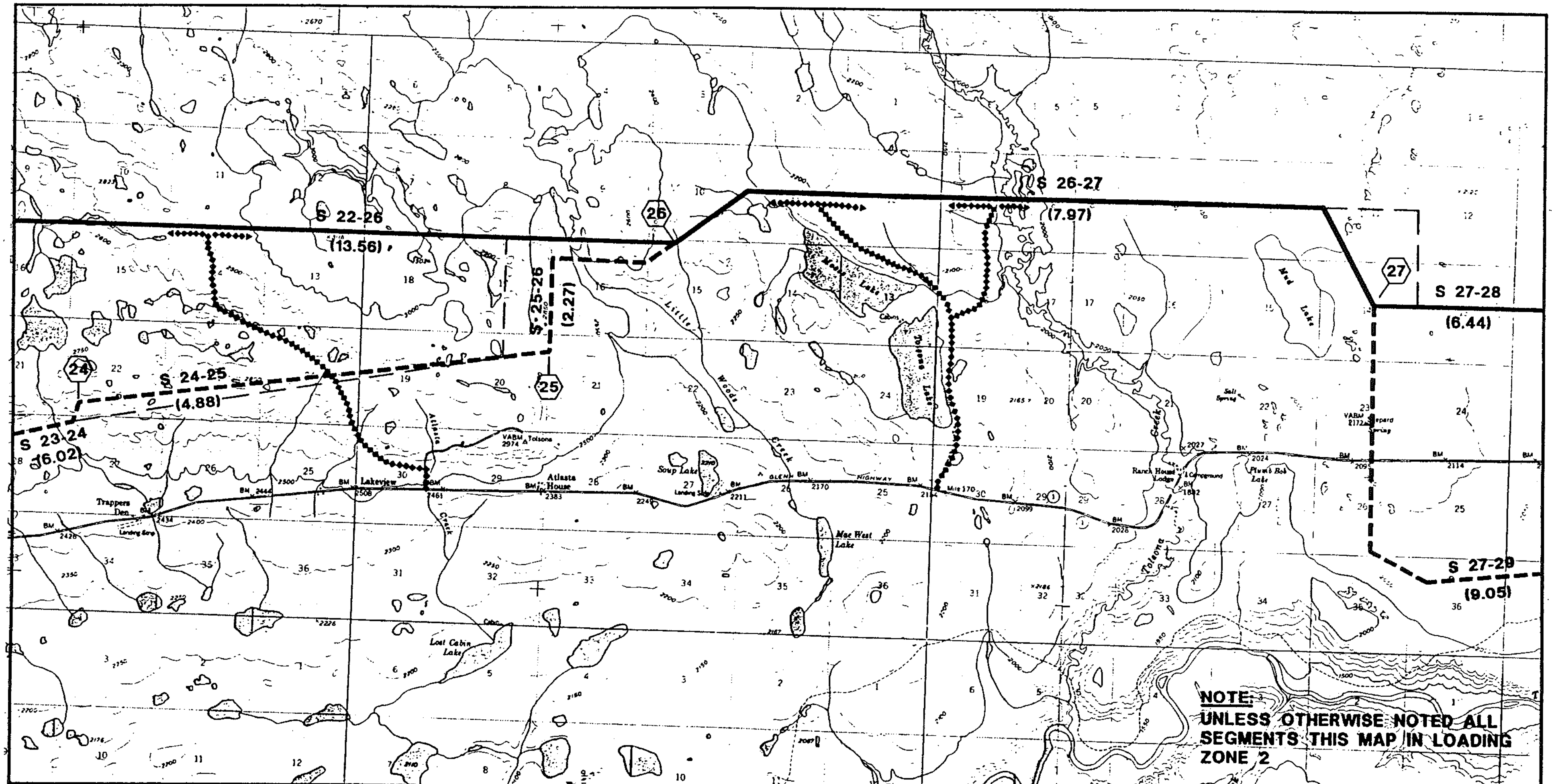
0 — 1 MILE
SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

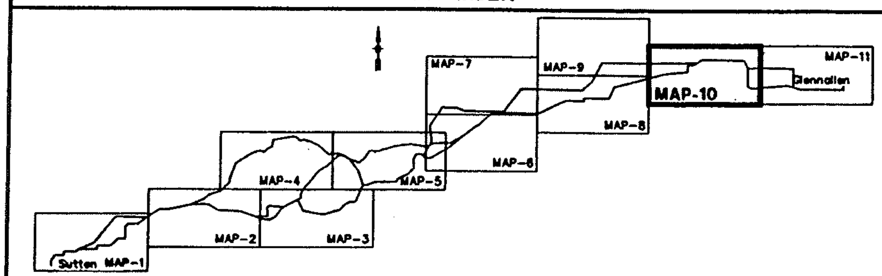
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES
MAP-9 OF 11 MAPS
APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- (1) S 1-2 (2) SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2
- (5.66) MILEAGE BETWEEN POINTS IN ( )
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

0 — 1 MILE

SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

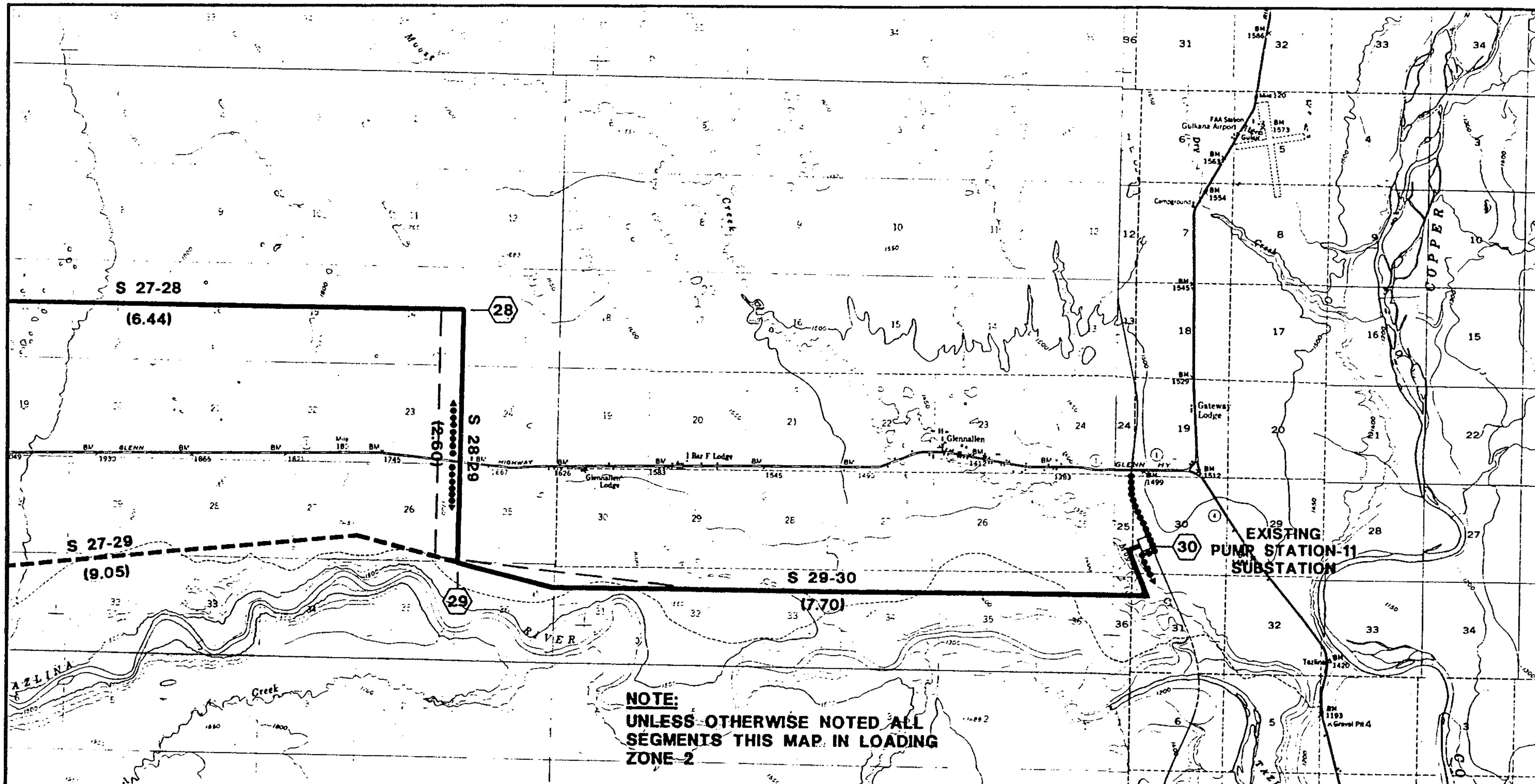
COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES

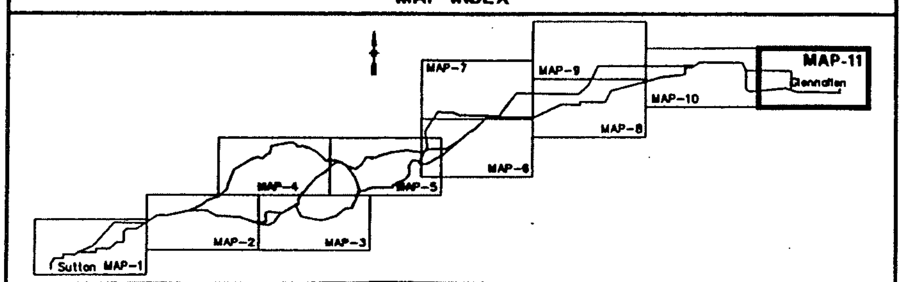
MAP-10 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES



MAP INDEX



LEGEND

- ROUTE ALTERNATIVE D
- ALTERNATIVE ROUTE SEGMENTS
- POSSIBLE ROUTE MODIFICATIONS
- EXISTING SUBSTATION
- PROPOSED NEW SUBSTATION
- (1) S 1-2 (2) (5.88) — SEGMENT DESIGNATION S1-2, i.e. BETWEEN POINTS 1 AND 2; MILEAGE BETWEEN POINTS IN ( )
- KNOWN AVAILABLE ACCESS TO ROW
- SOME POSSIBLE EXISTING ACCESS ROUTES MAY REQUIRE EXTENSION/UPGRADE

N

0 — 1 MILE

SCALE: 1:63,360

ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

STUDY ROUTE ALTERNATIVES

MAP-11 OF 11 MAPS

APRIL 1994

R.W. BECK AND ASSOCIATES

FEASIBILITY DESIGN - TRANSMISSION LINE

A. SYSTEM CONFIGURATION OPTIONS

There are several basic options for constructing an Intertie from an interconnection with MEA to CVEA. These options are discussed below.

1. Voltage Selection for the Intertie

The legislative authorization for a CVEA Intertie specified a line rating of 'at least 138 kV.' The project studied in this feasibility study is for a 138-kV line to serve only CVEA's long-term power needs. Future upgrading of the line to 230 kV was not considered. To upgrade the line to 230 kV (or higher) for use as a second Anchorage-Fairbanks intertie in an expanded Railbelt system would require (1) essentially completely dismantling the 138 kV line and constructing a new 230-kV line, and (2) reevaluating ROW width and probably acquiring additional ROW and renegotiating easement agreements.

The MEA 115-kV and CVEA 138-kV systems are voltage incompatible and an autotransformer is required to mate the systems. The auto could be located at either end of the Intertie, but higher losses and maybe overall higher life cycle costs for a 115 kV line make it preferable to locate the auto on the MEA system and operate an Intertie at 138 kV. This voltage level is adequate to serve the assumed long term power needs of the CVEA system, but it is not adequate to serve as a link to other systems beyond CVEA as might be desirable in the context of regional network planning. Power Technologies, Inc. (PTI) has expressed the preliminary opinion that a 138-kV Intertie rated at 80-100 MW for future use as a link in a second Anchorage-Fairbanks Intertie is feasible. However, the use of 556 Dove or 605 Teal would lead to unacceptable voltage drop, on the order of 18% just to Glennallen of which about 5%-6% is pure resistive drop. This would require substantial reactive compensation probably in the form of a static VAR compensator. No detailed study of this scenario was undertaken for the Intertie.

2. Location of the Autotransformer on MEA System

The 115/138 kV autotransformer could be located logically in any one of three places: at the existing MEA O'Neill Substation in Sutton, at a new substation fed from the 115 kV O'Neill Tap Line, or at the O'Neill Tap point.

Location of the autotransformer in the existing O'Neill Substation has few advantages other than existing right-of-way (ROW) and easement. Considerable expansion of the substation would be required while maintaining service to Sutton. To avoid working the substation hot a mobile substation could be used to maintain service. However, since the existing substation is located in a residential zone between two existing homes off Jonesville Road, selecting a getaway route for an Intertie is very restricted and could engender increased public opposition. This option was selected for study in [1].

The Mat-Su Borough Planning Commission proposed, and we support, use of a new substation located on a borough parcel about 0.7 mile west of O'Neill adjacent to the O'Neill 115 kV Tap Line.

The autotransformer could also be placed at the O'Neill Tap point. This would require the uprating of the tap line to 138 kV operation and replacement of certain equipment at the O'Neill Substation. Increasing voltage level could also require modification of easement agreements and lead to further public opposition. MEA has considered conversion to 138 kV.

3. Substation Switching Arrangements

The existing MEA O'Neill Substation in Sutton is fed radially via a 16-mile, 115- kV transmission line from an unbreakered, three-way tap of the Teeland-Eklutna 115-kV line. The O'Neill Tap line and the lines adjacent to the O'Neill Tap are protected by a circuit switcher at MEA's Shaw Substation, about 8 miles toward Teeland from the tap, and a circuit breaker at Eklutna, about 18 miles from the tap. Currently a fault on any of the three lines emanating from the tap will outage the O'Neill Tap line and an Intertie.

Although the lines in question have been highly reliable, a ring-bus switching station at the O'Neill Tap would enhance reliability and continuity of service to the O'Neill Tap Line and an Intertie, and it would provide MEA with increased operational flexibility. This is discussed further in Volume 2, PTI Reports. However, no switching station at the O'Neill Tap has been included in this study due to the marginal near-term benefit to CVEA.

At the Sutton interconnection with MEA, a direct, radial tap of the O'Neill Tap Line is proposed. This is the simplest and least costly practical alternative for the new substation at Sutton. This configuration would require one interrupting device, either a circuit switcher or breaker, on each side of the autotransformer. CVEA requested, and we have included, isolation and bypass switching of the interrupting devices. In view of the fact that bypassing an interrupting device compromises autotransformer protection, we would not recommend extended bypass operation. Special measures should be studied and implemented in final design to isolate the autotransformer from all sources in the event of an internal transformer fault.

In the event of a fault on any line adjacent to the O'Neill Tap, the O'Neill Tap Line will be lost. If CVEA sources are paralleled at the Pump Station No. 11 Substation bus, this would directly connect the MEA Sutton load to the CVEA system, creating up to a 1.5 MW backfeed situation. Not only would the CVEA connected sources have to pick up the CVEA load served by the Intertie prior to the loss of Railbelt power, but also this 1.5 MW load. CVEA would likely experience underfrequency problems under this scenario. Generally, the higher the proportion of CVEA load served by the Intertie the more severe will be the frequency changes due to an outage of the O'Neill Tap Line. To mitigate the severity of this interruption, reverse power and underfrequency relays would be used to sever the Intertie at Sutton or Pump Station No. 11.

Sutton load could be served by CVEA in the event the Railbelt interconnection is lost, but this would require shunt reactor compensation to limit voltage rise under the light load (1.5 MW) condition in Sutton. We have not determined the required size of reactor nor taken into account any specific provisions for serving the load in Sutton from the CVEA grid. The presence of a shunt reactor in Sutton will not correct the adverse underfrequency effects caused by islanding the CVEA system for conditions when a significant portion of CVEA load is being served over the Intertie. Before Sutton load could be served, adequate CVEA local generation resources would have to brought on line and Sutton load picked up together with CVEA load.

At Pump Station No. 11 Substation in Glennallen, a single bus arrangement is proposed with the existing power distribution transformer connected to the bus through a circuit switcher and the two lines (i.e., from Valdez and the Intertie) connected via breakers. CVEA has expressed the opinion that it does not need the additional operational flexibility of a ring-bus or main-transfer bus arrangement.

4. Future Regional Grid Concerns

The link from MEA to CVEA has been considered as part of an eventual second Intertie with GVEA through Delta Junction. These regional plans would logically include consideration of an upgrade of the MEA 115-kV system and extension of the existing 230-kV system to at least O'Neill Tap. We have not given any consideration in the feasibility study to the sizing or rating of Intertie equipment for the eventual purpose of relocating to other parts of the grid. For a discussion of possible region-wide ramifications see Volume 2, PTI Reports and the following section.

In summary then, we selected a system based on a direct tap of the O'Neill tap line, a new substation in Sutton with a single bus and a 138 kV Intertie voltage, and a single bus configuration at Pump Station No. 11 Substation.

B. SUMMARY OF PTI SYSTEM STUDIES

PTI was retained as a subconsultant by R. W. Beck to perform electrical system studies for proposed project. These studies included steady-state power flow, fundamental voltage switching response, and transient stability simulations. The system as modeled for each study included the proposed Intertie, the multi-utility Alaska Railbelt system (which includes MEA) and the CVEA system. A maximum Intertie transfer capability of 10 MW into the CVEA system was assumed in the original study analysis. A supplementary study was performed to identify the maximum transfer limits for the Intertie under steady state conditions. PTI's full report is found in Volume 2, Appendix O.

1. Original Study Conclusions

The steady-state power flow analysis showed that the interconnection of the CVEA and Railbelt systems by the proposed Intertie is technically feasible and provides acceptable steady state performance under the various load level, power transfer and generation dispatches analyzed. However, a 10 MVAR line-connected shunt reactor will be required at the Glennallen end to obtain acceptable line energizations and steady-state voltage performance. The power flow analysis also confirmed that the Intertie will only marginally affect potential MEA 115-kV system line overloading situations but will not degrade the voltage performance of that system.

Switching performance is better when the Intertie is energized from the MEA side although switching simulations concluded that the Intertie can be energized from either end provided that the reactive compensation as discussed above is in place. The reactive compensation is required to control the voltage rise due to the large amount of capacitance developed in the long transmission Intertie.

Transient stability studies confirmed that the interconnected CVEA and Railbelt system exhibits stable dynamic response for non-islanding disturbances in either system. Disturbances in the CVEA system do not significantly affect the MEA system. The Railbelt system is subject to instability across the Northern Intertie for loss of the Pt. Mackenzie-Teeland 230-kV line when transferring about 40 MW to the north. The proposed Intertie does not significantly affect the Northern Intertie transfer stability limit. However, for loss of the CVEA 138-kV lines, the Valdez area of the system responds no better than without the Intertie. The remainder of the system which remains interconnected responds significantly better. Loss of the Intertie with no power transfer creates no problems for either system.

Although connection to the comparatively robust Railbelt grid via the Intertie will make the CVEA system more immune to loss of load due to loss of internal generating units and other internal disturbances, the loss of the Intertie itself under moderate to heavy import conditions would result in a blackout or significant loss of load in the CVEA system. Moreover, interconnection to the Railbelt grid via the Intertie will expose the CVEA system to Railbelt system disturbances, specifically underfrequency situations which would follow the loss of large generating units. The magnitude of such an impact will depend on the amount and nature of spinning reserve in the CVEA system, implementation of CVEA's load shedding program, and the percentage of CVEA load provided over the Intertie prior to the disturbance.

2. Supplemental Study

PTI produced a supplemental study which analyzed the proposed Intertie and interconnected systems under future load conditions where power transfers into CVEA were maximized. This study consisted of steady-state power flow analysis only. The results of this supplemental study indicate that the Intertie can provide a power transfer capability of about 24 MW into the CVEA system under system intact conditions. Under single contingency outage conditions, power transfer capability is reduced to approximately 15 MW. These transfer limits assume that both CVEA and MEA systems loads are increased by the same percentage above present winter peak levels. The limiting factor in all cases is the steady-state voltage limit being reached on the MEA system, and to a lessor extent on the CVEA system. For the single contingency condition of an outage of the Pt. Mackenzie-Teeland 230-kV line, Intertie transfer capability is reduced to about 14 MW, based on line loading limitations in the MEA system.

In all cases, the above transfer limits are achievable only by switching off most all of the shunt reactors, including the recommended 10 MVAR unit at Glennallen, in the CVEA system. Based on the large difference between the system intact and single contingency transfer levels, operation at the system intact level would not be possible without the risk of voltage collapse following a single contingency. Operation at or above the single contingency transfer limits noted would require facilities to provide dynamic voltage control (static VAR compensators - SVC) since small load changes would result in large voltage changes under the conditions simulated. However, use of an appropriately sized SVC at the Glennallen end of the Intertie would replace the need for the 10 MVAR reactor recommended in the main study and also limit or eliminate the need to provide switching facilities for the existing 138-kV line reactor at Pump Station No. 11.

3. Discussion of Intertie Operation and SVC

It has been demonstrated in the PTI supplemental study, Volume 2, Appendix O, that maximum transfers of about 24 MW are possible for an intact system based on low voltage limits on the MEA system and assuming equal load growth on MEA and CVEA systems. If only CVEA system load growth is assumed, i.e. MEA load growth is zero, the maximum intact transfer climbs to 27 MW based on low voltage limits on the CVEA system. These limits correspond roughly with the High Case Scenario peak demand of 22 MW in year 2013. Under two scenarios of a single contingency (N-1)outage, the maximum transfer is reduced to about 13-15 MW based on line loading or low voltage limits on the MEA system.

PTI states that "*depending on the transfer level to which the Intertie would be operated, the pattern of future load growth, and minimum generation configurations to be used, one or more SVC (static VAR controller) would be required. ... switched, shunt capacitor additions would also be required on the MEA system .... in conjunction with the SVCs.*" PTI goes on to note that the MEA line loading limit of 13.7 MW for a Pt. MacKenzie - Teeland 230 kV line outage would not be corrected by the addition of capacitors or SVCs. The only corrections for this limit would be to reconductor the overloaded line or build a 230-kV line from Teeland to Anchorage.

It is clear from the PTI study that improvements to the MEA system would be required to fully use the 40 MW design transfer capacity of the Intertie. The need for certain improvements will depend on load growth on both MEA and CVEA systems. In the absence of a CVEA intertie, MEA may still have to make improvements. Given a certain level of load at which the MEA improvements are necessary and assuming MEA load grows at the same rate with or without the Intertie, the addition of Intertie load will cause MEA to make those improvements sooner than without the Intertie. Stated another way, without the Intertie MEA could defer capital expenditure for the improvements.

Standard industry planning practice would dictate that the Intertie power flow not reduce the reliability of service or quality of power on the wheeling Railbelt Utilities under N-1 outage conditions, at a minimum. This standard of practice is well-established by the North American Electric Reliability Council (NERC) and is employed by the Railbelt Utilities. For planning purposes a N-1 outage is assumed to happen at any time, usually under the most likely or restrictive conditions. If reliability and power quality are to be maintained over the largest service area possible or, conversely, if adverse impacts are to be limited, the interconnected utilities must take some appropriate action to accommodate the Intertie.

There are four basic ways in which the impacts of a N-1 outage on the MEA system could be limited and contained: (1) sever the Intertie and island the CVEA system for a given Intertie power flow and a N-1 condition, (2) implement a load shedding program on the CVEA system, (3) make improvements to certain MEA system facilities, or (4) implement dynamic voltage control via a SVC on the CVEA system. We understand that the Anchorage-Fairbanks Intertie is operated based on response (1) for a 40-MW northern transfer to GVEA.

Both responses (1) and (2) raise issues of lower reliability and power quality for CVEA customers. CVEA could limit or eliminate these effects by maintaining a substantial amount of spinning reserve capacity. However, this would be contrary to the guiding reasoning for the Intertie, namely retiring CVEA diesel generation. CVEA has advanced the position that the N-1 contingencies studied by PTI are infrequent and of short duration, thereby making a SVC unnecessary. Based on this reasoning, CVEA confirmed it is amenable to implementing responses (1) and (2) for those short periods, perhaps in conjunction with maintaining hydro spinning reserve. No costs have been assigned to maintaining CVEA hydro spinning reserve capacity or implementing a load shedding program. However, the cost of diesel generation to replace Intertie power imports is included based on an Intertie unavailability of 2% (availability of 98%).

The line loading limit of 13.7 MW in the PTI study cannot be improved without upgrading MEA facilities (Response (3)). MEA may need to consider upgrading irrespective of the Intertie, based on its own load projections. No costs have been included for upgrading MEA facilities because they would not necessarily be attributable to the Intertie.

Response (4), one or more SVCs on CVEA system, would provide the dynamic voltage control required for reliable operation of the Intertie at power flows in excess of the N-1 limits identified by PTI.

They would not remedy the overloaded line on the MEA system. Although the SVCs would improve power quality and reliability for the interconnected utilities, they are not absolutely necessary since CVEA is willing to suffer loss of the Intertie under the N-1 contingencies, taking remedial action within its own system.

C. DESIGN CRITERIA

1. Background

A Sutton to Glennallen transmission line has been studied previously on its own to serve the Copper Valley system [1], as part of the Railbelt Intertie [2], or as a link from the Railbelt to Cordova [6]. For the latter two studies the proposed line was rated at 230 kV and was intended to interconnect the Golden Valley Electric Association system or the City of Cordova to the Railbelt. The most recent study [1], prepared for CVEA by Power Engineers (PEI) covers the Sutton to Glennallen 138-kV Intertie along the same basic route as the present feasibility study. It also represents the most thorough discussion to date of design criteria in concert with the current operating and maintenance desires of CVEA.

In [2] the capital cost of the complete second Railbelt Intertie at 230-kV from Palmer through Glennallen to Delta Junction was estimated at $156 million in 1989 dollars and was subsequently judged to be too expensive to pursue at the time of the study. The scope of the present feasibility study requires only consideration of a 138 kV transmission line to serve the needs of CVEA without regard for possible future use as a link in a regional network despite demonstrations that a second Railbelt Intertie would have definite regional electrical system performance advantages [2]. A line designed for 138 kV operation and with a conductor sized only to serve a 40 MW projected CVEA load (i.e., 556 ACSR Dove or similar) would rule out effective upgrading to serve as a link in a wider network without essentially completely reconstructing the line. Further studies would be required to verify that 138 kV is or is not suitable for a second Intertie to GVEA. No computations were made to predict the impact a 90 MW flow would have on operating temperature.

We were initially directed by the Authority to develop a basis of feasibility design which would provide a level of reliability for the Intertie comparable to other lines in Alaska. In agreement with the Authority, we took [1] as a reasonable starting point for the basis of design.

A thorough review of [1] was conducted. To supplement our firm's experience, the Intertie was discussed with the engineering and operations staff of CVEA, MEA, GVEA and AEA as well as other transmission design engineers familiar with Alaskan conditions. Meteorological data was assembled from [6] and national or state organizations. Computations were performed as necessary to confirm or modify design assumptions in [1].

The culmination of this effort was a draft basis of feasibility design which was circulated to members of the Technical Review Committee, comprised of representatives from Railbelt Utilities, the Authority, and CVEA, prior to a technical review meeting (TRM) held in Anchorage on July 6, 1993. The meeting proceedings were recorded, transcribed, summarized and distributed to participants for comment. The meeting summary is included in Appendix E.

Based on results of the TRM, we revised some basic design criteria and assumptions. In the remainder of this section we present the basis of feasibility design.

2. Project Location

The Sutton to Glennallen 138-kV Intertie will originate in Sutton at a new substation located approximately 0.7 mile west of the O'Neill Substation on a parcel owned by the Matanuska-Susitna Borough. The line will terminate and interconnect with the CVEA system at the Pump Station No. 11 Substation, currently owned by AEA but operated and maintained by CVEA , located adjacent to the Alyeska Pipeline in Glennallen about one mile south of Glenn Highway.

The Intertie alternative routes will principally follow combinations of the Matanuska River Valley, Boulder Creek, Caribou Creek, Hicks Creek, Squaw Creek, and Alfred Creek before crossing into the Copper River Basin where the line will run generally parallel to the Glenn Highway. Refer to base maps 1 through 11 at the end of Section III for the routes.

For most of the routes study segments, elevations are 500 to 2,500 ft. In the mountain passes, elevations will increase to nearly 5,000 ft and will require consideration of more severe loading criteria. The Intertie would be approximately 135 miles in length and would be approximately located at latitude 62 degrees north and longitude 145.5 to 148.5 degrees east.

3. Electric Loading

The Intertie will be designed for the ultimate transfer of 40 MW at 0.90 lagging power factor (receiving) at 138 kV. As mentioned earlier, no consideration was given to providing for higher transfer levels as part of a second Railbelt Intertie.

The basic conductor for the Intertie was initially designated by others [1] as 556 kcmil 26/7 ACSR (code name "Dove"). The selection of 556 Dove was based largely on CVEA stocking considerations. However, based on design loading conditions and preliminary computations, alternative conductors with strength and sag advantages should be considered for the potential of significant project cost benefits. Alternative conductors include 556 Dove with an extra-high strength steel core, standard 605 and 636 kcmil sizes of ACSR with 30/19 stranding (i.e., higher steel content stranding), 605 kcmil size of steel-supported aluminum conductor (SSAC™), ACSR/T2Linnet, and Dove ACSR/SD self-damping conductor.

We performed detailed computations and compared the effects of using 556 Dove ACSR, 605 Teal ACSR, 605 Teal ACSR/EHSS, 556 Dove ACSR/SD, 2 x 336 T2Linnet ACSR/T2, 605 Teal SSAC, and 37 No. 9 Alumoweld. The results of this comparison are given later in this Section. In summary, we recommend, as the most appropriate conductors, 605 Teal ACSR in Loading Zones 1, 2, and 3 and 37 No. 9 Alumoweld in Loading Zone 4. However, the range of line unit cost variations among Dove, Teal and T2Linnet was not significant for most cases, and a full optimization study in final design should determine the optimal conductor selection.

Computations for 556 Dove, based on a pure radial transfer of 40 MW, 0.90 power factor lagging (receiving end conditions), indicate about 3.8% power losses and a voltage drop of about 5.8%, which are acceptable for the feasibility study. For the same loading conditions, losses for 605 Teal are 3.6%. System studies were based on 556 Dove and will provide more definitive values for losses and system performance under steady state heavy and light loading plus transient behavior. See Volume 2, Appendix O, PTI Report.

4. Ampacity

Reference [1] proposed developing ampacity ratings and maximum operating temperature based on (1) maximum MVA transfer rather than arbitrary standard values such as 75°C or 100°C; (2) maximum ambient temperatures 90°F (32°C) summer full sun and 50°F (10°C) winter with no solar input, i.e., cloudy; and (3) windspeed at 2 feet per second (fps), coefficient of absorptivity of 0.55 and coefficient of emissivity of 0.5. Maximum operating temperatures of about 110°F in summer and less than 60°F in winter for 40 MVA loading were predicted. Recognizing that CVEA is currently a winter-peaking utility, [1] states that future consideration could be given to reducing the MVA basis for the summer ampacity rating, but that the recommendation is to use 110°F as the maximum design conductor operating temperature for clearance determination. CVEA later indicated that fish processing load may eventually create a summer-peaking scenario.

Actual maximum MVA loading should be the basis for determining maximum operating temperature in accordance with the NESC. We verified that the ambient temperature assumptions in [1] are reasonable. The value of windspeed of 2 fps (2.9 mph) is a commonly-used and accepted number in the industry and we have no reason to question its use in [1]. However, it is now generally thought that the 2 fps value is on the conservative side (i.e., lower than typically occurs) and a meteorological study could be requested to recommend an average value of windspeed which might be different and serve to reduce operating temperatures, especially in the Copper River Basin area.

The use of 110°F as a maximum operating temperature, however, would not be in compliance with NESC Rule 232 which requires a minimum of 120°F for the application of Rule 232.

For some of their length, most line route segments follow valleys which may tend to channel wind parallel to the line with reduced cooling effect[3]. The assumptions of 0.55 for solar absorbtivity and emissivity are typical of new, unoxidized aluminum conductors. The line will be in service many years and values for a typical blackened conductor, 0.95 for solar absorptivity and 0.91 for infrared emissivity, would appear appropriate for a check.

We computed maximum operating temperatures for three conductors and four scenarios as shown in Table IV-1.

Table IV-1
Conductor Operating Temperatures (1)(2)

	WINTER 10°C *Wind E-W*	SUMMER 32°C *Wind E-W*	SUMMER 32°C *Wind N-S*	SUMMER 32°C *Wind E-W / Aged Conductor*
Teal 605 ACSR(3)	24.5°C (76°F)	55.8°C (132°F)	45.5°C (114°F)	61.0°C (142°F)
Dove 556 ACSR(3)	24.9°C (77°F)	56.1°C (133°F)	45.5°C (114°F)	61.1°C (142°F)
37 No. 9 AW(4)	35.3°C (96°F)	67.0°C (153°F)	48.9°C (120°F)	69.6°C (157°F)

(1) Line current is 170 amps, latitude 62 N, longitude 147 E, summer date July 4, time 15:00 PST, winter date January 1, time 13:00 PST.
(2) Coefficient of solar absorbtivity is 0.55 and coefficient of infrared emissivity is 0.50, except for aged conductor which uses 0.95 and 0.91, respectively.
(3) Elevation is 2,500 ft above sea level, windspeed 2 ft per second.
(4) Elevation is 4,500 ft above sea level, windspeed 3 ft per second.

Based on the results in Table IV-1, we will assume for the feasibility study a maximum operating temperature of 150°F (66°C) for 556 Dove ACSR, 605 Teal ACSR and other ACSR-variant conductor types. For reference we also include temperatures for a 37 No. 9 Alumoweld conductor which might be used in the Chitna Pass area. The maximum operating temperature for this conductor will be chosen as 160°F (71°C). We note that a maximum temperature of 120°F where prevailing winds are north-south and 135°F where they are east-west could be considered for some reduced sag benefits in final design.

The TRM did not address operating temperature.

5. Weather Data

Weather data is critical for formulating reasonable physical loading criteria. Most critical is information on ambient temperatures, windspeed and direction, ice, snow and frost accumulation and densities, snow pack, and isokeraunic level (i.e., thunderstorm activity) for lightning protection design. Weather data for the Intertie corridor is very limited. This situation is complicated by micro-climates which can create very severe and special loading conditions.

Major sources of basic weather data measurements are the Alaska Climate Summary (ACS), the Western Regional Climate Center (WRCC, Reno, Nevada), and the National Climate Data Center (Asheville, North Carolina). In addition, reference [3] provides meteorological analysis of limited weather data for the Palmer-Glennallen corridor in the Matanuska River Valley and parallel to the Glenn Highway and develops detailed recommendations for extreme loading conditions [see Part e. below]. Firsthand observations by local utility workers and line designers are also invaluable for selecting extreme loading conditions. The TRM addressed, in-depth, the issue of extreme ice/snow and wind loading.

Minimum and maximum ambient temperature data were obtained for weather stations at Palmer, Sutton, Gunsight Mountain, Snowshoe Lake, Eureka, Little Nelchina Road Camp, Tahneta Pass, Glennallen, and Gulkana from the WRCC. This basic information was used to evaluate the appropriateness of conductor operating temperatures and ambient conditions under different loadings.

a. Extreme Windspeed

Recorded values of 70-75 mph at Glennallen in 1992 and 115 mph in Palmer in 1979 were cited in [1]. The consensus opinion of people familiar with the area, including the Anchorage National Weather Service, was that the line route can be a "very windy place." The ACS provides no wind data of significance. One fastest mile sample reading was obtained for Gulkana and converted to 50-year and 100-year recurrent interval wind speeds or 91 mph and 100 mph respectively. Reference [1] concludes that an extreme 100 mph windspeed is reasonable and should be used. PEI further suggest that reductions in the design wind speed for the shielding effects of trees and terrain can be considered in final design.

An extreme windspeed of 100 mph is generally in agreement with meteorological analysis of the corridor [3], which estimated a maximum one-minute 75-year windspeed of 89 mph and maximum 5-second 75-year gust windspeed of 121 mph. These maxima were predicted for a portion of the corridor near Sheep Mountain and Lions Head. The wind channeling in this area is high and similar loads could be expected in back country valley routes. Weighted averages of the 75-year windspeeds for the entire length of the corridor were calculated to be 75 mph for the one-minute windspeed and 103 mph for the 5-second gust windspeed.

We will use an extreme windspeed of 100 mph applied to horizontal spans and a gust windspeed of 120 mph applied to the structure only for most of the Intertie, Loading Zones 1, 2 and 3. Shielding effects of trees and terrain may be possible for transverse winds in certain locations and this is considered in detail in [3]; in the absence of a detailed meteorological analysis for the present routes, however, shielding effects will not be considered in this study. Higher, channeled winds may be experienced when crossing major streams and creeks. Longitudinal winds would be largely unshielded but their loading effect on wires is also reduced by the shallow impact angle.

We will use an extreme windspeed of 125 mph applied to horizontal spans and a gust windspeed of 150 mph applied to the structure only for the Chitna Pass route (Loading Zone 4). Extreme winds of 100-175 mph have been used for design of several high, exposed line segments in Alaska, e.g., 175 mph for Glennallen-Valdez line in Thompson Pass and 200 mph at Snettisham.

Since extreme wind loading typically controls the design and sizing of tangent structures, final design should explore the opportunities to rationally reduce extreme wind loads. Such opportunities include the shielding effect of trees, the direction of prevailing winds and perhaps the dependence of the wind pressure coefficient on elevation and temperature [5, Table 2.1-1]. A meteorological study is also recommended.

b. Ambient Temperature

Temperature records for Gulkana, Snowshoe Lake, Tahneta Pass, and Sutton, are listed [1]. The Gulkana station recording period is the longest (1942-1987) and shows the most extreme ambient temperature values (-65°F record low and 91°F record high).

Several ambient temperatures are of interest: maximum summer temperature for determining maximum operating temperature, extreme minimum temperature for studying uplift situations, ambient temperatures during extreme loading conditions, and the annual average minimum temperature (AAMT) used with tension limits to control aeolian vibration for certain conductor types.

The selection in [1] of maximum ambient temperature of 90°F in summer for computation of maximum conductor temperature is appropriate. Since CVEA is currently a winter-peaking utility it appears unlikely that the maximum operating temperature will be reached thus giving the Intertie substantial thermal margin.

A single cold temperature of -60°F for the entire project is recommended in [1]. This recommendation is based on the fact that the cold temperature tension limits will not control sag-tension behavior in view of the extreme ice loadings, except in very short spans where tensions at -60°F should be checked against limits. The selection of -60°F as the extreme minimum cold condition is appropriate for the line and will affect only structure locations and types in uplift situations, e.g., in the bottom of valleys and toes of slopes.

An AAMT is used essentially for aeolian vibration tension limits and [1] selects -25°C (-1°F), based on a 10% coldest temperature criterion. This value appears appropriate for the western portion of the line but not for the back country routes and eastern portion based on estimated minimum temperatures in Table IV-2. For this feasibility study we will use an AAMT of -32°C (-25°F) for the ACSR conductors. Note that SSAC, ACSR/SD, and ACSR/T2 conductor types have inherent self-damping characteristics which do not require application of the AAMT limits.

Table IV-2
Average of Annual Minimum of Monthly Average
of Daily Minimum Temperatures
(degrees Fahrenheit)

Station	Years	Highest/Lowest Annual Minimum	Mean	Std Dev	Mean-2SD
Sutton	1978-1992	16.4/-11.3	2.8	7.8	-12.8
Palmer	1961-1992	12.5/-11.4	-0.6	6.3	-13.2
Gunsight	1966-1974	-20.9/-40.4	-29.7	5.7	-41.1
Eureka	1957-1968	10.5/-2.1	4.3	4.1	-3.9
Snowshoe	1963-1992	-9.7/-35.8	-23.1	6.2	-35.5
Glennallen	1965-1992	-1.68/-37.7	-23.2	9.1	-41.4
Gulkana	1961-1992	-0.3/-36.5	-19.7	8.4	-36.5

c. *Snow Ground Cover*

Reference [1] cites maximum snow accumulation data from the ACS for Gulkana (48"), Snowshoe Lake (36"), Tahneta Pass (48"), and Sutton (36"). A design value of 48 inches of snow ground cover was chosen for the determination of NESC clearances to grade. The need to consider greater snow cover or clearances in areas of high snow machine usage is prudently mentioned in [1].

We will use 48 inches of snow cover as the basis for the feasibility study for non-back country areas (i.e., Loading Zones 1 and 2). We will assume a snow cover of 60 inches in back country areas (i.e., Loading Zones 3 and 4).

d. Ice and Snow Accumulation

The TRM addressed extreme combined ice/snow and wind loading at length. The selection of ice and snow loading criteria for transmission line design in Alaska has been the subject of much discussion and study over the past few years. Engaging meteorological consultants to develop recommended extreme loadings has been common in recent transmission line design and failure analysis work in Alaska. We recommend that a meteorological consultant be hired to develop such recommended loadings prior to final design.

Very large build-ups of snow and underlying ice have been observed on several lines including the Healy-Willow 345-kV Transmission Line, the Glennallen-Valdez 138-kV Transmission Line, and the Tyee Lake 138-kV Transmission Line in Southeast Alaska. Each of these lines has experienced excessive sags due to accumulated ice and snow, but no outright cascading failures due to ice build-up.

On the Tyee Lake Transmission Line 556 Dove section across Vank and Woronkofski Islands, excessive sags have led to conductor-snow/ground contact and low-level ground faults [4]. On the Healy-Willow line with 2-954 ACSR conductors, contact with 15' tall trees and severely reduced highway clearances have been experienced [8]; ice has also been observed to bridge the subconductors at spacer locations. CVEA personnel reported that 5"-6" diameter snow at unknown density over 1" radial ice were observed on the CVEA Glennallen-Valdez line just north of Thompson Pass with no failures. Extreme diameters of heavy ice and snow accumulation of up to 18 inches and typically 4-12 inches have commonly been observed on Alaskan lines but efforts to measure accumulation have been only partially successful.

MEA designs its distribution and transmission lines to NESC Heavy and reportedly has encountered no failures[1]. CVEA also designs its distribution lines for NESC Heavy and has also experienced no failures to date.

In [1] a value of 1" of radial ice was selected for design extreme ice loading, reasoning that it is better to accept the risk of greater ice loading and consequent failures than the certainty of increased capital costs for improved reliability. This is a trade-off made for virtually all lines designed for areas where extreme loading is unknown or where the cost to withstand infrequent but severe loading (e.g., hurricanes, tornadoes) would be exorbitant.

A 1" radial ice extreme loading is consistent with criteria selected for several lines in Alaska, including loading zone II for the Glennallen-Valdez line extending from Pump Station No. 11 south to mile 70. The reliability of this line segment has been excellent in its 8-9 year service life. We note that this section is parallel to prevailing winds in the Copper River basin, whereas an Intertie would be perpendicular to the prevailing winds.

Reference [5] cites recommended procedures for assuming ice loadings based on maximum measurement or observations in the absence of statistical data. Specifically one suggested procedure would assume a mean ice radial thickness of 0.60 times the maximum observed thickness with a standard deviation of 0.40 times the mean [5]. Table IV-3a below gives several examples of how this methodology would apply to observations. The two-standard deviation assumption is only slightly greater than the maximum observation. Assuming a Gaussian distribution the one-standard deviation radius would have an annual probability of occurrence of 15.9%, corresponding to approximately a 6-year mean recurrence interval, while a two-standard deviation radius would have a 2.2% annual probability, corresponding to a 50-year recurrence interval. A probability of occurrence for a given project lifetime can be computed and is shown in Table IV-3b.

Table IV 3a
Extreme Ice Assumptions in the Absence of Statistical Data
(All values of radial ice in inches)

Maximum Observed Ice Radius (inches)	**Estimated Mean** (inches)	**Calculated Std. Dev.** (inches)	**One Std. Radius** (inches)	**Two-Std. Radius** (inches)
0.50	0.30	0.12	0.42	0.54
1.00	0.60	0.24	0.84	1.08
1.50	0.90	0.36	1.26	1.62
2.00	1.20	0.48	1.68	2.16
2.50	1.50	0.60	2.10	2.70
3.00	1.80	0.72	2.52	3.24

Table IV-3b
Probability of Occurrence of 1-SD and 2-SD Ice Loadings

Project Lifetime (years)	**Probability of 1 SD Ice**	**Probability of 2 SD Ice**
5	0.5785	0.1084
10	0.8223	0.2051
15	0.9251	0.2913
20	0.9684	0.3682
25	0.9867	0.4367
30	0.9943	0.4978
35	0.9976	0.5523
40	0.9990	0.6008
45	0.9995	0.6441
50	0.9998	0.6827

For this feasibility study we will assume ice and snow loadings as given in Table IV-5.

e. Meteorological Research, Inc. Technical Report

Reference [3] contains a detailed analysis of limited available weather information and develops specific extreme loading criteria for the Palmer-Glennallen corridor, basically following the Glenn Highway. One of the principal authors of [3] was contacted during the present study to discuss the appropriateness of the findings in [3] to the route alternatives under consideration in this study. He advised that the findings in [3] are not valid for the route alternatives under study but that they are still probably valid for the routes studied in 1982. Despite its limitation to the 1982 routes, the findings and recommendations of this report are discussed in this section.

Two climatic zones are identified. The western portion lies in a transition zone through the Matanuska River Valley, characterized by a mixture of cool, moist weather and cold, dry weather. The eastern portion lies in the continental zone through the Copper River Valley, characterized by cold, dry weather.

A tabulation for twelve weather stations indicates maximum ambient temperatures of 90°F for Palmer and Glennallen, 91°F for Gulkana, and 85°F for Eureka and Snowshoe Lake. This corroborates the selection of 90°F for maximum ambient temperature.

A tabulation for the same twelve weather stations indicates minimum ambient temperatures of -60° to -65°F in the Copper River Valley and -35° to -44°F from Palmer to Eureka. This corroborates the selection of -60°F for extreme cold temperature.

A tabulation for the same twelve weather stations indicates a mean annual snowfall of 65 to 68 inches on the western end of the Matanuska Valley, 41 to 53 inches between Snowshoe Lake and Gulkana in the Copper River Valley, and 117 inches in Eureka. This would seem to corroborate the selection of 48 inches of ground snow cover for clearance checks. However, the value of nearly 10 ft of total annual snowfall in Eureka indicates a higher value of snow cover would be appropriate for the areas of Eureka and back country routes. We will use a snow cover of 60 inches for clearance checks in these areas.

Analysis of maximum one-minute hourly winds (e.g., extreme wind values) at 30 ft above ground showed 50-year return period windspeeds for Gulkana of 59 mph, Sheep Mountain 69 mph and Palmer 74 mph. The direction of extreme winds was generally NNE or SSE for Gulkana, S and SSE for Snowshoe Lake, and NE or ENE for Sheep Mountain and Palmer respectively. Extreme wind occurrences are distributed evenly from fall to spring for Gulkana but are somewhat concentrated in the winter months November to March for Sheep Mountain, Palmer and Snowshoe Lake. This data indicates that extreme winds will generally be transverse to the Intertie route east of Eureka and longitudinal to the route in the valleys west of Eureka, and that extreme winds are very likely to occur in winter. MRI suggests that a reduction of windspeed up to 20% in the "lee of stands (of spruce)" is possible and that larger reductions of 20-50% are possible in denser, taller forest stands. The value of 20% should be used, according to MRI, where the transmission line cleared ROW is parallel to the prevailing winds.

The MRI report discusses span factors which reflect the span coverage of winds of different durations. For instance, gusts will not typically affect more than 100 ft of span while steady one-minute winds will affect up to 1,000 ft. Mountainous terrain is recognized as creating special wind turbulence.

The report culminates with tables giving 25-, 50- and 75-year return period values for one-minute wind speeds, 5-second gust speeds, mixed icing loads, glaze icing loads and rime icing loads by proposed line segment. The windspeed values are adjusted for exposure, elevation and for a common height above ground of 30 ft. Total transverse wind load on iced conductors is included. Wet snow occurrences were cited as being too infrequent and short to result in any significant accumulation. We reverse-computed assumptions for coincident wind loading embedded in the 50-year table and derived Table IV-4 which summarizes the maximum MRI-recommended 50-year loadings for the 1982 route.

Table IV-4
Reduction of MRI 50-Year Data for Intertie Study

Loading Condition	West	East	Maximum	Glaze Ice Equivalent
EXTREME WIND				
One-minute mph	74	71	85	NA
GUST				
5-sec mph	101	98	115	NA
MIXED ICE (1)(2)(3)				
Radial inches	0.75	1.00	1.00	0.573
Weight lb/ft	0.68	1.05	1.05	
Wind mph	5	10	10	12
RIME ICE (1)(2)(3)				
Radial inches	NA	NA	1.50	0.893
Weight lb/ft	NA	NA	1.98	
Wind mph	NA	NA	40	48
GLAZE ICE (1)(2)(3)				
Radial inches	0.25	0.25	0.25	0.25
Weight lb/ft	0.36		0.36	
Wind mph	15		18	

(1) Weight of ice loading is weight of ice only over Dove 556 ACSR conductor.
(2) All ice loadings considered at 0°F.
(3) Rime and mixed ice at 0.4 g/cc or 25 pcf and glaze ice at 0.9 g/cc or 56 pcf.

MRI comments that mixed icing events (i.e., rime and hoarfrost) are the result of light winds and dense fog conditions and that significant accumulations can be expected at elevations below 2,000 ft in the Matanuska River Valley. In the Copper River Valley significant rime ice accumulations are expected at elevations above 3,300 ft, which would also apply to back country areas in our opinion, and that significant mixed icing events will occur in the basin from Tolsona to Glennallen, at elevations below 2,500 ft.

No recommendations are given for assumed ambient temperatures during ice and wind loading.

MRI recommended low windspeeds for icing events based on the line being generally parallel to prevailing winds in the Matanuska River Valley and based on weather records in the Copper River Valley. We note that observed extreme loadings in the region have apparently exceeded MRI findings.

6. Design Loadings and Loading Zones

The Intertie corridor spans at least two distinct climatic zones, the Matanuska River Valley and the Copper River Basin. Moreover, several route segments are located in more remote high elevation back country valleys which must be expected to present more extreme loading conditions than either distinct climatic zone. Pursuant to the TRM, four loading zones were selected. These are depicted in the base maps at the end of Section III and listed along with associated route segments in Table III-1. Table IV-5 summarizes the design loading conditions for all loading zones which will be used in the feasibility study.

Table IV-5
Assumed Study Design Criteria

LOADING CONDITION	**Parameter**	**Units**	**Loading Zone 1**	**Loading Zone 2**	**Loading Zone 3**	**Loading Zone 4**
NESC Heavy	Radial Ice	in	0.5	0.5	0.5	0.5
	Wind speed	mph	40	40	40	40
	Wind PSF	lb/sf	4	4	4	4
	Temperature	deg F				
Extreme Ice	Radial Ice	in	1	1.5	1.5	2
	Temperature	deg F				
Extreme Wind	Wind speed	mph	100	100	100	125
	Wind PSF	lb/sf	26	26	26	40
	Gust	mph	120	120	120	150
	Gust	lb/sf	37	37	37	58
	Temperature	deg F	20	10	10	10
Extreme Combined Ice/Snow and Wind	Radial Ice	in	0	1	1.5	2
	Radial Snow	in	2.5	0	0	0
	Snow Density	pcf	30	NA	NA	NA
	Ice Equiv	in	1.704	1	1.5	2
	Wind speed	mph	20	40	40	75
	Wind PSF	lb/sf	1	4	4	14
	Wind Equiv	lb/sf	1.362	4	4	14
	Temperature	deg F	30	20	20	20
Ambient Temperatures	AAMT	deg F	-25	-25	-25	-25
	Maximum	deg F	90	90	90	90
	Mimimum	deg F	-60	-60	-60	-60
Elevation	Maximum	ft	2500	3300	4400	4900
Air Gap Structure Dims	No Wind	in	54	54	60	60
	Mod Wind	in	36	36	40	40
	High Wind	in	20	20	24	24

Loading Zone 1 extends east from Sutton to approximately Caribou Creek in the Matanuska River Valley and is generally located at elevations less than 2,500 ft above sea level (ASL). Loading Zone 2 extends east from Tahneta Pass to Glennallen in the Copper River Basin and is generally located at elevations less than 3,000 ft ASL. Loading Zone 3 includes all route segments above 3,300 ft ASL, or in remote back country valleys. The cutoff of 3,300 ft was suggested at the TRM as that maximum elevation at which CVEA has line operating experience, e.g., near Eureka. Loading Zone 4 is a 9-mile segment over Chitna Pass, reaching elevations up to 4,900 ft ASL.

7. Overload Capacity Factors and Safety Factors

The overload capacity factors in Table IV-6 will be used to size transmission line structures, guys, and anchors:

Table IV-6
Overload Capacity Factors

STEEL STRUCTURES

Loading Condition	Overload Capacity Factor		
	Transverse Wind	Vertical Load	Transverse Tension
NESC Heavy, Grade B	2.50	1.50	1.65
Extreme Loadings	1.10	1.10	1.10

WOOD STRUCTURES

Loading Condition	Overload Capacity Factor		
	Transverse Wind	Vertical Load	Transverse Tension
NESC Heavy, Grade B	4.00	2.20	2.00
Extreme Loadings	1.30	1.30	1.30

GUYS, ANCHORS AND FOUNDATIONS

Loading Condition	Overload Capacity Factor		
	Transverse Wind	Vertical Load	Transverse Tension
NESC Heavy, Grade B	2.50	1.50	1.65

Anchors will be designed for an additional safety factor of 1.3 based on calculated maximum loads. Guy strand will be selected based on not exceeding 90% of its ultimate rated strength (URS) under the above loading conditions and overload capacity factors applied.

8. Conductor Sag-Tension Limits

Conductor tension limiting conditions and limits are summarized in Table IV-7.

Table IV-7
Conductor Tension Limits

Loading Condition	Self-Damping Types	Loading Zone 1 Non-Self Damping Conductors	Loading Zones 2, 3 and 4 Non-Self Damping Conductors
NESC Heavy	60%(1)	60%	60%
Extreme Wind, No Ice	70%	70%	70%
Extreme Ice, No Wind	70%	70%	70%
Combined Extreme Loading	80%	80%	80%
Initial Unloaded Tension	35% (60°F)(1)	35% (-25°F)	25% (-25°F)
Final Unloaded Tension	25% (60°F)(1)	25% (-25°F)	20% (-25°F)

(1) NESC Rule 261 required maximum limits.

The selection of unloaded tension limits depends on the type of conductor and the estimated risk of aeolian vibration damage. For standard ACSR conductors our practice is to use reduced initial unloaded tension limits of about 20% URS at the AAMT without dampers. This is in line with REA recommendations [9]. However, this will lead to increased sags and shorter spans with an attendant cost penalty. The NESC stipulates that the unloaded tension must not exceed 35% URS under initial conditions or 25% URS under final conditions at 60°F. REA and Alcoa recommend about the same limits, 33% initial and 25% final, but at 0°F for the NESC Heavy Zone. Manufacturers have indicated that self-damping type conductors (ACSR/SD, SSAC, ACSR/T2) can use the NESC limits.

The corridor can be divided into two parts where prevailing winds are generally parallel (west of Eureka) or perpendicular (east of Eureka) to the alignment. For this study we will apply the higher NESC unloaded tension limits to all self-damping type conductors in all loading zones. For ACSR and Alumoweld conductors we will apply limits of 35% initial and 25% final at the AAMT (-25°F) in Loading Zone 1 since the prevailing wind is parallel to the alignment. In Loading Zones 2, 3 and 4, we will apply lower limits of 25% initial and 20% final at the AAMT since the prevailing wind is perpendicular to the alignment in the case of Loading Zone 2 or as a somewhat conservative assumption in the less well-known severe Loading Zones 3 and 4.

Vibration dampers would be used as needed depending on the final conductor chosen and a vibration analysis in final design.

Sag tension runs are not included due to the volume of material. A summary of sags for the various conductors is discussed under heading D - Feasibility Design Alternatives, later in this section.

9. Failure Containment and Sequence

A decision to implement a failure containment design is based on the premise that it is too costly and perhaps unreliable to design the line against any failures for any extreme loading conditions. Recognizing the possibility of severe extreme loading conditions in Alaska, failure containment is a primary concern of all experienced line designers in Alaska. Several different approaches have been taken ranging from guyed X structures designed to have their guy yokes yield under high unbalanced longitudinal load (e.g., Tyee-Wrangell) to the frequent application of longitudinally strong structures (e.g., Swan Lake).

Reference [1] discusses at length a design philosophy to contain failures and achieve a specified failure sequence based on a CVEA-stated preference that "loadings that develop high conductor tensions should result in conductor failure before structure failure." The basis for this preference is the widespread failure that occurred due to an avalanche in Thompson Ridge Pass in 1991 it is reported that the high strength 19 No. 5 Alumoweld conductor (URS 73350 lbs) used in the pass did not break during the avalanche and tore down several structures which otherwise might not have failed.

Coordinating conductor and structure failure is difficult to implement with confidence. We further agree with the rephrasing of the design requirements in [1]: "... *the failure of an element on the line should not be allowed to propagate into the failure of other elements such that the cost of the failure is disproportionate to the probability of its occurring*." Implementing this philosophy is made difficult by a lack of knowledge of the probability of extreme loading conditions. The failure containment philosophy in [1], i.e., based on the premise of accepting limited failure and containing failures by providing periodic longitudinally and transversely strong structures, is commonly used and comparatively easily implemented.

Relying on the conductor as the weak link in the system is not reliable due to the nature of ACSR stress-strain at high tensions and that other elements of the system would have to be substantially over designed to accommodate this weak link. We agree with the conclusion that depending on the conductor to fail before structures is not a practical or desirable solution, except perhaps in known, well-defined avalanche chutes.

Avalanches are a concern, especially in some back country routes. Where practical unavoidable avalanche chutes should be spanned and where not practical structures should be made "sacrificial." Strong containment structures would be used either side of known or suspected chutes or with deadend fuse links. A weak conductor could be used for passing through avalanche areas as well. Where spanning avalanche chutes with the expectation of avoiding the forces of moving rock or snow, high frontal avalanche winds should nevertheless be considered for the span.

The use of fuse links, propagation damping and containment are discussed in [1] to limit failures due to unbalanced longitudinal loads. Using fuse links will require structures with high longitudinal strength to withstand the dynamic release of conductor tension from one side of the structure and the residual longitudinal unbalance due to the remaining conductor which may or may not drop. This method should be used to prevent the conductor from exceeding its serviceable, working limit. However, if the fuse link is designed to act at or before the working limit and if the working limit is applied to reasonably probable loading conditions, nuisance failures can be expected.

Propagation damping relies basically on insulator swing and structure deflection to relieve longitudinal unbalance loads. This feature is inherent in a line with suspension strings and unguyed H-frame or guyed X-frame construction. The level of damping may be fairly well predicted for given loading cases and structure load-deflection data; typically, longitudinal unbalance due to the extreme case of a broken conductor will die out after 5-10 spans in a tangent run.

Containment relies on strong deadend structures to withstand longitudinal loads. This is the most reliable method of limiting failures due to unbalanced longitudinal loads.

The proposed failure sequence in [1], while reasonable in general, has the following shortcoming. The failure sequence specifies that conductor attachments and insulator string assemblies will be designed to withstand all load cases combined V, T and L loads with NESC load factor 2.00 (actually a strength factor of 50%, Rule 277). This factored load is then used as the basis for calculating loads on all other structure components. Application of NESC load factors to extreme loads will distort the strength requirements for the insulator string and structure components. While this imparts strength to the line it can also be costly in materials. It can also be unreliable in predicting a failure sequence.

Rather than relate all loads to NESC values, we recommend for final design a load factor reliability design approach in which ultimate loads are used in conjunction with component or line importance factors and the ultimate strengths of system components [5] to establish line performance. Design loads would be compared to NESC Rule 252 loads to verify compliance.

For the feasibility study we will not apply a detailed failure sequence or compute design loads for achieving an order of strength. Deadend structures will be applied in heavy angle situations at about one every 3.5 miles. In addition, longitudinal guying at selected tangent structures would provide intermediate strength.

10. Electrical Clearances

Electrical clearances to grade are stipulated in the NESC Rule 232. The basic clearances required by the NESC have been adjusted for voltage, elevation and design margins as given in Table IV-8 below and discussed later.

Table IV-8
Electrical Clearances (ft)

Nature of Crossing	NESC Table 232-1(1)	Clearance(2) Net Winter Loading Zones 1, 2	Net Winter Loading Zones 3, 4(3)
Railway	26.5	30.6	NA
Major Road	18.5	22.6	NA
Minor Road Driveway	18.5	26.6(4)	32.8(5)
Land Accessible to Vehicles	18.5	26.6(4)	32.8(5)
Land Inaccessible to Vehicles	14.5	22.6	28.8(5)
Water Bodies - No Boating	17.0	21.1	27.2(5)

(1) Includes NESC reference, electrical and mechanical components of clearance.
(2) Includes voltage adder of 2.1 ft and 2.0 ft for survey and construction variances.
(3) Includes adder for elevation at 3% times the voltage adder per 1,000 ft in excess of 3,300 ft, assuming 5,300 ft maximum elevation.
(4) Includes 4.0 ft snow cover.
(5) Includes 5.0 ft snow cover and 5.0 ft margin to account for structure deflection.

We will determine the above-clearances under maximum sag conditions either at NESC Heavy ice loading, i.e., 0.5 radial inches of ice at 32°F, or maximum operating temperature, e.g., 150°F for ACSR variant conductors

On studies for the Bradley Lake transmission line maximum vehicle height on snow-covered terrain was determined to be about 12 ft (Sno-Cat with antenna). Added to the 5 ft snow cover this results in a reference height of 17 ft, compared to the standard NESC reference height of 14 ft derived from state regulations limiting vehicle heights. In the clearances in Table IV-8 we have applied the NESC reference height on top of the snow cover, giving an extra margin of 2 ft clearance. This extra margin is desirable in part to account for increased sag due to structure and insulator deflection.

The substantial amount of snowmobiling in back country areas in Loading Zones 3 and 4 makes it very important to consider clearances under extreme loading conditions. The situation of very high sags in remote areas of the Tyee Lake 138-kV line (i.e., on Vank and Woronkofski Islands) cannot be tolerated on the Intertie because of the snowmobile activity. Means to provide extra clearance include shortening spans, reducing the longitudinal flexibility of structures, raising structure height, using inverted V insulator strings, and perhaps other methods. In the case of actual contact with the snow, ground fault current may be severely limited by high resistivity snow and too low to trip the line on the CVEA end. Methods to deliberately short the line to ground with interset structures or underbuilt ground wires could be used but are considered much less desirable than providing extra clearance margins. Where practical, the line should be routed away from established snowmobile routes, recognizing though that the ROW itself will be an attractive new route for some snowmobilers.

To account for the increase in sag under extreme ice loading unbalance consider the case of Teal ACSR, Loading Zone 3, and a 1,100 ft span. The sag under 1.5 inches radial ice at 0°F (43.6 ft) is 8.8 ft greater than the sag at 0.5 inches radial ice at 32°F (34.8 ft) under which Table IV-8 clearances are applied. The basic clearance to grade for Loading Zone 3 was 27.8 ft in Table IV-8 before considering structure deflection. The clearance to 5 ft snow cover would be 14.0 ft (27.8 ft-8.8 ft-5 ft) without structure deflection. A very small total deflection will yield a much larger increase in sag. For example, an increase in slack due to structure or insulator deflection of about 1 ft will lead to an increase of about 5 ft in sag. A 1 ft limit on deflection is stringent. To account for deflection, we would not recommend less than 9 ft clearance to the 5 ft snow cover under extreme unbalanced ice and therefore have added 5 ft to the basic clearance margin in Table IV-8 for Loading Zones 3 and 4.

11. Foundations, Guys and Anchors

Reference [1] proposed direct embedment of structures in granular soils and erection on driven pipe piles for structures in permafrost and muskeg locations. Pipe piles were selected in [1] due to their omnidirectional strength properties, required to match the strength of H-frame poles. H-piles were eliminated because of their typical application with the weak axis resisting longitudinal loads. PEI recommends study of other pile options with the promise of large cost savings. Rock may be encountered in Loading Zone 1 and we will assume rock-anchored foundation types for the feasibility study. A typical pile length of 20 is assumed in [1]. For the feasibility study, we will assume that X-frame structures and 3-pole structures in muskeg are supported on H-pile foundations. An active layer of 3-5 ft in permafrost areas will be assumed and pile lengths computed accordingly.

We will assume that guy anchors are driven H-piles in muskeg, driven H-piles or log anchors in granular soils or rock anchors. H-pile is assumed as 10x57, although smaller piles may suffice for tangent X-frame structures.

12. Insulator Assemblies

Polymer insulators will be assumed for the feasibility study. H-frame and X-frame structures will use outboard I-strings and a center V-string. We would recommend consideration of inverted V assemblies to limit conductor slack increase. For the feasibility study, insulator maximum working load (i.e., equal to the routine test load "RTL" of polymeric insulators) will not be exceeded under NESC Heavy loading conditions without overload factors. Because of concern over long term extreme loading effects on the strength rating of polymer insulators and the underlying assumption that the importance of this line increases with time, we will assume that under any extreme loading condition the insulators will not be loaded to more than 125% of the RTL.

13. ROW Width

There is no industry-wide standard for prescribing ROW width. The actual ROW width requirements are computed based on several criteria for a given line. Reference [9] cites a typical ROW width range of 100-150 ft for 138 kV lines.

ROW width provides for clear construction of a line, containment of energized conductors under wind conditions (e.g., blowout) and containment of structure failure, access for maintenance, removal of encroaching vegetation and danger trees, and some control over unsafe development occurring in the ROW. Conductors must not extend beyond ROW limits under wind conditions for safety reasons. This requires that wider ROW be acquired for longer spans. Recently electric and magnetic field limits have played a role in determining ROW widths and public concern over possible health effects has made magnetic fields an issue in the design and siting of an Intertie. However, no field limits are used to determine ROW width for an Intertie and no State regulations limit fields at this time. We have accepted the line routing criterion that magnetic fields in occupied structures should not be measurably greater than they would be without an Intertie, i.e., practically meaning the increase should be calculated at less than 0.1 milligauss. Because this limit is not attainable at the edge of typical rights-of-way, we sited the line at least 600 ft from known occupied buildings.

ROW width is determined by the need to contain the line and its conductors within the ROW under moderate and extreme wind conditions and the extent to which danger trees must be removed. Some utilities select width such that if structures fail they would fall inside the ROW. For this study we will determine ROW width based on conductor blowout at 60 mph wind (6 psf) maintaining NESC Rule 234 clearances -- in this case 10 ft -- to the edge of ROW or under extreme wind conditions with a margin of 0-2 ft. Because development immediately adjacent to the ROW is unlikely, we adopted a 0-ft margin under extreme wind. It should be noted that where prevailing winds are parallel to the line, the ROW width determination in final design should consider a smaller blowout wind force.

D. FEASIBILITY DESIGN ALTERNATIVES

1. Background

The feasibility study was initially directed to base its cost estimate for an Intertie on a line design of comparable reliability to existing lines in Alaska. Efforts were focused on an X-frame steel tangent structure design, commonly used on Alaskan lines, especially in permafrost zones (e.g., Tyee Lake, Glennallen to Valdez, Anchorage-Fairbanks Intertie, and other lines). Pursuant to the TRM held on July 6, 1993 the study team was directed to expand the study to seek a least cost alternative for construction of the Intertie, considering alternative conductor types, wood construction, reduced ROW clearing, and other line design aspects.

The following section presents our methodology, findings and recommendations on a least cost alternative for estimating the Intertie. All exhibit references in this section are found in Appendix B, Preliminary Design Documentation.

2. Methodology

We first ran sag tension computations for candidate conductors and tabulated maximum sags versus ruling span. We also ran power loss computations for Dove, Teal and T2Linnet. We selected seven tangent structure types for evaluation: single wood pole, single steel pole, wood unbraced H-frame, wood braced H-frame, steel unbraced H-frame, steel braced H-frame, and X-frame structures. We used appropriate software to size the different structure types and selected as a starting point the best match of maximum span allowed by sag/clearance requirements and that allowed by structure strength; in doing this we attempted to minimize under- or oversizing basic structures.

A simple structure family was established for all construction options to include tangent, light angle (up to 15 degrees line angle), medium angle (up to 30 degrees line angle), and a deadend/heavy angle structure designed for full-deadend capacity. Except for the single pole options which were assumed to have guyed single pole angles and deadends, all non-tangent structures were assumed to be three-pole structures. We expect that a different and expanded family of structures will be developed in final design to best fit the line angle distribution of the final route alignment. All angle structures were assumed to be guyed and were evaluated based on axial loading limits and REA criteria of maintaining a safety factor of 2.00 for light and medium angle structures and 3.00 for heavy angles and deadends [9].

We sized all non X-frame structures with software available in-house. We prepared a detailed package of concept and design loadings for X-frame structures and sent it to Meyer Industries for estimating; however, they were overburdened and unable to lend engineering assistance for sizing the structures in the short time available. We resorted to sizing the X-frames using an approximate method wherein we tabulated weights and maximum resultant loadings (and then ground line moments) from the Tyee Lake and Bradley Lake projects, and estimated the weights of the Intertie structures based on interpolating with Intertie ground line moments. While approximate, this does lead to Intertie structure weights lying between the more lightly designed Tyee Lake structures and the move heavily designed Bradley Lake structures. A spot computation of structure weight, based on axial loading of upper and lower legs and bending loads on the crossarm, for Teal in Loading Zone 1, came within 1% of our estimated weight by the approximate method.

Non direct-embedment foundations were sized only for Teal conductor loads in Loading Zones 1-3 and 37 No. 9 Alumoweld in Loading Zone 4. We developed designs for H-pile foundations for use with X-frame structures, pipe pile (or driven caisson) foundations for use with H-frame structures, and concrete cap/rock anchor bolt foundations for special deadend A-frame structures.

After all material sizing was complete we solicited material quotes from various vendors and developed the unit cost estimating database suite. This is discussed in further detail in Section VI, Project Cost Estimates.

3. Conductor Selection

a. Introduction

We investigated the use of several conductors including 556 kcmil 26/7 ACSR Dove, 556 kcmil 26/7 ACSR/EHS Dove (with an extra high strength steel core), 556 kcmil 26/7 ACSR/SD Dove (self-damping ACSR), 605 kcmil 30/19 ACSR Teal, 605 kcmil 30/19 Teal SSAC, 2x336 kcmil 26/7 ACSR/T2Linnet, and 37 No. 9 Alumoweld. Other conductor types are worthy of consideration in final design. Such types might include using 6201 aluminum alloy strands in place of standard 1350-H19 alloy, conductors using trapezoidal strands (i.e., TW and TWD designations), and non-standard constructions. Descriptions of the main conductors investigated follow.

(1) Dove ACSR with an Extra High Strength (EHS) Steel Core

Standard ACSR conductor is typically fabricated using high strength steel core. It is possible to fabricate Dove ACSR with an extra-high strength steel core. Special compression fittings would probably be required to be compatible with the increased strength of the core. Because the Dove/EHS would be identical in appearance to the standard Dove used elsewhere on the system, there is a risk that the standard Dove conductor or fittings could be inadvertently installed in lieu of the Dove/EHS conductor or fittings for repairs; this could be prevented with stamping and color coding. Vibration dampers and galloping considerations for phase spacing apply.

(2) 605 kcmil ACSR 30/19 stranding, Code Name "Teal"

Teal ACSR has a nominally larger overall diameter of 0.994 inches compared to Dove ACSR at 0.927 inches. The higher content of steel in Teal ACSR gives it markedly improved sag characteristics over Dove ACSR for the same loading conditions. In Loading Zone 1, the sag of Teal is 7 ft less than standard Dove for a 1000 ft ruling span. The disadvantages to using Teal are (1) new requirements for spare materials and (2) higher tensions and marginally higher design wind and ice loads. Additional sag benefits would be obtained with an EHS core. Vibration dampers and galloping considerations for phase spacing apply.

(3) SSAC, Teal Stranding 605 kcmil

SSAC uses a standard steel core (high strength or extra high strength) with soft temper (alloy 1350-O temper) aluminum outer strands, forcing the steel core to take up most or all of the conductor mechanical load throughout the loading regime. It appears essentially the same as its standard ACSR counterpart. The disadvantages of Teal SSAC are (1) new requirements for spare materials, (2) higher cost for conductor and (3) a higher cost to install if prestretching is specified. Because of its marginal sag advantages ,though, this conductor was not considered in the search for a least cost option. SSAC conductor exhibits a high degree of self-damping which could eliminate the need for dampers. Galloping must still be considered for phase spacing with this conductor.

(4) Alumoweld Conductor

Alumoweld strand has been frequently used in Alaska where severe loadings are expected (e.g., Glennallen-Valdez 138-kV line in Thompson Pass uses 19 No. 5 AW and Tyee Lake - Petersburg 138-kV line at high elevations uses 37 No. 8 AW). CVEA has experienced a major avalanche failure in Thompson Pass when the Alumoweld conductor did not break and took out several structures which were outside the avalanche zone. The recurrence of this type of incident can be countered by carefully routing around possible landslide chutes, placing sacrificial structures and low strength conductors/assemblies in the chute where unavoidable, and installing strong structures either side of the chutes with comparatively weak deadend strings which would fail before cascading could occur.

Alumoweld conductor shows much less sag than ACSR or SSAC conductors for the same loading conditions. The disadvantages of Alumoweld include (1) much higher tensions and (2) much greater power losses. Alumoweld conductor would only be considered for use in Loading Zone 4. Vibration dampers and galloping considerations for phase spacing apply.

(5) T2Linnet, 2x336 kcmil 26/7 ACSR Conductor

T2Linnet conductor consists of two standard Linnet (336 kcmil 26/7 ACSR) subconductors helically would around each other. The principal application of T2 conductor is to prevent galloping. It has a high degree of self-damping and needs no vibration dampers. It was suggested to the study team for its possible savings in ROW costs due to higher allowable design tensions and no need to consider galloping in the determination of phase spacing. Special hardware is required for T2 conductor, but is now widely available. We confined our comparison to T2Linnet because it offered the closest match to the 556-605 kcmil size of conductor required for adequate electrical performance. Other special strandings could be considered. We found that

T2 conductor was not appropriate for the severe loadings in Loading Zone 4. (As a note "T2" is the designation used by the original developer of the conductor, Kaiser Aluminum. Currently, though, Southwire is the only manufacturer of this conductor which it designates as Type VR.)

b. Sag Tension Characteristics

Sag tension computations were made using ALCOA SAG10™ and the SAGT task module of EPRI TL Workstation™ for most conductor types. For the extra-high strength core types sag tension computations were performed by ALCAN at our request. CABLEC also supplied SSAC conductor sag tension computations which would differ slightly from the EPRI program results due to the use of a higher order polynomial for approximating stress-strain curves. Sag tension conditions and tension limits were as cited in the previous Part C, Design Criteria. Table IV-9 gives a summary of maximum sags for a 1000 ft ruling span, allowing quick inspection of the height advantages of different conductor types. Exhibit B-1 gives a summary of key design data (e.g., ruling span, tensions and sags) for each of the major conductors in each appropriate loading zone. No sag tension program output is included because of the volume of material generated.

Table IV-9
Maximum Sag Comparison(1)

Ruling Span = 1,000 ft
(sags in feet)

	Loading Zone			
Conductor	**1**	**2**	**3**	**4**
Dove 556 ACSR	33.92	35.08	35.04	61.18
Dove 556 ACSR/SD	33.76	34.94	34.89	NA
Dove 556 ACSR/EHS	25.83	34.52	NA	NA
Teal 605 ACSR	26.93	29.82	29.73	42.19
Teal 605 ACSR/EHS	NA	NA	NA	NA
Teal 605 SSAC	28.11	27.47	27.52	46.76
T2Linnet 2X336	28.59	29.45	29.36	NA
37 No. 9 Alumoweld	NA	NA	18.68	18.18

(1) Sags at NESC heavy 0.5 inch radial ice, 32ºF, no wind final condition or maximum operating temperature sag final condition.

c. Power Loss Comparison

Power loss computations were made using a long-line, radial model for Dove 556 ACSR, Teal 605 ACSR, and T2Linnet 2x336 ACSR. To evaluate this effect we assumed an Intertie load factor at 0.60, cost of energy at $0.08/kWh, 15 MVA loading and a 135-mile length of line. The resultant total line losses under these conditions were estimated to be 525 kW for Dove, 508 kW for Teal and 482 kW for T2Linnet. The annual cost of losses was estimated at $220,725 for Dove, $213,570 for Teal, and $206,650 for T2Linnet. These differences are considered practically insignificant.

d. Phase Spacing

Phase spacing was computed in two ways: (1) by performing galloping analysis for the various conductors and loading zones (see Exhibit B-2 for a sample computation and plot), and (2) using recommended REA methods [9] for computing spacing based principally on conductor sags. Table IV-10 gives a comparison of the methods and resulting phase spacings, demonstrating that phase spacings do not vary greatly among conductors, except 37 No. 9 Alumoweld in Loading Zone 4, where clearing is not an issue. The range of spacings for Teal over all loading zones is 15 to 17 ft, for T2Linnet the range is 14 to 16 ft and for Dove the range is 17 to 19+ ft. It is worth noting that a minimum spacing will be determined by electrical clearances at the structure and will be on the order of 13 ft for a typical flat configuration structure and would require restrained insulator assemblies to limit conductor swing.

Table IV-10
Horizontal Phase Spacing Comparison

Line voltage (kV)	138		PSF	6	
Line Voltage *1.05	144.9	kV			
Unit Weight (lb/ft)	0.766	0.939	0.939	1.108	0.926
Bare Diameter (in)	0.927	0.994	0.994	0.801	1.180
Phi/Swing Angle	31.2	27.9	27.9	19.9	32.5

	CONDUCTOR					
	Dove	Teal	Teal SSAC	37#9AW	T2Linnet	
LOADING ZONE 1						
Ruling Span	1000	1000	1000	NA	1000	
Ruling Span Sag	28.61	21.75	21.96	NA	23.94	
Length of Insulator	5	5	5	5	5	
Experience Factor	1.25	1.25	1.25	1.25	1.25	
Input Spacing >>>	15	14	14	16	14	
Maximum Span	1315	1336	1330	NA	1274	Seek 1300
Spacing/Gallop	17	15	16	NA	NA	
LOADING ZONE 2						
Ruling Span	1200	1200	1200	NA	1200	
Ruling Span Sag	49.97	34.76	36.1		41.56	
Length of Insulator	5	5	5	5	5	
Experience Factor	1.25	1.25	1.25	1.25	1.25	
Input Spacing >>>	16	14.5	14.5	16	15	
Maximum Span	1329	1350	1324	NA	1309	Seek 1300
Spacing/Gallop	18+	16	16	NA	NA	
LOADING ZONE 3						
Ruling Span	1100	1100	1100	NA	1100	
Ruling Span Sag	40.31	30.01	27.65	NA	33.2	
Length of Insulator	6	6	6	6	6	
Experience Factor	1.3	1.3	1.3	1.3	1.3	
Input Spacing >>>	16.5	15.5	15	16	16	
Maximum Span	1302	1355	1331	NA	1362	Seek 1300
Spacing/Gallop	18	16	15	NA	NA	
LOADING ZONE 4						
Ruling Span	900	1000	1000	1000	NA	
Ruling Span Sag	45.16	38.91	44.2	13.84	NA	
Length of Insulator	5	5	5	5	5	
Experience Factor	1.4	1.4	1.4	1.4	1.4	
Input Spacing >>>	18	16	17	12	16	
Maximum Span	1128	1121	1159	1111	NA	Seek 1100
Spacing/Gallop	19+	17	17	NA	NA	

e. *ROW Width Effects*

Using phase spacing as determined in the previous section we investigated ROW width in several ways.

First we computed the required ROW width to accommodate the same maximum span length - based on the selected ruling span - for each conductor and loading zone. See Exhibit B-3 for a sample computation. This resulted in ROW widths as given in Table IV-11, which shows that of the three ACSR-variant conductors Teal has the narrowest ROW requirements for the given assumptions and that both Teal and T2Linnet are narrower than Dove. Since the use of the same maximum span for the different conductors and types of construction may not be a valid assumption, we investigated ROW width in another fashion.

Table IV-11
ROW Width for Same Given Maximum Span(1)
(in feet)

Maximum Span>>	Loading Zone 1 1,100'	Loading Zone 2 1,400'	Loading Zone 3 1,300'	Loading Zone 4 1,200'
Teal	121.3	151.4	139.8	170.4
Dove	145.1	191.1	169.1	195.5
T2Linnet	127.8	168.2	152.6	NA
37 No. 9 Alumoweld	NA	NA	NA	92.2

(1) All ROW widths controlled by extreme wind blowout.

Second we computed the maximum allowable span for the same 125-ft ROW width. See Exhibit B-4 for a sample computation. This resulted in maximum spans as given in Table IV-12, which shows that Teal will allow a longer maximum span in a 125-ft ROW than Dove or T2Linnet. Inspection of Exhibit B-4 indicates that a 125-ft ROW width is well-matched to the maximum allowable span for all conductor and loading zone combinations except Dove and T2Linnet in Loading Zone 2, which require greater widths than 125 ft.

Table IV-12
Maximum Spans for 125-ft Right-of-Way(1)
(in feet)

	Loading Zone 1	Loading Zone 2	Loading Zone 3	Loading Zone 4
Teal	1,230	1,205	1,190	950
Dove	1,060	1,010	1,025	775
T2Linnet	1,180	1,122	1,125	NA
37 No. 9 Alumoweld	NA	NA	NA	1,450

(1) All maximum spans controlled by extreme wind blowout.

Third we computed ROW widths based on danger tree removal. In practice, ROW widths need to be sufficient to allow felling of danger trees at the typical height of the prevailing forest cover. Sometimes it is possible to obtain permission to clear danger trees outside the ROW, but we do not consider this a practical assumption for this project. The computation accounts for danger tree height as well as terrain slope. See Exhibit B-5 for the computation for flat configuration/multi-pole structures and Exhibit B-6 for single pole construction. This computation indicates that a 125-ft ROW is appropriate for slopes up to 30% and tree height less than 60 ft roughly in the case of a flat configuration structure. In the case of single pole construction, a 125-ft ROW would be appropriate up to a 70-ft tree height and 30% slope. These are typical tree heights in Loading Zone 1.

As a final check on ROW width effects, we computed the required ROW width based solely on conductor blowout for flat configuration structures (X-frames) and single pole structures in Loading Zones 1 and 2 for Dove, Teal and T2Linnet. The computations (see Exhibit B-7 for sample computation) used the maximum span based on clearances for the base structure heights. Required ROW widths are given in Table IV-13 below.

Table IV-13
ROW Width Requirements Based on Conductor Blowout and Maximum Spans - Loading Zones 1 and 2

	Required ROW Width (ft) Type of Structure		
	Flat Configuration		Single-Pole
	LZ1	LZ2	LZ1
Dove	111	152	93
Teal	98	119	83
T2Linnet	100	136	89

The bottom line is that ROW width is not much affected by conductor selection and a 125-ft ROW is sufficient and basically well-matched to design maximum spans. Single pole construction would not appear to reduce the ROW requirements significantly in heavily forested areas (i.e., Loading Zone 1) due to danger tree removal requirements. Typical ROW cross sections are shown in Figures IV-7 (heavy forest) and IV-8 (low growth forest). REA [9] cites the typical range for ROW width at 100-150 ft for 138 kV lines.

f. Summary of Conductor Selection

Conductor selection for the feasibility study was based principally on sag tension behavior and the attendant effects on structure size and quantity. Other factors considered included effects on ROW width, clearing, power losses, and phase spacing.

Sag tension runs showed Teal ACSR and T2Linnet ACSR to have 5-7 ft less sag than Dove ACSR in Loading Zones 1-3. EHS core variants of Teal ACSR and T2Linnet ACSR would produce additional sag benefits. There was no significant difference in maximum sag between Teal ACSR and T2Linnet ACSR (1.7 ft-0.7 ft), based on assumed sag tension limits; this indicates the offsetting effects of the greater steel content of Teal ACSR and higher allowable unloaded tension limits for T2Linnet ACSR. T2Linnet was found not capable of handling the loading conditions of Loading Zone 4. Type 37 No. 9 Alumoweld conductor was considered only for Loading Zone 4 and had 28 ft and 43 ft less sag than Teal ACSR and Dove ACSR, respectively. Based on clearances alone, Teal ACSR and T2Linnet were considered equivalent choices for Loading Zones 1-3 and both T2Linnet ACSR and Dove ACSR were eliminated as practical choices for Loading Zone 4. Advantage: Teal and T2Linnet for Loading Zones 1-3 and 37 No. 9 Alumoweld in Loading Zone 4; this impact is reflected to a greater extent in the computation of number of structures per 10-mile segment discussed below.

Power loss computations for Teal ACSR, Dove ACSR and T2Linnet ACSR showed an estimated total annual benefit of $7,000 for T2Linnet compared to Teal ACSR and $14,000 for T2Linnet compared to Dove ACSR. This difference is insignificant given the feasibility nature of this study. Over a 40-year project life and assuming a 5% discount rate, the stream of annual $7,000 benefits would only amount to a net present value of about $120,000. Advantage: T2Linnet, slight impact.

Phase spacing varied from 14 ft to over 19 ft for the various conductors and loading zone combinations. Dove ACSR had required spacings of 16-19+ ft typically more than 2 ft greater than Teal ACSR. T2Linnet showed a 1 ft advantage over Teal ACSR, a figure which could conceivably be improved to 2-3 ft if additional money is spent to fix all insulator assemblies at each structure, maintaining bare clearances to structure of about 6 ft. This advantage would lead to overall structure widths of 28 ft for T2Linnet ACSR and 32 ft for Teal ACSR. Advantage: T2Linnet, moderate impact.

ROW widths were investigated in several ways. Teal ACSR consistently showed narrower ROW requirements based on maximum assumed spans or longer allowable spans for given ROW width than T2Linnet and, to a greater extent, Dove ACSR. Advantage: Teal, moderate impact.

The quantity and size of structures was also considered. We made these comparisons for all seven structure types and four loading zones. In Tables IV-14 through IV-17 comparisons are shown which demonstrate that Teal ACSR fairly consistently requires the fewest number of similar-sized structures or roughly the same number of smaller-sized structures per 10-mile segment based on the best match of structure size and maximum clearance span. Advantage: Teal.

The conductors selected for this feasibility study based on the above technical considerations are Teal ACSR in Loading Zones 1-3 and 37 No. 9 Alumoweld in Loading Zone 4. Unit cost model results also indicate an advantage for these conductors. It should be emphasized that an optimal conductor selection must be part of final project design. The differences among the conductor types chosen for comparison in this study are in many respects slight and small changes to study assumptions could affect the outcome of this study's findings.

4. Structure Selection

We selected seven tangent structure types for evaluation: single wood pole, single steel pole, wood unbraced H-frame, wood braced H-frame, steel unbraced H-frame, steel braced H-frame, and X-frame structures. Typical structure outlines are shown in Figure IV-1 (X-frame), Figure IV-2 (wood H-frame), Figure IV-3 (single wood pole), Figure IV-4 (single steel pole), and Figure IV-5 (3-pole angle structure). In addition, a self-supporting A-frame structure was assumed for failure containment in Loading Zone 4 (see Figure IV-6).

a. Wood H-Frame Structures

The selection of wood H-frame structures began with running H-frame sizing software for the various Loading Zone and conductor data (see Exhibit B-8). This led to maximum spans for Type 1 (i.e., REA TH-10 unbraced) and Type 4 (i.e., REA TH-10V4X braced structures) based on wood pole strength. We assumed western red cedar poles for this computation to facilitate the supply of poles in a tight market, for its natural resistance to decay, and its comparative lightness. A mix of Douglas fir and western red cedar may be desirable to expedite supply for the project.

We then combined tables of spans limited by sag and these maximum horizontal spans limited by pole strength to match appropriate pole size with ruling span. Exhibit B-9 is a sample of this combined spreadsheet for Type 4 H-frames for Loading Zone 1 and ruling spans 800-1,200 ft. This table also computes the number of tangent structures in a level 10-mile segment to evaluate the effect of different sags. In the table you will note, for instance, that a theoretical horizontal span limit for 75/1 poles is 973 ft for Teal and that this corresponds well with the 962 ft span limited by sag, which corresponds to an assumed ruling span of 1,000 ft. The number of structures per 10-mile segment for this case is 55, shown in the outlined box in the table. Several tables were developed for all loading zones and for both braced and unbraced H-frames, both direct embedded and pile-supported.

Table IV-14 summarizes the selection of pole sizes and span lengths for wood H-frame structures for Loading Zones 1,2 and 3 and conductor types Dove, Teal and T2Linnet. Wood H-frame structures were not considered for the severe Loading Zone 4. Also, consultation with McFarland-Cascade Pole Company indicated that, although pole supply is still relatively stable, length/class combinations greater than H2/85 would be more difficult to furnish and that it would be prudent to design with smaller poles. As can be inferred from Exhibit B-9, class H1 or H2 poles would be generally oversized for the allowable span lengths due to sag for poles less than 85 ft long, except for the use of T2Linnet.

Wood was not a practical selection for angle and deadend structures, which were taken as guyed, 3-pole, tubular steel structures, direct embedded in Loading Zones 1,3 and 4 but supported on pile foundations in Loading Zone 2.

Wood H-frames Type 1, unbraced, were considered only for Loading Zone 2, since they would respond better to uneven foundation jacking than Type 4 braced H-frames. Type 4 braced H-frames were considered for Loading Zone 3, although geotechnical investigations may indicate Type 1 is more suitable in Loading Zone 3 if permafrost is encountered.

b. Steel H-frame Structures

H-frame structures are also used frequently in Alaska (GVEA, HEA, CEA, and other utilities). They can be direct-embedded in rock and good, native soil where either there is no permafrost or the active layer is shallow. In poor soil they can be direct embedded with gravel or rock backfill, inserted in a caisson driven into good soil layers and backfilled with select material, or supported on piles (e.g. Swan Lake). H-frames are simple, standard REA structures and can make good use of pole sizes less than H2/85 (wood). There would be no limit on steel H-frames.

Table IV-14
Comparison of Wood H-Frame Spans

LOADING ZONE	ITEM	CONDUCTOR *Dove* HF4	*Dove* HF1	*Teal* HF4	*Teal* HF1	*T2Linnet* HF4	*T2Linnet* HF1
1	Max HS (ft)	1025	1025	972	1175	1013	1007
	Max Clr Span (ft)	1000	970	962	1101	1014	979
	Average Span (ft)	900	873	866	991	912	881
	Ruling Span (ft)	1000	1000	950	1100	1000	1000
	L/Class-Match	85/1	75/H1	75/1	75/H2	80/H1	70/H2
	Qty/10-mi	59	60	61	53	58	60
2	Max HS (ft)	1045	1076	1205	1039	1027	1042
	Max Clr Span (ft)	1033	1060	1139	993	965	999
	Average Span (ft)	930	954	1025	894	869	899
	Ruling Span (ft)	1000	1000	1100	1000	1000	1000
	L/Class-Match	75/1	70/H1	75/H1	60/H1	65/H1	60/H2
	Qty/10-mi	57	55	52	59	61	59
3	Max HS (ft)	1039	1025	1207	1175	1018	1015
	Max Clr Span (ft)	991	1026	1157	1132	1009	975
	Average Span (ft)	892	923	1041	1019	908	878
	Ruling Span (ft)	1000	1000	1200	1100	1000	1000
	L/Class-Match	80/1	75/H1	75/H1	75/H2	75/H1	65/H2
	Qty/10-mi	59	57	51	52	58	60

General Notes

1. Average spans calculated at 90% * minimum of Max HS or Max Clr Span.
2. Not used.
3. Max HS is the maximum horizontal span based on pole strength for given length/class.
4. Max Clr Span is the maximum span for the given structure type, pole length and class based on providing code clearances under maximum sag for the given ruling span.
5. L/Class-Match is the selection of pole length and class at which Max HS and Max Clr Span are most equal. This results in the optimum preliminary match of strength and clearance requirements.
6. Qty/10-mi is number of structures in 10-mile segment based on Average Span.

H-frames do not typically respond well to permafrost and frost jack situations. GVEA has experienced several H-frame failures due to frost-heave. This is especially true of the braced H-frame, whose stiffness is a distinct disadvantage in permafrost soils. Even the unbraced H-frame has reportedly not performed well on the GVEA system. A serious disadvantage to the H-frame in Loading Zone 2 is that repair of jacked foundations would require removal of the structure and maybe the pile cap to lengthen and redrive the foundation piles. This would take significantly longer than for an X-frame. It might be possible to design a fix using outboard driven piles that would not require removal of the structure, but in any case repair of H-frame jacking will be more expensive than for the X-frame alternative.

The selection of steel H-frame structures began with running wood H-frame sizing software with steel overload capacity factors for the various loading zone and conductor data (see Exhibit B-10). This led to maximum spans for Type 1 (i.e., REA TH-10 unbraced) and Type 4 (i.e., REA TH-10V4X braced structures) based on wood pole strength. We then substituted wood-pole equivalent steel poles, in this case Meyer LD Series poles.

We then combined tables of spans limited by sag and these maximum horizontal spans limited by pole strength to match appropriate pole size with ruling span. Exhibit B-11 is a sample of this combined spreadsheet for Type 4 H-frames for Loading Zone 1 and ruling spans 800-1200 ft. This table also computes the number of tangent structures in a level 10-mile segment to evaluate the effect of different sags. Several tables were developed for all loading zones and for both braced and unbraced H-frames, both direct embedded and pile-supported.

In Exhibit B-11, it can be seen for instance that 85/1 poles (or LD-1 in the Meyer series) would be a good match for Teal conductor with a 10-mile count of 47, that 75/1 poles are a good match for T2Linnet conductor with a 10-mile count of 57, and that steel poles generally are oversized for Dove conductor.

Table IV-15 summarizes the selection of pole sizes and span lengths for steel H-frame structures for Loading Zones 1,2 and 3 and conductor types Dove, Teal and T2Linnet.

Angle and deadend structures were assumed to be guyed, 3-pole tubular steel structures, direct embedded in Loading Zones 1, 3 and 4 but supported on pile foundations in Loading Zone 2. They were sized using point load information (see Exhibit B-12) and axial loading analysis (see Exhibit B-13).

Steel H-frames, both Types 1 and 4, were considered for all loading zones.

Table IV-15
Comparison of Steel H-Frame Spans

LOADING ZONE	Conductor>>> ITEM	Dove				Teal				T2Linnet				37#9AW			
		Type 1 HF		Type 4 HF		Type 1 HF		Type 4 HF		Type 1 HF		Type 4 HF		Type 1 HF		Type 4 HF	
		Pile	DE	Pile	DE	Pile	DE	Pile	DE	Pile	DE	Pile	DE	Pile	DE	Pile	DE
1	Max Clr Span (ft)	na	970	na	938	na	1101	na	1134	na	979	na	933	na	na	na	na
	Max HS (ft)	na	1030	na	1236	na	1178	na	1140	na	1016	na	975	na	na	na	na
	Average Span (ft)	na	873	na	844	na	991	na	1021	na	881	na	840	na	na	na	na
	Ruling Span (ft)	na	1000	na	900	na	1100	na	1100	na	1000	na	1000	na	na	na	na
	L/Class- Match	na	75/1	na	80/1	na	75/H1	na	85/1	na	70/H1	na	75/1	na	na	na	na
	Qty/10-mi	na	60	na	63	na	53	na	52	na	60	na	63	na	na	na	na
2	Max Clr Span (ft)	1150	na	1080	na	1187	na	1139	na	999	na	1152	na	na	na	na	na
	Max HS (ft)	1273	na	1236	na	1235	na	1156	na	1068	na	1204	na	na	na	na	na
	Average Span (ft)	1035	na	972	na	1068	na	1025	na	899	na	1037	na	na	na	na	na
	Ruling Span (ft)	1200	na	1100	na	1200	na	1100	na	1000	na	1200	na	na	na	na	na
	L/Class- Match	80/H1	na	80/1	na	70/H1	na	75/1	na	60/H1	na	80/H1	na	na	na	na	na
	Qty/10-mi	51	na	54	na	49	na	52	na	59	na	51	na	na	na	na	na
3	Max Clr Span (ft)	na	1026	na	991	na	1187	na	1093	na	1178	na	1151	na	na	na	na
	Max HS (ft)	na	1030	na	1236	na	1206	na	1153	na	1217	na	1204	na	na	na	na
	Average Span (ft)	na	923	na	892	na	1068	na	984	na	1060	na	1036	na	na	na	na
	Ruling Span (ft)	na	1000	na	1000	na	1200	na	1100	na	1200	na	1200	na	na	na	na
	L/Class- Match	na	75/1	na	80/1	na	70/H1	na	80/1	na	75/H2	na	80/H1	na	na	na	na
	Qty/10-mi	na	57	na	59	na	49	na	54	na	50	na	51	na	na	na	na
4	Max Clr Span (ft)	na	na	na	na	na	675	na	706	na	na	na	na	na	1065	na	1139
	Max HS (ft)	na	na	na	na	na	725	na	737	na	na	na	na	na	1064	na	1132
	Average Span (ft)	na	na	na	na	na	608	na	635	na	na	na	na	na	958	na	1019
	L/Class- Match	na	na	na	na	na	750	na	700	na	na	na	na	na	1000	na	1100
	Basic Height (ft)	na	na	na	na	na	75/H1	na	75/1	na	na	na	na	na	70/H2	na	80/H1
	Qty/10-mi	na	na	na	na	na	87	na	83	na	na	na	na	na	55	na	52

Notes:
1. Average spans calculated at 90%*minimum of Max HS or Max Clr Span.
2. Not used.
3. Max Clr Span is the maximum span for the given structure height based on providing code clearances under maximum sag for the given ruling span.
4. L/Class-Match is best match of pole strength and clearance span.
5. Qty/10-mi is number of structures in 10-mile segment based on Average Span.
6. Type 1 HF is unbraced, Type 4 HF is fully braced.
7. Pile refers to pile supported structures with assumed 2' stickup, assuming moment at 6' from base (butt).
8. DE refers to direct embedment structures at 10% + 3 ft.
9. Wood pole equivalents computed for extreme wind, using steel OCFs 1.10.

c. *Steel X-frame Structures*

The X-frame tangent structure is used extensively in Alaska (e.g., Anchorage-Fairbanks Intertie, Lake Tyee, Bradley Lake, and the Glennallen-Valdez lines) due to its inherent longitudinal capacity, ease of maintenance and installation, and response to frost-jacking situations, likely to be extensively encountered in Loading Zone 2.

A study of alternatives for the Anchorage-Fairbanks Intertie [13] evaluated ten different structure types including single steel pole, steel and wood H-frames, steel X-frame, both aluminum and steel guyed lattice, and self-supporting steel lattice structures and concluded that the X-frame structure promised to be the most long-term, cost-effective tangent structure selection.

Advantages of the X-frame are numerous. With its fore and aft longitudinal guys and guy yokes, designed to yield but not fail under excessive longitudinal unbalanced loading, the X-frame provides a significant degree of longitudinal strength to the line. Design of pile foundations and field guidelines are made simpler by the fact that, due to its geometry, foundation base reactions are relatively independent of structure height. The X-frame is a lighter structure than a comparably loaded, self-supporting H-frame, especially if sizable longitudinal capacity is required. The installation of X-frames by helicopter is less cumbersome than for direct-embedded H-frame structures. While X-frame structures require pile foundations, this also has the advantages of (1) standardizing foundation types and materials, and (2) allowing relatively easy correction of jacked footings and other out of plumb situations. The X-frame structure does not absolutely need to be removed from the foundations to lengthen and redrive the piles to achieve greater penetration, although this operation may be facilitated by temporary removal.

The X-frame is a more complicated structure to design, fabricate and assemble. Its unit cost in dollars per pound, therefore, is slightly higher than tubular steel pole structures. Each structure has two driven pile foundations and two guys, which might require more maintenance than self-supporting, direct-embedded structures to retighten guys and redrive piles. It is expected, though, that jacking situations would appear most frequently in the early stages of project life and would diminish as the project ages. This also depends on the extent of geotechnical investigation done for foundation design.

Steel X-frame structures are custom designed, meaning that, based on selected design spans and loading criteria, point loads are developed and specified for detailed sizing of the structures. It is not possible to accurately design these structures without utilizing complex structural analysis software, something we had neither time nor budget to do. To size the X-frames we first determined basic heights according to sag tension data for Dove, Teal, T2Linnet, and 37 No. 9 Alumoweld for the four loading zones as appropriate. Basic heights were limited to less than 85 ft above ground generally to be consistent with other structure choices. Maximum spans and corresponding heights are given in Exhibit B-14. Based on these spans we developed point loads for all X-frame structure/conductor/loading zone combination using load computation software (see Exhibit B-12). We then developed a complete set of loading tables and concept drawings to submit to Meyer Industries with a request for estimated weights and costs. Our load tables included unbalanced longitudinal loading but not a loading case for nominal differential foundation jacking in permafrost areas, which could control. Unfortunately, Meyer engineering staff was unable to lend any modeling assistance because of other obligations and it appeared that all tubular steel fabricators were in the same bind.

We then resorted to an approximate method whereby we tabulated X-frame weights and maximum loadings for the Tyee Lake and Bradley Lake lines and basically used interpolation of resultant overturning moment to estimate Intertie weights. While not highly accurate, this method did result in weights for Intertie structures between the more lightly loaded Tyee structures and the more heavily loaded Bradley Lake structures and was considered sufficiently accurate for evaluating a least cost construction type.

Table IV-16 summarizes the selection of structure heights and span lengths for steel X-frame structures. Because the use of H-pile foundations is feasible for all expected geotechnical conditions, the X-frame structure was considered for all loading zones.

Table IV-16
Comparison of X-Frame Spans

LOADING ZONE	ITEM	CONDUCTOR Dove	Teal	T2Linnet	37#9AW
1	Max Clr Span (ft)	1007	1045	1014	na
	Average Span (ft)	906	941	913	na
	Ruling Span (ft)	1000	1000	1000	na
	Basic Height (ft)	65	60	60	na
	Qty/10-mi	58	56	58	na
2	Max Clr Span (ft)	1206	1187	1228	na
	Average Span (ft)	1085	1068	1105	na
	Ruling Span (ft)	1200	1200	1200	na
	Basic Height (ft)	85	75	80	na
	Qty/10-mi	49	49	48	na
3	Max Clr Span (ft)	1090	1074	1085	na
	Average Span (ft)	981	967	977	na
	Ruling Span (ft)	1100	1100	1100	na
	Basic Height (ft)	80	70	75	na
	Qty/10-mi	54	55	54	na
4	Max Clr Span (ft)	906	1012	na	987
	Average Span (ft)	815	911	na	888
	Ruling Span (ft)	900	1000	na	1000
	Basic Height (ft)	85	80	na	55
	Qty/10-mi	65	58	na	59

General Notes
1. Average spans calculated as 90%* Max Clr Span.
2. Not used.
3. Max Clr Span is the maximum span for the given structure height based on providing code clearances under maximum sag for the given ruling span.
4. Basic Height is the structure height corresponding to the Max Clr Span.
5. Qty/10-mi is number of structures in 10-mile segment based on Average Span.

Angle and deadend structures were assumed to be guyed, 3-pole tubular steel structures, direct embedded in Loading Zones 1,3 and 4 but supported on pile foundations in Loading Zone 2. They were sized using point load information (see Exhibit B-12) and axial loading analysis (see Exhibit B-13).

d. Single Wood and Steel Poles

Single wood pole construction is common on the MEA system and is used on the O'Neill Tap Line. Spans of 300-400 ft are typical, largely because the line is designed to carry distribution circuit underbuild. Although the Intertie would not have to carry underbuild, design loadings and conductor sag tension characteristics limit effective spans to 300-450 ft. This is familiar construction which facilitates maintenance. The south central region of Alaska is not harsh on wood poles and a relatively long wood pole life can be expected. Single pole construction would take less space at line angle points than the flat configuration options which have been assumed as three-pole structures. In Loading Zone 1 many line angle points would be necessary at property corners and self-supporting single pole construction would make it easier to turn those angles without guys reaching into adjoining properties; flat configuration construction options are assumed to be three-pole structures and would take more room at such corners.

Wood pole supply may be questionable at project time and wood is penalized for its variable physical characteristics with higher overload capacity factors than steel. A major wood pole supplier has indicated that supply of wood poles up to class and length H2/85 ft is not a foreseeable problem although it would be prudent to consider a mix of Douglas fir and western red cedar. A promising alternative to wood poles is the laminated pole which can be custom fabricated to fit the length, dimension, camber, and strength requirements of the project without apparent supply problems.

Single steel poles offer the same basic advantages of wood except that they can handle spans about twice as long as for single wood poles. Although wood poles are reportedly long-lasting in south central Alaska, the steel pole must be considered to have a somewhat longer lifetime. Self-supporting steel poles with pier foundations may be required where absolute minimum ROW is required at property corner heavy line angles.

Single poles, whether wood or steel, were considered not appropriate in Loading Zone 2 because of their relatively poor response to frost-heave in the extensive permafrost and the vertical phase configuration which presents a greater risk for line-trumpeter swan collisions. They were not considered appropriate in Loading Zones 3 and 4 because of the advantages of spanning out with flat configuration structures.

Tangent single wood poles were evaluated based on ground line moment capacity for both Douglas fir and western red cedar. Computations were made to compare maximum span length based on ground line moment capacity to maximum spans based on sags and clearance with a check of maximum span based on REA ice jump criteria (see Exhibit B-15). The most appropriate match of class/height for each conductor type is given in Table IV-17. Angle and deadend structures were assumed to be single guyed wood or steel pole structures. Computations based on axial loading indicate that H2 wood poles may be appropriate for light angle structures but that higher class poles would be required for medium angle and deadend structures. Based on conversations with a major wood pole supplier, who advised that it would not be prudent to design with poles greater than class H2 at this stage given the wood pole market, we assumed guyed tubular steel structures for medium angle and deadend structures. These structures were sized based on axial loading criteria (see Exhibit B-13). It is noted that, to prevent conductor slapping incidents due to ice unloading, local utilities have expressed a preference for using vertical post insulators to offset conductors. The use of vertical posts is practical with wood structures although double post assemblies may be needed to provide adequate cantilever strength. We have assumed a structure with horizontal-vee pivoting type insulator assemblies with increased vertical phase spacing to achieve similar reliability.

Tangent steel poles were evaluated using VALMONT tubular steel pole sizing software which basically selected poles from their wood-pole equivalent SWP series. Tangent steel pole span lengths were on the order of twice the wood pole span lengths. We evaluated all conductors for a 950 ft maximum span. Structures would utilize davit arm construction and V-string insulator assemblies. Table IV-17 also gives a summary of tangent steel structure sizing. All angle and deadend structures were assumed to guyed, single steel pole structures whose sizing is based on axial loading (see Exhibit B-13).

Table IV-17
Single Pole Comparison

LOADING ZONE		ITEM	CONDUCTOR Dove	Teal	T2Linnet
1	WOOD	Max HS (ft)	458	522	459
		Max Clr Span (ft)	468	518	423
		Average Span (ft)	412	466	381
		Ruling Span (ft)	425	475	375
		Basic L/Class	65/1	65/H1	60/H1
		Qty/10-mi	128	113	139
1	STEEL	Max HS (ft)	950	950	950
		Max Clr Span (ft)	800	800	800
		Average Span (ft)	720	720	720
		Ruling Span (ft)	800	800	800
		Basic Length (ft)	80	75	75
		Steel Pole Size	80.063	75.063	75.07
		Qty/10-mi	73	73	73

General Notes
1. Average spans calculated at 90% minimum of Max HS or Max Clr Span.
2. Not used.
3. Max Clr Span is the maximum span for the given structure height based on providing code clearances under maximum sag for the given ruling span.
4. Basic Height is the structure height corresponding to the Max Clr Span.
5. Qty/10-mi is number of structures in 10-mile segment based on Average Span.
6. Steel Pole Size is Valmont catalog number for their SW series.

5. Foundation and Anchor Selection

a. *Introduction*

Several different soil and rock conditions will be present along the transmission line corridor. Dames & Moore provided a preliminary overview of geotechnical conditions along the proposed Intertie alignments (see Exhibit B-F-1). A family of foundations with application guidelines for on-the-spot-field decisions will be necessary to provide schedule and for cost efficiencies. Wetland and poor soil conditions will have to be delineated in Loading Zones 1, 3 and 4. In Loading Zone 2, wetlands are so extensive that it is prudent to assume pile foundations everywhere. Depending on the extent of geotechnical surveys and if piles are selected throughout, the H-pile driving crew can act as a discovery crew; if refusal due to bedrock is premature, the H-pile crew can move on, leaving that site for a rock crew. Generally, only three types of foundations will be considered appropriate for the Intertie: direct embedment, pile foundations, and rock anchor/concrete cap foundations.

Granular alluvial and colluvial soils with varying frequency and size of cobbles and boulders are typical of Matanuska Valley and back country valleys. Soils overlays bedrock at estimated 10'-20' usually at lower elevations, closer to creek beds, with exposed or shallow bedrock in some locations. The presence of rock and boulders is expected to increase with slope. It is expected that we can adjust structure spotting during construction to limit rock foundations and to avoid large boulders, although a price will be paid in terms of delay and remobilization.

East of Tahneta Pass, in the Copper River Basin, the soil structure is dominated by glacial till or muskeg overlaying permafrost. Muskeg areas also exist in pockets along route segments west of Tahneta Pass, but without permafrost. The active layer in the vicinity of Pump Stations 11 and 12 on the Aleyeska Pipeline is 3-5 ft and the permafrost is estimated at about 2,000 ft thick. CVEA has successfully and routinely driven H-pile to 15 ft penetration to support jacked single distribution poles. This is consistent with the cited active layer.

In remote areas of expected severe loading strategically placed, self-supporting structures with increased longitudinal capability are planned. These structures would be mounted to rock anchor/anchor bolt concrete foundations. These areas are in Loading Zone 4 and include sections of the line above 3,500 ft in Chitna Pass and the route alternative around Strelshla Mountain.

b. Direct Embedment Foundations

Direct embedment is appropriate for glacial till, rock and permafrost areas with shallow active layers. Direct embedment is practical for glacial till soils but presents problems for rock encounters and keeping excavated holes open if poles are to be set at a later date. Excavation also represents a greater impact on the environment in terms of soil disturbance and spoils. This could require more lengthy permitting scrutiny in the case of a Corps 404 permit in wetland areas.

Direct embedment would apply to single pole or H-frame structures, guyed and unguyed. However, direct embedment foundations for unguyed structures may be limited by the deformation properties of the annulas backfill material. Direct embedment requires augering to sufficient embedment depth, typically 9 ft to 15 ft, setting the poles or structures, backfilling and tamping. The hole must be maintained, i.e., must be prevented from collapsing, until the poles are set. Direct embedment in rock requires drilling for and blasting, excavating, then backfilling holes with imported material and tamping.

Direct embedment is not desirable in permafrost areas with thick active layers or in areas of thick muskeg because of excessive embedment depth. Gravel and rock backfill have been used with mixed results in muskeg situations, but we do not recommend this for the Intertie. Correcting a jacked situation is expensive requiring removal of the structure, temporary support of wires, re-augering the hole, and resetting the pole(s). It would not be practical to set the same structure deeper, and the jacking problem would likely persist intermittently throughout the project life.

Three operation sequences can be envisioned for different geotechnical conditions. First, for glacial till of adequate resisting capacity and depth after the site is laid out, holes can be augered and the pole immediately set or, if the poles aren't going to be set until later, casing can be installed for shoring, and the casing backfilled, tamped and capped. The poles could then be installed at anytime, similar to the X-frame.

Second, for sites with poor or unstable upper soil layers, after the site is laid out, a pipe pile can be driven, the poor or unstable soil within the pile removed, and the pipe pile capped for later pole installation.

This procedure would require a pile driving device and an auger. Driving the pipe pile could also serve as discovery for rock. This is a good/tried method in poor muskeg soils. The pipe pile is driven to required penetration of good soil or permafrost, a hole is augered inside the pipe pile and backfilled with suitable materiel to desired depth, the pole set to standard embedment depth in the augered hole inside the pipe pile, then backfilled and tamped. The pipe pile serves to transfer lateral loads from the pole to good soil.

Third, if rock is discovered, the augering crew would be demobilized, and a blasting/rock crew mobilized. No shoring is required but import of suitable backfill material may be necessary. If rock is known and planned, no demobilization is necessary. If large boulders are encountered either by the auger or pipe pile, structure relocation would be the preferred solution if it could be assured this would solve the problem. This would involve extra survey time to restake the structure and engineering time to evaluate the move from a spotting standpoint. A new site could also require review for the presence of important cultural resources.

In creek beds and occasional swampy/bog areas, direct embed holes will have to be shored and dewatered. Final design would attempt to limit the number of these sites. Winter construction would allow augering or pile driving without dewatering.

Direct embedment equal to 10% pole length plus 3 ft was assumed for Loading Zones 1, 3 and 4.

c. Pile Foundations

Pile foundations are appropriate for almost all soil and rock conditions. Since concrete foundations are not considered a feasible option, pile foundations would be used with X-frame structures; this is the common practice in Alaska. Pile foundations could also be used with guyed and unguyed single pole and H-frame structures. Pile types that could reasonably be considered include H-piles, pipe piles, and perhaps screw-tripod footings, a hybrid. Pile foundations are desirable for glacial till /muskeg/permafrost situations. This is due to (a) the relatively minor soil and wetland disturbance, especially during winter, and hence permitting advantages, (b) the ability to penetrate deep into the soil in order to obtain sufficient holding capacity, and (c) the flexibility to easily adjust to variable depth requirements. Pile foundations would apply best to structures with light lateral loads such as guyed single pole and X-frame structures.

Piles are usually used at sites where the soil layers, in which direct embedment foundations would normally be established, consist of poor or unstable soils. Piles provide good vertical load capacity as governed by their penetration into the good soil or permafrost. A single pile supporting a pole or structure must be sized to resist the design lateral loads. Therefore, in order to minimize the cost of a pile foundation the structures are often designed as a truss and/or guyed to reduce the lateral loading on the pile. Thus the popularity of the X-frame structure, an inherent braced design, in areas of poor or unstable soils.

Pile foundations, loaded to more than a single pile's capacity consist of multiple piles often installed at an incline (or batter) and tied together with pile caps that also connect the pole or structure. The batter provides some stability for eccentrically applied axial loads, should the pole ever go out-of-plumb.

H-piles have a strong and weak axis, making them optimal choices for applications where the design lateral loading on one axis is light relative to the other axis. H-piles with special, proven pin-connecting brackets are the usual choice for X-frame structures in Alaska.

Round (pipe) piles have the advantage of having equal strength in all lateral directions. They also can provide an adequate socket for direct embedding pole structures inside the pipe. A pinned connection to the top of the pipe pile would require a more elaborate attachment bracket than those commonly used for H-piles.

For guyed single pole structures a system of two, battered piles would be used as is common in Alaska. Alternatively three screw anchors in tripod formation could be, and have been, used.

Pile foundations require driving two H-piles, one for each X-frame structure leg, and an assumed two H-piles for each guyed single pole structure (six piles per 3-pole structure). There is no need to shore and protect a hole or backfill and tamp after setting a structure, as is the case with direct embedment. Welding is required for splicing pile sections (can be performed in marshall yards) and perhaps installation of pile caps for mounting single poles. Bolted connections for splices and pile caps may be a practical alternative.

To support self-supporting, unguyed structures the piles would have to have sufficient section modulus to resist the moment reaction from the mating structure leg. Special moment connection fittings would be required to attach self-supporting structures to the foundation pile(s). Such connection alternatives include (a) a can or baseplate mounted via a bolted connection to multiple H-piles with the pole fitted and grouted inside the can or bolted to the baseplate, (b) a driven pipe pile with an anchor bolt cap/mating plate with anchor bolt connection to baseplate of poles, (c) a special pole-slip-over-pile fitting as yet undesigned, and (d) a driven pipe pile with internal support ring at grade with pole set in the pipe pile stick-up and backfilled with select material or grout.

Practical pile-driving equipment alternatives include vibratory hammer with separate power pack or hydraulic hammer. In cold permafrost areas, piles may be installed with the aid of a preheated pilot hole.

Three operation sequences can be envisioned for different geotechnical conditions. First, after the site is laid out, piles are driven the full required length. Poles or structures could then be installed at anytime. For the X-frame structure it might be advisable to drive H-piles for the fore and aft guy anchors. Pile stick-up would be 4-6 ft.

Second, if bedrock is encountered, i.e., refusal occurs prematurely, the pile-driving crew would (a) attempt to drive at other foundation/anchors to verify extent and depth of rock then demobilize/mobilize to next site, or (b) directly demobilize/mobilize to next site. A rock foundation crew would then mobilize to install rock-anchored and grouted H-pile, excavating and backfilling as necessary. An alternative construction method, which may not work well in the bedrock of the Matanuska Valley, would entail pre-drilling the foundation rock, driving the pile in to refusal (estimated 2-3 ft), then installing rock anchors from the surface. This latter method, if practical, would probably result in less disturbance to the surface and soils.

If large boulders are encountered which lead to premature refusal structure relocation would be the preferred solution if it could be assured this would solve the problem. Driven H-piles generally penetrate boulder-laden soils fairly well, and it is expected that the number of structure relocations will be fewer than for the direct embedment alternative. If relocation is deemed desirable, it would involve extra survey time to restake the structure and engineering time to evaluate the move from a spotting standpoint. A new site could also require review for the presence of important cultural resources.

Pile foundations were sized for extreme wind conditions and Teal conductor. H-pile foundations were sized for X-frame structures assuming 10X57 piles, 3H/8V batter on legs, 21-ft crossarm to waist dimension, medium soil compaction, a 7-ft active layer, a 3-ft reveal, compressive skin friction 2,000 lb/sf, and uplift skin friction of 1,000 lb/sf. Pipe pile foundations for H-frames in Loading Zone 2 were sized based on sheer and overturning moment at 30-inches diameter and 0.25 inch thick.

d. Anchors

Discussions with an Alaskan line contractor indicate a strong preference for log anchors where excavation is practical, due to their reliable development of adequate holding capacity under test. H-pile anchors would be practical for X-frame structures since a pile driver would already be mobilized. Rock anchors, either grouted or expandable type, would be used in rock situations.

6. Anchorage-Fairbanks Intertie Structure Study

Prior to design of the Anchorage-Fairbanks 345-kV Intertie, Commonwealth Associates, Inc. prepared a comparative study of structure types [13]. This study evaluated eight different structure types including self-supporting steel poles, self-supporting steel and wood H-frames, guyed steel X-frames, self-supporting steel lattice towers, guyed steel or aluminum lattice X-frame, guyed steel or aluminum lattice delta, and guyed aluminum lattice wye configurations. The observations and conclusions of [13] are applicable to the present feasibility study as well. Major findings are summarized below.

The self-supporting steel pole was judged to be the most aesthetically pleasing type due to its simplicity, narrow silhouette, self-weathering steel color (light to dark brown), and potential for screening. The self-supporting steel H-frame, guyed steel X-frame, and self-supporting wood H-frame were considered acceptable in this regard.

The guyed X-frame and self-supporting steel pole structures were evaluated to be the most reliable and easiest to maintain, except that the self-supporting steel pole was a much taller and heavier structure which would make replacement difficult. This latter concern does not apply to the same extent on the Sutton-Glennallen Intertie because the design loads are much smaller. The X-frame structure was overall judged the best in terms of reliability and maintenance because of simple, reliable foundations, flexibility in frost-heave situations, and ease of replacement. Steel H-frames (braced) were penalized for poor performance in frost-heave situations and difficult replacement due to their weight. Wood H-frames were critiqued for their susceptibility to fire damage, low resistance to avalanche forces, and poor performance in frost-heave or differential settlement situations. The authors mention that in remote locations, where helicopter access may be severely limited at certain times of the year, it may be prudent to station replacement structures or components along the line.

The guyed X-frame was judged to be the most constructible type considering foundations and anchor requirements, terrain and ease of setting in uneven terrain, number of components, and weight of components. The advantages of the X-frame were cited as its comparatively light structure component weights, the less critical tolerance on foundations, and simplicity of foundations. The required fore and aft anchors were listed as disadvantages although their possible use as a field erection aid was mentioned.

The guyed X-frame was evaluated to have the least total 100-year life-cycle cost per mile including both capital and maintenance costs. The self-supporting steel H-frame was evaluated to be not significantly more costly (only 1.02 times the X-frame cost/mile) than the X-frame structure option.

Overall [13] recommended the guyed steel X-frame structure as the most desirable structure type for the project considering its high rating in all the evaluation categories above.

7. Construction Plan

a. Background

The Intertie corridor can be logically divided into three or four construction zones roughly parallel to the loading zones selected for the feasibility study. For the purposes of this study the construction zones will be taken as equivalent to the four loading zones, although differences in terrain, permitting restrictions, access, and other factors would be expected to create some overlaps.

Characteristics of the four zones can be described as follows:

Loading Zone 1 stretches from Sutton to Caribou Creek in the Matanuska River Valley. It is generally heavily to moderately heavily forested with alder, cottonwood, white spruce, and birch on the western end of the zone. It is estimated that the forest resources have no commercial value and would not have to be removed, but a formal determination of this rests with ADNR. Special treatment of cleared white spruce (e.g., chipping, crushing, or controlled burning) will be required to control the bark beetle infestation. The zone lies in parts of the Matanuska Valley Moose Range (MVMR) and has the most potential conflict with private, native and native-selected lands. Elevations are 500-2,500 ft ASL. Glacial till is the dominant soil type with pockets of muskeg and rock expected. No permafrost is expected and direct embedment foundations are practical. There are four major creek and river crossings (Granite, Kings, Chickaloon, Boulder) and limited access to the ROW from the Glenn Highway unless the few existing trails can be upgraded for use. Access overland along ROW is possible. Year round construction is possible.

Loading Zone 2 lies in the Copper River Basin and east of Syncline Mountain. The terrain is barren at higher elevations and moderately heavily forested with predominantly black spruce from Slide Mountain eastward. There may be some forest stands of commercial value mostly in Ahtna lands in the easternmost 10-15 miles of line corridor. Winter roller crusher clearing is appropriate for this zone. The zone lies mostly in state and Ahtna lands. The soils are characterized by extensive permafrost and wetlands. There is high potential for impacts and construction restrictions due to wildlife and waterfowl habitat. No new access roads are assumed but there will be good access in winter. Foundation construction will take place in winter only and will use driven piles to minimize damage to wetland areas. Special construction methods would be required for stringing in non-frozen conditions. Elevations are 1,700-3,300 ft ASL.

Loading Zone 3 is located at elevations generally greater than 3,300 and not in Zone 4. This includes back country valleys in the Talkeetna Mountains. Soils will be mostly glacial till and colluvial with pockets of muskeg and wetlands. No permafrost is anticipated except perhaps on north-facing slopes. Direct embedment foundations are estimated to be practical. Route alternatives in Loading Zone 3 follow creeks and streams with only a few crossings. Construction would require a combination of helicopter and limited overland access to the ROW. Access along ROW is assumed practical between major streams. Except for the north bank of Squaw Creek with relatively heavy forest cover, open land is the rule with little or no clearing required. Loading Zone 3 would be non-winter construction mostly with some fringe winter construction possible such as in the higher elevation muskeg areas near Pass Creek and Crooked Creek. Routes in Loading Zone 3 lie mostly on state and federal lands with numerous unpatented mining claims. Moderate construction restrictions may apply to limit impacts to wildlife habitat.

Loading Zone 4 includes all route segments above elevation 3,300 ft and occurs in only two locations, north of Strelshla Mountain and over Chitna Pass. The dominant soil types are expected to be glacial till, colluvial soils with increased presence of rock compared to Loading Zone 3. Loading Zone 4 would require all-helicopter construction with no overland access assumed. Construction would be restricted to non-winter periods only. The terrain is characterized by open land with no clearing required. All route segments in Loading Zone 4 are on state land, with some unpatented mining claims expected. The only wildlife habitat construction restrictions would appear to be with regard to Dall sheep.

b. Feasibility Study Construction Plan

Several factors determine how the Intertie would be constructed. A project schedule is presented in Section VII and is based largely on the assumptions below.

(1) Road and Trail Access

The line route alternatives do not parallel at close distance any existing road. The Glenn Highway would be used to move material, equipment and labor along the length of the corridor to several marshall yards. Access to the ROW along adequate existing roads is only known to be possible from seven locations: Jonesville Road, Martin Road, Tractor Trail at Eureka, Lake Louise Road, Tolsona Lake/Moose Lake Road, the Glenn Highway crossing and the Alyeska Pipeline access road. An estimated 50 miles of ROW could be accessed without crossing major streams using these access points.

From aerial photography and topographic maps, supplemented by helicopter reconnaissance, we note that several major and many minor trails lead from the Glenn Highway to the various route segments. It does not appear desirable, however, to upgrade or use most of the public trails in the Matanuska Valley for construction access due to the historic and recreational importance of many trails. However, based on review of aerial photos there do appear to be some trails which might be usable for a single entry point to the ROW on otherwise isolated line sections (e.g. Segment 2-3). It is assumed that trails in state land in the Copper River Basin (e.g. Nickoli Lake, Atlasta Creek) could be upgraded and used, although this would be subject to ADNR approval. Trails also extend the length of Boulder, Caribou, Alfred, Squaw and Crooked Creeks. The Squaw Creek trail is apparently heavily used and would be suitable for construction access, although if the final line route is on the south bank of Squaw Creek the road would be of limited use unless Squaw Creek can be crossed. Portions of Squaw Creek and Crooked Creek trails were explored on ATVs during the study. The Crooked Creek trail and most trails in the area passed through pockets of muskeg which would not support heavy equipment except in winter or perhaps using special vehicles. Several active mining claims, and a few abandoned ones, were noted and it is clear that this part of the corridor is no stranger to moderately heavy mining equipment.

Crossing anadromous streams is of particular concern, as evidenced by construction delays on the Anchorage-Fairbanks Intertie project. To construct a route segment between two streams a contractor would have to (a) gain direct access to the ROW, (b) cross the streams either by fording or temporary bridge, or (c) transport equipment by helicopter.

Option (a) has been ruled out for some segments such as Segments 4-7 and 7-8 by not assuming any new access points to the ROW or use of popular public trails for access.

Option (b) would be the most cost effective if it could be assured that the crossings would be possible and allowed in a timely way. Granite Creek, Kings River, and Chickaloon River are apparently too steep at the ROW juncture to allow crossing within the ROW. The open-water timing windows for fording or construction in anadromous streams is tied to the absence of salmon eggs or frye in the stream (May 15 to July 15 approximately in Matanuska Valley, June 1 to August 1 in the Copper River Basin) and, generally, eggs are fairly resistant to cold and other disturbance about two months after spawning in mid-July to early-August. Crossing the streams or construction in them is also permissible under frozen conditions, say late November to late February. ADF&G personnel indicate that damage to stream banks and restoration of same would be highly important permitting criteria.

Several types of temporary bridges could be considered such as culvert beds, flat railcar deck or extendible Bailey truss bridges. The use of temporary bridges would facilitate the movement of different equipment along the ROW for the duration of the project but would allow increased off-road vehicle access to corridor lands during the project.

Option (c), the transportation of equipment by helicopter is practical in most circumstances but requires equipment that weighs less than the practical lift capacity of heavy helicopters (25,000 lb approximately) or which can be broken down and assembled at the project site. Pile-drivers, diggers, rock drills, and most stringing equipment will meet this criterion. This is a costly solution to ROW access unless is could be dovetailed with other tasks to give a high utilization of the helicopter and avoid high mobilization/demobilization costs.

Of special concern are the significant wetlands in the Copper River Basin. Most construction through structure erection will occur in winter. However, conductor installation will occur anywhere from late spring to early fall during which time the ground may not be frozen enough to allow tensioners, pullers and sagging equipment to move along the ROW without causing some damage to the wetlands. The damage may be viewed as temporary by ADF&G and ADNR and allowable. Wetlands may be avoidable by leaving the ROW. Permits with the ADNR, ADF&G and BLM should strive to include a provision of this nature. Site improvement or mats may be necessary to support certain equipment at stringing set-up locations. Construction activities may be restricted in the vicinity of trumpeter swan habitat in the May 1 to August 31 period.

For the purposes of the feasibility study and based on public concern over the issue of increased access to corridor lands, we assume that no new access roads would be built to the ROW, although access would be initiated at the road crossings cited above. It is assumed that some trails could be upgraded to allow access to a few segments, e.g., Segment 2-3. East of Syncline Mountain, where most construction will be during the winter, access is assumed very good using tracked, snow vehicles. We also assume, based on discussions with ADF&G, that equipment can be moved along the ROW over most of the Intertie route, subject to timing windows cited above. A grubbed, 12 ft primitive path along the ROW would be available for equipment travel on good soil.

(2) Helicopter Use

Helicopters may be used throughout the project for appropriate tasks. Only in a few situations will a contractor be required by the construction specifications to use helicopters. Such helicopter-requirement instances will be identified during the permitting process and might include stringing a pilot line in the wetland areas of Zone 2. Otherwise, use of helicopters would largely be up to the line contractor(s). Generally, helicopters are viewed as cost efficient for tasks like structure installation, pilot line stringing, material delivery, crew transport, etc., and are often a contractor's method of choice.

For the feasibility study it is assumed that all structure material will be delivered to the site by helicopter, including foundation and anchor material, fully-framed structures and conductor reels. Helicopters would be used selectively to move construction equipment and personnel to the ROW and from site to site, and exclusively for both materials and construction in Zone 4.

A wide range of helicopter capacity is appropriate for different tasks, as demonstrated on the Anchorage-Fairbanks 345 kV Intertie and other Alaskan transmission line projects. Light helicopters, such as the Bell 205-206 variety, would be used for personnel transport, light material transport, and pilot line stringing. Typical costs for this class of helicopters would be $550-$700/ flight-hour plus fuel.

Medium lift helicopters such as a Boeing VERTOL 107 (10,500 lb sea-level lift capacity), operated by Columbia Helicopters out of Oregon, or, to a much smaller extent, an Aerospatiale Super Puma (6,000 lb sea-level lift capacity), operated by ERA Helicopter in Anchorage, are capable of hauling typical fully-framed X-frame, H-frames and single pole structures. Weights for these structures are generally expected to be 3,000-9,000 lb Our rough engineering computations show some structure weights above that amount but we expect that special care during engineering design to limit structure weights or break them down into lighter components would be successful in meeting the 10,500 lb limit, but it would be more difficult to meet the 6,000 lb limit. The 10,500 lb limit capacity is sufficient for the maximum reel weight for 10,490 ft of Teal ACSR at 9,860 lb, while the 6,000 lb limit would be restricted to half-size reels. Typical costs for this class of helicopter would be $2500-$3000/flight-hour plus fuel. The Columbia VERTOL 107 is commonly used for logging in Southeast Alaska and returned to Oregon in the winter. If high utilization rate is probable, the VERTOL can be made available for line construction in Alaska, with a lower mobilization cost than a helicopter coming directly from Oregon.

Heavy lift helicopters, such as the Boeing CHINOOK 234 (26,000 lb sea level lift capacity), operated by Columbia Helicopters or the Sikorski SKYCRANE (20,000 or 24,000 lb sea level lift capacity) operated by Erickson Skycrane, both based in Oregon, could easily lift any structure or standard reel size contemplated for the project as well as most equipment. Erickson has developed and implemented an anti-rotation lift device that allows precise and rapid placement of structures. The SKYCRANE also features a rear-facing pilot position that facilitates lifting and placement of loads. Both firms principally use these helicopters for logging due to the high utilization rate. Neither is based in Alaska and would require a mobilization and demobilization cost estimated at $150,000. If any portion of the work absolutely requires this lift capacity it would seem prudent to maximize its use. For the purpose of this feasibility study, we have assumed no usage of this helicopter since it is not certain if this capacity would be required. Typical costs for this class of helicopter would be $6500-$7500/flight-hour.

The efficiency in structure erection gained by use of helicopters is impressive. On a recent storm rebuild project (345-kV, wood H-frame, 65-miles long), 149 structures were set by helicopter in one 9-hour day and all 400 structures were set in four days. In this case marshall yards were located on the ROW. On a section of a New Jersey project which traversed inaccessible wetlands, helicopters were used to fly in vibratory hammers/power packs for driving 9-10 steel caissons and then to fly in and set framed single steel pole structures, all in one day. There have been similar experiences on Alaskan projects such as Swan Lake, Tyee Lake, Anchorage-Fairbanks Intertie, and Bradley Lake.

We have assumed for the feasibility study that such efficiencies would also be beneficial and that all structure erection takes place over a two-month period by flying in fully-framed structures. There may be sections of the line which would benefit from land-based installation, such as in Sutton and other areas where access to the ROW with construction equipment is easy. We have not precisely accounted for these sections in the study.

(3) Foundations

Foundations for transmission structures can be of several basic types with the most commonly used being direct embedment, driven pile, drilled concrete-pier, concrete pad with rock anchoring, and concrete or steel spread footings in excavated holes. The high cost of transporting concrete to distant line locations makes drilled concrete piers, concrete spread footings and concrete pad footings undesirable except where special self-supporting structures are required.

Direct embedment and driven piles are the most commonly used support systems for transmission structures in Alaska and the most cost-effective. Concrete foundations will be considered only for self-supporting deadend or angle structures.

Direct embedment is only practical where granular soils or rock allow sufficient development of soil overturning resistance for a stable footing. This method would appear to be most appropriate for Loading Zones 1, 3 and 4. A modified construction technique has been used where a caisson is driven through poor soil like muskeg and into underlying good soil strata, then overaugering and backfilling with select backfill to standard embedment depth, setting the pole and backfilling the hole; the caisson is relied on to transfer base reactions to good soil strata and must be properly sized. This technique might be used in Loading Zones 2 and 3 where wetlands are encountered, except that it would require significant excavation and spoils which might complicate permitting.

If helicopter-erection of structures is assumed, the direct embedment of structures on the Intertie would require a caisson or some other means of shoring to maintain the holes ahead of structure erection. In areas where boulders and cobbles dominate, wide holes would be excavated and suitable backfill material would have to be imported at significant cost. In rock areas holes would have to be blasted and excavated. In all direct embedment cases the embedment hole will have to be backfilled in a separate operation. Direct embedment is suitable for both self-supporting and guyed structures. Equipment required would depend on the type of soil but would typically be a pile-driver for the caisson, an auger for excavating holes and equipment for handling the caisson.

Efficient and productive pile-driving will depend largely on the type and size of equipment selected for the task. We discussed pile-driving options with a line contractor with experience on the Swan Lake Project and familiarity with the Anchorage-Fairbanks Intertie.

On the Swan Lake Project versatile, relatively lightweight pile-driving equipment was developed for rough terrain operation and where no roads were allowed. A modified hydraulic demolition hammer was mounted on a Menzi-Muck all-terrain backhoe (*Transmission & Distribution*, September 1987 issue, page 50). The Menzi-Muck was also modified and special construction equipment developed to carry rock drills and to perform foundation uplift tests. It was highly mobile at the structure sites, with the ability to swivel 360 degrees, an articulated arm and self-propulsion. On the Swan Lake Project, a 20,000-lb lift helicopter was used to move the Menzi-Muck with pile-driver (total weight 17,000 lb) along the ROW in conjunction with logging operations. However, it is feasible to assume a Menzi-Muck would be able to move along the ROW without helicopter assistance, albeit at a rate of about 500 ft/hr. It can be outfitted with oversized tires to traverse swampy areas with minimal disruption. It can operate on slopes up to 45 degrees without the need for anchors and as outfitted for the Swan lake Project could manipulate and handle up to 30-ft piles.

A mix of Menzi-Muck mounted pile drivers for rough or unfrozen wetland terrain and more common tracked crawler-backhoes outfitted for pile drivers on firm ground where a grubbed primitive road is available for movement along the ROW would be most desirable coupled with an appropriate selection of pile-driver equipment.

Pile-supported foundations would be suitable for the pin connection of the guyed X-frame structure and poles of the three-pole structure family. In rocky areas, drilling a pilot hole prior to pile driving has proven effective in achieving required driven lengths. Another method used on Swan Lake involved driving piles to resistance, and depending on embedment at that point, installation of anchor rock bolts to provide the balance of strength required; prefabricated cans were mounted on the H-piles for receiving the (wood) poles. Driven piles offer distinct advantages in terms of construction plan scheduling since the foundation may be left in place until structure erection can be scheduled and will be ready to immediately accept the structure. Driven piles would be used for all structures in permafrost and wetlands areas, i.e., mostly in Loading Zones 2 and 3. Equipment would include a rock drill rig where rock is known to exist, an hydraulic ram pile driver and equipment to handle the piles.

Piles would be used for X-frame structures in all loading zones, all structure types in Loading Zone 2, and for 3-pole structures in mostly Loading Zones 2 and 3 where wetlands are encountered. Direct embedment could be used for 3-pole structures in Loading Zones 1, 3 and 4.

(4) Structure Erection

Two basic methods could be considered for the Intertie. First, structures could be delivered to the structure sites ahead of foundations and in a disassembled state. The structure field assembly, framing and erection would then take place immediately after foundations are completed. Second, the structures could be assembled in marshall yards, flown to the structure site fully framed with travellers and installed well after foundations are in place.

The first method would likely suffer some inefficiencies because of the poorer field conditions and lack of some equipment to aid structure assembly. Because this method would allow immediate erection and backfilling, it would not be necessary to shore or case augered holes in good soil. Structures could be delivered to the site any time prior to foundations. However, the project schedule in Section VII assumes a furnish and install contract in which the line contractor(s) purchase structures from August 1996 to January 1997, while foundations are being installed. To use the first method and keep the same schedule, structures would have to be purchased (and later stored) by CVEA under separate procurement contract earlier in the project. While this would save contractor mark-up costs, the additional owner costs for storage, an extra contract process and the risks associated with possible realignments and relocations after structure purchase are compelling reasons to use the furnish and install contract. Major equipment would typically include a tracked auger and rough terrain crane.

The second method entails the assembly and full framing of structures in one of 7-8 marshall yards located along the Glenn Highway. Assembly would include insulator strings and stringing travellers and fixed climbing devices for steel structures. Folding ladders could also be attached and flown in with the structure for rapid ascent by field crews. In this method the structure site would be inspected and prepared for arrival of the structure. For direct embedded structures this might entail removing any cover on augered holes, verifying the condition of the hole bottom, and perhaps verifying the hole depth. On pile-supported structures, the same level of preparation would not be necessary. This method allows for a concentrated helicopter lift period and excellent helicopter utilization, on the order of 8 hours per day, well above the usual minimum-use stipulation in helicopter contracts. Although we have allotted two months in the schedule for structure erection by this method, it is not unreasonable to expect that helicopter delivery of about 700 structures to their sites, assuming a well-organized operation on the ground, would take no more than one month or less, based on recent experience. No major equipment would be required for this operation, only small tools and, for direct embed operations, tampers for backfilling.

We assumed the second method for all structure erection. It may be desirable to use the first method in Loading Zone 1. There is a definite possibility that, especially for direct embed structures, helicopter delivery could outrun ground crew productivity. Some means to rapidly transport ground crews from site to site will be required to keep up with the helicopter.

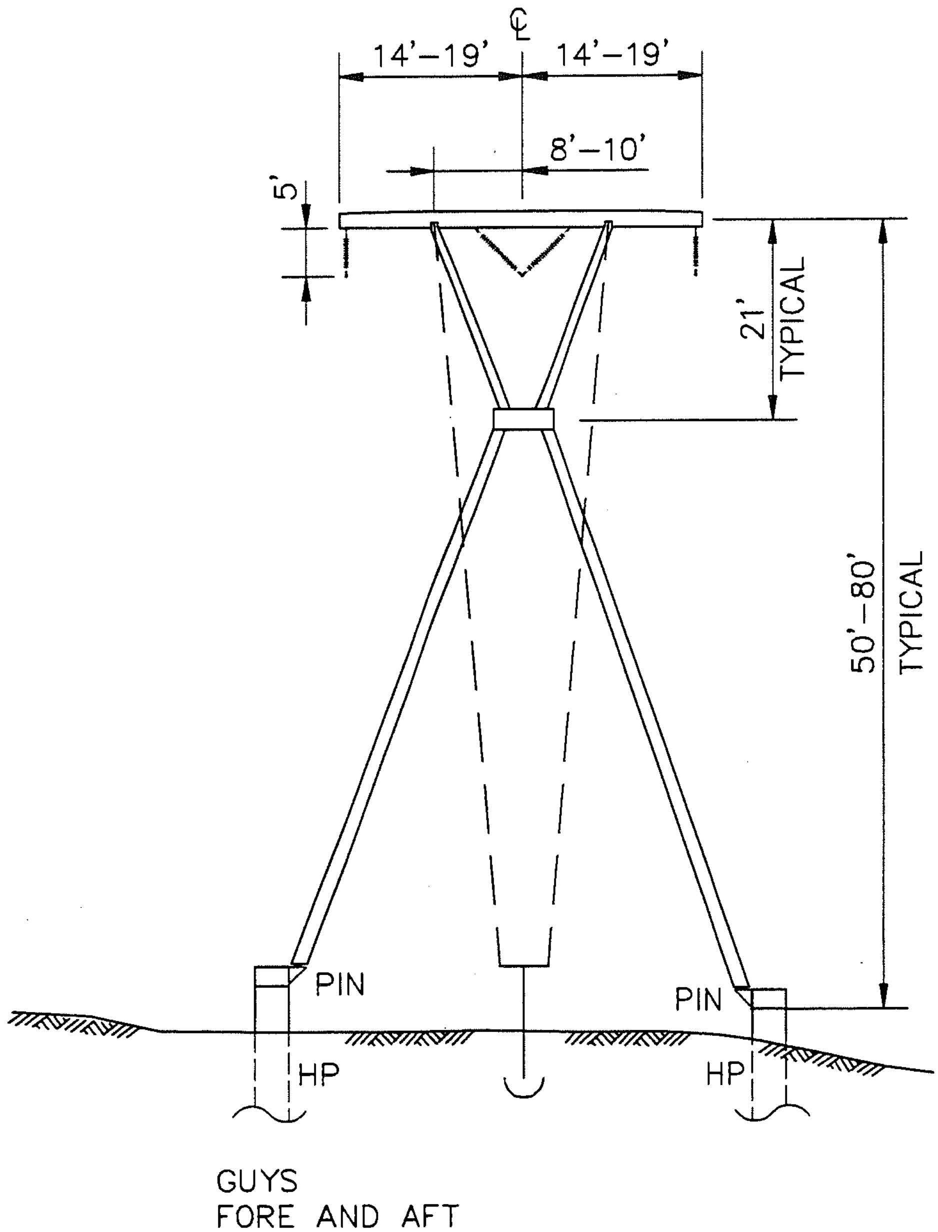
(5) Conductor Stringing

Conductor stringing involves installation of the travellers on the insulator strings, establishing conductor reel and pulling sites, pulling in the pilot line usually with a small helicopter, then pulling in and sagging the conductor. Later operations include clipping in the conductor, installation of vibration dampers, and making up deadend assemblies.

Typical reel sizes on the project contain about 5,000 ft of conductor; larger reels are possible but would require larger stringing equipment. It would appear practical to double-sock and even triple-sock using stringing equipment with 5,000 lb tension rating, to limit the number of set-up sites. This would be especially important in Loading Zone 2 wetlands.

Conductor stringing would take place from late spring to early fall, beyond the possibility of ice-up or other significant loads which could render the critical stringing sag specifications useless.

Stringing would take place immediately following structure erection as shown in the project schedule in Section VII.

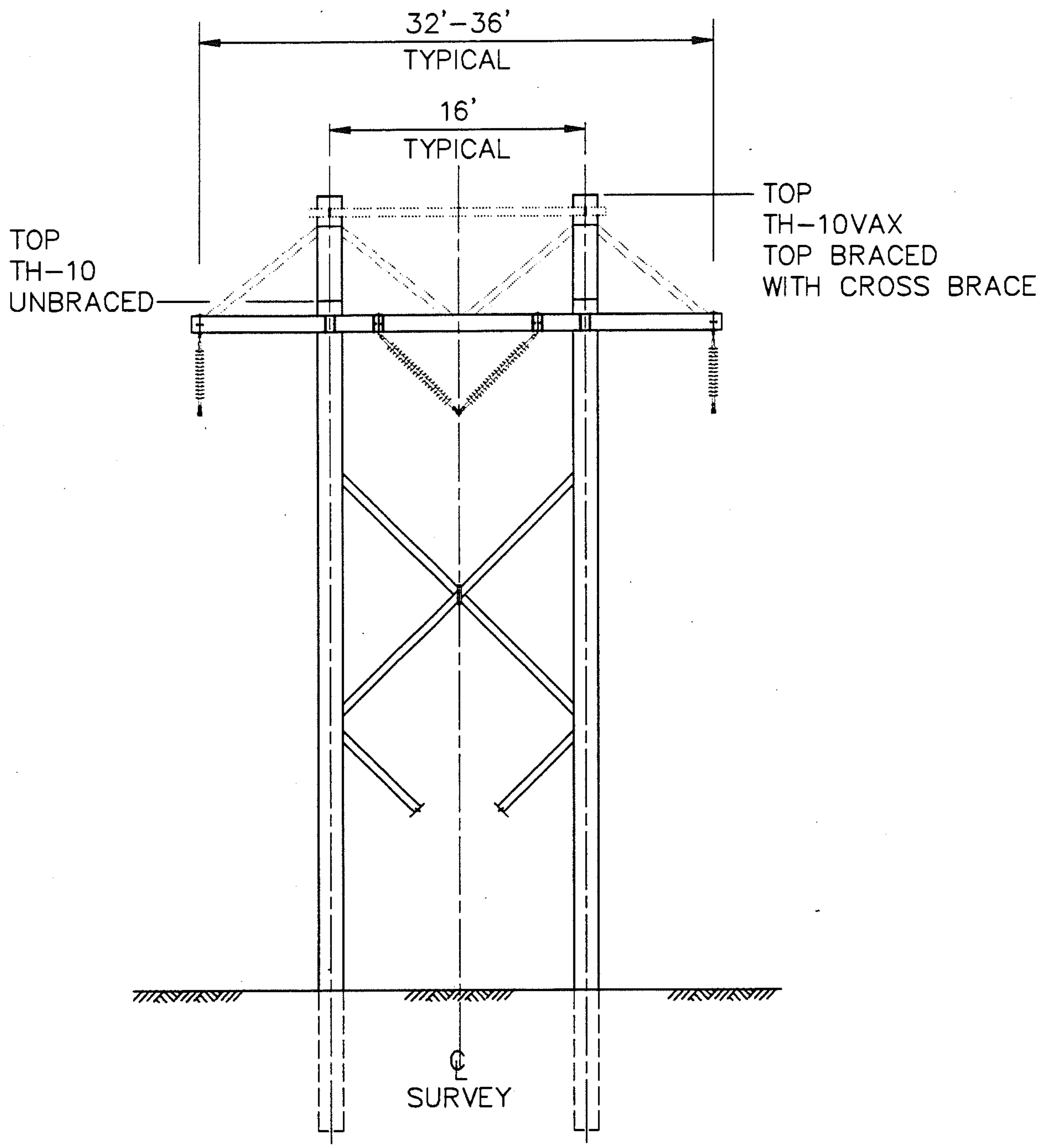


NOTE:
PHASE SPACING VARIES WITH CONDUCTOR AND LOADING ZONE.

FIGURE IV-1
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
TANGENT X- FRAME STRUCTURE

R.W. BECK AND ASSOCIATES

AAB07002



DIRECT–EMBEDDED OPTION SHOWN
ALTERNATIVE PILE–MOUNTING

FIGURE IV-2
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
TANGENT WOOD H-FRAME STRUCTURE

R.W. BECK AND ASSOCIATES

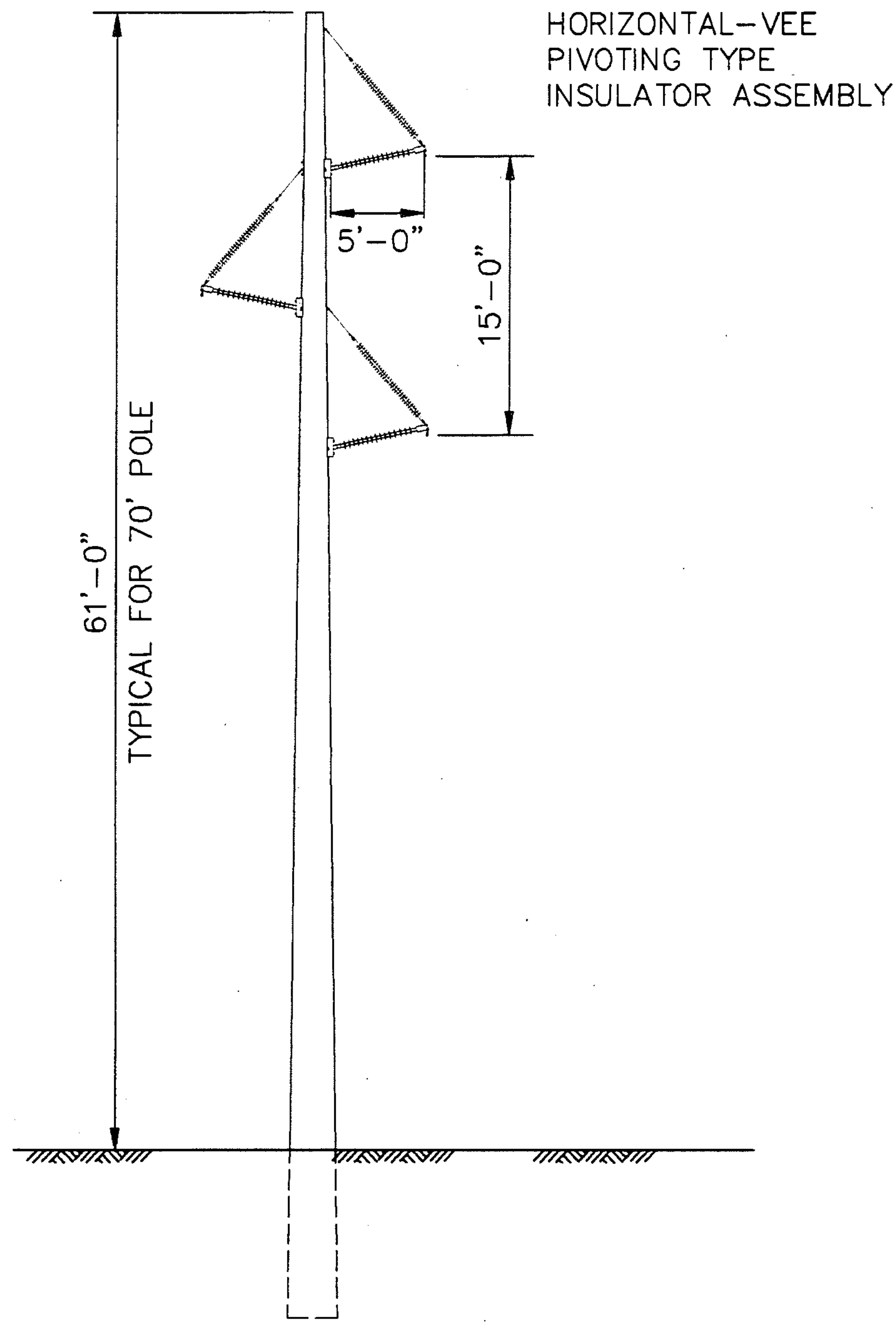


FIGURE IV-3
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
TANGENT SINGLE WOOD POLE

R.W. BECK AND ASSOCIATES

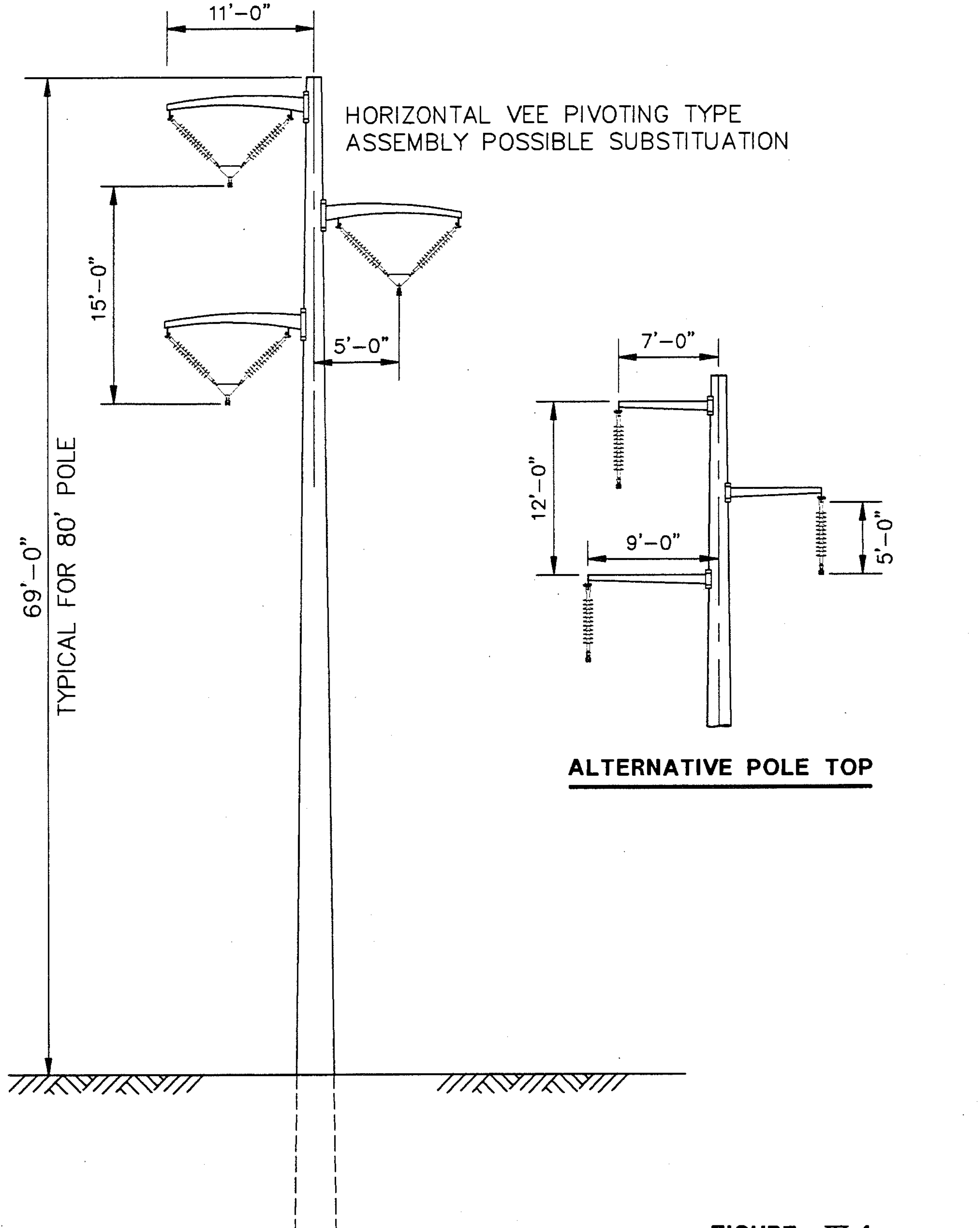


FIGURE IV-4
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
TANGENT SINGLE STEEL POLE

R.W. BECK AND ASSOCIATES

AAB07005

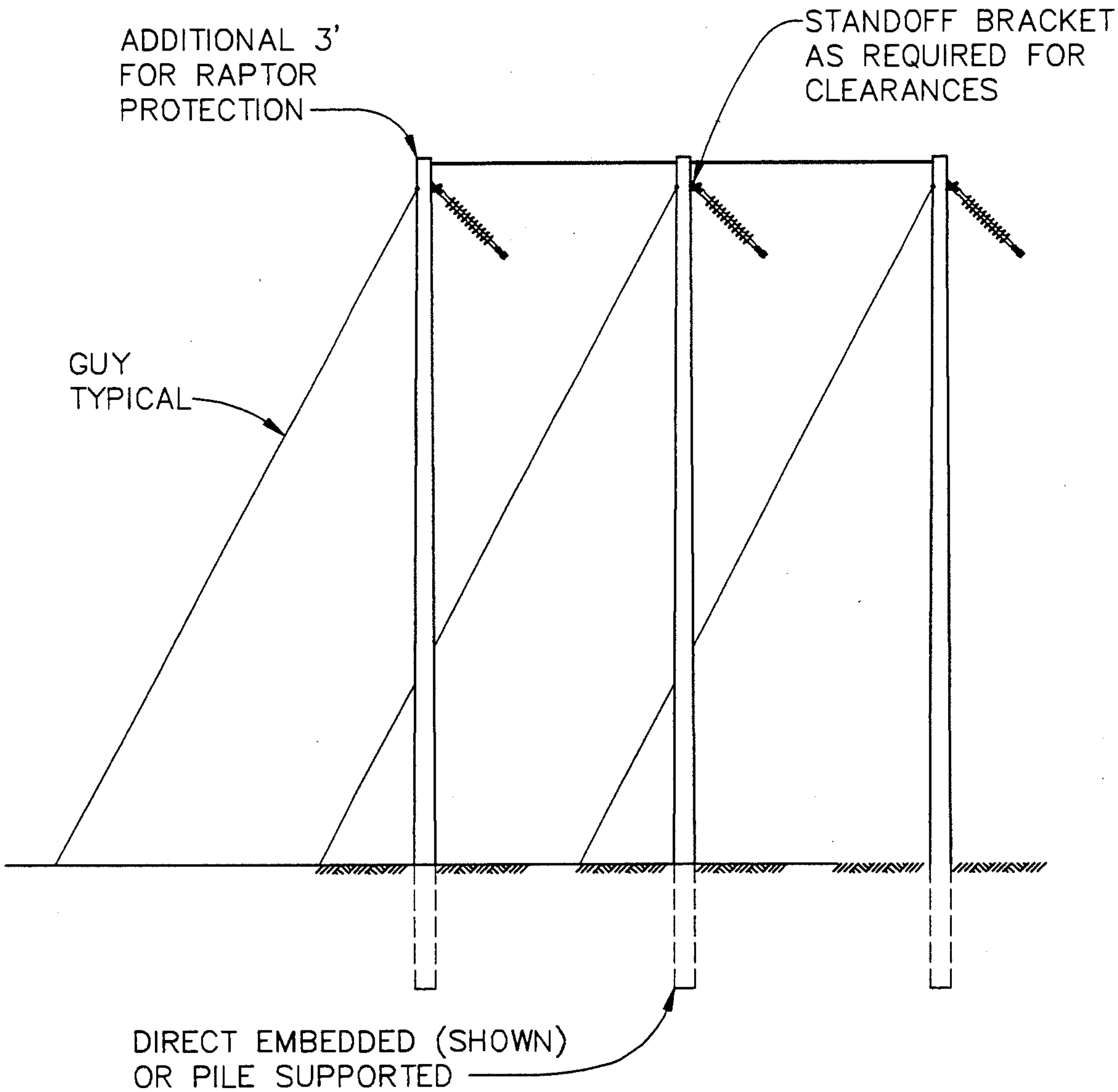
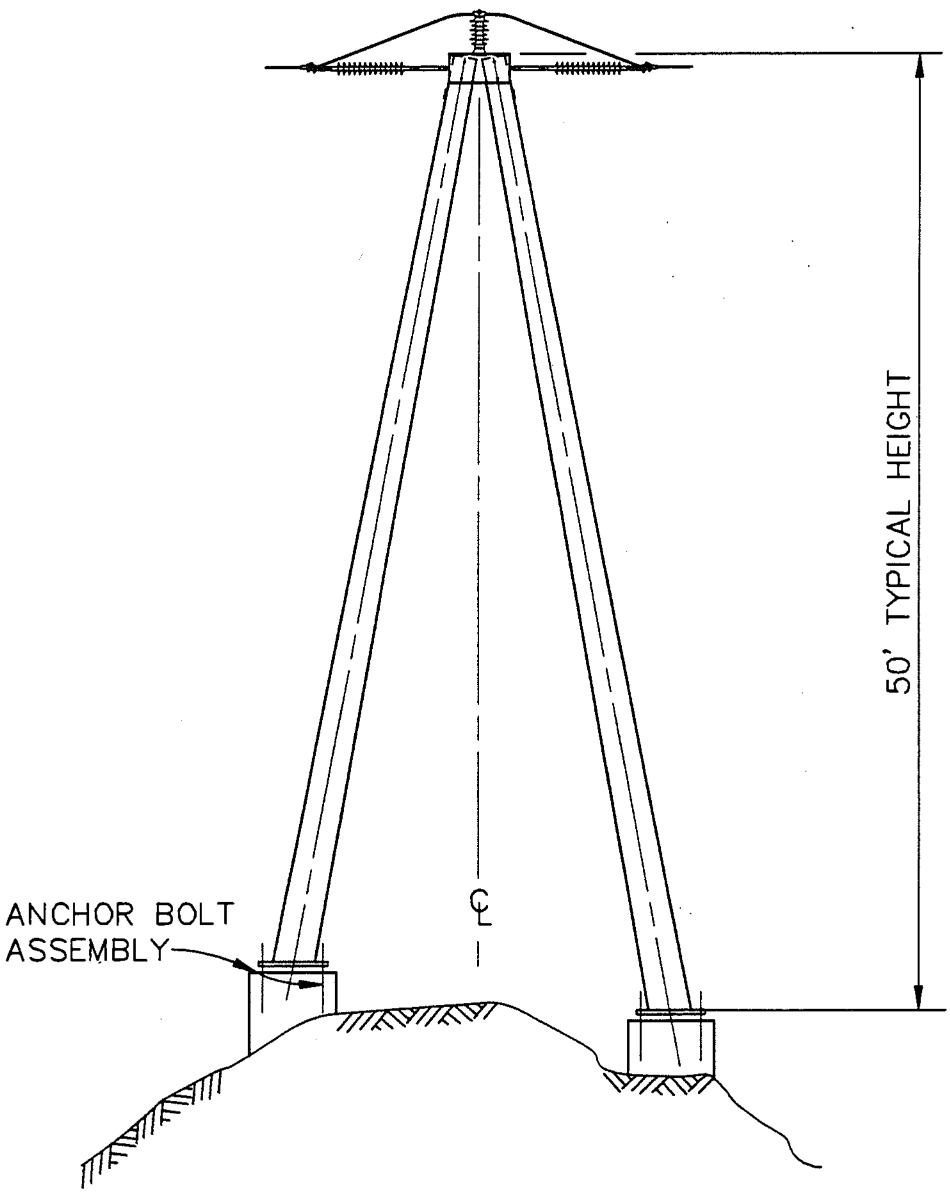


FIGURE IV-5
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
RUNNING ANGLE THREE POLE STRUCTURE

R.W. BECK AND ASSOCIATES

AAB07006



NOTE:
ONE STRUCTURE PER PHASE.

FIGURE IV-6

ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

TYPICAL STEEL A-FRAME STRUCTURE LONG SPAN CROSSINGS

R.W. BECK AND ASSOCIATES

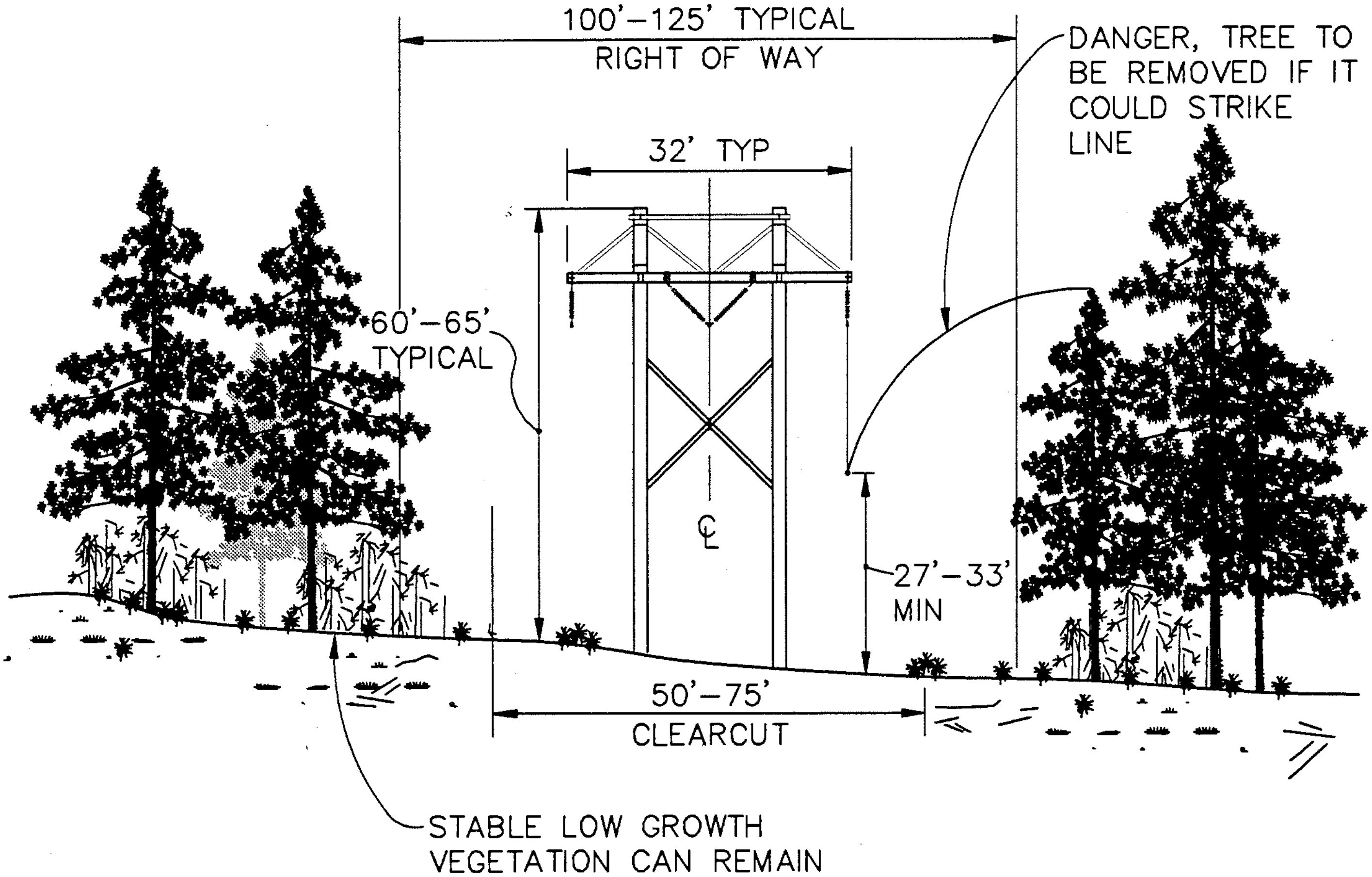


FIGURE IV-7

ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

RIGHT-OF-WAY CROSS SECTION HEAVY FOREST

R.W. BECK AND ASSOCIATES

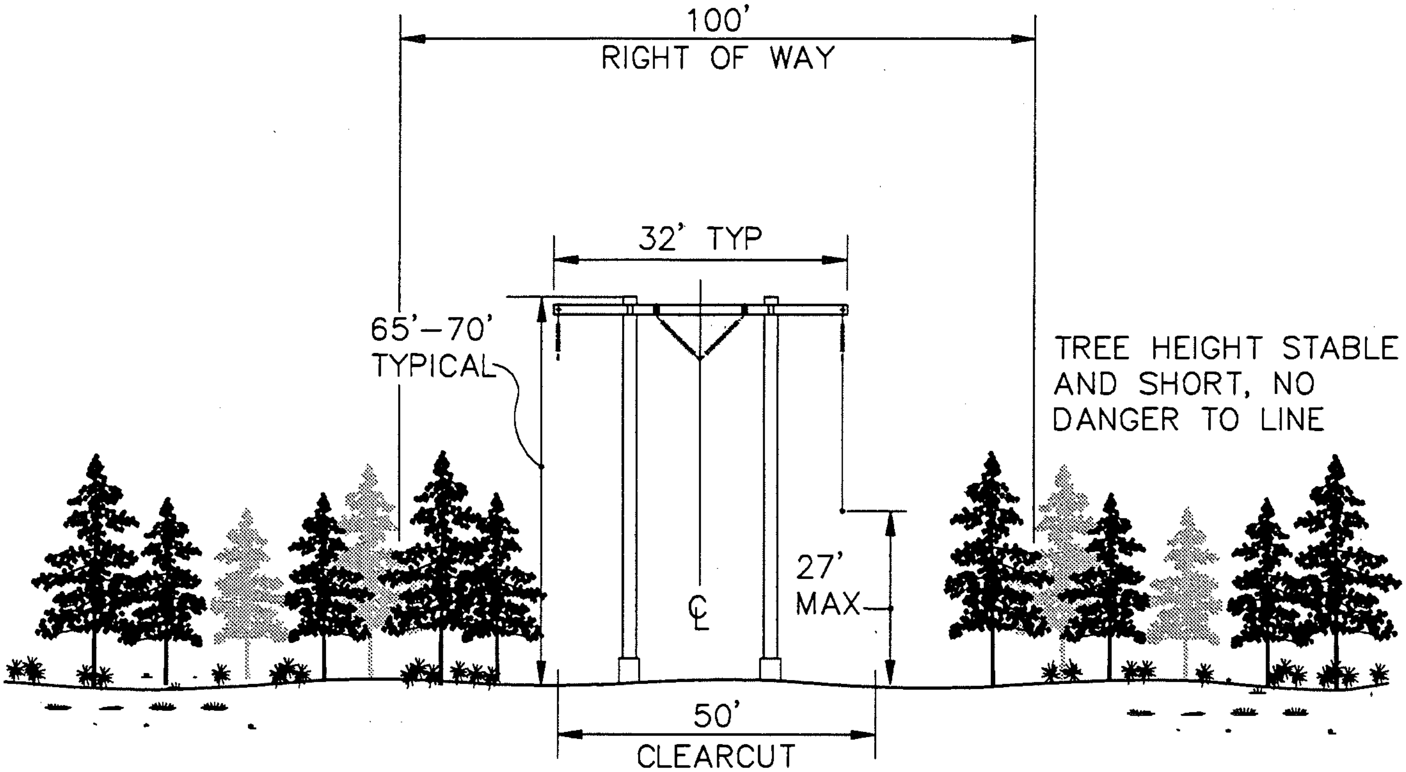


FIGURE IV-8
ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY
RIGHT-OF-WAY CROSS SECTION SPARSE / LOW FOREST

R.W. BECK AND ASSOCIATES

FEASIBILITY DESIGN - SUBSTATIONS

A. BACKGROUND

Reference [1] assumed that the Intertie would originate at MEA's O'Neill Substation in Sutton and terminate at Authority Pump Station No. 11 Substation in Glennallen. The switching configuration and cost estimates were developed based on expansion of the two substations.

The difficulty of routing a new transmission line out of O'Neill Substation, located in a residential zone of Sutton, and expanding the substation while maintaining load, have made it preferable in our opinion, to situate the starting point of the Intertie at a new substation located about 0.7 mile west of the O'Neill Substation on Mat-Su Borough land, along the 115-kV transmission line feeding O'Neill Substation.

Figure V-1 shows a one-line system configuration of the proposed Intertie.

B. NEW SUBSTATION NEAR O'NEILL SUBSTATION

Figure V-2 shows an equipment layout of the new substation. The new substation will tap into the existing 115-kV line feeding O'Neill Substation at about 0.7 mile west of O'Neill Substation. Two disconnect switches will be provided at the tap point for line maintenance purposes as discussed with MEA staff. We have proposed a simple, radial transformer tap switching configuration with a circuit switcher on the 115-kV side and a circuit breaker on the 138-kV side. Omission of the 138-kV side circuit breaker and replacement of the 115-kV side circuit switcher with a circuit breaker should be considered during final detail design. No integral disconnect switch is provided with the circuit switcher, but separate disconnects are provided on each side of the circuit switcher as well as for the circuit breaker. Both the circuit switcher and the circuit breaker are provided with a bypass disconnect switch as requested by CVEA.

During circuit breaker or circuit switcher bypass operation, a line-side, spring-loaded short-circuit ground switch could provide transformer protection by creating a ground fault that would be sensed and cleared by remote end overcurrent protection. It should also be considered during detail engineering whether the 138-kV side circuit breaker could be omitted, and only rely on the short-circuiting ground switch and the remote end circuit breaker (at Pump Station No. 11 Substation) to clear transformer faults from the 138-kV side.

A 12/16/20 MVA auto-transformer steps the voltage up from 115 kV to 138 kV. The transformer rating is adequate for the 20-year load projection of about 20 MW and greater than the single contingency transfer limit identified by PTI (Volume 2, Appendix O). The foundations and oil containment will be sized for the ultimate station capacity.

CVEA requested that no PLC communication system be included for transfer tripping on the Intertie based on perceived marginal benefit and poor experience with existing PLC systems. We did not investigate alternative means of providing a communications link (e.g., microwave, leased telephone line, fiber optic). Omitting a communications link requires that stepped distance relaying at each end operate independently to isolate faults. If Intertie interruption devices are bypassed, the far end distance relays may not reliably recognize and clear internal transformer faults. Special attention to protection schemes under bypass operation will be required in final design.

The Intertie will be provided with stepped distance relays with built in directional ground overcurrent relays. Distance and directional ground overcurrent relaying on the 115-kV side has also been included in the cost estimate, but the 115-kV side protection philosophy and relay coordination need to be studied further during detail design. Disconnection of the Intertie from the MEA system would transfer the O'Neill load (up to 1.5 MW maximum) to the CVEA system which could result in underfrequency condition on the CVEA system. Underfrequency relaying or underfrequency in conjunction with directional power relays may therefore be necessary at the new substation near O'Neill or at O'Neill substation to drop O'Neill during underfrequency conditions.

Station service power will be sourced from two power voltage transformers, located on the 115-kV and 138-kV line sides. Alternatively, MEA could feed the station service system with a distribution line. A small prefabricated building will house control, protective relay and auxiliary equipment. Tubular steel type, combined dead-end and circuit breaker disconnect and bypass switch supports are proposed on both the 115-kV and 138-kV sides. The station will occupy an area of approximately 100 ft x 70 ft.

C. PUMP STATION NO. 11 SUBSTATION EXPANSION

The existing Pump Station No. 11 Substation consists of a 12/16/20 MVA 138-14.4 kV transformer, a single 138-kV oil circuit breaker with bypass switch and a 5 MVAR reactor connected permanently to the 138-kV incoming transmission line from Valdez. The existing substation layout makes it difficult to connect the Intertie in a radial bus configuration without first modifying the equipment arrangement.

We propose to relocate the existing line-connected 5-MVAR shunt reactor, voltage transformers, and line traps to make room for a 138-kV bus to which the Intertie can be connected. We also propose to relocate the existing 138-kV circuit breaker on the line to Pump Station No. 12 Substation, and to provide a circuit switcher without built-on disconnect switch in place of the relocated circuit breaker for the existing power transformer. Figure V-3 shows the proposed equipment layout. The existing reactor will be provided with a disconnect switch to facilitate disconnecting it from the line and space will be provided for future addition of a circuit breaker to facilitate reactor switching under load.

A new 10-MVAR shunt reactor will be connected to the 138-kV Intertie for voltage control. In the absence of an Intertie communication channel, reactor faults cannot be reliably cleared from the new substation near O'Neill substation. The reactor will therefore be provided with fuses for short-circuit protection and to facilitate disconnecting it from the line for maintenance purposes. Space will be provided for future addition of a reactor circuit breaker or circuit switcher. Intertie protection will be provided by stepped distance relays with built-in directional ground fault relays.

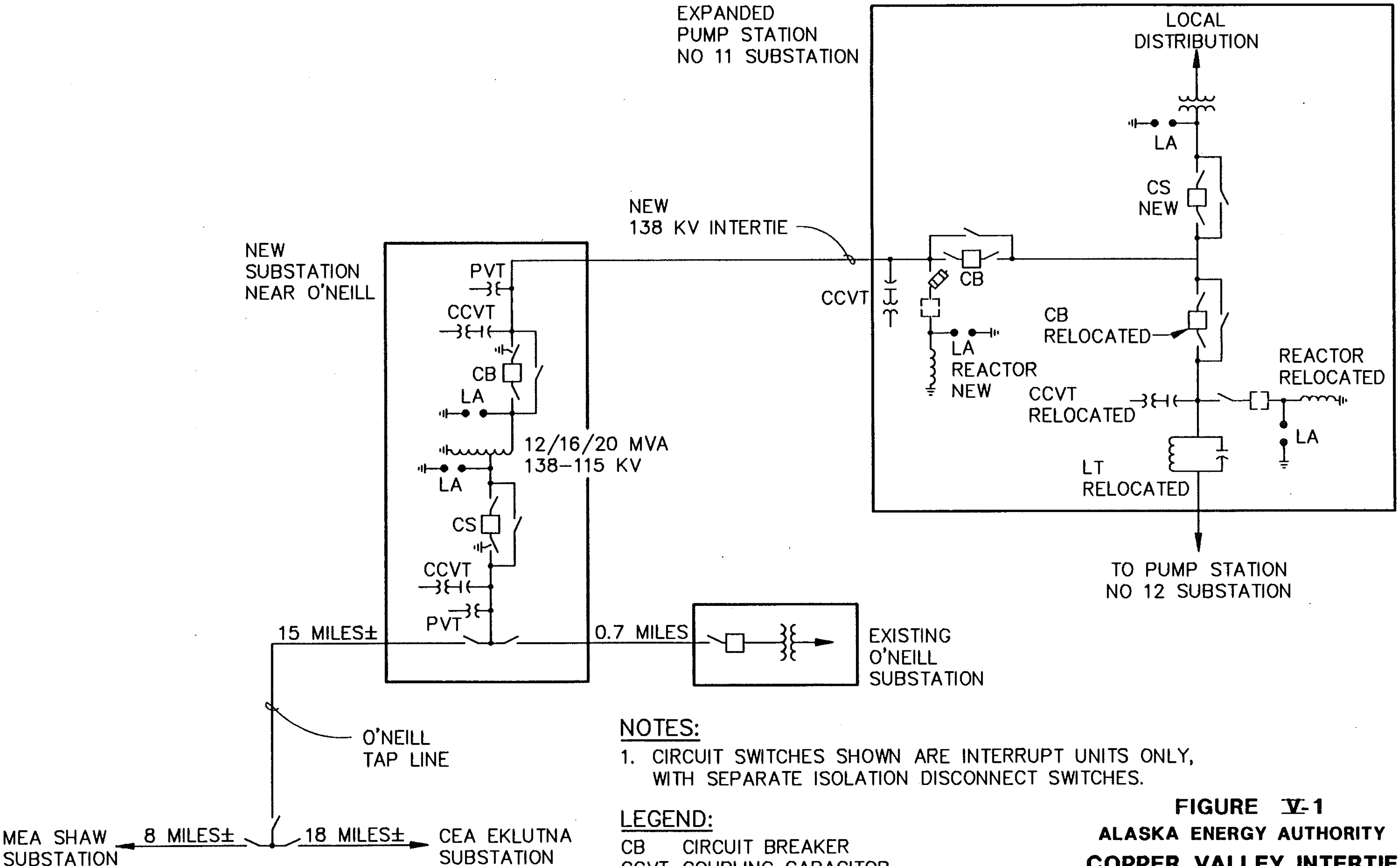
Oil containment will be provided for the reactors as well as for the relocated circuit breaker.

The new configuration will not fit within the existing substation fence (about 150 ft x 150 ft), but will be contained within the substation property lines as furnished by CVEA/Authority. It is estimated that the fence line will have to be moved about 55 ft to the west and about 15-20 ft on the north and south sides. The rebuilt substation will thus occupy an area of about 205 ft x 185 ft.

Outages required to rebuild the substation will have to be coordinated with diesel generator maintenance and periods of low hydropower generation. Due to these constraints, construction of the substation modifications should be scheduled for the fall.

No SVC is included in the design of Pump Station No. 11 modifications. See Section IV.B.1.c. for a discussion.

AAB07009



NOTES:

1. CIRCUIT SWITCHES SHOWN ARE INTERRUPT UNITS ONLY, WITH SEPARATE ISOLATION DISCONNECT SWITCHES.

LEGEND:

CB	CIRCUIT BREAKER
CCVT	COUPLING CAPACITOR VOLTAGE TRANSFORMER
CS	CIRCUIT SWITCHER
LA	LIGHTNING ARRESTER
LT	LINE TRAP
PVT	POWER VOLTAGE TRANSFORMER

FIGURE V-1

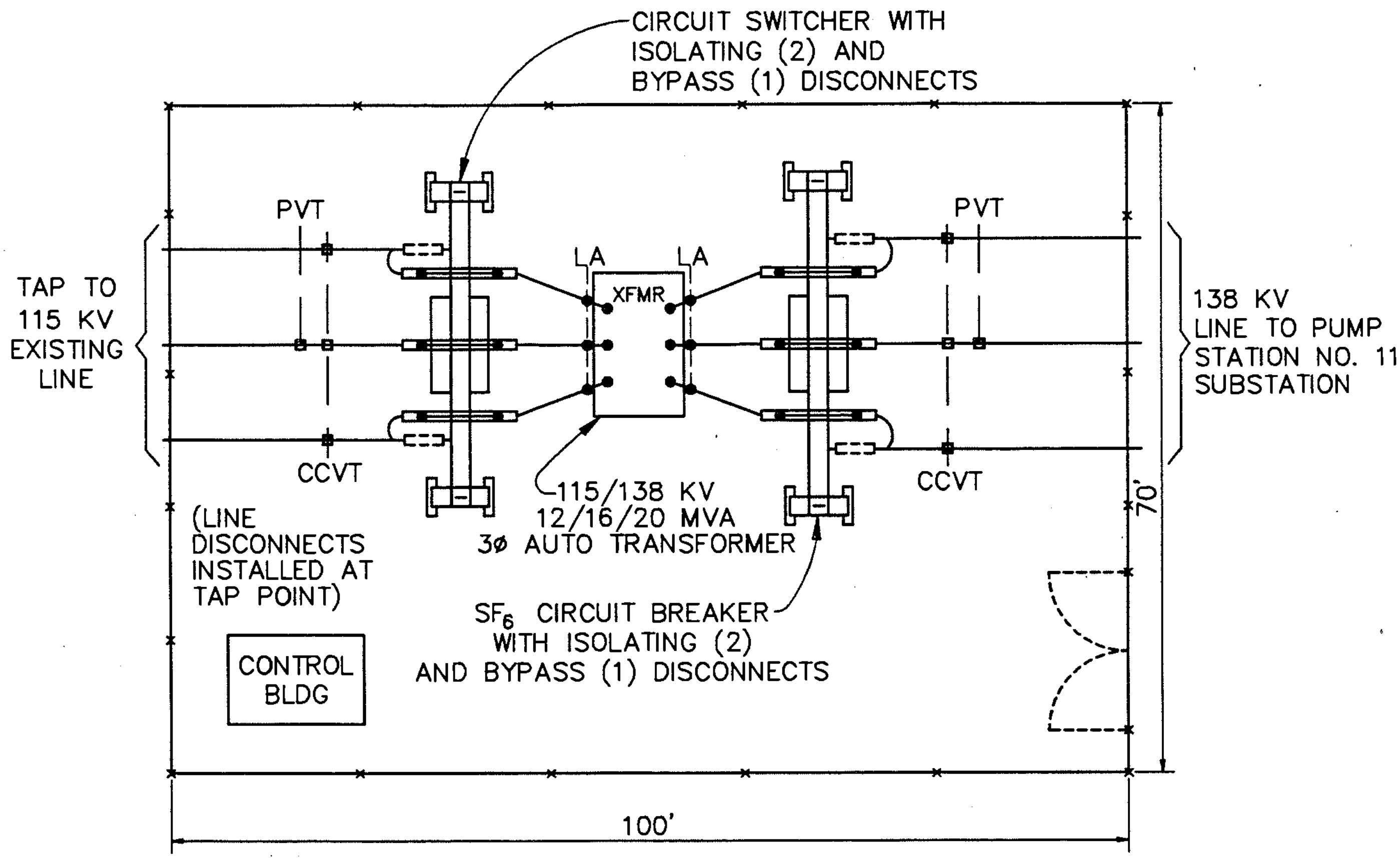
ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

SYSTEM ONE-LINE DIAGRAM

R.W. BECK AND ASSOCIATES

AAB07010



CCVT – CAPACITOR VOLTAGE TRANSFORMER

PVT – POWER VOLTAGE TRANSFORMER

LA – LIGHTNING ARRESTER

FIGURE V-2

ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

LAYOUT NEW SUTTON SUBSTATION

R.W. BECK AND ASSOCIATES

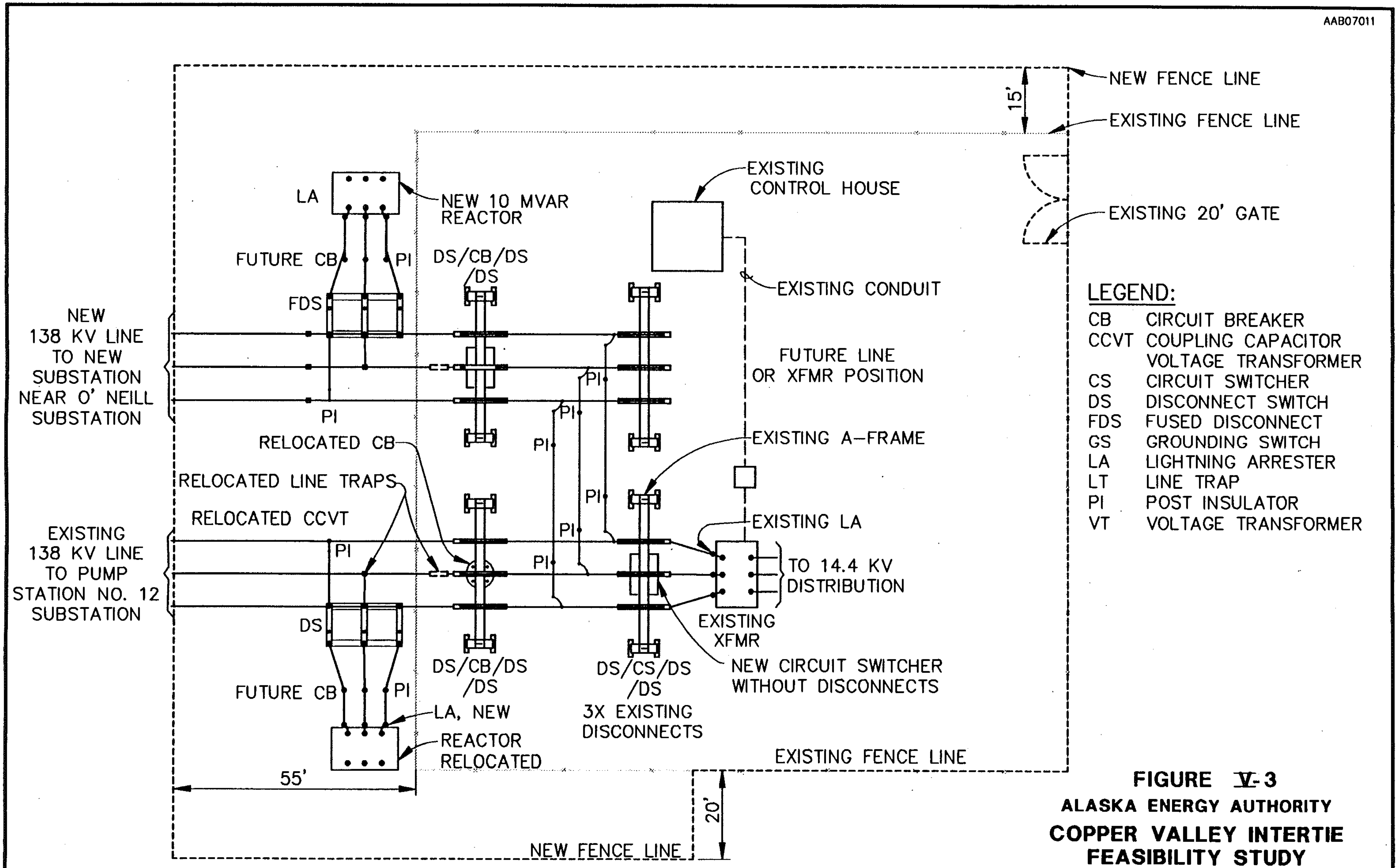


FIGURE V-3

ALASKA ENERGY AUTHORITY

COPPER VALLEY INTERTIE FEASIBILITY STUDY

PUMP STATION NO. 11 SUBSTATION LAYOUT

R.W. BECK AND ASSOCIATES

Section VI

PROJECT COST ESTIMATES

A. INTRODUCTION AND BACKGROUND

1. Introduction

Pursuant to the Technical Review Meeting (TRM) of July 6, 1993, we were essentially directed to seek a least cost construction option for the Intertie, based on design criteria established at the meeting. Section IV presented these design criteria and discussed the various construction alternatives.

This section presents the assumptions, methodology, and results of the feasibility-level cost estimates for the various Intertie project alternatives. Project costs include all costs required to plan, develop, engineer, build, operate, and maintain the Intertie. Project costs are broken down into construction costs, engineering costs, owner costs, and operation/maintenance costs for discussion.

Three other studies have included a capital cost estimate for an Intertie between the Railbelt and CVEA in some form [1, 2, 6]. In two studies, the Intertie was a 230-kV link in a longer interconnection [2, 6]. Total capital cost estimates for the 230-kV Intertie links ranged from approximately $48 million [2, Vol. 8A, p. XII-92, 1989] to $61.6 million [6, for 155-mile line, 1982].

In the most recent study [1] a similar 138-kV configuration was estimated to have a total project development cost of slightly over $40 million. The latter estimate was termed a "screening study" for the purposes of determining initial feasibility. Although we reviewed [1] in the course of this study, our scope required us to develop our estimate independently of any previous work. As discussed in this section we developed an estimating model using a different and independent approach from [1]. Furthermore, our cost estimates were prepared by transmission line engineers who did not participate in the economic analysis or cost estimates of alternative power sources.

Two very recent transmission line projects in South Central Alaska provide some basis for comparison with our cost estimates. These are the Bradley Lake Transmission Line (1992, X-frame design, 34 line-miles) and the Soldotna-Fritz Creek Project (1988-1991, wood H-frame, 65 line-miles). In addition, several transmission lines built in Alaska in the 1980's also provide a basis for comparison although the difference between them and the present Intertie are significant. These lines include the Tyee Lake 138-kV Transmission Line (82 miles total, steel X-frame construction, 1984), the Swan Lake 115-kV Transmission Line (30 miles total, wood H-frame on pile construction, 1983), the Terror Lake 138-kV Transmission Line (13 miles total, single steel pole construction with concrete pier foundations, 1985), and the Anchorage-Fairbanks 345-kV Intertie (170 miles, combination steel X-frame/single steel pole, 1985). The actual costs of these projects are compared to the cost estimate for this project later in this section.

2. Final Report Cost Estimate Adjustments - A Discussion

During the Draft Report review several comments were made on the report and its cost estimates. Design and cost assumptions were critiqued and possible cost item omissions were brought to the study team's attention. We did not modify any design or cost assumptions because we stand behind the assumptions and the methods used to obtain them. Below we discuss ramifications to the cost estimate based on the possible omissions.

MEA commented that no land acquisition costs were included for State Mental Health, Native-Selected or Mat-Su Borough lands, nor is the cost of a right-of-way agent's services included. At $1000/ac for land acquisition the total impact of these costs with 10% contingency would be approximately plus $372,000 to the estimate. These costs have been added in the Final Report cost estimates.

No costs were included in the Draft Report for preparation of a full Environmental Impact Statement (EIS), under the assumption that an Environmental Assessment (EA) would result in a finding-of-no-significant-impact (FONSI). Review of the probable federal permits required for the Intertie and the level of public opposition to the Intertie has made it clear that an EIS will likely be required in fulfillment of the NEPA regulations, adding both time and money to the project. An EIS has been incorporated in the cost estimate at $1.3 million (estimated range is $775,000 to $1,840,000) and in the project schedule. The effect of the $1.3 million EIS with 10% contingency is to add $1.43 million to the project development cost.

No explicit costs for litigation or condemnation proceedings have been included, although this is a real possibility if the project moves forward. We cannot estimate this cost with any confidence.

No cost for an SVC system is included based on CVEA operating the Intertie in such a way that it is severed from the Railbelt under Intertie power flow near the N-1 transfer limit during a N-1 event. Costs have been included for the CVEA diesel generation required to replace Intertie imports based on Intertie availability of 98%. No cost for a communication system end-to-end is included because of very marginal benefits.

There are many elements which could also push the cost estimate down by using less expensive equipment in the substations or fine-tuning transmission line design assumptions for instance. However, no adjustments to the transmission line or substation construction costs were implemented in the Final Report.

B. TRANSMISSION LINE CONSTRUCTION COST ESTIMATES

Construction costs cover all the material, labor, and equipment required to build the Intertie transmission line facilities. Engineering, construction management, and owner costs are treated separately. Overhead and profit are included.

1. Methodology

The following steps were taken to develop reliable feasibility level cost estimates:

a. Select Design Criteria

Design criteria were selected after review of assumptions in [1, 2, 6] and discussion with other line designers with experience in Alaska. After the TRM on July 6, 1993, final design criteria assumptions were adopted for guiding engineering analysis (see Section IV).

b. Preliminary Engineering

Using these design criteria, we performed preliminary engineering calculations in sufficient detail on seven construction options, three conductor options, and four loading zones to select preliminary material requirements such as structure dimensions and size, insulator strength and dimensions, and conductor size. Manufacturer engineering assistance was requested for wood H-frame structure alternatives, sag tension data for SSAC and EHS-core conductors, and steel X-frame structures.

c. Line Layout, Quantity Tabulations and Assumptions

Key line layout information was tabulated or estimated for each loading zone and each route alternative. Tabulated information included total line lengths, length of each loading zone, and distribution of line angles. For each combination of construction option, loading zone and conductor type, we determined a base height or length and size of structure, average span length and height distribution of structures. All this information was tabulated on spreadsheet UNITCOST.XLS and the various database files, e.g., DBSHF1.XLS. Height distribution on a preliminary optimization run in [1] was reviewed for a comparison and slight adjustments in the assumed height distributions were made. Preliminary quantities were developed from the foregoing and used to request budgetary quotes for material from suppliers.

d. Right-of-Way Costs

Right-of-way costs include the costs to clear and prepare the right-of-way, permit and acquire right-of-way easements, and rental of land.

(1) Right-of-Way Clearing Costs

Right-of-way clearing costs include the cost to fell and buck trees, treat slash, and grub a primitive road where allowable. Burning or chipping white spruce trees may be required west of Sheep Mountain if roller crushers are not feasible.

From large scale, color infrared aerial photography and photos taken during the aerial and ground reconnaissance, we estimated the percentage of each route segment which could be characterized by dense, medium, sparse or open forest cover. We assumed an average tree height and an average right-of-way width for each segment based on computations and observations. We computed the total right-of-way acres for each segment and, based on an assumption for clear-cut width (50 ft or 75 ft), we then computed the subtotal of acres to be cleared.

One of four types of clearing methods was assigned to each route segment and an estimated clearcut cost computed. Assumed costs and descriptions of those clearing methods are given in Table VI-1. We estimated a number of danger trees per each uncleared acre in the right-of-way and added in a cost to remove the danger trees. Finally, a cost to clear each route segment was computed and a total for each route alternative determined. A cost of $1,500 per mile of open terrain was included to cover the costs of moving operations down the right-of-way.

ADNR commented, in its review of the Draft Report, that some commercial grade timber resources may exist in the easternmost 10-15 miles of the line route. Final determination of the extent and value of these resources would depend on a pre-clearing timber cruise. No cost for harvesting commercial grade timber or benefit from the sale of such timber is included in the cost estimate under the assumption that the timber would not be harvested if it were found financially unfeasible to do so.

We solicited comments from Red Carlos Contracting and met with Mr. Carlos in Seattle to discuss our methodology. Mr. Carlos assisted us with proposed clearing methods, timing and production rates.

Table VI-1
Right-of-Way Clearing Cost Assumptions

Clearing Method	Description	Unit Cost
1	Combination manual/machine clearing, high cost of slash treatment, with grubbed road, some burning	$6,000/acre
2	Combination manual/machine clearing, minimal cost of slash treatment with grubbed road, no burning	$5,000/acre
3	Not used	--
4	Roller crusher, timber crushed and left	$3,500/acre
5	Manual clearing for remote, spot situations by T-line contractor	$4,000/acre
	Danger trees	$75/each

(2) Right-of-Way Permits

Dames & Moore provided a preliminary list of probable permitting requirements, permit application fees, and land rental fees. Costs to support and file permit applications were developed jointly with Dames & Moore. Costs to perform studies and conduct a full NEPA process to prepare an EIS were included. (See part A.2. earlier in this Section.)

(3) Right-of-Way Acquisition and Rental Fees

We discussed right-of-way easement acquisition costs with MEA right-of-way personnel and Land Field Services. An acquisition cost of $1,000/acre was assumed for private parcels and native lands although the final acquisition cost will be based on fair market value appraisal. For our estimates we did not explicitly account for any condemnation proceedings, which would be a last resort. We assumed $1,000/claim for unpatented mining claims in state and federal lands. MEA, with the assistance of Land Field Services, furnished a large scale map obtained from the Division of Mines in Fairbanks, showing large, 640-acre sections of mining claim set asides. Typical state and federal individual claims vary between 20 and 40 acres. No precise data on the number of individual claims was available and we estimated claims as 125, 20, 50, and 125 for route alternatives A, B, C, and D, respectively. The actual number of claims, if all tracts shown were fully allocated could be several hundred.

In addition to these costs we estimated that the services of a right-of-way agent for one year would cost about $100,000. (See part A.2. earlier in this Section.) The right-of-way agent would be indispensable to the smooth prosecution of the project. The agent would prepare initial ownership lists, make initial contacts with landowners, coordinate permitting, obtain temporary agreements for survey, geotechnical and other field crews, perform appraisals and negotiate final easement agreements.

e. Request Material and Other Cost Quotes

Based on preliminary quantities we solicited cost quotes for major material delivered to Anchorage for wood structures and framing, conductors, steel structures, and miscellaneous items. Selected major material quotes are included in Appendix D for reference.

f. Develop Spreadsheets for Estimates

Exhibit references in this section are found in Appendix C.

To evaluate least-cost construction alternative estimates and our final least cost project development cost we prepared a custom, linked set of spreadsheets. Four unit cost estimate spreadsheets, e.g., COSTMOD1.XLS (see Exhibit C-1), were developed, one for each loading zone, to keep the size of files manageable and to allow links from all four to a summary sheet. Each COSTMODX.XLS spreadsheet has five construction item groups: structures, foundations, guys and anchors, framing, and conductor. The activities performed and included under each of these construction item groups is discussed briefly below.

(1) Structures

Structures are off-loaded in Anchorage (or Valdez)and moved to a central storage yard for control and packaging. Structures are packaged and delivered by truck to marshall yards located along the Glenn Highway. At the marshall yards the structures are assembled and framed by yard crews for transportation by helicopter to specific structure locations on the right-of-way. Alternatively, structure components could be flown in with assembly and framing in the field. This activity includes the actual ground crews employed to guide structure installation at each site and construction surveying to reestablish stakes.

(2) Foundations

Foundation material is purchased and received in the central storage yard. Foundation material is then bulk-packaged for truck delivery to marshall yards where foundation piles and other materials would be prepared for delivery to specific structure sites. Preparation in the marshall yards would include installation of pile tips and splices to obtain longer piles where known to be necessary, thus avoiding field spices. This task includes augering for direct embedment structures, installation of shoring material, driving piles, and construction surveying for the foundations.

(3) Guys and Anchors

Anchor and guy material are purchased and delivered to marshall yards. The material is delivered to structure sites. This item includes excavation for anchors, placement of anchors, and installation of structure guys. It also includes surveyor time for staking guys.

(4) Framing

This includes furnishing and installation of crossarm, crossbrace, insulators, grounding, and other miscellaneous assemblies. Only minimal labor is included for arms and braces because this logically would be done under structure assembly.

(5) Conductor

Under this item conductor is furnished and installed. This includes all stringing, sagging and clipping operations. Marker balls, vibration dampers and miscellaneous units associated with conductor installation are included.

The unit cost spreadsheets derive structure data (Group A) from one of seven database files, e.g., DBSHF1.XLS for type 1 steel, unbraced H-frame structures (see Exhibit C-2). A criteria range and extract range are set on COSTMODX.XLS and the database range is set externally to the database in one of the seven structure database files. Depending on conductor type and construction option input in the criteria range, the external database is searched for the appropriate structure type, height, quantity, size, and cost.

Material costs in COSTMODX.XLS are linked to UNITCOST.XLS (see Exhibit C-3) which, in turn, is linked to material take-off sheets, e.g., MATTEAL.XLS (see Exhibit C-4).

Installation costs were estimated based on a computation of crew sizes, crew hourly rates and crew productivity for each task. Crews were developed in spreadsheet CREWS.XLS (see Exhibit C-5) whose rates are fed to the COSTMODX.XLS unit cost estimate sheets. We estimated a normal number of crew hours for the installation of each material item and adjusted them for impacts due to height, winter or summer construction, etc. The assumptions, in the form of adjustment factors, are located above the crew designations in COSTMODX.XLS.

A summary cost sheet, SUMMARY.XLS (see Exhibit C-6) totals all construction costs by group over all four unit cost estimate sheets, one per loading zone, and pulls in costs for substations (Exhibit C-8), right-of-way clearing (Exhibit C-9), engineering design (Exhibit C-10), right-of-way land ownership (Exhibit C-11), and other costs via links to various other spreadsheets as indicated. SUMMARY.XLS computes a total project development cost for specific construction options in each loading zone and for a specific route alternative (A, B, C, or D). A tabulation of loading zone lengths is found in Exhibit C-12.

Exhibit C-7 gives a diagram showing the links between spreadsheets.

Table VI-2 shows a comparison of unit costs per mile for all construction options, loading zone and conductor combinations considered. The least cost alternative was estimated to be the steel H-frame, Type 1, unbraced structure (designation "ShF1") using Teal conductor in Loading Zones 1-3, and the braced steel structure (designation "ShF4") using 37#9AW in Loading Zone 4. This is similar to the construction assumed for most of the line in [1]. Table VI-2 indicates that several options are competitive for each loading zone within the accuracy limits of the estimates.

Table VI-2
Unit Cost Estimate Comparison
Transmission Line Construction Only
($1,000/mile units)(1)(2)(3)

	LOADING ZONE 1			*LOADING ZONE 2*			*LOADING ZONE 3*			*LOADING ZONE 4*	
Options \ *Conductor*	***Dove***	***Teal***	***T2Linnet***	***Dove***	***Teal***	***T2Linnet***	***Dove***	***Teal***	***T2Linnet***	***Teal***	***37#9AW***
SSP-Single Steel Pole	238K	239K	234K								
SWP-Single Wood Pole	294K	276K	314K								
X-FrameGuyed Steel X-Frame	253K	247K	251K	272K	270K	267K	293K	292K	292K	475K	430K
Shf1-Steel Unbraced H-Frame	240K	227K	237K	229K	223K	237K	266K	245K	248K	467K	391K
Shf4-Steel Braced H-Frame	259K	235K	257K				283K	271K	258K	468K	377K
Whf1-Wood Unbraced H-Frame				230K	238K	235K					
Whf4-Wood Braced H-Frame	247K	252K	245K				278K	255K	267K		

(1) Includes mobilization/demobilization @ 5%, material contingency @ 10%, installation contingency @ 20%.
(2) Does not include right-of-way clearing costs.
(3) Unit costs based on Route Alternative D. *Shaded areas were not estimated.

g. Develop Labor Rates and Productivity

We obtained current NECA/IBEW total burdened labor rates from an Alaskan line contractor. We were informed that new contracts are being negotiated and that it would be prudent to assume some nominal increase in base wages. We discussed overhead, overtime, work week, and other cost assumptions with the line contractor in a meeting held October 1, 1993. They critiqued our crew sizes and manhour allocations per task. The cost estimating model was too detailed to discuss all assumptions, but per mile costs for major tasks on recent lines in Alaska were discussed. In conjunction with the meeting, CVEA suggested that it would help other parties review our work if per mile costs were computed in the SUMMARY.XLS file. We implemented this suggestion as well as a computation of manhours per task and loaded labor rate per task on the unit cost spreadsheets, COSTMODX.XLS.

h. Feasibility Cost Estimates

For each Intertie route alternative we prepared a detailed transmission line construction cost estimate. These are summarized in Table VI-4.

2. Cost Assumptions

Numerous assumptions form the basis for these feasibility-level estimates. Typical assumptions are contained in sample spreadsheets included in Appendix C, Exhibits 1-6. Key assumptions are discussed below for the major line components.

a. Structure Size and Type/Height Distribution

The distribution of structure types was selected based on measurement of major line angles for Route Alternatives A, B, C and D. Five structure types were selected for estimating with the approximate percentages shown as follows for Route Alternative A, steel H-frame, Teal conductor option:

Tangent Structure	90%	
Light Angle 3-Pole Structure	1.3%	
Medium Angle 3-Pole Structure	2.6%	
Heavy Angle/Deadend 3-Pole Structure	5.5%	
Long-Span, Deadend A-Frame Structure	0.6%	(Loading Zone 4 only)

Deviations from this percentage distribution will depend largely on the number of minor route changes late in the design phase. The dimensions and size of structures were determined in preliminary engineering (see Section IV for design criteria). Structure base heights were 50 ft to 85 ft typically.

Based on preliminary engineering computations an appropriate match of structure height/length and allowable span was determined for each construction/conductor/loading zone combination. This base height of structures was taken as a median value and two heights above (+10 ft and +20 ft) and below (-10 ft and -15 ft) the base were computed. In some cases where a very short base structure occurred, the shortest structure computed this way would violate code clearances at the structure itself. A minimum structure height test was applied to the computation of heights and the heights adjusted upward slightly.

The distribution of heights for Loading Zones 1, 3 and 4 was taken as 10%, 20%, 40%, 15% and 15% from shortest to tallest. For Loading Zone 2, where terrain is very level and predictable, the distribution was 5%, 15%, 60%, 15% and 5%, again shortest to tallest.

Costs for coastal Douglas Fir and Western Red Cedar wood poles and structure framing materials were obtained from manufacturers. Steel costs were discussed with a major supplier and were estimated between $1.05 and $1.20 per pound delivered to Anchorage depending on complexity of structure and size.

b. Foundations

For structures in muskeg and permafrost areas and for all X-frame structures, we assumed either 30-inch pipe pile at $110/ft or 10 X 57 H-pile at $80/ft. All other construction options were direct embedded either in soil or rock. Shoring at $300 each in soil and at $200 each in rock were included to maintain holes for structure installation at a later date.

c. Conductor

Conductor costs were obtained from two manufacturers. The basis for these budgetary quotes was slightly different, leading to greater costs from one manufacturer. We used the lower of the two costs. The estimating costs used were for regular, specular conductor. A price escalation factor of 10% was applied to aluminum costs on the aluminum content of one manufacturer's costs in accordance with its recommendations. We note, however, that there is current downward pressure on aluminum prices due to the recent high level of imports from the Commonwealth of Independent States (e.g., ex-Soviet Union). The costs used in the study estimates are: Dove ACSR @ $0.92/lb., Teal ACSR @ $0.97/lb., T2 Linnet ACSR @ $1.03/lb., and 37#9 Alumoweld @ $1.47/lb. Conductor length includes a 5% margin for sag, jumpers, and wastage.

d. Burdened Labor Rates

We obtained current union labor rates from an experienced Alaskan line contractor which applied to a recent Alaskan project including all fund contributions, payroll taxes and insurance. Rates for straight time, time and a half, and double time were obtained, as were average rates based on a work week of six 9-hour days and six 10-hour days. Using the six days, 9 hours per day work week, typical levelized current hourly rates are: Journeyman Lineman @ $49.38, Lineman Foreman @ $52.71, and Groundman @ $41.05 (equivalent to an Apprentice @ 80%).

Selling prices for labor were obtained by applying a 40% overhead, 15% profit, and a $75/day per person subsistence allowance. Typical equipment was selected and assigned to each crew. Equipment rates were taken from Data Quest or helicopter operators. A total crew hourly cost was determined.

Overhead rates merit some discussion. Overhead covers bonding, insurance, field office operations including maintenance and surveillance, home office operations dedicated to the project, small tools and equipment, mark-up on subcontractors, and other miscellaneous operating expenses. Overhead rates vary typically from 30% to 50% depending on the nature of the project. High overhead rates would apply to projects with high material procurement components, a joint venture or many subcontractors, remote construction, or burdensome submittal and reporting requirements. The overhead rate on the Bradley Lake Transmission Line was reported close to 50% while other projects on the Kenai Peninsula were closer to 30%. We selected a median 40% overhead largely based on discussions with the prospective owner, CVEA, that streamlined contracting would be the rule but tempered by the fact that the rate would be pushed up if schedule and bonding requirements dictated a joint venture or multiple subcontracts.

e. Crews

Exhibit C-5 gives the make-up of crews, their rates, and short descriptions. This information was reviewed with an experienced line contractor in Alaska, and adjusted based on the line contractor's comments.

f. Miscellaneous Materials

Aerial marker balls (36" EHV type) were assumed at eight per span for ten spans in each loading zone, for the purpose of marking potential obstructions to air navigation across major streams and rivers. In addition, 24" EHV marker balls were assumed every 200' for 15% of the length of Loading Zone 2 for the purpose of mitigating the risk of trumpeter swan and other waterfowl collisions. It should be noted that we did not take into account any effect these marker balls would have on conductor sags or tensions. It is also noted here that CVEA has found aerial marker balls susceptible to breakage under suspected eccentric snow load and burn down. Alternative marking devices should be explored in final design.

g. Mobilization/Demobilization

A mobilization/demobilization rate of 5% was applied to the construction cost of the transmission line. For comparison, we show figures for the Bradley Lake, Tyee Lake, Swan Lake, and Intertie numbers:

Table VI-3
Mobilization Costs

Project	Total Cost of Construction(1)	Cost of Mobilization/ Demobilization	Base of Operation
Bradley Lake	$16,066,495(2)	$1,099,798 (6.9%)	Remote/Homer
Tyee Lake	$20,111,889(3)	$1,100,000 (5.5%)	Wrangell, Bradfield, Petersburg
Swan Lake	$15,576,367(4)	$1,190,108 (7.6%)	Ketchikan
Intertie	$26,972,496(5)	$1,284,405 (5%)	Palmer/Glennallen

(1) Excludes ROW clearing.
(2) Initial bid tabulation March 14, 1989.
(3) Based on final BID/Change Item Status March 15, 1984.
(4) Based on Change Order No. 15, October 5, 1983.
(5) Route Alternative D feasibility level cost estimate, December 1993, no contingency.

A figure of 5% was selected due to the relatively good access to the Intertie corridor via the Glenn Highway.

h. Contingency

Based on discussions and general consensus at the TRM, a contingency of 10% was placed on material costs and 20% on installation costs. There are many compelling reasons not to reduce these contingencies based on a feasibility-level design. First, a final route has not been selected and while we could fairly confidently predict the final length would fall in the range of 133 to 138 miles, it is probable that minor route or design adjustments will have to be implemented during the right-of-way acquisition and permitting phase. Second, final geotechnical survey data could end up increasing foundation costs. If soils turn out to be highly variable, many small structure relocations can be expected unless a very adaptable foundation plan is implemented. Third, competing Alaskan or Pacific Northwest line projects could create tight labor and/or material markets and drive up bids. Fourth, unforeseen weather conditions could lead to costly construction delays and missed timing construction windows for stream crossings. Fifth, it is not clear at this stage that removal of some commercial timber would not be required. If determined to be required by ADNR, it would add to costs although these costs would be offset by the commercial value of the timber sales. These and other reasons are ample justification for the contingency values used.

i. Spares and Structure Testing

No allowances for spare materials or structure tests are explicitly included in the cost estimate.

3. Feasibility Cost Estimates - Transmission Line Construction

Transmission line construction cost estimates only are presented in Table VI-4. These costs would be the combined sum of contractor bids for line construction and right-of-way clearing.

Table VI-4
Transmission Line Feasibility Level Construction Cost Estimates(1)
Least Cost Option - All Route Alternatives(2)
($1993)(3)

Route Alternative	Transmission Line Estimated Construction Cost
A	$34,742,576
B	$35,575,209
C	$36,012,373
D	$34,112,928

(1) Does not include engineering, construction management, permitting, right-of-way acquisition, owner's cost, or any costs related to substations.
(2) Based on least cost options identified for each Route Alternative.
(3) Includes 20% contingency on installation, 10% contingency on materials, and right-of-way clearing costs.

4. Transmission Line Cost Estimate Reasonableness

In addition to detailed checking of input assumptions and computations, the transmission line cost estimate should also be subjected to reasonableness tests (e.g. total manhours vs. schedule, final loaded labor rates, material/labor ratio, and construction cost breakdown) and comparison with historical line construction costs in Alaska.

a. Reasonableness Checks

(1) Total Labor Effort

We modified the cost estimate sheets to compute total estimated manhours to complete the Intertie. For Route Alternative D, using the unbraced steel H-frame design for most of the line, the total estimated labor effort is 136,000 person-hours. We consulted two line contractors for an estimate of effort to complete the Intertie, without divulging our estimate. These estimates varied widely from a high of 250,000 person-hours to 110,000-140,000 person-hours, the latter closely corroborating our estimate. The 110,000 ph effort represents about 815 ph/mile for a 135-mile line; this is considered efficient construction in the US outside of Alaska. For example a recent 30-mile wood pole 115-kV line along a railroad with significant guying requirements in Pennsylvania required about 50,000 ph over an 18-month period, or about 1,668 ph/mile.

Over a 20-month construction period, a 136,000 ph effort would require on average 6,800 ph/month. Based on six 9-hour days per workweek or about 238 ph/month-person, this effort would equate to about a 29-person full time construction team. This could represent a project management and support team of 10 (PM, time keeper, office assistant, resident construction engineer, equipment maintenance crews, material handling crews) and 3-4 construction crews ranging in size from 4-7 persons.

(2) Material/Labor Ratio

Given the high cost of labor and challenging construction environment in Alaska, material costs range from 33% to 50% and labor costs from 67% to 50% of total construction costs for typical Alaskan projects. For Route Alternative D, the total estimated material and labor costs, excluding right-of-way clearing, are $11,517,296 and $19,802,672 respectively for an M/L breakdown of 37%M/63%L which is in line with other Alaskan work.

(3) Loaded Labor Rates

The loaded labor rate includes all project construction cost elements such as direct and indirect salary, overhead, equipment rental and profit, and is computed by dividing total cost to complete a task by the number of hours devoted to the task. Loaded rates are computed in Exhibit C-1 and for Route Alternative D typically fall in the range $105/hr-$125/hr. The average loaded labor rate, calculated without contingency, is $121/hr., which compares closely with a commonly used loaded labor rate of $125/hr [1].

(4) Cost Breakdown and Comparison to Recent Alaskan Projects

It is useful to determine the percentage contribution of major cost components (i.e., structures and framing, foundations and anchors, and conductor) and compare them with other completed projects. For the purpose of comparison clearing costs have been excluded since they vary significantly. Table VI-5 below shows a comparison of the breakdowns for Swan Lake, Tyee Lake, Bradley Lake, and the Intertie estimate.

Table VI-5
Construction Cost Comparison
Swan Lake, Tyee Lake and Intertie
% of Total ($ million)

COST COMPONENT	SWAN LAKE LINE(1) (Entire Line)	TYEE LAKE LINE(2) (Overhead Portion)	BRADLEY LAKE LINE(3)	INTERTIE ROUTE(4) ALTERNATIVE D
Mobilization/ Demobilization	6% (0.8)	4% (0.8)	7% (1.1)	5% (1.5)
Conductor	20% (2.9)	22% (4.4)	22% (3.7)	24% (7.6)
Structures & Framing	33% (4.7)	37% (7.3)	37% (6.2)	42% (13.5)
Foundation & Anchors	41% (5.9)	37% (7.3)	34% (5.6)	29% (9.5)
Differing Characteristics	Wood Pole H-Frame 336 Oriole/AW Significant Underbuild CFC Lands, Urban Portion	Tubular Steel X-Frame 556 Dove/AW, 37 No. AW	Tubular Steel X-Frame 556 AACSR Conductor No Clearing	Steel Pole H-Frame 605 Teal ACSR

(1) Based on Change Order No. 15, October 5, 1983, excluding clearing costs.
(2) Based on Bid/Change Item Status, March 15, 1984, excluding clearing costs.
(3) Based on initial construction bids, March 1989, excluding clearing costs.
(4) Feasibility-level estimate October 1993, excluding contingencies.

b. Comparison of Historical Line Costs in Alaska

Reference [15] tabulated line costs on a per mile basis for some eighteen projects completed throughout Alaska starting in 1974. In their tabulation, the authors attempted to point out the very different construction circumstances which affected the ultimate construction cost. We reformatted the table in [15], added the Bradley Lake and Soldotna-Fritz Creek projects, and applied two different escalation factors to adjust costs to 1993.

One escalation factor is derived from a weighted average of the cost indices for line-related categories (75% Towers & Fixtures and 25% Overhead Conductors & Devices) from the Handy-Whitman Index[16] for the Pacific Region of the US. This weighted index is applied directly to the actual historical construction cost to obtain an adjusted 1993 cost. Any special escalation factor for Alaskan work is assumed to be accounted for in the original historical cost. Costs were also escalated at a fixed annual rate of 5%.

Table VI-6 gives the results of this exercise and shows a wide range of costs for 115-kV and 138-kV construction, from $93k/mile to $983k/mile. The considerable variation in costs is due to the equally considerable variation in design, construction circumstances, level of right-of-way clearing and logging, use of helicopters for construction in remote or sensitive areas, and other factors. The total per mile estimated cost of the Intertie for Route Alternative D is about $254k/mile including clearing and contingencies. The cost per mile varies according to loading zone between approximately $240k/mile and $400k/mile. The line mileage-weighted average of all 115-kV and 138-kV transmission lines in Table VI-6 is $352k/mile based on escalation of costs at 5% and $288k/mile based on escalation of costs using Handy-Whitman indices.

Based on Table VI-6 and considering the significant differences among the projects, the unit cost per mile for Route Alternative D is in line with historical costs and recent project costs for similar construction circumstances. Bradley Lake has been cited as representative of typical line costs in Alaska. It is not appropriate to compare Bradley Lake to the Intertie directly because of more extreme loading conditions, the type of structure (steel X-frame), expensive foundations, remote site requiring essentially all-helicopter construction, burdensome state reporting requirements, and other differences. There are several examples of lines built by utilities at 115-kV and 138-kV for far less, on the order of $100k/mile to $300k/mile, than Bradley Lake at $530k/mile.

C. SUBSTATION CONSTRUCTION COST ESTIMATES

Construction costs cover all the material, labor and equipment required to build the substation facilities. Engineering, construction management and owner costs are treated separately. Overhead and profit are included.

1. Methodology

The following steps were taken to develop feasibility-level cost estimates.

a. Select Design Criteria

Design criteria in terms of switching arrangements were selected based on existing switching configurations, on reliability considerations, and CVEA preferences. Equipment ratings were selected based on system characteristics such as load levels and fault current levels.

b. Preliminary Engineering

Based on the selected switching configurations and other design criteria we performed basic engineering to determine equipment ratings, civil works estimates, substation size requirements and materials quantities.

c. Request Material Cost Quotes

For the estimated material quantities we solicited cost quotes from suppliers for major equipment such as the autotransformer, circuit breakers, disconnect switches, etc. The quotes included transport to Anchorage.

d. Develop Other Cost Components

Construction costs, local transport and storage costs, mobilization/demobilization costs, as well as overhead and profits were lumped together and added to the material costs.

The main basis for estimating these costs was the Means Electrical Cost Data 1993 and R.W. Beck and Associates' recent bidding experience. Civil works and major equipment costs were estimated separately.

e. Develop Spreadsheets for Estimates

The various cost components were entered into spreadsheets showing estimated material quantities, unit prices, and total costs. Total costs were computed for each substation alternative.

2. Cost Assumptions

Key assumptions affecting the cost estimates for the substations are discussed below.

a. Power Transformer and Shunt Reactor

We have assumed that an autotransformer rated 12/16/20 MVA OA/FA/FA will be used to interconnect the 115-kV and 138-kV systems. The transformer would be equipped with only no-load taps. The shunt reactor proposed for the Intertie is an oil-filled unit, rated 10 MVAR at 138 kV. No power transformer tertiary winding is available at Pump Station No. 11 Substation for connecting the reactor at medium voltage. No shunt reactor was included in Sutton, but may be necessary to allow CVEA to serve Sutton load.

b. Communication System

No communication link has been included between the new O'Neill Substation and Pump Station No. 11 Substation. This decision is based on CVEA's poor experience with existing power line carrier systems and on CVEA's desire to lower the overall initial cost of the Intertie. Although the lack of a communication link puts some limitation on the Intertie protective relay systems and may also complicate future operational issues, it is not absolutely necessary for the reliable operation of the Intertie.

c. Static VAR Compensator (SVC)

The PTI report, Volume 2, Appendix O, indicates that a SVC system would be a preferred system improvement to permit reliable Intertie power transfers in excess of 15 MW, the transfer limit for single contingency (N-1)outage events in the Railbelt system. The -10 to +25 MVAR SVC at Dave's Creek on the Kenai Peninsula on the CEA system cost about $5.6 million in 1992-93. This is approximately the size of SVC that would be required on the CVEA system.

Certain improvements to the Railbelt system, such as MEA upgrades to a 230-kV trunk system or reconductoring certain 115-kV lines, would appear necessary at some future point to correct low voltage and thermal limit problems on the MEA grid based on assumed study load growth and irrespective of the Intertie. These improvements could delay the need for a SVC. However, Intertie loading would also accelerate the need for the improvements to maintain reliability on the MEA system. It is also possible for CVEA and the Railbelt Utilities to operate the Intertie such that it is disconnected from the Railbelt during critical N-1 outage conditions on the Railbelt system during Intertie transfers in excess of the N-1 limit.

We have not included the cost of a SVC system in the project cost estimate because CVEA has expressed willingness to sever the Intertie for critical N-1 outage conditions in the Railbelt. If included, the cost of the SVC would appear as an O&M cost expenditure in roughly the year when 15 MW load transfer is forecast.

3. Feasibility Cost Estimates - Substation Construction

Total feasibility construction cost estimates for the new substation in Sutton and Pump Station No. 11 Substation are $1,824,000 and $1,794,000, respectively.

Table VI-6
Tabulation of Historical Transmission Line Construction Costs

Project	Year	Voltage kV	Approx Length (mi)	Basic Structure Type	Project Description	Area	Terrain	Access	Helicopter	Clearing	Distribution	Hot Line	Equipment	Season	Approximate Construction Cost/Mile ($1000/mi)	Escalation Factor (Notes 1,2)	1993 Adjusted Construction Cost/Mile ($1000/mi)
1	1976	115	17.7	HPT-1 Wood Single Poles	MEA - Four Corners to Herning to Teeland	Palmer	Roll/Flat	Excellent	No	No	Majority	yes	Highway	Sum/Fall	$54	1.95 2.29	$105 $123
2	1979	115	3.9	HPT-1 Wood Single Pole	MEA- LaZelle 115 IV Tap	Wasilla	Roll/Flat	Excellent	No	Owner	Some	yes	Highway	Winter	$57	1.62 1.98	$93 $113
3	1980	115	6.5	STX-10 Tubular Steel X-frame	MEA- Eagle River	Eagle Riv	Rolling	Very Good	Yes	Owner	No	No	Helicopter	Summer	$95	1.44 1.89	$137 $180
4	1974	115	4.2	TH-1A Wood Hframe	MEA - Palmer to Four Corners	Palmer	Roll/Steep	Good	No	Owner	No	No	High/Track	Summer	$56	2.50 2.53	$141 $142
5	1977	115	20.5	STX-10 Tubular Steel X-frame	MEA - Teeland to Willow	Willow	Flat	Good	No	Owner	No	No	Highway	Winnter	$71	1.86 2.18	$132 $155
6	1982	115	30.5	Wood H-frame (25.5 mi) Single Steel Pole (5 mi)	APA - Swan Lake Hydro Project	Ketchikcan	Rolling	poor (HF)	Yes	Yes/log	Yes(5mi)	Yes (5 mi)	Heli/High	all	$390	1.30 1.71	$505 $667
7	1976	138	12.5	TH-10S Wood H-frame	GVEA - T Line North to Fairbanks	Fairbanks	Flat	Excellent	No	Owner	No	No	Highway	Fall/Win	$81	1.95 2.29	$159 $187
8	1977	138	7.4	TH-10S Wood H-frame &Single Pole	GVEA - Johnson Road to Delta - Part 1	Fairbanks	Roll/Steep	Excellent	No	Some	No	No	High/track	Winter	$68	1.86 2.18	$126 $147
9	1977	138	24	TH-10S Wood H-frame	GVEA - Johnson Road to Delta - Part 2	Fairbanks	Roll/Steep	Excellent	No	Some	No	No	High/track	Winter	$66	1.86 2.18	$123 $144

Table VI-6 *(continued)*

Project	Year	Voltage kV	Approx Length (mi)	Basic Structure Type	Project Description	*Area*	*Terrain*	*Access*	*Helicopter*	*Clearing*	*Distribution*	*Hot Line*	*Equipment*	*Season*	Approximate Construction Cost/Mile ($1000/mi)	Escalation Factor (Notes 1,2)	1993 Adjusted Construction Cost/Mile ($1000/mi)
10	1974	138	26.2	TX-10 AL X-Tower	CEA - Point McKenzie to Teeland	GooseBay	Flat	poor	yes	Yes	No	No	Heli/track	Fall	$65	2.50 2.53	$162 $163
11	1979	138	55.8	STX-138 Tubular Steel X-Tower	CVEA - Solomon Gulch to Glennallen Phase 1	Glennallen	Flat/Hilly	TAP road	Yes	NA	No	No	Helicopter	all	$112	1.62 1.98	$182 $222
12	1979	138	50.1	STX-138 TH-10	CVEA - Solomon Gulch to Glennallen Phase 2	Valdez	Mountain	poor/TAP	Yes	NA	No	No	Helicopter	all	$229	1.62 1.98	$370 $453
13	1982	138	68.2	STX-E Tubular Steel	APA - Tyee Lake Hydro Project	Wrangell	Mountain	poor	Yes	Yes	No	No	Helicopter	all	$256	1.30 1.71	$332 $438
14	1983	138	17.4	Tubular Self-Supp Steel Poles	APA - Terror Lake Hydro Project	Kodiak	Mountain	poor	Yes	Minimal	No	No	Helicopter	Summer	$603	1.25 1.63	$752 $983
15	1981	230	11	Single SP 2-ckt	CEA - Fritz Creek to University Substation	Anchorage	Flat	Excellent	No	Some	No	No	Highway	NA	$318	1.32 1.80	$421 $571
16	1982	230	20.1	STX-10 Aluminum X-Tower	CEA - Six Mile Line	Pt Mc-Sus	Flat	Good	No	Yes	No	No	NA	NA	$147	1.30 1.71	$190 $251
17	1983	345	97	Tubular Steel X-Tower	APA - Anchorage to Fairbanks Intertie (South End)	Willow -Hur	Flat/Roll	Poor	NA	Yes	No	No	NA	all	$349	1.25 1.63	$434 $568
18	1983	345	72	Tubular Steel X-Tower	APA - Anchorage to Fairbanks Intertie (NorthEnd)	Hur-Healy	Flat/Mount	Poor	Some	Yes	No	No	Heli/Mix	all	$346	1.25 1.63	$431 $563
19	1992 Assumed	115	34	Tubular Steel X-Tower	AEA - Bradley Lake Project	Kenai	Mountain	Poor	Yes	Not Incl	No	No	Heli/Mix	all	$505	1.05 1.05	$529 $530
20	1991 Assumed	115	60 Estimated	Wood H-frame	HEA - Soldotna - Fritz Creek Line	Kenai	Roll/Flat	Fair	No	Not Incl	No	No	Mix	all	233	1.01 1.10	$236 $257

Notes

1. Based on an average of the Handy-Whitman Indices for categories Towers&Fixtures and Overhead Conductors&Devices for the Pacific Region and assuming 1993 =1.00, times Alaska factor = 1.00
2. Factor on top is derived per Note 1, Factor on bottom is based on straight escalation at 5%

D. ENGINEERING COSTS

Engineering costs cover preliminary design and route selection, permitting support, surveying, geotechnical investigations, meteorological investigations, final engineering design, contract document preparation, bidding assistance, and construction phase technical assistance.

Geotechnical investigation costs were obtained from Dames & Moore (Exhibit F-1) and cover review of aerial photographs and alignment, helicopter and ground reconnaissance, a 50-bore hole drilling program (assuming boring frequency of one/two miles Sutton-Syncline Mountain and one/five miles Copper River Basin), a limited 25-line seismic survey, laboratory testing program, and final geotechnical report with foundation recommendations. It should be noted that no account was taken of potential seismic loads on structures as these loads typically do not control design.

Survey costs were estimated at $10,000 per mile. This cost is based on discussions with two survey firms experienced in transmission line surveying. A detailed plan for surveying was furnished by G. E. Raleigh and Associates (Exhibit F-5). Survey tasks would include setting vertical and horizontal control, aerial photogrammetry, preparation of plan and profile drawings, centerline ground survey, property corner and monument ties, right-of-way clearing demarcation, and structure staking.

A meteorological survey is included at $35,000 based on extensive discussions with Richmond Meteorological Consulting. We highly recommend such a study to assist value engineering efforts.

Substation engineering costs are estimated at $350,500 total for both substations. This is approximately 10% of the total estimated construction cost of the substations. It includes preparation of a major equipment procurement contract, a construction contract for the substations, and special construction plan for the cutover at Pump Station 11 Substation.

Transmission line engineering costs are estimated at $912,500 and include permitting support, subcontracts for survey, geotechnical and meteorological services, preparation of REA documents, final system studies, final design, and contracts for right-of-way clearing and construction. This cost represents about 2% of the total transmission line and clearing estimated costs of approximately $40 million. This is a minimum level of engineering effort which basically reflects the economies of scale for a long line.

E. CONSTRUCTION MANAGEMENT COSTS

Construction management costs cover contract execution and administration, inspection services, change order control, testing and start-up, and construction records. Construction management costs are estimated at 5% of total construction costs.

For comparison, on the Tyee Lake Project final engineering and construction management costs were 8% of total construction costs for a more complex project than the Intertie. On the Swan Lake Project, they represented about 14% of total construction costs, again for a more complex project. We estimate on the Swan Lake Project that construction management itself amounted to about 5% to 6% of total project costs. We were not able to obtain similar data for other projects.

F. PERMITTING COSTS

Permitting costs cover all scientific studies and engineering support, the actual costs of filing and obtaining all required permits. The permits which may be required for the Intertie are discussed briefly in Volume 2, Appendix N. Filing fees for each permit are nominal as reported by Dames & Moore, but costs for permit preparation, including attachments, will be substantially greater.

Permitting costs include an EIS and associated field studies, limited visual simulation studies, and preparation/support of required permits. The major permits likely to be required for an Intertie are a Mat-Su Conditional Use Permit for the Chickaloon Special Land Use District, a Title 16 Fish Habitat permit from ADF&G for crossing anadromous streams, a right-of-way permit from ADNR, possibly a Section 404 permit from COE for construction in wetlands, and an ASDOT-PF permit for state road crossings. It should be noted that construction of transmission lines in wetland areas may be covered by COE Nationwide Permit No. 12, requiring only that excavated materials be deposited in upland areas and that disturbed areas be revegetated. Winter construction and driven piles will minimize such disturbance. The total cost of permitting is estimated at $340,000. It does not include any reimbursement of costs to permitting agencies for work done by their own staffs either for processing the permits or conducting field investigations. See part A.2. earlier in this section regarding an EIS.

G. OWNER COSTS

Owner costs include all costs incurred by CVEA for its own project staff and supporting independent services required to plan and manage the project. We estimated this cost at 3% of total project costs, including construction costs, engineering and construction management, and permitting. For comparison, on the more complex Tyee Lake Project, owner costs were about 5.4% of total project costs. Our selection of 3% is based on CVEA's stated willingness to streamline its management of the project, by relinquishing a substantial portion of the burdensome requirements on similar state projects.

H. TOTAL PROJECT DEVELOPMENT COST ESTIMATES

Total feasibility-level project development cost estimates, including all costs to plan, permit, design and construct the Intertie, are summarized in Table VI-7 below.

Table VI-7
Total Intertie Development Cost Estimates
All Alternatives

Route Alternative	Total Development Cost Estimate(1)
A	$48,342,000
B	$49,147,000
C	$49,607,000
D	$47,604,000

(1) Based on the least cost option identified at the feasibility-design level.

A breakdown of project development cost estimates for each alternative shown in Table VI-7 is given in Exhibit C-6.

I. OPERATION AND MAINTENANCE COSTS

1. Basic O&M Cost Estimate

Operation and maintenance (O&M) costs cover periodic inspection of the Intertie facilities, repair, replacement and maintenance activities, right-of-way vegetation management, dispatch operations for power transfer over the Intertie, any FERC, REA, APUC or other reporting requirements attributable to the Intertie, insurance on major equipment, and right-of-way rental fees. Contributions to an O&M contingency fund may also be included.

The O&M costs of the Tyee Lake line from 1988 to 1991 averaged about $330,000 or 1.1% per year [11]. For the Swan Lake line, O&M costs have fluctuated from about $2,000 to $48,000 per year, representing less than 0.3% maximum of construction costs for the line. Discussions with Homer Electric Association indicate O&M budgets between 0.5% and 1.0% of construction costs are appropriate for lines in its area. The expenditure level for O&M will increase when substation equipment is included and as the system ages. O&M expenditures also are a function of the responsible party's estimate of the inspection and maintenance frequency, and level of effort required.

For the purpose of this feasibility study a stream of annual O&M expenditures was estimated in current (1993) dollars over the 30-year assumed project life span, as shown in Table VI-8 for steel H-frame, Table VI-9 for wood construction, and Table VI-10 for steel X-frame construction.

State land rental fees could be on the order of $100/acre-year, although according to ADNR this figure is negotiable. The various route alternatives will occupy approximately 1,400 to 1,660 acres, which could require an annual rental payment of $140,000 to $166,000 based on $100/acre. This level of rental fee is not explicitly included in the O&M cost stream projected in Tables VI-8 to VI-10 although the $75,000 miscellaneous expenses fund was meant to cover rental fees. Alaska statutes allow, but do not require, ADNR to waive rental fees for qualifying utilities, such as CVEA. CVEA has represented that they do not currently pay such fees.

2. Impact of Using Steel X-Frames on O&M Costs

X-frame structures are particularly forgiving in permafrost situations where frost action in active layers can differentially heave the foundations. The X-frame footing piles can probably be readily redriven and even lengthened without need to completely remove the structure. The problem of underestimated active layers can be comparatively inexpensively addressed. With effective remediation it is reasonable to expect that frost heaving problems would be largely eliminated over time or stabilize at a low level of occurrence.

Typical H-frame construction in permafrost areas would require expensive removal and temporary support of the H-frame structure to redrive pile footings. The H-frame would be typically attached to a welded pile cap or pole shoe which would have to be removed to add and drive more pile length, then reinstalled. We have given no thought to conceptualizing a detachable footing connection for the H-frame to facilitate correction of a frost heave situation. H-frame structures themselves do not handle differential jacking well and would be expected to suffer more damage than the X-frame.

To account for this difference we have assumed that three frost jack situations occur in each of the first twenty years and that the H-frames require two replacements through year 20 and one replacement per year thereafter while no replacements are required for the X-frame through year 20 and one every five years thereafter. Also we assume different costs for repair or replacement of the structures as given in Tables VI-8 and VI-10.

The X-frame further affords significant longitudinal strength to the line with longitudinal guying and inherent flexibility due to the use of guy-yoke designed to yield at a predetermined load. If properly designed, the X-frame construction will contain failures due to longitudinal unbalanced loads by yielding and relieving stress without failing. H-frame structures will depend on pole strength and bending moment resistance in the longitudinal direction or longitudinal guying to prevent cascading failures. There is no confident way to estimate the different impacts on O&M costs of these two construction methods and their response to longitudinal unbalanced loads of unpredictable severity.

Table VI-8
Annual Operation and Maintenance Costs
Steel H-Frame Construction Alternative
(1993 dollars)

Years	Scheduled Full Line Inspections(1)	Unscheduled Line Inspections(2)	Climbing Inspections(3)	Wood Pole Test Program(4)	Repair Cost(5)	Replace-ment Cost(6)	Testing/ Inspection(7)	Substation Repair(8)	Substation Equipment Replacement(9)	Right-of-Way Trimming(10)	Other Costs(11)	Total Annual O&M Cost
1-4	$18,160	$3,950	$6,160	n/a	$17,880	$50,000	$24,000	$1,500	-0-	$10,000	$75,000	$206,650
5	$18,160	$3,950	$6,160	n/a	$17,880	$50,000	$99,000	$1,500	-0-	$10,000	$75,000	$281,650
6-9	$18,160	$3,950	$6,160	n/a	$17,880	$50,000	$24,000	$1,500	-0-	$10,000	$75,000	$206,650
10	$18,160	$3,950	$6,160	n/a	$17,880	$50,000	$99,000	$1,500	-0-	$10,000	$75,000	$281,650
11-14	$18,160	$3,950	$6,160	n/a	$29,800	$50,000	$24,000	$4,000	-0-	$10,000	$75,000	$221,070
15	$18,160	$3,950	$6,160	n/a	$29,800	$50,000	$99,000	$4,000	$50,000	$10,000	$75,000	$346,070
16-19	$27,240	$7,900	$12,320	n/a	$29,800	$50,000	$24,000	$4,000	-0-	$10,000	$75,000	$240,260
20	$27,240	$7,900	$12,320	n/a	$29,800	$50,000	$99,000	$4,000	$50,000	$10,000	$75,000	$365,260
21-24	$27,240	$7,900	$12,320	n/a	$47,680	$20,000	$24,000	$10,000	-0-	$10,000	$75,000	$234,140
25	$27,240	$7,900	$12,320	n/a	$47,680	$20,000	$99,000	$10,000	$300,000	$10,000	$75,000	$609,140
26-29	$27,240	$7,900	$12,320	n/a	$47,680	$20,000	$24,000	$10,000	-0-	$10,000	$75,000	$234,140
30	$27,240	$7,900	$12,320	n/a	$47,680	$20,000	$99,000	$10,000	$500,000	$10,000	$75,000	$809,140

(1) Full line inspection costs two person days (8 hrs/day, $70/hr), helicopter at $650/hr for 8 hours, for $9,080/inspection; two inspections/yr for years 1-15, three inspections/yr for years 16-30.
(2) Unscheduled (outage) inspection costs 10 person-hours at $70/hr, helicopter at $650/hr for 5 hours, for $3,950/inspection; one inspection/yr for years 1-15, two inspections/yr for years 16-30.
(3) Climbing inspections at 1 person-hour/structure, including transportation time, 8 structures per day per lineman, 2 linemen per trip at $60/hr, helicopter at $650/hr and 8 hrs/16 structures; 16 structure inspections/yr for years 1-15 at an annual cost of $6,160 and 32 inspections/yr for years 16-30 at an annual cost of $12,320.
(4) Based on discussions with utilities in South Central Alaska wood pole decay is rare and wood pole inspection and testing programs are not required as a rule.
(5) Includes all costs allocated to actual repair of existing facilities, such as broken insulators, downed conductors, damaged marker balls, jacked foundations,loose guys, etc. O&M costs assumed at $1,000 material/structure, 16 person-hours/structure at $60/hr, helicopter and other equipment at $1,000/hr, 4 hrs per structure, three structures/yr for years 1-10 for an annual cost of $17,880, five structures/yr for years 11-20 ($29,800), eight structures/yr for years 21-30 ($47,680).
(6) Replacement cost is for replacing a structure and framing. Cost to replace a steel structure and transfer wires is assumed to be $25,000. Two replacements per year are assumed for years 1-20 and one per year thereafter.
(7) Monthly testing/inspection of new Sutton Substation and expansion of Pump Station No. 11 Substation equipment at $750/mo or $9,000/yr. Annual inspection/testing at $15,000/yr. Major testing by outside firm assumed every five years at $75,000 /yr for both substations.
(8) Repair of substation equipment assumed at $1,500/yr for years 1-10, $4,000/yr for years 11-20, $10,000/yr for years 21-30.
(9) Replacement assumed at $50,000 in years 15 and 20, at $300,000 in year 25, and $500,000 in year 30.
(10) Right-of-way trimming and vegetation management costs assumed at two person-weeks for 80 person-hours @ $60/hr plus equipment and subsistence for total estimate of $10,000/yr.
(11) Other costs include contributions to an O&M contingency fund, equipment insurance, reporting requirements linked to operation of the Intertie, and miscellaneous costs (level cost assumed at $75,000/yr).

Table VI-9
Annual Operation and Maintenance Costs
Wood Construction Alternative
(1993 dollars)

Years	Scheduled Full Line Inspections(1)	Unscheduled Line Inspections(2)	Climbing Inspections(3)	Wood Pole Test Program(4)	Repair Cost(5)	Replacement Cost(6)	Testing/ Inspection(7)	Substation Repair(8)	Substation Equipment Replacement(9)	Right-of-Way Trimming(10)	Other Costs(11)	Total Annual O&M Cost
1-4	$18,160	$3,950	$6,160	-0-	$22,840	$30,000	$24,000	$1,500	-0-	$10,000	$75,000	$191,610
5	$18,160	$3,950	$6,160	-0-	$22,840	$30,000	$99,000	$1,500	-0-	$10,000	$75,000	$266,610
6-9	$18,160	$3,950	$6,160	-0-	$22,840	$30,000	$24,000	$1,500	-0-	$10,000	$75,000	$191,610
10	$18,160	$3,950	$6,160	-0-	$22,840	$30,000	$99,000	$1,500	-0-	$10,000	$75,000	$266,600
11-14	$18,160	$3,950	$6,160	-0-	$34,260	$30,000	$24,000	$4,000	-0-	$10,000	$75,000	$205,530
15	$18,160	$3,950	$6,160	-0-	$34,260	$30,000	$99,000	$4,000	$50,000	$10,000	$75,000	$330,530
16-19	$27,240	$7,900	$12,320	-0-	$34,260	$30,000	$24,000	$4,000	-0-	$10,000	$75,000	$224,720
20	$27,240	$7,900	$12,320	-0-	$34,260	$30,000	$99,000	$4,000	$50,000	$10,000	$75,000	$349,720
21-24	$27,240	$7,900	$12,320	-0-	$45,680	$15,000	$24,000	$10,000	-0-	$10,000	$75,000	$277,140
25	$27,240	$7,900	$12,320	-0-	$45,680	$15,000	$99,000	$10,000	$300,000	$10,000	$75,000	$652,140
26-29	$27,240	$7,900	$12,320	-0-	$45,680	$15,000	$24,000	$10,000	-0-	$10,000	$75,000	$277,140
30	$27,240	$7,900	$12,320	-0-	$45,680	$15,000	$99,000	$10,000	$500,000	$10,000	$75,000	$852,140

(1) Full line inspection costs two person days (8 hrs/day, $70/hr), helicopter at $650/hr for 8 hours, for $9,080/inspection; two inspections/yr for years 1-15, three inspections/yr for years 16-30.

(2) Unscheduled (outage) inspection costs 10 person-hours at $70/hr, helicopter at $650/hr for 5 hours, for $3,950/inspection; one inspection/yr for years 1-15, two inspections/yr for years 16-30.

(3) Climbing inspections at 1 person-hour/structure, including transportation time, 8 structures per day per lineman, 2 linemen per trip at $60/hr, helicopter at $650/hr and 8 hrs/16 structures; 16 structure inspections/yr for years 1-15 at an annual cost of $6,160 and 32 inspections/yr for years 16-30 at an annual cost of $12,320.

(4) A wood pole test program would cover the cost of a specialized firm to test wood poles for residual strength and signs of decay and prescribe remedial action. Based on discussions with utility personnel, South Central Alaska is a favorable climate for wood poles and pole inspection programs are not required.

(5) Includes all costs allocated to actual repair of existing facilities, such as broken insulators, downed conductors, damaged marker balls, jacked foundations loose guys, etc. O&M costs assumed at $750 material/structure, 16 person-hours/structure at $60/hr, helicopter and other equipment at $1,000/hr, 4 hrs per structure, four structures/yr for years 1-10 for an annual cost of $22,840, six structures/yr for years 11-20 ($34,260), eight structures/yr for years 21-30 ($45,680).

(6) Replacement cost is for replacing a structure and framing. Cost to replace a wood structure and transfer wires is assumed to be $15,000. Two replacements/yr for years 1-20 for a total of $30,000/yr is assumed; for years 21-30, one replacement/yr for a total of $15,000/yr is assumed.

(7) Monthly testing/inspection of new Sutton Substation and expansion of Pump Station No. 11 Substation equipment at $750/mo or $9,000/yr. Annual inspection/testing at $15,000/yr. Major testing by outside firm assumed every five years at $75,000 /yr for both substations.

(8) Repair of switchyard equipment assumed at $1,500/yr for years 1-10, $4,000/yr for years 11-20, $10,000/yr for years 21-30.

(9) Replacement assumed at $50,000 in years 15 and 20, at $300,000 in year 25, and $500,000 in year 30.

(10) Right-of-way trimming and vegetation management costs assumed at two person-weeks for 80 person-hours @ $60/hr plus equipment and subsistence for total estimate of $10,000/yr.

(11) Other costs include contributions to an O&M contingency fund, equipment insurance, reporting requirements linked to operation of the Intertie, and miscellaneous costs (level cost assumed at $75,000/yr).

Table VI-10
Annual Operation and Maintenance Costs
Steel X-Frame Construction Alternative
(1993 dollars)

Years	Scheduled Full Line Inspections(1)	Unscheduled Line Inspections(2)	Climbing Inspections(3)	Wood Pole Test Program(4)	Repair Cost(5)	Replacement Cost(6)	Testing/ Inspection(7)	Substation Repair(8)	Substation Equipment Replacement(9)	Right-of-Way Trimming(10)	Other Costs(11)	Total Annual O&M Cost
1-4	$18,160	$3,950	$6,160	n/a	$15,690	-0-	$24,000	$1,500	-0-	$10,000	$75,000	$154,460
5	$18,160	$3,950	$6,160	n/a	$15,690	-0-	$99,000	$1,500	-0-	$10,000	$75,000	$229,460
6-9	$18,160	$3,950	$6,160	n/a	$15,690	-0-	$24,000	$1,500	-0-	$10,000	$75,000	$154,460
10	$18,160	$3,950	$6,160	n/a	$15,690	-0-	$99,000	$1,500	-0-	$10,000	$75,000	$229,460
11-14	$18,160	$3,950	$6,160	n/a	$26,150	-0-	$24,000	$4,000	-0-	$10,000	$75,000	$167,420
15	$18,160	$3,950	$6,160	n/a	$26,150	-0-	$99,000	$4,000	$50,000	$10,000	$75,000	$292,420
16-19	$27,240	$7,900	$12,320	n/a	$26,150	-0-	$24,000	$4,000	-0-	$10,000	$75,000	$186,610
20	$27,240	$7,900	$12,320	n/a	$26,150	-0-	$99,000	$4,000	$50,000	$10,000	$75,000	$311,610
21-24	$27,240	$7,900	$12,320	n/a	$41,840	$20,000	$24,000	$10,000	-0-	$10,000	$75,000	$208,300
25	$27,240	$7,900	$12,320	n/a	$41,840	$20,000	$99,000	$10,000	$300,000	$10,000	$75,000	$603,300
26-29	$27,240	$7,900	$12,320	n/a	$41,840	$20,000	$24,000	$10,000	-0-	$10,000	$75,000	$208,300
30	$27,240	$7,900	$12,320	n/a	$41,840	$20,000	$99,000	$10,000	$500,000	$10,000	$75,000	$803,300

(1) Full line inspection costs two person days (8 hrs/day, $70/hr), helicopter at $650/hr for 8 hours, for $9,080/inspection; two inspections/yr for years 1-15, three inspections/yr for years 16-30.

(2) Unscheduled (outage) inspection costs 10 person-hours at $70/hr, helicopter at $650/hr for 5 hours, for $3,950/inspection; one inspection/yr for years 1-15, two inspections/yr for years 16-30.

(3) Climbing inspections at 1 person-hour/structure, including transportation time, 8 structures per day per lineman, 2 linemen per trip at $60/hr, helicopter at $650/hr and 8 hrs/16 structures; 16 structure inspections/yr for years 1-15 at an annual cost of $6,160 and 32 inspections/yr for years 16-30 at an annual cost of $12,320.

(4) Based on discussions with utilities in South Central Alaska wood pole decay is rare and wood pole inspection and testing programs are not required as a rule.

(5) Includes all costs allocated to actual repair of existing facilities, such as broken insulators, downed conductors, damaged marker balls, jacked foundations, loose guys, etc. O&M costs assumed at $750 material/structure, 8 person-hours/structure at $60/hr, helicopter and other equipment at $1,000/hr, 4 hrs per structure, three structures/yr for years 1-10 for an annual cost of $15,690, five structures/yr for years 11-20 ($26,150), eight structures/yr for years 21-30 ($41,840).

(6) Replacement cost is for replacing a structure and framing. Cost to replace a steel structure and transfer wires is assumed to be $20,000. No replacements are assumed for years 1-10. Steel X-frame structure replacements will be at a rate of one every five years starting in year 21.

(7) Monthly testing/inspection of new Sutton Substation and expansion of Pump Station No. 11 Substation equipment at $750/mo or $9,000/yr. Annual inspection/testing at $15,000/yr. Major testing by outside firm assumed every five years at $75,000 /yr for both substations.

(8) Repair of substation equipment assumed at $1,500/yr for years 1-10, $4,000/yr for years 11-20, $10,000/yr for years 21-30.

(9) Replacement assumed at $50,000 in years 15 and 20, at $300,000 in year 25, and $500,000 in year 30.

(10) Right-of-way trimming and vegetation management costs assumed at two person-weeks for 80 person-hours @ $60/hr plus equipment and subsistence for total estimate of $10,000/yr.

(11) Other costs include contributions to an O&M contingency fund, equipment insurance, reporting requirements linked to operation of the Intertie, and miscellaneous costs (level cost assumed at $75,000/yr).

Section VII

PROJECT SCHEDULE

The following section on project schedule was prepared for the Draft Feasibility Report and was based on completion of the NEPA process through an Environmental Assessment. Completion of a full Environmental Impact Statement (EIS) and other schedule factors could delay this schedule by approximately one to two years. Some schedule could be regained by committing sufficient resources and performing certain tasks in parallel. A project schedule assuming the full EIS was briefly investigated and its estimated completion date was in late 1999.

A preliminary schedule for total project implementation is shown in Figure VII-1. This schedule was developed based on other project experience in Alaska and the project organization described below. We believe the schedule is practical, though it depends on many assumptions and, above all, careful planning for an accelerated schedule.

If funding to pursue a project EIS and other permitting is authorized in July 1994, we estimate completion of the Intertie in the fall of 1998.

Each major project phase, its duration, and relationship to other phases are shown in Figure VII-1. Further elaboration of project schedule phases and assumptions follows.

A. PROJECT DEVELOPMENT ORGANIZATION

The project can be organized and managed in four basic ways, namely (1) CVEA acts as the project manager, (2) CVEA contracts externally for project manager, (3) a turnkey design and construct project, or (4) a combination of the above depending on project phase.

The project schedule is based on (2) above where CVEA contracts for a project manager but retains some oversight control over the project. The four alternative project organization methods are discussed below.

1. CVEA Acts as Project Manager

Under this option CVEA would maintain management of the project and would contract with several entities for the permitting, design and construction of the project. As project manager CVEA would then retain control and the entities selected would have the best qualifications for the different stages of project work. These entities would each be accountable to CVEA.

This approach provides the greatest degree of input and control for CVEA and would tend to have more distinct decision points for the project. However, CVEA would have greater administrative and project management responsibilities that would require staff additions and more staff time. Since several contracts would be involved for outside services, the project schedule would be longer for this option.

2. CVEA Contracts Externally for Project Manager

Under this option CVEA would contract with a single entity for the management, permitting, design and construction of the project. This project manager (PM) would then be responsible for progress on the project and would maintain project records and books for allocation of costs. The PM would perform some project duties directly and in turn would likely utilize subcontracts for services which may be outside of PM area of expertise, such as environmental, right-of-way acquisition, and possibly design.

Advantages of this option are several. Utilizing PM would relieve CVEA staff of majority of time commitment to the project. Use of single contract for PM may slightly shorten the project development schedule since many services will be obtained/negotiated by PM which may streamline the formal RFP-Proposal-Selection process and time associated with this for each subcontract.

This option may also allow some concurrent prosecution of project tasks such as environmental, permitting and conceptual design provided PM has all of these capabilities in-house or under contract.

Disadvantages are also manifold. CVEA's direct involvement is limited and this insulation may decrease input or control of decisions. CVEA has expressed a preference for controlling independent inspection during construction. Typically, the multiple stages of the RFP-Proposal-Selection process provides more flexibility and some additional cost control. If schedule acceleration is warranted it may not be identified as soon as if CVEA acts as PM. In the event that the individual acting as PM is changed and a new PM is acquired the project could suffer since the new PM would be lacking much knowledge about the early stages of the project and CVEA staff would have also been isolated from the project. If an external entity were to serve as PM, this may add another layer of costs to the project.

3. Turnkey (Design/Build)

Under this option CVEA would contract with a single entity for the design, construction, and energization of the project. The prime would likely be the construction contractor. The contractor would perform the material procurement and construction and in turn would likely utilize subcontracts for services which may be outside of the contractor's area of expertise, such as surveying, geotechnical investigations, and design.

The primary advantage of this type of contract is ability to compress/accelerate schedule. If a detailed bid document can be developed, this approach may provide the best estimate of the total development cost for the project at the earliest point in the project. It is expected that a turnkey contract would be issued after environmental and permitting work is complete.

In the way of disadvantages, this type of contract is typically more difficult or costly to suspend if CVEA chooses to change approach. Importantly, CVEA would have limited input to decisions.

4. Hybrid - CVEA as Project Manager & Turnkey (Design/Build)

Under this option CVEA would manage the project through the permitting and conceptual design stage to fully define the project requirements and would then contract with a single entity for the design, construction, and energization of the project.

This approach provides the best opportunity for schedule acceleration at some mid-point of the project. This approach provides for a relatively firm cost for the project at about a third of the way through the project effort.

The disadvantages of this approach are basically the same as described for the turnkey contract in 3. above.

B. SCHEDULE ASSUMPTIONS

Many assumptions underlie the project development schedule in Figure VII-1. These are discussed below.

1. Project Financing

The feasibility study in final form is assumed to be issued March 31, 1994. Assuming feasibility is demonstrated, a plan of finance would have to be prepared. It is not clear at this stage how the balance of financing would be obtained nor how long that would take. It is assumed though that the state would release funds set aside for the Intertie by July 15, 1994 and that this would not depend on securing the balance of financing.

2. Environmental Assessment

In our schedule, it is assumed that if feasibility is shown, CVEA will undertake on its own to complete an EA. It is recommended that the draft feasibility study with environmental report be distributed to key permitting agencies for their detailed review. It is estimated that completion and processing of the EA would take five to six months. It has also been suggested that the EA work should be timed so that permitting agencies can schedule any required field work for summer 1995. The REA Borrower's Environmental Report would be prepared after the EA and is assumed to take one month.

Based on discussions at the agency meeting on March 17, 1993, it appears that an EIS will not be required although this cannot be guaranteed until the EA is actually ruled on. See Section VI, part A.2., regarding an EIS. If an EIS is required, the schedule may be delayed.

3. Permitting

At a minimum, permits from the Alaska Department of Natural Resources, Alaska Department of Fish and Game, Alaska Department of Transportation and Public Facilities, U.S. Army Corps of Engineers, Bureau of Land Management, and the Matanuska-Susitna Borough will be required.

Careful preparation of construction plans using best management practices and mitigation measures should facilitate permitting. It is assumed that this process would begin in late spring 1995 and take nine months, with completion in December 1995.

The most difficult permit to obtain would appear to be the Conditional Use Permit for the Chickaloon Special Land Use District (CSLUD) within the jurisdiction of the Matanuska-Susitna Borough. The

Chickaloon Community Plan, which sets out the prohibited and conditional land uses for the CSLUD, specifically lists power lines in the latter category. There appears no way to route the Intertie so as to completely avoid the CSLUD and a CUP will have to be submitted to the Matanuska-Susitna Planning Commission which would approve or disapprove the CUP. There is no indication that a CUP would be disapproved if all reasonable efforts are taken to reduce adverse impacts.

4. Right-of-Way Easement Acquisition

We assume right-of-way easement acquisition would be handled by a right-of-way agent. It would begin during the late stages of the EA work, in winter 1995, with compiling land owner lists for a selected route corridor. Initial owner contacts would be made and temporary access agreements obtained to allow entry of survey and geotechnical crews. Detailed review of unpatented mining claims would be made. It is assumed that right-of-way acquisition would be completed within sixteen months, by May 1996. This should occur before clearing contracts could be issued although limited clearing contracts could be considered for significant, contiguous lengths of right-of-way. No condemnation proceedings have been accounted for, although they may be required.

5. Preliminary Design

The preliminary design phase includes aerial surveys, geotechnical investigations, final route selection, support of permitting, value engineering, final system and switching studies, meteorological study, and plan/profile preparation.

The final route alignment is assumed to be selected prior to the EA work, by September 1994.

Aerial surveys are assumed to take place July-October 1995 after selection of the final route. Late spring has been suggested as the best time for an aerial survey but this cannot be accommodated, in our view, before the assumed time. Geotechnical studies and a foundation report are shown taking place in winter/spring 1996. It is possible that some borings could take place in summer/fall 1995 to accelerate schedule but this would depend highly on the status of right-of-way acquisition. Preparation of plan and profile drawings and strip drawings for right-of-way clearing contracts would be prepared over seven months with completion by May 1996. System studies and meteorological studies would be completed in winter/spring 1995, and do not control the schedule.

6. Final Design

This includes final line and substation design, drawing and plan preparation, procurement and construction contracts, and centerline surveys. This phase can begin during preparation of the plan and profile drawings but cannot end until after the geotechnical report is issued. It is assumed that final design will take about 13 months and be completed by the end of December 1996. If survey and geotechnical work can be accelerated, there may be room for accelerating final design.

7. Contracts

Five contracts have been assumed for this project, although more may be necessary to attract competitive bids. A three-month bid period, i.e., between advertisement and notice of award, is assumed for each contract.

A substation major equipment procurement contract would be awarded in December 1996 with completion of delivery by September 1997.

The material supply contracting and actual supply are assumed to extend about 13 months total. Included in a separate contract would be substation equipment, including the power transformer, circuit breakers, circuit switchers, disconnect switches, line traps and instrument transformers, and pre-wired control building. Estimated lead times for major items are as follows:

Item	Lead Time (ARO)
Power Transformer	44 weeks
Switchgear	34 weeks
Conductor	24 weeks
Wood Poles	24 weeks
Steel Structures (including Shop Drawing Review)	24-30 weeks

The substation construction contract would be awarded in spring 1997 allowing for completion of civil works at the substations by fall when CVEA has indicated it would be preferable to take an outage for equipment installation at Pump Station 11 Substation. The substation work as shown could be completed under the above scenario about one year ahead of the Intertie; it is not on the critical path. Completion of work on the substations could also be delayed until fall 1998.

One clearing contract with three schedules or multiple clearing contracts would be required to make schedule. This would be awarded in September 1996 and take an assumed seven months to complete. Discussions with Red Carlos Contracting indicated that use of roller crushers east of Little Nelchina River during the winter would be the most efficient and least costly clearing method if allowed by ADNR and BLM. The Ahtna Native Corporation has indicated that it wants to perform the clearing work for right-of-way on its lands, about 13 miles. In the Matanuska River Valley, a combination of manual and machine clearing would be used and would also be completed by May 1997.

Two transmission line construction contracts or a single contract with multiple schedules are planned. It does not appear that local Alaskan contractors alone could support the bonding requirements of the full project. The contract(s) would be awarded in spring 1997.

It is suggested that the line contract(s) be of the furnish-and-install variety. The contractor(s) would furnish structures and conductor by December 1997. Driving the schedule are the requirements to set foundations in Loading Zone 2 in the winter and to string conductor from late spring to early fall. To achieve energization by fall 1998, two sets of foundation crews are assumed to complete Zones 1, 3 and 4 by November 1997 when they can be merged to complete Zone 2 by April 1998. Structure installation by helicopter is scheduled for a two-month period ending in late May 1998. Conductor stringing would be accomplished by two separate sets of crews in a period of five months ending by October 1998.

8. Energization Date

We estimate an energization date of December 31, 1998 for a total project development time of about five years.

C. PROJECT SCHEDULE COMPARISONS

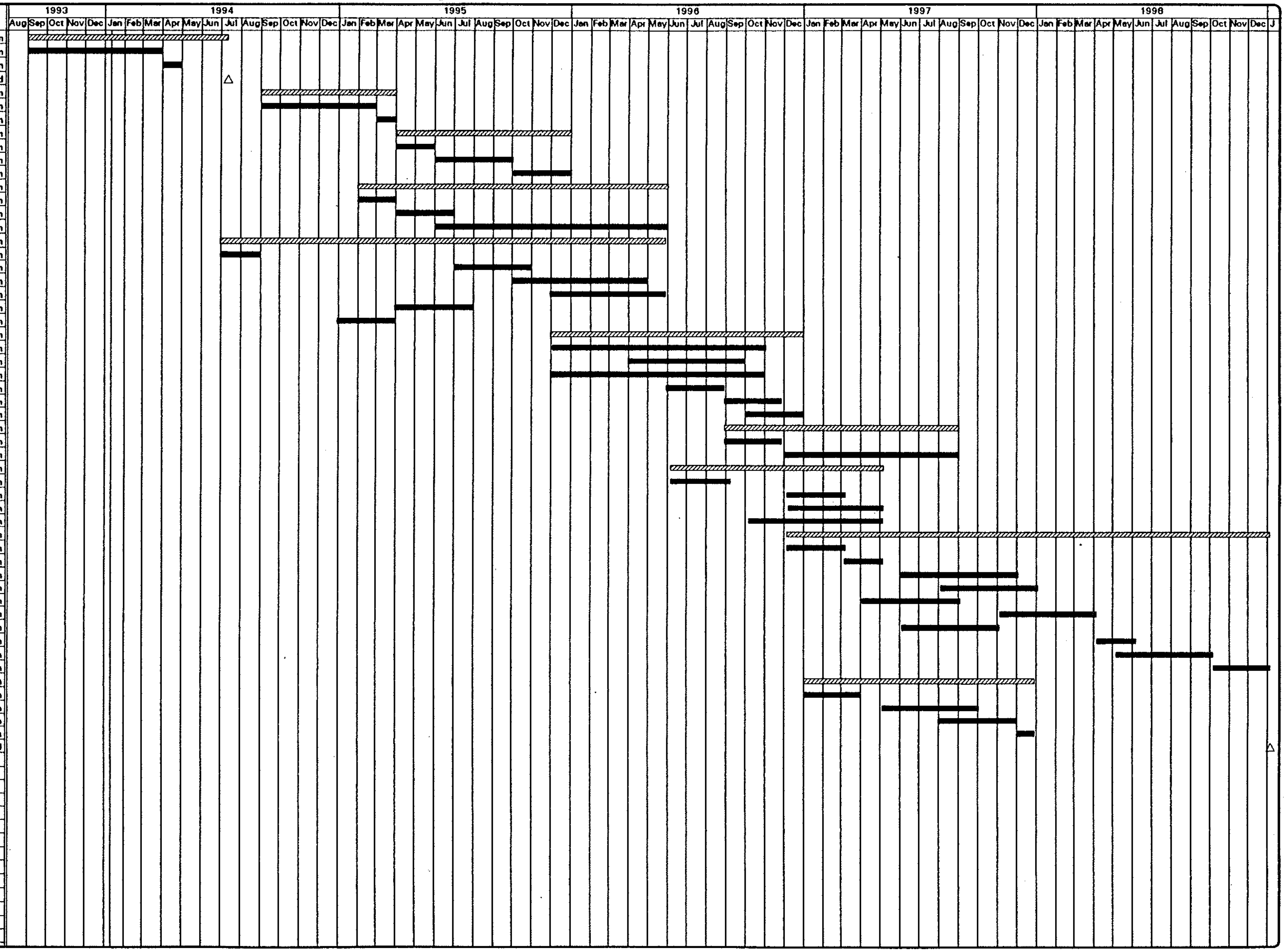
It has been assumed that CVEA would contract an engineering firm to (1) support the EA and permitting processes, (2) execute final design and, later, construction management, (3) coordinate all specialized services such as surveying and geotechnical investigations, and (4) prepare material and construction contracts. Under this scenario, it is assumed that a period of 30 months would be required for engineering up to a notice-to-proceed (NTP) for construction. By comparison, and recognizing that major hydroelectric facilities were involved, similar phases for the shorter Tyee Lake and Swan Lake projects took 27 and 23 months, respectively.

The construction phase is assumed to last 19 months, commencing with mobilization in March 1997. Foundation and anchor construction is assumed to take place mostly from spring 1997 to winter 1998 over a 12-month construction season, with structure framing and staging over the 1997-1998 winter, and structure erection and stringing in the spring/summer/fall of 1998.

For comparison, on the Swan Lake line a construction contract NTP was issued in April 1982, and construction was completed by June 1983, almost five months ahead of schedule, for a total construction period of 14 months. The Tyee Lake line was completed over a 15-month period, from a NTP in July 1982 to October 1983. Construction contracts on both lines took advantage of two construction seasons, beginning in spring/summer and ending in fall/winter of the following year, similar to the schedule for the Intertie.

COPPER VALLEY INTERTIE
SUTTON - GLENNALLEN 138kV TRANSMISSION LINE
Project Schedule

Task Name	Duration
Planning Stage	10.30 m
Feasibility Study	7.00 m
Plan of Financing	1.00 m
Financing obtained	0.00 d
Environment	7.00 m
Environment Assessment	6.00 m
Borrower's Environment Report	1.00 m
R/W Permitting	9.00 m
Application	2.00 m
Field Studies	4.00 m
Review	3.00 m
R/W Acquisition	16.00 m
Ownership List	2.00 m
Temp. Easements	3.00 m
Easement Acquistion	12.00 m
Preliminary Design Stage	22.91 m
Final Route Selection	2.00 m
Aerial Survey And Control Panels	4.00 m
Plan And Profile Drawings	7.00 m
Geotechnical Investigation	6.00 m
Meteorological Study	4.00 m
Final System Studies	3.00 m
Final Design Stage	13.00 m
Final Design Transmission Line	11.00 m
Final Design Substations	6.00 m
Structure Staking/C.L. Survey	11.00 m
Subst. Major Equip. Spec.	3.00 m
T. Line Technical Specifications/Contract	3.00 m
Sub. Technical Spec/Contract	3.00 m
Contract 1 - Major Substation Eqt	12.04 m
Bid Period / Award	3.00 m
Performance	9.00 m
Contract 2 - Clearing /Access Roads	11.00 m
Bid Period / Award	3.00 m
Schedule A - East	3.00 m
Schedule B - Ahtna	5.00 m
Schedule C - West	7.00 m
Contract 3 and 4 - Tline Construction	24.91 m
Bid Period/Award	3.00 m
Mobilization	2.00 m
Structure Delivery	6.00 m
Conductor Delivery	5.00 m
Foundations / Anchors Zone 1	5.00 m
Foundations / Anchors Zone 2	5.00 m
Foundations / Anchors Zone 3 and 4	5.00 m
Structure Installation	2.00 m
Conductor Stringing	5.00 m
Final Inspection / Clean Up	3.00 m
Contract 5 - Substation Construction	11.90 m
Bid Period/Award	3.00 m
Civil Works	5.00 m
Equipment Erection	4.00 m
Testing	1.00 m
Energization	0.00 d



R. W. BECK & ASSOCIATES

FIGURE VII-1

ELECTRIC LOAD FORECAST

A. INTRODUCTION

This section of the report describes the methodology, assumptions, and results of the load forecast prepared as part of the process to assess the future need for electric power in the Valdez and Copper River service areas and serves as the basis for an economic evaluation of the Intertie. The actual load projections for Copper Valley Electric Association's (CVEA) service area are provided in detail in the attached appendices, along with comparable historical data.

CVEA provides electric service to its customers in two distinct load centers, Valdez and the Copper Basin, which is primarily the Glennallen area. These load centers, although served by CVEA as a single utility service area, are considered sufficiently diverse in economic activity, climate and location to warrant separate load forecasts for each area. In addition, the two areas are interconnected by a 106-mile transmission line that has experienced outages in the past, electrically isolating the two load centers from each other. CVEA maintains generation capacity in both Glennallen and Valdez and it is important to consider each area separately when estimating which generating plants are to be used by CVEA in the future. The load forecast presented in this report was prepared separately for both Valdez and Glennallen and then totaled for the entire CVEA system.

B. METHODOLOGY

The preparation of the electric system load forecast for the Valdez and Copper River areas involved a combination of several efforts. The general economic growth of the area and its influence on energy usage was modeled based on historical relationships between energy usage and changes in population, employment, income, and other factors. Because of the relative importance of several large commercial loads, the loads of the fifteen largest commercial class customers were examined separately. Previous studies of the area's economy were also reviewed and adjusted based on interviews with area planners, business managers, and civic leaders. The methodology used in developing this load forecast is consistent with current techniques used to project loads for smaller utility systems, including the methodological requirements and standards described in the Rural Electrification Administration Revised REA Bulletin 120-1, Development, Approval, and Use of Power Requirements Studies.

Historical CVEA data for disaggregated customer classes were analyzed in conjunction with available economic and demographic data for the Valdez and Copper River areas. Based on these analyses, an econometric load forecasting model was developed for the CVEA service area. Briefly, the load forecast model includes the effects of changing population, employment, per capita income, and inflation levels (among other factors) in the Valdez and Copper River areas to produce various projections of future energy and demand requirements for CVEA. Among other features, the model is able to account for the impact of changes in the price of electricity on the future demand for electricity. There are specific price elasticity estimates included in the model for both the residential and commercial customer classes that were developed using CVEA historical operating data.

The following specific steps were taken in developing the econometric system load forecast for the CVEA service area in Valdez and the Copper River Valley:

- Review CVEA annual billing records and energy requirement statistics for the period of 1980 through 1992.
- Collect historical population, employment, per capita income, inflation, and other non-utility data for the same time period, as available.
- Review monthly billing records for CVEA's fifteen largest customers and analyze historical energy and demand levels for these customers.
- Conduct interviews with several of CVEA's largest customers concerning historical, current, and future energy characteristics and requirements.
- Conduct a statistical analysis of historical energy and demand levels for each CVEA customer class.
- Collect economic and demographic data and develop input projections for the alternative load forecast scenarios.
- Develop an econometric system load forecasting model and develop CVEA load forecast projections under medium, high, and low growth case scenarios.

The number of CVEA residential class customer accounts was modeled using an equation based on past statistical relationships between residential customers and population. The equation for Valdez explains 86% of the historical growth of the number of residential class customers from 1980 to 1992 in Valdez. The equation indicates that a 1% increase in Valdez population would result in a 0.72% increase in CVEA's Valdez residential customer accounts. Glennallen residential customers were modeled using a simple statistical relationship between the number of customers and Copper River Valley population. Valdez residential average electricity usage per customer was modeled using a distributed lag equation using prior year's average usage per customer, average real (inflation adjusted) residential rates and heating degree days. A short-term price elasticity factor of -0.23 and a long-term price elasticity estimate of -0.45 were used based on an equation explaining 81% of the historical residential average usage pattern from 1981 to 1992. Glennallen residential electricity usage per customer was also modeled using an equation based on average real residential rates for the prior year. A price elasticity factor of -0.30 was used based on the historical Glennallen residential average usage pattern from 1980 to 1992.

Commercial class energy usage was modeled using a combination of econometric equations and projected discrete additions derived from interviews with large commercial class customers. For Valdez small commercial energy sales, a statistical equation was developed based on estimates of Valdez employment levels and real commercial electric rates (lagged one year) and was based on small commercial energy usage data from 1980 through 1992. The statistical equation explains 71% of the historical pattern and has a price elasticity factor of -0.16. Glennallen small commercial energy usage per customer is modeled using an average 1992 level which is slightly higher than the historical pattern of 1980 to 1992.

Data from the fifteen large CVEA commercial customers (constituting about 95% of total CVEA large commercial class energy sales in 1992) collected through interviews and from CVEA were used in the development of the discrete power requirement projections for the large commercial class with the remainder of the large commercial class being projected using historical ratios.

Energy sales to public class accounts were also projected using a combination of an econometric approach as well as other statistical relationships. A statistical review of the public class data indicated no significant price elasticity component. The Valdez public building class energy sales was modeled based on an equation estimated using statistical relationships experienced over the 1984 to 1992 time horizon that explains 90% of the historical growth for that class. This equation is based on Valdez employment and real per capita income. Glennallen public building energy sales is a product of public building customers and public building usage per customer. Both the Valdez and Glennallen number of public building customers are assumed to grow at half of the rate of population growth for the respective areas. Valdez public building energy usage per customer is calculated, and Glennallen public building usage per customer is assumed to remain constant. Public streetlighting customers in both Valdez and Glennallen are estimated to increase at the rate of population growth in the respective areas, while usage per customer, in both locations, is assumed to remain constant.

Projected CVEA energy sales for each year of the forecast period were derived by adding the energy sales projections for the residential, commercial, and public classes in both Valdez and Glennallen. Estimates of future energy requirements were derived by adding estimated energy losses to CVEA's projected annual system energy sales. CVEA's system losses were projected at 8.0% of total energy requirements in all three cases, based on average losses experienced in the past.

The peak demand for the CVEA system in the Valdez and Copper River Valley areas was projected separately for each area based on an average relationship between total annual energy requirements and peak demand experienced in the past. An explicit adjustment to the peak demand for Valdez has been made to account for the addition of the Petro Star refinery load, which has a higher load factor than that for the rest of the community. This adjustment results in a higher load factor for the system than has been exhibited in the past. The projected peak demand, which is based solely on projected annual energy requirements, does not include the effects on CVEA's peak demand that can be caused by possible extreme weather conditions.

Alternative load forecast cases have been developed to accommodate a range of possible future growth scenarios for the CVEA service area. These cases use alternative low, medium and high population growth projections, among other alternative assumptions, as the basis for the number of customers served and total energy sales in the future. Alternative growth scenarios for the fifteen largest commercial customers have also been developed. The Petro Star refinery located in Valdez began full operation in early 1993 and Petro Star is CVEA's largest customer. Petro Star has indicated that it expects to expand its production facility over the next few years. An independent assessment conducted in early 1994 by Petroleum Marketing Solutions at the request of the Division, indicated that it is very likely that the Petro Star refinery will substantially increase its production capability in the next two to three years but that further expansion beyond the capability achieved at that time would be unlikely. The report on the assessment of the Petro Star refinery expansion is included as Appendix N of this report. Three separate forecasts of the power requirements of the Petro Star refinery have been developed, one each for the low, medium and high forecast scenarios. The basis for these scenarios are described in more detail throughout this section of the report.

C. ASSUMPTIONS OF THE LOAD FORECAST

The economy of the Valdez and Copper River Valley areas is predominantly influenced by the petroleum industry, seafood processing, tourism, and state and federal spending.

Estimated population in Valdez has increased from 3,079 in 1980 to an estimated 4,279 in 1991, a 3.0% average annual rate of growth. Population in the Copper River Valley has increased from 2,721 in 1980 to an estimated 2,801 in 1991, a 0.3% annual rate of growth (see Figure VIII-1). Total employment in Valdez increased from 1,746 in 1980 to 2,146 in 1991, a 1.9% average annual rate of growth. Total Copper River Valley employment has decreased from 935 in 1980 to an estimated 728 in 1991, a -2.2% annual rate of growth. Total population in both areas increased 2.2% per year from 1985 to 1991. Per capita income data are available for the Valdez/Cordova area and has increased significantly during this time period from $12,675 in 1980 to $24,523 in 1990. Real (inflation adjusted) per capita income increased from $21,663 in 1980 to $25,312 in 1990. (See Appendix A, page 6, for historical economic and demographic data for the Valdez and Copper River Valley.)

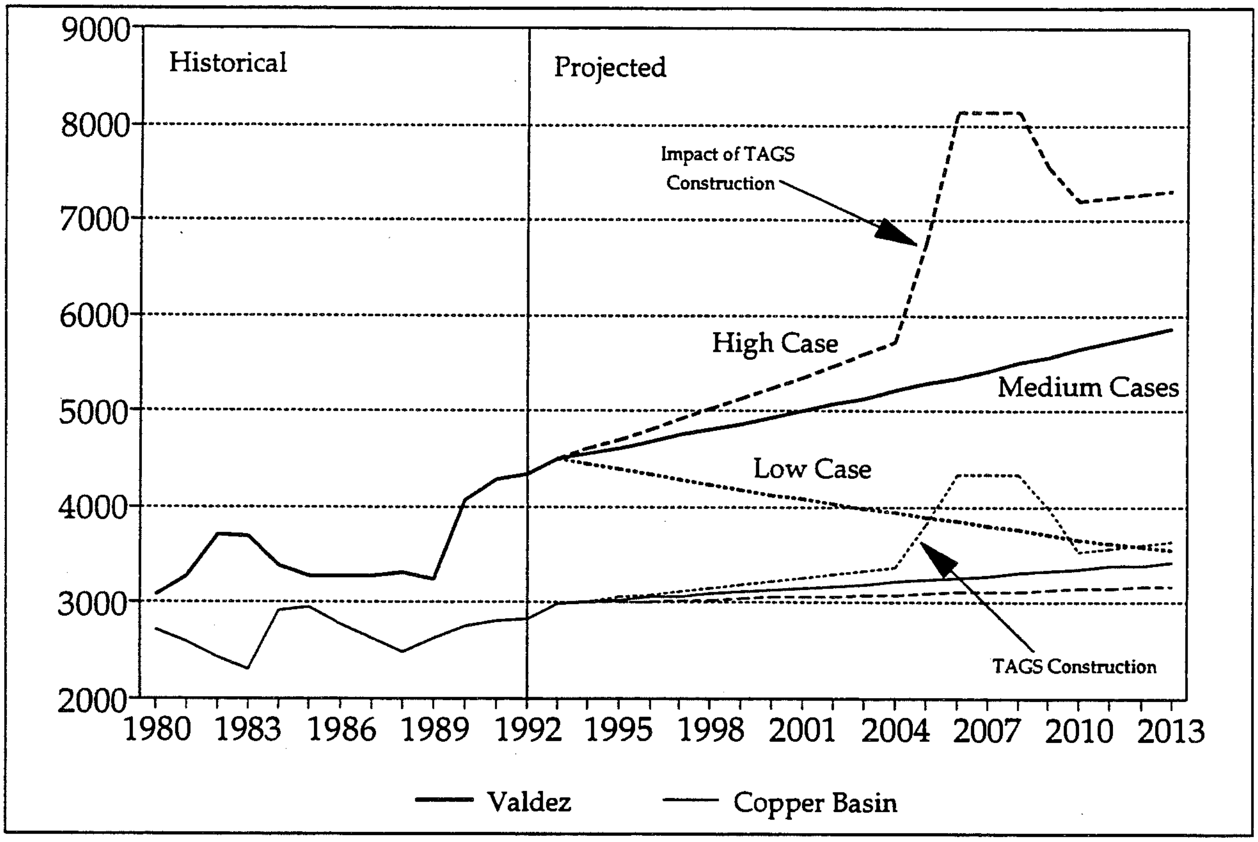


Figure VIII-1: Copper Valley Electric Association - Population

Given the limited size and remote location of the Valdez and Copper River Valley areas and dependence of the areas on a few key industries, projecting future economic and demographic growth is difficult. A review of recent studies of the areas indicates that:

- The State Department of Revenue (DOR) is projecting diminishing oil flows from the Alaska North Slope (ANS) over the next twenty years. These projections include anticipated production from the new fields at Point McIntyre and Niakuk. Some fields, such as

Kuparuk, have produced far more than was predicted in past projections. The current DOR projections do not include ARCO's Kuvlum field. According to ARCO, this field will only be developed if it can be confirmed that the field can produce at least 1 billion barrels, although some estimates indicate it could produce as much as 6 billion barrels. As of October 1993, ARCO had failed to confirm at least 1 billion barrels at the Kuvlum field. ARCO has also recently announced that the Wild Weasel prospect near Kuvlum has no commercial quantities of oil and there are no further plans for further drilling in the area. If Kuvlum is eventually developed, it could spur other remote smaller fields to connect to the pipeline, and other exploration projects in the Beaufort Sea. Any or all of these projects could extend the oil flow to Valdez beyond the horizon of Prudhoe Bay production, as presently projected.

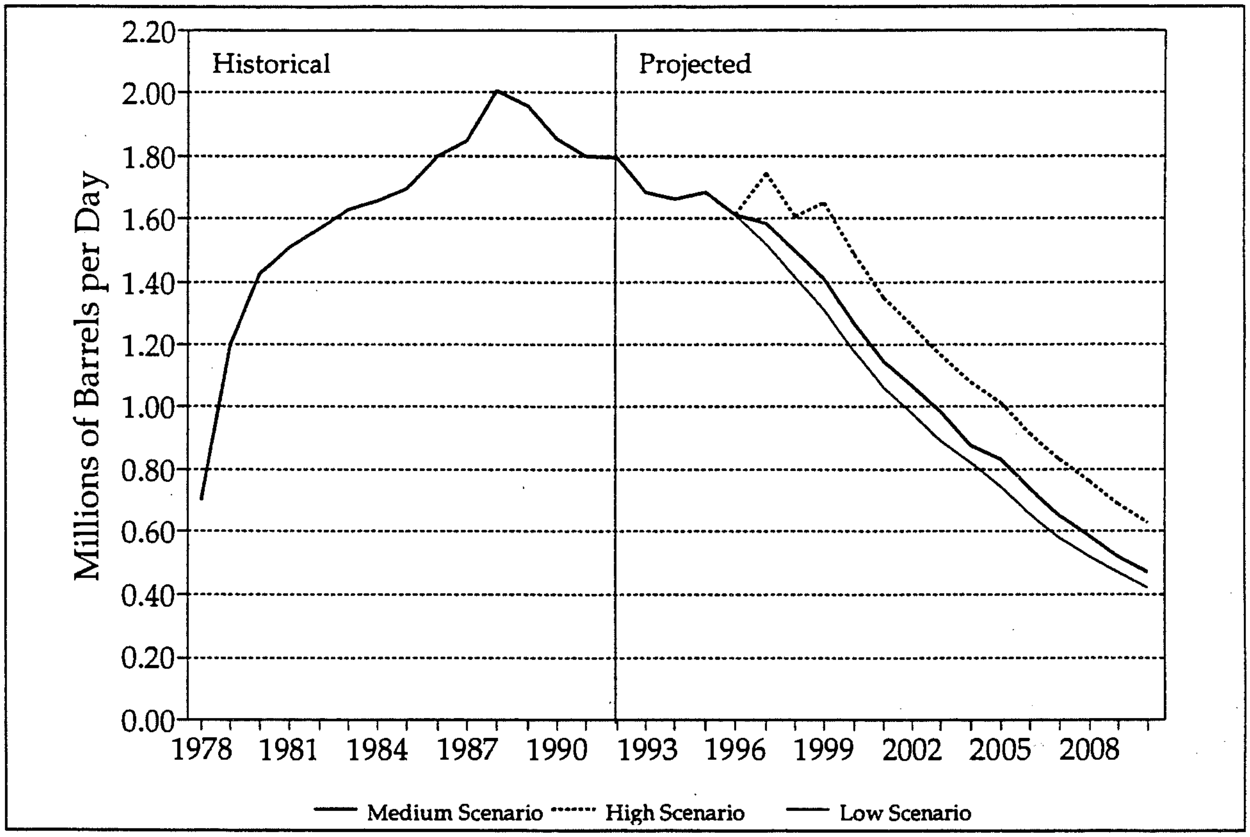


Figure VIII-2: DOR-Alaska North Slope Production

- In April 1993, the United States General Accounting Office (GAO) issued a report entitled "Trans-Alaska Pipeline - Projections of Long-Term Viability Are Uncertain". In its report, the GAO focused much of its effort on the review of projections made in 1991 in a report prepared by the United States Department of Energy (DOE), of the year in which the Trans-Alaska pipeline would be shut down. DOE concluded that the pipeline will shut down between 2006 and 2011, with 2009 identified as the "most likely" year considering projected oil availability on the North Slope, the pipeline's minimum operating levels, and other factors. GAO indicated that although the shut down could actually be predicted to occur anytime between 2001 and 2021 by varying the basic assumptions, it could not estimate a more reliable termination date than DOE. It is important to note that both DOE and GAO assume some new oil field development in making their projections, but neither has assumed development of oil fields in the Arctic National Wildlife Refuge (ANWR). DOE and GAO estimate that development of oil fields in the ANWR would require 10 to 12 years following congressional approval of a lease sale.

- According to the City of Valdez Comprehensive Development Plan dated Spring 1991, the fishery resource in the Prince William Sound area is able to support further development of fish processing activity in Valdez. In its "most likely" scenario, the Comprehensive Development Plan projects that there will be a 3.4% annual growth in the demand for Prince William Sound fish that results in an annual Prince William Sound salmon catch of 40.2 million fish units by the year 2000.. The Comprehensive Development Plan also states that there is no reason to expect any future changes in the Valdez share of the total Prince William Sound commercial fishing activity. The Comprehensive Development Plan further acknowledges that there could be fluctuations in the year-to-year catch volumes. This is evidenced by a record harvest in 1992 and a moderately low catch in 1993. The establishment and contribution of the salmon hatcheries in the Prince William Sound area is considered to be the likely explanation of the continued increases in the pink salmon harvests since 1979.

- The Division of Tourism reports that Alaska is very competitive as a tourist destination, and predicts that the growth in tourism will continue. Growth of tourism in Valdez in the long-term should continue in parallel with the growth throughout Alaska. The anticipated National Park Service Visitor Information Center in the Copper River Valley will create more tourism and "ecotourism" opportunities in that area. The Valdez Comprehensive Development Plan estimates that tourism activity in Valdez will increase at a rate between 2.2% and 4.3% per year.

Although few specific population and employment projections for the Valdez and Copper River areas have been made, projections by the Alaska Department of Labor (DOL) and local agencies, along with those of other studies, have ranged between a low of -2.5% to a high of 3.5% annually over the next ten to 20 years. Given the outlook of slowly diminishing oil flow and moderate development of the fish processing and tourism industries, we have estimated that total long-term population and employment for the CVEA service territory will increase at 1.3% and 1.1% annually. These growth rates are higher than projections used by the City of Valdez in its Comprehensive Development Plan and historical patterns for Glennallen, but lower than projections made by the DOL. DOL projections use a census area migration estimate reflecting the pattern observed in the 1988 and 1989 period. This may cause over-estimation in Valdez. For this and other reasons, a long-term population growth rate between the DOL series and the Comprehensive Development Plan long-term projections was used. It should be noted that the Institute of Social and Economic Research (ISER) of the University of Alaska regularly prepares population projections for the Railbelt region of Alaska. ISER has not developed population projections for Valdez or the Copper River Valley.

The Valdez Comprehensive Development Plan prepared for the Valdez Community Development Department contains an economic base study that includes a demand analysis as well as a forecast of future trends. It includes analysis regarding various sectors of the Valdez economy, namely; the petroleum industry, fisheries, tourism, federal and state government spending, other external markets and potential local investment projects. The net effect of these individual demand projections were analyzed in the Comprehensive Development Plan and presented in a forecast for the Valdez economy and ultimately, in a projection of population growth in the Valdez area of 1.1% per year for its most likely scenario. The medium case population growth projection used in the development of the electric load forecast of 1.3% per year was derived as an average of the population growth rate provided in the Comprehensive Development Plan and DOL's population projection. Since the resulting medium case population growth is higher than the Comprehensive Development Plan projection, it can be implied that the underlying assumed economic growth factors for the Valdez economy would be higher than those defined in the Comprehensive Development Plan.

Alternative high and low population and employment annual growth projections of 2.0% and 2.5% for high case population and employment and -0.3% and -1.8% for low case population and employment have also been assumed in the development of this load forecast. The low case population estimates for Valdez are not as low as the estimates contained in the Valdez Comprehensive Development Plan (pessimistic case) where there is a growth rate of -2.4% per year, but are lower than the Alaska Department of Labor's projections (low case) of +0.57%. The low case developed for this load forecast assumes that the Trans-Alaska pipeline ceases operation prior to the end of the projection period. Consequently, 400 Alyeska jobs at the Valdez terminal facility are projected to be lost in the last four years of the projection period for the low case.

Estimates of the key input variables used in the load forecast are provided on Page 5 of the attached load forecast projections for each scenario, medium, high and low, in Appendix B. Table VIII-1 provides a summary of the major assumptions used in the load forecast with compounded annual growth rates for population, employment, and other assumptions summarized for the medium, high, and low case scenarios.

Table VIII-1
Load Forecast Assumptions for
High, Medium, and Low Case Scenarios(1)

	Compound Annual Growth Rates (%)								
	1992-1997			1997-2002			1992-2013		
Input Assumption	High	Medium	Low	High	Medium	Low	High	Medium	Low
Valdez Population	2.55	1.87	-0.19	2.20	1.35	-1.20	2.53	1.47	-0.96
Copper River Population	1.96	1.62	1.32	1.10	0.67	0.30	1.20	0.90	0.54
Valdez Employment	2.10	1.38	-0.14	2.10	1.00	-0.89	2.86	1.09	-1.78
Copper River Employment	2.39	2.05	-1.70	1.10	0.67	-1.70	1.36	1.00	-1.70
Real Per Capita Income	2.00	0.00	-1.00	2.00	0.00	-1.00	2.00	0.00	-1.00
Inflation	4.50	3.50	2.50	4.50	3.50	2.50	4.50	3.50	2.50
Average Electric Rate Increases	-1.02	-1.02	-1.02	0.88	0.69	0.50	2.30	1.74	1.17

(1) See Appendix B for specific data.

Following is a summary of major assumptions that underlie the medium, high, and low growth load forecast scenarios in this load forecast:

- For the medium case, it is assumed that oil flows in the Alaska pipeline will continue at declining levels corresponding to recent DOR projections throughout the study period. The assumed continued flow of ANS oil is assumed to provide for continued operation and employment, although at slowly decreasing levels, at Alyeska's tanker loading facility in Valdez through the forecast period. The medium case is further differentiated into medium-low and medium-high cases beginning in the year 2018. At that time it is assumed for the medium-low case that the Alaska pipeline and the Petro Star refinery are both shut down but that the economic impact in Valdez of the pipeline shut down itself will be compensated by other industrial growth (e.g., a natural gas pipeline). There is no compensation assumed, however, for loss of the refinery load. The medium-high case assumes continued operation of both the pipeline and the Petro Star refinery beyond 2018. The differentiation between the medium-low and medium-high cases is not shown in the results of the load forecast because the load forecast period is only through 2013, and the only difference between the two cases is the refinery load beyond 2018. The affects of the two medium growth cases on the results of the economic analysis, which evaluates costs and benefits over a much longer period of time, is shown in Section 10 of this report.

- For the low case, oil flows in the pipeline are assumed to decrease over time in accordance with low projections as developed by the Alaska DOR and that it is assumed the pipeline is shut down by 2013. In the high case, oil flows are assumed to decline, but at a slower rate as projected in the DOR high case, and the Trans-Alaska Gas System (TAGS) is assumed to become operational in 2009. Construction of TAGS is assumed to begin in 2005.

- Continued development of fish processing activity in Valdez will result in moderate energy increases for commercial processors in all three scenarios, with growth ranging between 0.0% annually in the low case and 5.2% annually in the high case. These estimates are based on interviews with the various seafood processors.

- At the present time, it has been indicated by various entities that a prototype facility for the High Altitude Auroral Research Project (HAARP) will be constructed by the federal government at a proposed site approximately 30 miles northeast of Glennallen. It is not known, however, if the federal government will continue to fully develop the HAARP facility in the future and whether or not any of the facility's electrical requirements would be supplied by CVEA. Presently, CVEA does not have adequate distribution facilities in place to serve electric power to HAARP. No potential power requirements of HAARP are included in any of the load forecast scenarios because of the speculative nature of additional federal funding, estimated in excess of $70 million, needed to build the proposed facility.

- Heating degree days in the Valdez and Copper River area are assumed to be at 30-year normal levels in each year of the forecast. No attempt has been made to analyze the impact of extreme weather conditions on CVEA's electric load, however, because there is very little, if any, electric space heat used by CVEA customers, it is not expected that extreme weather conditions would significantly impact electricity requirements.

- The cost of electricity to consumers is assumed to decrease by 5% in 1994 and remain constant thereafter until 2002, at which time it is assumed to increase at the assumed rate of general inflation over the remainder of the forecast period. CVEA has indicated that it expects to lower electric rates to its consumers in the near future and does not foresee any need to increase rates for many years to come. The cost of electricity is an input variable for the equations for forecasted electricity usage per customer and energy sales.

- A general inflation rate of 3.5% annually has been assumed in the medium case, bracketed by 4.5% in the high case and 2.5% in the low case scenarios, respectively. Inflation is used in the forecast to adjust per capita income and electric rate increases.

- For the medium case scenario, real per capita income has been assumed to remain constant. Real per capita income growth of 2% and -1.0% annually has been assumed for the high and low case scenarios, respectively. Per capita income is used in the forecast for public class energy sales.

These economic and demographic assumptions were used in the econometric model to project future energy and demand levels for CVEA. The econometric equations used to update the load forecasting model are provided in Appendix C.

D. LARGE COMMERCIAL CUSTOMERS

In order to acknowledge discrete changes in the energy requirements of CVEA's fifteen largest commercial customers, the energy requirements of these customers have been forecasted for each customer separately. The energy requirements of these customers represented over 50% of CVEA's total energy sales in 1992, excluding most of the impacts of energy sales to the Petro Star refinery which became fully operational in early 1993. For the most part, the energy requirements of these customers have been forecasted using growth patterns experienced by each customer in recent years. The actual rate of increase in energy use for each customer has been adjusted to account for assumed and projected changes in a customer's related industry. Much of the variation in projected industrial activity is acknowledged in the differences indicated between the low, medium and high growth scenarios for each customer.

The following descriptions provide an overview of the size of the electric load, the type of business and the assumed changes in electricity requirements for several of the large customers. Many of CVEA's large customers in both Valdez and Glennallen were visited personally to discuss expected electricity needs. Except for a few specific changes, however, most of the large customers visited were unable to indicate precisely when and in what amount electricity requirements might change in the near future.

1. Petro Star Refinery

Petro Star operates an oil refinery that primarily produces aviation and marine fuels and is located on the south shore of Port Valdez not far from the Alyeska Marine Terminal. Regular operation began in January 1993. By mid-1993, the average electric load of the Petro Star refinery was approximately 1.6 MW. As indicated in the Petro Star Valdez Refinery Expansion Assessment prepared by Petroleum Marketing Solutions, dated February 28, 1994 (See Appendix M), the Petro Star refinery presently operates at a level of approximately 30,000 barrels per day. The Expansion Assessment further indicates that it is very likely that Petro Star will expand its operation to 50,000 barrels per day in the next two to three years but that expansion beyond 50,000 barrels per day is unlikely because of the necessary capital and permitting requirements and the fact that at that level of operation the refinery would need to cross the threshold from in-state markets to export markets. It is estimated that at 50,000 barrels per day, the refinery power requirements would be in the range of 2.85 MW.

As an industrial facility, Petro Star could possibly produce electricity with waste heat or other waste products (cogeneration) that would reduce its need to purchase power from CVEA. Although some mention of cogeneration opportunities have been made, Petro Star presently has no plans to install cogeneration facilities, nor have any studies been conducted to evaluate the feasibility of cogeneration at the Petro Star Refinery. At the present time, the Tesoro refinery in Soldotna has cogeneration facilities whereas the two refineries in the Fairbanks area do not. With the installation of cogeneration facilities in recent years, the Tesoro refinery has greatly reduced its power purchases from the Homer Electric Association. The decision to cogenerate at some time in the future may be made by Petro Star based on, among other factors, economic and power delivery reliability issues. As Petro Star continues to establish its operation in Valdez, it should be expected that the option of cogeneration will be evaluated more thoroughly. We have not conducted a review of Petro Star's cogeneration options as part of this study and it is not known whether Petro Star will determine at some time that cogeneration is economically and operationally beneficial. Given the importance of the Petro Star load, a long-term power sales agreement between Petro Star and CVEA would be an important means to reduce the uncertainty of CVEA's future power requirements with regards to Petro Star.

For purposes of the medium scenario of the load forecast, it has been estimated that Petro Star's electric energy requirements will be 14,600 MWh in 1994 and that peak demand will be approximately 1.9 MW. Peak demand is projected to increase each year to approximately 2.4 MW in 1995 and to 2.85 MW by 1997 and energy requirements are projected to increase accordingly at an assumed 90% annual load factor. Energy requirements thereafter are not projected to increase through the remainder of the forecast period. The total annual energy requirements of Petro Star are estimated to be 22,500 MWh once the maximum load is achieved.

In the low case, it is assumed that Petro Star energy requirements will increase to 2.4 MW by 1995 but that they will remain constant at projected 1995 levels of 18,900 MWh with a peak demand of 2.4 MW until the year 2012. The Petro Star load is removed from the forecast in 2013 consistent with the assumed shutdown of the Trans-Alaska pipeline for the low load forecast scenario. Although Petro Star could conceivably install cogeneration equipment at sometime in the future, it is expected that if oil flows in the pipeline continue to decline to the point where the pipeline will no longer operate, as projected in the low case, Petro Star will not invest in cogeneration improvements. The high case assumes that Petro Star's electricity requirements will increase at the same rate as defined previously for the medium load forecast scenario but that the peak load expands to 3.1 MW by 1997. This level of power requirement is assumed to be consistent with operation of the refinery at 55,000 barrels per day.

2. Seafood Processors

CVEA sells power to three seafood processors in Valdez; Seahawk Seafoods, Peter Pan Seafoods and Nautilus Marine. At the present time, most of the processing activity at these facilities is in the summer and fall months, although some indication was made that operations could be extended through the winter months in the future with bottom-fish processing. Seahawk Seafoods is presently in the process of adding additional cold storage capacity at its facility.

It has been assumed that the energy requirements of the seafood processors will increase annually by between 1% and 2.6% (different rates of growth are assumed for each processor) for the medium case forecast. The assumed growth rates are reflective of increases experienced by the seafood processors in recent years with acknowledgment of projected increases in general activity. For the low case energy requirements are assumed to essentially remain constant and for the high case, energy requirements are projected to increase between 1.5% and 5.2% annually.

3. Alyeska Pipeline Service Company

Alyeska purchases power from CVEA to operate certain facilities located along the Trans-Alaska Pipeline such as Pump Station 12 and various communication facilities. Much of this power is purchased under a long-term contract that terminates in 2004 and guarantees minimum purchase amounts. The amount of energy purchased by Alyeska has increased steadily over the past few years, despite decreases in the amount of oil flowing through the pipeline. The medium case assumes that the amount of energy purchased by Alyeska will remain constant at 1990 levels through the end of the forecast period. Energy sales to Alyeska are projected to increase at 3.0% per year in the high case, which is approximately the rate of growth in sales to Alyeska between 1985 and 1992. For the low case, energy sales to Alyeska are projected to decrease by 2.8% per year through 2010, which still considers the contract minimum purchase amounts in effect through 2004. After 2010, energy sales are projected to decrease by 50% per year, resulting in no energy sales beginning in 2013. The decrease in energy requirements forecasted in the low case are based on the assumed reduction and eventual termination of oil flows in the pipeline as described earlier in the overall assumptions for the low case.

CVEA does not sell power to the terminal facility in Valdez. Recently, however, Alyeska has discussed the possibility of purchasing power from CVEA for use at the terminal facility, indicating that the price of power is critical to its decision. At the present time, Alyeska generates its power requirements at the terminal facility, estimated to be approximately 7-9 MW, using its own combustion turbines fueled with diesel fuel and hydrocarbon laden waste gases extracted from storage tanks as the tanks are filled. With the addition of Alyeska's proposed tanker vapor recovery system sometime in the next few years, Alyeska has indicated that it may have additional waste gases to use for combustion turbine fuel. If Alyeska were to purchase power in the future, CVEA would need to sell power at a rate comparable to Alyeska's cost of generation. Although the possibility does exist that CVEA could sell power to the terminal facility in the future, there is a significant degree of uncertainty as to how much and at what price power could be sold. Power sales to the terminal facility are not included in any of the load forecast scenarios.

Alyeska has also recently indicated that its installed power generation facilities at the terminal facility are aging and that it will be evaluating its power supply options over the next few months. Issues of concern to Alyeska will include the cost of replacing the existing facilities, the need to use or dispose of an increasing amount of recovered waste gases and vapors, and the need to produce certain quantities of non-combustible gases (typically exhaust gases) for filling empty storage tanks.

4. State of Alaska Department of Mental Health

The State operates the Harborview Developmental Center in Valdez adjacent to and in the same complex with the City of Valdez Community Hospital. In recent years, the number of residents at Harborview has declined primarily due to more patient out-placement. The State has discussed the possibility of closing Harborview and it is not certain what the future of the facility will be. For the purposes of the forecast, it has been assumed that Harborview or some other operation will continue to utilize the existing facility in the medium and high cases. For the medium case, energy use is assumed to remain constant at the 1992 level. The high case uses a slow growth rate of 1.0% per year, while the low case assumes the facility is closed in 1998.

5. City of Valdez

CVEA sells power to the City of Valdez for various public buildings and other municipal facilities. Since 1985, the amount of energy purchased by the City has increased steadily at 2.6% per year, while population growth in Valdez has grown at an estimated 4.1% per year during that same time period. For the medium case, sales to the City are estimated to grow at a rate of 1.2% per year. A continuation of the recent trend of 2.6% growth per year is estimated for the high case, and energy sales are held constant at 1992 levels in the low case.

6. Other Large Commercial Customers

The energy requirements of the following large commercial customers were also discretely forecasted:

- Alascom
- Alaska Department of Transportation
- City (of Valdez) Schools
- Copper River School District
- Miro Eagle QVC
- Sheffield Hotel
- United States Coast Guard
- Valdez (Convention) Center

7. Potential New Large Loads

a. Ship Escort Response Vessel System (SERVS)

SERVS was established in 1989 to assist oil tankers in safe navigation through Prince William Sound and to provide the first level of response in the event of a tanker problem or oil spill. SERVS presently operates out of a facility leased from Tesoro and is planning to construct a new facility elsewhere in Valdez. The new facility is expected to begin operation in December 1994 and is estimated to require power mainly for lighting and boiler feed pumps. Presently, it is estimated that the net increase in SERVS annual energy requirements caused by the new SERVS facility will be approximately 1,000 MWh.

b. Trans-Alaska Gas System (TAGS)

The feasibility of TAGS is presently under investigation by the Yukon Pacific Corporation. TAGS would conceivably involve a pipeline system presumably adjacent to the existing Trans-Alaska pipeline to deliver natural gas from the North Slope to Anderson Bay near Valdez. At Anderson Bay the gas would be liquefied and loaded on ocean tankers for shipment to Pacific Rim Asian nations. It is expected that TAGS would self-generate most if not all of the power it requires at its liquefaction and shipping facility and that the direct demand on CVEA would be minimal. The impact of construction and operation of TAGS on the Valdez community, from an employment and demographic perspective, would be extensive, however. It is not known if or when construction of TAGS would begin, although Yukon Pacific currently projects that construction and operation could begin sometime after the year 2000.

For the purposes of the high case of the load forecast, it has been assumed that TAGS would be constructed between 2005 and 2009. TAGS is not assumed to be constructed for either the low or medium scenarios. It is further assumed that the impact of construction and operation of TAGS on the Valdez economy would be similar to that experienced during the construction and subsequent operation of the Trans-Alaska pipeline and its Valdez terminal facility.

c. *High Altitude Auroral Research Project (HAARP)*

HAARP is presently being considered by the U.S. government for development northeast of Glennallen, near Gulkana. The HAARP facility if developed as a full-scale facility is estimated to require a significant amount of power, possibly in the range of 12 to 13 MW, much of it to supply a radically fluctuating radar pulse load during research campaigns. A constant load in the range of 1 to 2 MW is expected to be in place for heat, air circulation and lighting. HAARP officials have discussed the possibility of purchasing power from CVEA to supply HAARP's power needs. CVEA would need to construct additional distribution facilities to supply HAARP. Although federal officials associated with HAARP have recently indicated that some limited development has been approved, significant questions exist with regard to long-term HAARP development plans, what the power requirements would be and how the HAARP load would be integrated into CVEA's system if it can be integrated at all. No portion of the potential HAARP load has been included in any of the load forecast scenarios.

E. LOAD FORECAST PROJECTIONS

The load forecast results for CVEA under medium-high, medium-low, high, and low case scenarios for the period 1993 through 2013 are presented in detail in a series of tables in Appendix B and are summarized in Tables VIII-2 and VIII-3 below. For comparison purposes, comparable historical data for the CVEA service area in Valdez and Copper River are provided in Appendix A.

1. Medium Case Scenarios

The medium-high case scenario provides load projections for CVEA under moderate growth conditions given current expectations and also assumes expansion of the Petro Star refinery. The economic scenario that underlies this forecast is one of moderate economic and demographic growth during the forecasted period based on a slowly declining oil industry, increasing seafood processing activity and continued development of tourism in the area. The medium-low scenario is identical to the medium-high, except that the Petro Star refinery load is dropped from the forecast in the years beyond 2018.

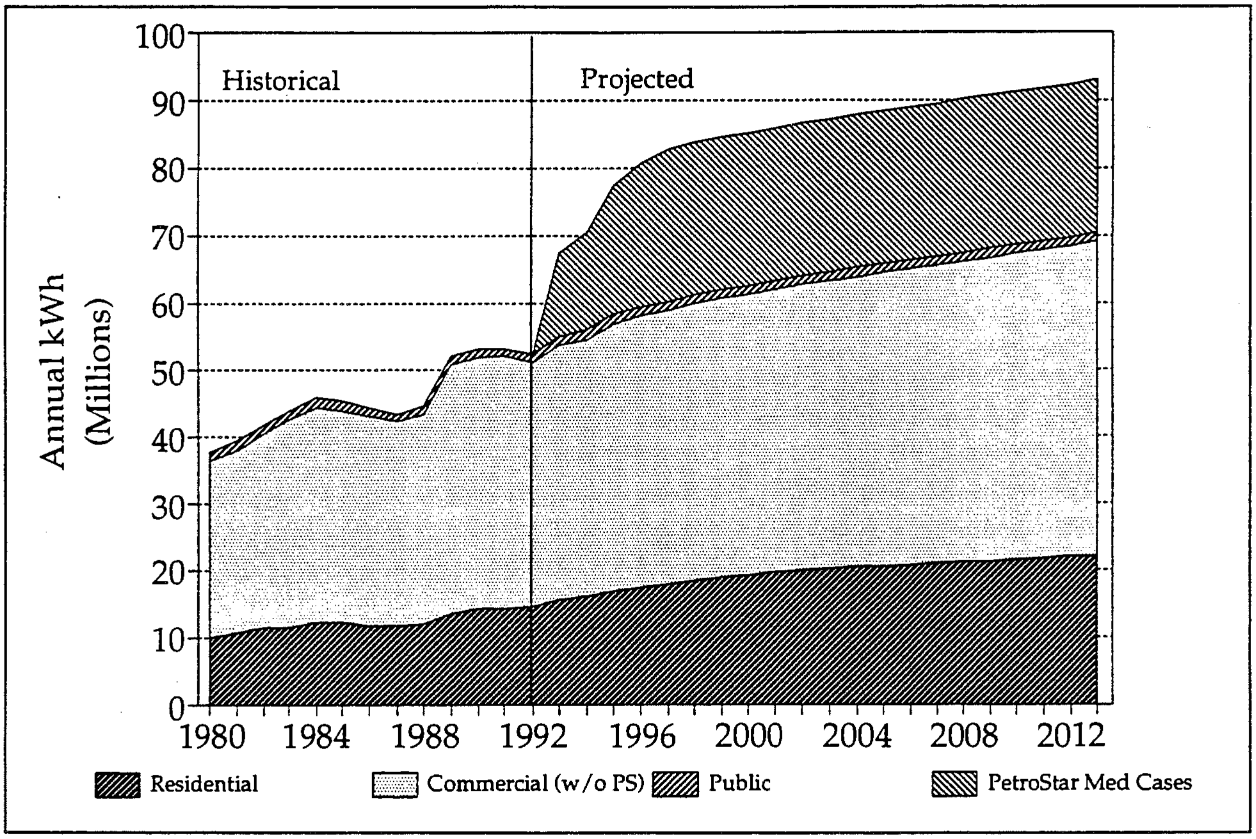


Figure VIII-3: Energy Sales by Class - *MEDIUM CASES*

a. CVEA Retail Sales

Under the medium case scenario, the CVEA retail sales are projected to increase moderately for the 20-year forecast period (see Table VIII-2 and Figure VIII-3). The number of CVEA residential, commercial, and public customer accounts are projected to increase at nearly the rate of population growth. Overall, customer growth is projected to be 1.1% annually compared to the projected total population growth of 1.3% annually. The overall projected customer growth rate of 1.1% is the same rate experienced historically between 1980 and 1988. The projected total population growth of 1.3% annually is higher than the 0.0% experienced between 1980 and 1988 but lower than the 1.8% experienced between 1980 and 1992. The forecast projects total employment to increase 1.1% annually, which is similar to the 1.0% annual rate experienced historically between 1980 and 1992 but higher than the -1.4% annual average rate between 1980 and 1988. Average electricity usage per customer for the residential and commercial classes is projected to increase significantly between 1992 and 1995 as a result of the expected decrease in CVEA rates in 1994. Thereafter, usage per customer is projected to increase moderately, but remain mostly unchanged in the public classes.

(1) Residential Class

In Valdez, residential sales are forecasted to increase at an average annual rate of 2.0% over the entire forecast period compared to a 2.3% rate experienced from 1980 to 1988. In the short term, sales are forecasted to increase at an annual rate of 3.6% from 1992 to 1997. This is higher than the 2.6% annual average rate experienced between 1989 and 1992. Residential sales in Glennallen are forecasted to increase at an average annual rate of 2.0% from 1992 to 2013. Glennallen's residential sales grew at 3.1% annually from 1980 to 1988 and 3.4% annually from

1980 to 1992. In the short term, sales are forecasted to increase at 5.3% annually between 1992 and 1997 compared to the historical 4.1% annual increase experienced between 1988 and 1992.

In Valdez, the number of residential customers is forecasted to increase at an average annual rate of 0.9% over the entire 20-year forecast period. This is higher than the 0.6% historical rate experienced in Valdez from 1980 to 1988 but lower than the 2.1% from 1980 to 1992. The number of Glennallen residential customers is projected to grow at 1.4% annually over the entire forecast period compared to the 2.5% and 2.6% annual growth rates experienced between 1980 and 1988, and 1980 and 1992, respectively. The short-term results of the forecast of residential customers in the Glennallen area show an average annual increase of 3.7% between 1992 and 1997, compared to 3.0% annually between 1989 and 1992 and 2.7% annually between 1988 and 1992. A portion of this projected increase is due to allowances made for CVEA's expectation that it may interconnect to additional areas such as Lake Louise, Summit, Chitina, and Paxson. (Similar allowances are made in the high and low cases.)

Energy usage per residential customer in Valdez is projected to increase at 1.0% annually over the entire forecast period. This is higher than the average growth rate experienced from 1988 to 1992, although lower than the 1.3% annual growth rate experienced from 1980 to 1992. In the short term, the forecast indicates an average annual growth rate of 2.7% between 1992 and 1997. This is higher than the historical rate of growth of 1.8% experienced between 1980 and 1988. (See Figure VIII-4.) Glennallen residential energy usage per customer is projected to increase at an annual average rate of 0.6% over the 20-year forecast period. This is compared to the 0.6% rate between 1980 and 1992. In the short term, the forecast shows a 1.6% annual growth rate between 1992 and 1997, higher than the 1.3% experienced between 1988 and 1992 and the 0.9% experienced between 1989 and 1992. As previously mentioned, much of the projected increase in electricity usage per customer is attributed to the assumed decrease in CVEA electricity rates. (See Figure VIII-4.)

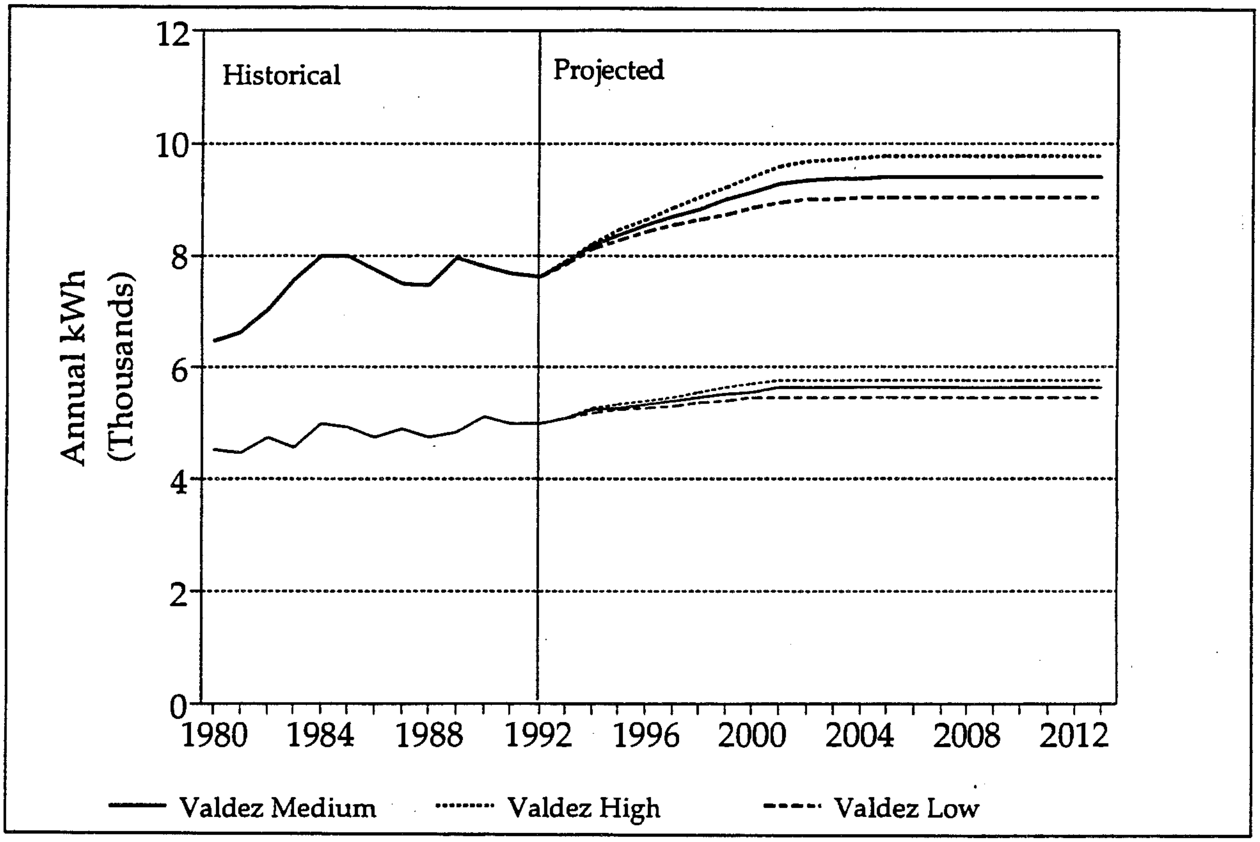


Figure VIII-4: Residential Usage per Customer

(2) Small Commercial Class

Energy sales to the small commercial class in Valdez are forecasted to increase 1.1% annually over the entire forecast period. This rate of growth is higher than the -0.4% annual rate experienced between 1980 and 1988 but lower than the 2.0% annual rate experienced between 1980 and 1992. The forecast shows a 2.2% average annual growth rate between 1992 and 1997, which is similar to the historical 2.0% annual rate between 1980 and 1992. Energy sales in Glennallen are forecasted to grow at a 0.8% annual rate over the entire 1993 through 2013 time horizon. The growth rate projected between 1992 and 1997 is 2.0% per year, which is twice as much as the short-term historical rate of 1.0% per year between 1988 and 1992.

The number of small commercial customers in Valdez is projected to increase 0.7% per year over the entire forecast. This growth rate is almost midway between the growth rates experienced from 1980 to 1992 and 1980 to 1988, with average annual rates of 1.4% and -0.1%, respectively. The number of small commercial customers in Glennallen is projected to grow at 0.8% annually over the forecast period. This is a higher growth rate than 0.1% experienced between 1980 and 1992 and the annual rate of -0.5% experienced between 1980 and 1988. The projected rate of growth in the short term of 1992 to 1997 is 2.0% annually, which is higher than the historical rates of 1.3% and 1.5% experienced between 1989 and 1992 and 1988 and 1992, respectively.

(3) Large Commercial Class

In the short term, Valdez large commercial class sales are forecasted to increase 16.5% for both the medium-high and medium-low scenarios annually from 1992 to 1997 compared to a historical annual growth rate of 8.6% from 1988 to 1992. The large increase in large commercial energy sales between 1992 and 1993 is due to the Petro Star Refinery becoming fully operational in January 1993. The annual forecast shows growth rates of 4.2% and 4.2%, respectively, for the medium-low and medium-high scenarios for Valdez over the entire forecast period. Historically, the growth rate has been 5.0% between 1980 and 1988 and 6.0% annually between 1980 and 1992. Large commercial energy sales in Glennallen are forecasted to increase 0.3% annually over the forecast horizon. Historically, Glennallen has seen a decrease of 0.3% annually between 1980 and 1992 and a decrease of 0.9% annually between 1988 and 1992. This forecast incorporates relatively constant Alyeska energy purchases.

b. CVEA Total Energy Sales

CVEA's estimated annual energy sales in the Valdez/Copper River service area are determined by summing the projected retail energy sales for Valdez and Glennallen in each of the projected years. Under the medium case scenario, CVEA total energy sales increase from an estimated 54,602 MWh in 1992 to 92,873 MWh in 2013. This represents approximately a 70% increase of total energy sales over that 21-year period and indicates an average compounded growth rate of 2.6% annually.

c. CVEA Energy Requirements

CVEA energy requirements follow the growth of energy sales with adjustments for system losses (see Table VIII-2 and Figure VIII-5). CVEA total energy requirements in the Valdez/Copper River service areas are projected to increase by approximately 49% between 1992 and 1997. This is based on the increases in system energy sales plus CVEA system losses estimated at 8.0% of total energy requirements in each year of the forecast. Energy losses associated with sales to Petro Star are assumed to be 2.0% of the refinery's energy requirement. Overall, total energy requirements are projected to increase during the next 20 years in CVEA's service area, from 59,227 MWh in 1992 to 99,543 MWh in 2013 for the medium case. As previously mentioned, the medium-high and medium-low cases are the same until 2018 at which time they diverge.

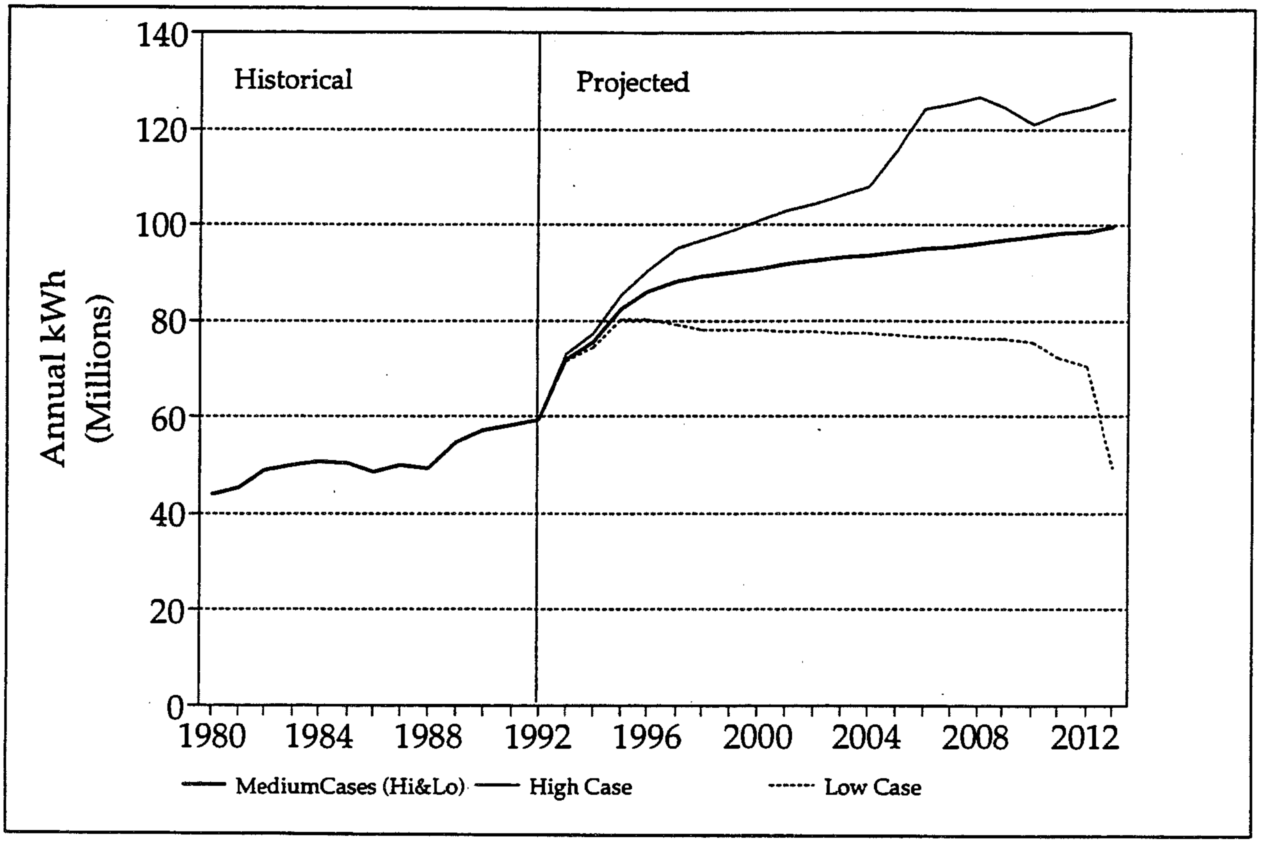


Figure VIII-5: Energy Requirements

d. Peak Demand Requirements

CVEA peak demand requirements for the Valdez/Copper River service area in the medium-high case scenario are projected to increase by 6,304 kW during the next 21 years to 17,204 kW in 2013, representing an average 2.2% annual rate of increase through 2013 (see Table VIII-3 and Figure VIII-6). For the medium-low case scenario, peak demand in 2013 is projected to be 17,204 kW, representing an average annual increase of 2.2% from 1992.

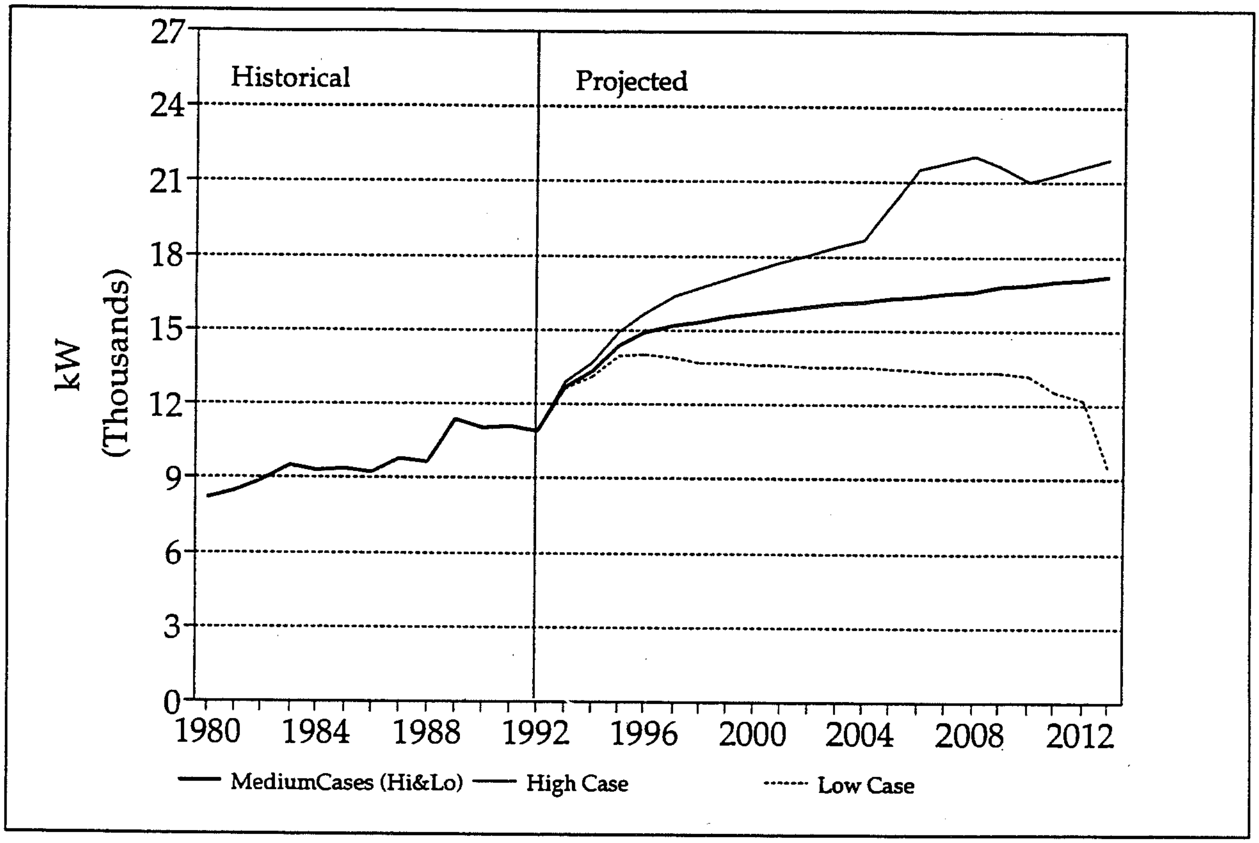


Figure VIII-6: Peak Demand

2. High Case Scenario

A high case scenario was developed based on the assumptions summarized in Table VIII-1 which are consistent with the assumption of continued activity in the petroleum industry in the Valdez and Copper River areas, along with steady development of fish processing and tourism-related activities through the year 2013. The continued activity of the petroleum industry includes the population and employment increases due to TAGS construction, as well as increased population and employment in the operational phase.

Projections in the high case scenario indicate CVEA's energy sales increasing significantly in both the near and long term. CVEA energy sales are projected to increase at a 10.3% annual rate from 1992 to 1997 in the high case scenario, and at approximately a 1.8% annual rate over the following 16 years (see Table VIII-2 and Figure VIII-5). In conjunction with these higher energy requirements, CVEA's peak demand requirements are projected to increase rapidly from 10,900 kW in 1992 to 21,969 kW in 2013, representing approximately a 3.4% average rate of growth per year during the next 21 years in the high case scenario (see Table VIII-3 and Figure VIII-6).

Table VIII-2
Historical and Projected
CVEA Energy Requirements (MWh)

Fiscal Year	High Case	Medium-High Case(1)	Medium-Low Case(1)	Low Case
1980	43,982	43,982	43,982	43,982
1985	50,500	50,500	50,500	50,500
1992	59,227	59,227	59,227	59,227
1997	95,107	88,141	88,141	79,215
2002	104,492	92,400	92,400	77,734
2013	126,369	99,453	99,453	49,360
Compounded Annual Growth Rates:				
1980-1992	2.5%	2.5%	2.5%	2.5%
1988-1992	4.7%	4.7%	4.7%	4.7%
1992-1997	9.8%	8.3%	8.3%	6.0%
1997-2002	1.9%	1.0%	1.0%	-0.4%
2002-2013	1.7%	0.7%	0.7%	-4.0%
1992-2013	3.7%	2.5%	2.5%	-0.9%

(1) The medium-high and medium-low case scenarios vary only in the assumed level of power sales to the Petro Star refinery beginning in 2018.

Table VIII-3
Historical and Projected
CVEA Peak Demand (kW)

Fiscal Year	High Case	Medium-High Case(1)	Medium-Low Case(1)	Low Case
1980	8,180	8,180	8,180	8,180
1985	9,350	9,350	9,350	9,350
1992	10,900	10,900	10,900	10,900
1997	16,398	15,234	15,234	13,844
2002	18,072	15,976	15,976	13,576
2013	21,969	17,204	17,204	9,449
Compounded Annual Growth Rates:				
1980-1992	2.4%	2.4%	2.4%	2.4%
1988-1992	3.2%	3.2%	3.2%	3.2%
1992-1997	8.5%	6.9%	6.9%	4.9%
1997-2002	2.0%	1.0%	1.0%	-0.4%
2002-2013	1.8%	0.7%	0.7%	-3.2%
1992-2013	3.4%	2.2%	2.2%	-0.7%

(1) The medium-high and medium-low case scenarios vary only in the assumed level of power sales to the Petro Star refinery beginning in 2018.

3. Low Case Scenario

Under the assumptions of the low case scenario, economic development in the Valdez and Copper River areas is affected by declines in the petroleum industry and only slow growth in fish processing and tourism. Consequently, population and employment is assumed to decrease at an average annual level of -0.3% and -1.8%, respectively, during the forecast period in the low case scenario.

CVEA energy sales under the low case scenario continue to decrease during the 20-year forecast period. CVEA energy requirements are projected to decrease from 59,227 MWh in 1992 to 49,360 MWh in 2013, representing a -0.9% average annual growth rate. Energy requirements are projected to increase between 1992 and 1996, however, with estimated increases in sales to Petro Star during that time period. The low case scenario projects CVEA peak demand to increase from 10,900 kW in 1992 to 14,035 kW in 1996 before decreasing gradually to 9,449 kW in 2013 with the assumed shutdown of the Trans-Alaska oil pipeline (see Table VIII-3 and Figure VIII-6). Much of this decrease is due to the assumed significant decrease in loads after 2010 in Glennallen of Alyeska Pump Station 12, and in Valdez of the Petro Star Refinery.

F. CONSIDERATIONS AND LIMITATIONS

The load projections developed in this study are based primarily on historical trends, causal relationships, and expectations of future conditions. We have not conducted an independent economic analysis of the Valdez and Copper River areas and of future development potential. Although demographic and economic relationships can be expected to remain relatively stable in the long term, the current economic transition in the Valdez and Copper River areas could distort these historical relationships.

The uncertainty inherent in this forecasting effort, as in any forecast, along with the specific limitations inherent in making the assumptions that underlie the forecast, should be recognized and considered in using the forecast results. For example, the future development in Valdez and in the Copper River Valley is dependent on numerous local conditions (e.g., commercial fisheries, petroleum products, etc.) and national and international conditions (e.g., supplies and costs of alternative petroleum resources, demand and price of fish products, etc.).

For these and other reasons, the existing data do not provide a precise indication of the magnitude of future load growth in the Valdez and Copper River areas. We have attempted to develop a range of load projections for CVEA that encompass the likely range of future events as they now appear to be developing. Alternative high and low case scenario projections are provided in an attempt to bracket the expected range of future load growth, but even these projections do not account for all possible load conditions that CVEA might experience. Also, we have assumed rate projections for the next five years based in part on information provided to us by CVEA, as well as on the current outlook for world fuel prices. Alternative rate levels resulting from possible increases in future fuel prices or other factors could significantly affect the load forecast projections.

Consideration should also be given to the nature of the forecasting procedure used. The primary purpose of this load forecasting effort was to develop long-term projections of future CVEA load requirements in the Valdez/Copper River service area for the evaluation of the proposed Intertie. As such, the procedures selected in this forecast have been used in an attempt to capture long-term historical relationships and to use them in projecting future load requirements. Short-term results may not be as accurate as could have been achieved using alternative forecasting techniques more appropriate to short-term applications.

G. CONCLUSIONS

Based on the medium case assumptions and analyses presented herein, it appears that CVEA can anticipate moderate growth in energy requirements during the next 20-year period in the Valdez/Copper River service areas. As discussed herein, the Valdez/Copper River service areas have significant economic development potential, as well as possibilities of a slow down in petroleum related industries. However, considerable uncertainty exists both as to the magnitude of certain large electric loads and to the overall pace that economic development in the area will take. Significant variance either in the assumptions used in preparation of this load forecast or in the experienced near-term load growth from that presented herein would warrant a re-examination of the area's load growth potential.

TABLE A-1

CVEA
HISTORICAL OPERATING RESULTS

ENERGY SALES AND REQUIREMENTS (kWh)

	VALDEZ						GLENNALLEN														
CALENDAR YEAR	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL SALES	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR
1978	6,455,372	3,543,857	10,678,293	158,307	264,713	21,100,542	3,089,948	2,849,197	10,791,904	23,800	380,193	17,135,042	38,235,584							
1979	6,392,547	3,530,621	10,622,719	225,117	292,018	21,063,022	2,961,325	3,125,852	8,901,392	27,199	445,085	15,460,853	36,523,875							
1980	6,914,452	3,905,942	9,877,970	307,004	353,009	21,358,377	2,905,351	3,371,945	9,218,992	20,080	527,435	16,043,803	37,402,180	6,579,420	43,981,600	15.0%	4,650	3,530	8,180	61.4%
1981	7,702,426	4,622,280	10,405,178	329,501	507,300	23,566,685	2,899,849	3,437,683	8,906,444	11,730	530,978	15,786,684	39,353,369	5,921,905	45,275,274	13.1%	4,850	3,600	8,450	61.2%
1982	8,354,892	4,017,084	12,048,254	315,300	327,220	25,062,750	3,136,898	3,710,893	9,296,716	22,680	541,018	16,708,205	41,770,955	6,974,219	48,745,174	14.3%	5,400	3,500	8,900	62.5%
1983	8,399,233	4,604,367	13,080,884	343,773	500,299	26,928,556	3,277,765	4,232,231	9,028,522	21,979	460,430	17,020,927	43,949,483	6,167,562	50,117,045	12.3%	6,000	3,500	9,500	60.2%
1984	8,717,285	4,354,435	14,285,543	396,803	607,689	28,361,755	3,652,189	4,567,910	8,764,840	25,435	442,547	17,452,921	45,814,676	4,883,492	50,698,168	9.6%	5,900	3,400	9,300	62.2%
1985	8,616,912	4,607,880	14,194,065	398,954	634,620	28,452,431	3,621,581	4,481,415	8,416,403	24,220	403,907	16,947,526	45,399,957	5,099,955	50,499,912	10.1%	5,600	3,750	9,350	61.7%
1986	8,266,039	4,372,927	14,020,550	97,721	604,150	27,361,387	3,485,285	4,085,264	8,685,045	86,970	371,193	16,713,757	44,075,144	4,553,995	48,629,139	9.4%	5,400	3,800	9,200	60.3%
1987	8,151,267	4,197,380	14,114,555	87,080	596,621	27,146,903	3,729,388	3,997,960	8,207,376	85,049	333,554	16,353,327	43,500,230	6,486,357	49,986,587	13.0%	5,850	3,900	9,750	58.5%
1988	8,324,873	3,791,857	14,570,794	67,499	634,738	27,389,761	3,701,597	4,428,468	8,586,975	96,366	371,266	17,184,672	44,574,433	4,740,417	49,314,850	9.6%	5,900	3,700	9,600	58.6%
1989	9,580,096	5,855,911	18,402,943	63,087	729,296	34,631,333	3,866,082	4,345,817	8,527,840	105,801	357,256	17,202,796	51,834,129	2,717,682	54,551,811	5.0%	7,500	3,900	11,400	54.6%
1990	10,078,636	4,968,635	19,093,835	58,309	669,808	34,869,223	4,217,374	4,580,776	8,832,240	43,777	381,405	18,055,572	52,924,795	4,295,813	57,220,608	7.5%	6,800	4,200	11,000	59.4%
1991	10,197,755	5,151,949	19,339,091	58,315	642,522	35,389,632	4,213,861	4,572,468	8,409,360	36,623	390,689	17,623,001	53,012,633	5,504,320	58,516,953	9.4%	7,300	3,800	11,100	60.2%
1992	10,357,519	4,951,406	20,259,252	69,648	693,079	36,330,904	4,342,066	4,600,078	8,891,200	35,936	401,978	18,271,258	54,602,162	4,625,014	59,227,176	7.8%	7,200	3,700	10,900	62.0%
															Average:	10.5%			Average:	60.2%

COMPOUNDED ANNUAL GROWTH RATES:

	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL SALES	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR
1980-92:	3.4%	2.0%	6.2%	-11.6%	5.8%	4.5%	3.4%	2.6%	-0.3%	5.0%	-2.2%	1.1%	3.2%	-2.9%	2.5%	-5.3%	3.7%	0.4%	2.4%	
1980-88:	2.3%	-0.4%	5.0%	-17.2%	7.6%	3.2%	3.1%	3.5%	-0.9%	21.7%	-4.3%	0.9%	2.2%	-4.0%	1.4%	-5.4%	3.0%	0.6%	2.0%	
1988-92:	5.6%	6.9%	8.6%	0.8%	2.2%	7.3%	4.1%	1.0%	0.9%	-21.9%	2.0%	1.5%	5.2%	-0.6%	4.7%	-5.1%	5.1%	-0.0%	3.2%	
1989-92:	2.6%	-5.4%	3.3%	3.4%	-1.7%	1.6%	3.9%	1.9%	1.4%	-30.2%	4.0%	2.0%	1.7%	19.4%	2.8%	16.2%	-1.3%	-1.7%	-1.5%	

TABLE A-1

CVEA
HISTORICAL OPERATING RESULTS

AVERAGE ANNUAL NUMBER OF CUSTOMER ACCOUNTS

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL
1978																
1979																
1980	1,066	196	33	10	21	1,326	642	209	18	4	32	905	1,708	456	67	2,231
1981	1,160	206	34	10	24	1,434	652	203	20	4	31	910	1,812	463	69	2,344
1982	1,187	205	42	10	23	1,467	660	212	19	4	31	926	1,847	478	68	2,393
1983	1,113	203	43	11	27	1,397	716	172	19	5	31	943	1,829	437	74	2,340
1984	1,089	199	45	11	26	1,370	732	173	18	5	30	959	1,821	436	72	2,329
1985	1,078	203	44	11	28	1,364	733	176	17	5	28	959	1,812	440	72	2,323
1986	1,068	200	45	8	28	1,350	735	176	17	5	27	961	1,804	438	69	2,311
1987	1,086	195	46	8	28	1,362	760	187	16	5	29	997	1,846	444	69	2,359
1988	1,116	195	51	9	30	1,400	782	200	12	6	31	1,030	1,898	458	75	2,430
1989	1,203	212	56	9	30	1,509	798	205	11	8	30	1,052	2,001	484	77	2,562
1990	1,291	220	57	9	29	1,606	823	208	11	9	30	1,080	2,114	496	77	2,686
1991	1,327	227	57	9	29	1,649	842	206	11	9	30	1,098	2,169	501	77	2,747
1992	1,363	231	60	9	29	1,692	872	213	11	9	31	1,135	2,234	515	78	2,827

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL
1980-92:	2.1%	1.4%	5.2%	-0.9%	2.7%	2.1%	2.6%	0.1%	-4.0%	7.0%	-0.4%	1.9%	2.3%	1.0%	1.2%	2.0%
1980-88:	0.6%	-0.1%	5.6%	-2.0%	4.5%	0.7%	2.5%	-0.5%	-5.1%	4.5%	-0.6%	1.6%	1.3%	0.1%	1.3%	1.1%
1988-92:	5.1%	4.3%	4.2%	1.4%	-0.7%	4.8%	2.7%	1.5%	-1.8%	12.3%	0.1%	2.4%	4.2%	3.0%	1.0%	3.9%
1989-92:	4.3%	2.9%	2.5%	0.0%	-1.1%	3.9%	3.0%	1.3%	0.0%	2.9%	0.7%	2.6%	3.7%	2.1%	0.2%	3.3%

TABLE A-1

CVEA
HISTORICAL OPERATING RESULTS

USAGE (KWh) PER CUSTOMER ACCOUNT

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1978																
1979																
1980	6,486	19,928	299,332	30,700	16,810	16,107	4,525	16,134	512,166	5,020	16,482	17,728	5,749	57,840	18,023	16,765
1981	6,640	22,438	306,035	32,950	21,138	16,434	4,448	16,934	445,322	2,933	17,128	17,348	5,851	59,118	19,993	16,789
1982	7,039	19,596	286,863	31,530	14,227	17,084	4,753	17,504	489,301	5,670	17,452	18,043	6,222	60,822	17,739	17,455
1983	7,546	22,682	304,207	31,252	18,530	19,276	4,578	24,606	475,185	4,396	14,853	18,050	6,384	70,815	17,925	18,782
1984	8,009	21,863	316,870	36,073	23,150	20,702	4,988	26,379	478,082	5,087	14,670	18,201	6,794	73,374	20,333	19,672
1985	7,991	22,718	321,983	37,112	22,665	20,860	4,940	25,511	492,667	4,844	14,425	17,674	6,756	72,100	20,372	19,544
1986	7,737	21,910	308,709	11,845	21,706	20,275	4,740	23,168	510,885	17,394	13,539	17,392	6,515	71,096	16,935	19,076
1987	7,505	21,571	308,515	10,885	21,630	19,930	4,907	21,370	505,069	18,225	11,704	16,409	6,435	68,784	16,034	18,443
1988	7,462	19,470	284,771	7,941	21,276	19,565	4,733	22,115	725,660	17,006	12,173	16,679	6,337	68,511	15,703	18,342
1989	7,966	27,666	328,136	7,010	24,310	22,944	4,844	21,225	775,258	12,824	11,909	16,350	6,720	76,799	16,252	20,235
1990	7,807	22,559	337,446	6,479	22,834	21,711	5,124	22,049	802,931	4,864	12,893	16,713	6,763	75,619	14,994	19,701
1991	7,687	22,663	339,282	6,479	22,156	21,462	5,005	22,187	764,487	4,069	12,915	16,045	6,646	74,734	14,604	19,297
1992	7,601	21,458	335,789	7,739	23,899	21,475	4,981	21,630	808,291	3,993	13,108	16,098	6,579	75,186	15,459	19,316

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1980-92:	1.3%	0.6%	1.0%	-10.8%	3.0%	2.4%	0.8%	2.5%	3.9%	-1.9%	-1.9%	-0.8%	1.1%	2.2%	-1.3%	1.2%
1980-88:	1.8%	-0.3%	-0.6%	-15.6%	3.0%	2.5%	0.6%	4.0%	4.5%	16.5%	-3.7%	-0.8%	1.2%	2.1%	-1.7%	1.1%
1988-92:	0.5%	2.5%	4.2%	-0.6%	2.9%	2.4%	1.3%	-0.6%	2.7%	-30.4%	1.9%	-0.9%	0.9%	2.4%	-0.4%	1.3%
1989-92:	-1.6%	-8.1%	0.8%	3.4%	-0.6%	-2.2%	0.9%	0.6%	1.4%	-32.2%	3.3%	-0.5%	-0.7%	-0.7%	-1.7%	-1.5%

TABLE A-1

CVEA
HISTORICAL OPERATING RESULTS

RETAIL PAYMENTS FOR ENERGY SALES ($)

CALENDAR YEAR	RES	SM COM	LG COM	TOTAL COM	PUB STL	PUB BLG	TOTAL RETAIL REVENUES	VALDEZ RES	GLENN RES	Total Res	VALDEZ SM COM	GLENN SM COM	LG Com	Tot Com	TOTAL RETAIL REVENUES
1978		775,517	2,171,250	2,946,767	18,857	72,790	4,138,342	710,363	389,565	1,099,928	372,891	402,626			4,138,342
1979		887,866	2,271,941	3,159,807	29,834	93,385	4,512,890	812,247	417,617	1,229,863	422,668	465,197			4,512,890
1980	1,605,545	1,176,132	2,791,409	3,967,541	47,978	137,404	5,758,468	1,073,895	531,650	1,605,545	577,804	598,327			5,758,468
1981	1,917,709	1,403,276	3,153,250	4,556,526	54,804	176,324	6,705,363	1,289,385	628,324	1,917,709	752,387	650,889			6,705,363
1982	1,716,676	1,125,134	2,722,812	3,847,946	46,147	128,465	5,739,234	1,130,059	586,617	1,716,676	546,924	578,210			5,739,234
1983	1,711,118	1,197,722	2,773,279	3,971,002	48,166	136,219	5,887,532	1,120,066	612,079	1,732,145	610,665	601,775	2,807,359	3,418,024	5,887,532
1984	1,760,014			3,999,439	52,232	143,406	5,914,979	1,069,463	650,439	1,719,902	545,268	610,034	2,752,991	3,298,259	5,914,979
1985	2,102,865			4,878,291	61,650	169,335	7,162,286	1,319,651	733,359	2,053,010	845,495	840,104			7,162,286
1986	2,110,307			4,789,614	32,457	162,906	7,077,262	1,379,692	712,593	2,092,285	790,634	894,433	3,263,996	4,054,630	7,077,262
1987	2,151,517			4,812,076	27,810	157,451	7,161,715	1,393,833	770,545	2,164,378	775,369	891,262	3,351,108	4,126,477	7,161,715
1988	2,138,535			4,819,625	28,637	165,790	7,188,960	1,412,382	762,526	2,174,908	612,010	879,681	3,405,617	4,017,627	7,188,960
1989	2,329,784	5,338,437	115,506	5,453,943	30,505	175,367	7,998,036	1,566,764	771,457	2,338,221	868,558	853,506	3,758,585	4,627,144	7,998,036
1990	2,516,398	5,410,717	170,145	5,580,862	20,171	171,542	8,334,311	1,705,022	856,713	2,561,736	782,347	908,723	4,023,085	4,805,432	8,334,311
1991	2,663,282	5,697,793	187,439	5,885,232	19,704	176,824	8,737,952	1,774,315	881,878	2,656,192	831,540	878,838	4,137,859	4,969,398	8,737,952
1992	2,644,890	1,672,962	4,209,525	5,882,487	20,872	179,886	8,781,505	1,792,901	905,359	2,698,260	801,064	933,563	4,288,087	5,089,151	8,781,505

COMPOUNDED ANNUAL GROWTH RATES:

	RES	SM COM	LG COM	TOTAL COM	PUB STL	PUB BLG	TOTAL RETAIL REVENUES	VALDEZ RES	GLENN RES	Total Res	VALDEZ SM COM	GLENN SM COM	LG Com	Tot Com	TOTAL RETAIL REVENUES
1980-92:	4.2%	3.0%	3.5%	3.3%	-6.7%	2.3%	3.6%	4.4%	4.5%	4.4%	2.8%	3.8%			3.6%
1980-88:	3.6%			2.5%	-6.2%	2.4%	2.8%	3.5%	4.6%	3.9%	0.7%	4.9%			2.8%
1988-92:	5.5%			5.1%	-7.6%	2.1%	5.1%	6.1%	4.4%	5.5%	7.0%	1.5%			5.1%
1989-92:	4.3%			2.6%	-11.9%	0.9%	3.2%	4.6%	5.5%	4.9%	-2.7%	3.0%			3.2%

TABLE A-1

CVEA
HISTORICAL OPERATING RESULTS

NOMINAL COST OF ELECTRICITY
(CENTS/KWH - NOMINAL)

CALENDAR YEAR	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1978	11.52	11.00	12.61	10.52	14.13	10.58	10.35	11.29	10.82
1979	13.15	12.71	14.10	11.97	14.88	12.07	11.82	12.67	12.36
1980	16.35	15.53	18.30	14.79	17.74	15.04	14.67	15.61	15.40
1981	18.09	16.74	21.67	16.28	18.93	16.65	16.06	16.98	17.04
1982	14.94	13.53	18.70	13.61	15.58	13.24	13.65	14.80	13.74
1983	14.83	13.34	18.67	13.26	14.22	12.83	13.17	14.18	13.40
1984	13.90	12.27	17.81	12.52	13.35	12.51	12.37	13.65	12.91
1985	16.78	15.31	20.25	18.35	18.75	15.39	14.57	16.31	15.78
1986	17.80	16.69	20.45	18.08	21.89	15.37	17.57	16.70	16.06
1987	18.22	17.10	20.66	18.47	22.29	15.77	16.16	16.93	16.46
1988	18.08	16.97	20.60	16.14	19.86	15.36	17.48	16.48	16.13
1989	17.39	16.35	19.95	14.83	19.64	14.69	18.06	16.14	15.43
1990	17.92	16.92	20.31	15.75	19.84	14.89	19.76	16.32	15.75
1991	18.43	17.40	20.93	16.14	19.22	15.71	20.75	17.11	16.48
1992	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08

REAL COST OF ELECTRICITY
(CENTS/KWH - CONSTANT 1992 DOLLARS)

CALENDAR YEAR	CPI	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1978	71.0	21.94	20.95	24.01	20.04	26.91	20.14	19.72	21.49	20.61
1979	77.0	23.09	22.31	24.76	21.02	26.13	21.19	20.76	22.25	21.70
1980	84.7	26.10	24.79	29.21	23.61	28.32	24.01	23.41	24.91	24.58
1981	92.0	26.58	24.60	31.84	23.92	27.82	24.46	23.60	24.96	25.04
1982	96.3	20.97	18.99	26.25	19.11	21.88	18.58	19.17	20.77	19.29
1983	99.9	20.08	18.05	25.27	17.95	19.24	17.37	17.82	19.19	18.13
1984	103.8	18.11	15.98	23.20	16.31	17.39	16.29	16.11	17.79	16.82
1985	107.5	21.10	19.26	25.47	23.08	23.58	19.35	18.32	20.51	19.84
1986	111.2	21.65	20.29	24.86	21.98	26.62	18.69	21.37	20.31	19.52
1987	114.4	21.53	20.21	24.42	21.83	26.35	18.64	19.09	20.00	19.46
1988	117.0	20.90	19.60	23.80	18.65	22.95	17.75	20.19	19.04	18.64
1989	121.4	19.37	18.21	22.22	16.52	21.87	16.36	20.12	17.97	17.18
1990	127.5	19.00	17.94	21.54	16.70	21.04	15.79	20.95	17.30	16.70
1991	131.6	18.94	17.88	21.50	16.58	19.75	16.13	21.32	17.58	16.93
1992	135.2	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08

COMPOUNDED ANNUAL GROWTH RATES:

	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE	CPI	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1980-92:	1.0%	0.9%	1.1%	0.7%	1.1%	0.1%	2.5%	0.4%	0.4%	4.0%	-2.9%	-2.9%	-2.8%	-3.1%	-2.7%	-3.7%	-1.4%	-3.4%	-3.5%
1980-88:	1.3%	1.1%	1.5%	1.1%	1.4%	0.3%	2.2%	0.7%	0.6%	4.1%	-2.7%	-2.9%	-2.5%	-2.9%	-2.6%	-3.7%	-1.8%	-3.3%	-3.4%
1988-92:	0.4%	0.5%	0.3%	0.1%	0.5%	-0.3%	3.1%	-0.1%	-0.1%	3.7%	-3.2%	-3.1%	-3.3%	-3.5%	-3.0%	-3.8%	-0.5%	-3.6%	-3.6%
1989-92:	1.8%	1.9%	1.5%	2.9%	1.1%	1.1%	3.1%	0.6%	1.4%	3.7%	-1.8%	-1.7%	-2.1%	-0.7%	-2.5%	-2.4%	-0.6%	-3.0%	-2.2%

TABLE A-1

CVEA
HISTORICAL ECONOMIC & DEMOGRAPHIC DATA

ECONOMIC & DEMOGRAPHIC DATA

VALDEZ AND COPPER RIVER VALLEY

CALENDAR YEAR	VALDEZ POP	COPPER RIVE POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVE EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day
1978													0.702
1979													1.197
1980	3,079	2,721	5,800	1,746	935	2,681	9,726	13,500	84.7	14,038	22,408	NA	1.422
1981	3,279	2,580	5,859	1,848	956	2,804	9,123	12,579	92.0	16,243	23,870	NA	1.511
1982	3,698	2,439	6,137	1,884	908	2,792	10,156	14,535	96.3	16,780	23,558	24,684	1.570
1983	3,687	2,298	5,985	1,822	885	2,707	9,550	13,523	99.9	16,414	22,214	16,495	1.627
1984	3,388	2,913	6,301	1,906	845	2,751	9,275	13,152	103.8	17,536	22,841	25,301	1.657
1985	3,271	2,943	6,214	1,850	561	2,411	10,136	13,553	107.5	20,982	26,389	29,108	1.694
1986	3,263	2,768	6,031	1,696	602	2,298	9,403	13,138	111.2	21,061	25,607	14,868	1.802
1987	3,288	2,629	5,917	1,712	566	2,278	9,087	12,218	114.4	20,842	24,631	33,105	1.849
1988	3,313	2,489	5,802	1,789	609	2,398	9,340	13,238	117.0	21,868	25,270	14,941	2.005
1989	3,238	2,626	5,864	2,887	600	3,487	9,615	13,431	121.4	26,257	29,242	24,520	1.960
1990	4,068	2,763	6,831	2,200	609	2,809	9,806	13,619	127.5	24,523	26,004	46,591	1.853
1991	4,279	2,801	7,080	2,146	728	2,874	9,223	13,243	131.6	25,392	26,087	39,900	1.799
1992	4,326	2,832	7,158	2,247	762	3,009	9,623	13,861	135.2	27,050	27,050	11,404	1.791
						12 YR AVG :	9,543	13,353			Avg:	25,538	
						HDD NORM	9,711	14,004					

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ POP	COPPER RIVE POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVE EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day
1980-92:	2.9%	0.3%	1.8%	2.1%	-1.7%	1.0%			4.0%	5.6%	1.6%	NA	1.9%
1980-88:	0.9%	-1.1%	0.0%	0.3%	-5.2%	-1.4%			4.1%	5.7%	1.5%	NA	4.4%
1988-92:	6.9%	3.3%	5.4%	5.9%	5.8%	5.8%			3.7%	5.5%	1.7%	-6.5%	-2.8%
1989-92:	10.1%	2.5%	6.9%	-8.0%	8.3%	-4.8%			3.7%	1.0%	-2.6%	-22.5%	-3.0%

TABLE B-1

CVEA
PROJECTED OPERATING RESULTS

MEDIUM_HIGH CASE
Full PetroStar Expansion

ENERGY SALES AND REQUIREMENTS (kWh)

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ RETAIL SALES	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR	
1992	10,357,519	4,951,406	20,259,252	69,648	693,079	36,330,904	4,342,066	4,600,078	8,891,200	35,936	401,978	18,271,258	54,602,162	4,625,014	59,227,176	7.8%	7,200	3,700	10,900	62.0%	
1993	10,851,968	5,211,333	30,940,840	72,400	678,683	47,755,224	4,712,240	4,752,999	9,132,377	37,911	445,671	19,081,197	66,836,421	5,000,580	71,837,001	7.0%	8,793	3,890	12,682	64.7%	1,262,571
1994	11,279,336	5,273,455	33,591,219	73,378	680,499	50,897,888	5,027,837	4,857,251	9,149,779	38,166	447,175	19,520,209	70,418,096	5,152,678	75,570,775	6.8%	9,234	4,052	13,286	64.9%	1,274,945
1995	11,684,571	5,380,677	39,294,451	74,368	682,321	57,116,388	5,276,289	4,960,466	9,171,918	38,424	448,685	19,895,781	77,012,169	5,437,509	82,449,678	6.6%	10,131	4,206	14,337	65.6%	1,337,850
1996	12,041,191	5,444,818	41,937,872	75,372	684,147	60,183,400	5,530,830	5,062,706	9,190,044	38,683	450,199	20,272,461	80,455,861	5,579,560	86,035,421	6.5%	10,560	4,366	14,927	65.8%	1,351,269
1997	12,376,691	5,509,724	43,404,705	76,390	685,978	62,053,487	5,629,727	5,083,380	9,208,520	38,945	451,718	20,412,290	82,465,778	5,675,635	88,141,413	6.4%	10,837	4,397	15,234	66.1%	1,364,976
1998	12,705,338	5,575,403	43,661,604	77,421	687,814	62,707,580	5,730,392	5,104,140	9,227,221	39,207	453,243	20,554,203	83,261,783	5,744,853	89,006,636	6.5%	10,958	4,427	15,385	66.0%	1,377,456
1999	13,034,511	5,641,865	43,922,758	78,466	689,655	63,367,256	5,832,857	5,124,984	9,246,279	39,472	454,773	20,698,364	84,065,620	5,814,752	89,880,372	6.5%	11,079	4,458	15,537	66.0%	1,390,145
2000	13,368,064	5,709,120	44,188,251	79,525	691,501	64,036,461	5,937,154	5,145,913	9,265,700	39,739	456,307	20,844,813	84,881,273	5,885,679	90,766,952	6.5%	11,202	4,490	15,692	66.0%	1,403,046
2001	13,708,052	5,777,176	44,458,166	80,599	693,352	64,717,345	6,043,316	5,166,928	9,285,491	40,007	457,847	20,993,589	85,710,935	5,957,823	91,668,758	6.5%	11,328	4,522	15,850	66.0%	1,416,165
2002	13,946,651	5,846,044	44,732,593	81,687	695,207	65,302,182	6,088,188	5,188,028	9,305,661	40,277	459,393	21,081,546	86,383,728	6,016,327	92,400,055	6.5%	11,436	4,541	15,976	66.0%	1,429,505
2003	14,134,478	5,882,979	45,011,618	82,790	697,068	65,808,934	6,133,393	5,209,215	9,326,216	40,549	460,943	21,170,315	86,979,249	6,068,111	93,047,360	6.5%	11,529	4,560	16,089	66.0%	1,443,070
2004	14,297,446	5,920,147	45,295,335	83,908	698,934	66,295,769	6,178,933	5,230,488	9,347,164	40,822	462,499	21,259,906	87,555,675	6,118,235	93,673,911	6.5%	11,619	4,579	16,198	66.0%	1,456,866
2005	14,448,639	5,957,551	45,583,835	85,040	700,805	66,775,869	6,224,812	5,251,848	9,368,513	41,098	464,060	21,350,330	88,126,199	6,167,846	94,294,045	6.5%	11,707	4,599	16,306	66.0%	1,470,897
2006	14,594,626	5,995,190	45,877,214	86,188	702,680	67,255,899	6,271,031	5,273,295	9,390,270	41,375	465,626	21,441,597	88,697,496	6,217,524	94,915,020	6.6%	11,796	4,618	16,414	66.0%	1,485,167
2007	14,738,699	6,033,068	46,175,569	87,352	704,561	67,739,249	6,317,593	5,294,830	9,412,444	41,655	467,197	21,533,719	89,272,968	6,267,565	95,540,533	6.6%	11,885	4,638	16,523	66.0%	1,499,681
2008	14,882,504	6,071,185	46,479,001	88,531	706,447	68,227,667	6,364,501	5,316,453	9,435,042	41,936	468,774	21,626,706	89,854,373	6,318,122	96,172,496	6.6%	11,975	4,658	16,633	66.0%	1,514,444
2009	15,026,870	6,109,542	46,787,611	89,726	708,337	68,722,087	6,411,758	5,338,164	9,458,074	42,219	470,356	21,720,570	90,442,658	6,369,277	96,811,935	6.6%	12,066	4,678	16,744	66.0%	1,529,462
2010	15,172,217	6,148,142	47,101,504	90,938	710,233	69,223,035	6,459,365	5,359,963	9,481,546	42,504	471,944	21,815,322	91,038,357	6,421,077	97,459,434	6.6%	12,158	4,699	16,857	66.0%	1,544,739
2011	15,318,762	6,186,986	47,420,786	92,165	712,134	69,730,833	6,507,326	5,381,852	9,505,470	42,791	473,537	21,910,975	91,641,808	6,473,551	98,115,359	6.6%	12,252	4,719	16,971	66.0%	1,560,280
2012	15,466,617	6,226,075	47,745,567	93,410	714,040	70,245,709	6,555,643	5,403,830	9,529,852	43,080	475,135	22,007,539	92,253,248	6,526,720	98,779,968	6.6%	12,347	4,740	17,087	66.0%	1,576,090
2013	15,615,848	6,265,411	48,075,957	94,671	715,951	70,767,839	6,604,318	5,425,898	9,554,702	43,370	476,738	22,105,027	92,872,866	6,580,600	99,453,466	6.6%	12,443	4,761	17,204	66.0%	1,592,177

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ RETAIL SALES	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)
1992-1997:	3.63%	2.16%	16.46%	1.87%	-0.21%	11.30%	5.33%	2.02%	0.70%	1.62%	2.36%	2.24%	8.60%	4.18%	8.28%	-3.78%	8.52%	3.51%	6.92%
1997-2002:	2.42%	1.19%	0.60%	1.35%	0.27%	1.03%	1.58%	0.41%	0.21%	0.67%	0.34%	0.65%	0.93%	1.17%	0.95%	0.22%	1.08%	0.65%	0.96%
2002-2013:	1.03%	0.63%	0.66%	1.35%	0.27%	0.73%	0.74%	0.41%	0.24%	0.68%	0.34%	0.43%	0.66%	0.82%	0.67%	0.15%	0.77%	0.43%	0.68%
1992-2013:	1.97%	1.13%	4.20%	1.47%	0.15%	3.23%	2.02%	0.79%	0.34%	0.90%	0.82%	0.91%	2.56%	1.69%	2.50%	-0.79%	2.64%	1.21%	2.20%

TABLE B-1

CVEA
PROJECTED OPERATING RESULTS

MEDIUM_HIGH CASE
Full PetroStar Expansion

AVERAGE ANNUAL NUMBER OF CUSTOMER ACCOUNTS

CALENDAR	VALDEZ					TOTAL	GLENNALLEN					TOTAL	TOTAL				
YEAR	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL	RES	SM COM	LG COM	PUB STL	PUB BLG	RETAIL	RES	COM	PUB	TOTAL	
1992	1,363	231	60	9	29	1,692	872	213	11	9	31	1,135	2,234	515	78	2,827	5.0
1993	1,380	233	61	9	30	1,713	924	220	12	9	34	1,200	2,304	526	82	2,912	5.1
1994	1,383	233	62	9	30	1,718	961	225	12	10	34	1,241	2,344	532	83	2,959	5.1
1995	1,396	235	63	10	30	1,734	998	229	12	10	34	1,284	2,395	539	83	3,017	5.2
1996	1,410	236	65	10	30	1,750	1,036	234	12	10	34	1,326	2,445	547	84	3,076	5.2
1997	1,423	238	66	10	30	1,767	1,043	235	12	10	34	1,335	2,467	550	84	3,102	5.2
1998	1,437	239	67	10	31	1,784	1,051	236	12	10	35	1,344	2,488	554	85	3,127	5.2
1999	1,451	241	68	10	31	1,800	1,059	237	12	10	35	1,353	2,510	558	86	3,153	5.3
2000	1,465	243	69	10	31	1,817	1,067	238	12	10	35	1,362	2,532	561	86	3,179	5.3
2001	1,479	244	70	10	31	1,835	1,075	239	12	10	35	1,371	2,554	565	87	3,205	5.3
2002	1,493	246	71	11	31	1,852	1,083	240	12	10	35	1,380	2,576	569	87	3,232	5.3
2003	1,508	247	72	11	32	1,869	1,091	241	12	10	35	1,389	2,598	572	88	3,258	5.3
2004	1,522	249	73	11	32	1,887	1,099	242	12	10	35	1,398	2,621	576	88	3,285	5.3
2005	1,537	251	74	11	32	1,905	1,107	243	12	10	35	1,408	2,644	580	89	3,312	5.4
2006	1,552	252	75	11	32	1,923	1,115	244	12	10	36	1,417	2,667	583	89	3,339	5.4
2007	1,567	254	76	11	32	1,941	1,124	245	12	10	36	1,426	2,690	587	90	3,367	5.4
2008	1,582	256	77	11	33	1,959	1,132	246	12	11	36	1,436	2,714	591	90	3,395	5.4
2009	1,597	257	78	12	33	1,977	1,140	247	12	11	36	1,446	2,737	594	91	3,423	5.4
2010	1,612	259	79	12	33	1,996	1,149	248	12	11	36	1,455	2,761	598	92	3,451	5.4
2011	1,628	261	80	12	33	2,014	1,157	249	12	11	36	1,465	2,785	602	92	3,479	5.5
2012	1,644	263	81	12	34	2,033	1,166	250	12	11	36	1,475	2,810	606	93	3,508	5.5
2013	1,659	264	82	12	34	2,052	1,175	251	12	11	36	1,485	2,834	610	93	3,537	5.5

COMPOUNDED ANNUAL GROWTH RATES:

	RES	SM COM	LG COM	PUB STL	PUB BLG	TOTAL RETAIL	RES	SM COM	LG COM	PUB STL	PUB BLG	TOTAL RETAIL	RES	COM	PUB	TOTAL
1992-1997:	0.87%	0.60%	1.68%	1.87%	0.93%	0.87%	3.66%	2.02%	1.76%	1.62%	2.36%	3.29%	2.00%	1.35%	1.69%	1.87%
1997-2002:	0.96%	0.67%	1.55%	1.35%	0.68%	0.94%	0.74%	0.41%	0.00%	0.67%	0.34%	0.67%	0.87%	0.65%	0.62%	0.82%
2002-2013:	0.96%	0.67%	1.38%	1.35%	0.67%	0.94%	0.74%	0.41%	0.00%	0.68%	0.34%	0.67%	0.87%	0.64%	0.63%	0.82%
1992-2013:	0.94%	0.65%	1.50%	1.47%	0.74%	0.92%	1.43%	0.79%	0.42%	0.90%	0.82%	1.29%	1.14%	0.81%	0.88%	1.07%

TABLE B-1

CVEA
PROJECTED OPERATING RESULTS

MEDIUM_HIGH CASE
Full PetroStar Expansion

USAGE (KWh) PER CUSTOMER ACCOUNT

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1992	7,601	21,458	335,789	7,739	23,899	21,475	4,981	21,630	808,291	3,993	13,108	16,098	6,579	75,186	15,459	19,316
1993	7,866	22,392	504,049	7,739	22,949	39,025	5,098	21,630	761,031	3,993	13,108	15,907	6,755	95,155	14,980	29,502
1994	8,157	22,623	538,011	7,739	22,857	40,997	5,231	21,630	762,482	3,993	13,108	15,724	6,957	99,365	14,943	30,394
1995	8,369	22,930	618,935	7,739	22,764	44,416	5,285	21,630	764,326	3,993	13,108	15,501	7,083	109,010	14,907	32,116
1996	8,542	23,050	649,812	7,739	22,672	45,967	5,340	21,630	765,837	3,993	13,108	15,290	7,186	112,718	14,871	32,745
1997	8,696	23,171	661,761	7,739	22,580	46,674	5,395	21,630	767,377	3,993	13,108	15,294	7,300	114,839	14,835	33,170
1998	8,842	23,292	655,176	7,739	22,489	46,683	5,451	21,630	768,935	3,993	13,108	15,298	7,409	114,748	14,799	33,199
1999	8,984	23,414	648,859	7,739	22,398	46,693	5,508	21,630	770,523	3,993	13,108	15,304	7,517	114,665	14,763	33,228
2000	9,126	23,536	642,798	7,739	22,307	46,705	5,565	21,630	772,142	3,993	13,108	15,310	7,625	114,589	14,727	33,258
2001	9,269	23,659	636,983	7,739	22,217	46,721	5,623	21,630	773,791	3,993	13,108	15,317	7,734	114,522	14,691	33,292
2002	9,340	23,783	631,405	7,739	22,127	46,648	5,623	21,630	775,472	3,993	13,108	15,279	7,778	114,463	14,655	33,255
2003	9,375	23,775	626,053	7,739	22,038	46,531	5,623	21,630	777,185	3,993	13,108	15,242	7,800	114,354	14,619	33,193
2004	9,393	23,767	620,920	7,739	21,948	46,403	5,623	21,630	778,930	3,993	13,108	15,205	7,812	114,254	14,583	33,124
2005	9,402	23,759	615,998	7,739	21,860	46,270	5,623	21,630	780,709	3,993	13,108	15,168	7,819	114,161	14,547	33,053
2006	9,406	23,751	611,278	7,739	21,771	46,136	5,623	21,630	782,523	3,993	13,108	15,132	7,824	114,076	14,512	32,981
2007	9,408	23,743	606,754	7,739	21,683	46,003	5,623	21,630	784,370	3,993	13,108	15,096	7,827	113,999	14,476	32,909
2008	9,409	23,735	602,420	7,739	21,595	45,872	5,623	21,630	786,254	3,993	13,108	15,061	7,830	113,930	14,441	32,839
2009	9,410	23,727	598,268	7,739	21,508	45,743	5,623	21,630	788,173	3,993	13,108	15,026	7,832	113,869	14,405	32,770
2010	9,410	23,719	594,293	7,739	21,421	45,616	5,623	21,630	790,129	3,993	13,108	14,991	7,834	113,816	14,369	32,702
2011	9,410	23,711	590,489	7,739	21,334	45,492	5,623	21,630	792,122	3,993	13,108	14,957	7,836	113,771	14,334	32,635
2012	9,410	23,703	586,851	7,739	21,248	45,370	5,623	21,630	794,154	3,993	13,108	14,923	7,838	113,733	14,299	32,570
2013	9,410	23,695	583,373	7,739	21,162	45,251	5,623	21,630	796,225	3,993	13,108	14,889	7,840	113,704	14,263	32,507
COMPOUNDED ANNUAL GROWTH RATES:																
1992-1997:	2.73%	1.55%	14.53%	0.00%	-1.13%	16.80%	1.61%	0.00%	-1.03%	0.00%	0.00%	-1.02%	2.10%	8.84%	-0.82%	11.42%
1997-2002:	1.44%	0.52%	-0.93%	0.00%	-0.40%	-0.01%	0.83%	0.00%	0.21%	0.00%	0.00%	-0.02%	1.28%	-0.07%	-0.24%	0.05%
2002-2013:	0.07%	-0.03%	-0.72%	0.00%	-0.40%	-0.28%	0.00%	0.00%	0.24%	0.00%	0.00%	-0.23%	0.07%	-0.06%	-0.25%	-0.21%
1992-2013:	1.02%	0.47%	2.67%	0.00%	-0.58%	3.61%	0.58%	0.00%	-0.07%	0.00%	0.00%	-0.37%	0.84%	1.99%	-0.38%	2.51%

CVEA-1
19-Apr-94
08:39 AM

TABLE B-1

CVEA
PROJECTED OPERATING RESULTS

MEDIUM_HIGH CASE
Full PetroStar Expansion

NOMINAL COST OF ELECTRICITY
(CENTS/KWH - NOMINAL)

CALENDAR YEAR	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1994	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1995	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1996	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1997	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1998	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1999	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2000	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2001	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2002	18.05	17.02	20.50	15.91	19.95	14.94	19.44	16.15	15.81
2003	18.68	17.62	21.22	16.46	20.65	15.47	20.12	16.72	16.37
2004	19.33	18.23	21.96	17.04	21.38	16.01	20.82	17.30	16.94
2005	20.01	18.87	22.73	17.64	22.12	16.57	21.55	17.91	17.53
2006	20.71	19.53	23.53	18.25	22.90	17.15	22.30	18.53	18.15
2007	21.44	20.21	24.35	18.89	23.70	17.75	23.09	19.18	18.78
2008	22.19	20.92	25.20	19.55	24.53	18.37	23.89	19.85	19.44
2009	22.96	21.65	26.08	20.24	25.39	19.01	24.73	20.55	20.12
2010	23.77	22.41	27.00	20.95	26.28	19.68	25.59	21.27	20.82
2011	24.60	23.20	27.94	21.68	27.20	20.37	26.49	22.01	21.55
2012	25.46	24.01	28.92	22.44	28.15	21.08	27.42	22.78	22.31
2013	26.35	24.85	29.93	23.22	29.13	21.82	28.38	23.58	23.09
COMPOUNDED ANNUAL GROWTH RATES:									
1992-1997:	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%
1997-2002:	0.69%	0.69%	0.69%	0.69%	0.69%	0.69%	0.69%	0.69%	0.69%
2002-2013:	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%
1992-2013:	1.74%	1.74%	1.74%	1.74%	1.74%	1.74%	1.74%	1.74%	1.74%

REAL COST OF ELECTRICITY
(CENTS/KWH - CONSTANT 1992 DOLLARS)

CALENDAR YEAR	CPI	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	135.2	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	139.9	17.74	16.72	20.15	15.63	19.61	14.69	19.10	15.87	15.54
1994	144.8	16.28	15.35	18.49	14.35	18.00	13.48	17.53	14.57	14.26
1995	149.9	15.73	14.83	17.87	13.86	17.39	13.02	16.94	14.08	13.78
1996	155.1	15.20	14.33	17.26	13.39	16.80	12.58	16.37	13.60	13.31
1997	160.6	14.68	13.85	16.68	12.94	16.23	12.16	15.81	13.14	12.86
1998	166.2	14.19	13.38	16.11	12.50	15.68	11.75	15.28	12.70	12.43
1999	172.0	13.71	12.93	15.57	12.08	15.15	11.35	14.76	12.27	12.01
2000	178.0	13.24	12.49	15.04	11.67	14.64	10.97	14.26	11.85	11.60
2001	184.3	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2002	190.7	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2003	197.4	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2004	204.3	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2005	211.4	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2006	218.8	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2007	226.5	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2008	234.4	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2009	242.6	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2010	251.1	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2011	259.9	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2012	269.0	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
2013	278.4	12.79	12.07	14.53	11.28	14.15	10.59	13.78	11.45	11.21
COMPOUNDED ANNUAL GROWTH RATES:										
1992-1997:	3.50%	-4.37%	-4.37%	-4.37%	-4.37%	-4.37%	-4.37%	-4.37%	-4.37%	-4.37%
1997-2002:	3.50%	-2.71%	-2.71%	-2.71%	-2.71%	-2.71%	-2.71%	-2.71%	-2.71%	-2.71%
2002-2013:	3.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1992-2013:	3.50%	-1.70%	-1.70%	-1.70%	-1.70%	-1.70%	-1.70%	-1.70%	-1.70%	-1.70%

TABLE B-1

CVEA
ECONOMIC & DEMOGRAPHIC DATA PROJECTIONS

MEDIUM_HIGH CASE
Full PetroStar Expansion

ECONOMIC & DEMOGRAPHIC DATA

VALDEZ AND COPPER RIVER VALLEY

CALENDAR YEAR	VALDEZ POP	COPPER RIVER POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVER EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV)	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day	PetroStar Energy Sales (kWh)
1992	4,326	2,832	7,158	2,247	762	3,009	9,623	13,861	135.2	27,050	27,050	11,404	1.791	2,362,992
1993	4,497	2,987	7,484	2,313	821	3,134	9,711	14,004	139.9	27,997	27,050	25,538	1.683	12,190,880
1994	4,558	3,008	7,565	2,336	827	3,162	9,711	14,004	144.8	28,976	27,050	25,538	1.661	14,585,400
1995	4,619	3,028	7,647	2,359	832	3,191	9,711	14,004	149.9	29,991	27,050	25,538	1.682	18,921,600
1996	4,682	3,048	7,730	2,383	838	3,220	9,711	14,004	155.1	31,040	27,050	25,538	1.612	21,286,800
1997	4,745	3,069	7,814	2,406	844	3,250	9,711	14,004	160.6	32,127	27,050	25,538	1.587	22,469,400
1998	4,809	3,090	7,898	2,430	849	3,280	9,711	14,004	166.2	33,251	27,050	25,538	1.499	22,469,400
1999	4,874	3,110	7,984	2,455	855	3,310	9,711	14,004	172.0	34,415	27,050	25,538	1.409	22,469,400
2000	4,940	3,131	8,071	2,479	861	3,340	9,711	14,004	178.0	35,619	27,050	25,538	1.268	22,469,400
2001	5,006	3,153	8,159	2,504	867	3,371	9,711	14,004	184.3	36,866	27,050	25,538	1.147	22,469,400
2002	5,074	3,174	8,248	2,529	872	3,401	9,711	14,004	190.7	38,156	27,050	25,538	1.069	22,469,400
2003	5,142	3,195	8,338	2,554	878	3,433	9,711	14,004	197.4	39,492	27,050	25,538	0.984	22,469,400
2004	5,212	3,217	8,429	2,580	884	3,464	9,711	14,004	204.3	40,874	27,050	25,538	0.877	22,469,400
2005	5,282	3,239	8,521	2,606	890	3,496	9,711	14,004	211.4	42,305	27,050	25,538	0.832	22,469,400
2006	5,353	3,260	8,614	2,632	896	3,528	9,711	14,004	218.8	43,785	27,050	25,538	0.739	22,469,400
2007	5,426	3,282	8,708	2,658	902	3,560	9,711	14,004	226.5	45,318	27,050	25,538	0.652	22,469,400
2008	5,499	3,305	8,804	2,684	908	3,593	9,711	14,004	234.4	46,904	27,050	25,538	0.582	22,469,400
2009	5,573	3,327	8,900	2,711	915	3,626	9,711	14,004	242.6	48,546	27,050	25,538	0.524	22,469,400
2010	5,648	3,349	8,998	2,738	921	3,659	9,711	14,004	251.1	50,245	27,050	25,538	0.472	22,469,400
2011	5,725	3,372	9,097	2,766	927	3,693	9,711	14,004	259.9	52,003	27,050	25,538	0.472	22,469,400
2012	5,802	3,395	9,197	2,793	933	3,726	9,711	14,004	269.0	53,823	27,050	25,538	0.472	22,469,400
2013	5,880	3,418	9,298	2,821	939	3,761	9,711	14,004	278.4	55,707	27,050	25,538	0.472	22,469,400
COMPOUNDED ANNUAL GROWTH RATES:														
1992-1997:	1.87%	1.62%	1.77%	1.38%	2.05%	1.55%			3.50%	3.50%	0.00%		-2.39%	56.90%
1997-2002:	1.35%	0.67%	1.09%	1.00%	0.67%	0.92%			3.50%	3.50%	0.00%		-7.60%	0.00%
2002-2013:	1.35%	0.68%	1.10%	1.00%	0.67%	0.92%			3.50%	3.50%	0.00%		-7.16%	0.00%
1992-2013:	1.47%	0.90%	1.25%	1.09%	1.00%	1.07%			3.50%	3.50%	0.00%		-6.15%	11.32%

TABLE B-3

CVEA
PROJECTED OPERATING RESULTS

HIGH CASE

ENERGY SALES AND REQUIREMENTS (kWh)

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ RETAIL SALES	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR
1992	10,357,519	4,951,406	20,259,252	69,648	693,079	36,330,904	4,342,066	4,600,078	8,891,200	35,936	401,978	18,271,258	54,602,162	4,625,014	59,227,176	7.8%	7,200	3,700	10,900	62.0%
1993	10,875,602	5,184,854	31,234,010	72,400	681,763	48,048,628	4,725,860	4,752,999	9,871,268	37,911	445,671	19,833,708	67,882,336	5,091,529	72,973,865	7.0%	8,847	4,043	12,890	64.6%
1994	11,408,691	5,291,030	34,143,367	73,993	690,185	51,607,266	5,132,286	4,897,753	10,165,830	38,328	448,122	20,682,319	72,289,585	5,315,416	77,605,002	6.8%	9,365	4,293	13,658	64.9%
1995	11,934,456	5,444,264	40,121,846	75,621	698,711	58,274,899	5,476,706	5,040,801	10,473,627	38,749	450,587	21,480,469	79,755,368	5,676,048	85,431,416	6.6%	10,345	4,541	14,885	65.5%
1996	12,422,540	5,555,753	43,068,972	77,285	707,343	61,831,892	5,832,764	5,182,293	10,786,214	39,175	453,065	22,293,513	84,125,405	5,898,651	90,024,056	6.6%	10,864	4,802	15,666	65.6%
1997	12,898,900	5,669,525	46,829,457	78,985	716,081	66,192,947	5,981,850	5,216,782	11,108,181	39,606	455,557	22,801,976	88,994,923	6,112,220	95,107,144	6.4%	11,487	4,911	16,398	66.2%
1998	13,377,321	5,785,627	47,381,107	80,722	724,927	67,349,704	6,134,747	5,251,499	11,439,485	40,042	458,063	23,323,836	90,673,540	6,258,187	96,931,727	6.5%	11,700	5,024	16,723	66.2%
1999	13,865,200	5,904,106	47,950,510	82,498	733,883	68,536,196	6,291,551	5,286,448	11,780,705	40,483	460,582	23,859,768	92,395,964	6,407,963	98,803,927	6.5%	11,918	5,139	17,058	66.1%
2000	14,366,635	6,025,011	48,538,366	84,313	742,949	69,757,275	6,452,363	5,321,629	12,132,136	40,928	463,115	24,410,171	94,167,446	6,562,005	100,729,451	6.5%	12,143	5,258	17,401	66.1%
2001	14,884,039	6,148,393	49,145,409	86,168	752,127	71,016,136	6,617,286	5,357,045	12,494,086	41,378	465,662	24,975,457	95,991,593	6,720,627	102,712,220	6.5%	12,375	5,379	17,755	66.0%
2002	15,266,178	6,274,301	49,772,406	88,064	761,419	72,162,368	6,697,355	5,392,696	12,866,871	41,833	468,224	25,466,978	97,629,346	6,863,040	104,492,386	6.6%	12,587	5,485	18,072	66.0%
2003	15,580,813	6,357,464	50,420,158	90,001	770,825	73,219,261	6,778,393	5,428,584	13,250,815	42,293	470,799	25,970,884	99,190,145	6,998,761	106,188,906	6.6%	12,781	5,594	18,375	66.0%
2004	15,863,134	6,441,730	51,089,505	91,981	780,347	74,266,697	6,860,412	5,464,711	13,646,253	42,759	473,388	26,487,523	100,754,220	7,134,768	107,888,988	6.6%	12,974	5,705	18,679	65.9%
2005	17,926,754	8,936,155	51,781,326	108,939	902,653	79,655,826	7,836,913	5,892,523	14,053,532	48,291	504,016	28,335,276	107,991,102	7,764,062	115,755,164	6.7%	13,967	6,103	20,070	65.8%
2006	20,473,864	11,076,766	52,496,539	131,050	995,420	85,173,639	9,049,793	6,394,099	14,473,005	55,086	539,473	30,511,457	115,685,095	8,433,105	124,118,200	6.8%	14,984	6,572	21,556	65.7%
2007	20,479,721	11,076,766	53,236,108	131,050	1,002,101	85,925,746	9,049,793	6,394,099	14,905,041	55,086	539,473	30,943,492	116,869,237	8,536,074	125,405,311	6.8%	15,123	6,665	21,788	65.7%
2008	20,482,612	11,076,766	54,001,039	131,050	1,008,828	86,700,294	9,049,793	6,394,099	15,350,014	55,086	539,473	31,388,466	118,088,760	8,642,119	126,730,879	6.8%	15,265	6,761	22,026	65.7%
2009	19,411,444	10,039,551	54,792,389	121,564	974,094	85,339,043	8,263,185	6,088,423	15,808,316	50,733	518,158	30,728,815	116,067,858	8,466,389	124,534,246	6.8%	15,015	6,619	21,633	65.7%
2010	18,762,269	7,926,511	55,611,263	115,917	887,052	83,303,013	7,194,949	5,655,523	16,280,344	44,771	487,710	29,663,297	112,966,310	8,196,689	121,162,999	6.8%	14,639	6,389	21,028	65.8%
2011	18,829,694	7,951,599	56,458,820	116,497	894,205	84,250,815	7,274,093	5,689,739	16,766,513	45,218	490,149	30,265,713	114,516,527	8,331,490	122,848,018	6.8%	14,814	6,519	21,333	65.7%
2012	18,897,199	7,976,766	57,336,274	117,079	901,415	85,228,733	7,354,108	5,724,162	17,267,248	45,671	492,600	30,883,788	116,112,520	8,470,272	124,582,793	6.8%	14,994	6,652	21,646	65.7%
2013	18,964,865	8,002,013	58,244,896	117,665	908,683	86,238,122	7,435,003	5,758,793	17,782,984	46,127	495,063	31,517,971	117,756,092	8,613,192	126,369,284	6.8%	15,180	6,789	21,969	65.7%
COMPOUNDED ANNUAL GROWTH RATES:																				
1992-1997:	4.49%	2.75%	18.24%	2.55%	0.66%	12.75%	6.62%	2.55%	4.55%	1.96%	2.53%	4.53%	10.26%	5.73%	9.94%		9.79%	5.83%	8.51%	
1997-2002:	3.43%	2.05%	1.23%	2.20%	1.24%	1.74%	2.29%	0.67%	2.98%	1.10%	0.55%	2.24%	1.87%	2.34%	1.90%		1.85%	2.24%	1.96%	
2002-2013:	1.99%	2.24%	1.44%	2.67%	1.62%	1.63%	0.95%	0.60%	2.99%	0.89%	0.51%	1.96%	1.72%	2.09%	1.74%		1.72%	1.96%	1.79%	
1992-2013:	2.92%	2.31%	5.16%	2.53%	1.30%	4.20%	2.59%	1.08%	3.36%	1.20%	1.00%	2.63%	3.73%	3.01%	3.67%		3.62%	2.93%	3.39%	

TABLE B-3

CVEA
PROJECTED OPERATING RESULTS

HIGH CASE

AVERAGE ANNUAL NUMBER OF CUSTOMER ACCOUNTS

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL	
1992	1,363	231	60	9	29	1,692	872	213	11	9	31	1,135	2,234	515	78	2,827	5.0
1993	1,380	233	62	9	30	1,713	924	220	12	9	34	1,200	2,304	526	82	2,913	5.1
1994	1,391	234	63	10	30	1,728	976	226	12	10	34	1,258	2,367	536	83	2,986	5.1
1995	1,413	237	65	10	30	1,754	1,027	233	12	10	34	1,316	2,440	546	84	3,071	5.2
1996	1,435	239	66	10	31	1,781	1,080	240	12	10	35	1,376	2,515	557	85	3,157	5.3
1997	1,458	242	67	10	31	1,808	1,093	241	12	10	35	1,391	2,551	562	86	3,199	5.3
1998	1,481	244	69	10	31	1,835	1,106	243	12	10	35	1,406	2,587	568	87	3,241	5.3
1999	1,504	247	70	11	32	1,863	1,119	244	12	10	35	1,421	2,623	574	88	3,284	5.3
2000	1,527	250	72	11	32	1,891	1,133	246	12	10	35	1,437	2,660	579	88	3,328	5.4
2001	1,551	252	73	11	32	1,920	1,147	248	12	10	36	1,452	2,698	585	89	3,372	5.4
2002	1,576	255	74	11	33	1,949	1,161	249	12	10	36	1,468	2,736	591	90	3,417	5.4
2003	1,600	258	76	12	33	1,979	1,175	251	12	11	36	1,484	2,775	597	91	3,463	5.5
2004	1,626	261	77	12	33	2,009	1,189	253	12	11	36	1,500	2,814	602	92	3,509	5.5
2005	1,835	284	79	14	36	2,248	1,358	272	12	12	38	1,693	3,193	647	101	3,941	5.7
2006	2,094	312	80	17	40	2,543	1,568	296	12	14	41	1,931	3,663	699	112	4,474	6.0
2007	2,094	312	81	17	40	2,544	1,568	296	12	14	41	1,931	3,663	701	112	4,475	6.0
2008	2,094	312	83	17	40	2,546	1,568	296	12	14	41	1,931	3,663	702	112	4,477	6.0
2009	1,985	300	84	16	39	2,424	1,432	281	12	13	40	1,778	3,417	678	107	4,201	5.9
2010	1,918	293	86	15	38	2,350	1,247	261	12	11	37	1,569	3,165	652	101	3,919	5.7
2011	1,925	294	87	15	38	2,359	1,261	263	12	11	37	1,584	3,186	656	102	3,943	5.7
2012	1,932	295	88	15	38	2,368	1,274	265	12	11	38	1,600	3,206	660	102	3,968	5.7
2013	1,939	296	90	15	38	2,378	1,288	266	12	12	38	1,616	3,227	664	103	3,994	5.7

COMPOUNDED ANNUAL GROWTH RATES:

Period	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL
1992-1997:	1.36%	0.94%	2.22%	2.55%	1.27%	1.34%	4.63%	2.55%	1.76%	1.96%	2.53%	4.15%	2.68%	1.78%	2.01%	2.50%
1997-2002:	1.57%	1.08%	2.00%	2.20%	1.10%	1.52%	1.21%	0.67%	0.00%	1.10%	0.55%	1.09%	1.42%	0.99%	1.01%	1.33%
2002-2013:	1.90%	1.35%	1.73%	2.67%	1.41%	1.82%	0.95%	0.60%	0.00%	0.89%	0.51%	0.88%	1.51%	1.06%	1.18%	1.43%
1992-2013:	1.69%	1.19%	1.91%	2.53%	1.30%	1.63%	1.88%	1.08%	0.42%	1.20%	1.00%	1.70%	1.77%	1.22%	1.33%	1.66%

TABLE B-3

CVEA
PROJECTED OPERATING RESULTS

HIGH CASE

USAGE (KWh) PER CUSTOMER ACCOUNT

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1992	7,601	21,458	335,789	7,739	23,899	21,475	4,981	21,630	808,291	3,993	13,108	16,098	6,579	75,186	15,459	19,316
1993	7,883	22,278	505,936	7,739	23,054	39,628	5,113	21,630	822,606	3,993	13,108	16,534	6,772	97,003	15,017	30,116
1994	8,201	22,605	540,784	7,739	23,084	41,840	5,261	21,630	847,153	3,993	13,108	16,444	6,989	101,745	15,023	31,141
1995	8,446	23,010	621,673	7,739	23,115	45,468	5,331	21,630	872,802	3,993	13,108	16,317	7,135	111,831	15,030	32,970
1996	8,656	23,230	653,152	7,739	23,146	47,240	5,402	21,630	898,851	3,993	13,108	16,205	7,259	116,031	15,036	33,714
1997	8,849	23,451	695,399	7,739	23,177	49,226	5,474	21,630	925,682	3,993	13,108	16,396	7,403	122,402	15,042	34,952
1998	9,035	23,675	689,244	7,739	23,208	49,404	5,546	21,630	953,290	3,993	13,108	16,591	7,543	123,010	15,048	35,172
1999	9,220	23,901	683,588	7,739	23,239	49,590	5,620	21,630	981,725	3,993	13,108	16,789	7,684	123,650	15,054	35,397
2000	9,406	24,129	678,412	7,739	23,271	49,785	5,695	21,630	1,011,011	3,993	13,108	16,992	7,826	124,323	15,060	35,630
2001	9,594	24,359	673,698	7,739	23,302	49,992	5,771	21,630	1,041,174	3,993	13,108	17,198	7,969	125,031	15,065	35,870
2002	9,688	24,592	669,430	7,739	23,333	50,086	5,771	21,630	1,072,239	3,993	13,108	17,347	8,027	125,772	15,071	36,021
2003	9,735	24,651	665,594	7,739	23,364	50,127	5,771	21,630	1,104,235	3,993	13,108	17,499	8,057	126,473	15,076	36,144
2004	9,758	24,710	662,177	7,739	23,395	50,159	5,771	21,630	1,137,188	3,993	13,108	17,655	8,074	127,209	15,082	36,262
2005	9,770	31,481	659,168	7,739	24,778	48,042	5,771	21,630	1,171,128	3,993	13,108	16,737	8,069	124,705	15,476	34,593
2006	9,775	35,553	656,557	7,739	24,807	45,492	5,771	21,630	1,206,084	3,993	13,108	15,803	8,061	120,781	15,365	32,678
2007	9,778	35,553	654,336	7,739	24,974	45,932	5,771	21,630	1,242,087	3,993	13,108	16,026	8,062	122,211	15,424	33,029
2008	9,780	35,553	652,496	7,739	25,141	46,386	5,771	21,630	1,279,168	3,993	13,108	16,257	8,063	123,691	15,484	33,391
2009	9,780	33,431	651,032	7,739	25,187	47,891	5,771	21,630	1,317,360	3,993	13,108	17,286	8,100	127,930	15,612	34,941
2010	9,781	27,019	649,937	7,739	23,482	48,071	5,771	21,630	1,356,695	3,993	13,108	18,910	8,201	131,016	15,176	36,397
2011	9,781	27,038	649,207	7,739	23,612	48,541	5,771	21,630	1,397,209	3,993	13,108	19,104	8,194	132,399	15,211	36,715
2012	9,781	27,057	648,839	7,739	23,743	49,027	5,771	21,630	1,438,937	3,993	13,108	19,302	8,187	133,832	15,246	37,042
2013	9,781	27,076	648,829	7,739	23,875	49,528	5,771	21,630	1,481,915	3,993	13,108	19,504	8,180	135,316	15,280	37,379

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1992-1997:	3.09%	1.79%	15.67%	0.00%	-0.61%	18.05%	1.90%	0.00%	2.75%	0.00%	0.00%	0.37%	2.39%	10.24%	-0.55%	12.59%
1997-2002:	1.83%	0.95%	-0.76%	0.00%	0.13%	0.35%	1.06%	0.00%	2.98%	0.00%	0.00%	1.13%	1.63%	0.54%	0.04%	0.60%
2002-2013:	0.09%	0.88%	-0.28%	0.00%	0.21%	-0.10%	0.00%	0.00%	2.99%	0.00%	0.00%	1.07%	0.17%	0.67%	0.13%	0.34%
1992-2013:	1.21%	1.11%	3.19%	0.00%	-0.00%	4.06%	0.70%	0.00%	2.93%	0.00%	0.00%	0.92%	1.04%	2.84%	-0.06%	3.19%

TABLE B-3

CVEA
PROJECTED OPERATING RESULTS

HIGH CASE

NOMINAL COST OF ELECTRICITY
(CENTS/KWH - NOMINAL)

CALENDAR YEAR	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1994	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1995	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1996	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1997	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1998	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1999	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2000	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2001	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2002	18.22	17.18	20.70	16.06	20.15	15.09	19.62	16.31	15.97
2003	19.04	17.96	21.63	16.78	21.05	15.77	20.51	17.04	16.68
2004	19.90	18.77	22.60	17.54	22.00	16.48	21.43	17.81	17.44
2005	20.80	19.61	23.62	18.33	22.99	17.22	22.40	18.61	18.22
2006	21.73	20.49	24.68	19.15	24.03	17.99	23.40	19.45	19.04
2007	22.71	21.42	25.80	20.02	25.11	18.80	24.46	20.32	19.90
2008	23.73	22.38	26.96	20.92	26.24	19.65	25.56	21.24	20.79
2009	24.80	23.39	28.17	21.86	27.42	20.53	26.71	22.19	21.73
2010	25.91	24.44	29.44	22.84	28.65	21.46	27.91	23.19	22.71
2011	27.08	25.54	30.76	23.87	29.94	22.42	29.16	24.24	23.73
2012	28.30	26.69	32.15	24.94	31.29	23.43	30.48	25.33	24.79
2013	29.57	27.89	33.59	26.06	32.70	24.49	31.85	26.47	25.91
COMPOUNDED ANNUAL GROWTH RATES:									
1992-1997:	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%
1997-2002:	0.88%	0.88%	0.88%	0.88%	0.88%	0.88%	0.88%	0.88%	0.88%
2002-2013:	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
1992-2013:	2.30%	2.30%	2.30%	2.30%	2.30%	2.30%	2.30%	2.30%	2.30%

REAL COST OF ELECTRICITY
(CENTS/KWH - CONSTANT 1992 DOLLARS)

CALENDAR YEAR	CPI	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	135.2	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	141.3	17.57	16.56	19.95	15.48	19.42	14.54	18.92	15.72	15.39
1994	147.6	15.97	15.06	18.14	14.07	17.66	13.22	17.20	14.29	13.99
1995	154.3	15.28	14.41	17.36	13.47	16.89	12.65	16.46	13.68	13.39
1996	161.2	14.62	13.79	16.61	12.89	16.17	12.11	15.75	13.09	12.81
1997	168.5	13.99	13.20	15.90	12.33	15.47	11.59	15.07	12.52	12.26
1998	176.1	13.39	12.63	15.21	11.80	14.80	11.09	14.42	11.98	11.73
1999	184.0	12.81	12.08	14.56	11.29	14.17	10.61	13.80	11.47	11.23
2000	192.3	12.26	11.56	13.93	10.81	13.56	10.15	13.21	10.97	10.74
2001	200.9	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2002	210.0	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2003	219.4	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2004	229.3	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2005	239.6	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2006	250.4	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2007	261.7	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2008	273.4	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2009	285.7	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2010	298.6	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2011	312.0	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2012	326.1	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
2013	340.7	11.73	11.07	13.33	10.34	12.97	9.72	12.64	10.50	10.28
COMPOUNDED ANNUAL GROWTH RATES:										
1992-1997:	4.50%	-5.28%	-5.28%	-5.28%	-5.28%	-5.28%	-5.28%	-5.28%	-5.28%	-5.28%
1997-2002:	4.50%	-3.46%	-3.46%	-3.46%	-3.46%	-3.46%	-3.46%	-3.46%	-3.46%	-3.46%
2002-2013:	4.50%	-0.00%	-0.00%	-0.00%	-0.00%	-0.00%	-0.00%	-0.00%	-0.00%	-0.00%
1992-2013:	4.50%	-2.11%	-2.11%	-2.11%	-2.11%	-2.11%	-2.11%	-2.11%	-2.11%	-2.11%

TABLE B-3

CVEA
ECONOMIC & DEMOGRAPHIC DATA PROJECTIONS

HIGH CASE

ECONOMIC & DEMOGRAPHIC DATA

CALENDAR YEAR	VALDEZ POP	COPPER RIVER POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVER EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV)	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day	PetroStar Energy Sales (kWh)
	VALDEZ AND COPPER RIVER VALLEY													
1992	4,326	2,832	7,158	2,247	762	3,009	9,623	13,861	135.2	27,050	27,050	11,404	1.791	2,362,992
1993	4,497	2,987	7,484	2,294	821	3,115	9,711	14,004	141.3	28,832	27,591	25,538	1.683	12,190,880
1994	4,596	3,020	7,616	2,342	830	3,172	9,711	14,004	147.6	30,732	28,143	25,538	1.661	14,585,400
1995	4,697	3,053	7,751	2,391	839	3,231	9,711	14,004	154.3	32,758	28,705	25,538	1.682	18,921,600
1996	4,800	3,087	7,887	2,442	849	3,290	9,711	14,004	161.2	34,916	29,280	25,538	1.612	21,286,800
1997	4,906	3,121	8,027	2,493	858	3,351	9,711	14,004	168.5	37,217	29,865	25,538	1.744	24,440,400
1998	5,014	3,155	8,169	2,545	867	3,413	9,711	14,004	176.1	39,670	30,462	25,538	1.609	24,440,400
1999	5,124	3,190	8,314	2,599	877	3,476	9,711	14,004	184.0	42,284	31,072	25,538	1.649	24,440,400
2000	5,237	3,225	8,462	2,653	887	3,540	9,711	14,004	192.3	45,071	31,693	25,538	1.489	24,440,400
2001	5,352	3,261	8,613	2,709	896	3,605	9,711	14,004	200.9	48,041	32,327	25,538	1.350	24,440,400
2002	5,470	3,297	8,766	2,766	906	3,672	9,711	14,004	210.0	51,207	32,974	25,538	1.265	24,440,400
2003	5,590	3,333	8,923	2,824	916	3,740	9,711	14,004	219.4	54,581	33,633	25,538	1.169	24,440,400
2004	5,713	3,369	9,083	2,883	926	3,809	9,711	14,004	229.3	58,178	34,306	25,538	1.081	24,440,400
2005	6,767	3,805	10,572	4,833	1,397	6,231	9,711	14,004	239.6	62,012	34,992	25,538	1.014	24,440,400
2006	8,140	4,341	12,481	6,783	1,765	8,548	9,711	14,004	250.4	66,099	35,692	25,538	0.914	24,440,400
2007	8,140	4,341	12,481	6,783	1,765	8,548	9,711	14,004	261.7	70,455	36,405	25,538	0.832	24,440,400
2008	8,140	4,341	12,481	6,783	1,765	8,548	9,711	14,004	273.4	75,098	37,134	25,538	0.761	24,440,400
2009	7,551	3,998	11,549	5,808	1,529	7,338	9,711	14,004	285.7	80,047	37,876	25,538	0.691	24,440,400
2010	7,200	3,528	10,728	4,000	980	4,980	9,711	14,004	298.6	85,322	38,634	25,538	0.627	24,440,400
2011	7,236	3,563	10,799	4,020	991	5,011	9,711	14,004	312.0	90,944	39,406	25,538	0.627	24,440,400
2012	7,272	3,599	10,871	4,040	1,002	5,042	9,711	14,004	326.1	96,938	40,195	25,538	0.627	24,440,400
2013	7,309	3,635	10,943	4,060	1,013	5,073	9,711	14,004	340.7	103,326	40,998	25,538	0.627	24,440,400

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ POP	COPPER RIVER POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVER EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV)	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day	PetroStar Energy Sales (kWh)
1992-1997:	2.55%	1.96%	2.32%	2.10%	2.39%	2.17%			4.50%	6.59%	2.00%		-0.53%	59.56%
1997-2002:	2.20%	1.10%	1.78%	2.10%	1.10%	1.85%			4.50%	6.59%	2.00%		-6.22%	0.00%
2002-2013:	2.67%	0.89%	2.04%	3.55%	1.02%	2.98%			4.50%	6.59%	2.00%		-6.18%	0.00%
1992-2013:	2.53%	1.20%	2.04%	2.86%	1.36%	2.52%			4.50%	6.59%	2.00%		-4.88%	11.77%

TABLE B-4

CVEA
PROJECTED OPERATING RESULTS

LOW CASE

ENERGY SALES AND REQUIREMENTS (kWh)

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ RETAIL SALES	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR
1992	10,357,519	4,951,406	20,259,252	69,648	693,079	36,330,904	4,342,066	4,600,078	8,891,200	35,936	401,978	18,271,258	54,602,162	4,625,014	59,227,176	7.8%	7,200	3,700	10,900	62.0%
1993	10,828,156	5,211,333	30,725,619	72,400	676,383	47,513,891	4,698,528	4,752,999	9,123,482	37,911	445,671	19,058,591	66,572,482	4,977,628	71,550,111	7.0%	8,748	3,885	12,633	64.7%
1994	11,014,957	5,202,657	33,134,311	71,531	672,475	50,095,932	4,926,787	4,818,187	8,927,363	38,024	446,340	19,156,701	69,252,633	5,051,334	74,303,967	6.8%	9,086	3,976	13,063	64.9%
1995	11,161,769	5,237,171	38,591,259	70,673	668,591	55,729,463	5,084,597	4,882,875	8,740,832	38,138	447,009	19,193,451	74,922,913	5,255,835	80,178,748	6.6%	9,876	4,057	13,933	65.7%
1996	11,248,535	5,228,452	38,607,374	69,825	664,728	55,818,914	5,244,884	4,947,080	8,554,964	38,253	447,680	19,232,860	75,051,774	5,267,040	80,318,813	6.6%	9,892	4,143	14,035	65.3%
1997	11,305,267	5,219,748	37,667,051	68,987	660,888	54,921,940	5,301,337	4,956,059	8,370,223	38,368	448,351	19,114,338	74,036,278	5,178,736	79,215,014	6.5%	9,727	4,117	13,844	65.3%
1998	11,347,084	5,211,058	36,727,676	68,159	657,070	54,011,047	5,358,397	4,965,054	8,190,301	38,483	449,024	19,001,258	73,012,305	5,089,695	78,102,000	6.5%	9,559	4,093	13,651	65.3%
1999	11,381,535	5,202,382	36,746,634	67,341	653,274	54,051,167	5,416,072	4,974,065	8,018,888	38,598	449,697	18,897,321	72,948,488	5,084,145	78,032,633	6.5%	9,566	4,070	13,637	65.3%
2000	11,412,369	5,193,721	36,766,523	66,533	649,501	54,088,646	5,474,368	4,983,093	7,852,061	38,714	450,372	18,798,608	72,887,254	5,078,821	77,966,075	6.5%	9,573	4,049	13,622	65.3%
2001	11,441,445	5,185,074	36,787,334	65,735	645,749	54,125,336	5,533,291	4,992,138	7,689,707	38,830	451,047	18,705,014	72,830,350	5,073,872	77,904,223	6.5%	9,580	4,029	13,609	65.3%
2002	11,405,787	5,176,442	36,809,059	64,946	642,018	54,098,252	5,551,551	5,001,198	7,531,719	38,947	451,724	18,575,138	72,673,390	5,060,224	77,733,614	6.5%	9,575	4,001	13,576	65.4%
2003	11,338,491	5,147,271	36,831,691	64,167	638,309	54,019,928	5,569,871	5,010,276	7,377,988	39,063	452,402	18,449,600	72,469,528	5,042,497	77,512,025	6.5%	9,561	3,974	13,534	65.4%
2004	11,256,049	5,118,264	36,855,223	63,397	634,622	53,927,554	5,588,252	5,019,369	7,228,413	39,181	453,080	18,328,295	72,255,849	5,023,916	77,279,765	6.5%	9,543	3,948	13,491	65.4%
2005	11,166,600	5,089,420	36,879,648	62,636	630,956	53,829,259	5,606,693	5,028,479	7,082,893	39,298	453,760	18,211,123	72,040,382	5,005,180	77,045,562	6.5%	9,525	3,922	13,448	65.4%
2006	11,074,140	5,060,739	36,904,959	61,884	627,311	53,729,033	5,625,195	5,037,606	6,941,328	39,416	454,440	18,097,985	71,827,018	4,986,626	76,813,644	6.5%	9,507	3,898	13,405	65.4%
2007	10,980,624	5,032,220	36,931,150	61,142	623,687	53,628,822	5,643,758	5,046,749	6,803,623	39,534	455,122	17,988,787	71,617,609	4,968,417	76,586,026	6.5%	9,488	3,875	13,363	65.4%
2008	10,887,007	5,003,861	36,958,215	60,408	620,084	53,529,575	5,662,383	5,055,909	6,669,685	39,653	455,805	17,883,434	71,413,009	4,950,625	76,363,635	6.5%	9,470	3,852	13,322	65.4%
2009	10,793,752	4,975,662	36,986,148	59,683	616,502	53,431,748	5,681,068	5,065,086	6,539,423	39,772	456,489	17,781,837	71,213,585	4,933,284	76,146,869	6.5%	9,452	3,830	13,282	65.4%
2010	10,701,083	4,788,387	37,014,944	58,967	604,489	53,167,870	5,699,816	5,074,279	6,412,748	39,891	457,173	17,683,907	70,851,777	4,901,823	75,753,600	6.5%	9,404	3,809	13,212	65.5%
2011	10,609,105	4,598,497	36,779,126	58,259	592,183	52,637,170	5,718,625	5,083,489	3,764,566	40,011	457,859	15,064,549	67,701,719	4,627,905	72,329,624	6.4%	9,306	3,245	12,550	65.8%
2012	10,517,866	4,405,707	36,683,533	57,560	579,546	52,244,213	5,737,497	5,092,715	2,445,429	40,131	458,546	13,774,317	66,018,530	4,481,540	70,500,070	6.4%	9,233	2,967	12,200	66.0%
2013	10,427,388	4,209,689	17,666,848	56,869	566,532	32,927,326	5,756,431	5,101,958	1,126,386	40,251	459,234	12,484,260	45,411,586	3,948,834	49,360,420	8.0%	6,760	2,689	9,449	59.6%

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ RETAIL SALES	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN RETAIL SALES	CVEA SYSTEM SALES	LINE LOSSES	ENERGY REQUIREMENT	LOSSES AS % OF RQT	VALDEZ PEAK DEMAND (kW)	GLENN PEAK DEMAND (kW)	TOTAL PEAK DEMAND (kW)	TOTAL SYSTEM LOAD FACTOR
1992-1997:	1.77%	1.06%	13.21%	-0.19%	-0.95%	8.62%	4.07%	1.50%	-1.20%	1.32%	2.21%	0.91%	6.28%	2.29%	5.99%		6.20%	2.16%	4.90%	
1997-2002:	0.18%	-0.17%	-0.46%	-1.20%	-0.58%	-0.30%	0.93%	0.18%	-2.09%	0.30%	0.15%	-0.57%	-0.37%	-0.46%	-0.38%		-0.31%	-0.57%	-0.39%	
2002-2013:	-0.81%	-1.86%	-6.46%	-1.20%	-1.13%	-4.41%	0.33%	0.18%	-15.86%	0.30%	0.15%	-3.55%	-4.18%	-2.23%	-4.04%		-3.11%	-3.55%	-3.24%	
1992-2013:	0.03%	-0.77%	-0.65%	-0.96%	-0.96%	-0.47%	1.35%	0.49%	-9.37%	0.54%	0.64%	-1.80%	-0.87%	-0.75%	-0.86%		-0.30%	-1.51%	-0.68%	

TABLE B-4

CVEA
PROJECTED OPERATING RESULTS

LOW CASE

AVERAGE ANNUAL NUMBER OF CUSTOMER ACCOUNTS

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL	
1992	1,363	231	60	9	29	1,692	872	213	11	9	31	1,135	2,234	515	78	2,827	5.0
1993	1,380	233	62	9	30	1,713	924	220	12	9	34	1,200	2,304	526	82	2,912	5.1
1994	1,358	230	61	9	29	1,688	947	223	12	10	34	1,226	2,305	526	82	2,914	5.1
1995	1,346	229	61	9	29	1,674	971	226	12	10	34	1,252	2,317	527	82	2,926	5.1
1996	1,335	227	60	9	29	1,661	994	229	12	10	34	1,278	2,328	529	82	2,939	5.1
1997	1,323	226	60	9	29	1,647	997	229	12	10	34	1,282	2,320	527	82	2,929	5.1
1998	1,312	225	60	9	29	1,634	1,000	230	12	10	34	1,286	2,312	526	81	2,919	5.1
1999	1,300	223	59	9	29	1,620	1,004	230	12	10	34	1,290	2,304	525	81	2,910	5.1
2000	1,289	222	59	9	28	1,607	1,007	230	12	10	34	1,293	2,296	523	81	2,901	5.1
2001	1,278	221	59	8	28	1,594	1,010	231	12	10	34	1,297	2,288	522	81	2,891	5.1
2002	1,267	219	58	8	28	1,581	1,014	231	12	10	34	1,301	2,281	521	81	2,882	5.1
2003	1,256	218	58	8	28	1,568	1,017	232	12	10	35	1,305	2,273	520	80	2,873	5.1
2004	1,245	217	58	8	28	1,556	1,020	232	12	10	35	1,309	2,266	519	80	2,864	5.0
2005	1,235	216	57	8	28	1,543	1,024	232	12	10	35	1,313	2,258	517	80	2,856	5.0
2006	1,224	214	57	8	27	1,531	1,027	233	12	10	35	1,316	2,251	516	80	2,847	5.0
2007	1,214	213	57	8	27	1,518	1,030	233	12	10	35	1,320	2,244	515	80	2,839	5.0
2008	1,203	212	56	8	27	1,506	1,034	234	12	10	35	1,324	2,237	514	80	2,830	5.0
2009	1,193	211	56	8	27	1,494	1,037	234	12	10	35	1,328	2,230	513	79	2,822	5.0
2010	1,182	209	56	8	27	1,482	1,041	235	12	10	35	1,332	2,223	511	79	2,814	5.0
2011	1,172	208	55	8	27	1,470	1,044	235	12	10	35	1,336	2,216	510	79	2,806	5.0
2012	1,162	207	55	7	26	1,458	1,048	235	12	10	35	1,340	2,210	509	79	2,798	5.0
2013	1,152	206	55	7	26	1,446	1,051	236	12	10	35	1,344	2,203	508	79	2,790	5.0

COMPOUNDED ANNUAL GROWTH RATES:

Period	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL TOTAL
1992-1997:	-0.59%	-0.40%	-0.09%	-0.19%	-0.09%	-0.53%	2.72%	1.50%	1.76%	1.32%	2.21%	2.46%	0.76%	0.48%	0.99%	0.71%
1997-2002:	-0.86%	-0.59%	-0.60%	-1.20%	-0.60%	-0.81%	0.33%	0.18%	0.00%	0.30%	0.15%	0.30%	-0.34%	-0.24%	-0.24%	-0.32%
2002-2013:	-0.86%	-0.59%	-0.60%	-1.20%	-0.60%	-0.81%	0.33%	0.18%	0.00%	0.30%	0.15%	0.30%	-0.31%	-0.23%	-0.22%	-0.30%
1992-2013:	-0.80%	-0.55%	-0.48%	-0.96%	-0.48%	-0.74%	0.89%	0.49%	0.42%	0.54%	0.64%	0.81%	-0.07%	-0.06%	0.06%	-0.06%

TABLE B-4

CVEA
PROJECTED OPERATING RESULTS

LOW CASE

USAGE (KWh) PER CUSTOMER ACCOUNT

CALENDAR YEAR	VALDEZ RES	VALDEZ SM COM	VALDEZ LG COM	VALDEZ PUB STL	VALDEZ PUB BLG	VALDEZ TOTAL RETAIL	GLENNALLEN RES	GLENNALLEN SM COM	GLENNALLEN LG COM	GLENNALLEN PUB STL	GLENNALLEN PUB BLG	GLENNALLEN TOTAL RETAIL	TOTAL RES	TOTAL COM	TOTAL PUB	TOTAL CUSTOMERS
1992	7,601	21,458	335,789	7,739	23,899	21,475	4,981	21,630	808,291	3,993	13,108	16,098	6,579	75,186	15,459	19,316
1993	7,849	22,392	499,397	7,739	22,872	38,868	5,083	21,630	760,290	3,993	13,108	15,888	6,739	94,704	14,952	29,402
1994	8,112	22,601	541,798	7,739	22,877	41,031	5,200	21,630	743,947	3,993	13,108	15,629	6,915	98,997	14,941	30,344
1995	8,292	22,887	634,836	7,739	22,882	44,754	5,239	21,630	728,403	3,993	13,108	15,331	7,013	108,943	14,931	32,165
1996	8,429	22,985	638,935	7,739	22,887	45,198	5,278	21,630	712,914	3,993	13,108	15,047	7,084	108,471	14,920	32,084
1997	8,545	23,084	627,136	7,739	22,892	44,951	5,317	21,630	697,519	3,993	13,108	14,910	7,158	106,605	14,910	31,803
1998	8,651	23,183	615,187	7,739	22,897	44,692	5,357	21,630	682,525	3,993	13,108	14,779	7,226	104,738	14,899	31,518
1999	8,752	23,283	619,220	7,739	22,902	45,018	5,397	21,630	668,241	3,993	13,108	14,654	7,291	104,703	14,888	31,563
2000	8,852	23,383	623,295	7,739	22,908	45,348	5,437	21,630	654,338	3,993	13,108	14,535	7,354	104,676	14,877	31,609
2001	8,952	23,484	627,412	7,739	22,913	45,684	5,477	21,630	640,809	3,993	13,108	14,420	7,418	104,657	14,866	31,658
2002	9,001	23,584	631,572	7,739	22,918	45,958	5,477	21,630	627,643	3,993	13,108	14,278	7,435	104,646	14,855	31,658
2003	9,026	23,592	635,775	7,739	22,923	46,204	5,477	21,630	614,832	3,993	13,108	14,139	7,438	104,604	14,844	31,643
2004	9,038	23,599	640,021	7,739	22,928	46,444	5,477	21,630	602,368	3,993	13,108	14,005	7,435	104,569	14,832	31,624
2005	9,044	23,606	644,311	7,739	22,933	46,684	5,477	21,630	590,241	3,993	13,108	13,874	7,427	104,542	14,821	31,604
2006	9,047	23,613	648,645	7,739	22,938	46,926	5,477	21,630	578,444	3,993	13,108	13,748	7,418	104,522	14,809	31,585
2007	9,048	23,620	653,024	7,739	22,944	47,172	5,477	21,630	566,969	3,993	13,108	13,624	7,409	104,509	14,798	31,567
2008	9,049	23,627	657,447	7,739	22,949	47,421	5,477	21,630	555,807	3,993	13,108	13,505	7,398	104,504	14,786	31,552
2009	9,049	23,635	661,915	7,739	22,954	47,675	5,477	21,630	544,952	3,993	13,108	13,388	7,388	104,506	14,774	31,538
2010	9,050	22,881	666,429	7,739	22,643	47,821	5,477	21,630	534,396	3,993	13,108	13,275	7,377	104,204	14,656	31,466
2011	9,050	22,105	666,181	7,739	22,315	46,068	5,477	21,630	313,714	3,993	13,108	11,276	7,367	98,432	14,533	29,500
2012	9,050	21,305	668,460	7,739	21,971	45,289	5,477	21,630	203,786	3,993	13,108	10,279	7,356	95,513	14,405	28,521
2013	9,050	20,478	323,875	7,739	21,607	31,407	5,477	21,630	93,866	3,993	13,108	9,289	7,346	55,326	14,271	20,752
COMPOUNDED ANNUAL GROWTH RATES:																
1992-1997:	2.37%	1.47%	13.31%	0.00%	-0.86%	15.92%	1.31%	0.00%	-2.90%	0.00%	0.00%	-1.52%	1.70%	7.23%	-0.72%	10.49%
1997-2002:	1.05%	0.43%	0.14%	0.00%	0.02%	0.44%	0.59%	0.00%	-2.09%	0.00%	0.00%	-0.86%	0.76%	-0.37%	-0.07%	-0.09%
2002-2013:	0.05%	-1.28%	-5.89%	0.00%	-0.53%	-3.40%	0.00%	0.00%	-15.86%	0.00%	0.00%	-3.83%	-0.11%	-5.63%	-0.36%	-3.77%
1992-2013:	0.83%	-0.22%	-0.17%	0.00%	-0.48%	1.83%	0.45%	0.00%	-9.74%	0.00%	0.00%	-2.58%	0.53%	-1.45%	-0.38%	0.34%

TABLE B-4

CVEA
PROJECTED OPERATING RESULTS

LOW CASE

NOMINAL COST OF ELECTRICITY
(CENTS/KWH - NOMINAL)

CALENDAR YEAR	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1994	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1995	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1996	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1997	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1998	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
1999	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2000	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2001	17.44	16.44	19.81	15.37	19.28	14.44	18.78	15.61	15.28
2002	17.87	16.86	20.30	15.75	19.76	14.80	19.25	16.00	15.66
2003	18.32	17.28	20.81	16.15	20.26	15.17	19.73	16.40	16.05
2004	18.78	17.71	21.33	16.55	20.76	15.55	20.22	16.81	16.45
2005	19.25	18.15	21.86	16.97	21.28	15.94	20.73	17.23	16.86
2006	19.73	18.61	22.41	17.39	21.81	16.34	21.25	17.66	17.29
2007	20.22	19.07	22.97	17.82	22.36	16.75	21.78	18.10	17.72
2008	20.73	19.55	23.55	18.27	22.92	17.16	22.32	18.55	18.16
2009	21.25	20.04	24.13	18.73	23.49	17.59	22.88	19.01	18.62
2010	21.78	20.54	24.74	19.19	24.08	18.03	23.45	19.49	19.08
2011	22.32	21.05	25.36	19.67	24.68	18.48	24.04	19.98	19.56
2012	22.88	21.58	25.99	20.17	25.30	18.95	24.64	20.48	20.05
2013	23.45	22.12	26.64	20.67	25.93	19.42	25.26	20.99	20.55
COMPOUNDED ANNUAL GROWTH RATES:									
1992-1997:	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%	-1.02%
1997-2002:	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
2002-2013:	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
1992-2013:	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%

REAL COST OF ELECTRICITY
(CENTS/KWH - CONSTANT 1992 DOLLARS)

CALENDAR YEAR	CPI	RES	Valdez RES	Glenn RES	Valdez SM COM	Glenn SM COM	COM	PUB STL	PUB BLG	OVERALL AVERAGE
1992	135.2	18.36	17.31	20.85	16.18	20.29	15.20	19.77	16.43	16.08
1993	138.6	17.91	16.89	20.34	15.78	19.80	14.83	19.29	16.03	15.69
1994	142.0	16.60	15.65	18.85	14.63	18.35	13.74	17.87	14.85	14.54
1995	145.6	16.19	15.27	18.39	14.27	17.90	13.41	17.44	14.49	14.19
1996	149.2	15.80	14.90	17.95	13.92	17.47	13.08	17.01	14.14	13.84
1997	153.0	15.41	14.53	17.51	13.58	17.04	12.76	16.60	13.79	13.50
1998	156.8	15.04	14.18	17.08	13.25	16.62	12.45	16.19	13.46	13.17
1999	160.7	14.67	13.83	16.66	12.93	16.22	12.15	15.80	13.13	12.85
2000	164.7	14.31	13.50	16.26	12.61	15.82	11.85	15.41	12.81	12.54
2001	168.8	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2002	173.1	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2003	177.4	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2004	181.8	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2005	186.4	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2006	191.0	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2007	195.8	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2008	200.7	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2009	205.7	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2010	210.9	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2011	216.1	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2012	221.5	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
2013	227.1	13.96	13.17	15.86	12.31	15.44	11.56	15.04	12.50	12.23
COMPOUNDED ANNUAL GROWTH RATES:										
1992-1997:	2.50%	-3.43%	-3.43%	-3.43%	-3.43%	-3.43%	-3.43%	-3.43%	-3.43%	-3.43%
1997-2002:	2.50%	-1.96%	-1.96%	-1.96%	-1.96%	-1.96%	-1.96%	-1.96%	-1.96%	-1.96%
2002-2013:	2.50%	0.00%	-0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1992-2013:	2.50%	-1.29%	-1.29%	-1.29%	-1.29%	-1.29%	-1.29%	-1.29%	-1.29%	-1.29%

TABLE B-4

CVEA
ECONOMIC & DEMOGRAPHIC DATA PROJECTIONS

LOW CASE

ECONOMIC & DEMOGRAPHIC DATA

VALDEZ AND COPPER RIVER VALLEY

CALENDAR YEAR	VALDEZ POP	COPPER RIVER POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVER EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV)	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day	PetroStar Energy Sales (kWh)
1992	4,326	2,832	7,158	2,247	762	3,009	9,623	13,861	135.2	27,050	27,050	11,404	1.791	2,362,992
1993	4,497	2,987	7,484	2,313	749	3,062	9,711	14,004	138.6	27,449	26,779	25,538	1.683	12,190,880
1994	4,443	2,996	7,439	2,292	737	3,029	9,711	14,004	142.0	27,854	26,511	25,538	1.660	14,585,400
1995	4,390	3,005	7,395	2,272	724	2,996	9,711	14,004	145.6	28,264	26,246	25,538	1.682	18,921,600
1996	4,337	3,014	7,351	2,252	712	2,963	9,711	14,004	149.2	28,681	25,984	25,538	1.612	18,921,600
1997	4,285	3,023	7,308	2,232	700	2,931	9,711	14,004	153.0	29,104	25,724	25,538	1.520	18,921,600
1998	4,234	3,032	7,266	2,212	688	2,899	9,711	14,004	156.8	29,534	25,467	25,538	1.414	18,921,600
1999	4,183	3,042	7,224	2,192	676	2,868	9,711	14,004	160.7	29,969	25,212	25,538	1.307	18,921,600
2000	4,133	3,051	7,183	2,173	665	2,837	9,711	14,004	164.7	30,411	24,960	25,538	1.176	18,921,600
2001	4,083	3,060	7,143	2,153	653	2,807	9,711	14,004	168.8	30,860	24,710	25,538	1.064	18,921,600
2002	4,034	3,069	7,103	2,134	642	2,776	9,711	14,004	173.1	31,315	24,463	25,538	0.980	18,921,600
2003	3,986	3,078	7,064	2,115	631	2,746	9,711	14,004	177.4	31,777	24,219	25,538	0.897	18,921,600
2004	3,938	3,087	7,025	2,096	620	2,717	9,711	14,004	181.8	32,246	23,977	25,538	0.820	18,921,600
2005	3,891	3,097	6,987	2,078	610	2,688	9,711	14,004	186.4	32,721	23,737	25,538	0.745	18,921,600
2006	3,844	3,106	6,950	2,059	600	2,659	9,711	14,004	191.0	33,204	23,499	25,538	0.659	18,921,600
2007	3,798	3,115	6,913	2,041	589	2,630	9,711	14,004	195.8	33,694	23,264	25,538	0.581	18,921,600
2008	3,752	3,125	6,877	2,023	579	2,602	9,711	14,004	200.7	34,191	23,032	25,538	0.521	18,921,600
2009	3,707	3,134	6,841	2,005	569	2,574	9,711	14,004	205.7	34,695	22,801	25,538	0.469	18,921,600
2010	3,663	3,143	6,806	1,887	560	2,447	9,711	14,004	210.9	35,207	22,573	25,538	0.421	18,921,600
2011	3,619	3,153	6,772	1,770	550	2,321	9,711	14,004	216.1	35,726	22,348	25,538	0.421	18,921,600
2012	3,575	3,162	6,738	1,655	541	2,196	9,711	14,004	221.5	36,253	22,124	25,538	0.421	18,921,600
2013	3,532	3,172	6,704	1,540	532	2,072	9,711	14,004	227.1	36,788	21,903	25,538	0.421	0

COMPOUNDED ANNUAL GROWTH RATES:

	VALDEZ POP	COPPER RIVER POPULATION	TOTAL POP	VALDEZ EMP	COPPER RIVER EMPLOYMENT	TOTAL EMP	HDD (VALDEZ)	HDD (GULKANA)	CPI	PER CAPITA INCOME (VLDZ/CRDV)	REAL PER CAP. INCOME	SALMON HARVEST (PWSMA)	ANS PRODUCTION mil bbl/day	PetroStar Energy Sales (kWh)
1992-1997:	-0.19%	1.32%	0.42%	-0.14%	-1.70%	-0.52%			2.50%	1.47%	-1.00%		-3.23%	51.60%
1997-2002:	-1.20%	0.30%	-0.57%	-0.89%	-1.70%	-1.08%			2.50%	1.48%	-1.00%		-8.40%	0.00%
2002-2013:	-1.20%	0.30%	-0.52%	-2.92%	-1.70%	-2.63%			2.50%	1.47%	-1.00%		-7.39%	-100.00%
1992-2013:	-0.96%	0.54%	-0.31%	-1.78%	-1.70%	-1.76%			2.50%	1.47%	-1.00%		-6.66%	-100.00%

COPPER VALLEY ELECTRIC ASSOCIATION
Electric System Load Forecast
Econometric Model Variable Listing

Energy Sales

VRKWHLN	Natural log of Valdez Residential Class Energy Sales (Annual)
VSCKWHLN	Natural log of Valdez Small Commercial Class Energy Sales (Annual)
VLCKWHLN	Natural log of Valdez Large Commercial Class Energy Sales (Annual)
VPSKWHLN	Natural log of Valdez Public Streetlight Class Energy Sales (Annual)
VPBKWHLN	Natural log of Valdez Public Building Class Energy Sales (Annual)
VTKWHLN	Natural log of Valdez Total Classes Energy Sales (Annual)
GRKWHLN	Natural log of Glennallen Residential Class Energy Sales (Annual)
GSCKWHLN	Natural log of Glennallen Small Commercial Class Energy Sales (Annual)
GLCKWHLN	Natural log of Glennallen Large Commercial Class Energy Sales (Annual)
GPSKWHLN	Natural log of Glennallen Public Streetlight Class Energy Sales (Annual)
GPBKWHLN	Natural log of Glennallen Public Building Class Energy Sales (Annual)
GTKWHLN	Natural log of Glennallen Total Classes Energy Sales (Annual)
TLCKWHLN	Natural log of Total Large Commercial Class Energy Sales (Annual)
TLCXTKWHLN	Natural log of Total Large Commercial excluding the Top 15 Customers Energy Sales (Annual)
TKWHLN	Natural log of Total Combined Classes Energy Sales (Annual)

Customer Accounts (i.e., Meters)

VRCUSLN	Natural log of Valdez Residential Customer Accts. (annual average)
VSCCUSLN	Natural log of Valdez Small Commercial Customer Accts. (annual average)
VLCCUSLN	Natural log of Valdez Large Commercial Customer Accts. (annual average)
VPSCUSLN	Natural log of Valdez Public Streetlight Customer Accts. (annual average)
VPBCUSLN	Natural log of Valdez Public Building Customer Accts. (annual average)
VTCUSLN	Natural log of Valdez Total Customer Accts. (annual average)
GRCUSLN	Natural log of Glennallen Residential Customer Accts. (annual average)
GSCCUSLN	Natural log of Glennallen Small Commercial Customer Accts. (annual average)
GLCCUSLN	Natural log of Glennallen Large Commercial Customer Accts. (annual average)
GPSCUSLN	Natural log of Glennallen Public Streetlight Customer Accts. (annual average)
GPBCUSLN	Natural log of Glennallen Public Building Customer Accts. (annual average)
GTCUSLN	Natural log of Glennallen Total Customer Accts. (annual average)

Energy Usage per Customer Account

VRUPCLN	Natural log of Valdez Residential Energy Sales per Customer Account
VSCUPCLN	Natural log of Valdez Small Commercial Energy Sales per Customer Account
VLCUPCLN	Natural log of Valdez Large Commercial Energy Sales per Customer Account
VPSUPCLN	Natural log of Valdez Public Streetlight Energy Sales per Customer Account
VPBUPCLN	Natural log of Valdez Public Building Energy Sales per Customer Account
VTUPCLN	Natural log of Valdez Total Energy Sales per Customer Account
GRUPCLN	Natural log of Glennallen Residential Energy Sales per Customer Account
GSCUPCLN	Natural log of Glennallen Small Commercial Energy Sales per Customer Account
GLCUPCLN	Natural log of Glennallen Large Commercial Energy Sales per Customer Account
GPSUPCLN	Natural log of Glennallen Public Streetlight Energy Sales per Customer Account
GPBUPCLN	Natural log of Glennallen Public Building Energy Sales per Customer Account
GTUPCLN	Natural log of Glennallen Total Energy Sales per Customer Account

Average Revenue per kWh of Energy Sales (i.e., Average Rate)

(Note: Real implies corrected for inflation by CPI Index.)

VRRATLN	Natural Log of Real Valdez Residential Electric Rate (calculated)
VSCRATLN	Natural Log of Real Valdez Small Commercial Electric Rate (calculated)
GRRATLN	Natural Log of Real Glennallen Residential Electric Rate (calculated)
GSCRATLN	Natural Log of Real Glennallen Small Commercial Electric Rate (calculated)
TCRATLN	Natural Log of Real Total Commercial Electric Rate (calculated)

Demographic/Economic/Other Variables

VPOP	Natural Log of Valdez Population (Annual Average)
CRPOP	Natural Log of Copper River Population (Annual Average)
TPOP	Natural Log of Total Area Population (Annual Average)
VEMP	Natural Log of Valdez Total Employment (Annual Average)
CREMP	Natural Log of Copper River Total Employment (Annual Average)
TEMP	Natural Log of Total Area Employment (Annual Average)
PCY	Natural Log of Estimated per Capita Income for Valdez/Cordova Area
CPI	Natural Log of Anchorage Consumer Price Index without Shelter
RPCY	Natural Log of Real per Capita Income (PCY adjusted by CPI)
VHDD	Natural Log of Valdez Heating Degree Days (Annual)
GHDD	Natural Log of Gulkana Heating Degree Days (Annual)
SALHARV	Natural Log of Total Commercial Salmon Harvest, Prince William Sound
ANSPROD	Natural Log of Millions of Barrels per Day Produced by the Alaska North Slope
DUM89	Dummy Variable for 1989
DUM89	Dummy Variable for 1989 and 1990
YEAR	Year

(Note: CVEA data is maintained on a January 1 to December 31 calendar year basis. All variables have been adjusted to correspond to this time period.)

LS // Dependent Variable is VRCUSLN
Date: 10-12-1993 / Time: 10:53
SMPL range: 1980 - 1992
Number of observations: 13

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	1.2012986	0.6847911	1.7542557	0.1099
VPOP	0.7158322	0.0837455	8.5477067	0.0000
DUM89	0.1051328	0.0345252	3.0451023	0.0124

R-squared	0.881447	Mean of dependent var	7.057084
Adjusted R-squared	0.857736	S.D. of dependent var	0.085649
S.E. of regression	0.032305	Sum of squared resid	0.010436
Log likelihood	27.88212	F-statistic	37.17522
Durbin-Watson stat	1.201906	Prob(F-statistic)	0.000023

```
==========================================================================
              Residual Plot                obs  RESIDUAL   ACTUAL   FITTED
==========================================================================
|           :       |    *  :          | 1980  0.02055  6.97167  6.95112
|           :       |       :         *| 1981  0.06000  7.05618  6.99617
|           :      *|       :          | 1982 -0.00307  7.07918  7.08225
|   *       :       |       :          | 1983 -0.06531  7.01481  7.08012
|           :*      |       :          | 1984 -0.02702  6.99256  7.01958
|           :    *  |       :          | 1985 -0.01125  6.98317  6.99442
|           :  *    |       :          | 1986 -0.01874  6.97393  6.99267
|           :     * |       :          | 1987 -0.00772  6.99041  6.99813
|           :       |  *    :          | 1988  0.01365  7.01721  7.00355
|           :       *       :          | 1989 -1.4E-17  7.09230  7.09230
|           :       |  *    :          | 1990  0.01259  7.16311  7.15051
|           :       |*      :          | 1991  0.00365  7.19036  7.18671
|           :       |     * :          | 1992  0.02266  7.21720  7.19454
==========================================================================
```

```
LS // Dependent Variable is VRUPCLN
Date: 10-12-1993 / Time: 10:55
SMPL range: 1981  -  1992
Number of observations: 12
```

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	4.3934525	2.2998367	1.9103324	0.0925
VRUPCLN(-1)	0.4934919	0.1138851	4.3332427	0.0025
VRRATLN	-0.2262485	0.0778397	-2.9065958	0.0197
VHDD	0.0876054	0.2002460	0.4374890	0.6733

R-squared	0.862397	Mean of dependent var	8.932236
Adjusted R-squared	0.810795	S.D. of dependent var	0.054893
S.E. of regression	0.023877	Sum of squared resid	0.004561
Log likelihood	30.22358	F-statistic	16.71269
Durbin-Watson stat	1.733705	Prob(F-statistic)	0.000832

```
========================================================================
              Residual Plot                  obs RESIDUAL  ACTUAL   FITTED
========================================================================
|          :        |*       :         | 1981  0.00160  8.80087  8.79927
|          : *      |        :         | 1982 -0.01962  8.85917  8.87879
|          :        |     *  :         | 1983  0.01515  8.92884  8.91369
|          :        |     *  :         | 1984  0.01522  8.98826  8.97304
|          :        |      * :         | 1985  0.01818  8.98607  8.96789
|          :        | *      :         | 1986  0.00532  8.95373  8.94841
|          :     *  |        :         | 1987 -0.00713  8.92327  8.93041
|          :     *  |        :         | 1988 -0.00709  8.91755  8.92464
|          :        |        :      *  | 1989  0.04188  8.98290  8.94102
|          :  *     |        :         | 1990 -0.01561  8.96282  8.97843
|          :  *     |        :         | 1991 -0.01664  8.94732  8.96396
|       *  :        |        :         | 1992 -0.03126  8.93602  8.96729
========================================================================
```

LS // Dependent Variable is GRUPCLN
Date: 10-19-1993 / Time: 13:11
SMPL range: 1980 - 1992
Number of observations: 13

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	9.4379162	0.1756665	53.726341	0.0000
GRRATLN	-0.3001454	0.0548993	-5.4671966	0.0002

R-squared	0.730987	Mean of dependent var	8.478163
Adjusted R-squared	0.706531	S.D. of dependent var	0.043000
S.E. of regression	0.023294	Sum of squared resid	0.005969
Log likelihood	31.51390	F-statistic	29.89024
Durbin-Watson stat	2.441587	Prob(F-statistic)	0.000196

```
=========================================================================
              Residual Plot                    obs RESIDUAL  ACTUAL   FITTED
=========================================================================
|          :     *  |        :         | 1980 -0.00760 8.41748 8.42508
|          :        *        :         | 1981  0.00095 8.40012 8.39918
|          :        |   *    :         | 1982  0.00942 8.46651 8.45709
|   *      :        |        :         | 1983 -0.03954 8.42899 8.46854
|          :        |       *:         | 1984  0.02046 8.51472 8.49425
|          :        |        :      *  | 1985  0.03882 8.50505 8.46622
|          :    *   |        :         | 1986 -0.00964 8.46385 8.47349
|          :        |       *:         | 1987  0.01947 8.49833 8.47885
|         *:        |        :         | 1988 -0.02418 8.46231 8.48649
|          *        |        :         | 1989 -0.02170 8.48543 8.50713
|          :        |        :*        | 1990  0.02528 8.54177 8.51649
|          :        *        :         | 1991  0.00106 8.51811 8.51705
|          :   *    |        :         | 1992 -0.01280 8.51345 8.52626
=========================================================================
```

LS // Dependent Variable is VSCKWHLN
Date: 10-12-1993 / Time: 10:57
SMPL range: 1980 - 1992
Number of observations: 13

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	10.997718	1.2750310	8.6254518	0.0000
VEMP	0.6335839	0.1378553	4.5960051	0.0010
TCRATLN(-1)	-0.1613899	0.1429910	-1.1286719	0.2854

R-squared	0.762197	Mean of dependent var	15.32800
Adjusted R-squared	0.714636	S.D. of dependent var	0.121280
S.E. of regression	0.064787	Sum of squared resid	0.041974
Log likelihood	18.83555	F-statistic	16.02577
Durbin-Watson stat	2.717740	Prob(F-statistic)	0.000760

```
===============================================================================
               Residual Plot                   obs RESIDUAL  ACTUAL   FITTED
===============================================================================
|            :*       |        :           | 1980 -0.05664  15.1780  15.2347
|            :        |        :    *      | 1981  0.09594  15.3464  15.2505
|            :*       |        :           | 1982 -0.05361  15.2061  15.2597
|            :        |        *           | 1983  0.05966  15.3425  15.2829
|            :  *     |        :           | 1984 -0.03563  15.2867  15.3223
|            :        |   *    :           | 1985  0.02954  15.3433  15.3137
|            :        |        *           | 1986  0.06006  15.2909  15.2309
|            :        |*       :           | 1987  0.00747  15.2500  15.2425
|   *        :        |        :           | 1988 -0.12245  15.1484  15.2708
|            :        *        :           | 1989  0.00108  15.5830  15.5819
|            :       *|        :           | 1990 -0.00423  15.4187  15.4229
|            :        |    *   :           | 1991  0.04207  15.4549  15.4128
|            :     *  |        :           | 1992 -0.02326  15.4152  15.4384
===============================================================================
```

LS // Dependent Variable is VPBKWHLN
Date: 10-12-1993 / Time: 11:00
SMPL range: 1984 - 1992
Number of observations: 9

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	7.8974732	1.3873734	5.6923920	0.0013
VEMP	0.2688922	0.0664161	4.0485971	0.0067
RPCY	0.3378168	0.1690507	1.9983167	0.0926

R-squared	0.921962	Mean of dependent var	13.37627
Adjusted R-squared	0.895949	S.D. of dependent var	0.067195
S.E. of regression	0.021675	Sum of squared resid	0.002819
Log likelihood	23.53854	F-statistic	35.44280
Durbin-Watson stat	2.902209	Prob(F-statistic)	0.000475

```
======================================================================
              Residual Plot                  obs RESIDUAL  ACTUAL   FITTED
======================================================================
|       :          *|          :      | 1984 -0.00136  13.3174  13.3188
|       :           |*         :      | 1985  0.00124  13.3608  13.3595
|       :   *       |          :      | 1986 -0.01443  13.3116  13.3260
|       :  *        |          :      | 1987 -0.01638  13.2990  13.3154
|       :           |          : *    | 1988  0.02508  13.3610  13.3359
|       :   *       |          :      | 1989 -0.01405  13.4998  13.5139
|       :           |     *    :      | 1990  0.01357  13.4147  13.4012
|       *           |          :      | 1991 -0.02241  13.3732  13.3956
|       :           |          :   *  | 1992  0.02874  13.4489  13.4202
======================================================================
```

Section IX

POWER SUPPLY EVALUATION

A. OVERVIEW

Presently, CVEA's primary source of power supply is hydroelectric power from the Solomon Gulch Hydroelectric Project (the "Solomon Gulch Project") owned by the State of Alaska. Diesel generators and an oil-fired combustion turbine provide the balance of CVEA's generation and reserve requirements. CVEA provides electric service to the communities of Valdez and the Copper Basin, which includes the town of Glennallen. The Copper Basin load center is referred to as Glennallen in this section and in Section X of this report. These service districts are interconnected by a 106 mile-long 138-kV transmission line owned by the State of Alaska and operated and maintained by CVEA under a long-term contract with the State.

As previously described in this report, the proposed Intertie consists of an approximately 135 mile-long 138-kV transmission line connecting CVEA to the systems of the electric utilities in Alaska's Railbelt. The Intertie would provide CVEA access to generation from the Anchorage area utilities to offset the use of CVEA's diesel generation, and reduce the need to build additional generating resources in the CVEA area. In the future, the Intertie would expand the territory in which generating resources could be developed to supply additional energy to the entire Railbelt region.

To determine the cost-effectiveness of the Intertie, an economic evaluation was prepared to compare the lifecycle power supply costs for CVEA with the Intertie to the lifecycle power supply costs with other power supply alternatives available to CVEA. In evaluating the lifecycle power supply costs, only the costs that are subject to change from case to case are included, e.g., the fixed costs of depreciation of CVEA's existing generating units, and costs associated with purchased power from the Solomon Gulch Project, are not included.

This section of the report provides a description of the various power supply alternatives and the assumptions used in the economic analysis. The alternative power supply resources identified for CVEA include two hydroelectric projects, diesel generation, and a coal-fired generating plant. CVEA could also implement demand-side management (DSM) or conservation measures to reduce demand and energy requirements. Various conservation measures have been identified for CVEA and are included in the analysis as a separate "Conservation Case."

A description of CVEA's existing system and CVEA's planning reserve criteria are discussed first followed by a presentation of future power supply needs based on the results of the load forecast included in Section VIII of this report. CVEA's reserve planning criteria are applied in the derivation of future power supply needs. Descriptions of the alternative resources identified for CVEA's future power supply requirements are provided including the expected capacity and energy from each resource, and the capital costs and operating and maintenance costs for each resource. Reports previously prepared for CVEA and the Authority were relied on for the costs and operating characteristics for the alternative hydroelectric projects. The costs and operating characteristics for the coal-fired generating project are based primarily on information provided by the project's private developer; however, the cost estimates have been reviewed as a part of this study and were adjusted as deemed appropriate to reflect the expected development cost.

B. CVEA'S EXISTING POWER SUPPLY SYSTEM

CVEA's primary source of power generation is the Solomon Gulch Project. Diesel generators located in each of the service districts and a combustion turbine located in Valdez provide the balance of CVEA's generation and reserve requirements.

1. Solomon Gulch Project

The Solomon Gulch Project became operational in 1982 and is owned by the State of Alaska and operated by CVEA, under a long-term contract with the State. All of the output from this project is sold to CVEA. The project consists of two Francis-type turbines with a nominal rating of 6,000 kW each. The Solomon Gulch Project has limited storage capability, and historically, energy production in the winter and early spring has been limited due to very low inflows to the reservoir during the winter. At the same time, inflows to the reservoir from melting snows in the late spring and summer coupled with summer precipitation have in the past exceeded CVEA's power needs and water has been spilled from the project reservoir in the summer months. With increasing power requirements in the summer months, CVEA will be able to more fully utilize the energy generation capability of the Solomon Gulch Project. The historical energy generation and estimated spill energy for the Solomon Gulch Project as provided by CVEA is summarized below:

Table IX-1
Solomon Gulch Hydroelectric Project
Estimated Available Energy Generation

Year	Spill Days	Estimated Spill Energy (kWh)	Annual Energy Generation (kWh)	Total Available Energy (kWh)
1987	103	15,015,868	42,440,000	57,455,868
1988	104	15,161,653	40,843,679	56,005,332
1989	100	14,578,512	39,600,000	54,178,512
1990	95	13,849,587	46,262,000	60,111,587
1991	43	6,268,760	39,634,000	45,902,760
1992	68	9,913,388	40,880,000	50,793,388

Based on CVEA's historical operation of the Solomon Gulch Project, the annual generation available from the project provides most of CVEA's energy requirements for nine to ten months of the year. Late in the winter season, the reservoir is exhausted and diesel generation is required to provide CVEA's energy requirements until the spring water run-off from snow melt begins. As CVEA's energy requirements increase, the project would potentially run out of water earlier in the winter and more diesel generation would be expected to be required, especially in the late winter. CVEA has indicated that the current dispatching method for Solomon Gulch may be modified and a minimum water level may be maintained throughout the winter and spring in the reservoir for reserves.

Based on historical stream flow data, the total annual gross generation available from the Solomon Gulch Project is estimated by the Authority to be 54,500 MWh for an average water year. This annual generation value includes approximately 25,900 MWh of generation during the winter period (October through May) and approximately 28,600 MWh of generation during the summer period (June through

September). During the summer period, the maximum gross generating capacity of the Solomon Gulch Project is assumed to be 12 MW. The maximum gross generating capacity is assumed to be reduced to 5 MW during the winter season, based on maintaining a minimum water level of 620 feet in the reservoir. Although CVEA has not typically operated the Solomon Gulch Project so that it is available to provide firm capacity throughout the winter, it is expected that in the future the reservoir will not be drawn down completely each winter as it has been in the past. Transmission losses from the Solomon Gulch Project to CVEA's electric system in Valdez and station use are assumed to be 2.5% and 1%, respectively, of total annual generation.

Power is sold from the Solomon Gulch Project to CVEA pursuant to a contract called the Four Dam Pool Power Sales Agreement. This contract also applies to the sales of power from three other State-owned hydroelectric projects. The cost of the Solomon Gulch Project output to CVEA includes both a debt service component and an operations and maintenance (O&M) component. The O&M component is adjusted annually to reflect actual O&M costs while the debt service component remains constant except for periodic changes as identified in the contract. Since the cost of power from the Solomon Gulch Project to CVEA is the same for all of the alternative resource plans evaluated as part of this analysis and CVEA is obligated to use the output of the Solomon Gulch Project prior to the use of any other resource, the cost of power from the Solomon Gulch Project is not included in this analysis.

With the Intertie, any surplus generation available from the Solomon Gulch Project could be sold to the Railbelt utilities. For the purpose of this analysis, the estimated surplus energy capability of the Solomon Gulch Project is assumed to be sold to utilities other than CVEA. This surplus energy will most likely reduce thermal generation in the Anchorage area. Consequently, the power is assumed to be valued at a rate equivalent to the economy energy rate discussed under the Intertie section below.

2. Existing Diesel Generation Capacity

CVEA currently has 14,500 kW of diesel generation installed, including 8,600 kW located at the Valdez Diesel plant and 5,900 kW located at the Glennallen Diesel plant. The type of units include several models of diesel generators and one oil-fired combustion turbine, all of which are fueled with #2 diesel fuel. Units 6 and 7 in Glennallen had until recently used #4 fuel, a heavier grade oil. Selected operating characteristics and the on-line dates for the units are summarized below:

Table IX-2
CVEA Generating Resources
Valdez Plant

Unit Name	Capacity Rating (kW)	Operating Capacity (kW)	Fuel Efficiency (kWh/gal)	On-line Date
Unit 1: Fairbanks Morse	600	500	12.3	1966
Unit 2: Fairbanks Morse	600	500	12.3	1966
Unit 3: Fairbanks Morse	600	500	12.3	1966
Unit 4: Enterprise	1700	1500	14.9	1972
Unit 5: Enterprise	2500	2200	13.9	1975
Unit 6: Enterprise	950	900	13.6	1975
Unit 7: Solar Turbine	2800	2500	8.0	1976

Table IX-3
CVEA Generating Resources
Glennallen Plant

Unit Name	Capacity Rating (kW)	Operating Capacity (kW)	Fuel Efficiency (kWh/gal)	On-line Date
Unit 1: Fairbanks Morse	300	Out of Service	--	1959
Unit 2: Fairbanks Morse	300	Out of Service	--	1959
Unit 3: Fairbanks Morse	600	500	12.2	1963
Unit 4: Fairbanks Morse	600	500	12.5	1966
Unit 5: Fairbanks Morse	600	500	12.5	1966
Unit 6: Enterprise	2500	2200	14.5	1975
Unit 7: Enterprise	2500	2200	13.3	1975

The variable operating and maintenance costs for CVEA's existing diesel generators are estimated as 3.0 cents per kWh (in 1993 dollars), based on information provided by CVEA. Fixed operating and maintenance costs for the units include capital recovery costs and labor related costs. The capital recovery costs for the existing plants are assumed not to change with the various alternative resource plans, and therefore are not included in the analysis. The labor related costs will vary depending on how the diesel generating facilities are operated. Operation of the diesel facilities to provide base load generation will require that CVEA maintains at least its existing staff level. However, if the facilities are operated on a standby basis, CVEA could reduce its current staffing levels.

CVEA's annual labor costs are estimated to decrease by $560,000 per year if the diesel units are used for standby purposes only, as would be the case if the Intertie were to be constructed. This assumes that the existing diesel operations and maintenance staffing level is reduced from 3 employees in Valdez and 6 employees in Glennallen to 1.5 employees per site. The average cost per employee in Glennallen is $94,000 per year and the average cost per employee in Valdez is $97,000 per year based on CVEA's 1993 payroll budget. Presently, CVEA has a staff of three operators at its Valdez diesel plant, a staff size sufficient only for day time operation of the plant. It is assumed that if significant levels of diesel generation are needed in Valdez, as is required if the Intertie is not constructed, a night shift of three operators will be added.

Based on CVEA's August 1992 generation report, all of the units are in excellent to good condition, except for the two Fairbanks Morse units, Units 1 and 2, at Glennallen which are no longer operational. Most of the generating units are over 20 years old and require major overhauls every 15,000 hours of operation. CVEA has indicated that the retirement of units will depend on the cost of replacement. A separate evaluation of the expected life of these units was not included as part of this study; however, based on discussions with CVEA staff, it is assumed that the diesel generating units will be replaced in the future rather than overhauled if a major overhaul is projected to be required during the study period.

Currently, CVEA is not required to limit the operation of the existing diesel units for pollution control purposes. As described below, new diesel generators are expected to be operated to limit air pollution emissions pursuant to current regulations. In addition, the new diesel generators are projected to generate the majority of CVEA's diesel generation once they are installed. It is expected that the existing diesel generators will be required to limit air pollution emissions at some time in the future, using techniques subsequently described for the new diesel generators.

C. PLANNING RESERVE CRITERIA

The planning reserve criteria for CVEA's system is an important assumption in this analysis. CVEA is currently an isolated system, with its two load districts interconnected by a 106 mile transmission line. This transmission line crosses over Thompson Pass and is subject to avalanche danger which has caused two major outages in its ten-year life. The most recent long-term outage on the line occurred in December 1988 and lasted nine months. Because of the possibility of an outage of the transmission line, CVEA's two load districts must maintain sufficient generation capacity to provide for their own power requirements. In addition, the potentially long outage time of the existing transmission line necessitates that CVEA maintain generation reserves in each load center. It is important to note that the firm generation capacity of the Solomon Gulch Project is limited by water availability during the winter and is estimated to be 5,000 kW under operating conditions assumed to be implemented by CVEA. With the Intertie and other resource alternatives, except diesel, CVEA is assumed to be able to increase the firm winter capacity of the Solomon Gulch Project to 6,500 kW. Each of the two Solomon Gulch Project turbine generators is capable of generating approximately this amount of power, consequently, the Solomon Gulch Project provides its own backup under peak load conditions.

With the Intertie, the Glennallen load center will be interconnected to both Valdez and the Railbelt utilities. It is still assumed that Glennallen would maintain sufficient diesel generation capacity to meet its full load but it will not be necessary under these circumstances to have surplus generation capacity in Glennallen. In the event of an outage of the existing CVEA transmission line and the unavailability of one of the diesel generating units in Glennallen, CVEA would rely upon power purchases over the Intertie to supply Glennallen power requirements. The planning reserve criteria for each load center is summarized in the following table.

Table IX-4
Generation Reserve Criteria

Load District	With Intertie	Without Intertie
Valdez	Peak Load plus Largest Generating Unit	Peak Load plus Largest Generating Unit
Glennallen	Peak Load	Peak Load plus Largest Generating Unit

The actual level of reserve capacity required for the CVEA system depends on the resource mix and the location of the resources. The Intertie could provide generation reserves to Glennallen depending on the purchase arrangement. However, any new generation located at Glennallen (including the Intertie) will not provide any additional capacity reserves for Valdez because of the possibility of a transmission outage between Glennallen and Valdez. Similarly, any new generation located in Valdez will not provide reserves for Glennallen.

D. PROJECTED POWER SUPPLY REQUIREMENTS

The peak load requirements as compared to the existing generation resources for the peak load period, which occurs in the winter, is summarized in Figure IX-1 below for Valdez and in Figure IX-2 for Glennallen. The three load growth alternatives, high, medium and low, shown in Figure IX-1 represent the load projections provided in Section VIII of this report plus the generation reserve requirement for each load district. The reserve requirements are based on providing backup for the largest diesel generator located at each load district, specifically 2,200 kW in Valdez and 2,200 kW in Glennallen. As shown in Figure IX-1, CVEA has sufficient reserves in the Valdez area for the medium and low projected levels of load growth. If CVEA experiences the projected high load growth, CVEA will need to add additional capacity in Valdez in 2002. As shown in Figure IX-2, Glennallen does not currently have sufficient generation capacity to supply its peak load requirement and maintain necessary backup generation.

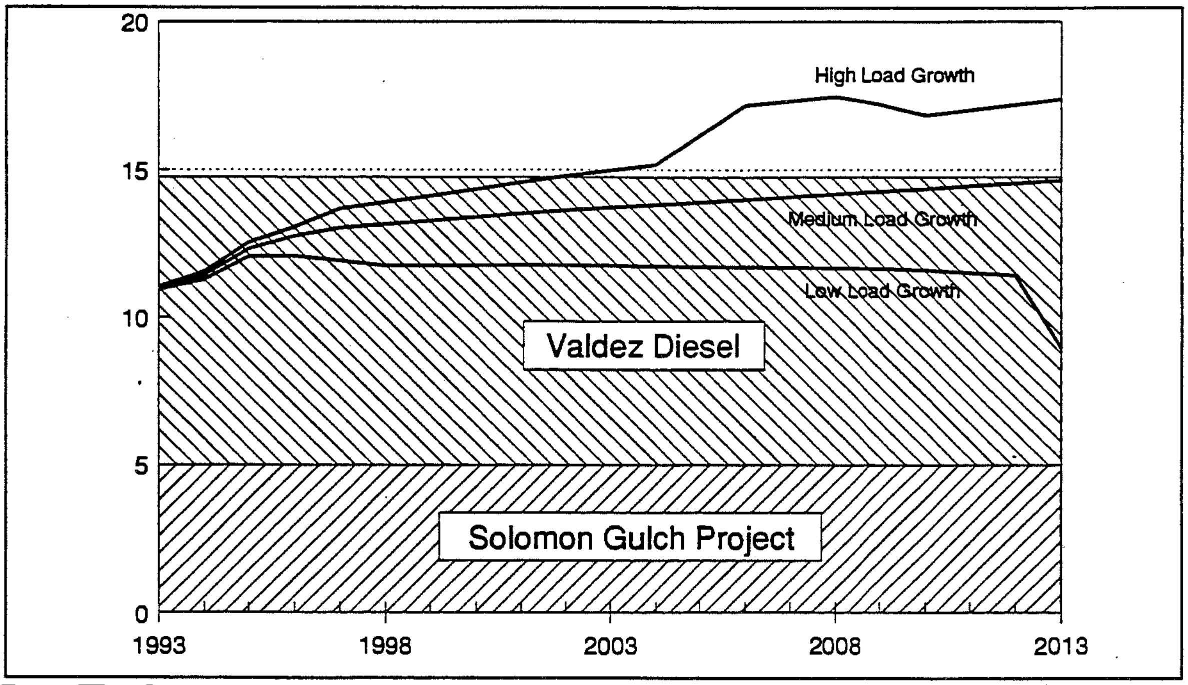


Figure IX-1: Peak Load Requirements and Existing Generation Capacity
Valdez Load Center, Winter Peak (MW)

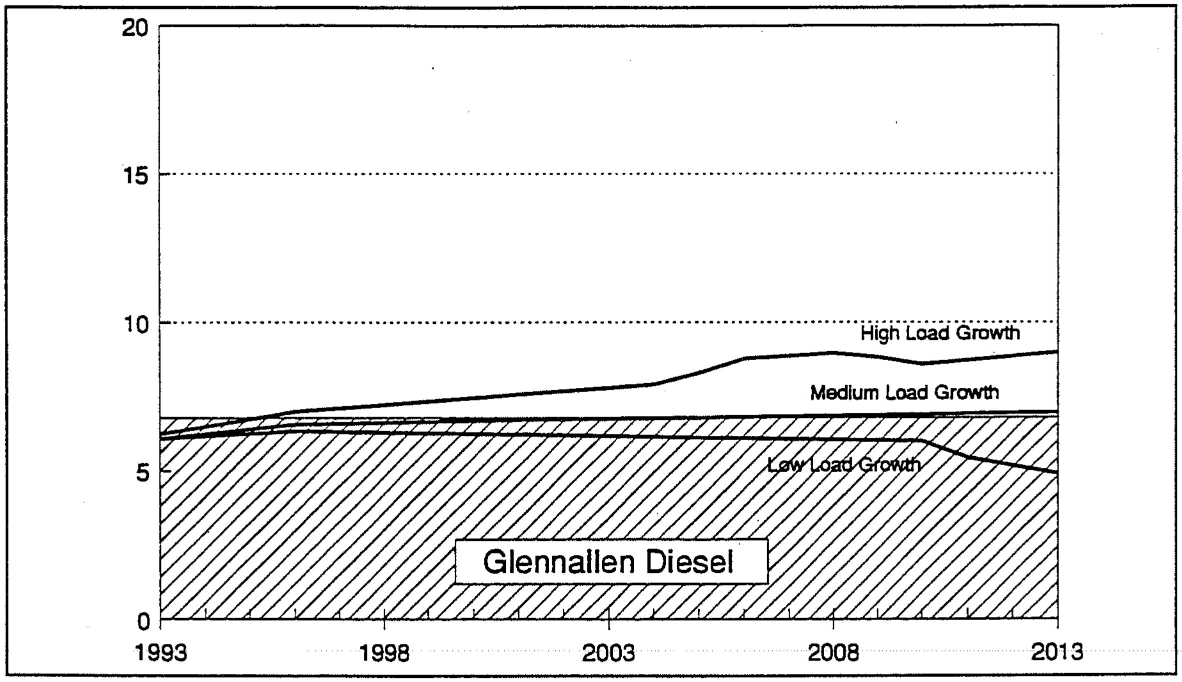


Figure IX-2: Peak Load Requirements and Existing Generation Capacity
Glennallen Load Center, Winter Peak (MW)

CVEA's energy requirements were separated into two periods based on typical hydroelectric generation availability. The winter period includes the eight months October through May and the summer period includes the four months June through September. The projected annual energy requirements for CVEA were allocated to these two periods based on a 70% and 30% split for the winter and summer seasons, respectively, as typically experienced by CVEA in the past. The energy resources projected to supply CVEA's total system energy requirements, without the Intertie or any other alternative resources, are summarized in Figure IX-3 for the winter period and in Figure IX-4 for the summer period. As shown in Figure IX-3, diesel generation is required during the winter period for all three of the load forecasts. During the summer period, the Solomon Gulch Project is projected to have surplus energy available under the medium and low load growth projections. The Solomon Gulch Project is projected to be fully utilized by 1999 under the high load growth projection, and additional diesel generation is projected to be required at that time.

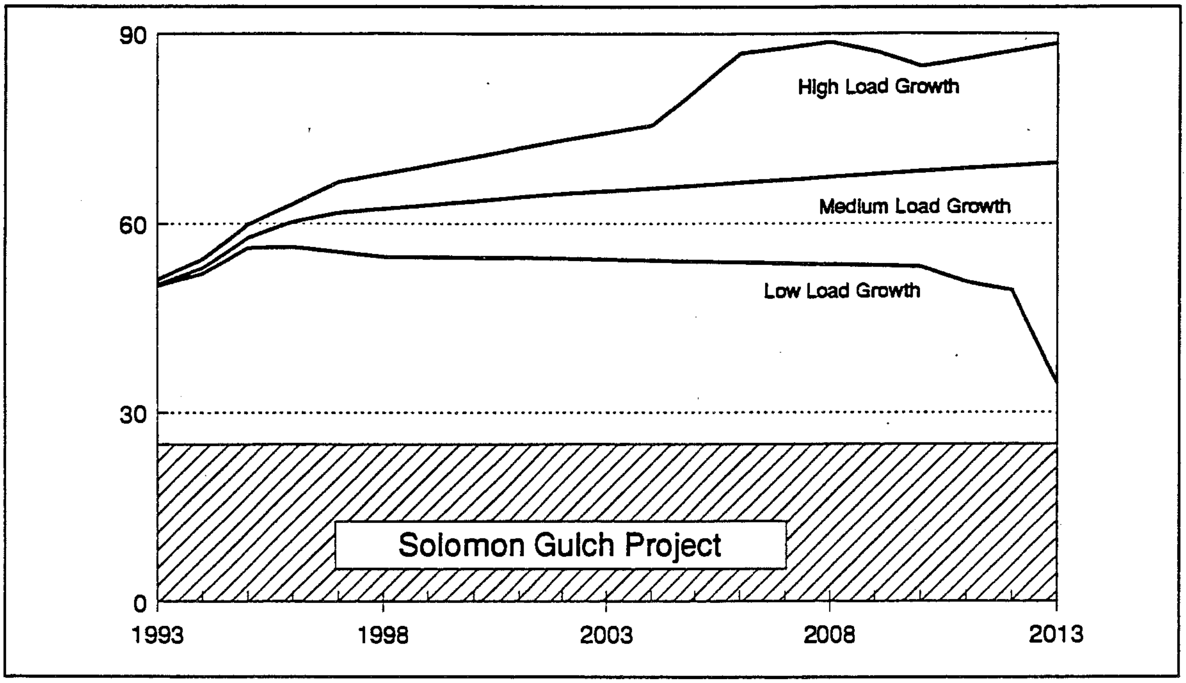


Figure IX-3: Projected Energy Requirements and Resources, Winter Period (MWh 000)

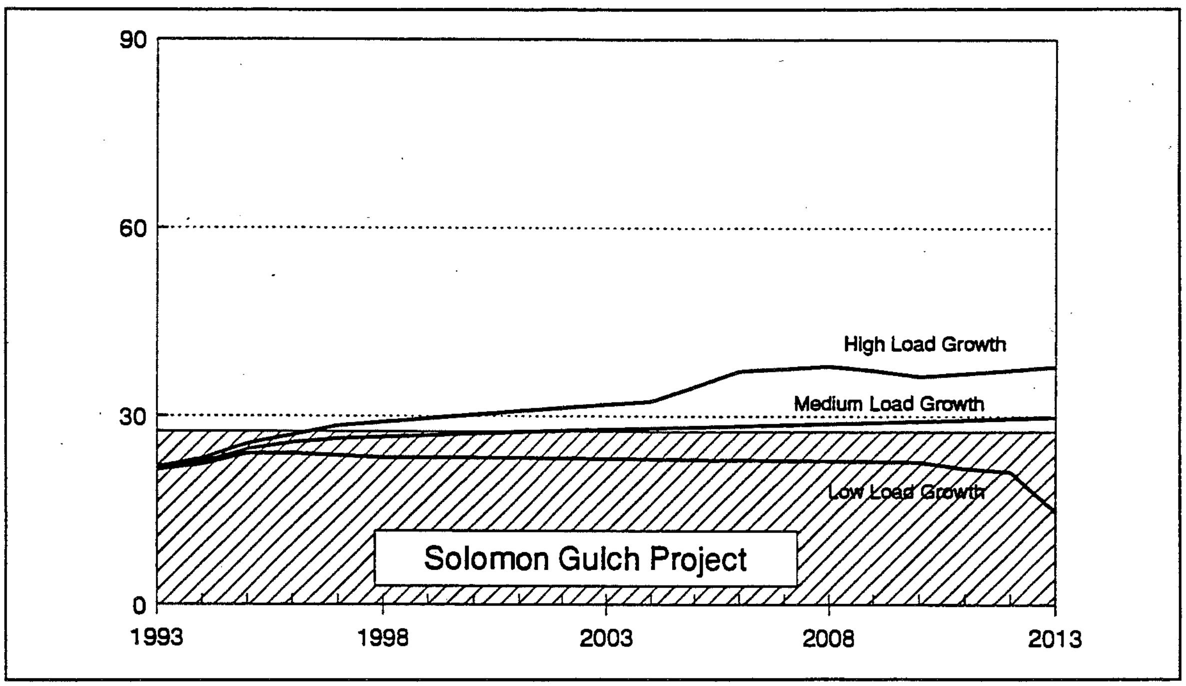


Figure IX-4: Projected Energy Requirements and Resources, Summer Period (MWh 000)

E. USE OF THE INTERTIE

The Intertie will connect the isolated CVEA electric system to the Railbelt utilities. CVEA will most likely purchase energy from the Railbelt utilities and offset its own diesel generation. Additionally, the Intertie would provide a market for CVEA's surplus hydroelectric generation and in the future could allow the Railbelt utilities to participate in the development and the use of cost effective generating resources which may be located near CVEA's electric system. In the event that electricity requirements in CVEA's system increase significantly in the future, CVEA may be able to avoid the cost of installing new base load generating facilities by purchasing power from the Railbelt utilities. CVEA will not need to replace its existing diesel generators in the near future if the Intertie is installed since these generators will be used only if interruptions occur in the delivery of power from the Railbelt utilities.

There are several possible arrangements to purchase power from the Anchorage area that can be envisioned for CVEA although power will most likely be purchased from either Chugach Electric Association (CEA) or Anchorage Municipal Light & Power (ML&P), the two largest power producers in the Railbelt region. Economy energy could be purchased to offset diesel energy generation. This type of purchase is assumed to be similar to that made by the Golden Valley Electric Association (GVEA) and would be on a non-firm basis, i.e. if immediate power needs in the Anchorage area were high or a generating unit went down in the Anchorage area the purchase could be curtailed. Economy energy sold to GVEA is generally considered to be surplus generation by CEA and ML&P and is usually priced at a rate that recovers the cost of fuel and variable operations and maintenance costs plus a small margin. It is not known whether or not power will continue to be available to CVEA at economy energy rates once the power requirements of CEA's and ML&P's own customers increase to fully utilize the installed generation capacity these two utilities presently have.

Fixed energy and capacity purchases may be arranged whereby CVEA could expect to have the power it purchases from CEA or ML&P available at all times. This type of contract arrangement would require CVEA to pay a rate that includes all allocated fixed and variable costs for the amount purchased, including capital recovery costs for the generating resources used to generate the power. Fixed power purchases from CEA or ML&P would probably be priced at a rate similar to what Matanuska Electric Association and the City of Seward presently pay for power purchased from CEA.

For the purpose of this analysis, an economy energy purchase was assumed to be made by CVEA and estimated to include only the variable cost of generation. The projected cost of economy energy is based on the provisions of the economy energy sales agreement between GVEA and CEA and includes only the cost of fuel and no operating margin for CEA. The estimated price of this energy is estimated to be 2.35 cents per kWh in 1993. In the future, the fuel cost component of economy energy is estimated to increase at the same level of increase assumed in this report for oil fuel prices. Although CEA and ML&P both use natural gas as their primary generation fuel, the gas prices paid by ML&P and CEA are adjusted by contract relative to oil prices.

Table IX-5
Projected Cost of Power from CEA(1)
(1993 cents per kWh)

	Fuel Price(2)	O&M Component (3)	Margin(4)	Total
1999	2.41	0.17	0.00	2.59
2000	2.45	0.17	0.00	2.63
2001	2.50	0.17	0.00	2.67
2002	2.54	0.17	0.00	2.71
2003	2.58	0.17	0.00	2.76
2004	2.63	0.17	0.00	2.80
2005	2.67	0.17	0.00	2.85
2006	2.72	0.17	0.00	2.89
2007	2.77	0.17	0.00	2.94
2008	2.81	0.17	0.00	2.99
2009	2.86	0.17	0.00	3.04
2010	2.91	0.17	0.00	3.09
2011	2.96	0.17	0.00	3.14
2012	3.01	0.17	0.00	3.19
2013	3.07	0.17	0.00	3.24

(1) Based on provisions similar to those identified in the contract for the sale of economy energy by CEA to GVEA which is currently in effect.
(2) Includes base fuel cost, taxes and royalties. Base fuel costs are adjusted relative to changes in fuel oil prices. Assumes fuel prices increase at the high fuel cost escalation.
(3) Estimated operations and maintenance component.
(4) The margin is not included in this analysis since it represents a transfer between CVEA and CEA rather than a net increase in Alaska costs. These costs will not change as a result of a sale of economy energy to CVEA.

Transmission losses for power generated in the Anchorage area and delivered to CVEA's electric system in Glennallen are estimated to be approximately 9.7% of the amount generated. These losses are 5.0% on CEA's transmission system, 2.0% on the MEA system, and 3.0% over the Intertie. CEA indicates that it typically includes in its power sales contracts an allowance of 5% for transmission losses over its transmission system regardless of the source of generation and the point of delivery. No wheeling costs are included in the economic analysis for the energy transmitted over the CEA or MEA transmission systems since these costs represent fixed operating costs of CEA and MEA that do not vary with or without the Intertie.

Surplus Solomon Gulch Project energy generation, if it is projected to be available, is assumed to be sold to the Anchorage area at a rate equivalent to the assumed economy energy rate.

F. ALTERNATIVE RESOURCE OPTIONS TO MEET FUTURE CVEA POWER SUPPLY NEEDS

Three types of generating resources have been identified for CVEA to meet future load growth as an alternative to constructing the Intertie. These resources include new diesel generators, two hydroelectric facilities located near Valdez, and a coal-fired generating plant to be located in Valdez. In addition, CVEA could implement certain conservation programs to reduce its power requirements. The following provides a description of these resource alternatives.

1. New Diesel Generation

Diesel generators have been used to provide reserve and generating requirements for isolated communities throughout Alaska. Diesel generators typically require relatively low initial capital investment, however, the price of fuel for diesel generators is subject to the price volatility of fuel costs and transportation costs. Diesel generation also negatively impacts air quality by the combustion of diesel fuel which produces various air pollutants.

For the purpose of this analysis, the costs and operating characteristics for new diesel generating units are based on the 1,650 kW and the 2,200 kW Caterpillar, 3600 series diesel engines. The largest diesel unit that CVEA currently owns and operates is 2,200 kW. It is assumed that CVEA would not add diesel units larger than this. Although, the cost of installation per unit of output is lower for larger units, smaller units allow more flexibility in meeting incremental load growth. Also, relying on larger units to serve load could increase the required reserve capacity for the CVEA system.

The capital cost of a new diesel generator in 1993 dollars is assumed to vary between $940 per kW for a 1,650 kW unit and $820 per kW for a 2,200 kW unit. The costs of new diesel generators summarized in the following table are based on estimates provided by vendors.

Table IX-6
Estimated Costs for New Diesel Generators
(1993 Dollars)

	Series 3606	Series 3608
Continuous Capacity Rating, kW	1,650	2,200
Net Output, kW	1,610	2,150
Cost Estimate		
Engine Generator Set......................	$830,060	$991,375
Cooling Components	50,930	67,540
Exhaust Components	10,230	12,210
Air Start Components	26,400	26,400
Fuel System Components	27,500	27,500
Station Battery Components............	7,700	7,700
Switch Gear Components................	110,000	110,000
Total Equipment..........................	$1,062,820	$1,242,725
Permitting, Site Preparation,		
Engineering and Installation (24%)	$255,077	$298,254
Delivery (3%)	31,885	37,281
Contingency (15%)............................	159,423	186,409
Total Cost Estimate............................	$1,509,205	$1,764,669
Cost per Unit of Output ($/kW)...........	937	821

The variable operating and maintenance costs including lube oil costs for new diesel generators are estimated to be $.01 per kWh and fixed operating costs, including labor, are assumed to be $12.00 per kW per year, both in 1993 cost levels. New diesel generators are estimated to operate at a fuel efficiency of 16.0 kWh per gallon, which has been adjusted to account for a less efficient heat rate because of timing retardation as is subsequently discussed.

Based on discussions with CVEA, it is assumed that one additional diesel generator unit could be added to the existing Glennallen power plant. The addition of more than one unit at the Glennallen site would require the construction of a new building to house the additional units or generating units presently in place would need to be removed. The addition of any units to the Valdez site would require the construction of a new building to house the units. The cost of a new building is assumed to be $500,000. A new building constructed at either site is assumed to be constructed to a sufficient size to house all additional units required at the site. A detailed evaluation of the need for additional fuel storage tanks or improvements needed for switching gear with new diesel generators has not been conducted as part of this study; however, provisions for these additions and improvements are included in the analysis based on assumed costs for typical equipment needs. The assumed cost for a 300,000 gallon storage tank which may be needed in Valdez in the future if more diesel generation is required, is $1.5 million. An allowance of $550,000 for substation and other improvements is included if diesel generation is expanded.

Although CVEA's current operation of its existing diesel generation units does not include any pollution control measures, it is assumed that new diesel units will trigger Prevention of Significant

Deterioration (PSD) review and the associated best available control technology (BACT) for pollution control, especially for the emission of nitrous oxides (NOx). There are several types of pollution control and it is currently not known what type will be required as BACT determinations are made on a case-by-case basis. The production of NOx in a diesel engine is primarily a function of the combustion temperature. One method to control the emission of NOx involves delaying the ignition timing to reduce the peak firing pressure and temperature. Since the efficiency of the unit is also directly proportional to the combustion temperature, reduction in the combustion temperature also reduces the efficiency of the unit.

Other forms of pollution control include selective catalytic reduction (SCR) and water/fuel emulsification. SCR requires additional equipment which is estimated to cost approximately $400 to $500 per kW installed. The operation costs would also increase by approximately 0.3 to 0.5 cents per kWh for ammonia consumption and catalyst replacement. In addition, SCR requires the onsite storage and use of ammonia, and the spent catalyst can be a potential hazardous waste. Although SCR technology has been used commonly on recent natural gas-fired combined cycle combustion turbine generating units, it is a relatively new application to diesel generators. Water/fuel emulsification includes injecting water into the fuel to improve the combustion efficiency and lower the combustion temperature.

The required BACT will be determined when CVEA applies for permits to install a new diesel generator unit. For the purpose of this analysis, it is assumed that NOx emission will be controlled through the delay of the fuel injection. This type of emission control has been recommended recently to other remote Alaskan utilities as the BACT. Further, the United States Environmental Protection Agency (EPA) approved timing retard as BACT in May 1993 for a 20-MW diesel generating station. The actual pollution control technology required at the time of construction of new diesel units may differ. The most costly control technology is SCR. For additional information on air permitting issues regarding new diesel generators, see Appendix G.

2. New Hydroelectric Facilities

Hydroelectric facilities are typically capital intensive projects; however, they offer a relatively stable cost of power over the life of the project, which can extend to 50 years or more. The two sites identified in previous studies conducted by the Authority for new hydroelectric facilities located near CVEA's service territory include Allison Lake and Silver Lake. Alternative designs have been proposed for each site. The proposed Allison Lake Project as included in this analysis would supplement the winter energy generation currently available from the Solomon Gulch Project and provide CVEA with a small level of additional capacity. The Silver Lake Project would provide additional capacity and generation, and also would provide substantial storage capability from which to regulate the output of CVEA's combined hydroelectric generation system.

Construction costs and operating costs for the hydroelectric facilities included in this analysis are based on information provided in other reports. Construction costs for the two hydroelectric facilities were originally provided in 1992 dollars and have been increased 4.12% to adjust the costs to 1993 dollars based on the Handy-Whitman Index of Public Utility Construction Costs. O&M costs were adjusted 3.2% from 1992 dollars to 1993 dollars.

a. Allison Lake Project

Allison Lake is located west of the Solomon Gulch Reservoir and is formed by small creeks and melt water from glaciers on Mount Kate. As previously discussed, the Solomon Gulch Project reservoir typically runs out of water around March, under current operating practices. The Allison Lake Project would divert water from Allison Lake to the Solomon Gulch Reservoir during the winter in order to provide additional generation at the Solomon Gulch Project. Several design options at Allison Lake were reviewed in the Allison Lake Reconnaissance Study (Allison Lake Study), prepared by HDR Engineering, Inc. (HDR) in September 1992 for the Authority. The preferred option identified in the Allison Lake Study consists of an 11,950 foot-long tunnel from Allison Lake to the Solomon Gulch Reservoir, a lake tap approximately 100 feet below the surface of Allison Lake, and a 3,145 kW hydroelectric generation facility located at the discharge from the tunnel at the Solomon Gulch reservoir. Water would be withdrawn from Allison Lake, flow through the tunnel, and then pass through the generating facility at the discharge to the Solomon Gulch Reservoir. This water from Allison Lake would then be available to provide additional generation at the existing Solomon Gulch Project generating facility.

The construction cost for the Allison Lake project is assumed to be approximately $32,240,000 in 1993 dollars, not including interest during construction. Annual operating and maintenance costs are assumed to be $284,000 in 1993 dollars. The earliest commercial operation date for this project, assuming project development would begin in July 1994, is assumed to be January 2000, which represents a 5½ year development schedule. These assumptions are based on information included in the Allison Lake Study which includes a more detailed description of the project. The Allison Lake Study was a reconnaissance level study and further review is required for several issues including the minimum water flow required for fish habitat needs in the natural outlet of the lake.

The optimal operation of the preliminary design of the Allison Lake Project described in the Allison Lake Study involves discharging water into the Solomon Gulch reservoir at a 100% capacity factor. This operation would generate approximately 2,300 MWh per month over a six month operating period, November through April, as identified in the Allison Lake Study. This mode of operation would provide the CVEA system an additional 3,145 kW of firm capacity in the winter months and 27,300 MWh of gross generation also in the winter months. The additional generation includes both the generation from Allison Lake of 13,775 MWh and the increase in generation from the Solomon Gulch Project of 13,621 MWh. Station use and transmission losses for the additional generation provided by the Allison Lake Project are assumed to be approximately 3.5%, the same level as assumed for generation from the Solomon Gulch Project.

The Allison Lake Study included comments provided by several State and federal agencies regarding the proposed Allison Lake Project. Several issues were raised which, according to HDR, would require additional study to fully determine the impact on the proposed development. These issues included insufficient identification of the expected impacts to fish and wildlife, and inadequate allowances for reserved streamflows in Allison Creek for fish habitat. These and other issues could affect the cost and operating characteristics of the Allison Lake Project.

b. Silver Lake Project

Silver Lake is located approximately 15 miles southwest of Valdez. The lake is approximately 3 miles long and up to 0.7 miles wide. The outlet from the lake forms Duck River which flows into Galena Bay. Several alternative configurations for a hydroelectric facility at Silver Lake have been proposed and two primary options were reviewed in the Allison Lake Study. The two options reviewed in the Allison Lake Study are summarized as follows:

(1) Design A

This design option was studied by Stone & Webster in 1982 and 1983. The project includes a 125-foot-high roller-compacted concrete (RCC) dam, 6,000-feet of 108-inch pipeline, and a 15 MW powerhouse located at elevation 65 on the Duck River. The powerhouse would be equipped with three 5 MW Francis turbines. Transmission to the Solomon Gulch Project would be accomplished with an approximately 22 mile-long overhead transmission line. The project would require a minimum water release of 5 cubic feet per second (cfs) at all times which would produce approximately 300 MWh of generation a month. Generation in excess of the minimum release could be regulated. Annual generation is estimated to be about 44,800 MWh per year. The capital cost for the project is estimated to be $54,185,000 in 1993 dollars. The fixed O&M costs are estimated to be $593,000 per year in 1993 dollars.

(2) Design B

This option is based on a design proposed by Whitewater Engineering in 1992. The project would consist of a 110-foot-high RCC dam, 10,000 feet of 108-inch diameter pipeline along the access road and a 14 MW powerhouse located at elevation 10 on Reverse Creek providing a higher head than Design A. The powerhouse would be equipped with two 7 MW Francis turbines. Transmission would be via 2.2 miles of overhead transmission line to Galena bay and then by a 18-mile submarine cable to Valdez. Design B is estimated to produce an energy generation capability of approximately 48,000 MWh per year. This includes the generation from the 5 cfs minimum water release, estimated to be approximately 600 MWh a month for the Design B configuration. HDR's cost estimates for the project, adjusted to 1993 dollars, includes $60,703,000 for capital cost and $593,000 per year for O&M costs.

Both design options for the Silver Lake Project are assumed to be operated as fully regulated projects, because of the large storage capacity. The reservoir storage and the sizing of the generator units would allow the project to serve as a backup to the Solomon Gulch Project. The estimated generation from the Silver Lake Project is based on historical water flow data and the net generation could actually be closer to 50,000 MWh per year. Further review is required for more detailed analysis and to address certain issues including fishery needs.

Whitewater Engineering ("Whitewater"), an independent power project development company, is still interested in developing a project at Silver Lake similar to design Option B described above. As an independent power producer, Whitewater would construct the project and sell the output to CVEA. Whitewater has recently estimated that the cost to construct the Silver Lake Project would be $25 million, not including land rights. An additional $8.0 million for construction of the submarine transmission cable is estimated to be needed by Whitewater. Significant differences in HDR's estimate and Whitewater's estimate include the following:

(1) HDR proposes to purchase the land and Whitewater proposes to lease the land at a cost based on the output from the project.

(2) HDR proposes to line the dam face with concrete and Whitewater proposes to line the dam with a pre-fab lining at a significant savings.

(3) HDR proposes to bury the penstock and Whitewater proposes to construct the penstock above ground.

A detailed review of the various Silver Lake Project development alternatives has not been included as a part of this study. For the purpose of the economic analysis, the costs of the Silver Lake Project are assumed to be those as provided in the Allison Lake Study for both Design Option A and Design Option B.

3. Valdez Coal-Fired Generation Plant

Hobbs Industries, Inc. ("Hobbs") had proposed to construct and operate an 11-MW coal-fired generation project in Glennallen. Since release of the draft feasibility study report, Hobbs has withdrawn its proposal for the Glennallen coal project and Alaska Cogeneration Systems, Inc. (ACSI) has proposed to construct and operate a 22-MW coal-fired cogeneration project in Valdez. ACSI has proposed to generate electrical power for sale to CVEA and produce steam for district heating of various public facilities in Valdez. The Valdez coal project is proposed as an independent power project that will be independently constructed and financed.

Certain components of the coal project, namely the boilers and turbine generators, have been previously used elsewhere but are expected to be fully refurbished before installation in the new facility. The project is proposed to be constructed adjacent to CVEA's Valdez diesel power plant. Coal fuel is expected to be provided from a mine located in the Matanuska Valley near Sutton that Hobbs has previously proposed to operate. Coal would be delivered to the power plant via truck, railroad and barge in containers. Water supplies and wastewater discharge services are expected by ACSI to be supplied locally. The coal project will incorporate several measures to control the emission of pollutants. It is estimated that the earliest the coal project would be operational is early 1998 if contractual agreements between CVEA and ACSI could be negotiated by the end of 1994.

ACSI proposes to operate the coal project in integration with CVEA's other generators. At times when the Solomon Gulch Project is generating at or near full capacity, the coal project will most likely not be generating. ACSI anticipates that the coal project will be shutdown for 2 months during the summer for annual maintenance although the coal project may be used only sparingly for generation for a longer period of time each year depending on the level of Solomon Gulch generation. A staff of 16 full-time employees is estimated to be required to operate and maintain the coal project.

A cost estimate for the Valdez coal project has been provided by ACSI and we have reviewed the estimate. Based on our review, it is estimated that the cost of development and construction of the coal project is $36,600,000 in 1993 dollars. This amount is significantly higher than presently estimated by ACSI. Included in the cost estimate are the estimated costs of installing a district heating system in Valdez and the costs associated with initial startup of the coal mine.

It is estimated that the coal project should be capable of producing approximately 160,000 MWh per year assuming 85% annual availability. Its actual generation will depend on the actual power requirements of CVEA as well as the energy generation of the Solomon Gulch Project. Generation from the coal project will be used to offset diesel generation and would not offset energy generation from the Solomon Gulch Project on an annual basis. Operations and maintenance expenses are estimated to be $.01 per kWh for variable costs and approximately $1.8 million per year for fixed costs including labor costs for the 16 employees expected to be employed at the project. The cost of fuel is proposed by ACSI to be $50 per ton delivered in 1993 dollars and the cost of fuel is expected to increase at the assumed rate of general inflation.

As an independent power project, ACSI has proposed that power from the coal project be sold to CVEA with a monthly fixed charge plus a per kWh energy charge. The rate to be charged will allow for the repayment of the capital costs of the project, operations and maintenance costs and fuel costs. For the purpose of this analysis, the nature of the actual contractual payment requirements is not important. Rather, the costs of operation have been estimated and are included in the economic analysis used to compare the costs of the various resource alternatives. Estimated revenues from the sale of district heating are assumed to be credited towards the costs of operation of the coal project. These revenues are assumed to be related to the value of the heating fuel displaced with the district heat system.

In reviewing the proposed coal project as outlined by ACSI, we have identified several issues which could significantly impact the costs of constructing and operating the project. It is not unusual that many of these issues would be unresolved at this stage of project development. They will need to be addressed before the project can be expected to proceed much farther and would almost undoubtedly need to be resolved before financing for the project can be secured. In addition, CVEA would need to be fully satisfied that these issues can be resolved before committing to purchase power from the project, particularly if the project is to provide firm power whereby CVEA forgoes development of other resource options. For additional information on the proposed Valdez coal project, see Appendix H, attached to this report.

4. Conservation Potential

In addition to generating resources, the resource analysis included an evaluation of the potential conservation or DSM programs that CVEA could implement to offset the cost of diesel generation and possibly delay the need to add new generating facilities. The potential DSM programs considered and the related assumptions are based on the results of the Final Report on Least-Cost Planning Demonstration Study prepared by Stone & Webster Management Consultants, Inc. in 1991 (Stone & Webster Study).

The evaluation of DSM potential is generally based on the premise that a utility can "invest" in conservation measures to reduce its customer's needs for electricity. Although CVEA can expect some of its customers to implement conservation measures on their own, to fully realize conservation benefits on a larger scale CVEA would need to pay for a portion if not all of the costs of implementation. The estimated savings and costs provided in the Stone & Webster Study were adjusted to include the impact of CVEA customers that would have implemented the DSM measures without any financial incentive offered by CVEA.

In evaluating the electricity conservation potential in CVEA's service territory it is important to note that a significant amount of electricity conservation potential has already been realized due to the high cost of electricity to consumers. For instance, the use of electricity for space heating is essentially non-existent and many of CVEA's customers use fuels other than electricity for water heating purposes. If electricity is used to heat water, some customers have installed timers on their electric water heaters to limit electricity use for this purpose. Because of these and other measures taken by CVEA's customers in the past, the amount of additional conservation savings that can be realized is less than may be expected by many electric utilities in general.

Based on the Stone & Webster Study the three cost effective residential DSM programs identified for CVEA include (1) high efficiency refrigerators, (2) high efficiency freezers, and (3) compact fluorescent lighting. In addition, the two commercial programs found to be cost effective include (1) high efficiency fluorescent lamps and ballasts and (2) compact fluorescent lighting.

The Stone & Webster Study included a review of over 27 potential DSM programs which were reduced to the five programs listed above, based on the cost effectiveness of the programs. Because there is little or no electric heat and very few electric hot water heaters in use by CVEA customers, weatherization programs or programs designed to provide energy efficient water heating are of no value to CVEA.

A survey of commercial customers to determine the end-use energy use by building type and to identify the appropriate high efficiency DSM replacement technologies was included as part of the Stone & Webster Study. In addition, Stone & Webster relied on information provided in previous studies prepared for the Alaska Railbelt area and other information available from other utilities.

The following summarizes the selected programs in the Stone & Webster study:

a. High Efficiency Refrigerator Program

The high efficiency refrigerator program is designed to encourage the purchase of more efficient refrigerators through financial incentives to customers and also by CVEA working with local appliance distributors to stock the more efficient units. The utility incentives would be provided to customers who are buying new or replacement refrigerators. It was estimated that the total number of new refrigerators purchased each year (for either new applications or replacements) represents approximately 5% of the total refrigerators in the CVEA service area. The utility would pay for the incremental cost between the purchase of a high efficiency refrigerator as compared to the purchase cost of an average efficiency refrigerator. It was estimated that approximately 10% of the eligible customers would participate in the first year. This participation rate would increase to 40% per year by the fourth year and remain at that level through the end of the study period. The per unit energy savings were estimated as 112 kWh per year. The per unit peak demand savings were estimated as 0.014 kW. The incremental cost of purchasing the high efficiency units was estimated as $32.00 per unit. The per unit cost was increased 60% for utility administrative costs.

b. High Efficiency Freezer Program

The high efficiency freezer program would be very similar to the high efficiency refrigerator program. Approximately 5% of the total freezers in the CVEA service area were assumed to represent the total number of new freezers purchased in a year. Of the eligible purchases approximately 10% were estimated to participate in the first year of the program. The participation level was estimated to increase to 40% by the fourth year of the program and remain at that level through the end of the study. The per unit energy savings and demand savings were estimated as 94 kWh per year and 0.010 kW per year, respectively. The incremental cost of purchasing the more efficient units was estimated as $20.00 per unit. The per unit cost to be incurred by the utility was increased 60% to include administrative costs for the utility.

c. Compact Fluorescent Lighting Program

The compact fluorescent lighting program is designed to introduce compact fluorescent lighting technologies as replacements for standard incandescent lamps. The utility is assumed to purchase the compact fluorescent bulbs in bulk and provide them to customers at no cost. Half of the estimated 2.6 bulbs per household that could be replaced are assumed to be replaced. The estimated energy savings per household is 142 kWh per year. The per unit cost of the compact fluorescent bulb is assumed to be $15.00. The per unit cost to be incurred by the utility was increased 60% to include administrative costs for the utility.

The cost effective DSM programs identified for the commercial customers included two lighting efficiency programs (1) high efficiency fluorescent lamps and ballasts, and (2) compact fluorescent lighting. Based on the survey data, the total lighting load for each building type was estimated. This was further broken down to the percent fluorescent and incandescent for each building type. This was combined with the estimated per unit savings to determine the total savings in the lighting load. The estimated peak demand savings were based on an assumed annual lighting load factor of 36% , or 3,200 hours per year. The estimated per unit cost for the high efficiency fluorescent lamps and ballasts was $20. The compact fluorescents were estimated to cost $15 per fixture. The program is assumed to reach 50% of the technical potential over 20 years. The program is assumed to reach 27% of the technical potential over 12 years. The per unit cost was increased by 60% for utility administrative costs.

The following table summarizes the estimated energy savings and costs for the selected conservation programs.

Table IX-7
CVEA Conservation Program Assessment
Total Estimated Energy and Demand Savings
and Total Estimated Costs

	Total Annual Savings for CVEA(1)		Annual Program
Description of Programs	Energy (MWh)	Demand (kW)	Costs(2) (1993 $000)
RESIDENTIAL			
High Efficiency Refrigerators	143	18	3
High Efficiency Freezers	75	8	1
Compact Fluorescent Lighting	172	64	7
COMMERCIAL			
High Efficiency Fluorescents	1,081	375	32
Compact Fluorescent Lighting	244	85	11
Total for All Programs	1,715	550	54

(1) Total annual savings which are estimated to be achieved in 2017 for all conservation measures projected to have been implemented by that year. The conservation measures are projected to be implemented gradually over time beginning in 1994.
(2) Costs of implementing the incremental increase in conservation measures in 2017. There are no assumed O&M costs associated with the conservation programs.

G. SAFETY AND RELIABILITY ISSUES

While a safety evaluation of the various resources has not been conducted as a part of this study, it is not expected that the general public and worker safety would be appreciably different among the resource alternatives. The electric resources addressed in this report are all of relatively standard technology and each type of resource has shown many years of safe and reliable operation if properly maintained and operated. Electric utility installations of any type can present hazards if proper precautions are not taken. It is assumed that all resources will be constructed and operated to utility standards and that all applicable codes and regulations will be strictly adhered to. For more information on safety and health issues related to the Intertie, including a discussion of health impacts related to electro-magnetic field issues, see the Environmental Review in Appendix N.

In general, transmission lines are more reliable than generating plants, i.e. they are subject to fewer failure conditions and have less downtime. For the purposes of this study, power supply reliability has been addressed through the application of generating reserves that are comparable among all the resource alternatives and with the Electric System Analysis included as Appendix M. It is not clear what impact the Intertie would have on the reliability of CVEA's electric service to its customers and how this impact would vary from the present situation. The CVEA system could be subject to disturbances caused by problems in the Railbelt electric systems if the Intertie is constructed. Alternatively, the Intertie would provide another source of emergency power in the event of a failure of CVEA's own generating resources. It will be necessary for CVEA to operate its electric system so as to minimize electric service interruptions.

The differences in reliability among the various resource alternatives that may occur have not been estimated at this time. Hydroelectric resources are generally highly reliable whereas diesel generators and coal-fired generating plants are less reliable as individual units. The availability of hydroelectric resources is typically close to 100% on an annual basis. Coal-fired generating plants are typically available in the range 90%. The reliability of various generating resources is usually factored in to the amount of backup generation that a utility maintains. It will be necessary for CVEA to consider reliability issues with regard to its future operation, with or without the Intertie.

EVALUATION OF ALTERNATIVE POWER SUPPLY PLANS AND ECONOMIC ANALYSIS

A. OVERVIEW

The primary use of the Intertie will be to offset CVEA's diesel generation with purchased power from the Railbelt area. In order to evaluate the economic benefits of the Intertie, alternative resource plans were developed which provide equivalent amounts of power to CVEA over the study period. These plans were then evaluated based on the cumulative present value of comparable annual costs over the expected life of the Intertie.

This section of the report provides a summary of the alternative resource plans and includes a description of the model used to develop and evaluate the resource plans and conduct the economic analysis. A list of the principal assumptions used in the analysis is also provided. Detailed descriptions of the various generating alternatives, which include new hydroelectric projects, diesel generators, conservation programs, and a coal-fired generation plant, are provided in Section IX of this report.

Many assumptions have been used in developing the resource plans and economic analysis. Among these are the projected power requirements of CVEA and the projected cost of oil which is reflected in the cost of generation fuel. Because these variables can greatly influence the results of the economic analysis, a range of assumptions has been made to evaluate the impact that these variables have on the bottom line results.

B. METHODOLOGY

An analytical model was developed to evaluate the alternative resource plans (the "Resource Model"). The Resource Model is divided into three sections: (1) peak load requirements and generation capacity (2) energy requirements and energy resources and (3) the economic analysis. The need for and specification of new generation additions are developed in the first section of the Resource Model since the capacity needs for CVEA form the basis for each alternative resource plan. The use of CVEA's resources to serve projected energy requirements is simulated in the second section of the Resource Model. This section indicates the source and quantities of energy generation by resource. The third section of the Resource Model shows the projected annual costs and the cumulative present value of the annual costs.

1. Resource Plans and Energy Generation

The alternative resource plans are based on CVEA's projected power requirements, the planning reserve criteria for each of CVEA's service districts, the existing resources available to serve the load and the alternative new resources, previously described in Section IX of this report. Diesel generators are estimated to be installed in all cases if capacity requirements are not met with existing resources or the alternative new resources. To determine when new diesel resources would be needed, the total firm capacity in each service district was compared to the projected peak load for the respective district. For each case, diesel units were then added to the system, as required, to provide the appropriate level of reserves in each year of the study period.

The Resource Model then simulates an economic dispatch of CVEA's resources for CVEA's system on a seasonal basis. The two seasons include the winter season defined as October through May and the summer season defined as June through September. Based on historical load data, CVEA's winter season energy requirements are assumed to represent approximately 70% of CVEA's total annual energy requirements and CVEA's summer season energy requirements are assumed to represent the remaining 30%. The available generation from the Solomon Gulch Project and from each of the alternative resources is defined in the Resource Model for each season, except for diesel generation which is defined on a total annual basis. CVEA is assumed to dispatch resources to serve the service district that the generation resource is located nearest first, with any surplus generation then available to be used to serve the other service district. Any generation produced in one service district to serve the energy requirements of the other service district is adjusted for transmission losses over existing Glennallen to Valdez transmission line.

The basic order of use of the generating resources to serve the projected load is the same for all of the alternative resource plans. The projected energy requirements are first reduced by any projected conservation savings for the Conservation Case. The Solomon Gulch Project is assumed to be used next to serve load, followed by any alternative new hydroelectric resources, namely the Allison Lake Project or the Silver Lake Project. New diesel generators followed by existing diesel generators are assumed to provide the balance of energy requirements. Power purchased over the Intertie or power generated by the coal project is assumed to offset diesel generation. As previously mentioned in Section IX of this report, power purchased over the Intertie is assumed to be purchased from Anchorage area utilities.

The coal facility is assumed to operate only during the winter season to offset diesel generation. The coal project is presumed to operate at a minimum level of 3 MW during the period in which it operates. Consequently, CVEA's minimum load requirements must be in excess of 3 MW on a continuous daily basis before the coal project is started up for the winter season. During the winter season, the coal project would be expected to operate at a fairly consistent level of output from hour-to-hour.

The use of CVEA's existing diesel units is based on the average fuel efficiency for each unit with the more efficient diesel generator units assumed to be used first. In Valdez, the Enterprise Units 4 and 5 are used first to serve load. Because of its remote control capability, the Solar Turbine is assumed to be used when load requirements exceed the combined capacity of Units 4 and 5. The usage order for the remaining units is Unit 6, Unit 2, Unit 3, and Unit 1, in that order. It is further assumed that the use of the existing diesel generating units is limited to a 35% load factor on an annual basis and that 5% of the diesel generation estimated to be needed in Valdez is supplied by the Solar Turbine.

The existing diesel generators assumed to be used first in Glennallen are the Enterprise Units 6 and 7. The usage order for the remaining Glennallen diesel units is Unit 4, Unit 5, and Unit 3, in that order.

2. Economic Analysis

The economic analysis performed determines the cumulative present value of the costs for each of the alternative resource plans over the expected economic life of the Intertie. Costs included in the analysis have no inflation applied in the future; however real escalation in fuel costs are assumed in the future. The cumulative present value for each alternative plan is calculated using an inflation free discount rate of 4.5%, as presently defined by the Authority.

Each resource plan is defined to provide similar levels of electric capacity and energy to CVEA over the analysis period. The costs for this power supply will vary for each case depending on the specific resources involved. The analysis period is the economic lifetime of the Intertie, an assumed 50 year period beginning in 1999. Costs included in the analysis are the annual capital recovery costs for new generation and transmission additions, operation and maintenance costs for new resource options and operation, maintenance and fuel costs of new and existing diesel generators. Excluded from the analysis are certain fixed operating and capital recovery costs related to CVEA's existing generation plant and the cost of power purchased by CVEA from the Solomon Gulch Project. These costs do not affect the outcome of the analysis because they will be incurred no matter what case is being evaluated. With the Intertie, CVEA anticipates that it would reduce the number of diesel generator operations and maintenance staff and a fixed cost credit is applied to the Intertie case to account for this reduction in labor costs. To a smaller degree, diesel generation labor costs are also assumed to be reduced if new hydroelectric plants or the coal project are included.

C. PRINCIPAL ASSUMPTIONS

Principal assumptions critical to the evaluation of alternative power supply plans are summarized as follows:

1. The expected initial year of commercial operation for the Intertie is 1999.

2. The initial study period begins in 1993 and extends through 2018, i.e., 20 years from the expected commercial operation date of the Intertie. Costs are then projected through an extended study period from 2019 through 2048. This covers the expected 50-year economic lifetime of the Intertie. All costs and electric load requirements are held constant after the 20-year initial study period.

3. All costs are stated in unescalated 1993 dollars and are assumed to have 0% per year real escalation, except for fuel costs which are assumed to escalate at a real rate corresponding to the oil price projections identified herein.

4. Estimated future annual costs are discounted to year end 1993 using an inflation free discount rate of 4.5% as provided by the Division

5. The base price of diesel fuel in 1993 is based on CVEA's 1993 mid-year reported purchase price as shown below:

Valdez	#2 Fuel Oil	70 cents per gallon
Glennallen	#2 Fuel Oil	75 cents per gallon

6. High average annual escalation rates of fuel costs are based on the escalation trends identified in the Alaska Energy Authority's recommended World Oil Price Forecast, medium scenario, dated December 22, 1992. Low average annual escalation rates of fuel costs are based on projections of the WTI oil price, mid scenario, as provided by the Alaska Depart-

ment of Revenue in its Revenue Sources Book dated November 15, 1993. Both high and low fuel cost forecasts are shown below in constant 1992 dollars per barrel.

	Low	High
1995	18.07	21.35
2000	20.22	24.16
2005	20.73	26.74
2010	21.26	29.35

7. The real price of diesel fuel for CVEA is estimated to increase at two-thirds the rate of the increase in assumed world or WTI oil prices to account for handling and transportation cost components, which should increase with inflation only, included in the price of fuel. The average annual rates of increase for the high and low projections are 1.73% and 0.66%, respectively.

8. The economic lives for the various resource alternatives are as follows:

   Intertie .... 50 years
   New Diesel Generators .... 20 years
   New Hydroelectric Facilities .... 50 years
   Coal-fired Power Plant .... 30 years

9. CVEA's total energy requirements are assumed to be seasonally shaped as approximately 70% during the winter period October-May and approximately 30% during the summer period June-September.

10. The capital costs of the Intertie and the other new resource alternatives are assumed to be recovered over a period equivalent to each resource's respective economic lifetime at an annual interest rate equivalent to the assumed discount rate.

11. The estimated capital cost of the Intertie, as shown in Table VI-5, is $47,604,000 in 1993 dollars. Annual operations and maintenance costs of the Intertie are as shown in Table VI-6 and average $230,000 per year over the first 15 years of Intertie operation.

12. The estimated capacity, energy generation capability, installed cost and annual operation and maintenance costs for each of the alternative generating resources are as described in Section IX of this report and are summarized in the following table.

Table X-1
Estimated Costs and Operating Characteristics of Resource Options

Resource	Available Capacity (kW)(1)		Annual Energy Capability (MWh)(1)			Installed Cost	Annual O&M Costs(6)
	Summer	Winter	Summer	Winter	Total	(1993 $000)	(1993 $000)
Diesel Generator	1,610	1,610	3,385	7,898	11,283(2)	1,509(7)	132
Diesel Generator	2,150	2,150	4,520	10,547	15,067(2)	1,765(7)	176
Allison Lake	0	6,255(3)	0	27,396	27,396(4)	32,240	284
Silver Lake -Option A	0	15,000	1,176	43,576	44,752(4)	54,185	593
-Option B	0	14,000	2,376	46,376	48,752(4)	60,703	593
Valdez Coal Facility	6,000(9)	22,000	30,000	122,000(5)	152,000	36,600	2,200(8)

(1) Summer period is June through September and the winter period is October through May.
(2) Energy generation is based on 80% annual capacity factor for illustrative purposes. Actual generation levels would vary.
(3) Includes 3,045 kW from the Allison Lake Project and 3,110 additional capacity at the Solomon Gulch Project.
(4) Based on assumed average water conditions.
(5) Assumes 95% availability during the winter period, October through May. Actual energy generation would vary.
(6) Excludes fuel costs.
(7) Costs shown do not include estimated additional costs for power plant building, fuel storage tank and switchyard improvements which would be needed for increasing base load diesel generation in Valdez. These costs are added directly as inputs to the economic analysis model.
(8) Includes variable and fixed operations and maintenance costs at an assumed generation level of 40,000 mWh annually. Includes estimated costs for insurance, administrative and general expenses and renewals and replacements. Excludes operations and maintenance costs associated with the district heating system.
(9) Only the smaller of the two turbines to be installed in the coal project is assumed to be available in the summer months.

13. Existing diesel generators are assumed to be replaced rather than overhauled if a major overhaul is estimated to be needed during the study period. The estimated time between overhauls is 15,000 hours, based on information provided by CVEA. When a diesel generator is replaced, CVEA's fixed diesel operation and maintenance costs will not increase.

14. Station use power requirements for diesel generating plants is estimated to be 3.66% of net diesel generation.

15. Current staffing levels at CVEA's diesel power plants will change depending on the nature of the resource alternatives and the expected amount of diesel generation. The following table indicates the staffing level changes with respect to current staffing levels:

Case	Valdez Power Plant	Glennallen Power Plant	Year of Adjustment	Estimated Adjusted Labor Cost (1993$)
All Diesel	+3	0	1997	$291,000
Intertie	-1.5	-4.5	1999	$(560,000)
Allison Lake	-1.5	0	1999	$(146,000)
Silver Lake (A&B)	-1.5	0	1999	$(146,000)
Coal Project	-1.5	-1.5	1998	$(291,000)
Conservation	+3	0	1997	$291,000

16. Variable operations and maintenance expenses for diesel generators is 3.0 cents per kWh for existing diesel generators and 1.0 cents per kWh for new diesel generators. Fixed operation and maintenance expenses for new diesel generators is $12 per kW-year.

17. Transmission losses over the Intertie and the existing Valdez to Glennallen transmission line are 3% of the power transmitted over each line.

18. For the Intertie Case, energy to be purchased from the Anchorage area by CVEA will be priced at an economy energy rate comparable to that presently paid by Golden Valley Electric Association. (See Table IX-5).

19. For the Intertie Case, energy generation at the Solomon Gulch Project surplus to the needs of CVEA is assumed to be sold to Anchorage utilities at the same rate CVEA is assumed to pay for power, i.e., an economy energy rate.

In reviewing the results of the analysis, it is important to keep in mind that this analysis is prepared from an overall perspective of the State and not from the perspective of CVEA or its customers. For example, if the Intertie is constructed and CVEA purchases power from the Anchorage area, CVEA may be assessed wheeling charges from MEA over that system. However, since MEA had no actual increase in costs to provide access to CVEA this cost is not included in the analysis. Another example is the capital cost of the Intertie itself. The Intertie cost is not reduced by an assumed level of State government contribution because the full cost of the Intertie will be borne by Alaskans.

D. DESCRIPTION OF ALTERNATIVE RESOURCE SCENARIOS

Several alternative resource scenarios have been developed which provide equivalent amounts of power to CVEA over the study period. Each of these scenarios has a specific list of resource additions and retirements based on the assumptions and operating criteria previously described. The resource scenarios have been developed for each of the four load forecast scenarios; high, medium-high, medium-low and low. As previously mentioned in Section VIII - Electric Load Forecast, the only difference between the two medium load forecast scenarios is with regard to the level of projected energy requirements at the Petro Star refinery beginning in 2018. The following subsections provide a description of each of the resource scenarios indicating what new resources are projected to be needed for each scenario and the years in which they will be added. Table X-2 provides a summary of the resource additions and retirements for each of the scenarios.

Tables are provided in Appendix J for each of the resource scenarios providing the results of the Resource Model for the low, medium low, medium-high and high load growth scenarios. These tables show the capacity and energy loads and resources and the estimated "comparable costs" of operation for each year of the study period. The results of the Resource Model for each resource scenario is six pages long. The present value of comparable costs for each scenario are accumulated for both the initial study period, 1993 through 2018, and the full study period, 1993 through 2048. These cumulative present values serve as the basis for the comparison of the various resource scenarios.

1. All Diesel Case

The All Diesel Case assumes that the Intertie is not constructed and that diesel generators are added as needed to provide CVEA's projected reserve and generation requirements. The reserve requirements are based on the ability to meet the peak load in each load center with an outage on the Valdez to Glennallen transmission line and an outage on the largest diesel generator located at each load center (which is currently 2,200 kW at each site). The Solomon Gulch Project and the existing diesel generators provide the firm capacity at Valdez. During the winter, the firm capacity available from the Solomon Gulch Project is assumed to be 5,000 kW and the Valdez diesel plant is assumed to provide 9,750 kW. The firm capacity located in Glennallen includes 6,800 kW from the existing diesel generators.

Based on the generation requirements for the medium-high and medium-low load forecasts, the next scheduled major diesel generator overhaul is assumed to be required for the Valdez diesel generators, Unit 4, Unit 6 and Unit 5, in 1997, 1998 and 2000 respectively. These units are assumed to be retired rather than overhauled at that time and replaced with new 2,150 kW units. A new diesel power plant building is assumed to be constructed in Valdez in 2004 also. A new 2,150 kW diesel generator is assumed be added in Glennallen in 1996 and Glennallen Unit 6 is retired and replaced in 1999.

To accommodate the increase in diesel generation, a night crew of three people is assumed to be added to the Valdez plant in 1999 at a cost of $291,000 per year. Also, a new fuel storage tank and switchyard improvements are assumed to be added in 1999.

Under the low load forecast, the existing Valdez diesel generators, Unit 4 and Unit 6, are assumed to be retired and replaced with new 2,150 kW diesel units in 1997 and 1998, respectively, instead of being overhauled. A new 2,150 kW diesel generator is assumed to be added in Glennallen in 1996. The projected annual amount of diesel generation for the low load forecast does not increase above existing levels so no changes in operating staff are included. Also, the new fuel storage tank and new switchyard are not included.

Based on the high load forecast, two existing Valdez diesel generators, Unit 4 and Unit 5, are assumed to be retired and replaced in 1997, with two new 2,150 kW diesel generators. Unit 6 is retired and replaced in 1998. Two additional diesel generators are assumed to be required in Valdez, one each in 2005 and 2018. Glennallen Unit 6 is assumed to be retired and replaced in 1998 with a new 2,150 kW diesel generator. In addition, two new 2,150 kW diesel generators are assumed to be added in Glennallen, one each in 1996 and 2005. A night crew of 3 people is assumed to be added in Valdez in 1997 to accommodate the increased amounts of diesel generation. Also a new fuel storage tank and switchyard improvements are assumed to be added in 1999 and a new power plant building is to be added in 2004.

The total cumulative present value of the annual costs for the All Diesel Case under the medium-high load growth projection is $84,771,000. The medium-low, high and the low load growth projections resulted in total cumulative net present values of $67,853,000, $121,562,000 and $39,565,000, respectively.

2. Intertie Case

The Intertie Case assumes that the Intertie is constructed and becomes operable by 1999. The reserve requirements for Valdez are based on the ability to provide peak load with an outage on the transmission line between Glennallen and Valdez and an outage on the largest diesel generator located in Valdez which is currently 2,200 kW. The ability to purchase economy energy over the Intertie is assumed to allow CVEA to adjust its management of the Solomon Gulch Project reservoir and increase the firm winter peak capability to 6,500 kW. The Valdez diesel plant is assumed to provide 9,750 kW. With the construction of the Intertie, Glennallen would be interconnected to the generating facilities in the Anchorage area as well as those in Valdez. The reserve requirement for Glennallen is assumed to be based on the ability to provide peak load with an outage on one of the transmission lines. Glennallen is assumed to maintain sufficient generation to meet its own peak load.

Based on the projected medium-high, medium-low and low load growth scenarios, no new generation in Valdez is assumed to be required during the study period. Although the Glennallen load center is slightly deficient in generation requirements prior to energization of the Intertie, no new diesel generators are assumed to be installed.

Economy energy purchases over the Intertie are assumed to displace all CVEA diesel generation. The existing operating staff at the Glennallen Power Plant and the Valdez Power Plant are assumed to be reduced to 1.5 employees per plant for an estimated savings of $560,000 per year compared to current operating staff labor costs. Also, no new fuel storage tank or switchyard improvements at the power plants are assumed to be required.

Under the medium-high, medium-low and low load growth projections, no new diesel generator units are to be added at Valdez or Glennallen.. For the high load growth scenario, one new 2,150 kW unit is to be added in Valdez in 2005 and one new unit is to be added in Glennallen in 2014. These new diesel generators are needed in the Intertie Case to maintain appropriate reserve capabilities in both load centers.

For all of the load growth scenarios, surplus generation from the Solomon Gulch Project is assumed to be sold over the Intertie and sold at the economy energy purchase rate.

The total cumulative net present value of the annual costs for the Intertie Cases for the medium-high and medium-low scenarios is $72,604,000 and $63,415,000, respectively. The high and low growth projections resulted in total cumulative net present values of $91,227,000 and $50,042,000, respectively.

3. Allison Lake Case

The Allison Lake Case assumes that the Allison Lake hydroelectric project is constructed and operable by 2000. This case also assumes that the Intertie is not constructed and diesel generators are added as required to meet future power requirements not met by the Allison Lake Project. The reserve requirements for each load center are based on the ability to provide peak load with an outage on the transmission line between Glennallen and Valdez and an outage on the largest diesel generator which is currently 2,500 kW for each load center. The Allison Lake project is assumed to provide 3,145 kW of firm capacity during the winter peak. Also, the additional hydro energy available from Allison Lake is assumed to allow CVEA to operate the Solomon Gulch Project reservoir to provide 6,500 kW of firm capacity during the winter peak period. The existing diesel generators in Valdez are assumed to provide 9,750 kW of firm capacity. The existing diesel generators in Glennallen provide 6,800 kW of firm capacity.

The current staffing level at the Valdez power plant is assumed to be reduced from 3 to 1.5 employees providing an annual savings of $145,500 when the Allison Lake Project comes on-line for the low and medium-low load forecast scenarios. No change in the existing staffing levels is assumed to occur at the Glennallen power plant because diesel generation is still required.

Under the projected medium-high and medium-low load growth cases, the next major overhaul for Valdez Unit 4 is assumed to be required in 1997. It is assumed that the unit would be retired and replaced with a 2,150 kW unit at that time. Valdez Unit 6 is also expected to be retired and replaced in 1998. The Glennallen Unit 6 would be retired and replaced at the time of its next scheduled overhaul in 1999. One new 2,150-kW unit is added in Glennallen in 1996. For the high load growth scenario, an additional new diesel generator is needed in Glennallen in 2006.

The total cumulative net present value of the annual costs for the Allison Lake Case for the medium-high load growth scenario is $71,989,000 and $60,596,000, $108,298,000 and $44,808,000 for the medium-low, high and low load forecasts, respectively.

4. Silver Lake Case

The Silver Lake Case assumes that the Silver Lake hydroelectric project is constructed and begins operation in 2001. This case also assumes that the Intertie is not constructed and that diesel generators are added as required to meet future power requirements. The reserve requirements for each load center are based on the ability to serve peak load with an outage on the transmission line between Glennallen and Valdez and an outage on the largest diesel generator which is currently 2,500 kW for each load center. Because of the long submarine transmission line interconnecting the Silver Lake Project to Valdez, the Silver Lake project is not assumed to provide firm capacity to CVEA. The Solomon Gulch Project and local diesel generators provide firm capacity. With the additional hydro energy available from Silver Lake, CVEA is assumed to be able to operate the Solomon Gulch Project reservoir to provide 6,500 kW during the winter peak period. The existing diesel generators in Glennallen provide 6,800 kW of firm capacity.

The current staffing level at the Valdez plant is assumed to be reduced to 1.5 employees providing an annual savings of $145,500 when the Silver Lake Project comes on-line. No change in the existing staffing levels is assumed to occur at the Glennallen plant because diesel generation is still required.

Under the projected high load growth case, Valdez Units 4 and 6 are retired and replaced in 1997 and 1998, respectively. Two new 2,150 kW diesel generators are projected to be added in Glennallen, one each in 1996 and 2006 for the high case. Unit 6 in Glennallen is retired and replaced in 1998 in the high load case. For the medium-high and medium-low cases, two units are retired and replaced in Valdez, one each in 1997 and 1998 and one unit is retired and replaced in Glennallen in 1999. A new unit is to be added in Glennallen in 1996 for these two scenarios and for the low load growth scenario.

The total cumulative net present value of the annual costs for the Silver Lake Case Option A project configuration is $74,929,000, $70,508,000, $108,298,000, and $67,992,000 for the medium-high, medium-low, high, and low load forecast scenarios, respectively. For the Option B configuration, the cumulative net present values are $76,720,000, $74,233,000, $108,600,000 and $67,992,000 for the medium-high, medium-low, and high and low load growth scenarios, respectively.

5. Glennallen Coal Project Case

The Coal Case assumes that a 22,000 kW coal facility is constructed in Valdez and begins operation by 1998. This case also assumes that the Intertie is not constructed and diesel generators would be added as required to meet any additional future power requirements. The reserve requirements for each load center are based on the ability to serve peak load with an outage on the transmission line between Glennallen and Valdez and an outage on the largest diesel generator which is currently 2,500 kW for each load center.

The current staffing levels at the Valdez and Glennallen plant are assumed to be reduced by 1.5 employees in 1998 at each site providing an annual savings of $291,000

Under all load growth cases, no new diesel generators are projected to be added in Valdez. One new unit is added in Glennallen in 1996 in all cases and a second, 2,150 kW unit is added in Glennallen in 2006 in the high case.

The total cumulative net present value of the annual costs for the Coal Case is $76,567,000, $77,062,000, $98,898,000 and $61,432,000 for the medium-high, medium-low, high, and low load forecast scenarios, respectively. Since the net annual costs of the coal facility are partially dependent on revenues received from the sale of district heating, the value of which is tied to oil prices, the cumulative present value for the medium-low load forecast scenario is lower than that for the medium-high load forecast scenario. Low oil price escalation is assumed in conjunction with the medium-low load forecast scenario.

6. Conservation Case

The Conservation Case assumes that the Intertie is not constructed and that conservation measures are implemented and diesel generators are added as needed to provide CVEA's power requirements. The conservation measures could be included in each case. However, a separate case has been developed to highlight the conservation impacts. The reserve requirements are the same as for the Diesel Case. During the winter peak, the firm capacity available from the Solomon Gulch Project is assumed to be 5,000 kW and the Valdez diesel plant is assumed to provide 9,750 kW. The Glennallen diesel plant is assumed to provide 6,800 kW.

The conservation programs identified in Section IX of this report are projected to be implemented beginning in 1994. The residential programs include (1) incentive payments for purchases of high-efficiency refrigerators and freezers and (2) the replacement of selected existing incandescent lights with compact fluorescent lights. The commercial programs include two lighting programs. The full implementation of these programs is expected to be completed over a 20-year period. Consequently, the total energy savings realized from the conservation measures are projected to gradually increase over time. The cost of the programs are also projected to be paid over the same period of time.

The retirement and replacement schedule for diesel generators and related facilities are the same as for the All Diesel Case for all load growth scenarios. This indicates that the conservation case does not provide enough capacity or energy reduction to delay the scheduled additions of new generating units.

The total cumulative present value of the annual costs for the Conservation Case under the medium-high and medium-low load growth scenarios is $84,098,000 and $67,777,000, respectively, representing only a slight savings from the costs of the All-Diesel Case. The Conservation Case was not run for the other resource alternatives, however, we would expect to see only minimal savings in the total cumulative present worth as is seen for the All Diesel Case.

Table X-2
Year of Generation Additions and Retirements
for the Alternative Resource Plans

	Load Forecast Scenario			
	High	**Medium-High**	**Medium-Low**	**Low**
ALL-DIESEL CASE				
Retirements				
Valdez Unit 4	1997	1997	1997	1997
Valdez Unit 5	1997	2000	2000	–
Valdez Unit 6	1998	1998	1998	1998
Glennallen Unit 6	1998	1999	1999	–
Replacements & Additions				
Valdez - 2,150 kW Diesel	1997(2), 1998, 2005, 2018	1997, 1998, 2000	1997, 1998, 2000	1997, 1998
Glennallen - 2,150 kW Diesel	1996, 1998, 2005	1996, 1999	1996, 1999	1996
INTERTIE CASE				
Retirements (None)				
Replacements & Additions				
Intertie	1999	1999	1999	1999
Valdez - 2,150 kW Diesel	2005			
Glennallen - 2,150 kW Diesel	2014			
ALLISON LAKE CASE				
Retirements				
Valdez Unit 4	1997	1997	1997	1997
Valdez Unit 5				
Valdez Unit 6	1998	1998	1998	
Glennallen Unit 6	1998	1999	1999	
Replacements & Additions				
Allison Lake Project	2000	2000	2000	2000
Valdez - 2,150 kW Diesel	1997, 1998	1997, 1998	1997, 1998	1997
Glennallen - 2,150 kW Diesel	1996,1998, 2006	1996, 1999	1996, 1999	1996

Table X-2
Year of Generation Additions and Retirements for the Alternative Resource Plans
(continued)

	Load Forecast Scenario			
	High	Medium-High	Medium-Low	Low
SILVER LAKE CASE				
Retirements				
Valdez Unit 4	1997	1997	1997	1997
Valdez Unit 5				
Valdez Unit 6	1998	1998	1998	
Glennallen Unit 6	1998	1999	1999	
Replacements & Additions				
Silver Lake Project	2001	2001	2001	2001
Valdez - 2,150 kW Diesel	1997, 1998,	1997, 1998	1997, 1998	1997
Glennallen - 2,150 kW Diesel	1996, 1998, 2006	1996, 1999	1996, 1999	1996
GLENNALLEN COAL PROJECT				
Retirements (None)				
Replacements & Additions				
Coal Project	1998	1998	1998	1998
Glennallen - 2,150 kW Diesel	1996, 2006	1996	1996	1996

E. COMPARISON OF ECONOMIC ANALYSIS RESULTS

Table X-3 provides a comparison of the cumulative present value of the comparable system costs over the full study period for the various resource scenarios for the high, medium-high, medium-low and low load growth scenarios. The high and medium-high load forecast cases shown in Table X-3 were evaluated assuming high escalation in fuel costs and the low and medium-low load forecast cases assumed low escalation in fuel costs. These cumulative present values can be compared within each column of the table, with the lowest value indicating the resource scenario which provides the greatest economic benefit relative to the other scenarios. As can be seen in Table X-3, the Intertie Case provides the lowest cumulative present value of all the resource scenarios for the high load growth scenario.

For the medium-high and medium-low load growth scenarios, the Allison Lake Case is the lowest cost resource scenario. For the low load growth scenario, the All Diesel Case is the lowest resource scenario. It should be noted that the cumulative present values for the Allison Lake and Intertie resource scenarios are very close for the medium-high and medium-low load growth scenarios. The Conservation Case shows only a slight benefit over the All Diesel Case in all load growth scenarios.

Table X-3
Summary of Economic Analysis
Cumulative Present Value of Comparable System Costs
($000)

Resource Scenario	Load Forecast/Fuel Price Scenario(1) High	Medium-High(2)	Medium-Low(2)	Low
All Diesel Case	121,562	84,771	67,853	39,565
Intertie Case	91,227	72,604	63,415	50,042
Allison Lake Case	108,298	71,989	60,596	44,808
Silver Lake A Case	108,376	74,929	70,508	63,462
Silver Lake B Case	108,600	76,720	74,233	67,992
Coal Facility Case	98,898	76,567	77,062	61,432
Conservation Case	120,690	84,098	67,777	39,775

(1) The high and medium-high load forecast scenarios are combined with the high fuel price scenario and the low and medium-low load forecast scenarios are combined with the low fuel price scenario in the economic analysis.
(2) The medium-high and medium-low cases vary only in the estimated energy requirements of the Petro Star refinery beginning in 2018 and in the fuel price scenario assumed.

A factor which is commonly used to quickly evaluate the relative costs of various resource alternatives is the benefit/cost ratio. This index divides the cumulative present value of the benefits of an alternative by the cumulative present value of the costs of the alternative. In the case of evaluating the various resource alternatives included in this study, the All Diesel case represents the benefits of an option and the specific option represents the costs. The All Diesel case is to be offset by the implementation of the resource option, therefore it represents the benefits. A benefit/cost ratio greater than 1.0 indicates that the benefits of the option exceed the costs. The following table shows the benefit cost ratios for the various resource options for each of the load forecast scenarios.

Table X-4
Comparison of Benefits and Costs
Benefit/Cost Ratios(1)

	Load Forecast/Fuel Price Scenario(2)			
Resource Scenario	**High**	**Medium-High(3)**	**Medium-Low(3)**	**Low**
All Diesel Case	1.00	1.00	1.00	1.00
Intertie Case	1.33	1.17	1.07	0.79
Allison Lake Case	1.12	1.18	1.12	0.88
Silver Lake A Case	1.12	1.13	0.96	0.62
Silver Lake B Case	1.12	1.10	0.91	0.58
Coal Facility Case	1.23	1.11	0.88	0.64
Conservation Case	1.01	1.01	1.00	0.99

(1) Benefit/cost ratios are calculated as the cumulative present value of the diesel alternative divided by the cumulative present value of the respective resource alternative. Benefit/cost ratios are calculated independently for each load forecast scenario.
(2) The high and medium-high load forecast scenarios are combined with the high fuel price scenario and the low and medium-low load forecast scenarios are combined with the low fuel price scenario.
(3) The medium-high and medium-low cases vary only in the estimated energy requirements of the Petro Star refinery beginning in 2018 and in the fuel price scenario assumed.

The results of the economic analysis are highly sensitive to adjustments in the forecasted load growth in CVEA's service area. Many assumptions and estimates have been used in developing the economic analysis and it must be acknowledged that if conditions are different than those that were assumed, the outcome of the analysis would be different. In addition to load growth, other factors which could significantly affect the economic analysis include the capital cost estimates of the various resources including the Intertie, the cost of fuel, the cost of power to be purchased by CVEA from Anchorage utilities and the amount of energy available from the Solomon Gulch Project.

Alternative capital cost scenarios were not included as part of this analysis. It is important to note when reviewing the results of the economic analysis that the level of detail employed in the development of the cost estimates for the various resources varies significantly. For instance, the cost estimates for the Allison Lake and Silver Lake projects that were used in this analysis were derived from previous reconnaissance level studies. Further, the costs associated with the Valdez coal project are considered very preliminary at this time and could vary significantly from the cost estimates used in this report. Although we have no indication whether the cost estimates for the diesel, coal and hydro projects are either high or low, we would attach a higher level of confidence to the Intertie cost estimate because it has been reviewed and developed in considerably greater detail.

F. COST OF POWER AND FINANCE CONSIDERATIONS

In Chapter 19, SLA 1993, the Alaska legislature appropriated $35.0 million to the Department of Community and Regional Affairs for payment as a loan to participating utilities for the design, and construction of a Sutton-Glennallen intertie. In addition, the legislation provides:

a. that the appropriation "is contingent upon the completion of a feasibility study and finance plan satisfactory to the Department of Community and Regional Affairs as set out in former AS 44.83.181," and

b. that the appropriation "is contingent on the participating utility or utilities and the Department of Community and Regional Affairs entering into an agreement for a loan at zero interest for a term of 50 years."

The 1993 Alaska legislature also authorized (in Chapter 18, Sec. 32) the issuance of up to $25.0 million in bonds by the Alaska Industrial Development and Export Authority "to finance the acquisition, design and construction of a power transmission intertie of at least 138 kilovolts between Sutton and Glennallen and owned, for the benefit of all of the utilities participating in the Intertie, by Copper Valley Electric Association."

For purposes of the economic analysis of this feasibility study, the value of the $35.0 million, zero interest, 50-year State loan is not deducted from the cost of the Intertie nor from any of the other resource alternatives per direction from the Division of Energy. The Division's reasoning is that, although a benefit-cost analysis conducted solely from the perspective of CVEA consumers would be limited to comparison of expected benefits and costs to CVEA, a benefit-cost analysis conducted from the perspective of the State of Alaska must consider all benefits and costs that would be borne by Alaskans. This would necessarily include any costs expected to be paid from the State treasury as well as costs expected to be paid directly by CVEA consumers.

In addition to the requirements for an overall economic analysis, regulations with respect to former AS 44.83.181 require that the feasibility study include "the estimated cost of power [for the proposed project] based on hypothetical financing conditions." Further, the regulations state (3 AAC 94.060(c)(6) and (7)):

1. that "various combinations of alternatives and timing will be evaluated to formulate plans which cost the least," and

2. that "cost of power" will be among the indicators used to evaluate each plan.

For this feasibility study, "cost of power" is assumed to mean the annual nominal wholesale cost per kWh to CVEA of generating and/or purchasing power delivered to the CVEA distribution system under each power supply scenario considered in the feasibility study, under hypothetical financing conditions, excluding costs that are common to all scenarios such as the purchase of Solomon Gulch energy, or depreciation of existing equipment. For example, the "cost of power" under the Intertie scenario is estimated by adding the following:

1. The sum of Intertie debt service, Intertie operation and maintenance expenses, and labor cost for maintenance of back-up diesel generation, divided by the number of kWh to be purchased over the Intertie.

2. The expected price per kWh to be paid to the Anchorage utility supplying the power to be purchased by CVEA, including estimated margins.

The cost of power has also been estimated for the Allison Lake scenario and the Glennallen Coal Project scenario. For each of these scenarios, the cost of power includes the cost of generation for the same amount of power as would be purchased over the Intertie. This amount of power is equal to CVEA's total energy requirement, less generation by the Solomon Gulch Project. If a scenario's primary resource is not large enough to supply the necessary net energy requirement, diesel generation is used to fulfill the remaining energy needs. The cost of power for each scenario includes all costs of generation and purchased power for that scenario.

A variant of the Allison Lake "cost of power" estimate is also presented based on the possibility that additional energy generated by the existing Solomon Gulch turbines due to the provision of additional water from Allison Lake will be assessed an additional wholesale charge of 6.4 cents per kWh, the existing wholesale power rate for the Four Dam Pool.

Additional discussions on the application of the $35.0 million state loan and the Four Dam Pool power cost is provided in Appendix L, attached to this report.

For this feasibility study, "cost of power" estimates have been developed to compare the various resource alternatives. These cost of power estimates are considered preliminary. A finance plan, presently being prepared for the Division, is expected to examine potential wholesale power costs for the different power supply alternatives in greater depth and detail. Certain additional assumptions and parameters should be noted for the "cost of power" estimates presented below:

1. Cost of power estimates are presented in this report only for two separate years; 2000 and 2010. In general, the difference between the cost of power estimates over time is related to the forecasted power requirements of CVEA and inflation impacts on fuel and other operating costs.

2. The cost of power estimates are highly sensitive to assumed load growth in the Copper Valley service territory. Cost of power is therefore estimated for all four load growth scenarios. As previously described for the economic analysis, the low and medium-low load forecast scenarios are combined with low fuel cost escalation and the high and medium-high load forecast scenarios are combined with the high fuel cost escalation.

3. The hypothetical financing conditions assumed for this analysis are as follows:

    a. The $35.0 million, zero interest, 50-year loan is used to finance the Intertie.

    While additional legislative action would be needed to use the $35.0 million appropriation for a project other than the Intertie, cases have been developed whereby the $35.0 million, zero-interest loan is used to finance the other capital intensive alternatives as well. The term of the state loan is reduced to 25 years for the proposed coal plant to correspond with its assumed repayment period. The full 50-year term is assumed to apply to Allison Lake. Diesel generators are not assumed to be financed with state loans in any scenario.

b. All supplemental financing is assumed to occur through issuance of debt at 7.5 percent interest and with repayment terms of 30 years for the Intertie and the hydroelectric projects, 20 years for diesel generators and 25 years for the coal project.

c. Costs are shown in nominal dollars based on an assumed 3.5 percent annual inflation rate.

d. Supplemental borrowed funds, if needed to fund capital costs, are assumed to be retained only after state loan monies are fully used. The estimated amount of these supplemental borrowings includes capitalized interest from the date of borrowing to the commercial operation date and a financing expense of 2.0% of the borrowed amount. Funds are assumed to be borrowed periodically as needed throughout construction.

The cost of power estimates have been developed using nominal costs (i.e., including inflation) as opposed to the use of constant dollar costs for the economic analysis. The cost of power includes all related fuel, operation and maintenance, applicable purchased power costs, and annual debt service costs. A critical element of the cost of power analysis is the estimation of annual debt service costs based on the estimated financing requirements of each resource alternative. For the Intertie, the estimated cost of construction of $47,604,000 in 1993 dollars is increased to $53,827,000 with assumed inflation during construction. It is further assumed that proceeds from the state loan would be used before supplemental debt is issued. The estimated supplemental borrowing would be $21,262,000 to cover remaining construction costs not funded with the state loan, pay interest during construction on the debt and pay the costs of issuance.

Total supplemental borrowing financing requirements for the Allison Lake Project, assuming a $35,000,000 state loan is available, are $2,518,000. Without the state loan, financing requirements for the Allison Lake Project are estimated to be $46,595,000. If the coal project could be funded with a $35,000,000 state loan, additional financing requirements would be $6,522,000. Without the state loan, the total financing requirements of the coal project would be $47,408,000.

The following table summarizes the cost of power projections for the resource alternatives under various load forecast and financing assumptions.

Table X-5
Estimated Cost of Power
(nominal cents/kWh)

	Load Forecast/Fuel Forecast Scenario(1)							
	High		Medium-High		Medium-Low		Low	
Resource Option	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
ALL DIESEL (2)	11.7	17.1	12.6	17.7	12.0	15.5	10.6	14.6
INTERTIE (3)	9.5	11.1	10.7	12.2	10.3	11.0	12.0	13.6
ALLISON LAKE								
State Loan (4)								
With Payment for Additional Solomon Gulch Energy (5)	10.1	13.6	10.1	12.5	9.9	11.6	9.2	10.4
Without Payment for Solomon Gulch Energy (6)	8.1	12.0	7.6	10.0	7.4	9.0	6.0	6.4
No State Loan (7)								
With Payment for Additional Solomon Gulch Energy (5)	16.4	18.1	18.0	19.3	17.8	18.3	19.5	21.3
Without Payment for Solomon Gulch Energy (6)	14.4	16.4	15.5	16.7	15.3	15.8	16.3	17.3
SILVER LAKE (8)								
State Loan (9)	10.0	11.8	11.2	10.3	11.2	10.3	13.5	14.0
No State Loan (10)	17.0	16.9	20.1	18.1	20.1	18.0	25.4	26.5
VALDEZ COAL PROJECT								
State Loan (11)	10.3	11.3	11.3	11.8	14.1	15.2	16.9	20.3
No State Loan (12)	15.2	14.6	17.3	16.9	17.7	18.3	21.6	25.3

(1) The high and medium load forecast scenarios assume the high fuel price scenario while the low and medium-low load forecast scenarios assume the low fuel price scenario.
(2) Assumes new diesel generating units are financed with revenue bonds. Includes estimated costs of new fuel storage system and switchyard improvements in 1999.
(3) Assumes capital cost of Intertie is financed with $35.0 million zero-interest state loan and $21.3 million of supplemental debt. Includes cost of power purchased from Anchorage utilities and estimated charges of 0.2 cent per kWh (1993 dollars) for transmission over MEA and CEA transmission lines.
(4) Assumes $35.0 million state loan is applied towards construction costs. Remaining capital costs of $2.5 million assumed to be financed with supplemental debt. It is assumed that the project comes on-line in 2000.
(5) Includes payments of 6.4 cents per kWh (pursuant to Four Dam Pool Power Sales Agreement) for additional energy generated at the Solomon Gulch Project resulting from water released into the Solomon Gulch reservoir from Allison Lake. Debt service component of 4.0 cents per kWh is held constant whereas O&M component is adjusted annually for inflation.
(6) Assumes additional power generated at the Solomon Gulch Project does not require any additional payment.
(7) Assumes Allison Lake Project is financed with $46.6 million of debt financing and no state loan is made available.
(8) Cost of power shown in the year 2000 column is for 2001, the first year of operation of the Silver Lake Project.
(9) Assumes $35.0 million state loan is applied towards construction costs. Remaining capital costs of $33.1 million assumed to be financed with supplemental debt.
(10) Assumes project is financed with $82.5 million of debt financing and that no state loan is made available.
(11) Assumes Coal Project is financed with $35.0 million zero-interest state loan and $6.5 million of supplemental debt.
(12) Assumes Coal Project is financed with $47.4 million of debt financing and that no state loan is made available.

BIBLIOGRAPHY

[1] Sutton to Glennallen 138 kV Transmission Intertie Project, Volumes 1 and 2, Final Report, prepared by Power Engineers, Inc. for Copper Valley Electric Association, January 1993.

[2] Railbelt Intertie Reconnaissance Study, Volumes 8a and 8b, Northeast Transmission Intertie Project, prepared by Power Engineers, Inc. for the Alaska Power Authority, June 1989.

[3] Meteorological Evaluation of the Proposed Palmer to Glennallen Transmission Line Route, No. MRI 82 FR-1868, prepared by Meteorological Research, Inc., for LEMCO Engineers in conjunction with the Cordova Power Supply Feasibility Study performed by Stone & Webster Engineering Corporation for the Alaska Power Authority, April 1982.

[4] Interim Report - Tyee Lake 138 kV Transmission Line Conductor, Structures & Foundations, Wrangell to Petersburg, prepared by Dryden & LaRue for the Alaska Energy Authority, December 1991.

[5] Guidelines for Electrical Transmission Line Structural Loading, ASCE Manuals and Reports on Engineering Practice No. 74, American Society of Civil Engineers, 1991.

[6] Cordova Power Supply Feasibility Study, prepared by Stone & Webster Engineering Corporation, for the Alaska Power Authority, 1982-1985.

[7] Design Review of Glennallen-Valdez 138-kV Transmission Line, Executive Summary, prepared by International Engineering Company for the Copper Valley Electric Association, 1985.

[8] Report on Problems on Anchorage-Fairbanks Intertie, letter report prepared by H. Brian White for the Alaska Energy Authority, February 1991.

[9] Design Manual for High Voltage Transmission Lines, Rural Electrification Administration Bulletin 1724E-2000, September 1992.

[10] Bradley 115 kV Transmission Lines, Basic Design Manual, prepared by Dryden & LaRue, Inc. for Stone & Webster Engineering Corporation, February 1986, revised November 1987.

[11] Draft Preliminary Market and Financial Assessment of the Lake Tyee to Swan Lake Intertie, by RSA Engineering, Inc. and R. W. Beck and Associates for the Alaska Energy Authority, December 27, 1990.

[12] Suggested Practices for Raptor Protection on Power Lines - The State of the Art in 1981, Raptor Research Report No. 4, Raptor Research Foundation, Inc. 1981.

[13] Anchorage-Fairbanks Transmission Intertie Structure Study for Alaska Power Authority, prepared by Commonwealth Associates, Inc. September 1981.

[14] Rental Rate Blue Book for Construction Equipment, DataQuest, January 1993.

[15[Feasibility Study of Transmission Line System Bradley Lake Hydroelectric Power Project, prepared for Alaska Power Authority by Dryden & LaRue, 1983.

[16] Bulletin No. 138, The Handy Whitman Index of Public Utility Construction Costs, Whitman, Requardt and Associates, July 1993.

Appendix A

ROUTE SELECTION EVALUATION DOCUMENTATION

Exhibit A-1 Transmission Line Routing Evaluation Criteria

Exhibit A-2 Routing Evaluation Scores and Ranking

Table S-1	Equal Weighting
Table S-2	High Financial Weighting
Table S-3	High Construction Weighting
Table S-4	High Land Use Weighting
Table S-5	High Environmental Weighting

Exhibit A-3 Route Evaluation Matrices

Tables A-1 thru A-4	Route Alternative A
Tables B-1 thru B-4	Route Alternative B
Tables C-1 thru C-4	Route Alternative C
Tables D-1 thru D-4	Route Alternative D

ALASKA ENERGY AUTHORITY

Copper Valley Intertie

Transmission Line Routing Evaluation Criteria

ENVIRONMENTAL CONSIDERATIONS

E-1 Potential Construction Impacts (Dust, Traffic, Noise)

Transmission line construction will create short-term construction impacts such as increased noise levels and generation of dust. Those traveling through the area where construction of the line is occurring may be affected by traffic disruption, and may be annoyed by short-term delays. Each 1,000-foot segment of line length adjacent to residences or roads represents one unit of measure. Because the impact will be temporary, a weight of 1 has been assigned to this criterion.

Construction-related traffic will occur all along the Glenn Highway and will result in short-term construction impacts even where the line is distant. All route alternatives have the same number of road crossings. These impacts, considered common to all route segments, were not evaluated separately.

E-2 Potential Habitat Damage or Need for Restoration

Areas with steep slopes are susceptible to erosion and gullying when vegetation is removed and machinery operates on the cleared areas. Effects from the resulting sedimentation are likely to affect adjacent habitat or water bodies. Special restoration measures are likely to be required to re-establish vegetative cover. Each 1,000-foot segment of line length that passes through steep terrain, defined for the purpose of this study as a 15° (27%) slope, and does not parallel paved roads represents one unit of measure. A weight of 3 has been assigned to this criterion.

E-3 Clearing in Wetland/Riparian Areas

Some clearing in wetlands or riparian areas may be necessary to provide access even though no structures would be placed in such areas. Any permanent clearing will reduce the amount of such habitat available to wildlife. Wetlands and riparian areas provide habitat of value to a large number of species, including a number of sensitive species. Each 1,000-foot segment of line length which may require some clearing in riparian or wetland areas represents one unit of measure. A weight of 5 has been assigned to this criterion, reflecting the high value of the habitat that may be affected.

E-4 Clearing in Treed Lands

The corridor has no significant commercial-value forest resources. West of Sheep Mountain in the Matanuska River Valley forests are dominated by cottonwood, birch, alder, and white spruce. East of Tahneta Pass forest cover is intermittent and dominated by relatively stunted black spruce. A bark beetle infestation is known to threaten the spruce stands, especially white spruce. Special right-of-way treatment will be required to prevent the spread of the bark beetle.

Clearing of trees on treed lands may cause significant impact due to habitat loss as well as aesthetic and recreational losses. The cleared right-of-way will, in some cases, provide another access trail for off-road vehicles with the possibility of increased hunting pressure and noise. In addition, reliability concerns may require clearing of a wider area to remove trees which could interfere with line operation. It is recognized that cleared lands may improve the habitat for certain species, e.g., moose. Each 1,000-foot segment of line length which may require clearing of trees represents one unit of measure. A weight of 5 has been assigned to this criterion.

E-5 Cultural Resource High Conflict Areas

Mapping indicates the majority of the study area has a high probability of including archaeological or historic resources. Siting of the line away from roads, other power lines, or developed areas increases the potential for impacts. Areas where archaeological or historic resources are known or likely to be present, such as along known historical trails, should be avoided if possible. Even if a site can be spanned, increased activity in an area increases risk of damage to the resources present. Each 1,000-foot segment through areas with high potential for cultural resource will represent one unit of measure. Where the line passes within 0.5 mile of a known trail will be counted as a conflict. A weight of 4 has been assigned to this criterion.

E-6 Residences Affected by Prominent Visual Intrusion

Where the line passes within 1,000 feet of a residence, it was considered to be an adverse impact on the aesthetic setting, except in cases where an existing utility line is present. Each residence within 1,000 feet of the transmission line center line represents one unit of measure. A weight of 5 has been assigned to this criterion.

E-7 Line Visually Prominent within Scenic Viewshed

Portions of the study area includes scenic viewsheds where the new transmission line could noticeably change the aesthetics of the visual environment and quality of the wilderness experience. Scenic viewsheds include back country valleys and trails used by snowmobilers and hikers. On trails in forested areas the line will generally not be visible except where the right-of-way crosses the trail or where the line is situated high up adjacent slopes above the trail user's line of sight. The line of sight down the right-of-way can be broken by line angles as one mitigation measure. On trails in broad, open valleys, such as Boulder and Squaw Creeks, the line will probably be visible for the entire length of trail. Each 1,000-foot segment of the line in visually sensitive areas represents one unit of measure. A weight of 5 has been assigned to this criterion.

E-8 Line Visually Prominent from Highway or Major Arterial

Travelers along the Glenn Highway, Lake Louise Road, and local roads in Sutton, Chickaloon, and other communities will be able to see the line where it crosses the road, where it parallels the road at close distance, or from some high vantage points where it appears in the viewshed. Each major road crossing is counted as three units and each 1,000-foot segment where the line route is judged to be probably visible from the road is counted as one unit. Where an existing line is present, the degradation of the visual environment was judged to be relatively minor and each 1,000-foot segment is counted as 0.5 units in this case. A weight of 5 has been assigned to this criterion.

E-9 Special Mitigation Requirements

Stream crossings will require special consideration to preserve spawning habitat and avoid siltation due to erosion. Eagles, peregrine falcons, trumpeter swans, and other waterfowl species will require special consideration during construction and in design to mitigate electrocution and line-bird strikes. Each eagle nest within 0.5 mile of a route segment is counted as one unit of measure; each 1,000-foot segment of line in a known migratory flyway will count as three units; each stream crossing will count as one unit of measure. A weight of 4 has been assigned to this criterion.

No flyway paths were identified explicitly for this study and a raptor survey is required to identify existing raptor nests.

E-10 Exposure to Electromagnetic Fields (EMF)

Power lines produce electromagnetic fields which, as a result of increased media attention and ongoing research regarding possible health affects, need to be addressed due to the public perception of possible impacts. This criterion is based upon distance from the line since the strength of the fields drops off rapidly and significantly. Where the transmission line passes within 600 feet of a known occupied structure it was considered to be a perceived impact and represents one unit of measure. A weight of 5 has been assigned to this criterion.

LAND USE CONSIDERATIONS

L-1 Private Land Parcels Affected by Acquisition

The effort to acquire right-of-way and any impact on land ownership is directly related to the number of private land parcels affected and the extent of right-of-way on private land. Each private land parcel crossed by the proposed right-of-way will represent one unit of measure and each 1,000-foot segment of right-of-way in private lands will represent an additional unit of measure. A weight of 5 has been assigned to this criterion.

Late in the study period it became evident that some estimated 100-200 unpatented mining claims exist in the Boulder Creek, Caribou Creek, Chitna Pass and Alfred Creek areas. Each claim holder would have to be dealt with individually.

L-2 Native Lands Affected by Acquisition

Some line route segments will pass through lands belonging to regional (Cook Inlet, Ahtna) and village (Chickaloon Moose Creek, Tazlina) native corporations. The effort to acquire right-of-way easements and any impact on land-ownership is related to the number of native corporations affected and the extent of right-of-way on native lands. Each separate, non-contiguous parcel occupied by the right-of-way and belonging to native corporations or similar groups will count as one unit of measure and each 1,000-foot segment on native lands as an additional unit of measure. BLM lands which have been selected by native corporations are included in this category, although some selected lands are part of an overselection and may not, ultimately, be conveyed to the native corporations. A weight of 5 has been assigned to this criterion.

L-3 State Lands

Study route alternatives pass through significant blocks of State land (about 70% of total length) and up to 13 miles of Mental Health Trust Lands. Discussions with ADNR Division of Lands staff indicated that obtaining right-of-way agreements in the Mental Health Trust Lands should not be an obstacle to proceeding with the Intertie as long as standard permitting procedures are followed and an equitable use fee is negotiated reflecting fair market values of the land in question. For the purposes of evaluating this criterion, Mental Health Trust Lands can be considered State land. Some BLM lands have been selected by the State and native groups but conveyance is pending. Any proposed development on these parcels will require approval of BLM as well as the selecting party. Each 1,000 ft segment of State land crossed by the right-of-way will count as one unit of measure. Each 1,000 ft segment of land currently belonging to BLM but selected by the State will count as two units of measure. A weight of 1 has been assigned to this criterion.

L-4 Land Use Impacts

In some areas the construction of a transmission line would have impacts to the existing or future land use. An example of conflict would be construction of a transmission line in an area that does not currently have roads or existing utility lines. A line, its right-of-way and associated access roads may increase public access to lands off Glenn Highway. Hunting pressure and noise impacts could increase. These impacts would be significantly less in areas with extensive access in place. Mining activities could be prohibited or limited in the right-of-way. Each 1,000-foot segment of line length represents one unit of measure. Other specific conflicts relate to the siting of the line adjacent to relatively high public use areas such as parks and schools. Each instance of this type would represent three units of measure but no such instance occurs for any of the route alternatives. A weight of 5 has been assigned to this criterion.

L-5 New Right-of-Way Requirements

A transmission line occupies space and can limit use of land within its designated right-of-way. Routing of lines can minimize this land use conflict by paralleling existing defined roadways or utilizing public lands to the maximum extent possible. Also, single pole structures, as opposed to multi-pole structures, minimize the quantity of land utilized. Each acre of new right-of-way required represents one unit of measure. A weight of 3 has been assigned to this criterion.

L-6 Special Restoration Efforts

Some areas characterized by steep terrain, with easily eroded soils, require special measures to ensure a successful revegetation effort if disturbed. Each 1,000-foot segment of line length with a slope of 15° (27%) or greater, i.e. in which special restoration efforts may be required represents one unit of measure. A weight of 1 has been assigned to this criterion.

CONSTRUCTION/ENGINEERING CONSIDERATIONS

C-1 Difficult Access (Construction/Maintenance)

Vehicle access is typically required to build and maintain a transmission line. Access can be divided into (1) access to the right-of-way and (2) access along the right-of-way. Difficult or poor access requires special construction techniques, extended construction time and complicated future maintenance. Due to the limited number of existing roads which intersect the right-of-way and the sensitive nature of the lands in the corridor, it is assumed that no new access roads will be pushed into the right-of-way. In Loading Zone 1 and portions of Loading Zone 3 it is assumed that a few access trails or roads could be upgraded. No new access roads in Loading Zone 4 were assumed.

Before the decision was made to abandon the notion of additional new access roads, we laid out a preliminary access road plan by which to evaluate this criterion. Each 1,000-foot length of estimated additional access road (not including access roads in the right-of-way) was counted as one unit of measure. East of Syncline Mountain no new access roads are assumed along with winter construction. This will, however, complicate maintenance during non-winter periods. A weight of 3 was applied to this criterion.

C-2 Remote Access

Some study route segments are too distant and remote to consider road construction as practical. These areas will rely almost exclusively on helicopter-assisted construction and maintenance. Each 1,000-foot segment of line length in Loading Zones 3 and 4 represents one unit of measure. A weight of 5 has been assigned to this criterion.

C-3 Travel Distance from Glenn Highway

The travel distance of a line segment from the Glenn Highway will affect costs to build and maintain the Intertie. Travel distances to the right-of-way were estimated and each 1,000-foot length of travel distance was counted as one unit of measure with a weight of 1.

C-4 Engineering Constraints (Terrain)

Line segments located in terrain with extreme change in elevation, along irregular alignments, in areas susceptible to avalanche damage, and across major streams or rivers will require special engineering considerations and structure types/design. Each 1,000-foot segment of line length represents one unit of measure; each occurrence of a known avalanche chute and major stream or river crossing will count as three units of measure. A weight of 3 has been assigned to this criterion.

C-5 Road/Utility Crossings

The crossing of a major arterial or electric transmission line often complicates design, permitting, construction, and maintenance of the line since this may involve non-standard structures, greater electrical clearances, and special construction methods. Each crossing represents one unit of measure. A weight of 2 has been assigned to this criterion.

C-6 Line Angles (PIs)

Angles structures will be guyed, resulting in greater construction and maintenance costs. Special features in the terrain, such as extreme elevation changes, may also result in a need to dead-end or add guys. Each of these conditions adds to the complexity of design, construction, and maintenance. Each structure represents one unit of measure. A weight of 2 has been assigned to this criterion.

C-7 Line Reliability

Line segments at high elevations and subject to microclimates of unknown severity must carry a higher risk of failure and outages than line segments whose loading conditions are better known. Areas of permafrost may subject structures to jacking forces which would not, however, be expected to cause an unscheduled outage. Each 1,000-foot segment above El 2000 and below El 3000 is counted as one unit of measure; above El 3000 is counted as three units of measure. A weight of 4 has been assigned to this criterion.

C-8 Service to Future MEA Substation

MEA has considered plans to install a distribution substation in the vicinity of mile 100 on Glenn Highway. Routes that pass far to the north (e.g., Segment S 4-7, etc.) make feeding a future substation difficult. This impact is not considered. A weight of 0 has been assigned to this criterion.

FINANCIAL CONSIDERATIONS

F-1 Construction Cost - Loading Zone 1

This accounts directly for the cost to develop and construct the Intertie in Loading Zone 1, assumed at $300,000 per mile. A weight of 0.2 was used to obtain results on the same order of magnitude as other categories.

F-2 Construction Cost - Loading Zone 2

This accounts directly for the cost to develop and construct the Intertie in Loading Zone 2, assumed at $300,000 per mile. A weight of 0.2 was used to obtain results on the same order of magnitude as other categories.

F-3 Construction Cost - Loading Zone 3

This accounts directly for the cost to develop and construct the Intertie in Loading Zone 3, assumed at $375,000 per mile. A weight of 0.2 was used to obtain results on the same order of magnitude as other categories.

F-4 Construction Cost - Loading Zone 4

This accounts directly for the cost to develop and construct the Intertie in Loading Zone 4, assumed at $425,000 per mile. A weight of 0.2 was used to obtain results on the same order of magnitude as other categories.

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

TABLE S-1

ROUTING EVALUATION SCORES AND RANKING

ROUTE ALTERNATIVE	ENVIRONMENTAL Weight = 2		LAND USE Weight = 2		CONSTRUCTION Weight = 2		FINANCIAL Weight = 2	
	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX
A	6241	2.14	7388	2.00	6809	2.51	8866	2.070
B	7106	2.43	7471	2.02	5417	2.00	8565	2.000
C	7451	2.55	7607	2.06	5939	2.19	8832	2.062
D	5838	2.00	7402	2.00	6398	2.36	8669	2.024

SCORE TOTAL

ROUTE	SCORE	RANK
A	29304	3
B	28559	2
C	29829	4
D	28307	1

INDEX TOTAL

ROUTE	INDEX	RANK
A	8.72	3
B	8.46	2
C	8.87	4
D	8.39	1

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

TABLE S-2

ROUTING EVALUATION SCORES AND RANKING

ROUTE ALTERNATIVE	ENVIRONMENTAL		LAND USE		CONSTRUCTION		FINANCIAL	
	Weight= 2		Weight= 2		Weight= 2		Weight= 5	
	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX
A	6241	2.14	7388	2.00	6809	2.51	8866	5.176
B	7106	2.43	7471	2.02	5417	2.00	8565	5.000
C	7451	2.55	7607	2.06	5939	2.19	8832	5.156
D	5838	2.00	7402	2.00	6398	2.36	8669	5.061

SCORE TOTAL		
ROUTE	SCORE	RANK
A	29304	3
B	28559	2
C	29829	4
D	28307	1

INDEX TOTAL		
ROUTE	INDEX	RANK
A	11.83	3
B	11.46	2
C	11.96	4
D	11.43	1

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

TABLE S-3

ROUTING EVALUATION SCORES AND RANKING

ROUTE ALTERNATIVE	ENVIRONMENTAL Weight = 2		LAND USE Weight = 2		CONSTRUCTION Weight = 5		FINANCIAL Weight = 2	
	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX
A	6241	2.14	7388	2.00	6809	6.28	8866	2.070
B	7106	2.43	7471	2.02	5417	5.00	8565	2.000
C	7451	2.55	7607	2.06	5939	5.48	8832	2.062
D	5838	2.00	7402	2.00	6398	5.90	8669	2.024

SCORE TOTAL		
ROUTE	SCORE	RANK
A	29304	3
B	28559	2
C	29829	4
D	28307	1

INDEX TOTAL		
ROUTE	INDEX	RANK
A	12.49	4
B	11.46	1
C	12.16	3
D	11.93	2

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

TABLE S-4

ROUTING EVALUATION SCORES AND RANKING

ROUTE ALTERNATIVE	ENVIRONMENTAL Weight= 2		LAND USE Weight= 5		CONSTRUCTION Weight= 2		FINANCIAL Weight= 2	
	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX
A	6241	2.14	7388	5.00	6809	2.51	8866	2.070
B	7106	2.43	7471	5.06	5417	2.00	8565	2.000
C	7451	2.55	7607	5.15	5939	2.19	8832	2.062
D	5838	2.00	7402	5.01	6398	2.36	8669	2.024

SCORE TOTAL

ROUTE	SCORE	RANK
A	29304	3
B	28559	2
C	29829	4
D	28307	1

INDEX TOTAL

ROUTE	INDEX	RANK
A	11.72	3
B	11.49	2
C	11.96	4
D	11.40	1

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

TABLE S-5

ROUTING EVALUATION SCORES AND RANKING

ROUTE ALTERNATIVE	ENVIRONMENTAL Weight= 5		LAND USE Weight= 2		CONSTRUCTION Weight= 2		FINANCIAL Weight= 2	
	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX	SCORE	WT INDEX
A	6241	5.34	7388	2.00	6809	2.51	8866	2.070
B	7106	6.09	7471	2.02	5417	2.00	8565	2.000
C	7451	6.38	7607	2.06	5939	2.19	8832	2.062
D	5838	5.00	7402	2.00	6398	2.36	8669	2.024

SCORE TOTAL		
ROUTE	SCORE	RANK
A	29304	3
B	28559	2
C	29829	4
D	28307	1

INDEX TOTAL		
ROUTE	INDEX	RANK
A	11.93	2
B	12.11	3
C	12.70	4
D	11.39	1

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE A EVALUATION MATRIX

TABLE A-1

ENVIRONMENTAL CONSIDERATIONS

EVALUATION CRITERIA:		E-1		E-2		E-3		E-4		E-5		E-6		E-7		E-8		E-9		E-10		
WEIGHT:		1		3		5		5		4		5		5		5		4		5		
UNIT:		1000'		1000'		1000'		1000'		1000'		Each		1000'		Each/1000'		Each/1000'		Each		SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	2	2.0	0	0.0	5	25.0	23	116.5	4	14.8	8	40.0	0	0	17	83.5	2	8.0	8	40	329.8
2-3	59980.8	1	1.0	0	0.0	4	18.5	40	197.5	5	21.2	0	0.0	23	114	0	0.0	6	24.0	0	0	375.7
3-4	35270.4	0	0.0	0	0.0	8	39.5	28	139.5	21	84.4	0	0.0	24	119	0	0.0	5	20.0	0	0	402.4
4-7	71438.4	0	0.0	0	0.0	29	145.0	31	155.5	71	285.6	0	0.0	71	357	0	0.0	10	40.0	0	0	983.1
7-8	66105.6	0	0.0	0	0.0	10	47.5	2	10.0	66	264.4	0	0.0	66	331	0	0.0	4	16.0	0	0	668.4
8-10	7603.2	0	0.0	0	0.0	5	25.0	0	1.0	8	30.4	0	0.0	8	38	0	0.0	3	12.0	0	0	106.4
10-15	66580.8	0	0.0	0	0.0	1	5.0	2	10.0	59	235.6	0	0.0	67	333	0	0.0	12	48.0	0	0	631.6
15-17	33052.8	0	0.0	0	0.0	2	7.5	0	0.0	33	132.4	0	0.0	33	166	0	0.0	6	24.0	0	0	329.4
17-19	47836.8	0	0.0	0	0.0	21	105.0	0	0.0	11	42.4	0	0.0	4	21	0	0.0	3	12.0	0	0	180.4
19-20	64046.4	0	0.0	0	0.0	26	129.5	32	160.0	0	0.0	0	0.0	0	0	0	0.0	3	12.0	0	0	301.5
20-22	26347.2	0	0.0	0	0.0	12	60.5	16	77.5	5	21.2	0	0.0	11	56	0	0.0	1	4.0	0	0	218.7
22-26	71596.8	1	1.0	0	0.0	24	119.0	63	315.0	0	0.0	0	0.0	0	0	11	54.5	8	32.0	0	0	521.5
26-27	42081.6	0	0.0	0	0.0	15	76.5	34	168.5	0	0.0	0	0.0	0	0	0	0.0	6	24.0	0	0	269.0
27-28	34003.2	0	0.0	0	0.0	24	117.5	27	136.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0	253.5
28-29	13728.0	1	1.0	0	0.0	7	33.0	13	62.5	0	0.0	0	0.0	3	16	11	54.5	0	0.0	0	0	167.0
29-30	40656.0	0	0.0	0	0.0	9	42.5	24	119.0	37	148.0	0	0.0	37	185	0	0.0	2	8.0	0	0	502.5
Total (ft)	709,685	5.0	5	0.0	0	199.3	997	333.7	1669	320.1	1280	8.0	40	346.8	1734	38.5	193	71.0	284	8.0	40	
Total (mi)	134.41																					

ENVIRONMENTAL TOTAL: 6240.9

ENVIRONMENTAL CONSIDERATIONS			
E-1	Potential Construction Impacts (Dust, Traffic, Noise)	E-6	Residences Affected by Prominent Visual Intrusion
E-2	Potential Habitat Damage or Need for Restoration	E-7	Line Visually Prominent within Scenic Viewshed
E-3	Clearing Riparian/Wetland Areas	E-8	Line Visually Prominent from Highway or Major Arterial
E-4	Clearing in Treed Lands	E-9	Special Mitigation Requirements
E-5	Cultural Resource Conflict Areas	E-10	Exposure to Electromagnetic Fields (EMF)

EXHIBIT A-3

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE A EVALUATION MATRIX

TABLE A-2

LAND USE CONSIDERATIONS

EVALUATION CRITERIA:		L-1		L-2		L-3		L-4		L-5		L-6		LAND USE SUBTOTAL
	WEIGHT:		5		5		3		5		3		1	
	UNIT:	Each/1000'		Each/1000'		Each		Each/1000'		Acres		1000 ft		
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	
1-2	29356.8	0	0	2	7.5	3	9.9	11	52.8	84	252.7	0	0.0	322.9
2-3	59980.8	0	0	0	0.0	11	34.2	12	61.8	172	516.4	11	10.5	622.9
3-4	35270.4	0	0	0	0.0	7	20.1	12	58.4	101	303.6	5	4.8	386.9
4-7	71438.4	0	0	0	0.0	11	32.4	15	72.7	205	615.0	5	5.2	725.3
7-8	66105.6	0	0	0	0.0	13	37.5	14	67.6	190	569.1	3	2.6	676.8
8-10	7603.2	0	0	0	0.0	1	4.2	2	12.2	22	65.5	0	0.0	81.9
10-15	66580.8	0	0	0	0.0	20	61.2	14	68.1	191	573.2	2	1.6	704.0
15-17	33052.8	0	0	0	0.0	12	35.7	7	36.3	95	284.5	0	0.0	356.5
17-19	47836.8	0	0	0	0.0	9	27.3	10	50.3	137	411.8	1	1.3	490.7
19-20	64046.4	0	0	0	0.0	12	36.3	13	65.7	184	551.4	0	0.0	653.3
20-22	26347.2	0	0	0	0.0	5	15.0	6	30.0	76	226.8	0	0.0	271.8
22-26	71596.8	0	0	0	0.0	14	40.8	15	72.8	205	616.4	0	0.0	730.0
26-27	42081.6	0	0	0	0.0	8	24.0	9	44.9	121	362.3	0	0.0	431.1
27-28	34003.2	0	0	6	30.0	1	4.2	7	37.2	98	292.7	0	0.0	364.1
28-29	13728.0	0	0	4	18.0	0	0.0	4	18.0	39	118.2	0	0.0	154.2
29-30	40656.0	0	0	8	41.5	0	0.0	8	41.6	111	332.7	0	0.0	415.8
Total (ft)	709,685	0	0	19.4	97	127.6	383	158.0	790	2030.8	6092	26.0	26	
Total (miles)	134.41													

LAND USE TOTAL: 7388.2

LAND USE CONSIDERATIONS	
L-1	Private Land Parcels Affected by Aquisition
L-2	Native Lands Affected by Aquisition
L-3	State Lands
L-4	Land Use Impacts
L-5	New Right-of-Way Requirements
L-6	Special Restoration Efforts

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE A EVALUATION MATRIX

TABLE A-3

CONSTRUCTION/ENGINEERING CONSIDERATIONS

EVALUATION CRITERIA:		C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		
WEIGHT:		4		5		2		3		2		2		4		0		
UNIT:		1000 ft		1000 ft		1000 ft		1000 ft		Each		Each		1000 ft		Each		
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	SUB -TOTAL
1-2	29356.8	8	31.2	0	0.0	8	15.8	9	26	1	2	6	12	1	4	0	0	90.6
2-3	59980.8	18	72.4	0	0.0	24	47.5	11	34	0	0	3	6	35	141	0	0	301.1
3-4	35270.4	11	44.7	0	0.0	24	47.5	6	18	0	0	3	6	18	72	0	0	187.8
4-7	71438.4	0	0.0	71	357.2	26	52.8	25	74	0	0	12	24	104	416	0	0	924.0
7-8	66105.6	0	0.0	66	330.5	79	158.4	44	133	0	0	9	18	159	636	0	0	1275.1
8-10	7603.2	0	0.0	8	38.0	79	158.4	0	0	0	0	1	2	7	30	0	0	228.0
10-15	66580.8	0	0.0	67	332.9	69	137.3	32	95	0	0	8	16	143	570	0	0	1151.7
15-17	33052.8	0	0.0	0	0.0	32	63.4	3	9	0	0	4	8	99	397	0	0	477.6
17-19	47836.8	0	0.0	0	0.0	32	63.4	27	81	0	0	3	6	107	428	0	0	578.8
19-20	64046.4	0	0.0	0	0.0	18	37.0	0	0	0	0	2	4	106	424	0	0	465.4
20-22	26347.2	0	0.0	0	0.0	11	21.1	0	0	0	0	3	6	26	106	0	0	132.7
22-26	71596.8	0	0.0	0	0.0	16	31.7	60	179	2	4	3	6	117	468	0	0	688.8
26-27	42081.6	0	0.0	0	0.0	21	42.2	3	9	0	0	3	6	40	158	0	0	215.6
27-28	34003.2	0	0.0	0	0.0	0	0.0	0	0	0	0	1	2	14	57	0	0	59.2
28-29	13728.0	0	0.0	0	0.0	0	0.0	0	0	1	2	1	2	0	0	0	0	4.0
29-30	40656.0	0	0.0	0	0.0	7	13.2	3	9	0	0	3	6	0	0	0	0	28.2
Total (ft)	709,685	37.1	148	211.7	1059	444.8	890	222	667	4	8	65	130	977	3907	0	0	
Total (miles)	134.41																	

CONSTRUCTION/ENGINEERING TOTAL: 6808.5

CONSTRUCTION/ENGINEERING CONSIDERATIONS			
C-1	Difficult Access (Construction/Maintenance)	C-5	Road/Utility Crossings
C-2	Remote Access	C-6	Line Angles over 30 Degrees or Complex Structures
C-3	Joint Construction with Other Utilities	C-7	Line Reliability
C-4	Engineering Constraints	C-8	Service to Future MEA Substations

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE A EVALUATION MATRIX

TABLE A-4

FINANCIAL CONSIDERATIONS

EVALUATION CRITERIA:		F-1		F-2		F-3		F-4		FINANCIAL
WEIGHT:		0.2		0.2		0.2		0.2		
UNIT:		300	k/mi	300	k/mi	375	k/mi	430	k/mi	
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	SUBTOTAL
1-2	29356.8	5.6	333.6	0.0	0.0	0.0	0.0	0.0	0.0	333.6
10-15	66580.8	0.0	0.0	0.0	0.0	12.6	945.8	0.0	0.0	945.8
15-17	33052.8	0.0	0.0	0.0	0.0	6.3	469.5	0.0	0.0	469.5
17-17A	16896.0	0.0	0.0	0.0	0.0	3.2	240.0	0.0	0.0	240.0
17A-19	30940.8	0.0	0.0	5.9	351.6	0.0	0.0	0.0	0.0	351.6
19-20	64046.4	0.0	0.0	12.1	727.8	0.0	0.0	0.0	0.0	727.8
2-3	59980.8	11.4	681.6	0.0	0.0	0.0	0.0	0.0	0.0	681.6
20-22	26347.2	0.0	0.0	5.0	299.4	0.0	0.0	0.0	0.0	299.4
22-26	71596.8	0.0	0.0	13.6	813.6	0.0	0.0	0.0	0.0	813.6
26-27	42081.6	0.0	0.0	8.0	478.2	0.0	0.0	0.0	0.0	478.2
27-28	34003.2	0.0	0.0	6.4	386.4	0.0	0.0	0.0	0.0	386.4
28-29	13728.0	0.0	0.0	2.6	156.0	0.0	0.0	0.0	0.0	156.0
29-30	40656.0	0.0	0.0	7.7	462.0	0.0	0.0	0.0	0.0	462.0
3-4	35270.4	6.7	400.8	0.0	0.0	0.0	0.0	0.0	0.0	400.8
4-4A	15417.6	2.9	175.2	0.0	0.0	0.0	0.0	0.0	0.0	175.2
4A-7	56020.8	0.0	0.0	0.0	0.0	10.6	795.8	0.0	0.0	795.8
7-7A	48945.6	0.0	0.0	0.0	0.0	0.0	0.0	9.3	797.2	797.2
7A-8	17160.0	0.0	0.0	0.0	0.0	3.3	243.8	0.0	0.0	243.8
8-10	7603.2	0.0	0.0	0.0	0.0	1.4	108.0	0.0	0.0	108.0
Total (ft)	709,685	26.5	1591.2	61.3	3675.0	37.4	2802.8	9.3	797.2	
Total (miles)	134.41									

FINANCIAL TOTAL: 8866.2

FINANCIAL CONSIDERATIONS	
F-1	Construction Cost - Loading Zone 1
F-2	Construction Cost - Loading Zone 2
F-3	Construction Cost - Loading Zone 3
F-4	Construction Cost - Loading Zone 4

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE B EVALUATION MATRIX

TABLE B-1

ENVIRONMENTAL CONSIDERATIONS

EVALUATION CRITERIA:		E-1		E-2		E-3		E-4		E-5		E-6		E-7		E-8		E-9		E-10		
WEIGHT:		1		3		5		5		4		5		5		5		4		5		
UNIT:		1000'		1000'		1000'		1000'		1000'		Each		1000'		Each/1000'		Each/1000'		Each		SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	2	2.0	0	0.0	5	25.0	23	116.5	4	14.8	8	40.0	0	0	17	83.5	2	8.0	8	40	329.8
2-31	34742.4	0	0.0	0	0.0	11	52.5	30	152.0	15	61.2	0	0.0	23	116	0	0.0	4	16.0	0	0	397.7
3-4	35270.4	0	0.0	0	0.0	8	39.5	28	139.5	21	84.4	0	0.0	24	119	0	0.0	5	20.0	0	0	402.4
4-5	43084.8	0	0.0	0	0.0	3	16.0	19	94.5	38	152.4	0	0.0	38	191	7	35.5	5	20.0	0	0	508.9
5-6	49209.6	0	0.0	0	0.0	7	37.0	11	55.0	7	27.6	0	0.0	12	58	11	53.0	9	36.0	0	0	266.6
6-9	24868.8	0	0.0	0	0.0	8	42.0	13	66.0	22	88.8	0	0.0	17	85	0	0.0	3	12.0	0	0	293.3
9-11	38913.6	0	0.0	0	0.0	8	40.0	10	50.5	8	31.6	0	0.0	4	20	0	0.0	6	24.0	0	0	166.1
11-12	25027.2	0	0.0	0	0.0	1	5.0	9	42.5	25	100.0	0	0.0	25	125	0	0.0	7	28.0	0	0	300.5
12-13	16579.2	0	0.0	0	0.0	1	5.0	9	42.5	11	44.4	0	0.0	11	56	8	40.5	4	16.0	0	0	203.9
13-14	17424.0	0	0.0	0	0.0	2	10.0	1	2.5	12	46.4	0	0.0	17	87	15	74.0	2	8.0	0	0	227.9
14-16	32736.0	0	0.0	0	0.0	2	10.0	2	10.0	3	10.4	0	0.0	13	64	33	163.5	6	24.0	0	0	281.4
16-18	31099.2	0	0.0	0	0.0	10	50.0	2	9.5	11	42.4	0	0.0	17	87	17	87.0	3	12.0	0	0	287.9
18-21	72600.0	0	0.0	0	0.0	22	111.0	36	181.5	0	0.0	0	0.0	0	0	12	58.0	6	24.0	0	0	374.5
21-23	27403.2	0	0.0	0	0.0	15	74.0	18	90.5	11	42.4	0	0.0	13	64	27	137.0	1	4.0	0	0	411.4
23-24	31785.6	1	1.0	0	0.0	10	47.5	29	143.0	0	0.0	0	0.0	27	135	35	174.0	1	4.0	0	0	504.0
24-25	25766.4	0	0.0	0	0.0	8	39.5	10	48.5	0	0.0	0	0.0	0	0	19	92.5	1	4.0	0	0	184.5
25-26	11985.6	0	0.0	0	0.0	8	39.5	10	48.0	0	0.0	0	0.0	0	0	12	60.0	2	8.0	0	0	155.5
26-27	42081.6	0	0.0	0	0.0	15	76.5	34	168.5	0	0.0	0	0.0	0	0	0	0.0	6	24.0	0	0	269.0
27-29	47784.0	1	1.0	0	0.0	40	198.0	38	191.0	31	122.4	0	0.0	25	123	11	54.5	0	0.0	0	0	689.9
29-30	40656.0	0	0.0	0	0.0	9	42.5	24	119.0	37	148.0	0	0.0	37	185	0	0.0	2	8.0	0	0	502.5
31-3	31099.2	0	0.0	0	0.0	0	0.0	27	136.0	13	52.8	0	0.0	31	156	0	0.0	1	4.0	0	0	348.3
Total (ft)	709,474	4.0	4.0	0.0	0	192.1	961	381.4	1907	267.5	1070	8.0	40	333.5	1668	222.6	1113	76.0	304	8.0	40	
Total (mi)	134.37																					

ENVIRONMENTAL TOTAL: 7106.0

ENVIRONMENTAL CONSIDERATIONS			
E-1	Potential Construction Impacts (Dust, Traffic, Noise)	E-6	Residences Affected by Prominent Visual Intrusion
E-2	Potential Habitat Damage or Need for Restoration	E-7	Line Visually Prominent within Scenic Viewshed
E-3	Clearing Riparian/Wetland Areas	E-8	Line Visually Prominent from Highway or Major Arterial
E-4	Clearing in Treed Lands	E-9	Special Mitigation Requirements
E-5	Cultural Resource Conflict Areas	E-10	Exposure to Electromagnetic Fields (EMF)

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE B EVALUATION MATRIX

TABLE B-2

LAND USE CONSIDERATIONS

EVALUATION CRITERIA:		L-1		L-2		L-3		L-4		L-5		L-6		LAND USE SUBTOTAL
WEIGHT:		5		5		3		5		3		1		
UNIT:		Each/1000'		Each/1000'		Each		Each/1000'		Acres		1000 ft		
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	
1-2	29356.8	0	0	2	7.5	3	9.9	11	52.8	84	252.7	0	0.0	322.9
2-31	34742.4	0	0	0	0.0	7	19.8	12	57.9	100	299.1	0	0.0	376.8
3-4	35270.4	0	0	0	0.0	7	20.1	12	58.4	101	303.6	5	4.8	386.9
4-5	43084.8	0	0	0	0.0	6	18.6	11	55.8	109	328.2	0	0.0	402.6
5-6	49209.6	0	0	3	13.5	8	22.8	10	50.6	144	431.6	15	14.5	533.0
6-9	24868.8	0	0	5	26.0	0	0.0	6	28.6	71	214.1	3	2.6	271.2
9-11	38913.6	0	0	2	8.5	7	20.1	8	41.9	112	335.0	7	7.1	412.6
11-12	25027.2	0	0	0	0.0	5	14.1	8	38.7	72	215.5	0	0.0	268.3
12-13	16579.2	0	0	0	0.0	3	9.3	4	20.7	48	142.7	0	0.0	172.7
13-14	17424.0	0	0	0	0.0	3	7.5	6	31.5	50	150.0	0	0.0	189.0
14-16	32736.0	0	0	0	0.0	12	37.2	7	36.0	94	281.8	0	0.0	355.0
16-18	31099.2	0	0	0	0.0	6	18.6	7	34.5	89	267.7	0	0.0	320.8
18-21	72600.0	0	0	0	0.0	14	41.4	15	73.8	208	625.0	0	0.0	740.2
21-23	27403.2	0	0	0	0.0	5	15.6	8	41.0	79	235.9	0	0.0	292.5
23-24	31785.6	0	0	0	0.0	6	18.0	7	35.1	91	273.6	0	0.0	326.7
24-25	25766.4	0	0	0	0.0	5	14.7	6	29.4	74	221.8	0	0.0	265.9
25-26	11985.6	0	0	0	0.0	2	6.9	3	16.4	34	103.2	0	0.0	126.4
26-27	42081.6	0	0	0	0.0	8	24.0	9	44.9	121	362.3	0	0.0	431.1
27-29	47784.0	0	0	6	28.5	4	13.2	10	50.3	137	411.4	0	0.0	503.3
29-30	40656.0	0	0	8	41.5	0	0.0	8	41.6	111	332.7	0	0.0	415.8
31-3	31099.2	1	6	3	13.8	5	14.7	11	54.5	89	267.7	0	0.0	356.9
Total (ft)	709,474	1	6	27.9	139	115.5	347	178.8	894	2018.6	6056	29.0	29	
Total (miles)	134.37													

LAND USE TOTAL: 7470.7

LAND USE CONSIDERATIONS			
L-1	Private Land Parcels Affected by Aquisition	L-4	Land Use Impacts
L-2	Native Lands Affected by Aquisition	L-5	New Right-of-Way Requirements
L-3	State Lands	L-6	Special Restoration Efforts

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE B EVALUATION MATRIX

TABLE B-3

CONSTRUCTION/ENGINEERING CONSIDERATIONS

EVALUATION CRITERIA:		C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		
WEIGHT:		4		5		2		3		2		2		4		0		
UNIT:		1000 ft		1000 ft		1000 ft		1000 ft		Each		Each		1000 ft		Each		SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	8	31.2	0	0.0	8	15.8	9	26	1	2	6	12	1	4	0	0	90.6
2-31	34742.4	9	36.3	0	0.0	13	26.4	6	18	0	0	4	8	1	4	0	0	92.7
3-4	35270.4	11	44.7	0	0.0	24	47.5	6	18	0	0	3	6	18	72	0	0	187.8
4-5	43084.8	11	45.3	0	0.0	16	31.7	11	34	0	0	3	6	46	186	0	0	302.5
5-6	49209.6	9	34.8	21	107.4	8	15.8	28	85	0	0	6	12	114	457	0	0	711.5
6-9	24868.8	5	20.0	25	124.3	11	21.1	11	33	0	0	4	8	33	133	0	0	339.6
9-11	38913.6	0	0.0	39	194.6	53	105.6	15	45	0	0	5	10	41	164	0	0	518.8
11-12	25027.2	1	4.0	25	125.1	24	47.5	0	0	0	0	5	10	25	99	0	0	285.9
12-13	16579.2	0	0.0	0	0.0	13	26.4	0	0	0	0	3	6	17	66	0	0	98.8
13-14	17424.0	0	0.0	0	0.0	13	26.4	20	61	0	0	4	8	52	209	0	0	304.4
14-16	32736.0	0	0.0	0	0.0	11	21.1	0	0	0	0	3	6	98	392	0	0	419.5
16-18	31099.2	0	0.0	0	0.0	8	15.8	0	0	0	0	0	0	73	293	0	0	309.0
18-21	72600.0	0	0.0	0	0.0	16	31.7	9	26	0	0	3	6	148	593	0	0	656.4
21-23	27403.2	0	0.0	0	0.0	8	15.8	0	0	0	0	4	8	28	110	0	0	133.8
23-24	31785.6	0	0.0	0	0.0	11	21.1	32	95	1	2	4	8	32	127	0	0	253.7
24-25	25766.4	0	0.0	0	0.0	8	15.8	26	77	0	0	1	2	26	103	0	0	198.4
25-26	11985.6	0	0.0	0	0.0	13	26.4	0	0	0	0	2	4	12	48	0	0	78.8
26-27	42081.6	0	0.0	0	0.0	21	42.2	3	9	0	0	3	6	40	158	0	0	215.6
27-29	47784.0	0	0.0	0	0.0	8	15.8	0	0	1	2	4	8	24	97	0	0	122.6
29-30	40656.0	0	0.0	0	0.0	7	13.2	3	9	0	0	3	6	0	0	0	0	28.2
31-3	31099.2	8	32.3	0	0.0	13	26.4	0	0	0	0	5	10	0	0	0	0	68.7
Total (ft)	709,474	62.2	249	110.3	551	304.9	610	179	536	3	6	75	150	829	3316	0	0	
Total (miles)	134.37																	

CONSTRUCTION/ENGINEERING TOTAL: 5417.4

CONSTRUCTION/ENGINEERING CONSIDERATIONS			
C-1	Difficult Access (Construction/Maintenance)	C-5	Road/Utility Crossings
C-2	Remote Access	C-6	Line Angles over 30 Degrees or Complex Structures
C-3	Joint Construction with Other Utilities	C-7	Line Reliability
C-4	Engineering Constraints	C-8	Service to Future MEA Substations

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE B EVALUATION MATRIX

TABLE B-4

FINANCIAL CONSIDERATIONS

EVALUATION CRITERIA:		F-1		F-2		F-3		F-4		FINANCIAL
WEIGHT:			0.2		0.2		0.2		0.2	
UNIT:		300	k/mi	300	k/mi	375	k/mi	430	k/mi	
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	SUBTOTAL
1-2	29357	5.6	333.6	0.0	0.0	0.0	0.0	0.0	0.0	333.6
11-12	25027	0.0	0.0	0.0	0.0	4.7	355.5	0.0	0.0	355.5
12-13	16579	0.0	0.0	3.1	188.4	0.0	0.0	0.0	0.0	188.4
13-14	17424	0.0	0.0	0.0	0.0	3.3	247.5	0.0	0.0	247.5
14-16	32736	0.0	0.0	0.0	0.0	6.2	465.0	0.0	0.0	465.0
16-18	31099	0.0	0.0	5.9	353.4	0.0	0.0	0.0	0.0	353.4
18-18A	15840	0.0	0.0	3.0	180.0	0.0	0.0	0.0	0.0	180.0
18A-18B	23496	0.0	0.0	0.0	0.0	4.5	333.8	0.0	0.0	333.8
18B-21	33264	0.0	0.0	6.3	378.0	0.0	0.0	0.0	0.0	378.0
2-31	34742	6.6	394.8	0.0	0.0	0.0	0.0	0.0	0.0	394.8
21-23	27403	0.0	0.0	5.2	311.4	0.0	0.0	0.0	0.0	311.4
23-24	31786	0.0	0.0	6.0	361.2	0.0	0.0	0.0	0.0	361.2
24-25	25766	0.0	0.0	4.9	292.8	0.0	0.0	0.0	0.0	292.8
25-26	11986	0.0	0.0	2.3	136.2	0.0	0.0	0.0	0.0	136.2
26-27	42082	0.0	0.0	8.0	478.2	0.0	0.0	0.0	0.0	478.2
27-29	47784	0.0	0.0	9.1	543.0	0.0	0.0	0.0	0.0	543.0
29-30	40656	0.0	0.0	7.7	462.0	0.0	0.0	0.0	0.0	462.0
3-4	35270	6.7	400.8	0.0	0.0	0.0	0.0	0.0	0.0	400.8
31-3	31099	5.9	353.4	0.0	0.0	0.0	0.0	0.0	0.0	353.4
4-4A	15418	2.9	175.2	0.0	0.0	0.0	0.0	0.0	0.0	175.2
4A-5	27667	5.2	314.4	0.0	0.0	0.0	0.0	0.0	0.0	314.4
5-5A	14203	2.7	161.4	0.0	0.0	0.0	0.0	0.0	0.0	161.4
5A-5B	10613	0.0	0.0	0.0	0.0	0.0	0.0	2.0	172.9	172.9
5B-5C	12038	0.0	0.0	0.0	0.0	0.0	0.0	2.3	196.1	196.1
5C-6	12355	2.3	140.4	0.0	0.0	0.0	0.0	0.0	0.0	140.4
6-9	24869	4.7	282.6	0.0	0.0	0.0	0.0	0.0	0.0	282.6
9-11	38914	0.0	0.0	0.0	0.0	7.4	552.8	0.0	0.0	552.8
Total (ft)	709473.60	42.6	2556.6	61.4	3684.6	26.1	1954.5	4.3	368.9	
Total (miles)	134.37									

FINANCIAL TOTAL: 8564.6

FINANCIAL CONSIDERATIONS	
F-1	Construction Cost - Loading Zone 1
F-2	Construction Cost - Loading Zone 2
F-3	Construction Cost - Loading Zone 3
F-4	Construction Cost - Loading Zone 4

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE C EVALUATION MATRIX

TABLE C-1

ENVIRONMENTAL CONSIDERATIONS

EVALUATION CRITERIA:		E-1		E-2		E-3		E-4		E-5		E-6		E-7		E-8		E-9		E-10		
WEIGHT:		1		3		5		5		4		5		5		5		4		5		
UNIT:		1000'		1000'		1000'		1000'		1000'		Each		1000'		Each/1000'		Each/1000'		Each		SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	2	2.0	0	0.0	5	25.0	23	116.5	4	14.8	8	40.0	0	0	17	83.5	2	8.0	8	40	329.8
2-31	34742.4	0	0.0	0	0.0	11	52.5	30	152.0	15	61.2	0	0.0	23	116	0	0.0	4	16.0	0	0	397.7
3-4	35270.4	0	0.0	0	0.0	8	39.5	28	139.5	21	84.4	0	0.0	24	119	0	0.0	5	20.0	0	0	402.4
4-5	43084.8	0	0.0	0	0.0	3	16.0	19	94.5	38	152.4	0	0.0	38	191	7	35.5	5	20.0	0	0	508.9
5-6	49209.6	0	0.0	0	0.0	7	37.0	11	55.0	7	27.6	0	0.0	12	58	11	53.0	9	36.0	0	0	266.6
6-8	46094.4	0	0.0	0	0.0	6	31.5	1	7.0	46	184.4	0	0.0	46	231	0	0.0	5	20.0	0	0	473.4
8-10	7603.2	0	0.0	0	0.0	5	25.0	0	1.0	8	30.4	0	0.0	8	38	0	0.0	3	12.0	0	0	106.4
10-11	22440.0	0	0.0	0	0.0	0	0.0	1	3.5	22	89.6	0	0.0	22	112	0	0.0	4	16.0	0	0	221.1
11-12	25027.2	0	0.0	0	0.0	1	5.0	9	42.5	25	100.0	0	0.0	25	125	0	0.0	7	28.0	0	0	300.5
12-13	16579.2	0	0.0	0	0.0	1	5.0	9	42.5	11	44.4	0	0.0	11	56	8	40.5	4	16.0	0	0	203.9
13-14	17424.0	0	0.0	0	0.0	2	10.0	1	2.5	12	46.4	0	0.0	17	87	15	74.0	2	8.0	0	0	227.9
14-15	10084.8	0	0.0	0	0.0	0	0.0	0	0.0	10	40.4	0	0.0	10	51	0	0.0	1	4.0	0	0	94.9
15-16	24129.6	0	0.0	0	0.0	2	10.0	1	3.5	5	21.2	0	0.0	16	79	14	68.5	2	8.0	0	0	190.2
16-18	31099.2	0	0.0	0	0.0	10	50.0	2	9.5	11	42.4	0	0.0	17	87	17	87.0	3	12.0	0	0	287.9
18-21	72600.0	0	0.0	0	0.0	22	111.0	36	181.5	0	0.0	0	0.0	0	0	12	58.0	6	24.0	0	0	374.5
21-23	27403.2	0	0.0	0	0.0	15	74.0	18	90.5	11	42.4	0	0.0	13	64	27	137.0	1	4.0	0	0	411.4
23-24	31785.6	1	1.0	0	0.0	10	47.5	29	143.0	0	0.0	0	0.0	27	135	35	174.0	1	4.0	0	0	504.0
24-25	25766.4	0	0.0	0	0.0	8	39.5	10	48.5	0	0.0	0	0.0	0	0	19	92.5	1	4.0	0	0	184.5
25-26	11985.6	0	0.0	0	0.0	8	39.5	10	48.0	0	0.0	0	0.0	0	0	12	60.0	2	8.0	0	0	155.5
26-27	42081.6	0	0.0	0	0.0	15	76.5	34	168.5	0	0.0	0	0.0	0	0	0	0.0	6	24.0	0	0	269.0
27-29	47784.0	1	1.0	0	0.0	40	198.0	38	191.0	31	122.4	0	0.0	25	123	11	54.5	0	0.0	0	0	689.9
29-30	40656.0	0	0.0	0	0.0	9	42.5	24	119.0	37	148.0	0	0.0	37	185	0	0.0	2	8.0	0	0	502.5
31-3	31099.2	0	0.0	0	0.0	0	0.0	27	136.0	13	52.8	0	0.0	31	156	0	0.0	1	4.0	0	0	348.3
Total (ft)	723,307	4.0	4	0.0	0	187.0	935	359.1	1796	326.3	1305	8.0	40	401.9	2010	203.6	1018	76.0	304	8.0	40	
Total (mi)	136.99																					

ENVIRONMENTAL TOTAL: 7451.2

ENVIRONMENTAL CONSIDERATIONS			
E-1	Potential Construction Impacts (Dust, Traffic, Noise)	E-6	Residences Affected by Prominent Visual Intrusion
E-2	Potential Habitat Damage or Need for Restoration	E-7	Line Visually Prominent within Scenic Viewshed
E-3	Clearing Riparian/Wetland Areas	E-8	Line Visually Prominent from Highway or Major Arterial
E-4	Clearing In Treed Lands	E-9	Special Mitigation Requirements
E-5	Cultural Resource Conflict Areas	E-10	Exposure to Electromagnetic Fields (EMF)

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE C EVALUATION MATRIX

TABLE C-2

LAND USE CONSIDERATIONS

EVALUATION CRITERIA:		L-1		L-2		L-3		L-4		L-5		L-6		LAND USE SUBTOTAL
WEIGHT:		5		5		3		5		3		1		
UNIT:		Each/1000'		Each/1000'		Each		Each/1000'		Acres		1000 ft		
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	
1-2	29356.8	0	0	2	7.5	3	9.9	11	52.8	84	252.7	0	0.0	322.9
2-31	34742.4	0	0	0	0.0	7	19.8	12	57.9	100	299.1	0	0.0	376.8
3-4	35270.4	0	0	0	0.0	7	20.1	12	58.4	101	303.6	5	4.8	386.9
4-5	43084.8	0	0	0	0.0	6	18.6	11	55.8	109	328.2	0	0.0	402.6
5-6	49209.6	0	0	3	13.5	8	22.8	10	50.6	144	431.6	15	14.5	533.0
6-8	46094.4	0	0	2	8.5	8	24.0	10	48.7	132	396.8	2	2.1	480.1
8-10	7603.2	0	0	0	0.0	1	4.2	2	12.2	22	65.5	0	0.0	81.9
10-11	22440.0	0	0	0	0.0	4	12.8	5	26.3	64	193.2	4	4.2	236.4
11-12	25027.2	0	0	0	0.0	5	14.1	8	38.7	72	215.5	0	0.0	268.3
12-13	16579.2	0	0	0	0.0	3	9.3	4	20.7	48	142.7	0	0.0	172.7
13-14	17424.0	0	0	0	0.0	3	7.5	6	31.5	50	150.0	0	0.0	189.0
14-15	10084.8	0	0	0	0.0	4	11.4	3	14.6	29	86.8	0	0.0	112.8
15-16	24129.6	0	0	0	0.0	9	27.6	6	27.9	69	207.7	1	1.3	264.5
16-18	31099.2	0	0	0	0.0	6	18.6	7	34.5	89	267.7	0	0.0	320.8
18-21	72600.0	0	0	0	0.0	14	41.4	15	73.8	208	625.0	0	0.0	740.2
21-23	27403.2	0	0	0	0.0	5	15.6	8	41.0	79	235.9	0	0.0	292.5
23-24	31785.6	0	0	0	0.0	6	18.0	7	35.1	91	273.6	0	0.0	326.7
24-25	25766.4	0	0	0	0.0	5	14.7	6	29.4	74	221.8	0	0.0	265.9
25-26	11985.6	0	0	0	0.0	2	6.9	3	16.4	34	103.2	0	0.0	126.4
26-27	42081.6	0	0	0	0.0	8	24.0	9	44.9	121	362.3	0	0.0	431.1
27-29	47784.0	0	0	6	28.5	4	13.2	10	50.3	137	411.4	0	0.0	503.3
29-30	40656.0	0	0	8	41.5	0	0.0	8	41.6	111	332.7	0	0.0	415.8
31-3	31099.2	1	6	3	13.8	5	14.7	11	54.5	89	267.7	0	0.0	356.9
Total (ft)	723,307	1	6	22.7	113	123.1	369	183.4	917	2058.3	6175	26.9	27	
Total (miles)	136.99													

LAND USE TOTAL: 7607.4

LAND USE CONSIDERATIONS			
L-1	Private Land Parcels Affected by Aquisition	L-4	Land Use Impacts
L-2	Native Lands Affected by Aquisition	L-5	New Right-of-Way Requirements
L-3	State Lands	L-6	Special Restoration Efforts

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE C EVALUATION MATRIX

TABLE C-3

CONSTRUCTION/ENGINEERING CONSIDERATIONS

EVALUATION CRITERIA:		C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		
WEIGHT:		4		5		2		3		2		2		4		0		
UNIT:		1000 ft		1000 ft		1000 ft		Each/1000'		Each		Each		1000 ft		Each		SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	8	31.2	0	0.0	8	15.8	9	26	1	2	6	12	1	4	0	0	90.6
2-31	34742.4	9	36.3	0	0.0	13	26.4	6	18	0	0	4	8	1	4	0	0	92.7
3-4	35270.4	11	44.7	0	0.0	24	47.5	6	18	0	0	3	6	18	72	0	0	187.8
4-5	43084.8	11	45.3	0	0.0	16	31.7	11	34	0	0	3	6	46	186	0	0	302.5
5-6	49209.6	9	34.8	21	107.4	8	15.8	28	85	0	0	6	12	114	457	0	0	711.5
6-8	46094.4	0	0.0	46	230.5	26	52.8	3	9	0	0	6	12	118	470	0	0	774.3
8-10	7603.2	0	0.0	8	38.0	79	158.4	0	0	0	0	1	2	7	30	0	0	228.0
10-11	22440.0	0	0.0	22	112.2	53	105.6	3	9	0	0	2	4	23	94	0	0	324.4
11-12	25027.2	1	4.0	25	125.1	24	47.5	0	0	0	0	5	10	25	99	0	0	285.9
12-13	16579.2	0	0.0	0	0.0	13	26.4	0	0	0	0	3	6	17	66	0	0	98.8
13-14	17424.0	0	0.0	0	0.0	13	26.4	20	61	0	0	4	8	52	209	0	0	304.4
14-15	10084.8	0	0.0	0	0.0	13	26.4	0	0	0	0	0	0	30	121	0	0	147.6
15-16	24129.6	0	0.0	0	0.0	16	31.7	0	0	0	0	2	4	72	289	0	0	324.9
16-18	31099.2	0	0.0	0	0.0	8	15.8	0	0	0	0	0	0	73	293	0	0	309.0
18-21	72600.0	0	0.0	0	0.0	16	31.7	9	26	0	0	3	6	148	593	0	0	656.4
21-23	27403.2	0	0.0	0	0.0	8	15.8	0	0	0	0	4	8	28	110	0	0	133.8
23-24	31785.6	0	0.0	0	0.0	11	21.1	32	95	1	2	4	8	32	127	0	0	253.7
24-25	25766.4	0	0.0	0	0.0	8	15.8	26	77	0	0	1	2	26	103	0	0	198.4
25-26	11985.6	0	0.0	0	0.0	13	26.4	0	0	0	0	2	4	12	48	0	0	78.8
26-27	42081.6	0	0.0	0	0.0	21	42.2	3	9	0	0	3	6	40	158	0	0	215.6
27-29	47784.0	0	0.0	0	0.0	8	15.8	0	0	1	2	4	8	24	97	0	0	122.6
29-30	40656.0	0	0.0	0	0.0	7	13.2	3	9	0	0	3	6	0	0	0	0	28.2
31-3	31099.2	8	32.3	0	0.0	13	26.4	0	0	0	0	5	10	0	0	0	0	68.7
Total (ft)	723,307	57.2	229	122.7	613	418.4	837	159	476	3	6	74	148	908	3630	0	0	
Total (miles)	136.99																	

CONSTRUCTION/ENGINEERING TOTAL: 5938.7

CONSTRUCTION/ENGINEERING CONSIDERATIONS			
C-1	Difficult Access (Construction/Maintenance)	C-5	Road/Utility Crossings
C-2	Remote Access	C-6	Line Angles over 30 Degrees or Complex Structures
C-3	Joint Construction with Other Utilities	C-7	Line Reliability
C-4	Engineering Constraints	C-8	Service to Future MEA Substations

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE C EVALUATION MATRIX

TABLE C-4

FINANCIAL CONSIDERATIONS

EVALUATION CRITERIA:		F-1		F-2		F-3		F-4		FINANCIAL
WEIGHT:		0.2		0.2		0.2		0.2		
UNIT:		300	k/mi	300	k/mi	375	k/mi	430	k/mi	
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	SUBTOTAL
1-2	29357	5.6	333.6	0.0	0.0	0.0	0.0	0.0	0.0	333.6
10-11	22440	0.0	0.0	0.0	0.0	4.3	318.8	0.0	0.0	318.8
11-12	25027	0.0	0.0	0.0	0.0	4.7	355.5	0.0	0.0	355.5
12-13	16579	0.0	0.0	3.1	188.4	0.0	0.0	0.0	0.0	188.4
13-14	17424	0.0	0.0	0.0	0.0	3.3	247.5	0.0	0.0	247.5
14-15	10085	0.0	0.0	0.0	0.0	1.9	143.3	0.0	0.0	143.3
15-16	24130	0.0	0.0	0.0	0.0	4.6	342.8	0.0	0.0	342.8
16-18	31099	0.0	0.0	5.9	353.4	0.0	0.0	0.0	0.0	353.4
18-18A	15840	0.0	0.0	3.0	180.0	0.0	0.0	0.0	0.0	180.0
18A-18B	23496	0.0	0.0	0.0	0.0	4.5	333.8	0.0	0.0	333.8
18B-21	33264	0.0	0.0	6.3	378.0	0.0	0.0	0.0	0.0	378.0
2-31	34742	6.6	394.8	0.0	0.0	0.0	0.0	0.0	0.0	394.8
21-23	27403	0.0	0.0	5.2	311.4	0.0	0.0	0.0	0.0	311.4
23-24	31786	0.0	0.0	6.0	361.2	0.0	0.0	0.0	0.0	361.2
24-25	25766	0.0	0.0	4.9	292.8	0.0	0.0	0.0	0.0	292.8
25-26	11986	0.0	0.0	2.3	136.2	0.0	0.0	0.0	0.0	136.2
26-27	42082	0.0	0.0	8.0	478.2	0.0	0.0	0.0	0.0	478.2
27-29	47784	0.0	0.0	9.1	543.0	0.0	0.0	0.0	0.0	543.0
29-30	40656	0.0	0.0	7.7	462.0	0.0	0.0	0.0	0.0	462.0
3-4	35270	6.7	400.8	0.0	0.0	0.0	0.0	0.0	0.0	400.8
31-3	31099	5.9	353.4	0.0	0.0	0.0	0.0	0.0	0.0	353.4
4-4A	15418	2.9	175.2	0.0	0.0	0.0	0.0	0.0	0.0	175.2
4A-5	27667	5.2	314.4	0.0	0.0	0.0	0.0	0.0	0.0	314.4
5-5A	14203	2.7	161.4	0.0	0.0	0.0	0.0	0.0	0.0	161.4
5A-5B	10613	0.0	0.0	0.0	0.0	0.0	0.0	2.0	172.9	172.9
5B-5C	12038	0.0	0.0	0.0	0.0	0.0	0.0	2.3	196.1	196.1
5C-6	12355	2.3	140.4	0.0	0.0	0.0	0.0	0.0	0.0	140.4
6-8	46094	0.0	0.0	0.0	0.0	8.7	654.8	0.0	0.0	654.8
8-10	7603	0.0	0.0	0.0	0.0	1.4	108.0	0.0	0.0	108.0
Total (ft)	723307.20	37.9	2274.0	61.4	3684.6	33.4	2504.3	4.3	368.9	
Total (miles)	136.99									

FINANCIAL TOTAL: 8831.8

FINANCIAL CONSIDERATIONS	
F-1	Construction Cost - Loading Zone 1
F-2	Construction Cost - Loading Zone 2
F-3	Construction Cost - Loading Zone 3
F-4	Construction Cost - Loading Zone 4

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE D EVALUATION MATRIX

TABLE D-1

ENVIRONMENTAL CONSIDERATIONS

EVALUATION CRITERIA:			E-1		E-2		E-3		E-4		E-5		E-6		E-7		E-8		E-9		E-10	
WEIGHT:			1		3		5		5		4		5		5		5		4		5	
UNIT:			1000'		1000'		1000'		1000'		1000'		Each		1000'		Each/1000'		Each/1000'		Each	SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.80	2	2.0	0	0.0	5	25.0	23	116.5	4	14.8	8	40.0	0	0	17	83.5	2	8.0	8	40	329.8
2-3	59980.80	1	1.0	0	0.0	4	18.5	40	197.5	5	21.2	0	0.0	23	114	0	0.0	6	24.0	0	0	375.7
3-4	35270.40	0	0.0	0	0.0	8	39.5	28	139.5	21	84.4	0	0.0	24	119	0	0.0	5	20.0	0	0	402.4
4-5	43084.80	0	0.0	0	0.0	3	16.0	19	94.5	38	152.4	0	0.0	38	191	7	35.5	5	20.0	0	0	508.9
5-6	49209.60	0	0.0	0	0.0	7	37.0	11	55.0	7	27.6	0	0.0	12	58	11	53.0	9	36.0	0	0	266.6
6-8	46094.40	0	0.0	0	0.0	6	31.5	1	7.0	46	184.4	0	0.0	46	231	0	0.0	5	20.0	0	0	473.4
8-10	7603.20	0	0.0	0	0.0	5	25.0	0	1.0	8	30.4	0	0.0	8	38	0	0.0	3	12.0	0	0	106.4
10-15	66580.80	0	0.0	0	0.0	1	5.0	2	10.0	59	235.6	0	0.0	67	333	0	0.0	12	48.0	0	0	631.6
15-17	33052.80	0	0.0	0	0.0	2	7.5	0	0.0	33	132.4	0	0.0	33	166	0	0.0	6	24.0	0	0	329.4
17-19	47836.80	0	0.0	0	0.0	21	105.0	0	0.0	11	42.4	0	0.0	4	21	0	0.0	3	12.0	0	0	180.4
19-20	64046.40	0	0.0	0	0.0	26	129.5	32	160.0	0	0.0	0	0.0	0	0	0	0.0	3	12.0	0	0	301.5
20-22	26347.20	0	0.0	0	0.0	12	60.5	16	77.5	5	21.2	0	0.0	11	56	0	0.0	1	4.0	0	0	218.7
22-26	71596.80	1	1.0	0	0.0	24	119.0	63	315.0	0	0.0	0	0.0	0	0	11	54.5	8	32.0	0	0	521.5
26-27	42081.60	0	0.0	0	0.0	15	76.5	34	168.5	0	0.0	0	0.0	0	0	0	0.0	6	24.0	0	0	269.0
27-28	34003.20	0	0.0	0	0.0	24	117.5	27	136.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0	253.5
28-29	13728.00	1	1.0	0	0.0	7	33.0	13	62.5	0	0.0	0	0.0	3	16	11	54.5	0	0.0	0	0	167.0
29-30	40656.00	0	0.0	0	0.0	9	42.5	24	119.0	37	148.0	0	0.0	37	185	0	0.0	2	8.0	0	0	502.5
Total (ft)	710,530	5.0	5	0.0	0	177.7	889	331.9	1660	273.7	1095	8.0	40	305.1	1526	56.2	281	76.0	304	8.0	40	
Total (mi)	134.57																					

ENVIRONMENTAL TOTAL: 5838.3

ENVIRONMENTAL CONSIDERATIONS			
E-1	Potential Construction Impacts (Dust, Traffic, Noise)	E-6	Residences Affected by Prominent Visual Intrusion
E-2	Potential Habitat Damage or Need for Restoration	E-7	Line Visually Prominent within Scenic Viewshed
E-3	Clearing Riparian/Wetland Areas	E-8	Line Visually Prominent from Highway or Major Arterial
E-4	Clearing in Treed Lands	E-9	Special Mitigation Requirements
E-5	Cultural Resource Conflict Areas	E-10	Exposure to Electromagnetic Fields (EMF)

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE D EVALUATION MATRIX

TABLE D-2

LAND USE CONSIDERATIONS

EVALUATION CRITERIA:		L-1		L-2		L-3		L-4		L-5		L-6		LAND USE SUBTOTAL
WEIGHT:		5		5		3		5		3		1		
UNIT:		Each/1000'		Each/1000'		Each		Each/1000'		Acres		1000 ft		
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	
1-2	29356.8	0	0	2	7.5	3	9.9	11	52.8	84	252.7	0	0.0	322.9
2-3	59980.8	0	0	0	0.0	11	34.2	12	61.8	172	516.4	11	10.5	622.9
3-4	35270.4	0	0	0	0.0	7	20.1	12	58.4	101	303.6	5	4.8	386.9
4-5	43084.8	0	0	0	0.0	6	18.6	11	55.8	109	328.2	0	0.0	402.6
5-6	49209.6	0	0	3	13.5	8	22.8	10	50.6	144	431.6	15	14.5	533.0
6-8	46094.4	0	0	2	8.5	8	24.0	10	48.7	132	396.8	2	2.1	480.1
8-10	7603.2	0	0	0	0.0	1	4.2	2	12.2	22	65.5	0	0.0	81.9
10-15	66580.8	0	0	0	0.0	20	61.2	14	68.1	191	573.2	2	1.6	704.0
15-17	33052.8	0	0	0	0.0	12	35.7	7	36.3	95	284.5	0	0.0	356.5
17-19	47836.8	0	0	0	0.0	9	27.3	10	50.3	137	411.8	1	1.3	490.7
19-20	64046.4	0	0	0	0.0	12	36.3	13	65.7	184	551.4	0	0.0	653.3
20-22	26347.2	0	0	0	0.0	5	15.0	6	30.0	76	226.8	0	0.0	271.8
22-26	71596.8	0	0	0	0.0	14	40.8	15	72.8	205	616.4	0	0.0	730.0
26-27	42081.6	0	0	0	0.0	8	24.0	9	44.9	121	362.3	0	0.0	431.1
27-28	34003.2	0	0	6	30.0	1	4.2	7	37.2	98	292.7	0	0.0	364.1
28-29	13728.0	0	0	4	18.0	0	0.0	4	18.0	39	118.2	0	0.0	154.2
29-30	40656.0	0	0	8	41.5	0	0.0	8	41.6	111	332.7	0	0.0	415.8
Total (ft)	710,530	0	0	23.8	119	126.1	378	161.0	805	2021.6	6065	34.8	35	
Total (mi)	134.57													

LAND USE TOTAL: 7401.9

LAND USE CONSIDERATIONS	
L-1	Private Land Parcels Affected by Aquisition
L-2	Native Lands Affected by Aquisition
L-3	State Lands
L-4	Land Use Impacts
L-5	New Right-of-Way Requirements
L-6	Special Restoration Efforts

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE D EVALUATION MATRIX

TABLE D-3

CONSTRUCTION/ENGINEERING CONSIDERATIONS

EVALUATION CRITERIA:		C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		
WEIGHT:			4		5		2		3		2		2		4		0	
UNIT:			1000 ft		1000 ft		1000 ft		1000 ft		Each		Each		1000 ft		Each	SUB
SEGMENT	LENGTH	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	Qty	Subt	-TOTAL
1-2	29356.8	8	31.2	0	0.0	8	15.8	9	26	1	2	6	12	1	4	0	0	90.6
2-3	59980.8	18	72.4	0	0.0	24	47.5	11	34	0	0	3	6	35	141	0	0	301.1
3-4	35270.4	11	44.7	0	0.0	24	47.5	6	18	0	0	3	6	18	72	0	0	187.8
4-5	43084.8	11	45.3	0	0.0	16	31.7	11	34	0	0	3	6	46	186	0	0	302.5
5-6	49209.6	9	34.8	21	107.4	8	15.8	28	85	0	0	6	12	114	457	0	0	711.5
6-8	46094.4	0	0.0	46	230.5	26	52.8	3	9	0	0	6	12	118	470	0	0	774.3
8-10	7603.2	0	0.0	8	38.0	79	158.4	0	0	0	0	1	2	7	30	0	0	228.0
10-15	66580.8	0	0.0	67	332.9	69	137.3	32	95	0	0	8	16	143	570	0	0	1151.7
15-17	33052.8	0	0.0	0	0.0	32	63.4	3	9	0	0	4	8	99	397	0	0	477.6
17-19	47836.8	0	0.0	0	0.0	32	63.4	27	81	0	0	3	6	107	428	0	0	578.8
19-20	64046.4	0	0.0	0	0.0	18	37.0	0	0	0	0	2	4	106	424	0	0	465.4
20-22	26347.2	0	0.0	0	0.0	11	21.1	0	0	0	0	3	6	26	106	0	0	132.7
22-26	71596.8	0	0.0	0	0.0	16	31.7	60	179	2	4	3	6	117	468	0	0	688.8
26-27	42081.6	0	0.0	0	0.0	21	42.2	3	9	0	0	3	6	40	158	0	0	215.6
27-28	34003.2	0	0.0	0	0.0	0	0.0	0	0	0	0	1	2	14	57	0	0	59.2
28-29	13728.0	0	0.0	0	0.0	0	0.0	0	0	1	2	1	2	0	0	0	0	4.0
29-30	40656.0	0	0.0	0	0.0	7	13.2	3	9	0	0	3	6	0	0	0	0	28.2
Total (ft)	710,530	57.1	228	141.8	709	389.4	779	196	587	4	8	59	118	992	3968	0	0	
Total (miles)	134.57																	

CONSTRUCTION/ENGINEERING TOTAL: 6397.6

CONSTRUCTION/ENGINEERING CONSIDERATIONS			
C-1	Difficult Access (Construction/Maintenance)	C-5	Road/Utility Crossings
C-2	Remote Access	C-6	Line Angles over 30 Degrees or Complex Structures
C-3	Joint Construction with Other Utilities	C-7	Line Reliability
C-4	Engineering Constraints	C-8	Service to Future MEA Substations

ALASKA ENERGY AUTHORITY
COPPER VALLEY INTERTIE FEASIBILITY STUDY

ROUTE ALTERNATIVE D EVALUATION MATRIX

TABLE D-4

FINANCIAL CONSIDERATIONS

EVALUATION CRITERIA:		F-1		F-2		F-3		F-4		FINANCIAL
WEIGHT:			0.2		0.2		0.2		0.2	
UNIT:		300	k/mi	300	k/mi	375	k/mi	430	k/mi	
SEGMENT	LENGTH	QTY	SUBT	QTY	SUBT	QTY	SUBT	QTY	SUBT	SUBTOTAL
1-2	29356.80	5.6	333.6	0.0	0.0	0.0	0.0	0.0	0.0	333.6
2-3	59980.80	11.4	681.6	0.0	0.0	0.0	0.0	0.0	0.0	681.6
3-4	35270.40	6.7	400.8	0.0	0.0	0.0	0.0	0.0	0.0	400.8
4-4A	15417.60	2.9	175.2	0.0	0.0	0.0	0.0	0.0	0.0	175.2
4A-5	27667.20	5.2	314.4	0.0	0.0	0.0	0.0	0.0	0.0	314.4
5-5A	14203.20	2.7	161.4	0.0	0.0	0.0	0.0	0.0	0.0	161.4
5A-5B	10612.80	0.0	0.0	0.0	0.0	0.0	0.0	2.0	172.9	172.9
5B-5C	12038.40	0.0	0.0	0.0	0.0	0.0	0.0	2.3	196.1	196.1
5C-6	12355.20	2.3	140.4	0.0	0.0	0.0	0.0	0.0	0.0	140.4
6-8	46094.40	0.0	0.0	0.0	0.0	8.7	654.8	0.0	0.0	654.8
8-10	7603.20	0.0	0.0	0.0	0.0	1.4	108.0	0.0	0.0	108.0
10-15	66580.80	0.0	0.0	0.0	0.0	12.6	945.8	0.0	0.0	945.8
15-17	33052.80	0.0	0.0	0.0	0.0	6.3	469.5	0.0	0.0	469.5
17-17A	16896.00	0.0	0.0	0.0	0.0	3.2	240.0	0.0	0.0	240.0
17A-19	30940.80	0.0	0.0	5.9	351.6	0.0	0.0	0.0	0.0	351.6
19-20	64046.40	0.0	0.0	12.1	727.8	0.0	0.0	0.0	0.0	727.8
20-22	26347.20	0.0	0.0	5.0	299.4	0.0	0.0	0.0	0.0	299.4
22-26	71596.80	0.0	0.0	13.6	813.6	0.0	0.0	0.0	0.0	813.6
26-27	42081.60	0.0	0.0	8.0	478.2	0.0	0.0	0.0	0.0	478.2
27-28	34003.20	0.0	0.0	6.4	386.4	0.0	0.0	0.0	0.0	386.4
28-29	13728.00	0.0	0.0	2.6	156.0	0.0	0.0	0.0	0.0	156.0
29-30	40656.00	0.0	0.0	7.7	462.0	0.0	0.0	0.0	0.0	462.0
Total (ft)	710,530	36.8	2207.4	61.3	3675.0	32.2	2418.0	4.3	368.9	
Total (miles)	134.57									

FINANCIAL TOTAL: 8669.3

FINANCIAL CONSIDERATIONS	
F-1	Construction Cost - Loading Zone 1
F-2	Construction Cost - Loading Zone 2
F-3	Construction Cost - Loading Zone 3
F-4	Construction Cost - Loading Zone 4

Appendix B

PRELIMINARY DESIGN DOCUMENTATION

Alaska Energy Authority
Copper Valley Intertie Feasibility Study
Key Conductor Design Values for Checking
8/12/93

		Dove	Teal	Teal/SSAC	T2Linnet	37No9 AW
LOADING ZONE 1						
Ruling Span		1000	1000	1000	1000	na
Tension	NESC	10256	13278	12802	14780	na
Tension	WIND	10172	13056	12708	15043	na
Tension	ICE	12809	15924	14514	17177	na
Tension	COMB	18080	21712	19857	22028	na
Sag	NESC Ice	33.92	26.93	28.11	28.59	na
Sag	Max Temp	31.32	24.64	24.89	26.63	na
Sag	6 PSF Wind	29.89	22.91	23.09	25.66	na
Sag	XTM Wind	34.85	28.07	30.49	30.43	na
LOADING ZONE 2						
Ruling Span		1200	1200	1200	1200	na
Tension	NESC	7959	11926	11605	11258	na
Tension	WIND	8117	11995	11692	12098	na
Tension	ICE	15820	20392	18620	19740	na
Tension	COMB	11248	15346	14211	14890	na
Sag	NESC Ice	53.83	40.30	42.43	46.01	na
Sag	Max Temp	52.65	37.99	39.32	44.47	na
Sag	6 PSF Wind	51.04	35.97	37.24	43.17	na
Sag	XTM Wind	54.17	40.96	44.77	47.20	na
LOADING ZONE 3						
Ruling Span		1100	1100	1100	1100	na
Tension	NESC	8373	11569	12347	11968	na
Tension	WIND	8505	11619	12397	12701	na
Tension	ICE	15820	19582	18260	19740	na
Tension	COMB	15976	19670	18757	19823	na
Sag	NESC Ice	44.00	34.83	34.14	37.28	na
Sag	Max Temp	42.98	33.08	30.78	36.04	na
Sag	6 PSF Wind	41.41	31.14	28.84	34.83	na
Sag	XTM Wind	44.37	35.40	36.44	38.52	na
LOADING ZONE 4						
Ruling Span		900	1000	1000	na	1000
Tension	NESC	5121	8132	7413	na	18501
Tension	WIND	7433	11050	10023	na	19397
Tension	ICE	15751	21000	18620	na	32422
Tension	COMB	18080	23688	21261	na	35628
Sag	NESC Ice	47.58	42.19	46.76	na	17.09
Sag	Max Temp	46.97	41.33	46.43	na	18.18
Sag	6 PSF Wind	45.62	39.50	44.66	na	14.30
Sag	XTM Wind	50.19	45.94	50.81	na	20.12

Work Order Account : ....:WW-1559-HA1-AC
Client:..........................:Alaska Energy Authority
Project:.........................:Copper Valley Intertie
Feature:.........................: Double Loop Galloping
Item:............................: Teal 605 kcmil 30/19,LZ3
By:..............................: PED 8/11/93
Check:........................... [handwritten initials] 11/5/93

The following computations generate and evaluate galloping ellipses for double loop galloping. Based on REA 62-1 eqs.

Step 1 - Define system units to be used

Coordinate system center

$X_{cen} := 0 \cdot ft \quad Y_{cen} := 0 \cdot ft$

Select direction of wind

1 means wind to right, -1 means wind to left

$DIR := -1$

Step 2 - Define line characteristics

Following values at 1/2 inch radial ice 30 degrees F

Tensions	Unit Weight	Diameter
$T_{ph} := 8159 \cdot lb$	$w_{ph} := 1.869 \cdot \frac{lb}{ft}$	$d_{ph} := 1.994 \cdot in$
$T_{sw} := 0 \cdot lb$	$w_{sw} := 0 \cdot \frac{lb}{ft}$	$d_{sw} := 0 \cdot in$

$RUL_{sp} := 1300 \cdot ft \quad WIND := 6 \cdot \frac{lb}{ft^2}$

Step 2a - Specify the number of wires on line by entering 1 (exists) or 0 (nada)

$$LINE := \begin{bmatrix} 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Shieldwire 1
Shieldwire 2
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6

Step 3 - Input coordinates of attachment points for phases and shieldwires

Note the coordinates are for either the end of the HLP, Vstring, or otherwise restrained conductor and for the point of insulator attachment for a tangent suspension assembly. Enter the coordinates relative to the chosen coordinate system center chosen in Step 1.Note that the Y dimension is arbitrary and can be altered to fit plot.

$$X := \begin{bmatrix} 0\cdot ft \\ 0\cdot ft \\ -15\cdot ft \\ 0\cdot ft \\ 15\cdot ft \\ 0\cdot ft \\ 0\cdot ft \\ 0\cdot ft \end{bmatrix} \qquad Y := \begin{bmatrix} 0\cdot ft \\ 0\cdot ft \\ 90\cdot ft \\ 90\cdot ft \\ 90\cdot ft \\ 0\cdot ft \\ 0\cdot ft \\ 0\cdot ft \end{bmatrix}$$

Shieldwire 1
Shieldwire 2
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6

Step 4 - Calculate ruling span sag for conductors and shieldwire

$$SAG_{ph} := \frac{T_{ph}}{w_{ph}}\cdot\left(\cosh\left(w_{ph}\cdot\frac{RUL_{sp}}{T_{ph}\cdot 2}\right) - 1\right) \qquad SAG_{ph} = 48.481\cdot ft$$

$$SAG_{sw} := \frac{T_{sw}}{w_{sw}}\cdot\left(\cosh\left(w_{sw}\cdot\frac{RUL_{sp}}{T_{sw}\cdot 2}\right) - 1\right) \qquad SAG_{sw} = 0\cdot ft$$

Step 5 - Calculate blowout angle of wires under wind

$$PHI_{ph} := DIR\cdot atan\left(\frac{WIND\cdot d_{ph}}{w_{ph}}\right) \qquad PHI_{ph} = -28.077\cdot deg$$

$$PHI_{sw} := DIR\cdot atan\left(\frac{WIND\cdot d_{sw}}{w_{sw}}\right) \qquad PHI_{sw} = 0\cdot deg$$

Step 6 - Calculate factor a in REA 62-1

$$a_{ph} := \sqrt{\left[\left(\frac{RUL_{sp}}{2}\right)^2 + SAG_{ph}^{\ 2}\right]} \qquad a_{ph} = 651.805\cdot ft$$

$$a_{sw} := \sqrt{\left[\left(\frac{RUL_{sp}}{2}\right)^2 + SAG_{sw}^{\ 2}\right]} \qquad a_{sw} = 650\cdot ft$$

Step 6 - Calculate the Double Loop Major Axis M

$$M_{ph} := 1\cdot ft + \sqrt{\frac{3\cdot a_{ph}\cdot\left(\frac{8\cdot SAG_{ph}^{\ 2}}{RUL_{sp}\cdot 3} + RUL_{sp} - 2\cdot a_{ph}\right)}{8}}$$

$$M_{ph} = 18.2\cdot ft$$

$$M_{sw} := 1\cdot ft + \sqrt{\frac{3\cdot a_{sw}\cdot\left(\frac{8\cdot SAG_{sw}^{2}}{RUL_{sp}\cdot 3} + RUL_{sp}\ \text{[redacted]}\ = 2\cdot a_{sw}\cdot ft\right)}{8}}$$

Step 7 - Calculate the Double Loop distance B from ellipse focus to ellipse on major axis

$B_{ph} := 0.20\cdot M_{ph}$ $\qquad$ $B_{ph} = 3.64\cdot ft$

$B_{sw} := 0.20\cdot M_{sw}$ $\qquad$ $B_{sw} = 0.2\cdot ft$

Step 8 - Calculate the Double Loop Minor Axis D

$D_{ph} := 2\cdot\sqrt{(M_{ph} - 1\cdot ft)\cdot ft}$ $\qquad$ $D_{ph} = 8.295\cdot ft$

$D_{sw} := 2\cdot\sqrt{(M_{sw} - 1\cdot ft)\cdot ft}$ $\qquad$ $D_{sw} = 0\cdot ft$

Step 9 - Input insulator lengths. Shieldwire, V-Strings and post insulators L=0. Compute total length of insulator string and sag.

Input

$$L := \begin{bmatrix} 0\cdot ft \\ 0\cdot ft \\ 5\cdot ft \\ 5\cdot ft \\ 5\cdot ft \\ 0\cdot ft \\ 0\cdot ft \\ 0\cdot ft \end{bmatrix} \qquad SAG := \begin{bmatrix} SAG_{sw} \\ SAG_{sw} \\ SAG_{ph} \\ SAG_{ph} \\ SAG_{ph} \\ SAG_{ph} \\ SAG_{ph} \\ SAG_{ph} \end{bmatrix} \qquad PHI := \begin{bmatrix} PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \\ PHI_{sw} \end{bmatrix}$$

Compute length from supports to ellipse focus L

$$L := \overrightarrow{(L + (LINE\cdot SAG))} \qquad L = \begin{bmatrix} 0 \\ 0 \\ 53.481 \\ 53.481 \\ 53.481 \\ 0 \\ 0 \\ 0 \end{bmatrix}\cdot ft$$

Step 10 - Compute the coordinates of the lissajous ellipse foci

$$PHI := \overrightarrow{(LINE\cdot PHI)}$$

$$X_f := \overrightarrow{(X + L\cdot\sin(PHI))} \qquad Y_f := \overrightarrow{(Y - (L\cdot\cos(PHI)))}$$

$$\begin{bmatrix} 0 \end{bmatrix} \qquad \begin{bmatrix} 0 \end{bmatrix}$$

$$X_f = \begin{bmatrix} -15 \\ 0 \\ 15 \\ 0 \\ 0 \\ 0 \end{bmatrix} \cdot ft \qquad Y_f = \begin{bmatrix} 36.519 \\ 36.519 \\ 36.519 \\ 0 \\ 0 \\ 0 \end{bmatrix} \cdot ft$$

Step 11 - A is the semi major axis, E the eccentricity of the ellipse

$$A_{sw} := \frac{M_{sw}}{2} \qquad E_{sw} := 1 - 2 \cdot \frac{B_{sw}}{M_{sw}}$$

$$A_{ph} := \frac{M_{ph}}{2} \qquad E_{ph} := 1 - 2 \cdot \frac{B_{ph}}{M_{ph}}$$

Step 12 - Express the polar equation for the lissajous ellipse as r(A,E).

Define the number of angle increments N and the angle increments

$$N := 200 \qquad i := 0 .. N \qquad \theta_i := i \cdot 2 \cdot \frac{\pi}{N} \qquad k := 0 \cdot ft .. 65 \cdot ft$$

k defines centerline of structure for plot

Express the polar equation for an ellipse as a vector for each ellipse

$$r_{sw} := \overrightarrow{\left[A_{sw} \cdot \frac{\left(1 - E_{sw}^{2}\right)}{\left(1 - E_{sw} \cdot \cos(\theta)\right)} \right]} \qquad r_{ph} := \overrightarrow{\left[A_{ph} \cdot \frac{\left(1 - E_{ph}^{2}\right)}{\left(1 - E_{ph} \cdot \cos(\theta)\right)} \right]}$$

$$x_{sw} := \overrightarrow{\left(-r_{sw} \cdot \sin(\theta)\right)} \qquad x_{ph} := \overrightarrow{\left(-r_{ph} \cdot \sin(\theta)\right)}$$

$$y_{sw} := \overrightarrow{\left(r_{sw} \cdot \cos(\theta)\right)} \qquad y_{ph} := \overrightarrow{\left(r_{ph} \cdot \cos(\theta)\right)}$$

Now rotate and translate x,y to tilt ellipse through PHI/2

$$X_{sw} := \overrightarrow{\left(x_{sw} \cdot \cos\left(\frac{PHI_{sw}}{2}\right) + y_{sw} \cdot \sin\left(\frac{PHI_{sw}}{2}\right)\right)}$$

$$Y_{sw} := \overrightarrow{\left(-x_{sw} \cdot \sin\left(\frac{PHI_{sw}}{2}\right) + y_{sw} \cdot \cos\left(\frac{PHI_{sw}}{2}\right)\right)}$$

$$X_{ph} := \overrightarrow{\left(x_{ph} \cdot \cos\left(\frac{PHI_{ph}}{2}\right) + y_{ph} \cdot \sin\left(\frac{PHI_{ph}}{2}\right)\right)}$$

$$Y_{ph} := \overrightarrow{\left(-x_{ph} \cdot \sin\left(\frac{PHI_{ph}}{}\right) + y_{ph} \cdot \cos\left(\frac{PHI_{ph}}{}\right)\right)}$$

$$X_{sw0} := \overrightarrow{\left(X_{sw} + X_{f_{0,0}}\right)}$$

$$X_{sw1} := \overrightarrow{\left(X_{sw} + X_{f_{1,0}}\right)}$$

$$X_{ph1} := \overrightarrow{\left(X_{ph} + X_{f_{2,0}}\right)}$$

$$X_{ph2} := \overrightarrow{\left(X_{ph} + X_{f_{3,0}}\right)}$$

$$Y_{sw0} := \overrightarrow{\left(Y_{sw} + Y_{f_{0,0}}\right)}$$

$$Y_{sw1} := \overrightarrow{\left(Y_{sw} + Y_{f_{1,0}}\right)}$$

$$Y_{ph1} := \overrightarrow{\left(Y_{ph} + Y_{f_{2,0}}\right)}$$

$$Y_{ph2} := \overrightarrow{\left(Y_{ph} + Y_{f_{3,0}}\right)}$$

$$X_{ph3} := \overrightarrow{\left(X_{ph} + X_{f_{4,0}}\right)}$$

$$X_{ph4} := \overrightarrow{\left(X_{ph} + X_{f_{5,0}}\right)}$$

$$X_{ph5} := \overrightarrow{\left(X_{ph} + X_{f_{6,0}}\right)}$$

$$X_{ph6} := \overrightarrow{\left(X_{ph} + X_{f_{7,0}}\right)}$$

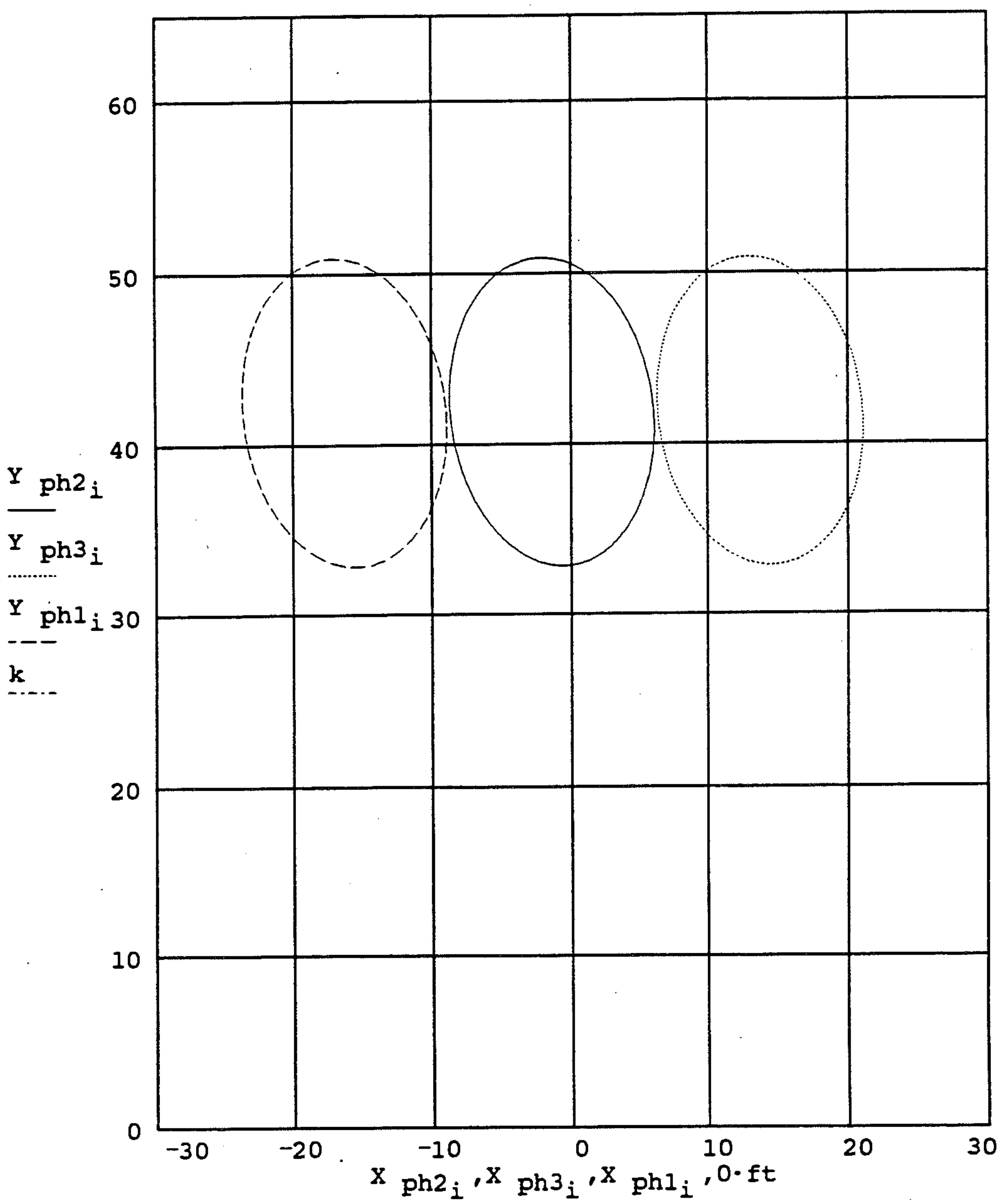
$$Y_{ph3} := \overrightarrow{\left(Y_{ph} + Y_{f_{4,0}}\right)}$$

$$Y_{ph4} := \overrightarrow{\left(Y_{ph} + Y_{f_{5,0}}\right)}$$

$$Y_{ph5} := \overrightarrow{\left(Y_{ph} + Y_{f_{6,0}}\right)}$$

$$Y_{ph6} := \overrightarrow{\left(Y_{ph} + Y_{f_{7,0}}\right)}$$

GRAPH OF GALLOPING ELLIPSES



21.0751

Blow Dove, XLS

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
Dove Conductor NF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)		*6*	PSF
ENTER	CONDUCTOR DIAMETER		*0.927*	INCHES
ENTER	UNIT CONDUCTOR WEIGHT		*0.766*	LBS/FT
CALC	UNIT TRANSVERSE LOAD		0.4635	LBS/FT
CALC	BLOWOUT ANGLE		31.2	DEGREES
ENTER		NA	-	FEET
ENTER	INSULATOR LENGTH		*5.0*	FEET
ENTER	STRUCTURE DEFLECTION		1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

		LOADING ZONE 1	LOADING ZONE 2	LOADING ZONE 3	LOADING ZONE 4
	STRUCTURE WIDTH	*34* FEET	*36* FEET	*36* FEET	*38* FEET
ENTER	RULING SPAN =	*1000*	*1200*	*1100*	*900*
ENTER	RS SAG WIND	29.9 FEET	51.0 FEET	41.4 FEET	45.6 FEET
ENTER	MAXIMUM SPAN	*1200* FEET	*1400* FEET	*1300* FEET	*1100* FEET
CALC	MAX SPAN SAG	43.0 FEET	69.5 FEET	57.8 FEET	68.1 FEET
CALC	ADD L1	48.0 FEET	74.5 FEET	62.8 FEET	73.1 FEET
CALC	BLOWOUT	24.9 FEET	38.6 FEET	32.5 FEET	37.9 FEET
	INSULATOR SIDE				
CALC	CL-BLOWOUT	42.9 FEET	57.6 FEET	51.5 FEET	57.9 FEET
ENTER	MARGIN	10.0 FEET	10.0 FEET	10.0 FEET	10.0 FEET
CALC	TOTAL WIDTH 1	52.9 FEET	67.6 FEET	61.5 FEET	67.9 FEET
	ROW x 2	105.7 FEET	135.1 FEET	123.1 FEET	135.7 FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)		26	PSF
ENTER	CONDUCTOR DIAMETER		0.927	INCHES
ENTER	UNIT CONDUCTOR WEIGHT		0.766	LBS/FT
CALC	UNIT TRANSVERSE LOAD		2.009	LBS/FT
CALC	BLOWOUT ANGLE		69.1	DEGREES
ENTER		NA		FEET
ENTER	INSULATOR LENGTH		5.0	FEET
ENTER	STRUCTURE DEFLECTION		4.0	FEET

		LOADING ZONE 1	LOADING ZONE 2	LOADING ZONE 3	USE ONLY XTM WIND 40 PSF LOADING ZONE 4
	STRUCTURE WIDTH	34 FEET	36 FEET	36 FEET	38 FEET
ENTER	RULING SPAN =	1000	1200	1100	900
ENTER	RS SAG WIND	34.9 FEET	54.2 FEET	44.4 FEET	50.2 FEET
ENTER	MAXIMUM SPAN	1200 FEET	1400 FEET	1300 FEET	1100 FEET
CALC	MAX SPAN SAG	50.2 FEET	73.7 FEET	62.0 FEET	75.0 FEET
CALC	ADD L1	55.2 FEET	78.7 FEET	67.0 FEET	80.0 FEET
CALC	BLOWOUT	51.6 FEET	73.6 FEET	62.6 FEET	74.7 FEET
	INSULATOR SIDE				
CALC	CL-BLOWOUT	72.6 FEET	95.6 FEET	84.6 FEET	97.7 FEET
ENTER	MARGIN	0.0 FEET	0.0 FEET	0.0 FEET	0.0 FEET
CALC	TOTAL WIDTH 1	72.6 FEET	95.6 FEET	84.6 FEET	97.7 FEET
	ROW x 2	145.1 FEET	191.1 FEET	169.1 FEET	195.5 FEET

EXHIBIT B-3

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
Teal SSAC Conductor HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	6	PSF
ENTER	CONDUCTOR DIAMETER	0.994	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.939	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.497	LBS/FT
CALC	BLOWOUT ANGLE	27.9	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	*32*	FEET	*32*	FEET	*30*	FEET	*34*	FEET
ENTER	RULING SPAN =	*1000*		*1200*		*1100*		*1000*	
ENTER	RS SAG WIND	23.1	FEET	37.2	FEET	28.8	FEET	72.8	FEET
ENTER	MAXIMUM SPAN	*1200*	FEET	*1400*	FEET	*1300*	FEET	*1200*	FEET
CALC	MAX SPAN SAG	33.2	FEET	50.7	FEET	40.3	FEET	104.8	FEET
CALC	ADD L1	38.2	FEET	55.7	FEET	45.3	FEET	109.8	FEET
CALC	BLOWOUT	17.9	FEET	26.1	FEET	21.2	FEET	51.4	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	34.9	FEET	43.1	FEET	37.2	FEET	69.4	FEET
ENTER	MARGIN	10.0	FEET	10.0	FEET	10.0	FEET	10.0	FEET
CALC	TOTAL WIDTH 1	44.9	FEET	53.1	FEET	47.2	FEET	79.4	FEET
	ROW x 2	89.8	FEET	106.1	FEET	94.4	FEET	158.7	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	26	PSF
ENTER	CONDUCTOR DIAMETER	0.994	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.9395	LBS/FT
CALC	UNIT TRANSVERSE LOAD	2.154	LBS/FT
CALC	BLOWOUT ANGLE	66.4	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

USE ONLY XTM WIND 40 PSF (Loading Zone 4)

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	32	FEET	32	FEET	30	FEET	34	FEET
ENTER	RULING SPAN =	1000		1200		1100		1000	
ENTER	RS SAG WIND	30.5	FEET	44.8	FEET	44.4	FEET	78.2	FEET
ENTER	MAXIMUM SPAN	1200	FEET	1400	FEET	1300	FEET	1200	FEET
CALC	MAX SPAN SAG	43.9	FEET	60.9	FEET	62.0	FEET	112.6	FEET
CALC	ADD L1	48.9	FEET	65.9	FEET	67.0	FEET	117.6	FEET
CALC	BLOWOUT	44.8	FEET	60.4	FEET	61.4	FEET	107.8	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	64.8	FEET	80.4	FEET	80.4	FEET	128.8	FEET
ENTER	MARGIN	0.0	FEET	0.0	FEET	0.0	FEET	0.0	FEET
CALC	TOTAL WIDTH 1	64.8	FEET	80.4	FEET	80.4	FEET	128.8	FEET
	ROW x 2	129.7	FEET	160.9	FEET	160.8	FEET	257.6	FEET

BLOWT2.XLS

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
T2 Linnet conductor HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	*6*	PSF
ENTER	CONDUCTOR DIAMETER	*1.18*	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	*0.926*	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.59	LBS/FT
CALC	BLOWOUT ANGLE	32.5	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	*5.0*	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

T2 not appropriate for LZ4

	LOADING ZONE 1			LOADING ZONE 2			LOADING ZONE 3			LOADING ZONE 4		
	STRUCTURE WIDTH	*28*	FEET	STRUCTURE WIDTH	*30*	FEET	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*0*	FEET
ENTER	RULING SPAN =	*1000*		RULING SPAN =	*1200*		RULING SPAN =	*1100*		RULING SPAN =	*1000*	
ENTER	RS SAG WIND	25.7	FEET	RS SAG WIND	43.2	FEET	RS SAG WIND	34.8	FEET	RS SAG WIND	0.0	FEET
ENTER	MAXIMUM SPAN	*1200*	FEET	MAXIMUM SPAN	*1400*	FEET	MAXIMUM SPAN	*1300*	FEET	MAXIMUM SPAN	*1200*	FEET
CALC	MAX SPAN SAG	37.0	FEET	MAX SPAN SAG	58.8	FEET	MAX SPAN SAG	48.6	FEET	MAX SPAN SAG	0.0	FEET
CALC	ADD L1	42.0	FEET	ADD L1	63.8	FEET	ADD L1	53.6	FEET	ADD L1	5.0	FEET
CALC	BLOWOUT	22.5	FEET	BLOWOUT	34.3	FEET	BLOWOUT	28.8	FEET	BLOWOUT	2.7	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	37.5	FEET	CL-BLOWOUT	50.3	FEET	CL-BLOWOUT	45.8	FEET	CL-BLOWOUT	3.7	FEET
ENTER	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET
CALC	TOTAL WIDTH 1	47.5	FEET	TOTAL WIDTH 1	60.3	FEET	TOTAL WIDTH 1	55.8	FEET	TOTAL WIDTH 1	13.7	FEET
	ROW x 2	95.1	FEET	ROW x 2	120.5	FEET	ROW x 2	111.7	FEET	ROW x 2	27.4	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	26	PSF
ENTER	CONDUCTOR DIAMETER	1.18	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.926	LBS/FT
CALC	UNIT TRANSVERSE LOAD	2.557	LBS/FT
CALC	BLOWOUT ANGLE	70.1	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

USE ONLY XTM WIND 40 PSF

	LOADING ZONE 1			LOADING ZONE 2			LOADING ZONE 3			LOADING ZONE 4		
	STRUCTURE WIDTH	28	FEET	STRUCTURE WIDTH	30	FEET	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	0	FEET
ENTER	RULING SPAN =	1000		RULING SPAN =	1200		RULING SPAN =	1100		RULING SPAN =	1000	
ENTER	RS SAG WIND	30.4	FEET	RS SAG WIND	47.2	FEET	RS SAG WIND	38.5	FEET	RS SAG WIND	78.2	FEET
ENTER	MAXIMUM SPAN	1200	FEET	MAXIMUM SPAN	1400	FEET	MAXIMUM SPAN	1300	FEET	MAXIMUM SPAN	1200	FEET
CALC	MAX SPAN SAG	43.8	FEET	MAX SPAN SAG	64.2	FEET	MAX SPAN SAG	53.8	FEET	MAX SPAN SAG	112.6	FEET
CALC	ADD L1	48.8	FEET	ADD L1	69.2	FEET	ADD L1	58.8	FEET	ADD L1	117.6	FEET
CALC	BLOWOUT	45.9	FEET	BLOWOUT	65.1	FEET	BLOWOUT	55.3	FEET	BLOWOUT	110.6	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	63.9	FEET	CL-BLOWOUT	84.1	FEET	CL-BLOWOUT	75.3	FEET	CL-BLOWOUT	114.6	FEET
ENTER	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET
CALC	TOTAL WIDTH 1	63.9	FEET	TOTAL WIDTH 1	84.1	FEET	TOTAL WIDTH 1	75.3	FEET	TOTAL WIDTH 1	114.6	FEET
	ROW x 2	127.8	FEET	ROW x 2	168.2	FEET	ROW x 2	150.6	FEET	ROW x 2	229.2	FEET

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
Dove Conductor HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	*6*	PSF
ENTER	CONDUCTOR DIAMETER	*0.927*	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	*0.766*	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.4635	LBS/FT
CALC	BLOWOUT ANGLE	31.2	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	*5.0*	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	*34*	FEET	*36*	FEET	*36*	FEET	*38*	FEET
ENTER	RULING SPAN =	*1000*		*1200*		*1100*		*900*	
ENTER	RS SAG WIND	29.9	FEET	51.0	FEET	41.4	FEET	45.6	FEET
ENTER	MAXIMUM SPAN	*1425*	FEET	*1300*	FEET	*1325*	FEET	*1015*	FEET
CALC	MAX SPAN SAG	60.7	FEET	59.9	FEET	60.1	FEET	58.0	FEET
CALC	ADD L1	65.7	FEET	64.9	FEET	65.1	FEET	63.0	FEET
CALC	BLOWOUT	34.0	FEET	33.6	FEET	33.7	FEET	32.6	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	52.0	FEET	52.6	FEET	52.7	FEET	52.6	FEET
ENTER	MARGIN	10.0	FEET	10.0	FEET	10.0	FEET	10.0	FEET
CALC	TOTAL WIDTH 1	62.0	FEET	62.6	FEET	62.7	FEET	62.6	FEET
	ROW x 2	124.0	FEET	125.2	FEET	125.4	FEET	125.3	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	40	PSF
ENTER	CONDUCTOR DIAMETER	0.927	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.766	LBS/FT
CALC	UNIT TRANSVERSE LOAD	3.090	LBS/FT
CALC	BLOWOUT ANGLE	76.1	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

USE ONLY XTM WIND 40 PSF

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	34	FEET	36	FEET	36	FEET	38	FEET
ENTER	RULING SPAN =	1000		1200		1100		900	
ENTER	RS SAG WIND	34.9	FEET	54.2	FEET	44.4	FEET	50.2	FEET
ENTER	MAXIMUM SPAN	1060	FEET	1010	FEET	1025	FEET	759	FEET
CALC	MAX SPAN SAG	39.2	FEET	38.4	FEET	38.5	FEET	35.7	FEET
CALC	ADD L1	44.2	FEET	43.4	FEET	43.5	FEET	40.7	FEET
CALC	BLOWOUT	42.9	FEET	42.1	FEET	42.2	FEET	39.5	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	63.9	FEET	64.1	FEET	64.2	FEET	62.5	FEET
ENTER	MARGIN	0.0	FEET	0.0	FEET	0.0	FEET	0.0	FEET
CALC	TOTAL WIDTH 1	63.9	FEET	64.1	FEET	64.2	FEET	62.5	FEET
	ROW x 2	127.7	FEET	128.2	FEET	128.5	FEET	125.0	FEET

EXHIBIT B-4

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
Teal Conductor HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	6	PSF
ENTER	CONDUCTOR DIAMETER	0.994	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.9395	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.497	LBS/FT
CALC	BLOWOUT ANGLE	27.9	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

	LOADING ZONE 1			LOADING ZONE 2			LOADING ZONE 3			LOADING ZONE 4		
	STRUCTURE WIDTH	*30*	FEET	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*32*	FEET
ENTER	RULING SPAN =	*1000*		RULING SPAN =	*1200*		RULING SPAN =	*1100*		RULING SPAN =	*1000*	
	--------------------			-----------------			-----------------			-----------------		
ENTER	RS SAG WIND	22.9	FEET	RS SAG WIND	36.0	FEET	RS SAG WIND	43.7	FEET	RS SAG WIND	39.5	FEET
ENTER	MAXIMUM SPAN	*1790*	FEET	MAXIMUM SPAN	*1685*	FEET	MAXIMUM SPAN	*1405*	FEET	MAXIMUM SPAN	*1340*	FEET
CALC	MAX SPAN SAG	73.4	FEET	MAX SPAN SAG	70.9	FEET	MAX SPAN SAG	71.3	FEET	MAX SPAN SAG	70.9	FEET
CALC	ADD Li	78.4	FEET	ADD Li	75.9	FEET	ADD Li	76.3	FEET	ADD Li	75.9	FEET
CALC	BLOWOUT	36.7	FEET	BLOWOUT	35.5	FEET	BLOWOUT	35.7	FEET	BLOWOUT	35.5	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	52.7	FEET	CL-BLOWOUT	52.5	FEET	CL-BLOWOUT	52.7	FEET	CL-BLOWOUT	52.5	FEET
ENTER	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET
CALC	TOTAL WIDTH 1	62.7	FEET	TOTAL WIDTH 1	62.5	FEET	TOTAL WIDTH 1	62.7	FEET	TOTAL WIDTH 1	62.5	FEET
	ROW x 2	125.3	FEET	ROW x 2	125.0	FEET	ROW x 2	125.3	FEET	ROW x 2	125.0	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	26	PSF
ENTER	CONDUCTOR DIAMETER	0.994	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.9395	LBS/FT
CALC	UNIT TRANSVERSE LOAD	2.154	LBS/FT
CALC	BLOWOUT ANGLE	66.4	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

	LOADING ZONE 1			LOADING ZONE 2			LOADING ZONE 3			LOADING ZONE 4		
	STRUCTURE WIDTH	30	FEET	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	32	FEET
ENTER	RULING SPAN =	1000		RULING SPAN =	1200		RULING SPAN =	1100		RULING SPAN =	1000	
	--------------------			-----------------			-----------------			-----------------		
ENTER	RS SAG WIND	28.1	FEET	RS SAG WIND	41.0	FEET	RS SAG WIND	35.4	FEET	RS SAG WIND	45.9	FEET
ENTER	MAXIMUM SPAN	1230	FEET	MAXIMUM SPAN	1205	FEET	MAXIMUM SPAN	1190	FEET	MAXIMUM SPAN	950	FEET
CALC	MAX SPAN SAG	42.5	FEET	MAX SPAN SAG	41.3	FEET	MAX SPAN SAG	41.4	FEET	MAX SPAN SAG	41.5	FEET
CALC	ADD Li	47.5	FEET	ADD Li	46.3	FEET	ADD Li	46.4	FEET	ADD Li	46.5	FEET
CALC	BLOWOUT	43.5	FEET	BLOWOUT	42.4	FEET	BLOWOUT	42.6	FEET	BLOWOUT	42.6	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	62.5	FEET	CL-BLOWOUT	62.4	FEET	CL-BLOWOUT	62.6	FEET	CL-BLOWOUT	62.6	FEET
ENTER	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET
CALC	TOTAL WIDTH 1	62.5	FEET	TOTAL WIDTH 1	62.4	FEET	TOTAL WIDTH 1	62.6	FEET	TOTAL WIDTH 1	62.6	FEET
	ROW x 2	125.0	FEET	ROW x 2	124.9	FEET	ROW x 2	125.1	FEET	ROW x 2	125.2	FEET

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
T2 Linnet conductor HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	6	PSF
ENTER	CONDUCTOR DIAMETER	*1.18*	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	*0.926*	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.59	LBS/FT
CALC	BLOWOUT ANGLE	32.5	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	*5.0*	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

T2 not appropriate for LZ4

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	*28*	FEET	*30*	FEET	*32*	FEET	*0*	FEET
ENTER	RULING SPAN =	*1000*		*1200*		*1100*		*1000*	
ENTER	RS SAG WIND	25.7	FEET	43.2	FEET	34.8	FEET	0.0	FEET
ENTER	MAXIMUM SPAN	*1590*	FEET	*1450*	FEET	*1455*	FEET	*1200*	FEET
CALC	MAX SPAN SAG	64.9	FEET	63.0	FEET	60.9	FEET	0.0	FEET
CALC	ADD L1	69.9	FEET	68.0	FEET	65.9	FEET	5.0	FEET
CALC	BLOWOUT	37.5	FEET	36.6	FEET	35.4	FEET	2.7	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	52.5	FEET	52.6	FEET	52.4	FEET	3.7	FEET
ENTER	MARGIN	10.0	FEET	10.0	FEET	10.0	FEET	10.0	FEET
CALC	TOTAL WIDTH 1	62.5	FEET	62.6	FEET	62.4	FEET	13.7	FEET
	ROW x 2	125.1	FEET	125.1	FEET	124.9	FEET	27.4	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	26	PSF
ENTER	CONDUCTOR DIAMETER	1.18	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	0.926	LBS/FT
CALC	UNIT TRANSVERSE LOAD	2.557	LBS/FT
CALC	BLOWOUT ANGLE	70.1	DEGREES
ENTER		NA	FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

USE ONLY XTM WIND 40 PSF

		LOADING ZONE 1		LOADING ZONE 2		LOADING ZONE 3		LOADING ZONE 4	
	STRUCTURE WIDTH	28	FEET	30	FEET	32	FEET	0	FEET
ENTER	RULING SPAN =	1000		1200		1100		1000	
ENTER	RS SAG WIND	30.4	FEET	47.2	FEET	38.5	FEET	78.2	FEET
ENTER	MAXIMUM SPAN	1180	FEET	1122	FEET	1125	FEET	855	FEET
CALC	MAX SPAN SAG	42.4	FEET	41.3	FEET	40.3	FEET	57.2	FEET
CALC	ADD L1	47.4	FEET	46.3	FEET	45.3	FEET	62.2	FEET
CALC	BLOWOUT	44.5	FEET	43.5	FEET	42.6	FEET	58.5	FEET
	INSULATOR SIDE								
CALC	CL-BLOWOUT	62.5	FEET	62.5	FEET	62.6	FEET	62.5	FEET
ENTER	MARGIN	0.0	FEET	0.0	FEET	0.0	FEET	0.0	FEET
CALC	TOTAL WIDTH 1	62.5	FEET	62.5	FEET	62.6	FEET	62.5	FEET
	ROW x 2	125.1	FEET	125.0	FEET	125.2	FEET	124.9	FEET

AEA COPPER VALLEY INTERTIE
138 KV TRANSMISSION LINE
CONDUCTOR BLOWOUT GUIDELINES
37 No 9 Alumoweld HF or XF construction
PED 8/12/93

MODERATE WIND

ENTER	UNIT WIND LOAD (PSF)	*6*	PSF
ENTER	CONDUCTOR DIAMETER	*0.801*	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	*1.108*	LBS/FT
CALC	UNIT TRANSVERSE LOAD	0.4005	LBS/FT
CALC	BLOWOUT ANGLE	19.9	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	*5.0*	FEET
ENTER	STRUCTURE DEFLECTION	1.0	FEET

Note that numbers in italics are for input, linked to corresponding cells below on page 2.

ONLY ↓

	LOADING ZONE 1 NOT APPLICABLE			LOADING ZONE 2 NOT APPLICABLE			LOADING ZONE 3 NOT APPLICABLE			LOADING ZONE 4		
	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*32*	FEET	STRUCTURE WIDTH	*30*	FEET
ENTER	RULING SPAN =	*1000*		RULING SPAN =	*1200*		RULING SPAN =	*1100*		RULING SPAN =	*1000*	
ENTER	RS SAG WIND	29.9	FEET	RS SAG WIND	51.0	FEET	RS SAG WIND	41.4	FEET	RS SAG WIND	14.3	FEET
ENTER	MAXIMUM SPAN	*1200*	FEET	MAXIMUM SPAN	*1400*	FEET	MAXIMUM SPAN	*1300*	FEET	MAXIMUM SPAN	*2650*	FEET
CALC	MAX SPAN SAG	43.0	FEET	MAX SPAN SAG	69.5	FEET	MAX SPAN SAG	57.8	FEET	MAX SPAN SAG	100.4	FEET
CALC	ADD L1	48.0	FEET	ADD L1	74.5	FEET	ADD L1	62.8	FEET	ADD L1	105.4	FEET
CALC	BLOWOUT	16.3	FEET	BLOWOUT	25.3	FEET	BLOWOUT	21.4	FEET	BLOWOUT	35.8	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	33.3	FEET	CL-BLOWOUT	42.3	FEET	CL-BLOWOUT	38.4	FEET	CL-BLOWOUT	51.8	FEET
ENTER	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET	MARGIN	10.0	FEET
CALC	TOTAL WIDTH 1	43.3	FEET	TOTAL WIDTH 1	52.3	FEET	TOTAL WIDTH 1	48.4	FEET	TOTAL WIDTH 1	61.8	FEET
	ROW x 2 NA		FEET	ROW x 2 NA		FEET	ROW x 2 NA		FEET	ROW x 2	123.7	FEET

EXTREME WIND

ENTER	UNIT WIND LOAD (PSF)	40	PSF
ENTER	CONDUCTOR DIAMETER	0.801	INCHES
ENTER	UNIT CONDUCTOR WEIGHT	1.108	LBS/FT
CALC	UNIT TRANSVERSE LOAD	2.670	LBS/FT
CALC	BLOWOUT ANGLE	67.5	DEGREES
ENTER	NA		FEET
ENTER	INSULATOR LENGTH	5.0	FEET
ENTER	STRUCTURE DEFLECTION	4.0	FEET

	LOADING ZONE 1 NOT APPLICABLE			LOADING ZONE 2 NOT APPLICABLE			LOADING ZONE 3 NOT APPLICABLE			USE ONLY XTM WIND 40 PSF LOADING ZONE 4		
	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	32	FEET	STRUCTURE WIDTH	30	FEET
ENTER	RULING SPAN =	1000		RULING SPAN =	1200		RULING SPAN =	1100		RULING SPAN =	1000	
ENTER	RS SAG WIND	34.9	FEET	RS SAG WIND	54.2	FEET	RS SAG WIND	44.4	FEET	RS SAG WIND	20.1	FEET
ENTER	MAXIMUM SPAN	1200	FEET	MAXIMUM SPAN	1400	FEET	MAXIMUM SPAN	1300	FEET	MAXIMUM SPAN	1450	FEET
CALC	MAX SPAN SAG	50.2	FEET	MAX SPAN SAG	73.7	FEET	MAX SPAN SAG	62.0	FEET	MAX SPAN SAG	42.3	FEET
CALC	ADD L1	55.2	FEET	ADD L1	78.7	FEET	ADD L1	67.0	FEET	ADD L1	47.3	FEET
CALC	BLOWOUT	51.0	FEET	BLOWOUT	72.7	FEET	BLOWOUT	61.9	FEET	BLOWOUT	43.7	FEET
	INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE			INSULATOR SIDE		
CALC	CL-BLOWOUT	71.0	FEET	CL-BLOWOUT	92.7	FEET	CL-BLOWOUT	81.9	FEET	CL-BLOWOUT	62.7	FEET
ENTER	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET	MARGIN	0.0	FEET
CALC	TOTAL WIDTH 1	71.0	FEET	TOTAL WIDTH 1	92.7	FEET	TOTAL WIDTH 1	81.9	FEET	TOTAL WIDTH 1	62.7	FEET
	ROW x 2 NA		FEET	ROW x 2 NA		FEET	ROW x 2 NA		FEET	ROW x 2	125.4	FEET

Work Order Account .:WW-1559-HA1-AC
Client........................:ALASKA ENERGY AUTHORITY
Project......................:SUTTON-GLENNALLEN 138kV INTERTIE
Feature......................:Right of Way Width Computation
Item ....:Hframe or Xframe Construction
Calculated By/Date....:Paul Dorvel 7/21/93
Checked By/Date.......:
Approved By/Date .....:

FIRST EXPRESS ROW WIDTH IN TERMS OF H (height of trees),w (width of ROW), delta (centerline to ROW edge distance), C (ground clearance), and P (percent slope). Solve equation symbolically.

$$H^2 - \left[(w-\delta)^2 + (C-(w-\delta)\cdot P)^2\right] \checkmark$$ uphill side of right-of-way

$$\begin{bmatrix} \frac{1}{\left[2\cdot(-1-P^2)\right]}\cdot\left(-2\cdot\delta - 2\cdot C\cdot P - 2\cdot P^2\cdot\delta + 2\cdot\sqrt{H^2 - C^2 + P^2\cdot H^2}\right) \\ \frac{1}{\left[2\cdot(-1-P^2)\right]}\cdot\left(-2\cdot\delta - 2\cdot C\cdot P - 2\cdot P^2\cdot\delta - 2\cdot\sqrt{H^2 - C^2 + P^2\cdot H^2}\right) \end{bmatrix}$$

$$H1^2 - \left[(w1-\delta)^2 + (C + P\cdot\delta\cdot 2 + (w1-\delta)\cdot P)^2\right]$$ downhill side of right-of-way

$$\begin{bmatrix} \frac{1}{\left[2\cdot(-1-P^2)\right]}\cdot\left(-2\cdot\delta + 2\cdot C\cdot P + 4\cdot P^2\cdot\delta + 2\cdot\sqrt{-6\cdot C\cdot P\cdot\delta - 9\cdot P^2\cdot\delta^2 + H1^2 - C^2 + P^2\cdot H1^2}\right) \\ \frac{1}{\left[2\cdot(-1-P^2)\right]}\cdot\left(-2\cdot\delta + 2\cdot C\cdot P + 4\cdot P^2\cdot\delta - 2\cdot\sqrt{-6\cdot C\cdot P\cdot\delta - 9\cdot P^2\cdot\delta^2 + H1^2 - C^2 + P^2\cdot H1^2}\right) \end{bmatrix}$$

Define variables
W1 is downhill side, W2 is uphill side.

$i := 0, 1 .. 6$ $\quad k := 2, 3 .. 9$ $\quad \delta := 16\cdot ft$

$P_i := i\cdot 0.05$ $\quad H_k := k\cdot 10\cdot ft$ $\quad C := 30\cdot ft$

$$W1_{i,k} := \frac{1}{\left[2\cdot\left[-1-(P_i)^2\right]\right]}\cdot\left[-2\cdot\delta + 2\cdot C\cdot P_i + 4\cdot(P_i)^2\cdot\delta - 2\cdot\sqrt{-6\cdot C\cdot P_i\cdot\delta - 9\cdot(P_i)^2\cdot\delta^2 + (H_k)^2 - C^2 + (P_i)^2\cdot(H_k)^2}\right] \checkmark$$

$$W2_{i,k} := \frac{1}{\left[2\cdot\left[-1-(P_i)^2\right]\right]}\cdot\left[-2\cdot\delta - 2\cdot C\cdot P_i - 2\cdot(P_i)^2\cdot\delta - 2\cdot\sqrt{(H_k)^2 - C^2 + (P_i)^2\cdot(H_k)^2}\right]$$

Set nonsensical solutions, i.e. imaginary, to 0

$$W1_{i,k} := \mathrm{if}\left[\left(\mathrm{Im}(W1_{i,k}) \neq 0\cdot ft\right), 0\cdot ft, W1_{i,k}\right]$$

$$W2_{i,k} := \mathrm{if}\left[\left(\mathrm{Im}(W2_{i,k}) \neq 0\cdot ft\right), 0\cdot ft, W2_{i,k}\right]$$

Combine matrices W1 and W2

$WT := W1 + W2$

$WT := \mathrm{augment}(P\cdot ft, WT)$

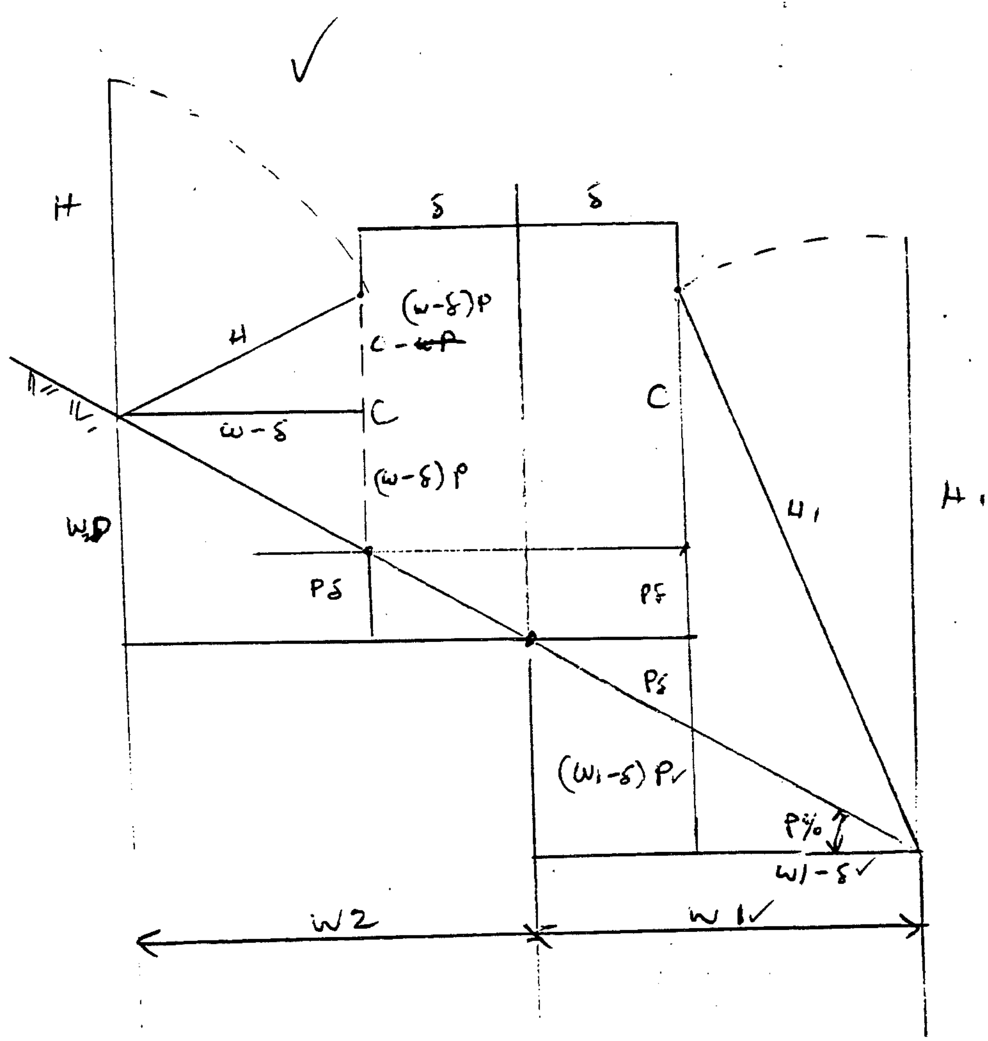
H

P 30 40 50 60 70 80 90

WT =

0	0	0	0	32	84.92	112	135.92	158.49	180.32	201.71
0.05	0	0	0	18.99	81.83	109.93	134.26	157.06	179.04	200.52
0.1	0	0	0	21.94	77.94	107.33	132.07	155.06	177.14	198.67
0.15	0	0	0	24.8	73.01	104.23	129.39	152.54	174.67	196.2
0.2	0	0	0	27.54	66.14	100.69	126.28	149.55	171.69	193.17
0.25	0	0	0	30.12	49.68	96.73	122.81	146.16	168.26	189.65
0.3	0	0	0	32.51	50.91	92.42	119.03	142.43	164.45	185.7

·ft



Work Order Account .:WW-1559-HA1-AC
Client........................:ALASKA ENERGY AUTHORITY
Project......................:SUTTON-GLENNALLEN 138kV INTERTIE
Feature.....................:Right of Way Width Computation
Item ....:Single Pole Construction
Calculated By/Date....:Paul Dorvel 7/21/93
Checked By/Date.......:
Approved By/Date .....:

FIRST EXPRESS ROW WIDTH IN TERMS OF H (height of trees),w (width of ROW), delta (centerline to ROW edge distance), C (ground clearance), and P (percent slope). Solve equation symbolically.

$$H^2 - \left[(w-\delta)^2 + (C-(w-\delta)\cdot P)^2\right]$$ uphill side of right-of-way

$$\begin{bmatrix} \frac{1}{\left[2\cdot\left(-1-P^2\right)\right]}\cdot\left(-2\cdot\delta - 2\cdot C\cdot P - 2\cdot P^2\cdot\delta + 2\cdot\sqrt{H^2 - C^2 + P^2\cdot H^2}\right) \\ \frac{1}{\left[2\cdot\left(-1-P^2\right)\right]}\cdot\left(-2\cdot\delta - 2\cdot C\cdot P - 2\cdot P^2\cdot\delta - 2\cdot\sqrt{H^2 - C^2 + P^2\cdot H^2}\right) \end{bmatrix}$$

$$H1^2 - \left[(w1-\delta)^2 + (C + P\cdot\delta\cdot 2 + (w1-\delta)\cdot P)^2\right]$$ downhill side of right-of-way

$$\begin{bmatrix} \frac{1}{\left[2\cdot\left(-1-P^2\right)\right]}\cdot\left(-2\cdot\delta + 2\cdot C\cdot P + 4\cdot P^2\cdot\delta + 2\cdot\sqrt{-6\cdot C\cdot P\cdot\delta - 9\cdot P^2\cdot\delta^2 + H1^2 - C^2 + P^2\cdot H1^2}\right) \\ \frac{1}{\left[2\cdot\left(-1-P^2\right)\right]}\cdot\left(-2\cdot\delta + 2\cdot C\cdot P + 4\cdot P^2\cdot\delta - 2\cdot\sqrt{-6\cdot C\cdot P\cdot\delta - 9\cdot P^2\cdot\delta^2 + H1^2 - C^2 + P^2\cdot H1^2}\right) \end{bmatrix}$$

Define variables
W1 is downhill side, W2 is uphill side.

$i := 0,1..6$ $\quad k := 2,3..9$ $\quad \delta := 6\cdot ft$

$P_i := i\cdot 0.05$ $\quad H_k := k\cdot 10\cdot ft$ $\quad C := 30\cdot ft$

$$W1_{i,k} := \frac{1}{\left[2\cdot\left[-1-\left(P_i\right)^2\right]\right]}\cdot\left[-2\cdot\delta + 2\cdot C\cdot P_i + 4\cdot\left(P_i\right)^2\cdot\delta - 2\cdot\sqrt{-6\cdot C\cdot P_i\cdot\delta - 9\cdot\left(P_i\right)^2\cdot\delta^2 + \left(H_k\right)^2 - C^2 + \left(P_i\right)^2\cdot\left(H_k\right)^2}\right]$$

$$W2_{i,k} := \frac{1}{\left[2\cdot\left[-1-\left(P_i\right)^2\right]\right]}\cdot\left[-2\cdot\delta - 2\cdot C\cdot P_i - 2\cdot\left(P_i\right)^2\cdot\delta - 2\cdot\sqrt{\left(H_k\right)^2 - C^2 + \left(P_i\right)^2\cdot\left(H_k\right)^2}\right]$$

Set nonsensical solutions, i.e. imaginary, to 0

$$W1_{i,k} := \mathrm{if}\left[\left(\mathrm{Im}\left(W1_{i,k}\right) \neq 0\cdot ft\right), 0\cdot ft, W1_{i,k}\right]$$

$$W2_{i,k} := \mathrm{if}\left[\left(\mathrm{Im}\left(W2_{i,k}\right) \neq 0\cdot ft\right), 0\cdot ft, W2_{i,k}\right]$$

Combine matrices W1 and W2

$WT := W1 + W2$

$WT := \mathrm{augment}(P\cdot ft, WT)$

H

P 40 50 60 70 80 90

$$WT = \begin{bmatrix} 0 & 0 & 0 & 0 & 12 & 64.92 & 92 & 115.92 & 138.49 & 160.32 & 181.71 \\ 0.05 & 0 & 0 & 0 & 8.99 & 63.84 & 91.22 & 115.26 & 137.89 & 159.76 & 181.15 \\ 0.1 & 0 & 0 & 0 & 11.94 & 62.66 & 90.26 & 114.34 & 136.95 & 158.79 & 180.14 \\ 0.15 & 0 & 0 & 0 & 14.8 & 61.42 & 89.12 & 113.16 & 135.7 & 157.44 & 178.69 \\ 0.2 & 0 & 0 & 0 & 17.54 & 60.13 & 87.83 & 111.76 & 134.15 & 155.74 & 176.84 \\ 0.25 & 0 & 0 & 0 & 20.12 & 58.81 & 86.42 & 110.15 & 132.35 & 153.73 & 174.61 \\ 0.3 & 0 & 0 & 0 & 22.51 & 57.49 & 84.9 & 108.38 & 130.31 & 151.43 & 172.06 \end{bmatrix} \cdot ft$$

Work Order Account ...:WW-1559-HA1-AC
Client................:ALASKA ENERGY AUTHORITY
Project...............:SUTTON-GLENNALLEN 138kV INTERTIE
Feature...............:Right-of-Way Width for Maximum Span
Item ....:Dove Loading Zone 1, XTM Wind, Xframe
Calculated By/Date....:Paul Porvel 7/21/93
Checked By/Date.......: KH 11/5/93
Approved By/Date .....:

INPUT DATA FOR EVALUATION

$LMAX := 1007 \cdot ft$ $dia := 0.927 \cdot in$ $weight := 0.766 \cdot \frac{lb}{ft}$ $L_{ins} := 5 \cdot ft$ $W := 17 \cdot ft$

$LRS := 1000 \cdot ft$ $SAGRS := 34.9 \cdot ft$ $PSF := 26 \cdot \frac{lb}{ft^2}$ $M := 0 \cdot ft$ $\delta := 1.0 \cdot ft$

COMPUTE PHI THE BLOWOUT ANGLE

$\Phi := atan\left(PSF \cdot \frac{dia}{weight}\right)$ $\Phi = 69 \cdot deg$

DEVELOP AND SYMBOLICALLY SOLVE EXPRESSION IN TERMS OF H (ROW width), w (width of structure, between outside phases), delta (structure deflection), SAGRS (ruling span sag under wind), Li (insulator length), LMAX (maxium allowable span), LRS (ruling span), phi (blowout angle) and M (margin).

$$H - 2 \cdot \left[W + \delta + \left[SAGRS \cdot \left(\frac{LMAX}{LRS}\right)^2 + L_{ins}\right] \cdot \sin(\Phi) + M\right]$$ expression

$$2 \cdot W + 2 \cdot \delta + 2 \cdot \sin(\Phi) \cdot SAGRS \cdot \frac{LMAX^2}{LRS^2} + 2 \cdot \sin(\Phi) \cdot L_{ins} + 2 \cdot M$$ solution

Set H equal to expression and evaluate

$$H := 2 \cdot W + 2 \cdot \delta + 2 \cdot \sin(\Phi) \cdot SAGRS \cdot \frac{LMAX^2}{LRS^2} + 2 \cdot \sin(\Phi) \cdot L_{ins} + 2 \cdot M$$

$H = 111 \cdot ft$ Required Right-of-Way Width Based on Conductor Blowout

CLIENT ....: ALASKA ENERGY AUTHORITY
PROJECT ....: COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE ....: COND TEAL ZONE 1,3 XTM WIND
ITEM..............: 70 CLASS 1 RUL SPAN 1000
WORK ORDER NUMBER : WW-1559-HA1-AC

BY/DATE ....: PED 8/4/93
CHECKED/DATE .....: [signature] 11/5/93

WOOD H-FRAME STRUCTURE ANALYSIS BASED ON REA 62-1 METHODS
NEGATIVE OR ANOMALOUS RESULTS MAY INDICATE INCORRECT STRUCTURE DIMENSIONS

ENTER INPUT DATA BELOW		INPUT VALUE	RANGE NAME	
WOOD POLE DATA				
WOOD TYPE (DF,WRC,SYP,AYC)	:	wrc	WOOD	TABLE2
CLASS POLES (1,2,3,H1-H6)	:	1	CLASS	2
POLE LENGTH (ft)	:	70	LTOT	
EMBEDMENT % L (%)	:	10%	EMBPER	
EMBEDMENT ADDER (ft)	:	3	EMBADD	
LINE DESIGN DATA				
LINE ANGLE (deg)	:	0	ANGLE	
RULING SPAN (ft)	:	1000	RS	
UNIT WIND FORCE (psf)	:	26.00	PSF	
RADIAL ICE (inches)	:	0.00	ICE	
SAFETY FACTOR NOTE: IF SAFETY FACTOR NOT 1, THEN OCFs =1.0				
WOOD POLE SAFETY FACTOR	:	1.00	SF	
OVERLOAD CAPACITY FACTORS				
OCF TENSION	:	1.30	OCFT	STEEL OCFS 1.10
OCF WIND	:	1.30	OCFW	WOOD OCFS 1.30
OCF WEIGHT	:	1.30	OCFWT	
PHASE CONDUCTOR DATA				
NUMBER PHASES	:	3	NPHASE	
BARE DIAMETER (inches)	:	0.994	PHDIAM	
UNIT WEIGHT (lbf/ft)	:	0.939	PHWT	
RULING SPAN TENSION (lbf)	:	0	PHTEN	NO EFFECT, NO ANGLE
ASSEMBLY WT (lbf)	:	100	PHWI	
SHIELDWIRE DATA				
NUMBER WIRES	:	0	NSW	
BARE DIAMETER (inches)	:	0.000	SWDIAM	
UNIT WEIGHT (lbf/ft)	:	0.000	SWWT	
RULING SPAN TENSION (lbf)	:	0	SWTEN	
ASSEMBLY WT (lbf)	:	0	SWWI	

ANALYSIS RESULTS

MAXIMUM HORIZONTAL SPANS
LIMITED BY POLE STRENGTH

STRUCTURE TYPE	CROSSARM LEVEL B	TOP OF XB LEVEL E	BOT OF XB LEVEL D	GROUNDLINE LEVEL A
H-FRAME 1	NA	NA	NA	794
H-FRAME 2	NO SW	741	1944	3622
H-FRAME 3	NA	796	1944	3622
H-FRAME 4	977	1314	1944	3622
H-FRAME 5	NO SW	741	8051	10582
H-FRAME 6	977	1314	8051	10582

STRUCTURE TYPE	**MAXIMUM HORIZONTAL SPAN LIMITED BY CROSSBRACE**			
		L	16.0	pole separation
H-FRAME 1	NA	L'	10.6	unbraced length
		kl/r	130.6	K=1
H-FRAME 2	829	Pcr	16400	ultimate load
		U	60797	94048
H-FRAME 3	829	area	14.77	wood xsection
		r	0.974	radius of gyr
H-FRAME 4	986	tttl	0	tension contribution
		wwwl	374.1	457.1
H-FRAME 5	1418	V	1333	for HF4 and HF6
		h2-a	37.3	47.2
H-FRAME 6	1632	www2	8.4	for HF4 and HF6

EXHIBIT B-8

WHF4 WOOD

Alaska Energy Authority
Copper Valley Intertie
Span Comparison

DIRECT EMBEDMENT
TYPE 4 HFRAME
BOXED NUMBERS
ARE QTY STRUCTRURES IN
10 MILE SEGMENT
WOOD

INSLZ1	TOPLZ1	ADDLZ1	PERLZ1	CLRLZ1
Insulator	Top to Xarm	Embed +	Embed %	Clearance
5 ft	8 ft	3 ft	10%	26.6 ft

ALLOWABLE SPANS BASED ON CLEARANCE/SAGS
LOADING ZONE 1

Ruling Span		Lp	Dove 556 ACSR 26/7	2	1	H1	H2	Qty	Teal 605 ACSR 30/19	2	1	H1	H2	Qty	Teal 605 SSAC 30/19	Qty	T2 Unnet 2x336 26/7	2	1	H1	H2	Qty	Dove/EHS 556 ACSR 26/7	Qty	Dove SD 556 SD	Qty
600	Ruling Span Sags >>>>>>>>		21.69	HORIZONTAL SPAN LIMITS					18.12	HORIZONTAL SPAN LIMITS					19.30		18.36	HORIZONTAL SPAN LIMITS					18.69		19.56	
		Lp		2	1	H1	H2			2	1	H1	H2					2	1	H1	H2					
		50	265					199	291					181	282	187	289					183	285	185	280	186
		55	449					116	494		INPUT			107	478	110	490		INPUT			108	484	109	475	111
		60	577	842	1061	1314	1604	91	635	786	990	1226	1496	83	615	86	630	662	834	1032	1260	84	621	85	611	86
		65	682					77	749					70	726	73	744					71	734	72	721	73
		70	772	829	1048	1302	1593	68	849	773	977	1214	1485	62	822	64	843	651	823	1023	1251	63	831	64	817	65
		75	853					62	938					56	909	58	932					57	918	57	903	58
		80	927	822	1039	1289	1581	57	1019	767	969	1202	1474	52	987	53	1012	646	816	1013	1242	52	998	53	981	54
		85	996					53	1094					48	1060	50	1087					49	1072	49	1053	50
900	Ruling Span Sags >>>>>>>>		27.04						22.36						23.56		23.23						22.26		26.39	
		Lp																								
		50	268					197	295					179	287	184	289					183	296	179	277	191
		55	455		INPUT			116	500		INPUT			106	487	108	491		INPUT			108	501	105	469	113
		60	584	842	1061	1314	1604	90	643	786	990	1226	1496	82	626	84	630	662	834	1032	1260	84	644	82	603	88
		65	690					77	759					70	739	71	745					71	761	69	712	74
		70	782	829	1048	1302	1593	68	860	773	977	1214	1485	61	837	63	843	651	823	1023	1251	63	862	61	807	65
		75	864					61	950					56	925	57	932					57	952	55	891	59
		80	938	822	1039	1289	1581	56	1032	767	969	1202	1474	51	1005	53	1012	646	816	1013	1242	52	1035	51	968	55
		85	1008					52	1108					48	1060	49	1087					49	1111	48	1040	51
1000	Ruling Span Sags >>>>>>>>		33.92						26.93						28.11		28.59						28.63		33.76	
		Lp																								
		50	266					198	299					177	292	181	290					182	305	173	267	198
		55	451		INPUT			117	506		INPUT			104	495	107	491		INPUT			107	517	102	452	117
		60	580	842	1061	1314	1604	91	651	786	990	1226	1496	81	637	83	631	662	834	1032	1260	84	664	79	581	91
		65	685					77	768					69	752	70	746					71	765	67	686	77
		70	776	829	1048	1302	1593	68	870	773	977	1214	1485	61	852	62	845	651	823	1023	1251	63	889	59	777	68
		75	857					62	962					55	941	56	933					57	982	54	859	61
		80	931	822	1039	1289	1581	57	1045	767	969	1202	1474	51	1023	52	1014	646	816	1013	1242	52	1067	49	933	57
		85	1000					53	1122					47	1098	48	1089					48	1146	46	1002	53
1100	Ruling Span Sags >>>>>>>>		43.31						31.87						32.93		35.28						32.23		43.13	
		Lp																								
		50	259					204	302					175	297	178	287					184	300	176	259	203
		55	439		INPUT			120	512		INPUT			103	504	105	486		INPUT			109	509	104	440	120
		60	564	842	1061	1314	1604	94	658	786	990	1226	1496	80	647	82	625	662	834	1032	1260	84	654	81	566	93
		65	666					79	777					68	764	69	738					72	773	68	668	79
		70	755	829	1048	1302	1593	70	880	773	977	1214	1485	60	866	61	836	651	823	1023	1251	63	875	60	757	70
		75	834					63	972					54	957	55	924					57	967	55	836	63
		80	906	822	1039	1289	1581	56	1057	767	969	1202	1474	50	1039	51	1004	646	816	1013	1242	53	1051	50	908	56
		85	973					54	1134					47	1116	47	1076					49	1128	47	975	54
1200	Ruling Span Sags >>>>>>>>		53.69						37.16						39.87		44.35						41.56		53.49	
		Lp																								
		50	254					208	305					173	294	179	279					189	288	183	254	208
		55	430		INPUT			123	517		INPUT			102	499	106	473		INPUT			112	489	108	431	122
		60	553	842	1061	1314	1604	95	665	786	990	1226	1496	79	642	82	608	662	834	1032	1260	87	628	84	554	95
		65	653					81	765					67	758	70	719					73	742	71	654	81
		70	740	829	1048	1302	1593	71	889	773	977	1214	1485	59	858	62	814	651	823	1023	1251	65	841	63	741	71
		75	817					65	982					54	948	56	899					59	929	57	819	64
		80	888	822	1039	1289	1581	59	1067	767	969	1202	1474	49	1030	51	977	646	816	1013	1242	54	1009	52	890	59
		85	954					55	1146					46	1107	48	1049					50	1084	49	955	55

EXHIBIT B-9

CLIENT ....: ALASKA ENERGY AUTHORITY
PROJECT ....: COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE ....: COND t21innet ZONE 2 XTH WIND
ITEM..............: 70 CLASS h1 RUL SPAN 1000
WORK ORDER NUMBER : WW-1559-HA1-AC

BY/DATE ....: PED 8/4/93
CHECKED/DATE .....: [signature] 11/5/93

WOOD H-FRAME STRUCTURE ANALYSIS BASED ON REA 62-1 METHODS
NEGATIVE OR ANOMALOUS RESULTS MAY INDICATE INCORRECT STRUCTURE DIMENSIONS

ENTER INPUT DATA BELOW

		INPUT VALUE	RANGE NAME	
WOOD POLE DATA				
WOOD TYPE (DF,WRC,SYP,AYC)	:	wrc	WOOD	TABLE2
CLASS POLES (1,2,3,H1-H6)	:	h1	CLASS	3
POLE LENGTH (ft)	:	70	LTOT	
EMBEDMENT % L (%)	:	0%	EMBPER	
EMBEDMENT ADDER (ft)	:	6	EMBADD	
LINE DESIGN DATA				
LINE ANGLE (deg)	:	0	ANGLE	
RULING SPAN (ft)	:	1000	RS	
UNIT WIND FORCE (psf)	:	26.00	PSF	
RADIAL ICE (inches)	:	0.00	ICE	
SAFETY FACTOR NOTE: IF SAFETY FACTOR NOT 1, THEN OCFs =1.0				
WOOD POLE SAFETY FACTOR	:	1.00	SF	
OVERLOAD CAPACITY FACTORS				
OCF TENSION	:	1.10	OCFT	STEEL OCFS 1.10
OCF WIND	:	1.10	OCFW	WOOD OCFS 1.30
OCF WEIGHT	:	1.10	OCFWT	
PHASE CONDUCTOR DATA				
NUMBER PHASES	:	3	NPHASE	
BARE DIAMETER (inches)	:	1.180	PHDIAM	
UNIT WEIGHT (lbf/ft)	:	0.926	PHWT	
RULING SPAN TENSION (lbf)	:	0	PHTEN	NO EFFECT, NO ANGLE
ASSEMBLY WT (lbf)	:	100	PHWI	
SHIELDWIRE DATA				
NUMBER WIRES	:	0	NSW	
BARE DIAMETER (inches)	:	0.000	SWDIAM	
UNIT WEIGHT (lbf/ft)	:	0.000	SWWT	
RULING SPAN TENSION (lbf)	:	0	SWTEN	
ASSEMBLY WT (lbf)	:	0	SWWI	

ANALYSIS RESULTS

MAXIMUM HORIZONTAL SPANS LIMITED BY POLE STRENGTH

STRUCTURE TYPE	CROSSARM LEVEL B	TOP OF XB LEVEL E	BOT OF XB LEVEL D	GROUNDLINE LEVEL A
H-FRAME 1	NA	NA	NA	1040
H-FRAME 2	NO SW	928	2151	4145
H-FRAME 3	NA	978	2151	4145
H-FRAME 4	1216	1633	2151	4145
H-FRAME 5	NO SW	928	7167	9894
H-FRAME 6	1216	1633	7167	9894

NOT APPLICABLE

STRUCTURE TYPE	**MAXIMUM HORIZONTAL SPAN LIMITED BY CROSSBRACE**			
		L	16.0	pole separation
H-FRAME 1	NA	L'	10.6	unbraced length
		kl/r	130.6	K=1
H-FRAME 2	806	Pcr	16400	ultimate load
		U	58967	91279
H-FRAME 3	806	area	14.77	wood xsection
		r	0.974	radius of gyr
H-FRAME 4	954	ttt1	0	tension contribution
		www1	387.4	473.7
H-FRAME 5	1374	V	1220	for HF4 and HF6
		h2-a	38.6	48.9
H-FRAME 6	1575	www2	8.4	for HF4 and HF6

EXHIBIT B-10

SHF4 STEEL

SHF4.XLS

Alaska Energy Authority
Copper Valley Intertie
Span Comparison

DIRECT EMBEDMENT
TYPE 4 HFRAME
BOXED NUMBERS
ARE QTY STRUCTRURES IN
10 MILE SEGMENT
ZONES 1,3 AND 4 PRACTICAL

INSLZ1	TOPLZ1	ADDLZ1	PERLZ1	CLRLZ1
Insulator	Top to Xarm	Embed +	Embed %	Clearance
5	8	3	10%	26.8
ft	ft	ft		ft

ALLOWABLE SPANS BASED ON CLEARANCE/SAGS
LOADING ZONE 1

Ruling Span	Lp	Dove 556 ACSR 26/7	1	H1	H2	H3	Qty	Teal 605 ACSR 30/19	1	H1	H2	H3	Qty	Teal 605 SSAC 30/19	Qty	T2 Linnet 2x336 26/7	1	H1	H2	H3	Qty	Dove/EHS 556 ACSR 26/7	Qty	Dove SD 556 SD	Qty
800	Ruling Span Sags >>>>>>>>	21.89	HORIZONTAL SPAN LIMITS					18.12	HORIZONTAL SPAN LIMITS					19.30		18.36	HORIZONTAL SPAN LIMITS					18.89		19.56	
	50	265					199	291					181	282	187	289					183	265	185	280	188
	55	449					118	494		INPUT			107	478	110	490		INPUT			108	484	109	475	111
	60	577	1263	1563	NC	NC	91	635	1178	1457	1778	2148	83	615	86	630	992	1228	1497	1809	84	621	85	611	86
	65	682					77	749					70	726	73	744					71	734	72	721	73
	70	772	1247	1548	NC	NC	68	849	1163	1444	1765	NC	62	822	64	843	980	1216	1487	1795	63	831	64	817	65
	75	853					62	938					56	909	58	932					57	918	57	903	58
	80	927	1236	1533	NC	NC	57	1019	1153	1430	1752	NC	52	987	53	1012	971	1204	1475	1780	52	998	53	981	54
	85	986					53	1094					48	1060	50	1087					49	1072	49	1053	50
900	Ruling Span Sags >>>>>>>>	27.04						22.35						23.56		23.23						22.25		25.39	
	50	268					197	295					179	287	184	289					183	296	179	277	191
	55	455		INPUT			110	500		INPUT			106	487	108	491		INPUT			108	501	105	469	113
	60	584	1263	1563	NC	NC	90	643	1178	1457	1778	2148	82	626	84	630	992	1228	1497	1809	84	644	82	603	88
	65	690					77	759					70	739	71	745					71	761	69	712	74
	70	782	1247	1548	NC	NC	68	860	1163	1444	1765	NC	61	837	63	843	980	1216	1487	1795	63	862	61	807	65
	75	864					61	950					56	925	57	932					57	952	55	891	59
	80	938	1236	1533	NC	NC	56	1032	1153	1430	1752	NC	51	1005	53	1012	971	1204	1475	1780	52	1035	51	968	55
	85	1008					52	1108					48	1080	49	1087					49	1111	48	1040	51
1000	Ruling Span Sags >>>>>>>>	33.92						26.93						28.11		28.59						25.83		33.76	
	50	266					198	299					177	292	181	290					182	305	173	267	198
	55	451		INPUT			117	506		INPUT			104	495	107	491		INPUT			107	517	102	452	117
	60	580	1263	1563	NC	NC	91	651	1178	1457	1778	2148	81	637	83	631	992	1228	1497	1809	84	664	79	581	91
	65	685					77	768					69	752	70	746					71	765	67	688	77
	70	778	1247	1548	NC	NC	68	870	1163	1444	1765	NC	61	852	62	845	980	1216	1487	1795	63	889	59	777	68
	75	857					62	962					55	941	56	933					57	982	54	859	61
	80	931	1236	1533	NC	NC	57	1045	1153	1430	1752	NC	51	1023	52	1014	971	1204	1475	1780	52	1067	49	933	57
	85	1000					53	1122					47	1098	48	1089					48	1146	46	1002	53
1100	Ruling Span Sags >>>>>>>>	43.31						31.87						32.93		35.28						32.23		43.13	
	50	259					204	302					175	297	178	287					184	300	176	259	203
	55	439		INPUT			120	512		INPUT			103	504	105	486		INPUT			109	509	104	440	120
	60	564	1263	1563	NC	NC	94	658	1178	1457	1778	2148	80	647	82	625	992	1228	1497	1809	84	654	81	566	93
	65	666					79	777					68	764	69	738					72	773	68	668	79
	70	755	1247	1548	NC	NC	70	880	1163	1444	1765	NC	60	866	61	836	980	1216	1487	1795	63	875	60	757	70
	75	834					63	972					54	957	55	924					57	967	55	836	63
	80	906	1236	1533	NC	NC	58	1057	1153	1430	1752	NC	50	1039	51	1004	971	1204	1475	1780	53	1051	50	908	58
	85	973					54	1134					47	1116	47	1078					49	1128	47	975	54
1200	Ruling Span Sags >>>>>>>>	53.69						37.16						39.87		44.35						41.66		53.46	
	50	254					208	305					173	294	179	279					189	288	183	254	208
	55	430		INPUT			123	517		INPUT			102	499	106	473		INPUT			112	489	108	431	122
	60	553	1263	1563	NC	NC	95	665	1178	1457	1778	2148	79	642	82	608	992	1228	1497	1809	87	628	84	554	95
	65	653					81	785					67	758	70	719					73	742	71	654	81
	70	740	1247	1548	NC	NC	71	889	1163	1444	1765	NC	59	858	62	814	980	1216	1487	1795	65	841	63	741	71
	75	817					65	982					54	948	56	899					59	929	57	819	64
	80	888	1236	1533	NC	NC	59	1067	1153	1430	1752	NC	49	1030	51	977	971	1204	1475	1780	54	1009	52	890	59
	85	954					55	1146					46	1107	48	1049					50	1084	49	955	55

↑ Steel oversized

EXHIBIT B-11

 LOADING ZONE 1

LOAD COMPUTATIONS

C	PROJECT ....:	COPPER VALLEY INTERTIE FEASIBILITY STUDY
O	CLIENT .....:	ALASKA ENERGY AUTHORITY
D	WORK ORDER .:	WW-1559-HA1-AC
E	FEATURE ....:	LIGHT ANGLE STRUCTURE
	ITEM ....:	INTACT LOADS, LOADING ZONE 1, OCFs = 1.00
	BY ....:	PED 11-Aug-93
	CHECK ......:	[signature] 11/5/93

INPUT DATA	SEE PAGE 4 FOR EQUATIONS AND REFERENCES

I	NESC CONDITION =	HEAVY	(LIGHT MEDIUM HEAVY)
I	GO 95 CONDITION=	HEAVY	(LIGHT,HEAVY)
I	MATERIAL =	STEEL	(WOOD,STEEL,PSCON,CONC)
I	LINE ANGLE =	15	ANGLE DEGREES
I	YAWED WIND =	NO	(YES, NO: YES=REDUCE PSF BY COS^3 DUE ANGLE)
I	STRUCTURE TYPE =	TAN	(TAN=INTACT WIRES,SDE=SINGLE DEADEND)

	WIRE >>>>>>>>>>>>	1	2	3	4
I	DESCRIPTION	DOVE ACSR	TEAL ACSR	T2 LINNET ACSR	TEAL SSAC
I	DESCRIPTION	556 26/7	605 30/19	2X336 26/7	605 30/19
I	BARE DIAMETER	0.927	0.994	1.18	0.994
I	BARE WEIGHT	0.766	0.939	0.926	0.939
I	WIRES/POSITION	1	1	1	1
I	POSITIONS	3	3	3	3
I	INSUL/HW WT	75	75	75	75
I	WEIGHT OF MAN	200	200	200	200
I	ECCENTRICITY	0	0	0	0
I	NUMBER ECC	0	0	0	0
I	TOP TO LOAD CTR	5	5	5	5
I	TENSION - NESC	10256	13278	14780	12802
I	TENSION - WIND	10172	13056	15043	12708
I	TENSION - ICE	12809	15924	17177	14514
I	TENSION - COMB XTR	18080	21712	22028	19857
I	TENSION - CONSTR	4000	5000	6000	6000
I	TENSION - GO 95	0	0	0	0
I	HORIZONTAL SPAN	1100	1100	1100	1100
I	VERTICAL SPAN	1300	1300	1300	1300
I	SNUB ANGLE FROM HORZ	20	20	20	20
I	HS FACTOR ONE SIDE	0.6	0.6	0.6	0.6
I	VS FACTOR ONE SIDE	0.6	0.6	0.6	0.6
I	ANGLE FROM BISECTOR (X-AXIS)	82.5 ANG1	82.5 ANG2	-82.5 ANG3	-82.5 ANG4
	VALUES FOR TAN				
F	HS FACTOR =	1	1	1	1
F	VS FACTOR =	1	1	1	1
F	TENSION FACTOR=	2	2	2	2

I	LOADING CONDITIONS	ASCE COMPUTATION DESIRED (YES, NO)=	NO

		ICE IN	WIND SPEED MPH	WIND FORCE PSF		OCF WIND	OCF TENS	OCF VERT
L	I - NESC	0.5	40	4.00		1.00	1.00	1.00
I	II - XTR WIND	0.00	100	25.60		1.00	1.00	1.00
I	III - XTR ICE	1.00	0	0.00		1.00	1.00	1.00
I	IV - COMB XTR	1.70	20	1.40		1.00	1.00	1.00
I	V - CONST	0.00	0	0.00		1.00	1.00	1.00
L	VI - GO 95	0.50	48.40	6.00	SF=		1.25	GR B

|::

ASCE EXTREME WIND VALUES	IF ASCE SELECTED FILL IN PAGE 3 DATA

V PSF WIRES = 24 PSF
V PSF STRUCTURE = 21 PSF ASCE VALUES NOT USED

V LOADS PER LOAD POSITION IN KIPS — YAWED WIND SELECTED = NO

			Dove 1	Teal 2	3	4
	I- NESC					
F	TRANSVERSE	X	3.38	4.20	4.66	4.07
F	LONGITUDINAL	Y	0.00	0.00	0.00	0.00
F	VERTICAL	Z	2.42	2.70	2.84	2.70
	II- XTR WIND					
F	TRANSVERSE	X	4.83	5.74	6.70	5.65
F	LONGITUDINAL	Y	0.00	0.00	0.00	0.00
F	VERTICAL	Z	1.27	1.50	1.48	1.50
	III-XTR ICE					
F	TRANSVERSE	X	3.34	4.16	4.48	3.79
F	LONGITUDINAL	Y	0.00	0.00	0.00	0.00
F	VERTICAL	Z	4.39	4.72	5.00	4.72
	IV- COMB XTR					
F	TRANSVERSE	X	5.28	6.23	6.34	5.75
F	LONGITUDINAL	Y	0.00	0.00	0.00	0.00
F	VERTICAL	Z	8.49	8.90	9.39	8.90
	V - CONST					
F	TRANSVERSE	X	1.04	1.31	1.57	1.57
F	LONGITUDINAL	Y	0.24	0.30	0.36	0.36
F	VERTICAL	Z	2.64	3.21	3.53	3.55
	VI- GO 95					
F	TRANSVERSE	X	1.32	1.37	1.50	1.37
F	LONGITUDINAL	Y	0.00	0.00	0.00	0.00
F	VERTICAL	Z	3.03	3.38	3.55	3.38

[illegible]

NOT APPLICABLE TO OTHER THAN SINGLE POLE STRUCTURES

I [illegible]
I [illegible]
I [illegible]

F [illegible]
F [illegible]
F [illegible]
F [illegible]
F [illegible]
F [illegible]

[illegible]

MEYERBUK.XLS

Single Pole Buckling Check
Alaska Energy Authority
Copper Valley Intertie Study
LOADING ZONE 1 T2 Linnet Deadend
PED 9/14/93
11/5/93

Assumed K	1	
Assumed E steel	29000000	psi
Assumed Guy Angle	45	deg
Fraction of Unsupported L	0.6	
Number of Same Load Points	3	
Loading Zone 1	Deadend	90 deg
	Assumed Dead Load	6 k

		Input Loads in Kips no OCFs			Axial due	Total
		Trans	Vert	Long	T,L	Axial
INPUT	NESC	7.86	4.11	0	7.86	41.91
INPUT	Xtm Wind	6.69	1.58	0	6.69	30.81
INPUT	Xtm Ice	4.61	5.3	0	4.61	35.73
INPUT	Xtm Comb	33.46	9.95	0	33.46	136.23
CALC	Max	136.23				

INPUT	*Meyers LD Series*		9	input 1-10			
INPUT	Embedment	DE	DE	DE	DE	DE direct embed	
INPUT	Top to Lowest Wire	24	24	24	24		
INPUT	Pole Length	70	80	90	100		
NO input	Top Dia	10	10	10	10		
NO input	taper	0.223	0.223	0.223	0.223		
CALC	Bottom Dia	25.61	27.84	30.07	32.3		
CALC	Embed	9	10	11	12		
CALC	L unsup	37	46	55	64	Shaded area below	
CALC	Dist up to D	22.2	27.6	33	38.4	used to choose t for	
CALC	Dist down to D	38.8	42.4	46	49.6	old LD series design	
CALC	D	18.6524	19.4552	20.258	21.0608	No longer used	
CALC	Test 1	FALSE	FALSE	FALSE	FALSE	is LD Class < 5	
CALC	Test 2	FALSE	FALSE	FALSE	FALSE	is LD Class 5-6	
CALC	Test 3	TRUE	TRUE	TRUE	TRUE	is LD Class 7-9	
CALC	Test 4	FALSE	FALSE	FALSE	FALSE	is LD Class 10	
CALC	Test 5	TRUE	TRUE	TRUE	FALSE	is dist fr top <47.5	
CALC	t	0.25	0.25	0.25	0.25	in	
CALC	Area	14.4836	15.1070	15.7303	16.3537	sq in	
CALC	Inertia	601.24	682.26	770.26	865.51	in 4	
CALC	Radius of Gyr	6.44	6.72	7.00	7.27	in	
CALC	Kl/r	68.91	82.14	94.32	105.57		
CALC	Fa	60	42	32	26	ksi	
CALC	fa	9	9	9	8	ksi	
CALC	Safety Factor	6.4	4.7	3.7	3.1		
INPUT	Required SF	3	3	3	3		3
		OK	OK	OK	OK		

Alaska Energy Authority
Copper Valley Intertie
Span Comparison

TYPE XFRAME
BOXED NUMBERS
ARE QTY STRUCTRURES IN
10 MILE SEGMENT

	INSLZ1	TOPLZ1	ADDLZ1	PERLZ1	CLRLZ1
	Insulator	Top to Xarm	Embed +	Embed %	Clearance
	5	1	-2	0	26.6
	ft	ft	ft		ft

	INSLZ2	TOPLZ2	ADDLZ2	PERLZ2
	Insulator	Top to Xarm	Embed +	Embed %
	5	1	-2	0
	ft	ft	ft	

ALLOWABLE SPANS BASED ON CLEARANCE/SAGS
LOADING ZONE 1

Ruling Span		Lp	Le	*Dove* 556 ACSR 26/7	Qty	*Teal* 605 ACSR 30/19	Qty	*Teal* 605 SSAC 30/19	Qty	*T2 Linnet* 2x336 26/7	Qty	*Dove/EHS* 556 ACSR 26/7	Qty	*Dove SD* 556 SD	Qty
800	Ruling Span Sags >>>>>>>>			21.89		18.12		19.30		18.36		18.89		19.56	
		50	50	713	74	784	67	760	70	779	68	768	69	755	70
		55	55	809	65	889	59	862	61	884	60	871	61	856	62
		60	60	895	59	984	54	953	55	977	54	963	55	947	56
		65	65	973	54	1070	49	1037	51	1063	50	1048	50	1030	51
		70	70	1046	50	1149	46	1114	47	1142	46	1126	47	1106	48
		75	75	1113	47	1224	43	1186	45	1216	43	1199	44	1176	45
		80	80	1177	45	1294	41	1254	42	1285	41	1267	42	1245	42
		85	85	1238	43	1360	39	1316	40	1352	39	1332	40	1309	40
900	Ruling Span Sags >>>>>>>>			27.04		22.35		23.56		23.23		22.25		26.39	
		50	50	722	73	794	66	773	68	779	68	796	66	745	71
		55	55	819	64	891	59	876	60	884	60	903	58	845	62
		60	60	906	58	997	53	971	54	977	54	999	53	935	56
		65	65	985	54	1064	49	1055	50	1063	50	1088	49	1017	52
		70	70	1056	50	1164	45	1134	47	1142	46	1167	45	1092	48
		75	75	1127	47	1240	43	1207	44	1216	43	1242	42	1163	45
		80	80	1192	44	1311	40	1277	41	1286	41	1314	40	1230	43
		85	85	1253	42	1378	38	1342	39	1352	39	1381	38	1293	41
1000	Ruling Span Sags >>>>>>>>			33.92		26.93		28.11		28.59		25.83		33.76	
		50	50	716	74	804	66	787	67	780	68	821	64	716	74
		55	55	813	65	912	58	893	59	885	60	931	57	815	65
		60	60	899	59	1009	52	987	53	979	54	1030	51	901	59
		65	65	977	54	1097	48	1074	49	1065	50	1120	47	980	54
		70	70	1050	50	1178	45	1153	46	1144	46	1203	44	1053	50
		75	75	1116	47	1255	42	1228	43	1218	43	1281	41	1121	47
		80	80	1182	45	1327	40	1299	41	1288	41	1355	39	1185	45
		85	85	1243	42	1395	38	1365	39	1354	39	1424	37	1248	42
1100	Ruling Span Sags >>>>>>>>			43.31		31.87		32.93		35.28		32.23		43.13	
		50	50	697	76	813	65	800	66	773	68	808	65	699	76
		55	55	791	67	922	57	907	58	877	60	917	58	793	67
		60	60	875	60	1020	52	1003	53	969	54	1014	52	877	60
		65	65	951	55	1109	48	1091	48	1054	50	1103	48	953	55
		70	70	1022	52	1192	44	1172	45	1133	47	1185	45	1024	52
		75	75	1088	49	1269	42	1246	42	1206	44	1262	42	1091	48
		80	80	1151	46	1342	39	1320	40	1275	41	1334	40	1153	46
		85	85	1210	44	1410	37	1386	38	1341	39	1403	38	1212	44
1200	Ruling Span Sags >>>>>>>>			53.69		37.16		39.87		44.35		41.66		53.48	
		50	50	683	77	821	64	793	67	752	70	778	68	684	77
		55	55	775	68	932	57	899	59	853	62	881	60	777	68
		60	60	857	62	1030	51	995	53	943	56	974	54	859	61
		65	65	932	57	1121	47	1082	49	1028	51	1060	50	934	57
		70	70	1002	53	1204	44	1162	45	1102	48	1138	46	1004	53
		75	75	1066	50	1282	41	1237	43	1173	45	1212	44	1068	49
		80	80	1128	47	1355	39	1306	40	1241	43	1282	41	1130	47
		85	85	1185	45	1425	37	1376	38	1304	40	1347	39	1188	44

ALLOWABLE SPANS BASED ON CLEARANCE/S
LOADING ZONE 2

Ruling Span	Lp	Le	*Dove* 556 ACSR 26/7	Qty	*Teal* 605 ACSR 30/19	Qty	*Teal* 605 SSAC 30/19	Qty	*T2 Linnet* 2x336 26/7	Qty
800			23.28		20.88		16.67		17.32	
	50	50	692	76	734	72	768	69	802	66
	55	55	785	67	833	63	872	61	910	58
	60	60	868	61	921	57	964	55	1006	52
	65	65	944	56	1001	53	1046	50	1094	48
	70	70	1014	52	1076	49	1126	47	1176	45
	75	75	1080	49	1146	46	1199	44	1252	42
	80	80	1142	46	1211	44	1266	42	1323	40
	85	85	1200	44	1273	41	1333	40	1391	38
900			28.31		25.08		23.03		22.47	
	50	50	708	75	750	70	788	67	792	67
	55	55	801	66	851	62	888	59	899	59
	60	60	885	60	941	56	982	54	994	53
	65	65	963	55	1023	52	1068	49	1081	49
	70	70	1034	51	1099	48	1147	46	1161	45
	75	75	1101	48	1170	45	1221	43	1238	43
	80	80	1165	45	1237	43	1291	41	1307	40
	85	85	1224	43	1301	41	1358	39	1374	38
1000			35.08		29.82		27.47		29.45	
	50	50	704	75	764	69	796	66	769	69
	55	55	799	66	867	61	903	58	872	61
	60	60	884	60	959	55	999	53	965	55
	65	65	961	55	1042	51	1086	49	1049	50
	70	70	1033	51	1120	47	1167	45	1127	47
	75	75	1099	48	1192	44	1242	42	1200	44
	80	80	1162	45	1261	42	1314	40	1269	42
	85	85	1222	43	1326	40	1381	38	1334	40
1100			44.00		34.69		34.07		37.31	
	50	50	692	76	777	68	786	67	751	70
	55	55	785	67	881	60	892	59	852	62
	60	60	868	61	975	54	986	54	943	56
	65	65	944	56	1060	50	1073	49	1025	52
	70	70	1014	52	1139	46	1153	46	1101	48
	75	75	1080	49	1213	44	1227	43	1173	45
	80	80	1142	46	1282	41	1297	41	1240	43
	85	85	1200	44	1348	39	1364	39	1304	41
1200			53.83		40.30		42.43		46.01	
	50	50	682	77	789	67	768	69	738	72
	55	55	774	68	895	59	872	61	837	63
	60	60	856	62	989	53	964	55	928	57
	65	65	931	57	1076	49	1049	50	1007	52
	70	70	1000	53	1158	46	1127	47	1082	49
	75	75	1065	50	1231	43	1200	44	1152	46
	80	80	1126	47	1301	41	1268	42	1218	43
	85	85	1184	45	1368	39	1334	40	1281	41

EXHIBIT B-14

Alaska Energy Authority
Copper Valley Intertie
Span Comparison

TYPE XFRAME
BOXED NUMBERS
ARE QTY STRUCTRURES IN
10 MILE SEGMENT

CLRLZ2	INSLZ3	TOPLZ3	ADDLZ3	PERLZ3	CLRLZ3
Clearance	Insulator	Top to Xarm	Embed +	Embed %	Clearance
26.6	5	1	-2	0	32.8
ft	ft	ft	ft		ft

AGS

ALLOWABLE SPANS BASED ON CLEARANCE/SAGS
LOADING ZONE 3

Ruling Span			*Dove/EHS* 556 ACSR 26/7		*Dove SD* 556 SD		*3/#9AW*		*Dove* 556 ACSR 26/7		*Teal* 605 ACSR 30/19		*Teal* 605 SSAC 30/19		*T2 Linnet* 2x336 26/7		*Dove/EHS* 556 ACSR 26/7		*Dove SD* 556 SD	
800	Ruling Span Sags >>>>>>>>		23.98		19.97		13.31		23.17		20.67		18.89		17.14				19.81	
	Lp	Le																		
	50	50	681	77	747	71	734	72	556	95	590	89	616	88	647	82	#DIV/0!	#DIV/0!	602	88
	55	55	773	68	847	62	883	60	669	79	710	74	741	71	778	68	#DIV/0!	#DIV/0!	723	73
	60	60	855	62	937	56	1010	52	765	69	812	65	848	62	890	59	#DIV/0!	#DIV/0!	828	64
	65	65	930	57	1019	52	1122	47	851	62	903	58	942	56	989	53	#DIV/0!	#DIV/0!	920	57
	70	70	999	53	1095	48	1225	43	928	57	985	54	1028	51	1079	49	#DIV/0!	#DIV/0!	1004	53
	75	75	1064	50	1166	45	1319	40	1000	53	1061	50	1107	48	1163	45	#DIV/0!	#DIV/0!	1081	49
	80	80	1125	47	1233	43	1408	38	1067	49	1132	47	1181	45	1240	43	#DIV/0!	#DIV/0!	1154	46
	85	85	1183	45	1296	41	1490	35	1130	47	1199	44	1251	42	1313	40	#DIV/0!	#DIV/0!	1222	43
900	Ruling Span Sags >>>>>>>>		29.05		26.98		15.91		28.22		24.98		23.07		22.32				26.87	
	Lp	Le																		
	50	50	697	76	723	73	755	70	567	93	603	88	627	84	638	83	#DIV/0!	#DIV/0!	581	91
	55	55	790	67	820	64	908	58	682	77	725	73	754	70	767	69	#DIV/0!	#DIV/0!	699	76
	60	60	874	60	907	58	1039	51	780	68	829	64	863	61	877	60	#DIV/0!	#DIV/0!	799	66
	65	65	950	56	986	54	1155	46	867	61	922	57	959	55	975	54	#DIV/0!	#DIV/0!	889	59
	70	70	1021	52	1060	50	1260	42	946	56	1006	52	1047	50	1064	50	#DIV/0!	#DIV/0!	970	54
	75	75	1087	49	1126	47	1358	39	1019	52	1083	49	1127	47	1146	46	#DIV/0!	#DIV/0!	1045	51
	80	80	1150	46	1193	44	1448	38	1087	49	1158	46	1203	44	1223	43	#DIV/0!	#DIV/0!	1114	47
	85	85	1209	44	1254	42	1534	34	1152	46	1224	43	1274	41	1295	41	#DIV/0!	#DIV/0!	1180	45
1000	Ruling Span Sags >>>>>>>>		34.52		34.94		18.68		35.04		29.73		27.52		29.36				34.89	
	Lp	Le																		
	50	50	710	74	706	75	774	66	565	93	614	86	638	83	616	85	#DIV/0!	#DIV/0!	567	93
	55	55	808	68	801	66	931	57	680	78	738	72	767	69	743	71	#DIV/0!	#DIV/0!	681	77
	60	60	891	59	886	60	1065	50	778	68	844	63	878	60	850	62	#DIV/0!	#DIV/0!	760	66
	65	65	969	55	963	55	1184	45	865	61	939	56	976	54	945	56	#DIV/0!	#DIV/0!	867	61
	70	70	1041	51	1035	51	1292	41	944	56	1024	52	1065	50	1031	51	#DIV/0!	#DIV/0!	946	56
	75	75	1108	48	1102	48	1392	38	1016	52	1103	48	1147	48	1110	48	#DIV/0!	#DIV/0!	1019	52
	80	80	1172	45	1165	45	1485	36	1084	49	1177	45	1224	43	1165	45	#DIV/0!	#DIV/0!	1087	49
	85	85	1232	43	1225	43	1573	34	1148	46	1247	42	1296	41	1254	42	#DIV/0!	#DIV/0!	1151	46
1100	Ruling Span Sags >>>>>>>>		40.42		43.83		21.62		44.00		34.83		34.14		37.28				43.83	
	Lp	Le																		
	50	50	722	73	693	76	792	67	555	95	624	85	630	84	603	88	#DIV/0!	#DIV/0!	556	95
	55	55	819	64	788	67	952	55	667	79	750	70	756	70	725	73	#DIV/0!	#DIV/0!	669	79
	60	60	908	58	870	61	1069	48	764	69	858	62	867	61	830	64	#DIV/0!	#DIV/0!	765	69
	65	65	985	54	946	56	1211	44	849	62	954	55	964	55	922	57	#DIV/0!	#DIV/0!	850	62
	70	70	1056	50	1016	52	1321	40	928	57	1041	51	1052	50	1006	52	#DIV/0!	#DIV/0!	928	57
	75	75	1127	47	1082	49	1423	37	988	53	1121	47	1133	47	1084	49	#DIV/0!	#DIV/0!	1000	53
	80	80	1191	44	1144	46	1518	35	1064	50	1196	44	1208	44	1156	48	#DIV/0!	#DIV/0!	1066	50
	85	85	1252	42	1203	44	1608	33	1127	47	1267	42	1260	41	1225	43	#DIV/0!	#DIV/0!	1129	47
1200	Ruling Span Sags >>>>>>>>		48.6		53.63		24.73		53.88		40.26		42.53		46.05				53.68	
	Lp	Le																		
	50	50	718	74	684	77	806	65	547	97	633	83	618	86	592	89	#DIV/0!	#DIV/0!	548	96
	55	55	815	65	778	68	871	54	658	80	761	69	741	71	712	74	#DIV/0!	#DIV/0!	659	80
	60	60	901	59	858	62	1111	48	753	70	871	61	847	62	814	65	#DIV/0!	#DIV/0!	754	70
	65	65	980	54	933	57	1235	43	837	63	968	55	942	58	905	56	#DIV/0!	#DIV/0!	838	63
	70	70	1053	50	1002	53	1348	39	913	58	1056	50	1028	51	988	53	#DIV/0!	#DIV/0!	915	58
	75	75	1121	47	1067	49	1452	36	984	54	1136	46	1107	48	1064	50	#DIV/0!	#DIV/0!	985	54
	80	80	1185	45	1128	47	1549	34	1049	50	1214	43	1181	45	1135	47	#DIV/0!	#DIV/0!	1051	50
	85	85	1246	42	1186	45	1640	32	1111	46	1285	41	1251	42	1202	44	#DIV/0!	#DIV/0!	1113	47

Alaska Energy Authority
Copper Valley Intertie
Span Comparison

TYPE XFRAME
BOXED NUMBERS
ARE QTY STRUCTRURES IN
10 MILE SEGMENT

INSLZ4	TOPLZ4	ADDLZ4	PERLZ4	CLRLZ4
Insulator	Top to Xarm	Embed +	Embed %	Clearance
5	1	-2	0	32.8
ft	ft	ft		ft

ALLOWABLE SPANS BASED ON CLEARANCE/SAGS
LOADING ZONE 4

Ruling Span		Lp	Le	3/#9AW		Dove 556 ACSR 26/7		Teal 605 ACSR 30/19		Teal 605 SSAC 30/19		T2 Linnet 2x336 26/7		Dove/EHS 556 ACSR 26/7		Dove SD 556 SD	
800	Ruling Span Sags >>>>>>>>			13.31		36.09		24.03		26.02		17.14		30.84		35.87	
		Lp	Le														
		50	50	734	72	446	##	546	97	525	##	647	82	462	110	446	##
		55	55	863	60	536	99	657	80	631	84	778	68	560	91	537	98
		60	60	1010	52	613	86	751	70	722	73	890	59	663	80	614	86
		65	65	1122	47	682	77	835	63	803	66	989	53	737	72	683	77
		70	70	1225	43	744	71	912	58	876	60	1079	49	805	66	745	71
		75	75	1319	40	801	66	982	54	944	56	1163	45	867	61	803	66
		80	80	1408	38	855	62	1048	50	1007	52	1240	43	925	57	856	62
		85	85	1490	35	905	58	1109	48	1066	50	1313	40	979	54	907	58
900	Ruling Span Sags >>>>>>>>			15.81		47.58		32.62		35.73		22.32		40.91		47.43	
		Lp	Le														
		50	50	755	70	437	##	528	##	504	##	636	83	471	112	437	##
		55	55	908	58	525	##	635	83	606	87	767	69	566	93	526	##
		60	60	1039	51	601	88	727	73	693	76	877	60	648	81	602	88
		65	65	1155	46	668	79	808	65	771	69	975	54	720	73	669	79
		70	70	1260	42	729	72	882	60	841	63	1064	50	786	67	730	72
		75	75	1358	39	785	67	950	56	906	58	1146	46	847	62	786	67
		80	80	1448	36	837	63	1013	52	966	55	1223	43	903	58	839	63
		85	85	1534	34	887	60	1073	49	1023	52	1295	41	956	55	888	59
1000	Ruling Span Sags >>>>>>>>			18.66		61.18		42.18		46.76		29.36		52.99		60.99	
		Lp	Le														
		50	50	774	66	428	##	515	##	489	##	616	85	460	115	429	##
		55	55	931	57	515	##	620	85	589	90	743	71	553	95	515	##
		60	60	1065	50	589	90	709	74	673	78	850	62	633	83	590	90
		65	65	1184	45	654	81	788	67	749	71	945	56	703	75	655	81
		70	70	1292	41	714	74	860	61	817	65	1031	51	767	69	715	74
		75	75	1392	38	769	69	926	57	880	60	1110	48	827	64	770	69
		80	80	1485	36	821	64	988	53	939	56	1185	45	882	60	822	64
		85	85	1573	34	869	61	1046	50	994	53	1254	42	934	57	870	61
1100	Ruling Span Sags >>>>>>>>			21.62		76.39		53.00		59.89		37.28		66.62		76.17	
		Lp	Le														
		50	50	792	67	421	##	506	##	476	##	603	88	451	117	422	##
		55	55	952	55	507	##	608	87	572	92	725	73	542	97	507	##
		60	60	1089	48	579	91	696	76	654	81	830	64	621	85	580	91
		65	65	1211	44	644	82	773	68	726	73	922	57	690	77	645	82
		70	70	1321	40	703	75	844	63	794	67	1006	52	753	70	704	75
		75	75	1423	37	757	70	909	58	855	62	1084	49	811	65	758	70
		80	80	1516	35	808	65	970	54	912	58	1158	46	865	61	809	65
		85	85	1608	33	855	62	1027	51	966	55	1225	43	916	58	857	62
1200	Ruling Span Sags >>>>>>>>			24.73		93.28		65.31		74.61		46.05		81.62		93.02	
		Lp	Le														
		50	50	808	65	416	##	497	##	465	##	592	89	445	119	418	##
		55	55	971	54	500	##	598	88	560	94	712	74	535	99	501	##
		60	60	1111	48	572	92	684	77	640	82	814	65	612	88	573	92
		65	65	1235	43	638	83	760	69	712	74	905	58	680	78	637	83
		70	70	1346	39	694	76	829	64	777	68	988	53	742	71	695	76
		75	75	1452	36	746	71	893	59	836	63	1064	50	799	66	749	71
		80	80	1549	34	798	66	953	55	892	59	1135	47	853	62	799	66
		85	85	1640	32	845	63	1009	52	945	56	1202	44	903	58	846	62

EXHIBIT B-15

Work Order Account .:WW-1559-HA1-AC
Client..............:Alaska Energy Authority
Project.............:Copper Valley Intertie
Feature.............:T2Linnet 2*336 kcmil 26/ 7 ACSR,XTM WIND
Item ....:Single Wood Pole Sizing and Optimization
Calculated By/Date..:PED
Checked By/Date.....: KH 11/5/93 Swp T2 EX
Approved By/Date ...:

PROBLEM STATEMENT

Compute maximum spans due to pole moment capacity at groundline, maximum spans for given pole top dimensions and required ground clearance, and maximum span based on required vertical phase separation in midspan. Compare to determine most appropriate span and pole combinations.

SET special units

$kip := 1000 \cdot lb$

SET indices for arrays, i for rows and k for columns, for circumferences 6 feet from butt.

$i := 1,2..14 \qquad k := 1,2..5$

INPUT transmission line data

Establish matrix of pole top dimensions, column 1 is X value of wire positions, column 2 is distance from pole top to phase, all in feet. Use -+ numbers to indicates positions on opposite pole sides.

$$DIST := \begin{pmatrix} 6 & 5 \\ -6 & 12 \\ 6 & 19 \end{pmatrix} \cdot ft$$

$CLR := 27.8 \cdot ft$ Clearance to grade

$$FSTRESSDF := 8000 \cdot \frac{lb}{in^2}$$

$$FSTRESSWRC := 6000 \cdot \frac{lb}{in^2}$$

LOADING CONDITION IS [NESC, EXTREME WIND, EXTREME COMBINED]

$PSF := 26 \cdot \frac{lb}{ft^2}$ wind pressure for loading condition

$ICE := 0.0 \cdot in$ radial ice for loading condition

$TENS := 8226 \cdot lb$ loading condition tension for ruling span given

$ANGLE := 0 \cdot deg$ line angle assumed

$dia := 1.18 \cdot in$ bare wire diameter

$weight := 0.926 \cdot \frac{lb}{ft}$ bare wire unit weight

$rulspan := 400 \cdot ft$ ruling span

$sagrsclr := 4.65 \cdot ft$ ruling span sag at maximum sag for clearance

$inswgt := 50 \cdot lb$ insulator weight

$OCFW := 1.3$ overload capacity factor transverse wind

:=

OCFV := 1.3 overload capacity factor vertical load

em1 := 0.10 embedment factor as percent of total pole length

em2 := 2·ft embedment adder

COMPUTE INTERMEDIATE SINGLE VALUES

$DIAICE := dia + 2 \cdot ICE$ $DIAICE = 1.18 \cdot in$

$WTICE := weight + 0.311 \cdot (DIAICE^2 - dia^2) \cdot \frac{lb}{in^2 \cdot ft}$ $WTICE = 0.926 \cdot \frac{lb}{ft}$

$PC := DIAICE \cdot PSF$ $PC = 2.557 \cdot \frac{lb}{ft}$

$MTEN := OCFT \cdot 2 \cdot TENS \cdot \sin\left(\frac{ANGLE}{2}\right)$ $MTEN = 0 \cdot lb$

$VERTARM := \sum_{l=0}^{2} DIST_{l,0}$ $VERTARM = 6 \cdot ft$

IMPORT associated files with ANSI 05.1 data on pole circumferences.

Note that WRCDIMS is associated with file WRCTABL.PRN and DFIRDIMS with file DFIRTABL.PRN in directory E:\AEA-CVEA. Suggest moving and reassociating when work is complete.

WRC := READPRN(WRCDIMS) DFIR := READPRN(DFIRDIMS)

should be 52.00 corrected

$WRC^T =$

0	23	25	27	29	31
60	46.5	50.5	53.5	56.5	59.5
65	48	51.5	55	58.5	61.5
70	49.5	53	56.5	60	63.5
75	51	54.5	58	61.5	65
80	52	56	59.5	63	67
85	53.5	57	61	64.5	68.5
90	54.5	58.5	62.5	66	70
95	0	59.5	63.5	67.5	71.5
100	0	61	65	69	72.5
105	0	62	66	70	74
110	0	63	67.5	71.5	75.5
115	0	64	68.5	72.5	76.5
120	0	65	69.5	74	78
125	0	66	70.5	75	79

$DFIR^T =$

0	23	25	27	29	31
60	42	45	48	51	54
65	43.5	46.5	49.5	52.5	55.5
70	45	48	51	54	57
75	46	49	52.5	55.5	59
80	47	50.5	54	57	60
85	48	51.5	55	58.5	61.5
90	49	53	56	59.5	63
95	0	54	57	61	64.5
100	0	55	58.5	62	65.5
105	0	56	59.5	63	67
110	0	57	60.5	64.5	68
115	0	58	61.5	65.5	69
120	0	59	62.5	66.5	70
125	0	59.5	63.5	67.5	71

Table of circumferences of Western Red Cedar(WRC) or Douglas fir and Southern Yellow Pine (DFIR) poles per ANSI 05.1. Columns 1-5 correspond to classes 3,2,1,H1, H2 respectively. Column 0 is pole length, Row 0 is minimum top circumference, other data are minimum circumference at 6 feet above the butt in inches.

EXPRESS array of lengths, either DF or WRC matrices will do

$$L_i := \left(WRC^T\right)_{i,0} \cdot ft \qquad \text{total pole length}$$

COMPUTE matrix of pole top diameters and diameters at 6 ft from butt.

$$dTWRC_{i,k} := \frac{\left(WRC^T\right)_{0,k} \cdot in}{\pi} \qquad dTDF_{i,k} := \frac{\left(DFIR^T\right)_{0,k}}{\pi} \cdot in$$

$$d6WRC_{i,k} := \frac{\left(WRC^T\right)_{i,k} \cdot in}{\pi} \qquad d6DF_{i,k} := \frac{\left(DFIR^T\right)_{i,k} \cdot in}{\pi}$$

$$EMB_i := L_i \cdot em1 + em2$$

$$LEXP_i := L_i - EMB_i$$

COMPUTE GROUNDLINE POLE DIAMETERS

$$dGLDF_{i,k} := dTDF_{i,k} + \frac{d6DF_{i,k} - dTDF_{i,k}}{L_i - 6 \cdot ft} \cdot LEXP_i$$

$$dGLWRC_{i,k} := dTWRC_{i,k} + \frac{d6WRC_{i,k} - dTWRC_{i,k}}{L_i - 6 \cdot ft} \cdot LEXP_i$$

COMPUTE groundline moment capacity of poles

$$MCAPDF_{i,k} := FSTRESSDF \cdot \pi \cdot \frac{\left(dGLDF_{i,k}\right)^3}{32}$$

$$MCAPWRC_{i,k} := FSTRESSWRC \cdot \pi \cdot \frac{\left(dGLWRC_{i,k}\right)^3}{32}$$

COMPUTE moment arm for PT, total transverse load due wind

$$MOMARM_i := \frac{\left(3 \cdot L_i - \sum_{n=0}^{2} DIST_{n,1}\right) \cdot PC}{3 \cdot PC} \qquad PT := 3 \cdot PC$$

COMPUTE wind on pole contribution

$$WPDF_{i,k} := \frac{PSF \cdot \left(2 \cdot dTDF_{i,k} + dGLDF_{i,k}\right) \cdot \left(LEXP_i\right)^2}{6}$$

$$WPWRC_{i,k} := \frac{PSF \cdot \left(2 \cdot dTWRC_{i,k} + dGLWRC_{i,k}\right) \cdot \left(LEXP_i\right)^2}{6}$$

COMPUTE maximum horizontal spans based on groundline moment

$$MAXHSDF_{i,k} := \frac{MCAPDF_{i,k} - WPDF_{i,k} \cdot OCFW - MTEN \cdot MOMARM_i \cdot OCFT}{PT \cdot MOMARM_i \cdot OCFW + WTICE \cdot VERTARM \cdot OCFV}$$

$$MAXHSWRC_{i,k} := \frac{MCAPWRC_{i,k} - WPWRC_{i,k} \cdot OCFW - MTEN \cdot MOMARM_i \cdot OCFT}{PT \cdot MOMARM_i \cdot OCFW + WTICE \cdot VERTARM \cdot OCFV}$$

COMPUTE maximum spans based on pole length and ground clearance

$$AVAILSAG_i := LEXP_i - DIST_{2,1} - CLR$$

Available sag subtracting distance from pole top to bottom phase attachment and clearance from exposed length.

$$MAXCLRSPAN_{i,k} := rulspan \cdot \sqrt{\frac{AVAILSAG_i}{sagrsclr}}$$

COMPUTE maximum span based on vertical midspan separation and ice jump

$$MIDSPANSEP := 3.6 \cdot ft$$

$$SAGICE := 6.35 \cdot ft$$

$$SAGNOICE := 2.35 \cdot ft$$

$$ADDER := 2.0 \cdot ft$$

$$A := DIST_{2,1} - DIST_{0,1}$$

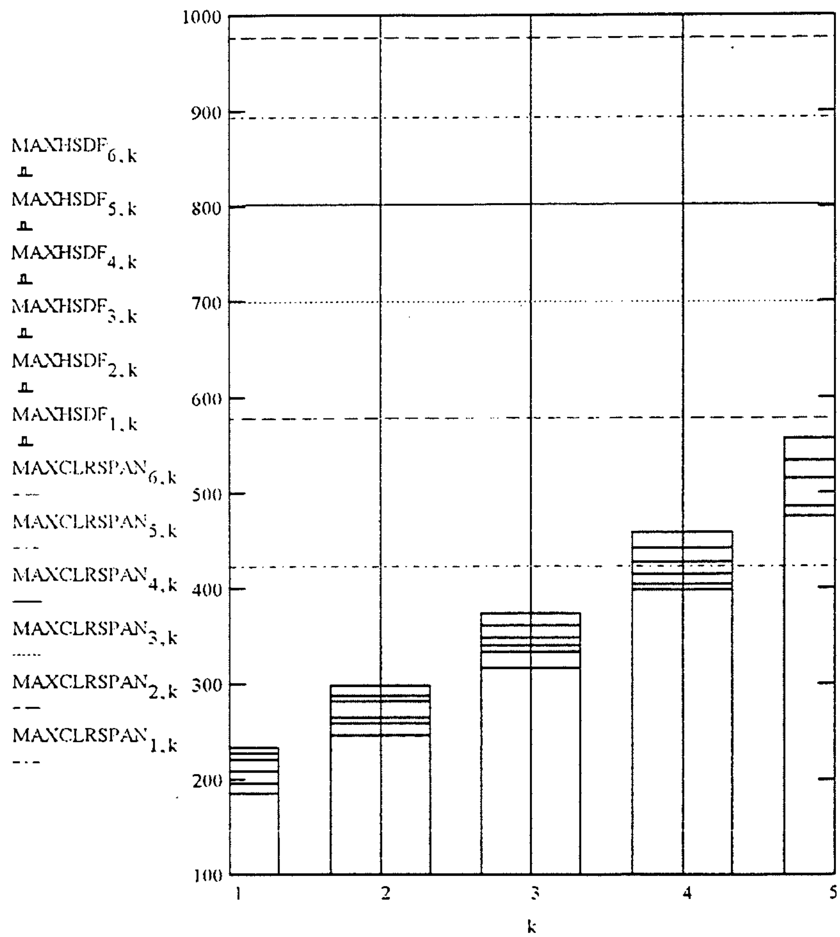
$$MAXICESPAN := rulspan \cdot \sqrt{\frac{MIDSPANSEP + ADDER - A}{SAGNOICE - SAGICE}}$$

$$MAXICESPAN = 580 \cdot ft$$

PLOT curves of maximum HS versus length of pole, maximum span based on clearance, and maximum span based on vertical midspan separation. Select classes and range of heights desired. In following case all classes 3-H2 and lengths 60-85 feet are considered.

$i := 1, 2 .. 6$ $\qquad$ $k := 1, 2 .. 5$

PLOT OF SPANS Douglas Fir Poles



MAXHSDF = (·ft)

			2	1	4	42
	0	0	0	0	0	0
60	0	233	298	373	459	557
65	0	226	288	360	441	533
70	0	221	280	349	426	514
75	0	208	264	340	414	514
	0	196	259	333	405	486
	0	186	246	316	397	476
	0	176	243	301	379	467
	0	−59	232	288	374	460
	0	−62	222	286	358	441
	0	−65	213	274	344	437
	0	−68	204	263	342	421
	0	−71	196	253	330	406
	0	−74	188	244	319	392
	0	−77	173	235	308	380

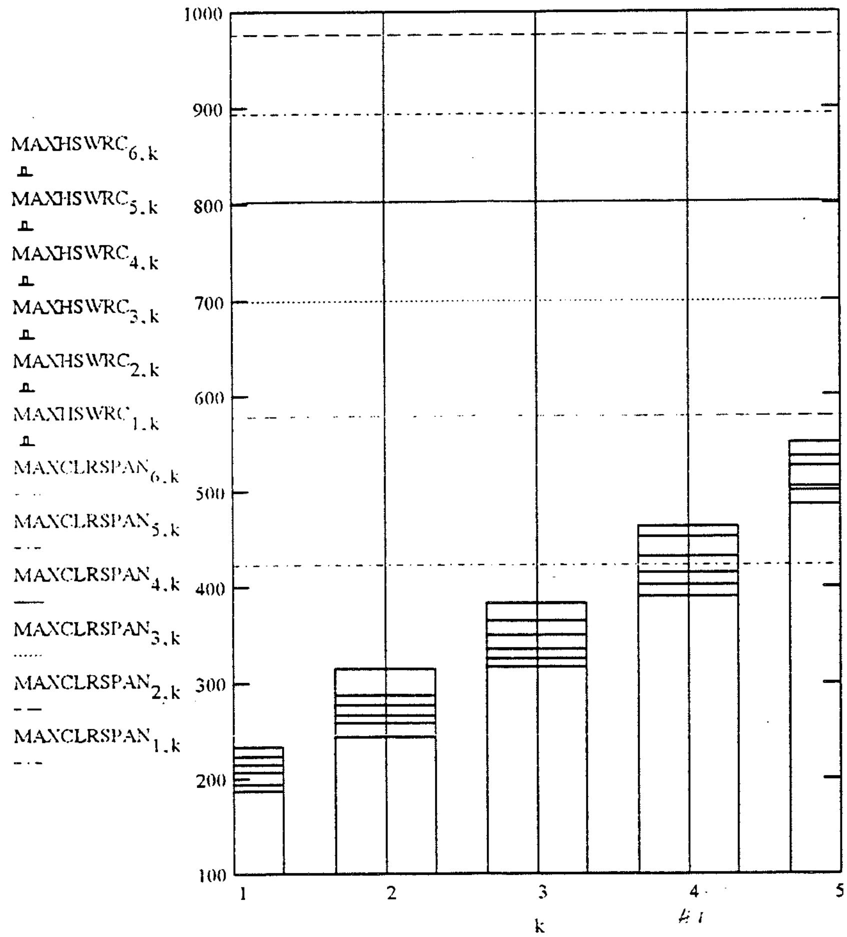
60/H1 423 → 420
65/H2 533 → 525

$MAXCLRSPAN^{<1>}$ = (·ft)

0
423
578
699
802
893
976
1053
1124
1191
1254
1314
1372
1427
1480

MAXICESPAN = 580·ft

PLOT OF SPANS Western Red Cedar



5

MAXHSWRC = (matrix) ·ft

		3	2	1	4	42
	0	0	0	0	0	0
60	0	233	314	383	462	550
65	0	223	288	365	452	536
70	0	214	277	349	432	526
	0	207	267	336	415	505
	0	193	259	325	401	500
	0	188	243	316	389	485
	0	177	237	308	379	471
	0	−59	224	292	370	459
	0	−62	220	286	362	437
	0	−65	208	272	345	429
	0	−68	197	267	339	421
	0	−71	187	255	324	403
	0	−74	178	243	320	397
	0	−77	168	232	306	381

60/. 383 → 375
4/42 ≤ 536 → 525

$MAXCLRSPAN^{\langle 1 \rangle}$ = (vector) ·ft

0
423
578
699
802
893
976
1053
1124
1191
1254
1314
1372
1427
1480

MAXICESPAN = 580·ft

Xframe Foundations
HP 10x57

Loading Zone	1	
Conductor	T2Linnet	
Vertical Load	1.63	Extreme Wind Case
Transverse Load	3.05	Extreme Wind Case
Wind on Structure	28.2	Extreme Wind Case

H,ft	X,ft	WOS,ft-k	M,ft-k	Wx1.1,k	C,kip	U,kip	Lc,ft	Lu,ft	Use L,ft
35	14.5	69.09	389.34	11.75	32.72603	18.625	17.27245	18.27778	19
40	18.25	90.24	456.24	12.2	31.09945	16.14658	16.91099	17.17626	18
45	22	114.21	525.96	12.65	30.23227	14.43636	16.71828	16.41616	17
50	25.75	141	598.5	13.1	29.79272	13.15874	16.6206	15.84833	17
55	29.5	170.61	673.86	13.55	29.61771	12.14873	16.58171	15.39944	17
60	33.25	203.04	752.04	14	29.61774	11.31579	16.58172	15.02924	17
65	37	238.29	833.04	14.45	29.73959	10.60608	16.6088	14.71381	17
70	40.75	276.36	916.86	14.9	29.94963	9.985583	16.65547	14.43804	17
75	44.5	317.25	1003.5	15.35	30.22556	9.431742	16.71679	14.19189	17
80	48.25	360.96	1092.96	15.8	30.55202	8.929016	16.78934	13.96845	17
85	52	407.49	1185.24	16.25	30.91808	8.466346	16.87068	13.76282	17
90	55.75	456.84	1280.34	16.7	31.31574	8.03565	16.95905	13.5714	17
95	59.5	509.01	1378.26	17.15	31.73903	7.630882	17.05312	13.3915	18
100	63.25	564	1479	17.6	32.1834	7.247431	17.15187	13.22108	18
105	67	621.81	1582.56	18.05	32.6453	6.881716	17.25451	13.05854	18
110	70.75	682.44	1688.94	18.5	33.12194	6.530919	17.36043	12.90263	18

Appendix C

SAMPLE COST ESTIMATING SHEETS

Exhibit C-1 Sample Transmission Line Unit Cost Estimates, Least Cost Option, Route Alternative A (COSTMODX.xls)

Exhibit C-2 Sample Structure Database File (DBSHF1.xls)

Exhibit C-3 Material Unit Costs (UNITCOST.xls)

Exhibit C-4 Insulator Assembly Costs (MATTEAL.xls)

Exhibit C-5 Crew Cost Development (CREWS.xls)

Exhibit C-6 Total Project Development Cost Estimates (SUMMARY.xls)

Exhibit C-7 Cost Estimating Spreadsheet Organization

Exhibit C-8 Substation Cost Estimates (SUBCOSTS.xls)

*Exhibit C-9 Right-of-Way Clearing Cost Estimates (ROWTAB.xls)

Exhibit C-10 Engineering Costs (DESGCOST.xls)

*Exhibit C-11 Tabulation of Land Ownership (LANDOWN.xls)

Exhibit C-12 Tabulation of Loading Zone Lengths (SEGTABL.xls)

---

* Not tailored to reflect latest route modifications 4-4A, 5A-5C, etc. Result: Route lengths different from other sheets by insignificant amount.

FILE: e:\ooe-cvea\phase1\design\costs\costmod1.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED P.D. | 12/12/93
CHECKED: GDH
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	ehf1	1	teal	D
LENGTH:	36.88	DO NOT ALTER			

<<INPUT OPTION, CONDUCTOR AND ROUTE (A-D)
Note that input of Route here is linked to database files, other costmodx.xls files, and summary.xls. Recalculate database file after changing route alternative.

Unit Costs are normal times appropriate adjustment in table depending on type of structure, length of structure, loading zone, and expected winter or summer construction. Adder (hours) computed to give $120/pick-xtr mile for given Zone miles.

DATABASE IS: Dbehf1.xls!Database

	M1	M2	SU1	STR1	STR3	HEL1 (extra avg miles)	STR2	HEL3 (extra avg miles)	HEL2 (extra avg miles)
Zone1	1.00	1.00	1.00	1.00	1.25	4.00	1.25	4.00	4.00
Zone2	1:00	1.00	1.00	1.00	1.00	3.00	1.00	3.00	3.00
Zone3	1.00	1.00	1.50	1.00	1.50	8.00	1.50	8.00	8.00
Zone4	1.00	1.00	1.75	1.00	2.00	12.00	2.00	12.00	12.00
Adder						0.03		0.015	0.024
Aframe	3.00	1.00	3.00	1.00	0.00	1.00	0.00	1.50	1.50
Height	0.00	0.00	0.02	0.05	0.00	1.00	0.20	0.00	0.00
_1.pole	0.75	0.75	0.50	1.00	0.00	1.00	0.75	0.50	0.50
_1G.Pole	1.00	1.00	0.50	1.10	0.00	1.00	0.75	0.50	0.50
_3G.pole	2.00	2.00	1.25	1.50	0.00	1.00	1.50	0.60	0.60
hframe4	1.50	1.50	0.75	1.50	0.00	1.00	1.00	1.00	1.00
hframe1	1.00	1.00	0.75	1.00	0.00	1.00	1.00	0.90	0.90
xframe	1.50	1.50	1.00	1.50	1.00	1.00	0.00	1.10	1.10
Winter	1.20	1.20	1.50	1.25	1.00	1.00	1.00	1.00	1.00
Summer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Normal	0.20	0.20	2.00	2.00	1.00	0.05	2.50	0.20	0.20

Note: structure data is extracted from Database in appropriate DBXXXX.xls file.

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

GROUP	No	Item / Application	Material	Type	Length	Class	Quantity	UNIT COST Material FOB Anchorage / Cost	M1 (6; $799)	M2 (8; $834)	SU1 (2; $179)	STR1 (6; $629)	STR3 (7; $560)	HEL1 (0; $581)	STR2 (7; $598)	HEL3 (0; $7,947)	HEL2 (0; $3,341; X)	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	SUBTOTAL	UNIT MANHOURS	LOADED RATE
A	1	STRUCTURES														enter "x" in one col above							
Extract Range		Application	Material	Type	Length	Class	Quantity	Cost															
	2	Tangent	steel	Hframe1	60	LD-2	18	3659	0.20	0.20	1.54	2.10	0.00	0.17	3.53	0.00	0.28	$5,052	$65,857	$90,939	$156,796	43	117
	3	Tangent	steel	Hframe1	65	LD-2	35	4055	0.20	0.20	1.56	2.15	0.00	0.17	3.73	0.00	0.28	$5,207	$141,917	$182,240	$324,158	45	116
	4	Tangent	steel	Hframe1	75	LD-2	70	4895	0.20	0.20	1.60	2.25	0.00	0.17	4.13	0.00	0.28	$5,516	$342,664	$386,136	$728,800	48	114
	5	Tangent	steel	Hframe1	85	LD-2	26	5539	0.20	0.20	1.64	2.35	0.00	0.17	4.53	0.00	0.28	$5,826	$144,024	$151,465	$295,489	52	112
	6	Tangent	steel	Hframe1	95	LD-2	26	6161	0.20	0.20	1.68	2.45	0.00	0.17	4.93	0.00	0.28	$6,135	$160,180	$159,508	$319,688	55	111
	7	Light Angle	steel	_3G.Pole	60	LD-3	0	5785	0.40	0.40	2.54	3.10	0.00	0.17	5.09	0.00	0.46	$0	$0	$0	$0	0	0
	8	Light Angle	steel	_3G.Pole	65	LD-3	1	6434	0.40	0.40	2.56	3.15	0.00	0.17	5.29	0.00	0.46	$7,878	$6,434	$7,878	$14,311	67	118
	9	Light Angle	steel	_3G.Pole	75	LD-3	2	7799	0.40	0.40	2.60	3.25	0.00	0.17	5.69	0.00	0.46	$8,187	$15,598	$16,374	$31,972	70	117
	10	Light Angle	steel	_3G.Pole	85	LD-3	1	8884	0.40	0.40	2.64	3.35	0.00	0.17	6.09	0.00	0.46	$8,496	$8,884	$8,496	$17,381	74	115
	11	Light Angle	steel	_3G.Pole	95	LD-3	1	9923	0.40	0.40	2.68	3.45	0.00	0.17	6.49	0.00	0.46	$8,806	$9,923	$8,806	$18,728	77	114
	12	Medium Angle	steel	_3G.Pole	60	LD-2	0	5488	0.40	0.40	2.54	3.10	0.00	0.17	5.09	0.00	0.46	$0	$0	$0	$0	0	0
	13	Medium Angle	steel	_3G.Pole	65	LD-3	1	6434	0.40	0.40	2.56	3.15	0.00	0.17	5.29	0.00	0.46	$7,878	$6,434	$7,878	$14,311	67	118
	14	Medium Angle	steel	_3G.Pole	75	LD-3	2	7799	0.40	0.40	2.60	3.25	0.00	0.17	5.69	0.00	0.46	$8,187	$15,598	$16,374	$31,972	70	117
	15	Medium Angle	steel	_3G.Pole	85	LD-3	1	8884	0.40	0.40	2.64	3.35	0.00	0.17	6.09	0.00	0.46	$8,496	$8,884	$8,496	$17,381	74	115
	16	Medium Angle	steel	_3G.Pole	95	LD-3	1	9923	0.40	0.40	2.68	3.45	0.00	0.17	6.49	0.00	0.46	$8,806	$9,923	$8,806	$18,728	77	114
	17	Deadend/HA	steel	_3G.Pole	60	LD-9	1	9103	0.40	0.40	2.54	3.10	0.00	0.17	5.09	0.00	0.46	$7,723	$9,103	$7,723	$16,825	65	119
	18	Deadend/HA	steel	_3G.Pole	65	LD-9	3	10253	0.40	0.40	2.56	3.15	0.00	0.17	5.29	0.00	0.46	$7,878	$30,759	$23,633	$54,392	67	118
	19	Deadend/HA	steel	_3G.Pole	75	LD-10	5	13330	0.40	0.40	2.60	3.25	0.00	0.17	5.69	0.00	0.46	$8,187	$66,649	$40,935	$107,584	70	117
	20	Deadend/HA	steel	_3G.Pole	85	LD-10	2	15350	0.40	0.40	2.64	3.35	0.00	0.17	6.09	0.00	0.46	$8,496	$30,700	$16,993	$47,693	74	115
	21	Deadend/HA	steel	_3G.Pole	95	LD-10	2	18152	0.40	0.40	2.68	3.45	0.00	0.17	6.49	0.00	0.46	$8,806	$36,303	$17,611	$53,915	77	114
	22	Self-Supporting	DE	Aframe	50	10000	0	$12,000	0.60	0.20	6.00	2.00	0.00	0.17	0.00	0.00	0.40	$0	$0	$0	$0	0	0
	23	(Note quantity is 3 per structure)																					
	24						198															manhours	helicopter
	25	Subtotal Hours							265	354	681	2824	0	34	6029	0	59					10187	92
	26																						
	27	Subtotal STRUCTURES																	$1,109,834	$1,160,291	$2,270,125	ok	

EXHIBIT C-1

FILE: e:\sea-cvea\phase1\design\costs\costmod1.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED: CAAW
COSTS AS OF : 1993

Database Criteria Range Directly Below

CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shl1	1	teal	D
LENGTH:	36.88	DO NOT ALTER			

<<INPUT OPTION, CONDUCTOR AND ROUTE (A-D)

Note that input of Route here is linked to database files, other costmodx.xls files, and summary.xls. Recalculate database file after changing route alternative.

	M1	HEL1	FP1	FP2	FDE1	FDE1	FR1	HEL2
BZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.25
BZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
BZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
BWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
BSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BVariable	0.00	0.00	0.00	0.05	0.05	0.15	0.05	0.00
BFixed	0.10	0.00	0.00	2.50	3.50	2.50	5.00	0.05

GROUP	No	Item	Type	Description	Depth/Len	Qty Per/Str	Unit	Total Quantity
B	28	FOUNDATIONS	Type		Depth/Len	Per/Str		
	29	Tangent	HPile1	Permafrost	20	0	ea	0
Hpile is 10x57	30	Tangent	HPile2	Glacial Till	17	0	ea	0
$80	31	Tangent	HPile3	Muskeg	25	0	ea	0
Cost per Ft	32	Tangent	Hpile4	Rock	8	0	ea	0
Pipe Pile	33	Tangent	Pipe	Muskeg/PF	20	2	ea	70
$110	34	Tangent	Embed	Glacial Till	10	2	ea	245
Cost per Ft	35	Tangent	Embed	Rock	8	2	ea	35
30"x0.25"t	36	Light Angle	HPile1	Permafrost	17	6	ea	0
Ton	37	Light Angle	HPile3	Muskeg	20	6	ea	6
175	38	Light angle	HPile4	Rock	8	0	ea	0
LA	39	Light Angle	Pipe	Muskeg	20	3	ea	0
5	40	Light Angle	Embed	Glacial Till	10	3	ea	11
MA	41	Light Angle	Embed	Rock	8	3	ea	2
5	42	Medium Angle	HPile1	Permafrost	20	6	ea	0
DE	43	Medium Angle	HPile3	Muskeg	23	6	ea	6
13	44	Medium Angle	HPile4	Rock	8	0	ea	0
SSA	45	Medium Angle	Pipe	Muskeg	23	3	ea	0
0	46	Medium Angle	Embed	Glacial Till	10	3	ea	11
	47	Medium Angle	Embed	Rock	8	3	ea	2
Geotech Info	48	Deadend/HA	HPile1	Permafrost	22	6	ea	0
from Unitcost	49	Deadend/HA	HPile3	Muskeg	25	6	ea	16
Glacial Till	50	Deadend/HA	HPile4	Rock	8	0	ea	0
70%	51	Deadend/HA	Pipe	Muskeg	25	3	ea	0
Muskeg	52	Deadend/HA	Embed	Glacial Till	10	3	ea	27
20%	53	Deadend/HA	Embed	Rock	8	3	ea	4
Permafrost	54	Pre-Auger Holes for Piling					ea	0
0%	55	Concrete Cap SSA	Concrete	Rock Anchor		2	ea	0
Rock	56	Pile Foundation Caps				1	ea	14
10%	57	Pile Splices	1 per pile foundation			1	ea	84
	58	Pile Tips					ea	22
	59	Foundation Uplift Tests	1	10 foundations			ls	7
	60	Small Helicopter Support						
	61	Subtotal Hours						
	62	Subtotal FOUNDATIONS						

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

No	UNIT COST Material FOB Anchorage	M1 (6) $799	HEL1 (0) $581	FP1 (4) $459	FP2 (4) $423	FDE1 (7) $693	FDE1 (7) $693	FR1 (3) $395	HEL2 (0) $3,341	UNIT COST Installation
28										
29	$1,600	0.10	0.00	0.00	3.50				0.08	$1,770
30	$1,380	0.10	0.00	0.00	3.35				0.08	$1,707
31	$2,000	0.10	0.00	0.00	3.75				0.08	$1,876
32	$1,750	0.10	0.00					5.40	0.08	$2,420
33	$2,200	0.10	0.00	0.00	3.50				0.08	$1,770
34	$300	0.10	0.00			5.00			0.08	$3,756
35	$200	0.10	0.00				4.63		0.08	$3,498
36	$1,380	0.10	0.00	0.00	3.35				0.08	$1,707
37	$1,600	0.10	0.00	0.00	3.50				0.08	$1,770
38	$1,750	0.10	0.00					5.40	0.08	$1,770
39	$2,200	0.10	0.00	0.00	3.50				0.08	$2,420
40	$300	0.10	0.00			5.00			0.08	$1,770
41	$200	0.10	0.00				4.63		0.08	$3,756
42	$1,600	0.10	0.00	0.00	3.50				0.08	$3,498
43	$1,840	0.10	0.00	0.00	3.65				0.08	$1,834
44	$1,750	0.10	0.00					5.40	0.08	$2,420
45	$2,530	0.10	0.00	0.00	3.65				0.08	$1,834
46	$300	0.10	0.00			5.00			0.08	$3,756
47	$200	0.10	0.00				4.63		0.08	$3,498
48	$1,760	0.10	0.00	0.00	3.60				0.08	$1,812
49	$2,000	0.10	0.00	0.00	3.75				0.08	$1,876
50	$1,750	0.10	0.00					5.40	0.08	$2,420
51	$2,750	0.10	0.00	0.00	3.75				0.08	$1,876
52	$300	0.10	0.00			5.00			0.08	$3,756
53	$200	0.10	0.00				4.63		0.08	$3,498
54	$500									$0
55	$2,000	0.10	0.00	0.00	0.00	0.00	0.00	12.00	0.50	$6,486
56	$150	0.00	0.00	5.00						$2,294
57	$100	0.00	0.00		1.50					$635
58	$50	0.00								$0
59	$1,500									
60			100							
61		261	100	280	1896	10290	1392	0	27	
62										

No	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
29	$0	$0	$0	0	0
30	$0	$0	$0	0	0
31	$0	$0	$0	0	0
32	$0	$0	$0	0	0
33	$154,000	$123,904	$277,904	15	121
34	$73,500	$920,254	$993,754	38	108
35	$7,000	$122,383	$129,383	33	108
36	$0	$0	$0	0	0
37	$9,600	$10,620	$20,220	15	121
38	$0	$0	$0	0	0
39	$0	$0	$0	0	0
40	$3,300	$19,471	$22,771	38	50
41	$400	$7,512	$7,912	33	114
42	$0	$0	$0	0	0
43	$11,040	$11,001	$22,041	15	121
44	$0	$0	$0	0	0
45	$0	$0	$0	0	0
46	$3,300	$41,318	$44,618	38	108
47	$400	$6,992	$7,392	33	108
48	$0	$0	$0	0	0
49	$32,000	$30,014	$62,014	16	120
50	$0	$0	$0	0	0
51	$0	$0	$0	0	0
52	$8,100	$101,418	$109,518	38	108
53	$800	$13,984	$14,784	33	108
54	$0	$0	$0	0	0
55	$0	$0	$0	0	0
56	$2,100	$32,117	$34,217	20	115
57	$8,400	$53,327	$61,727	6	108
58	$1,100	$0	$1,100	0	0
59	$10,500	$0	$10,500	0	0
60		$58,058	$58,058	Manhours	helicopter
61				13858	127
62	$325,540	$1,552,352	$1,877,892	ok	

FILE: e:\aea-cvea\phase1\design\costs\costmod3.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE:	Feasibility/Planning
ESTIMATED: PED	12/12/93
CHECKED:	
APPROVED:	
COSTS AS OF : 1993	

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf1	3	teal	D
LENGTH:	32.24	DO NOT ALTER			

Unit Costs are normal times appropriate adjustment in table depending on type of structure, length of structure, loading zone, and expected winter or summer construction. Adder (hours) computed to give $120/pick-xtr mile for given Zone miles.

DATABASE IS Dbshf1.xls!Database

Note: structure data is extracted from Database in appropriate DBXXXX.xls file.

	M1	M2	SU1	STR1	STR3	HEL1 (extra avg miles)	STR2	HEL3 (extra avg miles)	HEL2 (extra avg miles)
Zone1	1.00	1.00	1.00	1.00	1.25	4.00	1.25	4.00	4.00
Zone2	1.00	1.00	1.00	1.00	1.00	3.00	1.00	3.00	3.00
Zone3	1.00	1.00	1.50	1.00	1.50	8.00	1.50	8.00	8.00
Zone4	1.00	1.00	1.75	1.00	2.00	12.00	2.00	12.00	12.00
Adder	[redacted]					0.03	[redacted]	0.015	0.024
Aframe	3.00	1.00	3.00	1.00	0.00	1.00	0.00	1.50	1.50
Height	0.00	0.00	0.02	0.05	0.00	1.00	0.20	0.00	0.00
_1.pole	0.75	0.75	0.50	1.00	0.00	1.00	0.75	0.50	0.50
_1G.Pole	1.00	1.00	0.50	1.10	0.00	1.00	0.75	0.50	0.50
_3G.pole	2.00	2.00	1.25	1.50	0.00	1.00	1.50	0.60	0.60
hframe4	1.50	1.50	0.75	1.50	0.00	1.00	1.00	1.00	1.00
hframe1	1.00	1.00	0.75	1.00	0.00	1.00	1.00	0.90	0.90
xframe	1.50	1.50	1.00	1.50	1.00	1.00	0.00	1.10	1.10
Winter	1.20	1.20	1.50	1.25	1.00	1.00	1.00	1.00	1.00
Summer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Normal	0.20	0.20	2.00	2.00	1.00	0.05	2.50	0.20	0.20

GROUP	No	Item / Application	Material	Type	Length	Class	Quantity	UNIT COST Material FOB Anchorage Cost	M1	M2	SU1	STR1	STR3	HEL1	STR2	HEL3	HEL2
		CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above															
								Material	6	6	2	6	7	0	7	0	0
								FOB Anchorage	$799	$834	$179	$629	$560	$581	$598	$7,947	$3,341
																	x
																enter "x" in one col above	
A	1	STRUCTURES															
Extract		Application	Material	Type	Length	Class	Quantity	Cost									
Range	2	Tangent	steel	Hframe1	55	LD-2	14	3290	0.21	0.21	2.65	2.22	0.00	0.29	3.95	0.00	0.37
	3	Tangent	steel	Hframe1	60	LD-2	28	3659	0.21	0.21	2.67	2.27	0.00	0.29	4.15	0.00	0.37
	4	Tangent	steel	Hframe1	70	LD-2	55	4468	0.21	0.21	2.71	2.37	0.00	0.29	4.55	0.00	0.37
	5	Tangent	steel	Hframe1	80	LD-2	21	5103	0.21	0.21	2.75	2.47	0.00	0.29	4.95	0.00	0.37
	6	Tangent	steel	Hframe1	90	LD-2	21	5992	0.21	0.21	2.79	2.57	0.00	0.29	5.35	0.00	0.37
	7	Light Angle	steel	_3G.Pole	55	LD-3	1	5173	0.43	0.43	4.40	3.30	0.00	0.29	5.83	0.00	0.55
	8	Light Angle	steel	_3G.Pole	60	LD-3	1	5765	0.43	0.43	4.42	3.35	0.00	0.29	6.03	0.00	0.55
	9	Light Angle	steel	_3G.Pole	70	LD-3	2	7107	0.43	0.43	4.46	3.45	0.00	0.29	6.43	0.00	0.55
	10	Light Angle	steel	_3G.Pole	80	LD-3	1	8157	0.43	0.43	4.50	3.55	0.00	0.29	6.83	0.00	0.55
	11	Light Angle	steel	_3G.Pole	90	LD-3	1	9629	0.43	0.43	4.54	3.65	0.00	0.29	7.23	0.00	0.55
	12	Medium Angle	steel	_3G.Pole	55	LD-2	1	4919	0.43	0.43	4.40	3.30	0.00	0.29	5.83	0.00	0.55
	13	Medium Angle	steel	_3G.Pole	60	LD-2	1	5488	0.43	0.43	4.42	3.35	0.00	0.29	6.03	0.00	0.55
	14	Medium Angle	steel	_3G.Pole	70	LD-3	2	7107	0.43	0.43	4.46	3.45	0.00	0.29	6.43	0.00	0.55
	15	Medium Angle	steel	_3G.Pole	80	LD-3	1	8157	0.43	0.43	4.50	3.55	0.00	0.29	6.83	0.00	0.55
	16	Medium Angle	steel	_3G.Pole	90	LD-3	1	9629	0.43	0.43	4.54	3.65	0.00	0.29	7.23	0.00	0.55
	17	Deadend/HA	steel	_3G.Pole	55	LD-9	1	8491	0.43	0.43	4.40	3.30	0.00	0.29	5.83	0.00	0.55
	18	Deadend/HA	steel	_3G.Pole	60	LD-9	2	9103	0.43	0.43	4.42	3.35	0.00	0.29	6.03	0.00	0.55
	19	Deadend/HA	steel	_3G.Pole	70	LD-10	4	12065	0.43	0.43	4.46	3.45	0.00	0.29	6.43	0.00	0.55
	20	Deadend/HA	steel	_3G.Pole	80	LD-10	2	13987	0.43	0.43	4.50	3.55	0.00	0.29	6.83	0.00	0.55
	21	Deadend/HA	steel	_3G.Pole	90	LD-10	2	16719	0.43	0.43	4.54	3.65	0.00	0.29	7.23	0.00	0.55
	22	Self-Supporting	DE	Aframe	50	10000	0	$12,000	0.64	0.21	10.50	2.17	0.00	0.29	0.00	0.00	0.49
	23	(Note quantity is 3 per structure)															
	24						162										
	25	Subtotal Hours							236.8	316	958	2460	0	47	5511	0	64
	26																
	27	Subtotal STRUCTURES															

No	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	SUBTOTAL	UNIT MANHOURS	LOADED RATE
2	$5,989	$45,914	$83,842	$129,756	49	122
3	$6,143	$102,444	$172,016	$274,460	51	121
4	$6,453	$245,726	$354,903	$600,629	54	119
5	$6,762	$107,159	$142,005	$249,164	58	117
6	$7,072	$125,835	$148,502	$274,336	61	115
7	$9,055	$5,173	$9,055	$14,228	75	120
8	$9,209	$5,785	$9,209	$14,994	77	119
9	$9,519	$14,215	$19,037	$33,252	81	118
10	$9,828	$8,157	$9,828	$17,985	84	117
11	$10,137	$9,629	$10,137	$19,767	88	116
12	$9,055	$4,919	$9,055	$13,974	75	120
13	$9,209	$5,488	$9,209	$14,697	77	119
14	$9,519	$14,215	$19,037	$33,252	81	118
15	$9,828	$8,157	$9,828	$17,985	84	117
16	$10,137	$9,629	$10,137	$19,767	88	116
17	$9,055	$8,491	$9,055	$17,546	75	120
18	$9,209	$18,205	$18,419	$36,624	77	119
19	$9,519	$48,261	$38,075	$86,335	81	118
20	$9,828	$27,975	$19,656	$47,631	84	117
21	$10,137	$33,439	$20,275	$53,714	88	116
22	$0	$0	$0	$0	0	0
25					Manhours 9529	Helicopter 111
27		$848,815	$1,121,281	$1,970,098	ok	

FILE: e:\sea-cvea\phase1\design\costs\costmod3.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf1	3	teal	D
LENGTH:	32.24	DO NOT ALTER			

	M1	HEL1	FP1	FP2	FDE1	FDE1	FR1	HEL2
BZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.25
BZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
BZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
BWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
BSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BVariable	0.00	0.00	0.00	0.05	0.05	0.15	0.05	0.00
BFixed	0.10	0.00	0.00	2.50	3.50	2.50	5.00	0.05

GROUP	No	Item	Type	Description	Depth/Len	Qty Per/Str	Unit	Total Quantity	UNIT COST Material FOB Anchorage
B	28	FOUNDATIONS	Type		Depth/Len	Per/Str			
	29	Tangent	HPile1	Permafrost	20	0	ea	0	$1,600
Hpile is 10x57	30	Tangent	HPile2	Glacial Till	17	0	ea	0	$1,360
$80	31	Tangent	HPile3	Muskeg	25	0	ea	0	$2,000
Cost per Ft	32	Tangent	Hpile4	Rock	8	0	ea	0	$1,750
Pipe Pile	33	Tangent	Pipe	Muskeg/PF	20	2	ea	112	$2,200
$110	34	Tangent	Embed	Glacial Till	10	2	ea	140	$300
Cost per Ft	35	Tangent	Embed	Rock	8	2	ea	28	$200
30"x0.25"t	36	Light Angle	HPile1	Permafrost	17	6	ea	7	$1,360
Ten	37	Light Angle	HPile3	Muskeg	20	6	ea	7	$1,600
140	38	Light angle	HPile4	Rock	8	0	ea	0	$1,750
LA	39	Light Angle	Pipe	Muskeg	20	3	ea	0	$2,200
6	40	Light Angle	Embed	Glacial Till	10	3	ea	9	$300
MA	41	Light Angle	Embed	Rock	8	3	ea	2	$200
6	42	Medium Angle	HPile1	Permafrost	20	6	ea	7	$1,600
DE	43	Medium Angle	HPile3	Muskeg	23	6	ea	7	$1,840
11	44	Medium Angle	HPile4	Rock	8	0	ea	0	$1,750
SSA	45	Medium Angle	Pipe	Muskeg	23	3	ea	0	$2,530
0	46	Medium Angle	Embed	Glacial Till	10	3	ea	9	$300
	47	Medium Angle	Embed	Rock	8	3	ea	2	$200
Geotech Info	48	Deadend/HA	HPile1	Permafrost	22	6	ea	13	$1,760
from Unitcost	49	Deadend/HA	HPile3	Muskeg	25	6	ea	13	$2,000
Glacial Till	50	Deadend/HA	HPile4	Rock	8	0	ea	0	$1,750
50%	51	Deadend/HA	Pipe	Muskeg	25	3	ea	0	$2,750
Muskeg	52	Deadend/HA	Embed	Glacial Till	10	3	ea	17	$300
20%	53	Deadend/HA	Embed	Rock	8	3	ea	3	$200
Permafrost	54	Pre-Auger Holes for Piling					ea	27	$500
20%	55	Concrete Cap SSA	Concrete	Rock Anchor		2	ea	0	$2,000
Rock	56	Pile Foundation Caps				1	ea	27	$150
10%	57	Pile Splices	1 per pile foundation			1	ea	139	$100
	58	Pile Tips					ea	40	$50
	59	Foundation Uplift Tests	1	10 foundations			ls	11	$1,500
	60								
	61	Subtotal Hours							
	62		Subtotal	FOUNDATIONS					

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

No	M1 (6) $799	HEL1 (0) $581	FP1 (4) $459	FP2 (4) $423	FDE1 (7) $693	FDE1 (7) $693	FR1 (3) $395	HEL2 (0) $3,341	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
29	0.11	0.00	0.00	4.55				0.07	$2,228	$0	$0	$0	0	0
30	0.11	0.00	0.00	4.38				0.07	$2,148	$0	$0	$0	0	0
31	0.11	0.00	0.00	4.88				0.07	$2,368	$0	$0	$0	0	0
32	0.11	0.00					7.02	0.07	$3,073	$0	$0	$0	0	0
33	0.11	0.00	0.00	4.55				0.07	$2,228	$248,400	$249,551	$495,951	19	118
34	0.11	0.00			5.20			0.07	$3,909	$42,000	$547,192	$589,192	37	106
35	0.11	0.00				4.81		0.07	$3,638	$5,600	$101,866	$107,466	34	108
36	0.11	0.00	0.00	4.38				0.07	$2,148	$9,520	$15,019	$24,539	18	119
37	0.11	0.00	0.00	4.55				0.07	$2,228	$11,200	$15,597	$26,797	19	118
38	0.11	0.00					7.02	0.07	$2,228	$0	$0	$0	0	0
39	0.11	0.00	0.00	4.55				0.07	$3,073	$0	$0	$0	0	0
40	0.11	0.00			5.20			0.07	$2,228	$2,700	$20,053	$22,753	37	80
41	0.11	0.00				4.81		0.07	$3,909	$400	$7,817	$8,217	34	114
42	0.11	0.00	0.00	4.55				0.07	$3,638	$11,200	$25,466	$36,666	19	193
43	0.11	0.00	0.00	4.75				0.07	$2,311	$12,880	$16,175	$29,055	20	118
44	0.11	0.00					7.02	0.07	$3,073	$0	$0	$0	0	0
45	0.11	0.00	0.00	4.75				0.07	$2,311	$0	$0	$0	0	0
46	0.11	0.00			5.20			0.07	$3,909	$2,700	$35,177	$37,877	37	106
47	0.11	0.00				4.81		0.07	$3,638	$400	$7,276	$7,676	34	108
48	0.11	0.00	0.00	4.68				0.07	$2,283	$22,880	$29,681	$52,561	19	118
49	0.11	0.00	0.00	4.88				0.07	$2,368	$28,000	$30,754	$58,754	20	117
50	0.11	0.00					7.02	0.07	$3,073	$0	$0	$0	0	0
51	0.11	0.00	0.00	4.88				0.07	$2,368	$0	$0	$0	0	0
52	0.11	0.00			5.20			0.07	$3,909	$5,100	$66,445	$71,545	37	106
53	0.11	0.00				4.81		0.07	$3,638	$600	$10,914	$11,514	34	106
54										$13,500	$0	$13,500	0	0
55	0.11	0.00	0.00	0.00	0.00	0.00	12.00	0.50	$6,491	$0	$0	$0	0	0
56	0.00	0.00	5.00						$2,294	$4,050	$61,939	$65,989	20	115
57	0.00	0.00		1.50					$635	$13,900	$88,244	$102,144	6	106
58	0.00								$0	$2,000	$0	$2,000	0	0
59										$16,500	$0	$16,500	0	0
60		100									$58,058	$58,058	Manhours	Helicopter
61	241	100	540	3879	6370	1178	0	24					11967	124
62										$449,530	$1,387,225	$1,836,755	ok	

FILE: e:\aea-cvea\phase1\design\costs\costmod1.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf1	1	teal	D
LENGTH:	36.88	DO NOT ALTER			

<<INPUT OPTION, CONDUCTOR AND ROUTE (A-D)
Note that input of Route here is linked to database files, other costmodx.xls files, and summary.xls. Recalculate database file after changing route alternative.

	M1	M2	ANC1	ANC2	FP2	ANC1	SU1	HEL2
CZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.00
CZone2	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
CZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
CZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
CWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
CSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CVariable	0.00	0.00	0.05	0.20	0.05	0.00	0.00	0.00
CFixed	0.00	0.10	2.50	1.50	1.00	1.00	1.00	0.10

GROUP	No	Item	Description		Length	Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage
C	63	GUY ANCHOR ASSEMBLIES			Length				
	64	Xframe Guy 1					ea	0	$223
Hpile is 10x57	65	Xframe Guy 2					ea	0	$290
$80	66	Single Down Guy	20k				ea	45	$111
Cost per Ft	67	Single Down Guy	30k				ea	0	$158
	68	Single Down Guy	35k				ea	0	$177
Tan	69	Single Down Guy	40k				ea	78	$236
175	70	Single Down Guy	60k				ea	0	$512
LA	71	Rockbolt Anchor	25k	Rock	6		ea	5	$48
5	72	Rockbolt Anchor	35k	Rock	7		ea	0	$56
MA	73	Rockbolt Anchor	45k	Rock	8		ea	0	$64
5	74	Rockbolt Anchor	50k	Rock	9		ea	8	$72
DE	75	Rockbolt Anchor	60k	Rock	10		ea	0	$80
13	76	HPile	25k	Muskeg	19		ea	9	$1,520
SSA	77	HPile	35k	Muskeg	22		ea	0	$1,840
0	78	Hpile	45k	Muskeg	25		ea	0	$2,160
	79	Hpile	50k	Muskeg	30		ea	16	$2,400
Geotech Info	80	Hpile	60k	Muskeg	33		ea	0	$2,800
from Unitcost	81	Log Anchor	25k	Till	5		ea	32	$100
Glacial Till	82	Log Anchor	35k	Till	7		ea	0	$150
70%	83	Log Anchor	45k	Till	8		ea	0	$200
Muskeg	84	Log Anchor	50k	Till	9		ea	55	$250
20%	85	Log Anchor	60k	Till	10		ea	0	$300
Permafrost	86								
0%	87	Anchor Tests	1 every		3 anchors		ea	41	$700
Rock	88								
10%	89	Subtotal Hours							
	90								
	91								
	92		Subtotal	GUY ANCHOR ASSEMBLIES					

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

No	M1	M2	ANC1	ANC2	FP2	ANC1	SU1	HEL2	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
(personnel)	6	8	2	3	4	2	2	0						
(hourly rate)	$799	$834	$222	$382	$423	$222	$179	$3,341						
63														
64	0.00	0.10				1.25			$361	$0	$0	$0	0	0
65	0.00	0.10				1.25			$361	$0	$0	$0	0	0
66	0.00	0.10				1.25			$361	$4,973	$16,250	$21,223	3	109
67	0.00	0.10				1.25			$361	$0	$0	$0	0	0
68	0.00	0.10				1.25			$361	$0	$0	$0	0	0
69	0.00	0.10				1.25			$361	$18,374	$28,167	$46,541	3	109
70	0.00	0.10				1.25			$361	$0	$0	$0	0	0
71	0.00	0.10		2.70			1.00	0.10	$1,627	$216	$7,320	$7,536	11	149
72	0.00	0.10		2.90			1.00	0.10	$1,703	$0	$0	$0	0	0
73	0.00	0.10		3.10			1.00	0.10	$1,779	$0	$0	$0	0	0
74	0.00	0.10		3.30			1.00	0.10	$1,856	$562	$14,475	$15,036	13	148
75	0.00	0.10		3.50			1.00	0.10	$1,932	$0	$0	$0	0	0
76	0.00	0.10			2.44		1.00	0.10	$1,628	$13,680	$14,651	$28,331	13	130
77	0.00	0.10			2.63		1.00	0.10	$1.707	$0	$0	$0	0	0
78	0.00	0.10			2.81		1.00	0.10	$1,787	$0	$0	$0	0	0
79	0.00	0.10			3.13		1.00	0.10	$1,919	$37,440	$29,934	$67,374	15	125
80	0.00	0.10			3.31		1.00	0.10	$1,998	$0	$0	$0	0	0
81	0.00	0.10	2.75				1.00	0.10	$1,207	$3,150	$38,028	$41,178	8	145
82	0.00	0.10	2.85				1.00	0.10	$1,229	$0	$0	$0	0	0
83	0.00	0.10	2.90				1.00	0.10	$1,241	$0	$0	$0	0	0
84	0.00	0.10	2.95				1.00	0.10	$1,252	$13,650	$68,341	$81,991	9	144
85	0.00	0.10	3.00				1.00	0.10	$1,263	$0	$0	$0	0	0
86													0	0
87										$28,700	$0	$28,700	0	0
88													Manhours	Helicopter
89	0	197	495	114	283	308	248	12					1642	12
90														
91														
92										$120,744	$217,165	$337,910	ok	

(COSTTEMP.XLW)COSTMOD1.XLS

FILE: e:\aea-cvea\phase1\design\costs\costmod1.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	ehf1	1	teal	D
LENGTH:	38.88	DO NOT ALTER			

< <INPUT OPTION, CONDUCTOR AND ROUTE (A-D)

Note that input of Route here is linked to database files, other costmodx.xls files, and summary.xls. Recalculate database file after changing route alternative.

	M1	M2	STR1	ANC1	CON3	HEL1	HEL1	HEL2
DZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	0.00
DZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
DZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
DZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
DWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
DSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DVariable	0.00	0.00	0.00	0.00	0.05	0.15	0.30	0.00
DFixed	0.10	0.10	0.00	0.50	1.50	1.00	1.00	1.00

CREW PRODUCTIVITY (hours/unit) ENTER CREW. Hourly Rate below, Personnel above

GROUP	No	Item	Description	Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage	M1 (6) $799	M2 (8) $834	STR1 (6) $629	ANC1 (2) $222	CON3 (6) $539	HEL1 (0)	HEL1 (0)	HEL2 (0) $3,341	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
D	93	STRUCTURE FRAMING, INSULATORS, GROUNDING																			
	94	Hframe, Wood, Type 1,TH-10 Framing			••	0	$900	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	95	Hframe, Wood, Type 4, TH-10V4X, Framing			••	0	$1,763	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	96	Hframe, Steel, Type 1, Framing			••	175	$1,020	0.10	0.10	0.00						$163	$178,500	$28,578	$207,078	1	117
	97	Hframe, Steel, Type 4, Framing			••	0	$1,570	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	98				••											$0	$0	$0	$0	0	0
	99	Davit Arms, Single Steel Pole		500	lb ••	0	$600	0.10	0.10							$163	$0	$0	$0	0	0
	100	Structure Signs			••	198	$15			0.05						$31	$2,970	$6,230	$9,200	0	105
	101	Aerial Patrol Signs			••	198	$80			0.20						$128	$15,840	$24,922	$40,762	1	105
	102				••											$0	$0	$0	$0	0	0
	103	Tangent I-String			••	350	$212	0.10	0.10	0.20						$289	$74,200	$101,210	$175,410	3	111
	104	Tangent V-String			••	175	$377	0.10	0.10	0.30						$352	$65,989	$61,618	$127,607	3	110
	105	Tangent Inverted V-String			••		$0	0.10	0.10	0.30						$352	$0	$0	$0	0	0
	106	Tangent Horizontal Vee	Pivoting Type		••	0	$700	0.10	0.10	0.35						$384	$0	$0	$0	0	0
	107	Running Light Angle String			••	15	$326	0.10	0.10	0.30						$352	$4,886	$5,282	$10,168	3	110
	108	Running Medium Angle String			••	15	$681	0.10	0.10	0.30						$352	$10,211	$5,282	$15,493	3	110
	109	Deadend String without Jumper			••	78	$283	0.10	0.10	0.20		1.88				$1,300	$22,050	$101,392	$123,442	14	94
	110	Jumper Support			••	20	$256	0.10	0.10	0.20		0.50				$559	$5,120	$11,174	$16,294	6	100
	111															$0	$0	$0	$0	0	0
	112	Grounding Assembly	Hframe, Steel		••	175	$30	0.10	0.10		0.50					$274	$5,250	$48,020	$53,270	2	114
	113	Grounding Assembly	Single Pole, Steel		••	0	$15	0.10	0.10		0.50					$274	$0	$D	$0	0	0
	114	Grounding Assembly	Hframe, Wood		••	0	$100	0.10	0.10		0.50					$274	$0	$0	$0	0	0
	115	Grounding Assembly	Single Pole, Wood		••	0	$60	0.10	0.10		0.50					$274	$0	$0	$0	0	0
	116	Grounding Assembly	3-Pole Structure, Steel		••	69	$50	0.10	0.10		0.50					$274	$3,450	$18,933	$22,383	2	114
	117															$0	$0	$0	$0	0	0
	118																				
	119																				
	120	Subtotal Hours						643	858	1204	244	938	0	0	0						
	121																				
	122	Subtotal FRAMING, etc.															$388,487	$412,641	$801,108	ok	

Manhours	Helicopter
3886	0

FILE: e:\eee-cvea\phase1\design\costs\costmod3.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	ahf1	3 1	teal	[illegible]
LENGTH:	32.24	DO NOT ALTER			

CZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.00
CZone2	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
CZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
CZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
CWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
CSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CVariable	0.00	0.00	0.05	0.20	0.05	0.00	0.00	0.00
CFixed	0.00	0.10	2.50	1.50	1.00	1.00	1.00	0.10

GROUP	No	Item	Description		Length	Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage	CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above								UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
										6	6	2	3	4	2	2	0						
										M1	M2	ANC1	ANC2	FP2	ANC1	SU1	HEL2						
										$799	$834	$222	$382	$423	$222	$179	$3,341						
C	63	GUY ANCHOR ASSEMBLIES			Length																		
	64	Xframe Guy 1						0	$223	0.00	0.11				1.30			$378	$0	$0	$0	0	0
Hpile is 10x57	65	Xframe Guy 2						0	$290	0.00	0.11				1.30			$378	$0	$0	$0	0	0
$80	66	Single Down Guy	20k				••	54	$111	0.00	0.11				1.30			$378	$5,968	$20,401	$26,368	3	109
Cost per Ft	67	Single Down Guy	30k				••	0	$158	0.00	0.11				1.30			$378	$0	$0	$0	0	0
	68	Single Down Guy	35k				••	0	$177	0.00	0.11				1.30			$378	$0	$0	$0	0	0
Tan	69	Single Down Guy	40k				••	66	$236	0.00	0.11				1.30			$378	$15,547	$24,934	$40,481	3	109
140	70	Single Down Guy	60k				••	0	$512	0.00	0.11				1.30			$378	$0	$0	$0	0	0
LA	71	Rockbolt Anchor	25k	Rock	6		••	5	$48	0.00	0.11		3.51			1.30	0.13	$2,095	$259	$11,315	$11,574	14	150
6	72	Rockbolt Anchor	35k	Rock	7		••	0	$56	0.00	0.11		3.77			1.30	0.13	$2,195	$0	$0	$0	0	0
MA	73	Rockbolt Anchor	45k	Rock	8		••	0	$64	0.00	0.11		4.03			1.30	0.13	$2,294	$0	$0	$0	0	0
6	74	Rockbolt Anchor	50k	Rock	9		••	7	$72	0.00	0.11		4.29			1.30	0.13	$2,393	$475	$15,794	$16,269	16	147
DE	75	Rockbolt Anchor	60k	Rock	10		••	0	$80	0.00	0.11		4.55			1.30	0.13	$2,492	$0	$0	$0	0	0
11	76	HPile	25k	Muskeg	19		••	22	$1,520	0.00	0.11			2.54		1.30	0.13	$1,829	$32,832	$39,496	$72,328	14	135
SSA	77	HPile	35k	Muskeg	22		••	0	$1,840	0.00	0.11			2.73		1.30	0.13	$1,911	$0	$0	$0	0	0
0	78	Hpile	45k	Muskeg	25		••	0	$2,160	0.00	0.11			2.93		1.30	0.13	$1,994	$0	$0	$0	0	0
	79	Hpile	50k	Muskeg	30		••	26	$2,400	0.00	0.11			3.25		1.30	0.13	$2,131	$63,360	$56,262	$119,622	16	130
Geotech Info	80	Hpile	60k	Muskeg	33		••	0	$2,800	0.00	0.11			3.45		1.30	0.13	$2,214	$0	$0	$0	0	0
from Unitcost	81	Log Anchor	25k	Till	5		••	27	$100	0.00	0.11	3.58				1.30	0.13	$1,550	$2,700	$41,848	$44,548	11	146
Glacial Till	82	Log Anchor	35k	Till	7		••	0	$150	0.00	0.11	3.71				1.30	0.13	$1,579	$0	$0	$0	0	0
50%	83	Log Anchor	45k	Till	8		••	0	$200	0.00	0.11	3.77				1.30	0.13	$1,593	$0	$0	$0	0	0
Muskeg	84	Log Anchor	50k	Till	9		••	33	$250	0.00	0.11	3.84				1.30	0.13	$1,608	$8,250	$53,054	$61,304	11	145
20%	85	Log Anchor	60k	Till	10		••	0	$300	0.00	0.11	3.90				1.30	0.13	$1,622	$0	$0	$0	0	0
Permafrost	86																					0	0
20%	87	Anchor Tests	1 every	3 anchors			••	40	$700										$28,000	$0	$28,000	0	0
Rock	88																					Manhours	Helicopter
10%	89	Subtotal Hours			-					0	205	446	142	562	312	312	16					1979	16
	90																						
	91																						
	92		Subtotal	GUY ANCHOR ASSEMBLIES															$157,391	$283,103	$420,494	ok	

FILE: e:\eee-cvea\phase1\design\costs\costmod3.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	ehf1	3	teal	D
LENGTH:	32.24	DO NOT ALTER			

DZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	0.00
DZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
DZone3	1,00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
DZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
DWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
DSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DVariable	0.00	0.00	0.00	0.00	0.05	0.15	0.30	0.00
DFixed	0.10	0.10	0.00	0.50	1.50	1.00	1.00	1.00

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

GROUP	No	Item	Description	Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage	6 M1 $799	6 M2 $634	6 STR1 $629	2 ANC1 $222	6 CON3 $539	0 HEL1	0 HEL1	0 HEL2 $3,341	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
D	93	STRUCTURE FRAMING, INSULATORS, GROUNDING																			
	94	Hframe, Wood, Type 1,TH-10 Framing			ea	0	$900	0.11	0.11	0.00						$174	$0	$0	$0	0	0
	95	Hframe, Wood, Type 4, TH-10V4X, Framing			ea	0	$1,763	0.11	0.11	0.00						$174	$0	$0	$0	0	0
	96	Hframe, Steel, Type 1, Framing			ea	140	$1,020	0.11	0.11	0.00						$174	$142,800	$24,387	$167,187	1	117
	97	Hframe, Steel, Type 4, Framing			ea	0	$1,570	0.11	0.11	0.00						$174	$0	$0	$0	0	0
	98				ea											$0	$0	$0	$0	0	0
	99	Davit Arms, Single Steel Pole	500	lb	ea	0	$600	0.11	0.11							$174	$0	$0	$0	0	0
	100	Structure Signs			ea	162	$15			0.05						$31	$2,430	$5,098	$7,528	0	105
	101	Aerial Patrol Signs			ea	162	$80			0.20						$126	$12,960	$20,390	$33,350	1	105
	102				ea											$0	$0	$0	$0	0	0
	103	Tangent I-String			ea	280	$201	0.11	0.11	0.20						$300	$56,207	$84,016	$140,224	3	111
	104	Tangent V-String			ea	140	$395	0.11	0.11	0.30						$363	$55,311	$50,819	$106,130	3	110
	105	Tangent Inverted V-String			ea		$0	0.11	0.11	0.30						$363	$0	$0	$0	0	0
	106	Tangent Horizontal Vee	Pivoting Type		ea	0	$700	0.11	0.11	0.35						$394	$0	$0	$0	0	0
	107	Running Light Angle String			ea	18	$335	0.11	0.11	0.30						$363	$6,025	$6,534	$12,559	3	110
	108	Running Medium Angle String			ea	18	$676	0.11	0.11	0.30						$363	$12,164	$6,534	$18,898	3	110
	109	Deadend String without Jumper			ea	66	$299	0.11	0.11	0.20		1.85				$1,351	$19,714	$89,180	$108,894	14	94
	110	Jumper Support			ea	16.5	$256	0.11	0.11	0.20		0.50				$570	$4,224	$9,398	$13,622	6	100
	111															$0	$0	$0	$0	0	0
	112	Grounding Assembly	Hframe, Steel		ea	140	$30	0.11	0.11		0.65					$319	$4,200	$44,608	$48,808	3	114
	113	Grounding Assembly	Single Pole, Steel		ea	0	$15	0.11	0.11		0.65					$319	$0	$0	$0	0	0
	114	Grounding Assembly	Hframe, Wood		ea	0	$100	0.11	0.11		0.65					$319	$0	$0	$0	0	0
	115	Grounding Assembly	Single Pole, Wood		ea	0	$60	0.11	0.11		0.65					$319	$0	$0	$0	0	0
	116	Grounding Assembly	3-Pole Structure, Steel		ea	69	$50	0.11	0.11		0.65					$319	$3,450	$21,984	$25,434	3	114
	117															$0	$0	$0	$0	0	0
	118																				
	119																			Manhours	Helicopter
	120	Subtotal Hours						569	757	995	272	822	0	0	0					3414	0
	121																				
	122		Subtotal FRAMING, etc.														$319,485	$362,946	$682,431	ok	

FILE: e:\aea-cvea\phase1\design\costs\costmod3.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	ehf1	3	teal	D
LENGTH:	32.24	DO NOT ALTER			

	M1	M2	CON1	CON2	CON3	HEL1	HEL2	HEL3
EZone1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EZone2	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
EZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
EZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
EWinter	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ESummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EVariable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EFixed	0.10	0.20	12.00	6.00	0.20	1.00	1.00	0.00

GROUP	No	Item	Description			Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage
E	123	CONDUCTOR	lb/ft	$/lb			3ph		
If Specular	124	Dove 556/ACSR	0.766	$0.95		0.00	ckmi	0.00	$11,496
Type 0 Below	125	Teal 605/ACSR	0.939	$1.00	x	33.85	ckmi	33.85	$14,890
If Non-Specul	126	T2 Linnet 2x336/ACSR	0.926	$1.05		0.00	ckmi	0.00	$15,465
Type 1 Below	127	Dove 556/ACSR/EHS	0.766	$0.98		0.00	ckmi	0.00	$11,945
1	128	Teal 605/ACSR/EHS	0.939	$1.04		0.00	ckmi	0.00	$15,532
	129	Teal 605/SSAC	0.939	$1.21		0.00	ckmi	0.00	$18,040
Length =	130	37#9 Alumoweld	1.109	$1.51		0.00	ckmi	0.00	$26,558
32.24	131								
Working Slack	132	Vibration Dampers	at	3	structure		ea	522	$30
5%	133	Splices	at	3	mile	97	ea	97	$33
Conductor L	134	Marker Balls,36"EHV	8 per	10	spans		ea	80	$275
536216	135		long span				ea		
33.85	136	Marker Balls,24"EHV	1	200	15%	0	ea	0	$175
	137	1 per 200 ft in LZ 2 only, 15% of L							
	138		Subtotal	CONDUCTOR					
	139	ADDERS							
	140	Special Helicopter Mobilization					ls		
	141	Subtotal Hours							
	142								
	143	Subtotal							
	144	Mobilization			5%		%		
	145								
	146								

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

No	M1	M2	CON1	CON2	CON3	HEL1	HEL2	HEL3	Installation
(Personnel)	6	8	12	6	6	0	0	0	
(Hourly Rate)	$799	$834	$1,073	$583	$539	$581	$3,341	$7,947	
123									
124	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
125	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
126	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
127	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
128	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
129	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
130	0.10	0.20	14.40	7.20		1.20	1.20	0.00	$24,610
131									$0
132					0.24				$129
133			0.20						$215
134	0.01	0.01		1.80					$1,063
135									$0
136	0.01	0.01		1.80					$1,063
141	23	61	6082	2326	752	41	41	0	

No	EXTENDED Material	EXTENDED Installation	Subtotal		UNIT MANHOURS	LOADED RATE
124	$0	$0	$0		0	0
125	$504,056	$833,108	$1,337,165		218	113
126	$0	$0	$0		0	0
127	$0	$0	$0		0	0
128	$0	$0	$0		0	0
129	$0	$0	$0		0	0
130	$0	$0	$0		0	0
131	$0	$0	$0		0	0
132	$15,660	$67,533	$83,193		1	90
133	$3,201	$20,823	$24,024		2	89
134	$22,000	$85,005	$107,005		11	87
135	$0	$0	$0		0	0
136	$0	$0	$0		0	0
138	$544,917	$1,006,469	$1,551,386	ok		
141					Manhours 9244	Helicopter 81
143	$2,320,138	$4,141,025	$6,461,163	err		
144	$116,007	$207,051				

SUMMARY	No		MH	HEL
SUMMARY	147	MANHOURS	MH	HEL
	148	A	9529	111
	149	B	11967	124
	150	C	1979	16
	151	D	3414	0
	152	E	9244	81
	153	TOTAL HOURS	36132	333

			Material	Installation	Subtotal
Subtotal			$2,436,145	$4,348,076	$6,784,221
Construction Allowance		0%	$0	$0	$0
Contingency Labor		20%		$869,615	$869,615
Contingency Material		10%	$243,615		$243,615
TOTAL COST	LOADING ZONE	3	$2,679,760	$5,217,691	$7,897,451
TOTAL COST PER MILE	32.24	MI	$83,119	$161,839	$244,958

FILE: e:\aea-cvea\phase1\design\costs\costmod4.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf4	4	37#9aw	D
LENGTH:	4	DO NOT ALTER			

Unit Costs are normal times appropriate adjustment in table depending on type of structure, length of structure, loading zone, and expected winter or summer construction. Adder (hours) computed to give $120/pick-xw mile for given Zone miles.

DATABASE IS Dbshf4.xls!Database

Note: structure data is extracted from Database in appropriate DBXXXX.xls file.

						extra avg miles		extra avg miles	extra avg miles
Zone1	1.00	1.00	1.00	1.00	1.25	4.00	1.25	4.00	4.00
Zone2	1.00	1.00	1.00	1.00	1.00	3.00	1.00	3.00	3.00
Zone3	1.00	1.00	1.50	1.00	1.50	8.00	1.50	8.00	8.00
Zone4	1.00	1.00	1.75	1.00	2.00	12.00	2.00	12.00	-12.00
Adder						0.03		0.015	0.024
Aframe	3.00	1.00	3.00	1.00	0.00	1.00	0.00	1.50	1.50
Height	0.00	0.00	0.02	0.05	0.00	1.00	0.20	0.00	0.00
_1.pole	0.75	0.75	0.50	1.00	0.00	1.00	0.75	0.50	0.50
_1G.Pole	1.00	1.00	0.50	1.10	0.00	1.00	0.75	0.50	0.50
_3G.pole	2.00	2.00	1.25	1.50	0.00	1.00	1.50	0.60	0.60
hframe4	1.50	1.50	0.75	1.50	0.00	1.00	1.00	1.00	1.00
hframe1	1.00	1.00	0.75	1.00	0.00	1.00	1.00	0.90	0.90
xframe	1.50	1.50	1.00	1.50	1.00	1.00	0.00	1.10	1.10
Winter	1.20	1.20	1.50	1.25	1.00	1.00	1.00	1.00	1.00
Summer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Normal	0.20	0.20	2.00	2.00	1.00	0.05	2.50	0.20	0.20

GROUP	No	Item	Material	Type	Length	Class	Quantity	UNIT COST Material FOB Anchorage	CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above									UNIT COST Installation	EXTENDED Material	EXTENDED Installation	SUBTOTAL	UNIT MANHOURS	LOADED RATE
									6	8	2	6	7	0	7	0	0						
									M1	M2	SU1	STR1	STR3	HEL1	STR2	HEL3	HEL2						
		Description					Qty		$799	$834	$179	$629	$560	$581	$598	$7,947	$3,341						
																	x						
A	1	STRUCTURES														enter "x" in one col above							
Extract		Application	Material	Type	Length	Class	Quantity	Cost															
Range	2	Tangent	steel	Hframe4	65	LD-2	2	4055	0.30	0.30	2.69	3.15	0.00	0.41	5.60	0.00	0.49	$8,168	$8,110	$16,337	$24,446	68	121
	3	Tangent	steel	Hframe4	70	LD-2	3	4468	0.30	0.30	2.71	3.20	0.00	0.41	5.80	0.00	0.49	$8,323	$13,403	$24,969	$38,372	69	120
	4	Tangent	steel	Hframe4	80	LD-2	6	5103	0.30	0.30	2.75	3.30	0.00	0.41	6.20	0.00	0.49	$8,632	$30,617	$51,794	$82,411	73	118
	5	Tangent	steel	Hframe4	90	LD-2	2	5992	0.30	0.30	2.79	3.40	0.00	0.41	6.60	0.00	0.49	$8,942	$11,984	$17,883	$29,868	76	117
	6	Tangent	steel	Hframe4	100	LD-2	2	6637	0.30	0.30	2.83	3.50	0.00	0.41	7.00	0.00	0.49	$9,251	$13,274	$18,502	$31,776	80	116
	7	Light Angle	steel	_3G.Pole	60	LD-3	0	5785	0.40	0.40	4.42	3.10	0.00	0.41	7.90	0.00	0.65	$0	$0	$0	$0	0	0
	8	Light Angle	steel	_3G.Pole	65	LD-3	0	6434	0.40	0.40	4.44	3.15	0.00	0.41	8.10	0.00	0.65	$0	$0	$0	$0	0	0
	9	Light Angle	steel	_3G.Pole	75	LD-4	0	8535	0.40	0.40	4.48	3.25	0.00	0.41	8.50	0.00	0.65	$0	$0	$0	$0	0	0
	10	Light Angle	steel	_3G.Pole	85	LD-4	0	9705	0.40	0.40	4.52	3.35	0.00	0.41	8.90	0.00	0.65	$0	$0	$0	$0	0	0
	11	Light Angle	steel	_3G.Pole	95	LD-4	0	10829	0.40	0.40	4.58	3.45	0.00	0.41	9.30	0.00	0.65	$0	$0	$0	$0	0	0
	12	Medium Angle	steel	_3G.Pole	60	LD-6	0	7691	0.40	0.40	4.42	3.10	0.00	0.41	7.90	0.00	0.65	$0	$0	$0	$0	0	0
	13	Medium Angle	steel	_3G.Pole	65	LD-6	0	8622	0.40	0.40	4.44	3.15	0.00	0.41	8.10	0.00	0.65	$0	$0	$0	$0	0	0
	14	Medium Angle	steel	_3G.Pole	75	LD-6	1	10052	0.40	0.40	4.48	3.25	0.00	0.41	8.50	0.00	0.65	$10,984	$10,052	$10,984	$21,036	94	117
	15	Medium Angle	steel	_3G.Pole	85	LD-6	0	12003	0.40	0.40	4.52	3.35	0.00	0.41	8.90	0.00	0.65	$0	$0	$0	$0	0	0
	16	Medium Angle	steel	_3G.Pole	95	LD-6	0	13458	0.40	0.40	4.58	3.45	0.00	0.41	9.30	0.00	0.65	$0	$0	$0	$0	0	0
	17	Deadend/HA	steel	_3G.Pole	60	LD-10	0	9622	0.40	0.40	4.42	3.10	0.00	0.41	7.90	0.00	0.65	$0	$0	$0	$0	0	0
	18	Deadend/HA	steel	_3G.Pole	65	LD-10	0	10842	0.40	0.40	4.44	3.15	0.00	0.41	8.10	0.00	0.65	$0	$0	$0	$0	0	0
	19	Deadend/HA	steel	_3G.Pole	75	LD-10	0	13330	0.40	0.40	4.48	3.25	0.00	0.41	8.50	0.00	0.65	$0	$0	$0	$0	0	0
	20	Deadend/HA	steel	_3G.Pole	85	LD-10	0	15350	0.40	0.40	4.52	3.35	0.00	0.41	8.90	0.00	0.65	$0	$0	$0	$0	0	0
	21	Deadend/HA	steel	_3G.Pole	95	LD-10	0	18152	0.40	0.40	4.58	3.45	0.00	0.41	9.30	0.00	0.65	$0	$0	$0	$0	0	0
	22	Self-Supporting	DE	Aframe	50	1E+04	9	$12,000	0.60	0.20	10.50	2.00	0.00	0.41	0.00	0.00	0.59	$5,982	$108,000	$53,835	$161,835	38	157
	23	(Note quantity is 3 per structure)																					
	24						19															Manhours	Helicopter
	25	Subtotal Hours							62	54	280	425	0	10	711	0	13					1541	23
	26																						
	27	Subtotal STRUCTURES																	$195,440	$194,305	$389,745	ok	

FILE: e:\aea-cvaa\phase1\design\costs\costmod4.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf4	4	37#9aw	D
LENGTH:	4	DO NOT ALTER			

	M1	HEL1	FP1	FP2	FDE1	FDE1	FR1	HEL2
BZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.25
BZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
BZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
BWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
BSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BVariable	0.00	0.00	0.00	0.05	0.05	0.15	0.05	0.00
BFixed	0.10	0.00	0.00	2.50	3.50	2.50	5.00	0.05

GROUP	No	Item	Type	Description	Depth/Len	Qty Per/Str	Unit	Total Quantity
B	28	FOUNDATIONS	Type		Depth/Len	Per/Str		
	29	Tangent	HPile1	Permafrost	20	0	ea	0
Hpile is 10x57	30	Tangent	HPile2	Glacial Till	17	0	ea	0
$80	31	Tangent	HPile3	Muskeg	25	0	ea	0
Cost per Ft	32	Tangent	Hpile4	Rock	8	0	ea	0
Pipe Pile	33	Tangent	Pipe	Muskeg/PF	20	2	ea	6
$110	34	Tangent	Embed	Glacial Till	10	2	ea	15
Cost per Ft	35	Tangent	Embed	Rock	8	2	ea	9
30"x0.25"t	36	Light Angle	HPile1	Permafrost	17	6	ea	0
Tan	37	Light Angle	HPile3	Muskeg	20	6	ea	0
15	38	Light angle	HPile4	Rock	8	0	ea	0
LA	39	Light Angle	Pipe	Muskeg	20	3	ea	0
0	40	Light Angle	Embed	Glacial Till	10	3	ea	0
MA	41	Light Angle	Embed	Rock	8	3	ea	0
1	42	Medium Angle	HPile1	Permafrost	20	6	ea	0
DE	43	Medium Angle	HPile3	Muskeg	23	6	ea	1
0	44	Medium Angle	HPile4	Rock	8	0	ea	0
SSA	45	Medium Angle	Pipe	Muskeg	23	3	ea	0
9	46	Medium Angle	Embed	Glacial Till	10	3	ea	2
	47	Medium Angle	Embed	Rock	8	3	ea	1
Geotech Info	48	Deadend/HA	HPile1	Permafrost	22	6	ea	0
from Unitcost	49	Deadend/HA	HPile3	Muskeg	25	6	ea	0
Glacial Till	50	Deadend/HA	HPile4	Rock	8	0	ea	0
50%	51	Deadend/HA	Pipe	Muskeg	25	3	ea	0
Muskeg	52	Deadend/HA	Embed	Glacial Till	10	3	ea	0
20%	53	Deadend/HA	Embed	Rock	8	3	ea	0
Permafrost	54	Pre-Auger Holes for Piling					ea	0
0%	55	Concrete Cap SSA	Concrete	Rock Anchor		2	ea	18
Rock	56	Pile Foundation Caps				1	ea	0.5
30%	57	Pile Splices	1 per pile foundation			1	ea	0.5
	58	Pile Tips					ea	1
	59	Foundation Uplift Tests	1	10 foundations			ls	1
	60							
	61	Subtotal Hours						
	62		Subtotal	FOUNDATIONS				

No	UNIT COST Material FOB Anchorage	M1	HEL1	FP1	FP2	FDE1	FDE1	FR1	HEL2	UNIT COST	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
	CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above														
(Personnel)		6	0	4	4	7	7	3	0						
(Rate)		$799	$581	$459	$423	$693	$693	$395	$3,341	$179					
29	$1,600	0.10	0.00	0.00	5.25				0.08	$2,552	$0	$0	$0	0	0
30	$1,360	0.10	0.00	0.00	5.03				0.08	$2,457	$0	$0	$0	0	0
31	$2,000	0.10	0.00	0.00	5.63				0.08	$2,711	$0	$0	$0	0	0
32	$1,750	0.10	0.00					8.10	0.08	$3,527	$0	$0	$0	0	0
33	$2,200	0.10	0.00	0.00	5.25				0.08	$2,552	$13,200	$15,315	$28,515	22	118
34	$300	0.10	0.00			6.00			0.08	$4,491	$4,500	$67,371	$71,871	43	105
35	$200	0.10	0.00				5.55		0.08	$4,179	$1,600	$37,614	$39,414	39	106
36	$1,360	0.10	0.00	0.00	5.03				0.08	$2,457	$0	$0	$0	0	0
37	$1,600	0.10	0.00	0.00	5.25				0.08	$2,552	$0	$0	$0	0	0
38	$1,750	0.10	0.00					8.10	0.08	$2,552	$0	$0	$0	0	0
39	$2,200	0.10	0.00	0.00	5.25				0.08	$3,527	$0	$0	$0	0	0
40	$300	0.10	0.00			6.00			0.08	$2,552	$0	$0	$0	0	0
41	$200	0.10	0.00				5.55		0.08	$4,491	$0	$0	$0	0	0
42	$1,600	0.10	0.00	0.00	5.25				0.08	$4,179	$0	$0	$0	0	0
43	$1,840	0.10	0.00	0.00	5.48				0.08	$2,648	$1,840	$2,648	$4,488	23	118
44	$1,750	0.10	0.00					8.10	0.08	$3,527	$0	$0	$0	0	0
45	$2,530	0.10	0.00	0.00	5.48				0.08	$2,648	$0	$0	$0	0	0
46	$300	0.10	0.00			6.00			0.08	$4,491	$600	$8,983	$9,583	43	105
47	$200	0.10	0.00				5.55		0.08	$4,179	$200	$4,179	$4,379	39	106
48	$1,760	0.10	0.00	0.00	5.40				0.08	$2,616	$0	$0	$0	0	0
49	$2,000	0.10	0.00	0.00	5.63				0.08	$2,711	$0	$0	$0	0	0
50	$1,750	0.10	0.00					8.10	0.08	$3,527	$0	$0	$0	0	0
51	$2,750	0.10	0.00	0.00	5.63				0.08	$2,711	$0	$0	$0	0	0
52	$300	0.10	0.00			6.00			0.08	$4,491	$0	$0	$0	0	0
53	$200	0.10	0.00				5.55		0.08	$4,179	$0	$0	$0	0	0
54	$500										$0	$0	$0	0	0
55	$2,000	0.10	0.00	0.00	0.00	0.00	0.00	12.00	0.50	$6,486	$38,000	$116,751	$152,751	37	177
56	$150	0.00	0.00	5.00						$2,294	$75	$1,147	$1,222	20	115
57	$100	0.00	0.00		1.50					$635	$650	$4,127	$4,777	8	106
58	$50	0.00								$0	$50	$0	$50	0	0
59	$1,500										$1,500	$0	$1,500	0	0
60			100									$58,058	$58,058	Manhours	Helicopter
61		31	100	10	187	714	389	648	12					1947	112
62											$60,415	$316,192	$376,607	ok	

FILE: e:\aee-cvea\phase1\design\costs\costmod4.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf4	4	37#9aw	D
LENGTH:	4	DO NOT ALTER			

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

	M1	M2	ANC1	ANC2	FP2	ANC1	SU1	HEL2
CZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.00
CZone2	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
CZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
CZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	-1.50
CWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
CSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CVariable	0.00	0.00	0.05	0.20	0.05	0.00	0.00	0.00
CFixed	0.00	0.10	2.50	1.50	1.00	1.00	1.00	0.10
Personnel	6	8	2	3	4	2	2	0
Hourly Rate	$799	$834	$222	$382	$423	$222	$179	$3,341

GROUP	No	Item	Description			Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage	M1	M2	ANC1	ANC2	FP2	ANC1	SU1	HEL2	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
C	63	GUY ANCHOR ASSEMBLIES			Length																		
	64	Xframe Guy 1						0	$223	0.00	0.10				1.50			$417	$0	$0	$0	0	0
Hpile is 10x57	65	Xframe Guy 2						0	$290	0.00	0.10				1.50			$417	$0	$0	$0	0	0
$80	66	Single Down Guy	20k				ea	0	$111	0.00	0.10				1.50			$417	$0	$0	$0	0	0
Cost per Ft	67	Single Down Guy	30k				ea	6	$158	0.00	0.10				1.50			$417	$946	$2,500	$3,446	4	110
	68	Single Down Guy	35k				ea	0	$177	0.00	0.10				1.50			$417	$0	$0	$0	0	0
Ten	69	Single Down Guy	40k				ea	0	$236	0.00	0.10				1.50			$417	$0	$0	$0	0	0
15	70	Single Down Guy	60k				ea	0	$512	0.00	0.10				1.50			$417	$0	$0	$0	0	0
LA	71	Rockbolt Anchor	25k	Rock	6		ea	0	$48	0.00	0.10		4.05			1.50	0.15	$2,398	$0	$0	$0	0	0
0	72	Rockbolt Anchor	35k	Rock	7		ea	2	$56	0.00	0.10		4.35			1.50	0.15	$2,513	$101	$4,523	$4,624	17	149
MA	73	Rockbolt Anchor	45k	Rock	8		ea	0	$64	0.00	0.10		4.65			1.50	0.15	$2,627	$0	$0	$0	0	0
1	74	Rockbolt Anchor	50k	Rock	9		ea	0	$72	0.00	0.10		4.95			1.50	0.15	$2,742	$0	$0	$0	0	0
DE	75	Rockbolt Anchor	60k	Rock	10		ea	0	$80	0.00	0.10		5.25			1.50	0.15	$2,856	$0	$0	$0	0	0
0	76	HPile	25k	Muskeg	19		ea	0	$1,520	0.00	0.10			2.93		1.50	0.15	$2,091	$0	$0	$0	0	0
SSA	77	HPile	35k	Muskeg	22		ea	1	$1,840	0.00	0.10			3.15		1.50	0.15	$2,186	$2,208	$2,623	$4,831	16	133
9	78	Hpile	45k	Muskeg	25		ea	0	$2,160	0.00	0.10			3.38		1.50	0.15	$2,281	$0	$0	$0	0	0
	79	Hpile	50k	Muskeg	30		ea	0	$2,400	0.00	0.10			3.75		1.50	0.15	$2,440	$0	$0	$0	0	0
Geotech Info	80	Hpile	60k	Muskeg	33		ea	0	$2,800	0.00	0.10			3.98		1.50	0.15	$2,535	$0	$0	$0	0	0
from Unitcost	81	Log Anchor	25k	Till	5		ea	0	$100	0.00	0.10	4.13				1.50	0.15	$1,769	$0	$0	$0	0	0
Glacial Till	82	Log Anchor	35k	Till	7		ea	3	$150	0.00	0.10	4.28				1.50	0.15	$1,802	$450	$5,407	$5,857	12	146
50%	83	Log Anchor	45k	Till	8		ea	0	$200	0.00	0.10	4.35				1.50	0.15	$1,819	$0	$0	$0	0	0
Muskeg	84	Log Anchor	50k	Till	9		ea	0	$250	0.00	0.10	4.43				1.50	0.15	$1,836	$0	$0	$0	0	0
20%	85	Log Anchor	60k	Till	10		ea	0	$300	0.00	0.10	4.50				1.50	0.15	$1,852	$0	$0	$0	0	0
Permafrost	86																					0	0
0%	87	Anchor Tests	1 every	3	anchors		ea	2	$900										$1,800	$0	$1,800	0	0
Rock	88																					Manhours	Helicopter
30%	89	Subtotal Hours								0	10	26	23	15	16	18	1					110	1
	90																						
	91																						
	92	Subtotal GUY ANCHOR ASSEMBLIES																	$5,504	$15,054	$20,558	ok	

FILE: e:\eee-cvea\phase1\design\costs\costmod4.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf4	4	37#9aw	D
LENGTH:	4	DO NOT ALTER			

	M1	M2	STR1	ANC1	CON3	HEL1	HEL1	HEL2
DZone1	1.00	1.00	1.00	1.00	1.25	1.25	1.00	0.00
DZone2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
DZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
DZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
DWinter	1.20	1.20	1.25	1.25	1.25	1.25	1.25	1.25
DSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DVariable	0.00	0.00	0.00	0.00	0.05	0.15	0.30	0.00
DFixed	0.10	0.10	0.00	0.50	1.50	1.00	1.00	1.00

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

GROUP	No	Item	Description	Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage	M1	M2	STR1	ANC1	CON3	HEL1	HEL1	HEL2	UNIT COST Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
								6	8	6	2	6	0	0	0						
								$799	$834	$629	$222	$539			$3,341						
D	93	STRUCTURE FRAMING, INSULATORS, GROUNDING																			
	94	Hframe, Wood, Type 1,TH-10 Framing			ea	0	$900	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	95	Hframe, Wood, Type 4, TH-10V4X, Framing			ea	0	$1,763	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	96	Hframe, Steel, Type 1, Framing			ea	0	$1,020	0.10	0.10	0.00						$163	$0	$0	$0	0	0
	97	Hframe, Steel, Type 4, Framing			ea	15	$1,570	0.10	0.10	0.00						$163	$23,550	$2,450	$26,000	1	117
	98				ea											$0	$0	$0	$0	0	0
	99	Devit Arms, Single Steel Pole	500 lb		ea	0	$600	0.10	0.10							$163	$0	$0	$0	0	0
	100	Structure Signs			ea	19	$15			0.05						$31	$285	$598	$883	0	105
	101	Aerial Patrol Signs			ea	19	$80			0.20						$126	$1,520	$2,391	$3,911	1	105
	102				ea											$0	$0	$0	$0	0	0
	103	Tangent I-String			ea	30	$163	0.10	0.10	0.20						$289	$4,893	$8,675	$13,568	3	111
	104	Tangent V-String			ea	15	$357	0.10	0.10	0.30						$352	$5,362	$5,282	$10,643	3	110
	105	Tangent Inverted V-String			ea		$0	0.10	0.10	0.30						$352	$0	$0	$0	0	0
	106	Tangent Horizontal Vee	Pivoting Type		ea	0	$700	0.10	0.10	0.35						$384	$0	$0	$0	0	0
	107	Running Light Angle String			ea	0	$383	0.10	0.10	0.30						$352	$0	$0	$0	0	0
	108	Running Medium Angle String			ea	3	$710	0.10	0.10	0.30						$352	$2,130	$1,056	$3,187	3	110
	109	Deadend String without Jumper			ea	0	$657	0.10	0.10	0.20		2.25				$1,502	$0	$0	$0	0	0
	110	Jumper Support			ea	0	$256	0.10	0.10	0.20		0.50				$559	$0	$0	$0	0	0
	111															$0	$0	$0	$0	0	0
	112	Grounding Assembly	Hframe, Steel		ea	15	$30	0.10	0.10		0.75					$330	$450	$4,949	$5,399	3	114
	113	Grounding Assembly	Single Pole, Steel		ea	0	$15	0.10	0.10		0.75					$330	$0	$0	$0	0	0
	114	Grounding Assembly	Hframe, Wood		ea	0	$100	0.10	0.10		0.75					$330	$0	$0	$0	0	0
	115	Grounding Assembly	Single Pole, Wood		ea	0	$60	0.10	0.10		0.75					$330	$0	$0	$0	0	0
	116	Grounding Assembly	3-Pole Structure, Steel		ea	3	$50	0.10	0.10		0.75					$330	$150	$990	$1,140	3	114
	117															$0	$0	$0	$0	0	0
	118																				
	119																			Manhours	Helicopter
	120	Subtotal Hours						49	65	97	27	0	0	0	0					237	0
	121																				
	122		Subtotal FRAMING, etc.														$38,340	$26,391	$64,731	ok	

FILE: e:\aee-cvea\phase1\design\costs\costmod4.xls
PROJ: COPPER VALLEY INTERTIE FEASIBILITY STUDY
PSA: WW-1559-HA1-AC

LEVEL OF ESTIMATE: Feasibility/Planning
ESTIMATED: PED 12/12/93
CHECKED:
APPROVED:
COSTS AS OF : 1993

Database Criteria Range Directly Below

	Material	Option	Zone	Conductor	Route
CRITERIA NAME:	Material	Option	Zone	Conductor	Route
SELECTION:	STEEL	shf4	4	37#9aw	0
LENGTH:	4	DO NOT ALTER			

	M1	M2	CON1	CON2	CON3	HEL1	HEL2	HEL3
EZone1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EZone2	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
EZone3	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20
EZone4	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
EWinter	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ESummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EVariable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EFixed	0.10	0.20	12.00	6.00	0.20	1.00	1.00	0.00

GROUP	No	Item	Description				Qty	Unit	Total Quantity	UNIT COST Material FOB Anchorage
E	123	CONDUCTOR	lb/ft	$/lb				3ph		
If Specular	124	Dove 556/ACSR	0.766	$0.85			0.00	ckml	0.00	$11,496
Type 0 Below	125	Teal 605/ACSR	0.939	$1.00			0.00	ckml	0.00	$14,890
If Non-Specul	126	T2 Linnet 2x336/ACSR	0.926	$1.05			0.00	ckml	0.00	$15,465
Type 1 Below	127	Dove 556/ACSR/EHS	0.766	$0.88			0.00	ckml	0.00	$11,945
1	128	Teal 605/ACSR/EHS	0.939	$1.04			0.00	ckml	0.00	$15,532
	129	Teal 605/SSAC	0.939	$1.21			0.00	ckml	0.00	$18,040
Length =	130	37#9 Alumoweld	1.108	$1.51		x	4.20	ckml	4.20	$26,558
4	131									
Working Slack	132	Vibration Dampers	at	3	structure			ea	48	$30
5%	133	Splices	at	3	mile		12	ea	12	$50
Conductor L	134	Marker Balls,36"EHV	8	per	10		spans	ea	80	$275
66528	135			long span				ea		
4.20	136	Marker Balls,24"EHV	1	200		15%	0	ea	0	$175
	137	1 per 200 ft in LZ only, 15% of L								
	138		Subtotal	CONDUCTOR						
	139	ADDERS								
	140	Special Helicopter Mobilization						ls		
	141	Subtotal Hours								
	142									
	143	Subtotal								
	144	Mobilization					5%	%		
	145									
	146									
SUMMARY	147	MANHOURS	MH	HEL						
	148	A	1541	23						
	149	B	1947	112						
	150	C	110	1						
	151	D	237	0						
	152	E	2347	13						
	153	TOTAL HOURS	6183	149						

CREW PRODUCTIVITY (hours/unit) ENTER CREW, Hourly Rate below, Personnel above

No	M1	M2	CON1	CON2	CON3	HEL1	HEL2	HEL3	Installation	EXTENDED Material	EXTENDED Installation	Subtotal	UNIT MANHOURS	LOADED RATE
Personnel	6	8	12	6	6	0	0	0						
Hourly Rate	$799	$834	$1,073	$583	$539	$581	$3,341	$7,947						
124	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
125	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
126	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
127	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
128	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
129	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$0	$0	$0	0	0
130	0.10	0.20	18.00	9.00		1.50	1.50	0.00	$30,701	$111,544	$128,945	$240,489	272	113
131									$0	$0	$0	$0	0	0
132					0.30				$162	$1,440	$7,762	$9,202	2	90
133			0.20						$215	$600	$2,576	$3,176	2	89
134	0.01	0.01		2.25					$1,325	$22,000	$106,009	$128,009	14	97
135									$0	$0	$0	$0	0	0
136	0.01	0.01		2.25					$1,325	$0	$0	$0	0	0
138										$135,564	$245,293	$380,877	ok	
141	5	13	936	1307	86	6	6	0					Manhours 2347	Helicopter 13
143										$435,283	$797,234	$1,232,517	ok	
144										$21,764	$39,862			

		EXTENDED Material	EXTENDED Installation	Subtotal
Subtotal		$457,047	$837,096	$1,294,143
Construction Allowance	0%	$0	$0	$0
Contingency Labor	20%		$167,419	$167,419
Contingency Material	10%	$45,705		$45,705
TOTAL COST LOADING ZONE	4	$502,752	$1,004,515	$1,507,267
TOTAL COST PER MILE 4 MI		$125,688	$251,129	$376,817

DBSHF1.XLS

FILE	E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	STRUCTURE DATA CONSOLIDATION
ITEM	**TYPES shf1**
BY	PED 9/17/93
CHECK	

ROUTE **D** 4
SPECIES **DF**

Angle Distribution by Loading Zone

	LOADING ZONE			
Order	1	2	3	4
DE	13	12	10	0
LA	4	1	5	0
MA	4	2	6	2
SSA	0	0	0	3
total	21	15	21	5

35 The cells in table at left are named LZ?_[LA,MA,DE,SS]Q
10 where Q denotes quantity.
14
3
Tangents computed as Zone length/avg span-total this table.

Route and Loading Zone lengths (MILES)
Data below linked to file SEGTABL.xls

		LOADING ZONE					
	ROUTE	1	2	3	4		totals
A	A	26.52	60.87	37.37	9.27	Cells named LEN_ALT[A,B,C,D]_LZ[1,2,3,4]	134.03
B	B	42.70	61.03	26.06	4.00		133.79
C	C	37.99	61.03	33.39	4.00		136.41
D	D	36.88	60.87	32.24	4.00		133.99

Tangent Height Distribution
Enter original data assumptions below.

		LOADING ZONE				
	Height	1	2	3	4	
	1	10%	5%	10%	10%	The cells in table at left are named LZ?_TANQ_[1-5]
	2	20%	15%	20%	20%	where Q denotes quantity, and 1-5 represent the height range.
BASE>>	3	40%	60%	40%	40%	) vary with construction option.
	4	15%	15%	15%	15%	
	5	15%	5%	15%	15%	
		ok	ok	ok	ok	Test if = 100%

BASE HEIGHTS ARE TAKEN AS HEIGHT 3 FOR DISTRIBUTION PURPOSES
Base Height/Length of Tangent Structures
Data taken from XFSUMM, HFSUMM, SHFSUMM and 1PSUMM.xls

Option	1				2				3				4		
below	Dove	T2Linnet	Teal		Dove	T2Linnet	Teal		Dove	T2Linnet	Teal		37#9aw	Dove	Teal
	1	2	3		1	2	3		1	2	3		1	2	3
SHF1	75	70	75	SHF1	80	60	70	SHF1	75	75	70	SHF1	70	na	75
SHF4	80	75	85	SHF4	80	80	75	SHF4	80	80	80	SHF4	80	na	75
SSP	80	75	75	SSP	na	na	na	SSP	na	na	na	SSP	na	na	na
SWP	65	60	65	SWP	na	na	na	SWP	na	na	na	SWP	na	na	na
WHF1	75	70	75	WHF1	70	60	60	WHF1	75	65	75	WHF1	na	na	na
WHF4	85	80	75	WHF4	75	65	75	WHF4	80	65	75	WHF4	na	na	na
XFRAME	65	60	60	XFRAME	85	80	75	XFRAME	80	75	70	XFRAME	55	85	80

EXHIBIT C-2

FILE	E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	STRUCTURE DATA CONSOLIDATION
ITEM	**TYPES shf1**
BY	PED 9/17/93
CHECK	

Base Height/Length of AngleStructures
Computed from table of Base Height/Length of Tangent Structures.

Option below	1			2			3			4			
	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	37#9AW	Dove	Teal	
	1	2	3	1	2	3	1	2	3	1	2	3	
SHF1	75	70	75	80	60	70	75	75	70	70	na	75	equal to B
SHF4	75	70	80	70	70	65	75	75	75	75	na	70	LZ2 equal B-10, else B-5
SSP	70	65	70	na	na	na	na	na	na	na	na	na	equal B + 5
SWP	80	75	80	na	na	na	na	na	na	na	na	na	equal B + 5
WHF1	75	70	75	70	60	60	75	65	75	na	na	na	equal to B
WHF4	80	75	70	65	55	65	75	60	70	na	na	na	LZ2 equal B-10, else B-5
XFRAME	65	60	60	85	80	75	80	75	70	55	85	80	equal B

DECR1	-15
DECR2	-10
INCR1	10
INCR2	20

Average Spans by Conductor, Construction Option, Loading Zone
NA means an incompatibility, i.e. option or conductor not suitable or not considered for Loading Zone
Data below linkded to files XFSUMM.xls, HFSUMM.xls,1PSUMM.xls,SHFSUMM.xls.

Option	1			2			3			4			
	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	37#9aw	Dove	Teal	
	1	2	3	1	2	3	1	2	3	1	2	3	
SHF1	873	881	991	1036	899	1068	923	1060	1068	958	na	608	Linked to SHFSUMM.xls
SHF4	844	840	1021	972	1037	1025	892	1036	984	1019	na	635	Linked to SHFSUMM.xls
SSP	720	720	720	na	na	na	na	na	na	na	na	na	Linked to 1PSUMM.xls
SWP	412	381	466	na	na	na	na	na	na	na	na	na	Linked to 1PSUMM.xls
WHF1	873	881	991	954	899	894	923	878	1019	na	na	na	Linked to HFSUMM.xls
WHF4	900	912	866	930	869	1025	892	908	1041	na	na	na	Linked to HFSUMM.xls
XFRAME	906	913	941	1085	1105	1068	981	977	967	888	815	911	Linked to XFSUMM.xls

Wood Pole Estimating Costs
Data linkded to UNITCOST.xls
Prices include freight to Anchorage.
Western Red Cedar

Order	CLASS	40	45	50	55	60	65	70	75	80	85
1	2	$603	$685	$905	$1,015	$1,125	$1,290	$1,455	$1,510	$1,895	$2,005
2	1	$630	$740	$981	$1,132	$1,289	$1,448	$1,628	$1,781	$2,170	$2,304
3	H1	$795	$960	$1,125	$1,414	$1,585	$1,775	$2,041	$2,256	$2,404	$2,555
4	H2	$1,015	$1,153	$1,325	$1,547	$1,742	$1,946	$2,224	$2,453	$2,704	$2,950

Douglas Fir

Order	CLASS	40	45	50	55	60	65	70	75	80	85
1	2	$575	$630	$850	$933	$1,015	$1,235	$1,455	$1,565	$1,785	$2,005
2	1	$658	$685	$912	$1,050	$1,209	$1,401	$1,609	$1,807	$2,037	$2,288
3	H1	$740	$850	$1,015	$1,218	$1,473	$1,651	$1,839	$2,039	$2,248	$2,445
4	H2	$905	$1,060	$1,216	$1,401	$1,654	$1,852	$2,060	$2,303	$2,534	$2,776

DBSHF1.XLS

FILE	E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	STRUCTURE DATA CONSOLIDATION
ITEM	**TYPES shf1**
BY	PED . 9/17/93
CHECK	

Steel Pole Estimating Costs
Data linkded to UNITCOST.xls
Prices include freight to Anchorage.
Based on Meyers LD Series

LENGTH(ft)	LD-1	LD-10	LD-2	LD-3	LD-4	LD-5	LD-6	LD-7	LD-8	LD-9
40	$1,077	$1,949	$1,111	$1,156	$1,263	$1,313	$1,523	$1,724	$1,790	$1,845
45	$1,236	$2,280	$1,280	$1,337	$1,460	$1,524	$1,768	$2,000	$2,083	$2,157
50	$1,403	$2,626	$1,457	$1,526	$1,668	$1,744	$2,024	$2,292	$2,393	$2,485
55	$1,575	$2,991	$1,640	$1,724	$1,885	$1,975	$2,294	$2,597	$2,722	$2,830
60	$1,751	$3,207	$1,829	$1,928	$2,100	$2,206	$2,564	$2,902	$2,914	$3,034
65	$1,936	$3,614	$2,027	$2,145	$2,347	$2,473	$2,874	$3,110	$3,273	$3,418
70	$2,129	$4,022	$2,234	$2,369	$2,590	$2,739	$3,043	$3,443	$3,631	$3,799
75	$2,327	$4,443	$2,448	$2,600	$2,845	$3,014	$3,351	$3,790	$4,006	$4,197
80	$2,421	$4,662	$2,551	$2,719	$2,973	$3,158	$3,669	$4,150	$4,395	$4,613
85	$2,622	$5,117	$2,770	$2,961	$3,235	$3,442	$4,001	$4,524	$4,582	$4,817
90	$2,830	$5,573	$2,996	$3,210	$3,502	$3,736	$4,344	$4,686	$4,983	$5,264
95	$2,904	$6,051	$3,080	$3,308	$3,610	$3,859	$4,486	$5,068	$5,399	$5,712
100	$3,122	$6,542	$3,319	$3,570	$3,886	$4,158	$5,196	$5,464	$5,845	$6,175
105	$3,336	$7,052	$3,553	$3,829	$4,169	$4,468	$5,570	$5,873	$6,292	$6,655
110	$3,566	$7,577	$3,794	$4,097	$4,461	$4,789	$6,172	$6,295	$6,754	$7,151
115	$3,906	$8,413	$4,163	$4,509	$4,911	$5,537	$6,570	$6,978	$7,482	$7,930
120	$4,138	$8,974	$4,422	$4,795	$5,219	$5,936	$6,570	$7,426	$7,973	$8,464

Weights

LENGTH(ft)	LD-1	LD-10	LD-2	LD-3	LD-4	LD-5	LD-6	LD-7	LD-8	LD-9
40	892	1614	920	957	1046	1087	1261	1428	1482	1528
45	1024	1888	1060	1107	1209	1262	1464	1656	1725	1786
50	1162	2175	1207	1264	1381	1444	1676	1898	1982	2058
55	1304	2477	1358	1428	1561	1636	1900	2151	2254	2344
60	1450	2777	1515	1597	1739	1827	2123	2403	2523	2627
65	1603	3129	1679	1776	1944	2048	2380	2693	2834	2959
70	1763	3482	1850	1962	2146	2268	2635	2981	3144	3289
75	1927	3847	2027	2153	2356	2496	2901	3281	3468	3634
80	2096	4229	2209	2354	2574	2734	3177	3593	3805	3994
85	2270	4641	2398	2564	2801	2980	3464	3917	4156	4369
90	2450	5055	2594	2779	3032	3235	3761	4250	4520	4775
95	2634	5488	2794	3000	3274	3500	4069	4597	4897	5181
100	2832	5934	3010	3238	3524	3771	4385	4956	5302	5601
105	3026	6396	3223	3473	3781	4063	4713	5327	5707	6036
110	3225	6873	3441	3716	4046	4344	5052	5710	6126	6486
115	3543	7631	3776	4090	4454	5022	5598	6329	6786	7193
120	3753	8140	4011	4349	4734	5384	5959	6736	7232	7677

FILE E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT WW-1669-HA1-AC
CLIENT ALASKA ENERGY AUTHORITY
PROJECT COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE STRUCTURE DATA CONSOLIDATION
ITEM **TYPES shf1**
BY PED 9/17/93
CHECK
XFRAME steel estimating costs. Data linked to UNITCOST.xls. Prices include freight to Anchorage.

		LOADING ZONE/costs				LOADING ZONE/weights			
	0	1	2	3	4	1	2	3	4
37#9AW	35	na	na	na	$5,009	na	na	na	3833
37#9AW	40	na	na	na	$4,804	na	na	na	4003
37#9AW	45	na	na	na	$5,009	na	na	na	4174
37#9AW	50	na	na	na	$5,213	na	na	na	4344
37#9AW	55	na	na	na	$5,328	na	na	na	4515
37#9AW	60	na	na	na	$5,996	na	na	na	5081
37#9AW	65	na	na	na	$6,256	na	na	na	5302
37#9AW	70	na	na	na	$6,517	na	na	na	5523
37#9AW	75	na	na	na	$7,994	na	na	na	6951
37#9AW	80	na	na	na	$8,377	na	na	na	7284
37#9AW	85	na	na	na	$8,758	na	na	na	7616
37#9AW	90	na	na	na	$9,141	na	na	na	7949
37#9AW	95	na	na	na	$9,524	na	na	na	8282
37#9AW	100	na	na	na	$9,907	na	na	na	8615
37#9AW	105	na	na	na	$12,978	na	na	na	11285
Dove	35	$4,568	$4,901	$4,568	#VALUE!	3807	4084	3807	na
Dove	40	$4,772	$5,105	$4,772	#VALUE!	3977	4254	3977	na
Dove	45	$4,976	$5,310	$4,976	#VALUE!	4147	4425	4147	na
Dove	50	$5,182	$5,422	$5,182	#VALUE!	4318	4595	4318	na
Dove	55	$5,296	$5,624	$5,296	#VALUE!	4488	4766	4488	na
Dove	60	$5,498	$5,824	$5,498	#VALUE!	4659	4936	4659	na
Dove	65	$6,226	$6,553	$6,226	#VALUE!	5276	5553	5276	na
Dove	70	$6,486	$6,813	$6,486	#VALUE!	5497	5774	5497	na
Dove	75	$6,576	$6,895	$6,576	#VALUE!	5718	5996	5718	na
Dove	80	$6,830	$8,666	$8,346	#VALUE!	5939	7535	7257	na
Dove	85	$8,729	$9,048	$8,729	#VALUE!	7590	7868	7590	na
Dove	90	$9,111	$9,431	$9,111	#VALUE!	7923	8201	7923	na
Dove	95	$9,494	$9,813	$9,494	#VALUE!	8256	8533	8256	na
Dove	100	$9,877	$10,196	$9,877	#VALUE!	8589	8866	8589	na
Dove	105	$10,260	$10,579	$10,260	#VALUE!	8922	9199	8922	na
T2Linnet	35	$4,675	$4,675	$4,675	na	3896	3896	3896	na
T2Linnet	40	$4,879	$4,879	$4,879	na	4066	4066	4066	na
T2Linnet	45	$5,083	$5,083	$5,083	na	4236	4236	4236	na
T2Linnet	50	$5,288	$5,288	$5,288	na	4407	4407	4407	na
T2Linnet	55	$5,401	$5,401	$5,401	na	4577	4577	4577	na
T2Linnet	60	$6,070	$6,070	$6,070	na	5144	5144	5144	na
T2Linnet	65	$6,331	$6,331	$6,331	na	5365	5365	5365	na
T2Linnet	70	$6,591	$6,591	$6,591	na	5586	5586	5586	na
T2Linnet	75	$8,065	$6,678	$8,065	na	7013	5807	7013	na
T2Linnet	80	$8,448	$8,448	$8,448	na	7346	7346	7346	na
T2Linnet	85	$8,903	$8,903	$9,386	na	7742	7742	8162	na
T2Linnet	90	$9,286	$9,286	$9,769	na	8075	8075	8495	na
T2Linnet	95	$9,669	$9,669	$10,152	na	8408	8408	8828	na
T2Linnet	100	$10,052	$10,052	$10,535	na	8741	8741	9161	na
T2Linnet	105	$10,435	$10,435	$13,606	na	9074	9074	11831	na
Teal	35	$4,417	$4,750	$4,750	$5,254	3681	3958	3958	4378
Teal	40	$4,621	$4,955	$4,955	$5,368	3851	4129	4129	4549
Teal	45	$4,826	$5,159	$5,159	$5,568	4022	4299	4299	4719
Teal	50	$5,030	$5,364	$5,364	$5,770	4192	4470	4470	4890
Teal	55	$5,148	$5,476	$5,476	$5,971	4363	4640	4640	5060
Teal	60	$5,349	$5,677	$5,677	$6,639	4533	4811	4811	5626
Teal	65	$6,077	$6,405	$6,405	$6,899	5150	5428	5428	5847
Teal	70	$6,338	$6,666	$6,642	$7,161	5371	5649	5629	6069
Teal	75	$6,431	$6,751	$6,751	$8,620	5592	5870	5870	7496
Teal	80	$8,202	$8,520	$8,520	$9,000	7132	7409	7409	7826

FILE E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT WW-1659-HA1-AC
CLIENT ALASKA ENERGY AUTHORITY
PROJECT COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE STRUCTURE DATA CONSOLIDATION
ITEM **TYPES shf1**
BY PED 9/17/93
CHECK

Teal	85	$8,585	$8,903	$8,903	$9,386	7465	7742	7742	8162
Teal	90	$8,968	$9,286	$9,286	$9,769	7798	8075	8075	8495
Teal	95	$9,350	$9,669	$9,669	$10,152	8130	8408	8408	8828
Teal	100	$9,732	$10,052	$10,052	$10,535	8463	8741	8741	9161
Teal	105	$10,115	$10,435	$10,435	$13,606	8796	9074	9074	11831

Classes of Single Poles

Option	SHF1	1	1	1	2	2	2	3	3	3	4	4	4
		Teal	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	Dove	37#9AW
HFRAME1	TAN	LD-2	LD-1	LD-2	LD-2	LD-2	LD-2	LD-2	LD-1	LD-3	LD-2	na	LD-3
HFRAME1	TAN	LD-2	LD-1	LD-2	LD-2	LD-2	LD-2	LD-2	LD-1	LD-3	LD-2	na	LD-3
HFRAME1	TAN	LD-2	LD-1	LD-2	LD-2	LD-2	LD-2	LD-2	LD-1	LD-3	LD-2	na	LD-3
HFRAME1	TAN	LD-2	LD-1	LD-2	LD-2	LD-2	LD-2	LD-2	LD-1	LD-3	LD-2	na	LD-3
HFRAME1	TAN	LD-2	LD-1	LD-2	LD-2	LD-2	LD-2	LD-2	LD-1	LD-3	LD-2	na	LD-3
SSP	LA	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-2	LD-2	LD-3
SSP	LA	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-2	LD-2	LD-3
SSP	LA	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-4
SSP	LA	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-4
SSP	LA	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-3	LD-4	LD-4	LD-4
SSP	MA	LD-2	LD-2	LD-2	LD-1	LD-2	LD-2	LD-2	LD-1	LD-2	LD-3	LD-3	LD-6
SSP	MA	LD-3	LD-2	LD-2	LD-1	LD-2	LD-2	LD-2	LD-1	LD-3	LD-4	LD-4	LD-6
SSP	MA	LD-3	LD-2	LD-3	LD-2	LD-3	LD-2	LD-3	LD-2	LD-3	LD-4	LD-4	LD-6
SSP	MA	LD-3	LD-3	LD-3	LD-2	LD-3	LD-2	LD-3	LD-2	LD-3	LD-4	LD-4	LD-6
SSP	MA	LD-3	LD-3	LD-3	LD-2	LD-3	LD-2	LD-3	LD-3	LD-3	LD-5	LD-5	LD-6
SSP	DE	LD-9	LD-9	LD-9	LD-8	LD-9	LD-7	LD-9	LD-9	LD-9	LD-9	LD-9	LD-10
SSP	DE	LD-9	LD-9	LD-9	LD-8	LD-9	LD-7	LD-9	LD-9	LD-9	LD-10	LD-10	LD-10
SSP	DE	LD-10	LD-10	LD-10	LD-9	LD-9	LD-7	LD-10	LD-9	LD-10	LD-10	LD-10	LD-10
SSP	DE	LD-10	LD-10	LD-10	LD-9	LD-9	LD-7	LD-10	LD-10	LD-10	LD-10	LD-10	LD-10
SSP	DE	LD-10	LD-10	LD-10	LD-10	LD-10	LD-7	LD-10	LD-10	LD-10	LD-10	LD-10	LD-10

FILE	E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	STRUCTURE DATA CONSOLIDATION
ITEM	**TYPES shf1**
BY	PED 9/17/93
CHECK	

REMEMBER: RESET DATABASE EACH FILE
START DATABASE ENTRIES FOR STRUCTURES

INPUT **Option: shf1**
INPUT **Zone: 1,2,3,4**
INPUT **Conductor: Teal, Dove, T2Linnet, 37#9AW**
INPUT **Application: TAN, LA, MA, DE**
INPUT **Index: 1,2,3,4,5 used to selected structure heights**
FORM Type: xframe, hframe1, hframe4, 1g-pole, 3g-pole
FORM Material: wood, steel
FORM Lmin: Minimum length or height of structure based on structure dimensions and required ground clearance at structure.
FORM Baselength: Base length/height of structure corresponding to index 3
FORM Length: Length of particular structure corresponding to index 1-5
If Baselength + DECR1 < Lmin, Lmin + (Index-1)*5
If Baselength + DECR1 >= Lmin, BL + DECR1, BL + DECR2, BL, BL + INCR1, BL + INCR2
FORM Class: structure class ((2,1,H1,H2 for Wood) and (LD-x for steel))
FORM Quantity: number of structures depending on zone, option, etc.
FORM Cost: unit cost taken from lookup table above.

Option	Zone	Conductor	Application	Type	Material	Index	Lmin	Baselength	Length	Class	Quantity	Cost
shf1	1	teal	tan	Hframe1	steel	1	55	75	60	LD-2	18	3659
shf1	1	teal	tan	Hframe1	steel	2	55	75	65	LD-2	35	4055
shf1	1	teal	tan	Hframe1	steel	3	55	75	75	LD-2	70	4895
shf1	1	teal	tan	Hframe1	steel	4	55	75	85	LD-2	26	5539
shf1	1	teal	tan	Hframe1	steel	5	55	75	95	LD-2	26	6161
shf1	1	teal	la	_3G.Pole	steel	1	55	75	60	LD-3	0	5785
shf1	1	teal	la	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	1	teal	la	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	1	teal	la	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	1	teal	la	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	1	teal	ma	_3G.Pole	steel	1	55	75	60	LD-2	0	5488
shf1	1	teal	ma	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	1	teal	ma	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	1	teal	ma	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	1	teal	ma	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	1	teal	de	_3G.Pole	steel	1	55	75	60	LD-9	1	9103
shf1	1	teal	de	_3G.Pole	steel	2	55	75	65	LD-8	3	10253
shf1	1	teal	de	_3G.Pole	steel	3	55	75	75	LD-10	5	13330
shf1	1	teal	de	_3G.Pole	steel	4	55	75	85	LD-10	2	15350
shf1	1	teal	de	_3G.Pole	steel	5	55	75	95	LD-10	2	18152
shf1	1	dove	tan	Hframe1	steel	1	55	75	60	LD-1	20	3502
shf1	1	dove	tan	Hframe1	steel	2	55	75	65	LD-1	40	3871
shf1	1	dove	tan	Hframe1	steel	3	55	75	75	LD-1	81	4654
shf1	1	dove	tan	Hframe1	steel	4	55	75	85	LD-1	30	5244
shf1	1	dove	tan	Hframe1	steel	5	55	75	95	LD-1	30	5808
shf1	1	dove	la	_3G.Pole	steel	1	55	75	60	LD-3	0	5785
shf1	1	dove	la	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	1	dove	la	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	1	dove	la	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	1	dove	la	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	1	dove	ma	_3G.Pole	steel	1	55	75	60	LD-2	0	5488
shf1	1	dove	ma	_3G.Pole	steel	2	55	75	65	LD-2	1	6082
shf1	1	dove	ma	_3G.Pole	steel	3	55	75	75	LD-2	2	7343
shf1	1	dove	ma	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	1	dove	ma	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	1	dove	de	_3G.Pole	steel	1	55	75	60	LD-9	1	9103
shf1	1	dove	de	_3G.Pole	steel	2	55	75	65	LD-9	3	10253
shf1	1	dove	de	_3G.Pole	steel	3	55	75	75	LD-10	5	13330

FILE	E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT	WW-1659-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	STRUCTURE DATA CONSOLIDATION
ITEM	TYPES shf1
BY	PED 9/17/93
CHECK	

shf1	1	dove	de	_3G.Pole	steel	4	55	75	85	LD-10	2	15360
shf1	1	dove	de	_3G.Pole	steel	5	55	75	95	LD-10	2	18152
shf1	1	t2linnet	tan	Hframe1	steel	1	55	70	55	LD-2	20	3280
shf1	1	t2linnet	tan	Hframe1	steel	2	55	70	60	LD-2	40	3659
shf1	1	t2linnet	tan	Hframe1	steel	3	55	70	70	LD-2	80	4468
shf1	1	t2linnet	tan	Hframe1	steel	4	55	70	80	LD-2	30	5103
shf1	1	t2linnet	tan	Hframe1	steel	5	55	70	90	LD-2	30	5992
shf1	1	t2linnet	la	_3G.Pole	steel	1	55	70	55	LD-3	0	5173
shf1	1	t2linnet	la	_3G.Pole	steel	2	55	70	60	LD-3	1	5786
shf1	1	t2linnet	la	_3G.Pole	steel	3	55	70	70	LD-3	2	7107
shf1	1	t2linnet	la	_3G.Pole	steel	4	55	70	80	LD-3	1	8157
shf1	1	t2linnet	la	_3G.Pole	steel	5	55	70	90	LD-3	1	9629
shf1	1	t2linnet	ma	_3G.Pole	steel	1	55	70	55	LD-2	0	4919
shf1	1	t2linnet	ma	_3G.Pole	steel	2	55	70	60	LD-2	1	5488
shf1	1	t2linnet	ma	_3G.Pole	steel	3	55	70	70	LD-3	2	7107
shf1	1	t2linnet	ma	_3G.Pole	steel	4	55	70	80	LD-3	1	8157
shf1	1	t2linnet	ma	_3G.Pole	steel	5	55	70	90	LD-3	1	9629
shf1	1	t2linnet	de	_3G.Pole	steel	1	55	70	55	LD-9	1	8491
shf1	1	t2linnet	de	_3G.Pole	steel	2	55	70	60	LD-9	3	9103
shf1	1	t2linnet	de	_3G.Pole	steel	3	55	70	70	LD-10	5	12065
shf1	1	t2linnet	de	_3G.Pole	steel	4	55	70	80	LD-10	2	13987
shf1	1	t2linnet	de	_3G.Pole	steel	5	55	70	90	LD-10	2	16719
shf1	2	teal	tan	Hframe1	steel	1	35	70	55	LD-2	14	3280
shf1	2	teal	tan	Hframe1	steel	2	35	70	60	LD-2	43	3659
shf1	2	teal	tan	Hframe1	steel	3	35	70	70	LD-2	172	4468
shf1	2	teal	tan	Hframe1	steel	4	35	70	80	LD-2	43	5103
shf1	2	teal	tan	Hframe1	steel	5	35	70	90	LD-2	14	5992
shf1	2	teal	la	_3G.Pole	steel	1	55	70	55	LD-3	0	5173
shf1	2	teal	la	_3G.Pole	steel	2	55	70	60	LD-3	0	5786
shf1	2	teal	la	_3G.Pole	steel	3	55	70	70	LD-3	1	7107
shf1	2	teal	la	_3G.Pole	steel	4	55	70	80	LD-3	0	8157
shf1	2	teal	la	_3G.Pole	steel	5	55	70	90	LD-3	0	9629
shf1	2	teal	ma	_3G.Pole	steel	1	55	70	55	LD-1	0	4724
shf1	2	teal	ma	_3G.Pole	steel	2	55	70	60	LD-1	0	5263
shf1	2	teal	ma	_3G.Pole	steel	3	55	70	70	LD-2	1	6702
shf1	2	teal	ma	_3G.Pole	steel	4	55	70	80	LD-2	0	7654
shf1	2	teal	ma	_3G.Pole	steel	5	55	70	90	LD-2	0	8988
shf1	2	teal	de	_3G.Pole	steel	1	55	70	55	LD-8	1	8165
shf1	2	teal	de	_3G.Pole	steel	2	55	70	60	LD-8	2	8742
shf1	2	teal	de	_3G.Pole	steel	3	55	70	70	LD-9	7	11396
shf1	2	teal	de	_3G.Pole	steel	4	55	70	60	LD-9	2	13839
shf1	2	teal	de	_3G.Pole	steel	5	55	70	90	LD-10	1	16719
shf1	2	dove	tan	Hframe1	steel	1	35	80	65	LD-2	15	4065
shf1	2	dove	tan	Hframe1	steel	2	35	80	70	LD-2	44	4469
shf1	2	dove	tan	Hframe1	steel	3	35	80	80	LD-2	177	5103
shf1	2	dove	tan	Hframe1	steel	4	35	80	90	LD-2	44	5992
shf1	2	dove	tan	Hframe1	steel	5	35	80	100	LD-2	15	6637
shf1	2	dove	la	_3G.Pole	steel	1	55	80	65	LD-3	0	6434
shf1	2	dove	la	_3G.Pole	steel	2	55	80	70	LD-3	0	7107
shf1	2	dove	la	_3G.Pole	steel	3	55	80	80	LD-3	1	8157
shf1	2	dove	la	_3G.Pole	steel	4	55	80	90	LD-3	0	9629
shf1	2	dove	la	_3G.Pole	steel	5	55	80	100	LD-3	0	10710
shf1	2	dove	ma	_3G.Pole	steel	1	55	80	65	LD-2	0	6082
shf1	2	dove	ma	_3G.Pole	steel	2	55	80	70	LD-2	0	6702
shf1	2	dove	ma	_3G.Pole	steel	3	55	80	80	LD-3	1	8157
shf1	2	dove	ma	_3G.Pole	steel	4	55	80	90	LD-3	0	9629
shf1	2	dove	ma	_3G.Pole	steel	5	55	80	100	LD-3	0	10710
shf1	2	dove	de	_3G.Pole	steel	1	55	80	65	LD-9	1	10253

FILE E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT WW-1559-HA1-AC
CLIENT ALASKA ENERGY AUTHORITY
PROJECT COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE STRUCTURE DATA CONSOLIDATION
ITEM TYPES shf1
BY PED 9/17/93
CHECK

shf1	2	dove	de	_3G.Pole	steel	2	55	80	70	LD-9	2	11398
shf1	2	dove	de	_3G.Pole	steel	3	55	80	80	LD-9	7	13839
shf1	2	dove	de	_3G.Pole	steel	4	55	80	90	LD-9	2	15793
shf1	2	dove	de	_3G.Pole	steel	5	55	80	100	LD-10	1	19627
shf1	2	t2linnet	tan	Hframe1	steel	1	35	60	45	LD-2	17	2560
shf1	2	t2linnet	tan	Hframe1	steel	2	35	60	50	LD-2	51	2915
shf1	2	t2linnet	tan	Hframe1	steel	3	35	60	60	LD-2	206	3659
shf1	2	t2linnet	tan	Hframe1	steel	4	35	60	70	LD-2	51	4468
shf1	2	t2linnet	tan	Hframe1	steel	5	35	60	80	LD-2	17	5103
shf1	2	t2linnet	la	_3G.Pole	steel	1	55	60	55	LD-3	0	5173
shf1	2	t2linnet	la	_3G.Pole	steel	2	55	60	60	LD-3	0	5785
shf1	2	t2linnet	la	_3G.Pole	steel	3	55	60	65	LD-3	1	6434
shf1	2	t2linnet	la	_3G.Pole	steel	4	55	60	70	LD-3	0	7107
shf1	2	t2linnet	la	_3G.Pole	steel	5	55	60	75	LD-3	0	7799
shf1	2	t2linnet	ma	_3G.Pole	steel	1	55	60	55	LD-2	0	4919
shf1	2	t2linnet	ma	_3G.Pole	steel	2	55	60	60	LD-2	0	5488
shf1	2	t2linnet	ma	_3G.Pole	steel	3	55	60	65	LD-2	1	6082
shf1	2	t2linnet	ma	_3G.Pole	steel	4	55	60	70	LD-2	0	6702
shf1	2	t2linnet	ma	_3G.Pole	steel	5	55	60	75	LD-2	0	7343
shf1	2	t2linnet	de	_3G.Pole	steel	1	55	60	55	LD-7	1	7792
shf1	2	t2linnet	de	_3G.Pole	steel	2	55	60	60	LD-7	2	8705
shf1	2	t2linnet	de	_3G.Pole	steel	3	55	60	65	LD-7	7	9331
shf1	2	t2linnet	de	_3G.Pole	steel	4	55	60	70	LD-7	2	10329
shf1	2	t2linnet	de	_3G.Pole	steel	5	55	60	75	LD-7	1	11369
shf1	3	teal	tan	Hframe1	steel	1	55	70	55	LD-2	14	3260
shf1	3	teal	tan	Hframe1	steel	2	55	70	60	LD-2	28	3659
shf1	3	teal	tan	Hframe1	steel	3	55	70	70	LD-2	55	4468
shf1	3	teal	tan	Hframe1	steel	4	55	70	80	LD-2	21	5103
shf1	3	teal	tan	Hframe1	steel	5	55	70	90	LD-2	21	5982
shf1	3	teal	la	_3G.Pole	steel	1	55	70	55	LD-3	1	5173
shf1	3	teal	la	_3G.Pole	steel	2	55	70	60	LD-3	1	5785
shf1	3	teal	la	_3G.Pole	steel	3	55	70	70	LD-3	2	7107
shf1	3	teal	la	_3G.Pole	steel	4	55	70	80	LD-3	1	8157
shf1	3	teal	la	_3G.Pole	steel	5	55	70	90	LD-3	1	9629
shf1	3	teal	ma	_3G.Pole	steel	1	55	70	55	LD-2	1	4919
shf1	3	teal	ma	_3G.Pole	steel	2	55	70	60	LD-2	1	5488
shf1	3	teal	ma	_3G.Pole	steel	3	55	70	70	LD-3	2	7107
shf1	3	teal	ma	_3G.Pole	steel	4	55	70	80	LD-3	1	8157
shf1	3	teal	ma	_3G.Pole	steel	5	55	70	90	LD-3	1	9629
shf1	3	teal	de	_3G.Pole	steel	1	55	70	55	LD-9	1	8491
shf1	3	teal	de	_3G.Pole	steel	2	55	70	60	LD-9	2	9103
shf1	3	teal	de	_3G.Pole	steel	3	55	70	70	LD-10	4	12065
shf1	3	teal	de	_3G.Pole	steel	4	55	70	80	LD-10	2	13987
shf1	3	teal	de	_3G.Pole	steel	5	55	70	90	LD-10	2	16719
shf1	3	dove	tan	Hframe1	steel	1	55	75	60	LD-1	16	3502
shf1	3	dove	tan	Hframe1	steel	2	55	75	65	LD-1	33	3871
shf1	3	dove	tan	Hframe1	steel	3	55	75	75	LD-1	65	4654
shf1	3	dove	tan	Hframe1	steel	4	55	75	85	LD-1	25	5244
shf1	3	dove	tan	Hframe1	steel	5	55	75	95	LD-1	25	5808
shf1	3	dove	la	_3G.Pole	steel	1	55	75	60	LD-3	1	5785
shf1	3	dove	la	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	3	dove	la	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	3	dove	la	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	3	dove	la	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	3	dove	ma	_3G.Pole	steel	1	55	75	60	LD-1	1	5253
shf1	3	dove	ma	_3G.Pole	steel	2	55	75	65	LD-1	1	5807
shf1	3	dove	ma	_3G.Pole	steel	3	55	75	75	LD-2	2	7343
shf1	3	dove	ma	_3G.Pole	steel	4	55	75	85	LD-2	1	8309

FILE E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT WW-1559-HA1-AC
CLIENT ALASKA ENERGY AUTHORITY
PROJECT COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE STRUCTURE DATA CONSOLIDATION
ITEM **TYPES shf1**
BY PED 9/17/93
CHECK

shf1	3	dove	ma	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	3	dove	de	_3G.Pole	steel	1	55	75	60	LD-9	1	9103
shf1	3	dove	de	_3G.Pole	steel	2	55	75	65	LD-9	2	10253
shf1	3	dove	de	_3G.Pole	steel	3	55	75	75	LD-8	4	12592
shf1	3	dove	de	_3G.Pole	steel	4	55	75	85	LD-10	2	15350
shf1	3	dove	de	_3G.Pole	steel	5	55	75	95	LD-10	2	18152
shf1	3	t2linnet	tan	Hframe1	steel	1	55	75	60	LD-3	14	3657
shf1	3	t2linnet	tan	Hframe1	steel	2	55	75	65	LD-3	28	4289
shf1	3	t2linnet	tan	Hframe1	steel	3	55	75	75	LD-3	56	5199
shf1	3	t2linnet	tan	Hframe1	steel	4	55	75	85	LD-3	21	5923
shf1	3	t2linnet	tan	Hframe1	steel	5	55	75	95	LD-3	21	6615
shf1	3	t2linnet	la	_3G.Pole	steel	1	55	75	60	LD-3	1	5785
shf1	3	t2linnet	la	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	3	t2linnet	la	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	3	t2linnet	la	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	3	t2linnet	la	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	3	t2linnet	ma	_3G.Pole	steel	1	55	75	60	LD-2	1	5488
shf1	3	t2linnet	ma	_3G.Pole	steel	2	55	75	65	LD-3	1	6434
shf1	3	t2linnet	ma	_3G.Pole	steel	3	55	75	75	LD-3	2	7799
shf1	3	t2linnet	ma	_3G.Pole	steel	4	55	75	85	LD-3	1	8884
shf1	3	t2linnet	ma	_3G.Pole	steel	5	55	75	95	LD-3	1	9923
shf1	3	t2linnet	de	_3G.Pole	steel	1	55	75	60	LD-9	1	9103
shf1	3	t2linnet	de	_3G.Pole	steel	2	55	75	65	LD-9	2	10253
shf1	3	t2linnet	de	_3G.Pole	steel	3	55	75	75	LD-10	4	13330
shf1	3	t2linnet	de	_3G.Pole	steel	4	55	75	85	LD-10	2	15350
shf1	3	t2linnet	de	_3G.Pole	steel	5	55	75	95	LD-10	2	18152
shf1	4	teal	tan	Hframe1	steel	1	55	75	60	LD-2	3	3659
shf1	4	teal	tan	Hframe1	steel	2	55	75	65	LD-2	6	4055
shf1	4	teal	tan	Hframe1	steel	3	55	75	75	LD-2	12	4895
shf1	4	teal	tan	Hframe1	steel	4	55	75	85	LD-2	4	5539
shf1	4	teal	tan	Hframe1	steel	5	55	75	95	LD-2	4	6161
shf1	4	teal	la	_3G.Pole	steel	1	55	75	60	LD-2	0	5488
shf1	4	teal	la	_3G.Pole	steel	2	55	75	65	LD-2	0	6082
shf1	4	teal	la	_3G.Pole	steel	3	55	75	75	LD-3	0	7799
shf1	4	teal	la	_3G.Pole	steel	4	55	75	85	LD-3	0	8884
shf1	4	teal	la	_3G.Pole	steel	5	55	75	95	LD-4	0	10829
shf1	4	teal	ma	_3G.Pole	steel	1	55	75	60	LD-3	0	5785
shf1	4	teal	ma	_3G.Pole	steel	2	55	75	65	LD-4	0	7042
shf1	4	teal	ma	_3G.Pole	steel	3	55	75	75	LD-4	1	8535
shf1	4	teal	ma	_3G.Pole	steel	4	55	75	85	LD-4	0	9706
shf1	4	teal	ma	_3G.Pole	steel	5	55	75	95	LD-5	0	11576
shf1	4	teal	de	_3G.Pole	steel	1	55	75	60	LD-9	0	9103
shf1	4	teal	de	_3G.Pole	steel	2	55	75	65	LD-10	0	10842
shf1	4	teal	de	_3G.Pole	steel	3	55	75	75	LD-10	0	13330
shf1	4	teal	de	_3G.Pole	steel	4	55	75	85	LD-10	0	15350
shf1	4	teal	de	_3G.Pole	steel	5	55	75	95	LD-10	0	18152
shf1	4	37#9aw	tan	Hframe1	steel	1	55	70	55	LD-3	2	3449
shf1	4	37#9aw	tan	Hframe1	steel	2	55	70	60	LD-3	3	3957
shf1	4	37#9aw	tan	Hframe1	steel	3	55	70	70	LD-3	7	4738
shf1	4	37#9aw	tan	Hframe1	steel	4	55	70	80	LD-3	3	5438
shf1	4	37#9aw	tan	Hframe1	steel	5	55	70	90	LD-3	3	6419
shf1	4	37#9aw	la	_3G.Pole	steel	1	55	70	55	LD-3	0	5173
shf1	4	37#9aw	la	_3G.Pole	steel	2	55	70	60	LD-3	0	5765
shf1	4	37#9aw	la	_3G.Pole	steel	3	55	70	70	LD-4	0	7770
shf1	4	37#9aw	la	_3G.Pole	steel	4	55	70	80	LD-4	0	8919
shf1	4	37#9aw	la	_3G.Pole	steel	5	55	70	90	LD-4	0	10506
shf1	4	37#9aw	ma	_3G.Pole	steel	1	55	70	55	LD-6	0	6883
shf1	4	37#9aw	ma	_3G.Pole	steel	2	55	70	60	LD-6	0	7691

FILE E:\AEA-CVEA\PHASE1\DESIGN\COSTS\dbshf1.xls
WO ACCOUNT WW-1559-HA1-AC
CLIENT ALASKA ENERGY AUTHORITY
PROJECT COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE STRUCTURE DATA CONSOLIDATION
ITEM **TYPES shf1**
BY PED 9/17/93
CHECK

shf1	4	37#9aw	ma	_3G.Pole	steel	3	55	70	70	LD-6	1	9130
shf1	4	37#9aw	ma	_3G.Pole	steel	4	55	70	80	LD-6	0	11008
shf1	4	37#9aw	ma	_3G.Pole	steel	5	55	70	90	LD-6	0	13032
shf1	4	37#8aw	de	_3G.Pole	steel	1	55	70	55	LD-10	0	8973
shf1	4	37#9aw	de	_3G.Pole	steel	2	55	70	60	LD-10	0	9822
shf1	4	37#9aw	de	_3G.Pole	steel	3	55	70	70	LD-10	0	12065
shf1	4	37#9aw	de	_3G.Pole	steel	4	55	70	80	LD-10	0	13987
shf1	4	37#9aw	de	_3G.Pole	steel	5	55	70	90	LD-10	0	16719

FILE	e:\aea-cvea\phase1\design\costs
WORK ORDER ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	Unit Costs - Materials
BY	PED 8/31/93 updated
CHECK	

Enter "1" in column A if Distributor, Inspection, or Shipping Costs included in table, "0" if not.

A **STRUCTURES**

WOOD POLES

Type of Wood >>> WRC

	name		name
0	DISWPYN	10%	DISTWP
0	INSWPYN	25	INSPWP
1	SHPWPYN	10%	SHIPWP

Source
McFarland Cascade Pole
costs in italics are RWB estimates
based on interpolation

QUOTED PRICES
LENGTH (ft)

CLASS	40	45	50	55	60	65	70	75	80	85	90
2	*$525*	*$600*	*$800*	*$900*	*$1,000*	*$1,150*	*$1,300*	*$1,350*	*$1,700*	*$1,800*	*$1,950*
1	*$550*	*$650*	$869	$1,006	$1,149	$1,294	$1,457	$1,596	$1,950	$2,072	*$2,150*
H1	*$700*	*$850*	*$1,000*	$1,263	$1,418	$1,591	$1,833	$2,028	$2,163	*$2,300*	*$2,400*
H2	*$900*	$1,025	$1,182	$1,384	$1,561	$1,746	$1,999	$2,207	$2,435	$2,659	*$2,800*

ADJUSTED PRICES
LENGTH (ft)

CLASS	40	45	50	55	60	65	70	75	80	85	90
2	$603	$685	$905	$1,015	$1,125	$1,290	$1,455	$1,510	$1,895	$2,005	$2,170
1	$630	$740	$981	$1,132	$1,289	$1,448	$1,628	$1,791	$2,170	$2,304	$2,390
H1	$795	$960	$1,125	$1,414	$1,585	$1,775	$2,041	$2,256	$2,404	$2,555	$2,665
H2	$1,015	$1,153	$1,325	$1,547	$1,742	$1,946	$2,224	$2,453	$2,704	$2,950	$3,105

Type of Wood >>> DF

QUOTED PRICES
LENGTH (ft)

CLASS	40	45	50	55	60	65	70	75	80	85	90
2	*$500*	*$550*	*$750*	*$825*	*$900*	*$1,100*	*$1,300*	*$1,400*	*$1,600*	*$1,800*	*$1,900*
1	*$575*	*$600*	$806	$932	$1,076	$1,251	$1,440	$1,620	$1,829	$2,057	*$2,100*
H1	*$650*	*$750*	*$900*	$1,083	$1,316	$1,478	$1,649	$1,831	$2,021	*$2,200*	*$2,300*
H2	*$800*	$941	$1,083	$1,251	$1,481	$1,661	$1,850	$2,071	$2,281	$2,501	*$2,650*

ADJUSTED PRICES
LENGTH (ft)

CLASS	40	45	50	55	60	65	70	75	80	85	90
2	$575	$630	$850	$933	$1,015	$1,235	$1,455	$1,565	$1,785	$2,005	$2,115
1	$658	$685	$912	$1,050	$1,209	$1,401	$1,609	$1,807	$2,037	$2,288	$2,335
H1	$740	$850	$1,015	$1,216	$1,473	$1,651	$1,839	$2,039	$2,248	$2,445	$2,555
H2	$905	$1,060	$1,216	$1,401	$1,654	$1,852	$2,060	$2,303	$2,534	$2,776	$2,940

STEEL POLES (Wood Pole Equivalents)

Enter "1" in column A if Distributor, Shipping or other Costs included in prices, "0" if not.

	name		name
0	DISSPYN	5%	DISTSP
1	SHPSPYN	10%	SHIPSP
1	PNTSPYN	7%	PAINTSP
1	GALSPYN	12%	GALVSP

Type of Steel>>> Self-weathering

Source	Date
	8/31/93
X	MEYERS
	PSI
	VALMONT

Criteria

WEIGHT(lbs)
CLASSIFICATION

LENGTH(ft)	LD-1	LD-10	LD-2	LD-3	LD-4	LD-5	LD-6	LD-7	LD-9	LD-9
40	882	1614	920	957	1046	1087	1261	1428	1482	1528
45	1024	1888	1060	1107	1209	1262	1464	1656	1725	1786
50	1162	2175	1207	1264	1381	1444	1676	1898	1982	2058
55	1304	2477	1358	1428	1561	1636	1900	2151	2254	2344
60	1450	2777	1515	1597	1739	1827	2123	2403	2523	2627
65	1603	3129	1679	1776	1944	2048	2380	2693	2834	2959
70	1763	3482	1850	1962	2145	2268	2635	2981	3144	3289

EXHIBIT C-3

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		FILE			e:\aea-cvea\phase1\design\costs															
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC															
3		CLIENT			ALASKA ENERGY AUTHORITY															
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY															
5		FEATURE			Unit Costs - Materials															
6		BY			PED	8/31/93	updated													
7		CHECK																		
63		Price/lb		*Length*	*Weight*	75	1927	3847	2027	2153	2358	2496	2901	3281	3468	3634				
64		$1.15	SPPRC1	75	2500	80	2096	4229	2209	2354	2574	2734	3177	3593	3805	3994				
65		$1.10	SPPRC2	90	4000	85	2270	4641	2398	2564	2801	2980	3464	3917	4156	4369				
66		$1.05	SPPRC3	105	5000	90	2450	5055	2594	2779	3032	3235	3761	4250	4520	4775				
67						95	2634	5488	2794	3000	3274	3500	4069	4597	4897	5181				
68						100	2832	5934	3010	3238	3524	3771	4385	4956	5302	5601				
69						105	3026	6396	3223	3473	3781	4053	4713	5327	5707	6036				
70						110	3225	6873	3441	3716	4046	4344	5052	5710	6126	6486				
71						115	3543	7631	3776	4090	4454	5022	5598	6329	6786	7193				
72						120	3753	8140	4011	4349	4734	5384	5959	6736	7232	7677				
73				Wood Pole Class Equiv > >			1		H1	H2	H3	H4	H5	H6						
74											PRICES									
75											CLASSIFICATION									
76						LENGTH(ft)	LD-1	LD-10	LD-2	LD-3	LD-4	LD-5	LD-6	LD-7	LD-8	LD-9				
77						40	$1,077	$1,949	$1,111	$1,156	$1,263	$1,313	$1,523	$1,724	$1,790	$1,845				
78		Note that new LD-5 and above weights are				45	$1,236	$2,280	$1,280	$1,337	$1,460	$1,524	$1,768	$2,000	$2,083	$2,157				
79		not shown; they have been revised due to				50	$1,403	$2,626	$1,457	$1,526	$1,668	$1,744	$2,024	$2,292	$2,393	$2,485				
80		Meyers selection of standard plate thickness				55	$1,575	$2,991	$1,640	$1,724	$1,885	$1,975	$2,294	$2,597	$2,722	$2,830				
81		for each classification of pole.				60	$1,751	$3,207	$1,829	$1,928	$2,100	$2,206	$2,564	$2,902	$2,914	$3,034				
82						65	$1,936	$3,614	$2,027	$2,145	$2,347	$2,473	$2,874	$3,110	$3,273	$3,418				
83						70	$2,129	$4,022	$2,234	$2,369	$2,590	$2,739	$3,043	$3,443	$3,631	$3,799				
84						75	$2,327	$4,443	$2,448	$2,600	$2,845	$3,014	$3,351	$3,790	$4,006	$4,197				
85						80	$2,421	$4,662	$2,551	$2,719	$2,973	$3,158	$3,669	$4,150	$4,395	$4,613				
86						85	$2,622	$5,117	$2,770	$2,961	$3,235	$3,442	$4,001	$4,524	$4,582	$4,817				
87						90	$2,830	$5,573	$2,996	$3,210	$3,502	$3,736	$4,344	$4,686	$4,983	$5,264				
88						95	$2,904	$6,051	$3,080	$3,308	$3,610	$3,859	$4,486	$5,068	$5,399	$5,712				
89						100	$3,122	$6,542	$3,319	$3,570	$3,885	$4,158	$5,196	$5,464	$5,845	$6,175				
90						105	$3,336	$7,052	$3,553	$3,829	$4,169	$4,468	$5,570	$5,873	$6,292	$6,655				
91						110	$3,556	$7,577	$3,794	$4,097	$4,461	$4,789	$6,172	$6,295	$6,754	$7,151				
92						115	$3,906	$8,413	$4,163	$4,509	$4,911	$5,537	$6,570	$6,978	$7,482	$7,930				
93						120	$4,138	$8,974	$4,422	$4,795	$5,219	$5,936	$6,570	$7,426	$7,973	$8,464				
94																				
95																				
96																				
97																				
98				Wood Pole Class Equiv > >			1	H1	H2	H3	H4	H5	H6							
99																				
100																				
101		X-FRAME STRUCTURES												ESTIMATED WEIGHTS						
102																				
103		Historical Structure Weights and Loads																		
104																				
105		TYEE LAKE TRANSMISSION LINE 138 KV								BRADLEY LAKE DOUBLE 115 KV LINES										
106							INDEX			STX-10A				INDEX						
107		DESIGN LOADS (lbs)				LENGTH	MOMENT	WEIGHT		DESIGN LOADS (kips)			LENGTH	MOMENT	WEIGHT					
108		CASE I	T =	4000	STX-E-	40	333	4081			CASE 5.1		40	654	7700					
109			V =	1200		45	375	*4250*	est		T =	5.5	45	736	7900					
110			L =	0		50	416	4547			V =	15.4	50	818	8100					
111			R =	*4*		55	458	4787			L =	0	55	898	*8500*	est				
112		CASE II	T =	2300		60	499	5026			R =	*16.4*	60	981	8900					
113			V =	8000		65	541	5355			CASE 6		65	1063	9100					
114			L =	0		70	583	5793			T =	0.2	70	1145	9700					
115			R =	*8.32*		75	624	6296			V =	9.5	75	1226	10100					
116		CASE III	T =	1500		80	666	7509			L =	5.5								

FILE	e:\aea-cvea\phase1\design\costs
WORK ORDER ACCOUNT	WW-1559-HA1-AC
CLIENT	ALASKA ENERGY AUTHORITY
PROJECT	COPPER VALLEY INTERTIE FEASIBILITY STUDY
FEATURE	Unit Costs - Materials
BY	PED 8/31/93 updated
CHECK	

V = 3000
L = 3000
R = *4.5*

R = *11.0*

Note that index moment above is resultant of point loads times structure height.

Max resultant and actual Xframe weights tabulated below.
These are used to compute a gradient (lbs/ft-lbs)at right.

	MAX RESULT		
HEIGHT	8320	16400	
35	*3750*	*5000*	0.154703
40	*4000*	*6200*	0.2722772
45	4250	7900	0.4517327
50	4547	8100	0.4397277
55	4787	8500	0.4595297
60	5026	8900	0.4794554
65	5355	9100	0.4834901
70	5793	9700	0.4835396
75	6296	10100	0.4707921
80	7509	*10500*	0.3701733
85	*8700*	*11400*	*0.3341584*
90	*9600*	*12300*	*0.3341584*
95	*10500*	*13200*	*0.3341584*
100	*11700*	*14000*	*0.2846535*
105	*13000*	*14800*	*0.2227723*
	weights		

LZ		Dove Index	Intertie Estimated Weight	Teal Index	Intertie Estimated Weight	T2Linnet Index	Intertie Estimated Weight	AW Index	Intertie Estimated Weight
1	35	*9350*	3807	*9810*	3681	*10350*	3896	na	na
	40		3977		3851		4066		na
	45		4147		4022		4236		na
	50		4318		4192		4407		na
	55		4488		4363		4577		na
	60		4659		4533		5144		na
	65		5276		5150		5365		na
	70		5497		5371		5586		na
	75		5718		5592		7013		na
	80		5939		7132		7346		na
	85		7590		7465		7679		na
	90		7923		7798		8012		na
	95		8256		8130		8345		na
	100		8589		8463		8678		na
	105		8922		8796		9011		na
2	35	*8160*	4084	*8610*	3958	*9100*	3896	na	na
	40		4254		4129		4066		na
	45		4425		4299		4236		na
	50		4595		4470		4407		na
	55		4766		4640		4577		na
	60		4936		4811		5144		na
	65		5553		5428		5365		na
	70		5774		5649		5586		na
	75		5996		5870		5807		na
	80		7535		7409		7346		na
	85		7868		7742		7679		na
	90		8201		8075		8012		na
	95		8533		8408		8345		na
	100		8866		8741		8678		na
	105		9199		9074		11348		na
3	35	*8620*	3907	*9080*	3958	*9610*	3896	na	na
	40		3977		4129		4066		na
	45		4147		4299		4236		na
	50		4318		4470		4407		na
	55		4488		4640		4577		na
	60		4659		4811		5144		na
	65		5276		5428		5365		na
	70		5497		5629		5586		na
	75		5718		5870		7013		na
	80		7257		7409		7346		na
	85		7590		7742		7679		na
	90		7923		8075		8012		na
	95		8256		8408		8345		na
	100		8589		8741		8678		na

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		FILE			e:\aea-cvea\phase1\design\costs															
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC															
3		CLIENT			ALASKA ENERGY AUTHORITY															
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY															
5		FEATURE			Unit Costs - Materials															
6		BY			PED	8/31/93	updated													
7		CHECK																		
171								105		8922		9074		11348		na				
172																				
173							4	35	*13390*	na	*14980*	4378	na	na	*16480*	3833				
174								40		na		4549		na		4003				
175								45		na		4718		na		4174				
176								50		na		4890		na		4344				
177								55		na		5060		na		4515				
178								60		na		5626		na		5081				
179								65		na		5847		na		5302				
180								70		na		6069		na		5523				
181								75		na		7496		na		6951				
182								80		na		7826		na		7284				
183								85		na		8162		na		7616				
184								90		na		8495		na		7949				
185								85		na		8828		na		8282				
186								100		na		9161		na		8615				
187								105		na		11831		na		11285				
188																				
189		X-frame Weights for Intertie																		
190											WEIGHTS							PRICES		
191											LOADING ZONE							LOADING ZONE		
192	1	DISXFYN	10%	DISTXF			Conductor	Height	1	2	3	4		Conductor	Height	1	2	3	4	
193	1	SHPXFYN	10%	SHIPXF																
194							Dove	35	3807	4084	3807	na		Dove	35	$4,568	$4,901	$4,568	#VALUE!	
195								40	3977	4254	3977	na			40	$4,772	$5,105	$4,772	#VALUE!	
196		Type of Steel>>>		Self-weathering				45	4147	4425	4147	na			45	$4,976	$5,310	$4,976	#VALUE!	
197								50	4318	4595	4318	na			50	$5,182	$5,422	$5,182	#VALUE!	
198		Source	Date	8/31/93				55	4488	4766	4488	na			55	$5,296	$5,624	$5,296	#VALUE!	
199		X	MEYERS					60	4659	4836	4659	na			60	$5,498	$5,824	$5,498	#VALUE!	
200			PSI					65	5276	5553	5276	na			65	$6,226	$6,553	$6,226	#VALUE!	
201			VALMONT					70	5497	5774	5497	na			70	$6,486	$6,813	$6,486	#VALUE!	
202								75	5718	5996	5718	na			75	$6,576	$6,895	$6,576	#VALUE!	
203					Criteria			80	5939	7535	7257	na			80	$6,830	$8,665	$8,346	#VALUE!	
204		Price/lb		*Length*	*Weight*			85	7590	7868	7590	na			85	$8,729	$9,048	$8,729	#VALUE!	
205		$1.20	XFPRC1	50	4500			90	7923	8201	7923	na			90	$9,111	$9,431	$9,111	#VALUE!	
206		$1.18	XFPRC2	70	7000			95	8256	8533	8256	na			95	$9,494	$9,813	$9,494	#VALUE!	
207		$1.15	XFPRC3	80	10000			100	8589	8866	8589	na			100	$9,877	$10,196	$9,877	#VALUE!	
208								105	8922	9199	8922	na			105	$10,260	$10,579	$10,260	#VALUE!	
209																				
210							Teal	35	3681	3958	3958	4378		Teal	35	$4,417	$4,750	$4,750	$5,254	
211								40	3851	4129	4129	4549			40	$4,621	$4,955	$4,955	$5,368	
212								45	4022	4299	4299	4719			45	$4,826	$5,159	$5,159	$5,568	
213								50	4192	4470	4470	4890			50	$5,030	$5,364	$5,364	$5,770	
214								55	4363	4640	4640	5060			55	$5,148	$5,475	$5,475	$5,971	
215								60	4533	4811	4811	5626			60	$5,349	$5,677	$5,677	$6,639	
216								65	5150	5428	5428	5847			65	$6,077	$6,405	$6,405	$6,899	
217								70	5371	5649	5629	6069			70	$6,338	$6,666	$6,642	$7,161	
218								75	5592	5870	5870	7496			75	$6,431	$6,751	$6,751	$8,620	
219								80	7132	7409	7409	7826			80	$8,202	$8,520	$8,520	$9,000	
220								85	7465	7742	7742	8162			85	$8,585	$8,903	$8,903	$9,386	
221								90	7798	8075	8075	8495			90	$8,968	$9,286	$9,286	$9,769	
222								95	8130	8408	8408	8828			95	$9,350	$9,669	$9,669	$10,152	
223								100	8463	8741	8741	9161			100	$9,732	$10,052	$10,052	$10,535	
224								105	8796	9074	9074	11831			105	$10,115	$10,435	$10,435	$13,606	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		FILE			e:\aea-cvea\phase1\design\costs															
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC															
3		CLIENT			ALASKA ENERGY AUTHORITY															
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY															
5		FEATURE			Unit Costs - Materials															
6		BY			PED	8/31/93	updated													
7		CHECK																		
225																				
226							T2Linnet	35	3896	3896	3896	na		T2Linnet	35	$4,675	$4,675	$4,675	na	
227								40	4066	4066	4066	na			40	$4,879	$4,879	$4,879	na	
228								45	4236	4236	4236	na			45	$5,083	$5,083	$5,083	na	
229								50	4407	4407	4407	na			50	$5,288	$5,288	$5,288	na	
230								55	4577	4577	4577	na			55	$5,401	$5,401	$5,401	na	
231								60	5144	5144	5144	na			60	$6,070	$6,070	$6,070	na	
232								65	5365	5365	5365	na			65	$6,331	$6,331	$6,331	na	
233								70	5586	5586	5586	na			70	$6,591	$6,591	$6,591	na	
234								75	7013	5807	7013	na			75	$8,065	$6,678	$8,065	na	
235								80	7346	7346	7346	na			80	$8,448	$8,448	$8,448	na	
236								85	7742	7742	8162	na			85	$8,903	$8,903	$9,386	na	
237								90	8075	8075	8495	na			90	$9,286	$9,286	$9,769	na	
238								95	8408	8408	8828	na			95	$9,669	$9,669	$10,152	na	
239								100	8741	8741	9161	na			100	$10,052	$10,052	$10,535	na	
240								105	9074	9074	11831	na			105	$10,435	$10,435	$13,606	na	
241																				
242							37#9AW	35	na	na	na	3833		37#9AW	35	na	na	na	$5,009	
243								40	na	na	na	4003			40	na	na	na	$4,804	
244								45	na	na	na	4174			45	na	na	na	$5,009	
245								50	na	na	na	4344			50	na	na	na	$5,213	
246								55	na	na	na	4515			55	na	na	na	$5,328	
247								60	na	na	na	5081			60	na	na	na	$5,996	
248								65	na	na	na	5302			65	na	na	na	$6,256	
249								70	na	na	na	5523			70	na	na	na	$6,517	
250								75	na	na	na	6951			75	na	na	na	$7,994	
251								80	na	na	na	7284			80	na	na	na	$8,377	
252								85	na	na	na	7616			85	na	na	na	$8,758	
253								90	na	na	na	7949			90	na	na	na	$9,141	
254								95	na	na	na	8282			95	na	na	na	$9,524	
255								100	na	na	na	8615			100	na	na	na	$9,907	
256								105	na	na	na	11285			105	na	na	na	$12,978	
257																				
258	B	INSULATOR ASSEMBLY																		
259						1	1	1	2	2	2	3	3	3	4	4	4			
260						Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	Dove	T2Linnet	Teal	37#9AW	Dove	Teal			
261		TANGENT	I-String			$212	$109	$212	$192	$109	$192	$201	$118	$201	$163	$201	$201			
262		TANGENT	V-String			$377	$275	$377	$377	$275	$377	$395	$293	$395	$357	$395	$385			
263		TANGENT	Inverted V-String																	
264		TANGENT	Horz-Vee			$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700			
265		LA	Running Angle, Bracket			$326	$243	$326	$383	$300	$383	$335	$317	$335	$383	$400	$400			
266		MA	Running Angle, No Bracket			$681	$266	$681	$681	$266	$681	$676	$361	$676	$710	$695	$695			
267		DE	No Jumper			$283	$322	$283	$283	$256	$283	$299	$312	$299	$657	$299	$299			
268		DE	With Jumper			$539	$578	$539	$539	$512	$539	$586	$599	$586	$944	$586	$586			
269																				
270																				
271																				
272																				
273																				
274																				
275																				
276																				
277																				
278	C	BRACING																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		FILE			e:\aes-cvea\phase1\design\costs															
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC															
3		CLIENT			ALASKA ENERGY AUTHORITY															
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY															
5		FEATURE			Unit Costs - Materials															
6		BY			PED	8/31/93	updated													
7		CHECK																		
279																				
280		Hframe, Type 1		TH-10 >>>>>>		$600		WOOD												
281		0	Xbrace			0		Xbrace	2056-16	$250	2096-16	$350	2094-16	$300						
282		0	VBrace			0		Xbrace	2077-16	$275	2096A-16	$375								
283		0	Crosstie			0		Xbrace	2086-16	$300	2096b-16	$400								
284		1	Xarm		600	600														
285																				
286		Hframe, Type 4		TH-10V4X >>>>>>		$1,175		V-brace	2025-11	$50										
287		1	Xbrace	HB 2094	400	400		V-brace	2038-11	$80										
288		4	Braces		75	300														
289		1	Crosstie		75	75		Xarm 1	4-5/8x9-3/8,36'		510									
290		1	Xarm	3-1/8x9'	400	400		Xarm 2	4-5/8x9-5/8,32'		475									
291																				
292		Steel Hframe, Type 1																		
293		0	Xbrace	0																
294		$1.20	Xarm	525	lb	$630	Zone2													
295		$1.20	Xarm	850	lb	$1,020	Others													
296		Steel Hframe, Type 4																		
297		$1.00	Xbrace	540	lb	$540														
298		$1.20	Xarm	525	lb	$630														
299		$100	Braces	4	ea	$400														
300						$1,570	All Zones													
301																				
302																				
303																				
304	D	FOUNDATIONS																		
305																				
306						cost/ft														
307		Xframe	Type 1	Hpile	10x57	$80				Estimated Material Cost										
308				1	2	3	4			1	2	3	4							
309			Teal	17	17	17	19		Teal	$1,360	$1,360	$1,360	$1,520							
310			Dove	16	17	17	18		Dove	$1,280	$1,360	$1,360	$1,440							
311			T2Linnet	17	18	18	na		T2Linnet	$1,360	$1,440	$1,440	na							
312			37#9AW	na	na	na	18		37#9AW	na	na	na	$1,440							
313			pile lengths do not vary appreciably with stucture height																	
314																				
315						cost/ft	lbs/ft													
316		Hframe	Pipe Pile	Pipe	30"x1/4"t	$110	79.60		Assumptions for Geotechnical											
317		Zone 2	H	L	Cost					1	2	3	4							
318			50	15.5	$1,705				Glacial Till	70%	10%	50%	50%							
319			55	16.0	$1,760				Muskeg	20%	10%	20%	20%							
320			60	16.5	$1,815				Permafrost	0%	80%	20%	0%							
321			65	17.0	$1,870				Rock	10%	0%	10%	30%							
322			70	17.0	$1,870															
323			75	17.5	$1,925															
324			80	18.0	$1,980															
325			85	- 18.5	$2,035															
326			90	19.0	$2,090															
327			85	19.5	$2,145															
328																				
329		3G-Pole	Hpile	2x17'	10x57	34	$2,720	per pole												
330		Zone 2		battered																
331																				
332																				

Row	A	B	C	D	E	F	G
1		FILE			e:\aea-cvea\phase1\design\costs		
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC		
3		CLIENT			ALASKA ENERGY AUTHORITY		
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY		
5		FEATURE			Unit Costs - Materials		
6		BY			PED	8/31/93	updated
7		CHECK					
361	E	**GUY ANCHOR ASSEMBLIES**					
363	1	DISANYN	10%	DISTANCH			
364	1	SHPANYN	10%	SHIPANCH			
366		**GUYS**					
368					Quote	Adjusted	
369		Xframe Guy Assembly 1			$222.78	$222.78	
370		Xframe Guy Assembly 2			$290.41	$290.41	
371		Single Down Guy 20k			$110.51	$110.51	
372		Single Down Guy 30k			$157.60	$157.60	
373		Single Down Guy 35k			$176.66	$176.66	
374		Single Down Guy 40k			$235.56	$235.56	
375		Single Down Guy 60k			$511.87	$511.87	

Row	B	C	E	F	H	I	J	K	L
377	**ANCHORS**							Cost/ft	
378								$80	
379	GLACIAL TILL		Length	Material Cost	MUSKEG/PF			Length	Cost
380	20k Anchor	Plate		*$40*	20k Anchor	Hpile	10x57	17	$1,360
381	30k Anchor	Plate		*$60*	30k Anchor	Hpile	10x57	21	$1,680
382	40k Anchor	Plate		*$80*	40k Anchor	Hpile	10x57	25	$2,000
383	50k Anchor	Plate		*$100*	50k Anchor	Hpile	10x57	30	$2,400
384	25k Anchor	Log		*$100*	assumes L = 8' + Tload/(4.5+0.5)				
385	35k Anchor	Log		*$150*			Fixed	Variable	
386	45k Anchor	Log		*$200*	ROCK		$0	$8	Cost

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		FILE			e:\aea-cvea\phase1\design\costs															
2		WORK ORDER ACCOUNT			WW-1559-HA1-AC															
3		CLIENT			ALASKA ENERGY AUTHORITY															
4		PROJECT			COPPER VALLEY INTERTIE FEASIBILITY STUDY															
5		FEATURE			Unit Costs - Materials															
6		BY			PED	8/31/93	updated													
7		CHECK																		
387		50k Anchor	Log			$250		25k Anchor	Rock bolt	6	ft	$48								
388		60kAnchor	Log			$300		35kAnchor	Rock bolt	7	ft	$56								
389		25k Anchor	HPile	10x57	19	$1,520		45kAnchor	Rock bolt	8	ft	$64								
390		35k Anchor	HPile	10x57	23	$1,840		50k Anchor	Rock bolt	9	ft	$72								
391		45k Anchor	HPile	10x57	27	$2,160		60k Anchor Bolt	Rock bo	10	ft	$80								
392		50k Anchor	HPile	10x57	30	$2,400		assumes 75 ksi working bond stress grout to rock												
393		60k Anchor	HPile	10x57	35	$2,800		assumes 9.5 k/ft load developed.												
394																				
395																				
396																				
397	F	CONDUCTOR																		
398										ALUM										
399	1	DISCONYN	10%	DISTCOND						ESCAL										
400	1	SHPCONYN	10%	SHIPCOND						10%		ADJUST		CONDUCTOR FINISH						
401	0	NONSPYN	2.80%	NONSPEC			unit	Alum	CABLEC	ACPC	ACPC	ACPC								
402							wt/ft	wt/ft	$/lb	$/lb	MFG$/LB	$/lb	name	SPEC	NONSPEC					
403		556	kcmil	ACSR	Dove	Standard	0.766	0.525	1.039	0.86	0.350339	$0.92	DOVE	$0.92	$0.95					
404		605	kcmil	ACSR	Teal	Standard	0.939	0.572	1.152	0.919	0.421535	$0.97	TEAL	$0.97	$1.00					
405		2x636	kcmil	ACSR/T2	T2/Linnet	Standard	0.926	0.634	1.166	0.864	0.454454	$1.03	T2LINNET	$1.03	$1.05					
406		556	kcmil	ASCR/ehs	Dove	HS CORE	0.766	0.525	1.081	0.896	0.386339	$0.96	DOVEEHS	$0.96	$0.98					
407		605	kcmil	ASCR/ehs	Teal	HS CORE	0.939	0.572	1.194	0.961	0.463535	$1.02	TEALEHS	$1.02	$1.04					
408		605	kcmil	SSAC	Teal	SSAC	0.939	0.572	1.325	1.125	0.627535	$1.18	TEALSSAC	$1.18	$1.21					
409		37#9AW	NA	AW		Alumoweld	1.108	NA	NA	1.472		$1.47	37#9AW	$1.47	$1.51					
410																				
411							$/lb			$/lb										
412					1993	AL INGOT	$0.56	EST FUT	AL INGOT	$0.65	65-0.56/0.56		16.07%							
413						ST CORE	$0.40	EST FUT	ST	$0.40										
414																				
415																				
416																				

EXHIBIT C-4

Alaska Energy Authority
Copper Valley Intertie
Insulator Assembly Material - TEAL Conductor
PED 8/18/93 REV 1/6/94

		Estimating Data							
	Loading Zone 1	Average Span	900 ft						
		Zone Length	26.55 mi						
		Total Structures	156						
75%	Tangent I String	Qty/Str	2						$212.00
107									
	Anchor Shackle	25k	AND	AS-25	1	214	$3.45		$3.45
	Insulator	12.5k RTL, YC-B	OB	511007-1201	1	214	$89.00		$89.00
	Suspension Clamp	30k	AND	HAS-182-S	1	214	$13.35		$13.35
	Armor Rod	Teal	PRE	AR 0137	1	214	$59.94		$59.94
	Vibration Damper	Teal/AR	FARGO	60710-12	1	214	$26.00		$26.00
	Tangent V-String	Qty/Str	1						$377.08
	Extension Link	12",25k	AND	HOO 30L	2	214	$21.20		$42.40
	Anchor Shackle	25k	AND	AS-25	2	214	$3.45		$6.90
	Insulator	12.5k RTL, YC-B	OB	511007-1201	2	214	$89.00		$178.00
	Socket Y Clevis	30k	AND	SYC 30	2	214	$8.28		$16.56
	Yoke Plate	30k	AND	YPD-30-15238-2	1	107	$26.57		$26.57
	Y Clevis	30k	AND	YCS-16-90	1	107	$7.36		$7.36
	Suspension Clamp	30k	AND	HAS-182-S	1	107	$13.35		$13.35
	Armor Rod	Teal	PRE	AR 0137	1	107	$59.94		$59.94
	Vibration Damper	Teal/AR	FARGO	60710-12	1	107	$26.00		$26.00
15%	LA Structure	Qty/Str	3						$325.74
21									
	Swinging Bracket	Heavy, 3ft	HB	2848-F	1	64	$134.00		$134.00
	Anchor Shackle	25k	AND	AS-25	1	64	$3.45		$3.45
	Insulator	12.5k RTL, YC-B	OB	511007-1201	1	64	$89.00		$89.00
	Suspension Clamp	30k	AND	HAS-182-S	1	64	$13.35		$13.35
	Armor Rod	Teal	PRE	AR 0137	1	64	$59.94		$59.94
	Vibration Damper	Teal/AR	FARGO	60710-12	1	64	$26.00		$26.00
10%	MA Structure	Qty/Str	3						$680.76
14									
	Swinging Bracket	Heavy, 2ft	HB	2848-A	1	43	$102.00		$102.00
	Anchor Shackle	50k	AND	AS-50	1	43	$5.40		$5.40
	Insulator	25k RTL, YC-B	OB	513007-1201	1	43	$168.00		$168.00
	Double AGS	40k	PRE	AGS-5826	1	43	$167.08		$167.08
	Yoke Plate	40k	PRE	YP 5909	1	43	$165.03		$165.03
	Socket Clevis	50k	PRE	SC-5329	1	43	$47.25		$47.25
	Vibration Damper		FARGO	60710-12	1	43	$26.00		$26.00
	Deadend	Qty/Str	6					$538.70	$282.70
13									
	Anchor Shackle	50k	AND	AS-50	1	78	$5.40		$5.40
	Insulator	25k RTL,YC-B	OB	513008-1201	1	78	$182.00		$182.00
	HL Socket -YClevis	50k	AND	HSYC-50	1	78	$21.88		$21.88
	Comp DE w Term	Teal	FARGO	A 0312-29	1	78	$45.00		$45.00
	Jumper Post		OB	522008-1102	0.0	0	$256.00		$0.00
	Suspension Clamp	Teal	AND	TSC-106	1	39	$4.83		$2.42
156	Vibration Damper		FARGO	60710-12	1	78	$26.00		$26.00