Public-data File 86-57

PRELIMINARY FEASIBILITY STUDY OF A COAL MINE AT CHICAGO CREEK

By

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April 1985

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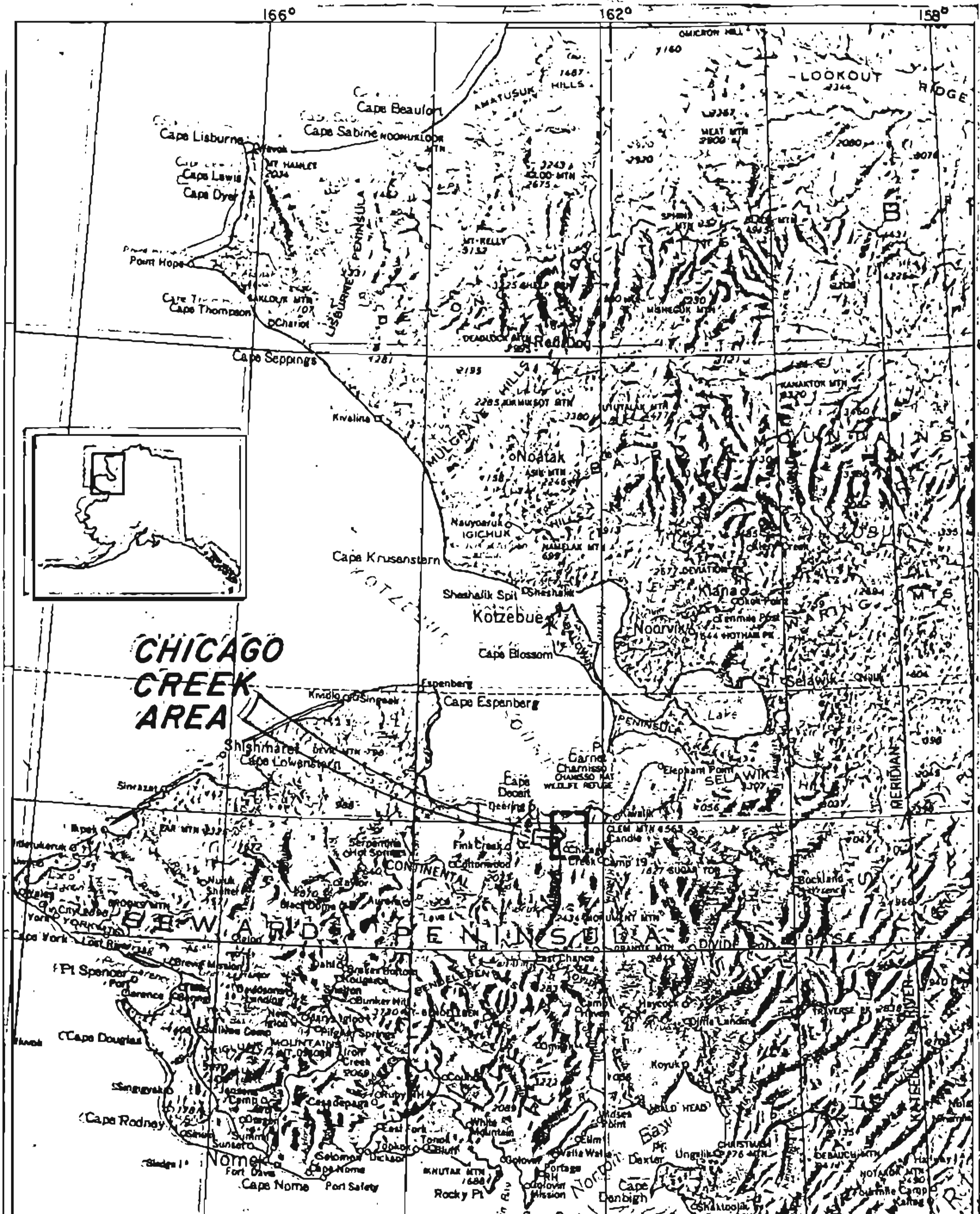
INTRODUCTION

This report addresses the feasibility of providing electrical power for Kotzebue and the nearby villages using coal mined at Chicago Creek, south of Kotzebue Sound. The feasibility study draws on the results of two seasons of field work by C. C. Hawley and Associates, Inc., including drilling, geologic mapping, and downhole and surface geophysical surveys. Data from previous studies was also utilized. The project was performed under the provisions of contract no. XXXXXXX, administered by the Division of Geological and Geophysical Surveys of the Alaska Department of Natural Resources.

The study was conducted by a group of consultants in appropriate fields, coordinated by Hawley Resource Group, Inc. Hawley Resource Group personnel involved in the study included C. C. Hawley, R. M. Retherford, T. K. Hinderman and J. P. Hawley. Consultants included Ralph Stefano of Stefano and Associates, Inc., R. W. Retherford, P. E., R. W. Christensen, Consulting Engineer, John Wood, P. E., Henry Springer of the Alaska Department of Transportation, Tom Humphrey, P. E., and John Rense and Burton Greist of NANA Regional Corporation.

LOCATION

The Chicago Creek coal deposit is located on the northeastern part of Alaska's Seward Peninsula, about 70 miles south of Kotzebue (Fig. 1). The proposed mine site is on Chicago Creek, about 1.25 miles east of its confluence with the Kugruk River, and about eight miles south of the coast of Kotzebue Sound.



Base map from USGS Alaska Map E, Scale 1:2,500,000

INDEX MAP

ACCESS

The most common means of access to the Chicago Creek area is by air. Light aircraft can land at a 1,200 foot gravel airstrip at a placer camp on the Kugruk River which is presently being leased by Virgil Vial of Candle. This strip is private and permission is required for use. The camp and airstrip are located approximately 1.5 miles from the project site. Drilling equipment and other heavy cargo can be flown to the 5000-foot airstrip at Candle, about 15 miles to the east, and transported to the Chicago Creek area over an existing tractor-trail system.

LAND STATUS

Permitting Evaluation

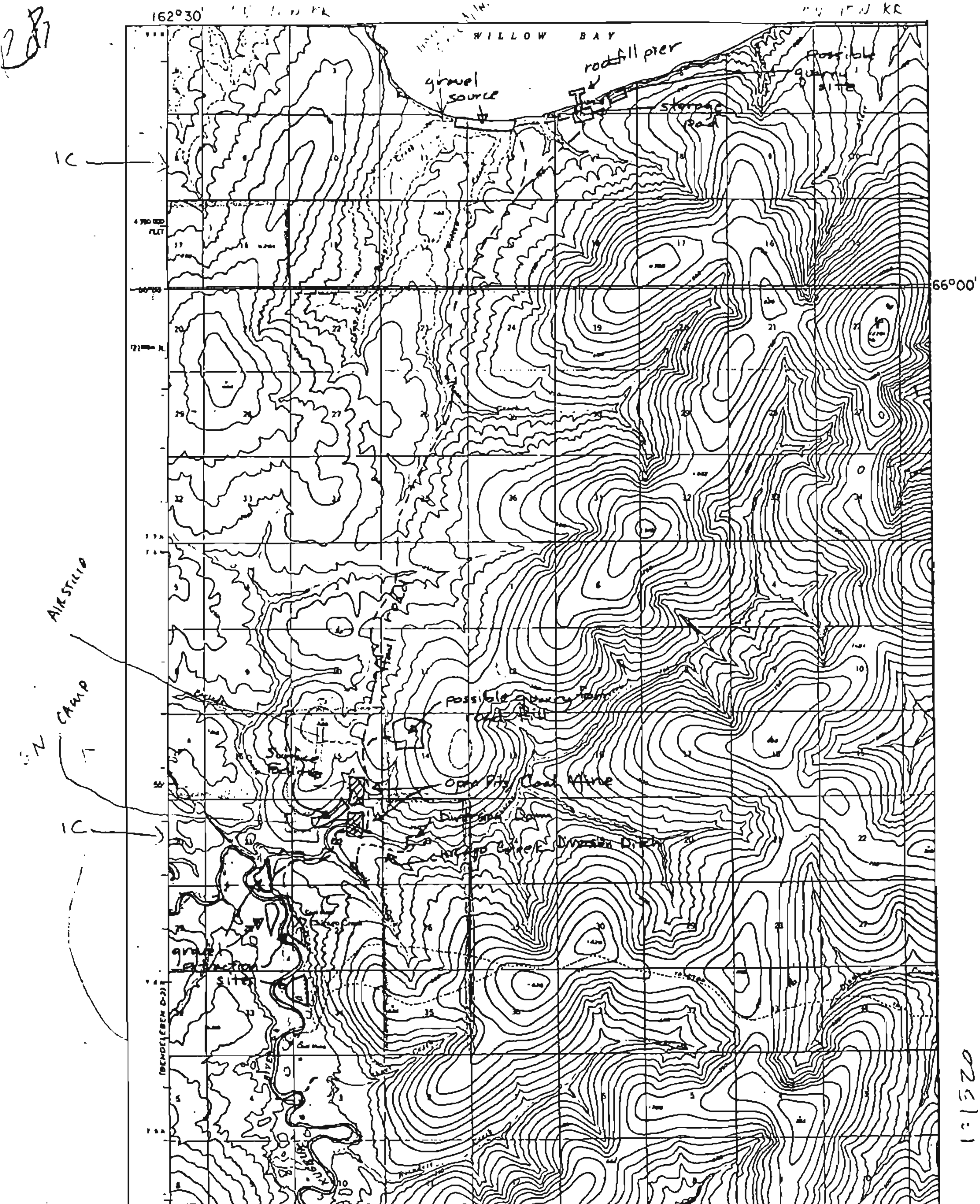
Development of the Chicago Creek coal, which could involve a mining operation, power plant, access road, and port, will require permitting through various local state and federal agencies. The full permitting plan would require systematic coordination and timing of public notices and public hearings.

This section provides generalized information regarding the types of authorizations, standards to be met, and baseline studies that will be required for the proposed development of the Chicago Creek coal. Further permits may be required for any special circumstances that may be encountered, such as historic sites or endangered species.

Surface Mining

Surface coal mining programs in Alaska are regulated by the Division of Mines, Department of Natural Resources, State of Alaska. Regulations found in 11 AAC, Chapter 90 were developed pursuant to the Alaska Surface Coal Mining Control and Reclamation Act (AS 41.45).

Application for a permit to mine coal will require environmental assessments of all phases of the impacted area, including but not



Base map from USGS Alaska: Bendeleben D-1, Kotzebue A-1.

limited to, the following:

Cultural and Historic Resources
Hydrology
Geology
Ground Water
Surface Water
Alternative Water Supply Information
Climatological Information
Vegetation
Fish and Wildlife Resources
Endangered Species
Soil Resources
Land Use

Minimum standards set out by the Act include, but are not limited to, the following:

1) Reclamation must occur as contemporaneously as practicable.

2) Backfilling and grading must follow coal removal according to an approved time schedule.

3) Final slopes must not exceed in grade the approximate pre-mining slopes.

4) Backfill and grading must achieve a minimum static safety factor of 1.3.

5) All acid-forming, toxic-forming or combustible materials remaining after mining must be covered by a minimum of 4 feet of non-toxic, non-combustible material.

6) Topsoil must be segregated, stockpiled, and redistributed upon reclamation.

7) Drill holes must be capped, cased, sealed, or backfilled to prevent acid or other toxic drainage from entering ground or surface water, and to minimize disturbance of the prevailing hydrologic balance.

8) Surface drainage from disturbed areas must be passed through sedimentation ponds or a treatment facility or

otherwise meet state and federal water quality laws and regulations.

9) All surface areas must be protected from erosion and air and water pollution derived from mining operations.

Air Quality

Compliance with the 1970 Clean Air Act would require an assessment of existing air quality in the vicinity of the project sites a pre-construction ambient air quality monitoring system and preparation of applications for a "Prevention of Significant Deterioration (PSD) Permit" and a "Permit to Construct-Air", regulated by the Alaska Department of Environmental Conservation.

Water Quality and Use

The U.S. Environmental Protection Agency administers the NPDES (National Pollutant Discharge and Elimination System) program under the authority of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. Under this program, EPA regulates point source discharges into a waterway.

The Alaska Department of Environmental Conservation must authorize the discharge of wastewater into or upon all waters or land surface of the state.

A water rights permit is required for use of public water and is authorized by the Alaska Department of Natural Resources.

The Corps of Engineers administers regulations of work such as construction of structures, excavation or fill in "navigable waters of the United States" under Section 10 of the Rivers and Harbors Act.

The Corps of Engineers also regulates, under Section 404 of the Clean Water Act, the discharge of dredged or fill material into U.S. waters, including wetlands.

Solid Waste

DEC administers solid waste disposal permits for proposed methods of operation of a facility to dispose of solid waste.

Fish and Wildlife

The Alaska Department of Fish and Game must approve any proposal to alter the natural flow or bed, or use equipment in rivers, lakes, or streams considered to be important for anadromous fish.

Dam Structure

The Department of Natural Resources (DNR) must approve construction of any dam structure over 10 feet high or that impounds over 5 acre-feet of water.

Tidelands Use

DNR issues temporary permits and permanent tidelands leases for structures or uses of tidelands. A tidelands lease for a permanent structure would be issued under a competitive bid.

Coastal Zone

The Governor's Office of Management and Budget coordinates permitting, public notices, public hearings, and agency review for authorization required within the Alaskan Coastal Zone Management. The proposed plan must be consistent with the State Coastal Zone Management Plan. At this time, there is no local coastal zone plan for the area.

Native Authorizations

A permit to operate and to develop the coal must be acquired from the NANA Regional Corporation.

LAND USE/ACCESS

The Chicago Creek coal field has an interim conveyance by the Bureau of Land Management under the Alaskan Native Claims Settlement Act to the NANA Regional Native Corporation and the village corporation of Deering. Although technically the subsurface resources belong to NANA and the surface to the village, NANA and its villages have a cooperative agreement regarding authorizing uses of the surface and subsurface of native conveyed land. NANA, Kotzebue, and other nearby villages have a strong interest in development of local coal resources and have designated an access route through their property from Chicago Creek to the coast in anticipation of future coal development.

PERMITTING ASSESSMENT

Because most applications for permits require full plans of operation, including much technical data, hydrologic information, engineering designs, reclamation plans, and baseline studies--all of which satisfy the reviewing agencies involved, preparation of applications requires a minimum of 1 to 2 years of planning time. Processing of permits includes public notices and public hearings which can be done concurrently for various permits. Allowing for possible controversial issues that would extend permitting schedule, 18 to 24 months of processing time should be anticipated for receiving all authorizations to proceed.

HISTORY OF THE CHICAGO CREEK COAL MINE

Coal was first discovered on Chicago Creek by gold prospectors in 1902 (Moffitt, 1906). Some development work was done that year, but there was little demand for the coal until the winter of 1904-05 when gold was discovered on the terraces above Candle Creek and the need arose for a source of low-cost heat for steam-thawing of placer ground. The coal mine area was staked in 1905 and the mine began production in 1908.

It was operated during the winter months only and was sealed in the summer, probably to prevent thawing and subsequent instability of the workings. In the summer of 1908 (Henshaw, 1909) the coal was being mined through a 330 foot shaft which was inclined at an angle of 18 to 36 degrees and which reached a depth of about 200 feet. Coal was being extracted at four levels, located at depths of 33, 80, 100, and 144 feet below the shaft house. During the interval between the beginning of operations and their abandonment in 1911, the mine had an estimated total production of about 110,000 tons (Ref?).

PREVIOUS INVESTIGATIONS

U.S. Geological Survey geologists published several reports that dealt with the Seward Peninsula and its gold fields in the 1900,s and some of these, in particular those by Moffit (1906), Henshaw (1909), and Smith and Eakin, (1911), reported on the progress of coal mining in the Chicago Creek area.

Interest in the deposit paled after the mine shut down in 1911, but a later report by the U. S. Bureau of mines (Toenges and Jolley, 1947) proposed a detailed plan for additional development of the deposit to provide coal for home heating for the local villages.

During the late 1970's and early 1980's, the State of Alaska funded several programs to investigate new sources of energy and innovative ways of using traditional fuels in remote regions. One of these studies (R. W. Retherford and Associates, 1980) suggested that coal could be a cost-effective energy alternative for the Kotzebue Sound area.

The Retherford study sparked interest in the coal reserves of the Kotzebue area and in 1982 a state-funded exploration program which included 1700 (?) feet of drilling was undertaken at Chicago Creek by Denali Drilling, Inc. and Stevens Exploration Management Corporation (Manning and Stevens, 1982). In 1983, a continuation of the program by C. C. Hawley and Associates, Inc. included 2,800 feet of drilling (Ramsey and others, 1983).

SCOPE OF THIS STUDY

BASIC ASSUMPTIONS

1. Mine-run coal from the Chicago Creek area will average at least 6500 BTU/lb. (tests to date have yielded an average value of 6987).

2. The electrical demand of Kotzbue and environs will require consumption of an annual mine production of 50,000 tons of coal.

3. The mine and power plant will each have a thirty-year life span.

4. Equipment costs are based on current prices, and all costs are for new rather than used equipment.

5. Existing and commonly used technology are chosen over more innovative methods which have not been proven in northern Alaska.

6. Nana Regional corporation is assumed to be an active participant, thus reducing or negating lands costs and permitting problems.

7. The power plant will be financed through an REA loan or some other existing public utility financing process, the mine, however, is assumed to support a reasonable level of profit for the operating entity.

8. Financing of the capital costs of the mine are assumed to be by the exdee-ex method, at an annual interest rate of 10%.

These assumptions have been chosen to err on the side of conservatism. In some cases new technology or the use of used equipment might result in substantially reduced costs. Comments in the report call attention to these possible savings where they have been identified. Some simplifying assumptions, such as the constant annual production rate, have been made to avoid complicated scenarios based on future trends which are difficult to forecast. These simplifying assumptions were also chosen to yield a conservative result.

MARKET DEMAND

Forecasting market demands for the Kotzebue area, as in the case of most attempts to predict the future, is an inexact proposition. Recent reports by Dames and Moore (1981, 1983), Arctic Slope Technical Services (1982), Arctic Slope Consulting Engineers (1984), and International Engineers, Inc. contain estimates of load growth both for Kotzebue and for nearby villages which might logically be included on a transmission net.

The energy forecasts from these studies are converted to coal tonnages using Chicago Creek coal Btu/lb. figures and summarized in the following tables:

TABLE 1

Coal Required for Electrical Demand (Kotzebue)

	1	2	3	4	5
1983			15,210		
1984				11,405	15,275
1985		36,676		13,361	17,896
1986		37,774		14,149	18,951
1987		39,103		15,155	20,299
1988		40,466		15,982	21,407
1989		41,791		16,835	22,549
1990		43,122		17,718	23,731
1991		44,710		18,632	24,955
1992		46,390		19,577	26,222
1993		48,076		20,556	27,533
1994		49,877			
1995		51,744			
1996		53,706			
1997		55,847			
1998		58,212			
1999		61,014			
2000	9,482	64,271			
2001		69,033			
2002		77,429			
2003					
2008					
2013					

1. Electric Power Generation, Dames and Moore, 1981.

2. Coal-Fired Co-Generation, Arctic Slope Technical Services and Others, 1982.

3. Electric Power Generation, Arctic Slope Engineers, 1984.

4. Electric Power Generation, International Engineering Co., Inc., 1985 (assuming 10,000 Btu/Kwh).

5. Electric Power Generation, International Engineering Co., Inc. 1985 (assuming 25% plant efficiency).

TABLE 2

Coal Required for Electrical Generation
(Kotzebue and Surrounding Villages*)

	1	2
1983		19,667
1988		22,091
1993		24,847
1998		27,988
2000	11,245	
2003		31,566
2008		35,647
2013		40,311

1. Dames and Moore, 1981.

2. Arctic Slope Engineers.

* Includes Kotzebue, Backland, Deering, Kiang, Noorvik, and Selawik

TABLE 3

Coal Required for Direct Heat **
(Kotzebue)

	1	2
1983		16,905
2000	20,343	

1. Dames and Moore, 1981.

2. Arctic Slope Engineers, 1984.

** Includes cooking and hot water energy demands.

TABLE 4

Coal Required for Direct Heat **
(Kotzebue and Surrounding Villages*)

	1	2
1983		24,247
1988		27,238
1993		30,642
1998		24,518
2000	26,492	
2003		38,935
2008		43,975
2013		49,732

1. Dames and Moore, 1981.

2. Arctic Slope Engineers, 1984.

* Includes Kotzebue, Backland, Deering, Kiang, Noorvik, and Selawik
** Includes cooking and hot water energy demands.

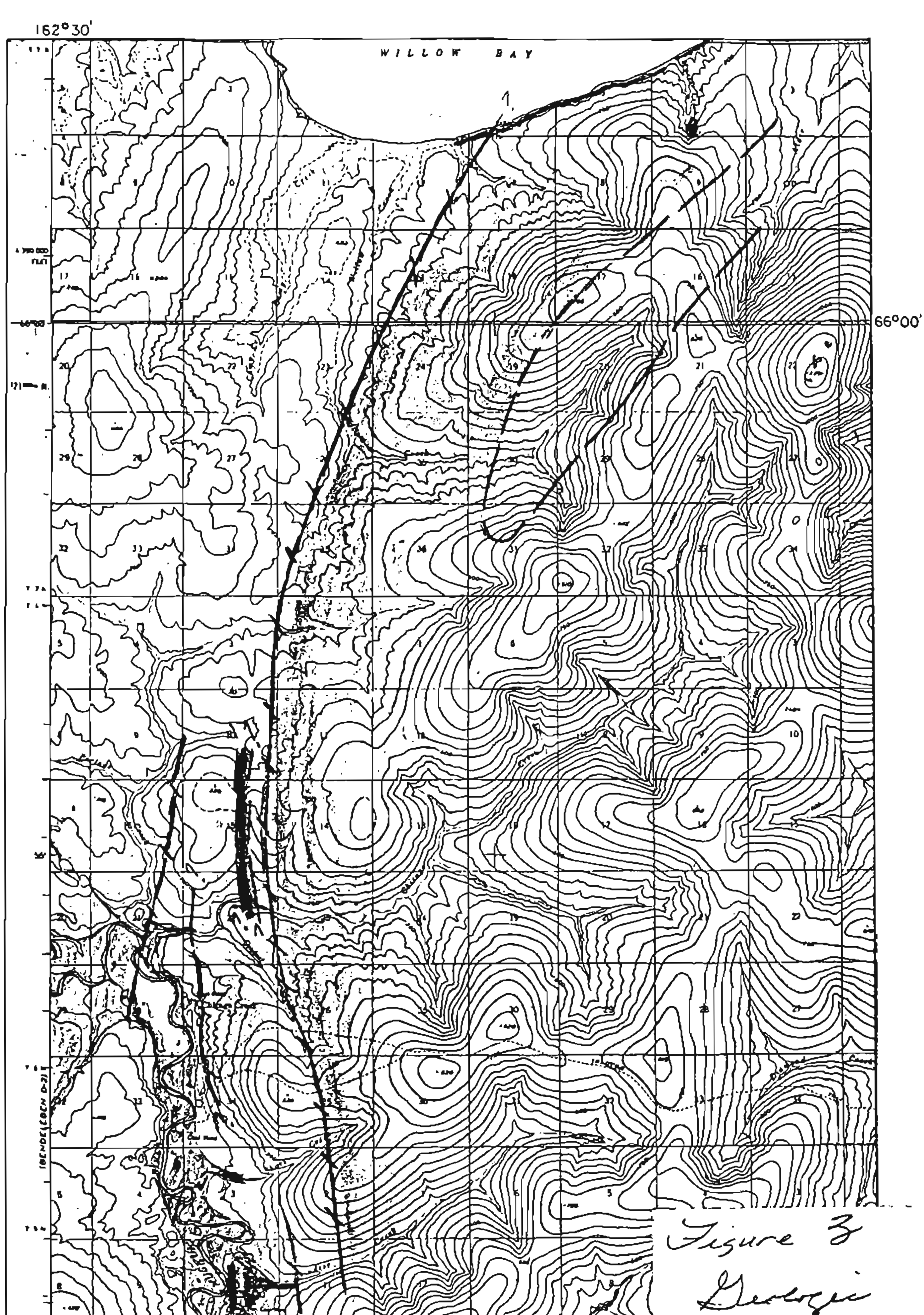
GEOLOGICAL SUMMARY

The Chicago Creek coal deposit consists of one fairly continuous seam striking north-south and dipping 45 degrees west. There is local thickening in the vicinity of Chicago Creek (88 feet true thickness), although average thickness appears to be on the order of 20 to 30 organics and averages 25 feet thick. All drilling done to date suggests that the deposit is open ended both north and south, although tectonic problems exist. Further drilling is planned downdip this summer to confirm coal thickness at depth.

BASIC ASSUMPTIONS

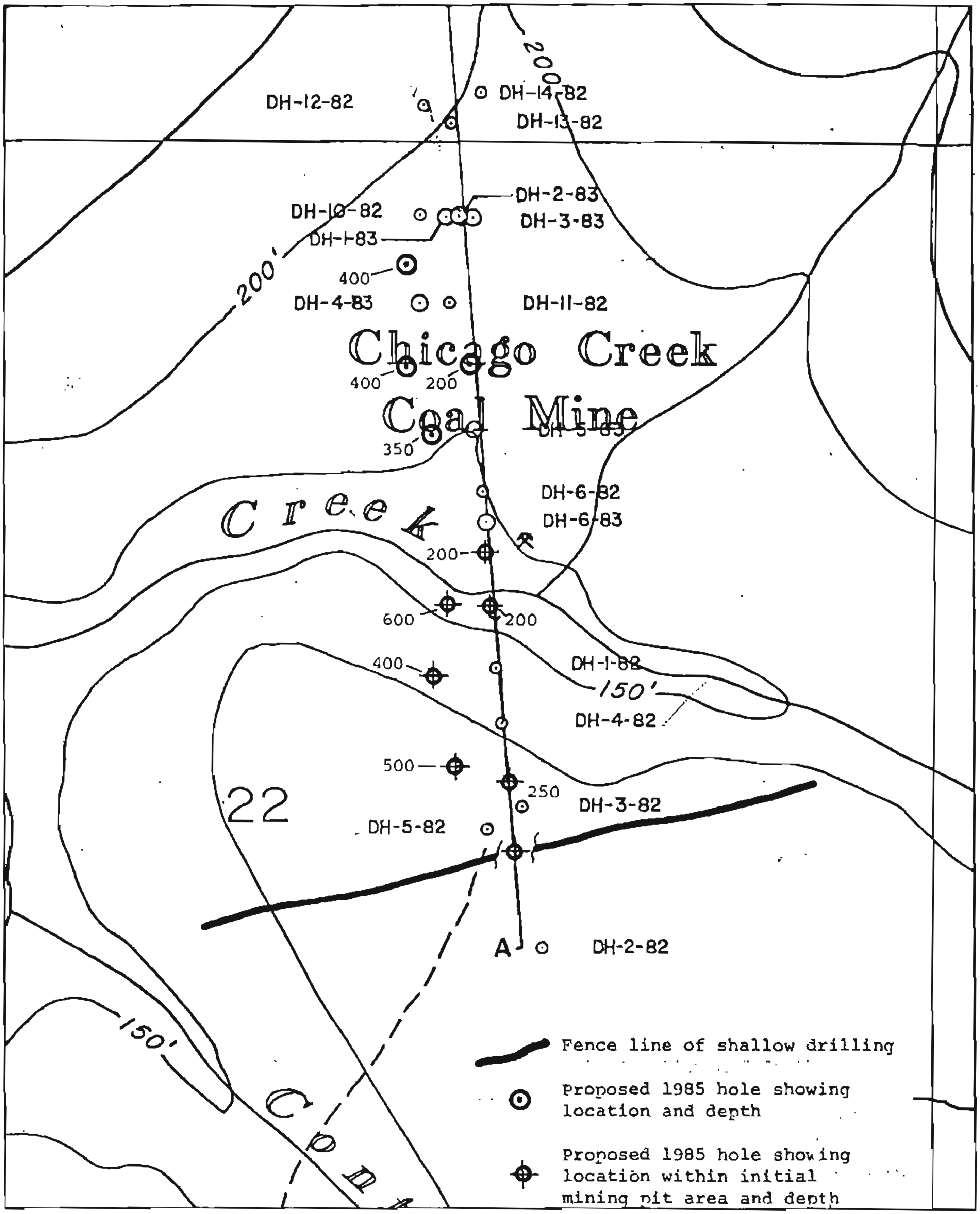
The scenario we are costing out as an option to diesel electrical and electrical/steam cogeneration is as follows. A 10 megawatt electrical, electrical/steam cogeneration plant will be constructed in Kotzebue. Although current demand is on the order of 7 megawatts, a 10 megawatt plant is the smallest "off the shelf" coal plant available and should provide a buffer for anticipated future demand. An open pit coal mine at Chicago Creek will be developed which will supply the plant with the required 50,000 tons per year of coal feedstock over the plant life of 30 years. Coal will be stripped, mined, and hauled by truck 10 miles to Willow Bay where it is then stockpiled. Later it is placed on barges and transported 50 miles across Kotzebue Sound for consumption.

Qa
Gb
Tc
Pzs
Pzcs
Pzc
Pzg



Base map from U.S.G.S. Alaska: Bendeleben D-1, Kotzebue A-1.

Figure 3
Geologic Summary



PROPOSED 1985 DRILLING, CHICAGO CREEK

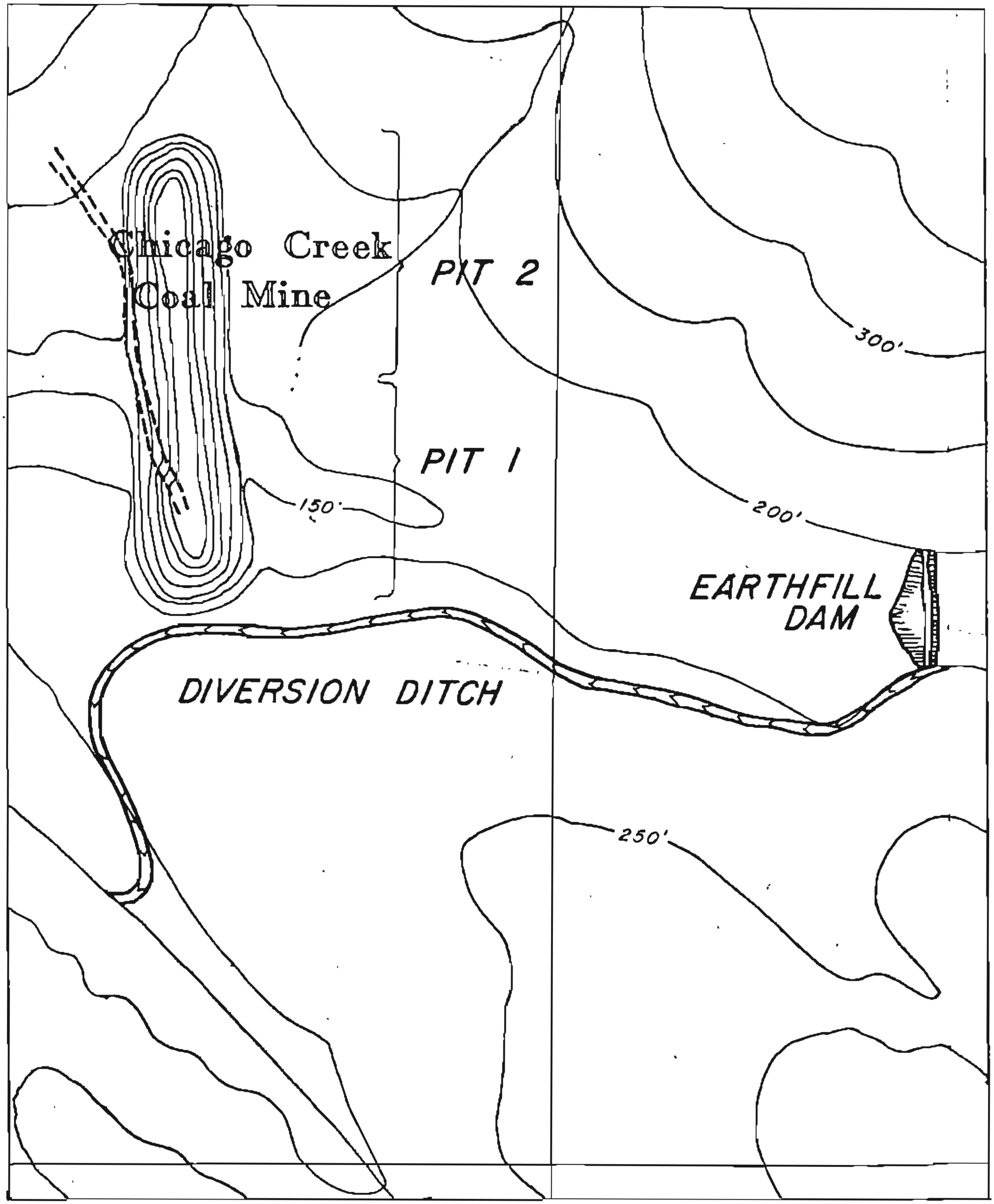
SCALE: 1" = 500'

All expense data developed, as well as all developmental and capital costs, are expressed in current 1985 dollars. Costs are assumed to be "out of pocket", and the cost of capital is not addressed.

PIT DESIGN

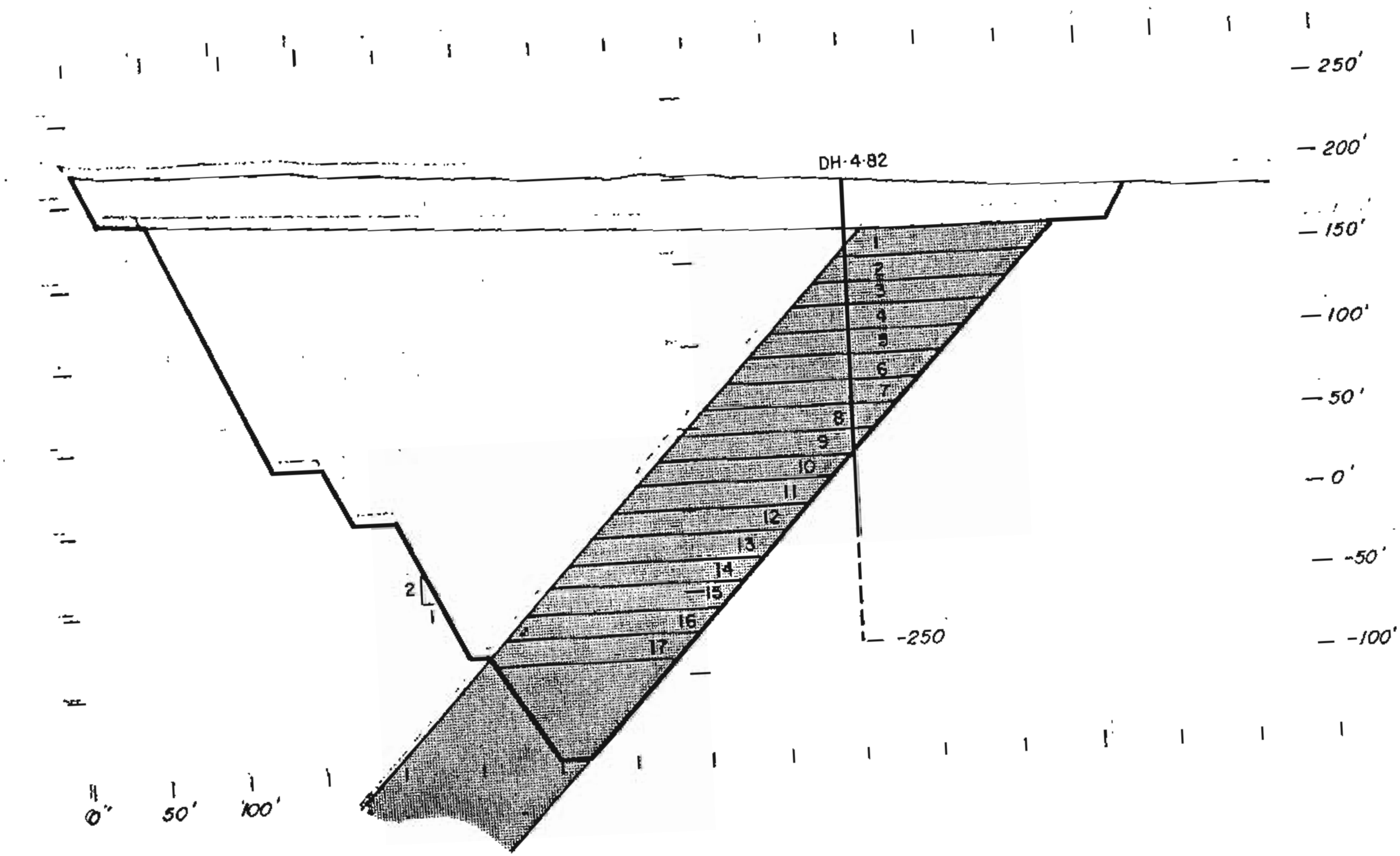
Mining sequence will proceed from south to north, the initial open pit being at the southern end of the drill reserves near Chicago Creek at a significantly thickened section where underground mining operation took place early this century. (Pit limits along strike and nomenclature used are as presented in an earlier report (C. C. Hawley, ______). Refer to Table 2 for pit data summary.) Chicago Creek is to be permanently re-routed to the south beyond the edge of operations and overburden from Segment I pit is to be placed on the bench immediately adjacent to the southwest. As this pit approaches exhaustion, stripping will begin on Segment II pit adjacent to the north, overburden being placed in the mined out portion. This sequence is to be followed for the remainder of the mine life.

Admittedly, little is known about the potential pit slope stabilities; drilling to date indicates wall rock to be reasonably competent. Coal and wall rock alike appear to be permanently frozen, suggesting slopes should remain reasonably stable and little, if any, ground water will be encountered. Therefore, the pit highwall has been designed at 1/2 to 1 which was utilized at the Healy and Chickaloon coal operations. Ultimate pit depths of 275 feet below the surface are planned for

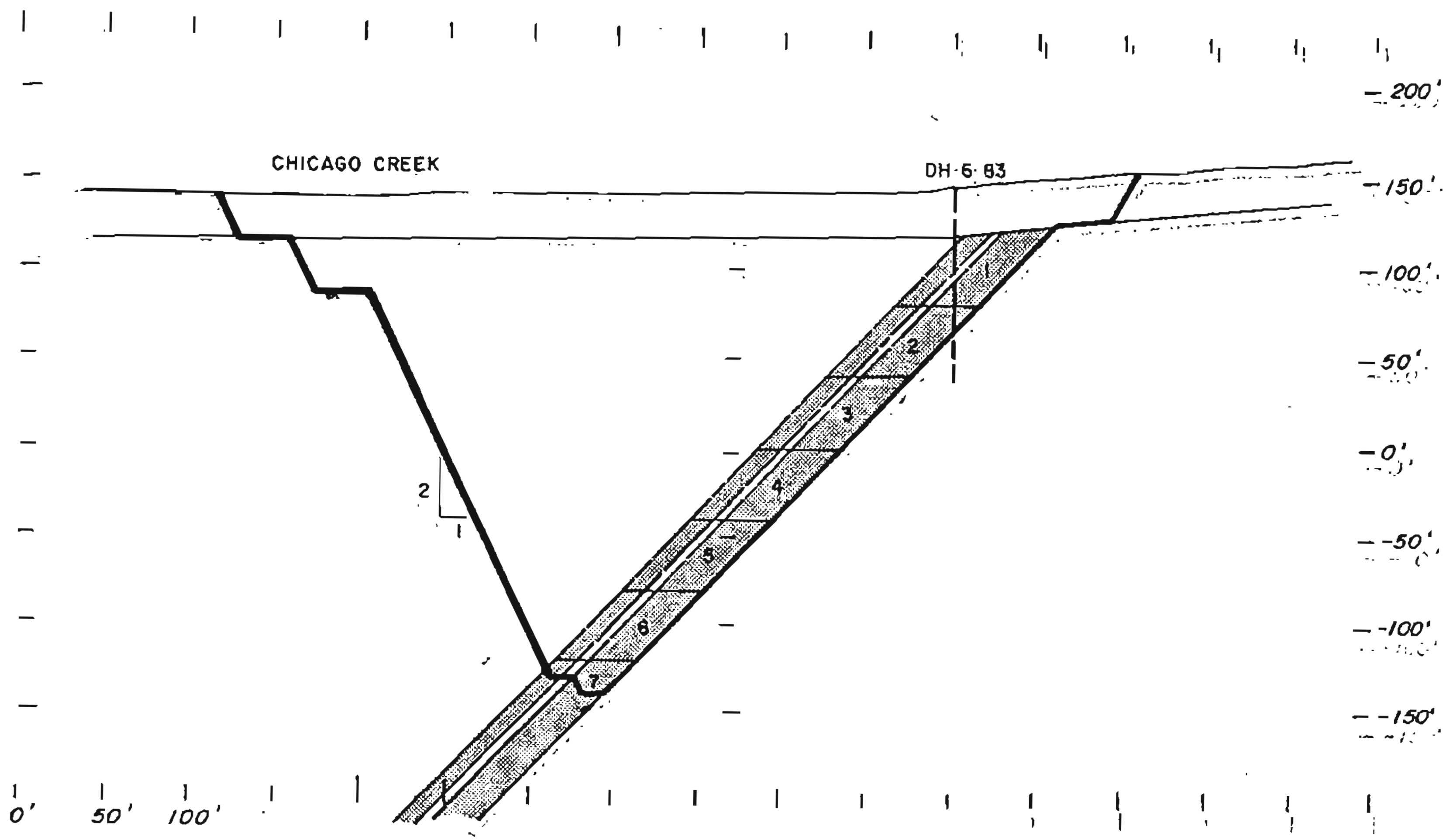


OPEN PIT AND DIVERSION DAM DETAIL

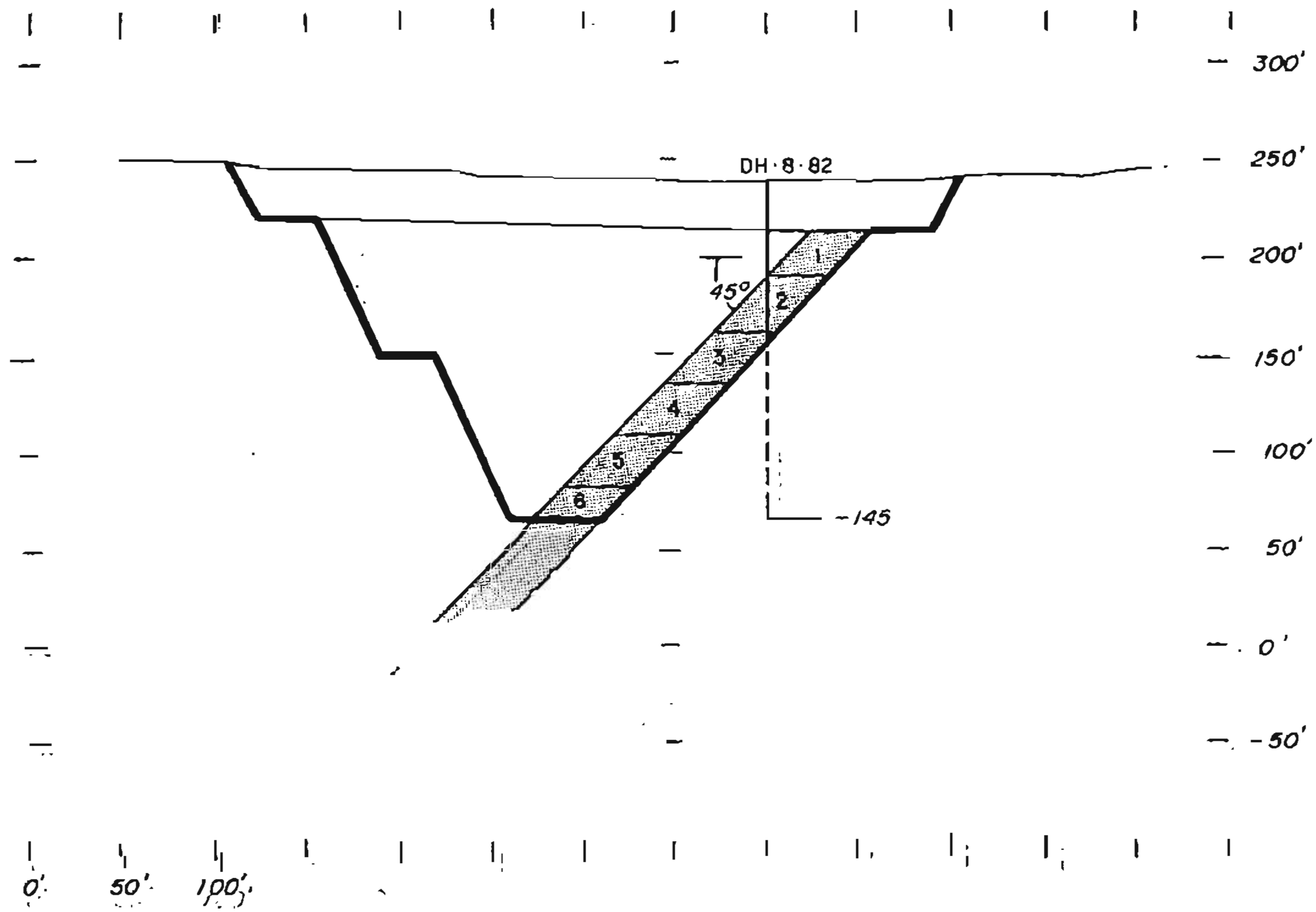
Scale 1" = 700'



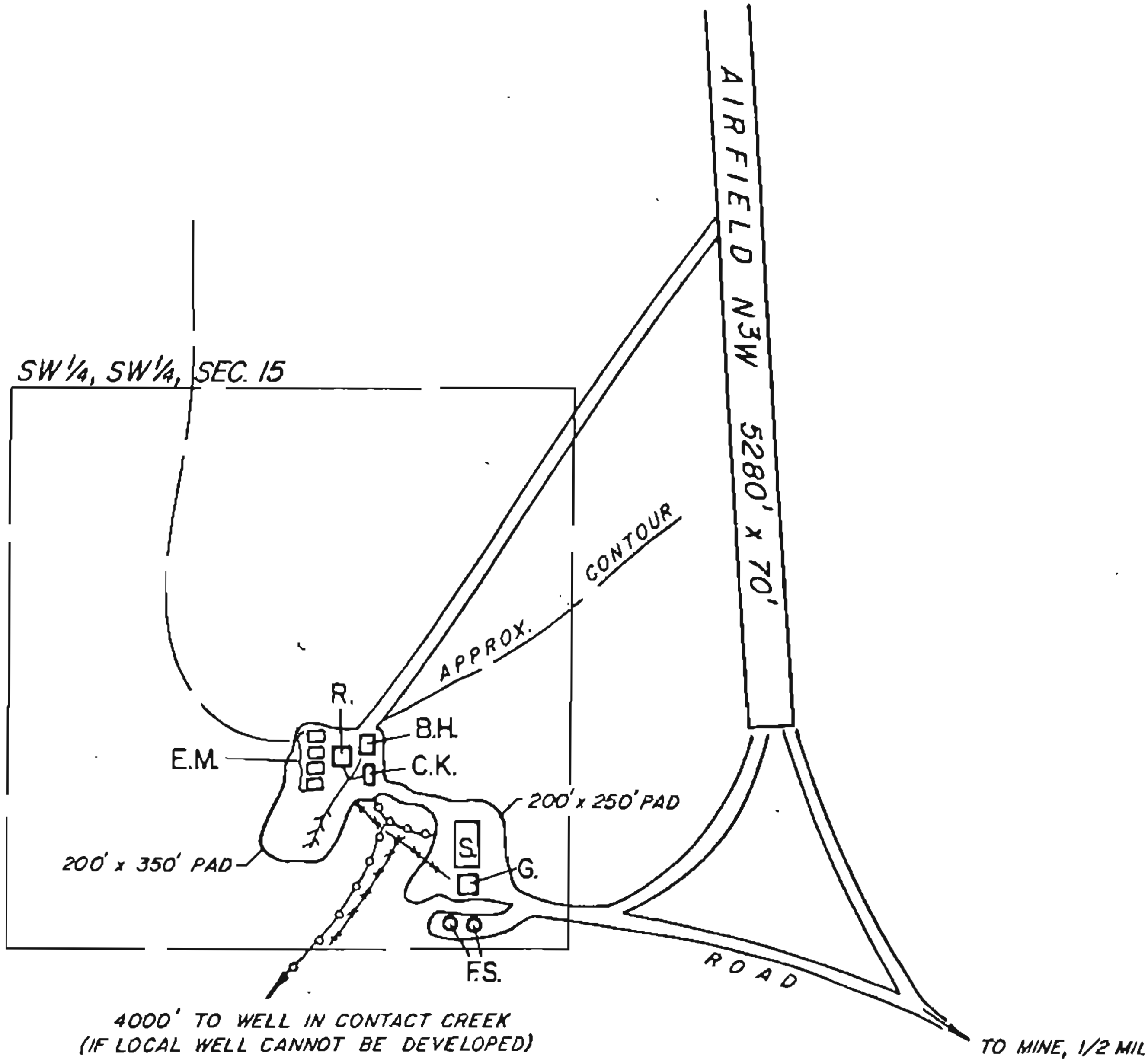
TYPICAL SECTION - SEGMENT I
SECTION A-A'



TYPICAL SECTION — SEGMENT II
SECTION A-A'



TYPICAL SECTION – SEGMENT IV
SECTION A-A'



EXPLANATION

F.S. – Fuel Storage
S. – Shop (6000 sf) and Warehouse/Office (4000 sf)
B.H. – Bunkhouse (2500 sf)
C.K. – Cafeteria-Kitchen (1500 sf)
R. – Recreation (1000 sf)
F.M. – Future Employee Modules
G. – Power Supply

Gravel Pad
Electric Distribution
Water Supply
Drainfield

SKETCH OF PROPOSED CAMP FACILITIES

Scale: 1" ≐ 400'

Segment I and II pits, 170 feet for Segment IV pit.

For many years, if slope failure is to occur, it will probably be along or behind the footwall of the seam. Stripping no more than two years in advance allows: (1) the toe of the seam to be butressed and (2) if massive sudden slope failure does occur, it will only destroy a maximum of two years' supply of stripped coal. In a typical year, ample time remains in August and September for remedial slope repairs should they become necessary (see Operations section).

Access into Segment I pit will be gained by cutting an access slot to the west and building a haul road at a -15% grade into the pit highwall (see Appendix B for typical pit sections). Segment II and IV pits have long enough strike lengths to allow for haul roads along the highwall and through earlier pits without having to cut specific access slots of any magnitude.

No pit is currently planned for the Segment III area; drill data suggests that the seam is discontinuous and perhaps faulted in this area. Should further drilling activities firm up economic reserves in this area, Segment III could be mined as well as, or instead of, Segment IV.

DEVELOPMENT ACTIVITIES -- CAMP AND HAUL ROAD

Development of the mine will require a camp, all-weather airstrip, and suitable haul road built prior to the onset of production (Figure 1). Haul road and camp construction will take place over a 2-year period. Heavy equipment, fuel, and temporary camp facilities will be delivered to Willow Bay in the fall. The next spring, the spring of Year 1 in Figure 1, before breakup, the equipment and camp will be moved crosscountry to the campsite. Airstrip and haul road construction will take place the first summer primarily utilizing gravels removed from the nearby Kugarok River bars and floodplains and the equipment which will be later used to strip and mine coal. The road will be about 10 miles long and will basically be a gravel overlay averaging 35 feet wide and 5 feet thick. About 350,000 cubic yards of gravel will be required. A straight section somewhat wider than the rest will be built near the camp and serve as an airstrip. Pads will also be constructed for shop-generator-fuel storage, bunkhouse area, and a pad suitable for a coal stockpile will be laid at the turminus of the road at Willow Bay. Approximately 115,000 additional yards of gravel will be needed for these purposes (Table 1). (A total gravel resource base of 500,000 yards is assumed for construction.) Because a majority of the annual heavy hauling will take place while the roadbed is essentially frozen in April, this road will not be built as "heavy duty" as otherwise required. Five months will be required to build this road.

Table 2 presents a detailed breakdown of developmental costs. Prior to haul road and camp construction, planning and engineering and environmental baseline studies need to be undertaken. Temporary camp costs need to be taken into account until the permanent camp is completed, the end of the second year. Finally, a contingency factor of 15% is added due to the scarcity of data available on existing site conditions.

Both initial and annual permanent camp costs are addressed in Table 4. A permanent camp with complete facilities for 25 men, as well as a modern shop, is to be constructed. Construction materials, as well as permanent fuel storage tanks, are to be delivered to Willow Bay during the fall of this first year. Inasmuch as many construction materials will be delivered in containers, excess containers can be used as temporary storage and possibly metal containers can be incorporated in some project items. The initial camp has diesel generators, with paired 150 KW and 50 KW units to be used, respectively, during working and standby periods. Waste heat from the units would largely beat the insulated 60′ X 140′ shop/warehouse. In future years, depending on diesel cost, a small coal system could be installed for prime power. During the next spring and summer (Year 2), the permanent camp is to be constructed, concurrent with the onset of coal stripping activities. Full occupancy is planned for the start of Year 3.

OPERATIONAL ACTIVITIES -- STRIPPING AND MINING

The short working season, relatively small demand, small proven reserves, remote location, and transportation methods required to deliver the coal to the plant site tend to make the operational aspects of the Chicago Creek Mine unique. Stripping and mining activities will be kept to the spring and summer months in order to take advantage of the long hours of daylight and warm weather to minimize equipment maintenance. Operations begin in early April when 50,000 tons of coal (one year's demand) which was stripped the previous season is mined and hauled to Willow Bay and stockpiled. This mining and hauling will take one month. The crews then begin on that year's stripping operation, which will continue for an average of 3 to 4 months, depending on the current depth of pit. Stripping operations will be completed and the mine completely shut down by September 1.

A summary of proposed mining and stripping operations are presented in Table 5. Stripping is so scheduled that at least one year's coal supply, but no more than two (see pit design discussion) is exposed before the summer's stripping is complete. Coal mining in April allows hauling to take place prior to breakup, allowing hauling on a frozen road base, minimizing maintenance and operating construction costs. Due to the low stripping ratio in Segment I pit, there will be years when no stripping activities will take place.

Equipment Section

Several unique problems manifest themselves in equipment selected for the project. Equipment yearly use time is low--averaging 1,000 hours annually. Volume to be moved is also small--totally 6,165,351 cubic yards of overburden and 1,500,000 tons of coal over 30 years, or 205,510 cubic yards and 50,000 tons annually. Due to the remoteness of the location, excessive equipment downtime would have a significant negative impact on production and expenses, much more so than if the location were less remote. Therefore, new equipment, rather than good used or new used equipment, has been specified for the project. This equipment suite is time proven in Alaskan conditions in places such as Healy and the North Slope. A complete listing of equipment and associated costs is in Table 6.

As earlier stated, little is known about the competency of the wallrock. Therefore, stripping is costed out assuming the rock is to be both drilled and blasted and further ripped and/or ripped and pushed prior to loading. Drilling and blasting will be accomplished by a rotary drill and truck utilizing ammonium nitrate powder, while ripping and/or ripping/pushing will utilize D-9L dozers. A Cat 245 backhoe with a Cat 988 loader standby will load, and four International 350 all-wheel drive payhaulers with an extra one for standby will haul the coal and waste. The dumpsite will be policed by either a D-9 or D-7. All of this equipment is off-the-shelf production line equipment with long successful record of use in similar arctic environments and is readily operable by the local labor force. The 350 Payhaulers will come equipped with both 50-ton coal boxes and 21 cubic yard rock boxes, so they can haul both coal to Willow Bay in the spring and then switch over to rock hauling for stripping operations.

A 10-year life is planned for all equipment. This corresponds to about 10,000 total hours (or 1,000 hours average per year), which falls well within manufacturer's recommendations for this type of usage. We have assumed the equipment would be replaced twice with an equivalent equipment spread. However, by the end of 10 years, both the general characteristics of the operation will be well worked out and additional details of the deposit will be proven through exploration drilling. If necessary, new types of equipment reflecting advanced technology or a change in mining plans or sequence or production rate can be conveniently brought into the operation at this time. In other words, there is built in flexibility, rather than planning a 30-year operation around a single expensive piece of equipment such as a large dragline.

Labor

Table 8 summarizes the annual labor cost and crew size as expected. A fully burdened wage rate of $35/hour is used in the analyses and includes all overtime and employer's contributions. It is felt that the superintendent/engineer, foreman, and shop foreman are key people to the field operation and should be paid year-round to insure their availability. They could be of limited use in the Kotzebue office in the winter. A winter caretaker should be employed in an attempt to prevent possible vandalism. A year-round home office staff of four is detailed. Although all of the hourly employees will probably be local hire (Kotzebue or vicinity), it is very likely that several of the initial salaried and year-round crew will need to be brought in from outside the immediate area, prior to training of local people for salaried jobs. Care should be taken to see that their salaries are high enough to insure that they remain long enough to successfully train a resident staff.

SUMMARY OF COSTS

The average annual costs developed in this study are summarized in Table 9. This shows that the average annual cost to strip and haul 50,000 tons of coal to stockpile at Willow Bay, with no provision for royalties or taxes, to be $2,446,000 or $48.92 per ton.

SENSITIVITY/IMPACT

Although a mine life of 30 years is planned, available data suggests additional coal resources are present at similar stripping ratios should the mine life be extended or yearly production increased. The operation costed out in this report could strip and mine at least 50% more coal at similar stripping ratios before a change in the operation would be required.

A shallowing of the anticipated highwall slope of 1/2:1 or footwall tectonic problems will adversely impact stripping ratios and subsequent mining costs.

TABLE 1

Gravel Needs for Road, Airfield, Camp, and Pad Construction

	Approximate Thousand Cubic Yards3
1. Road	
A. 10 Miles X 35 Feet X 5 Feet	350
2. Other	
A. Extra Material for Airstrip (35′ X 5,280′ X 5′)	34
B. Shop/Generator/Fuel Storage Pad (200′ X 250′ X 10′)	19
C. Bunkhouse/Cafeteria/Recreation/Housing/ Drain Field Pad: (200′ X 350′ X 10′)	26
D. Camp Road Complex (35′ X 3,000′ X 5′)	19
E. Willow Bay Load-out Pad	15
Subtotal	113 = 115
Approximate Total	485 = 500

TABLE 2

Pit Data Summary

	Segment I Pit	Segment II Pit	Segment IV Pit
Coal Thickness	88′	20′	28′
Dip	45o	45o	45o
Depth of Overburden	25′	25′	25′
Total Vertical Depth	275′	275′	170′
Length	700′	1100′	1200′
Stripping Volume	2,154,466 cy	2,628,241 cy	1,382,644 cy
Coal Volume	885,950 T	326,900 T	304,800 T
Years to be Mined	17.7	6.5	6.1
Stripping Ratio	2.4:1	8.0:1	4.1:1

TABLE 3

Developmental Costs

Road & Airstrip Construction, 1st Year (5 Months):		
Field Labor	$ 750,000 X 1.40 =	$1,050,000
Equipment Cost	1,000,000 X 1.40 =	1,400,000
Home Office & Salaries	260,000 X 1.40 =	260,000
Air Transportation	50,000 X 1.40 =	50,000
Culverts & Bridges	100,000 X 1.40 =	140,000
Temporary Camp Costs	150,000 X 1.40 =	150,000
Water Supply System	100,000 X 1.40 =	100,000
Drain Fields	150,000 X 1.40 =	150,000
		3,300,000
15% Contingency		495,000
		3,795,000
Temporary Camp Costs, 2nd Year		150,000
		3,945,000
Environmental Baseline Studies	$100,000	
Planning & Engineering	250,000	350,000
TOTAL DEVELOPMENTAL COST		$4,295,000

ANNUALIZED DEVELOPMENT COST = $4,295,000/30 = $143,667

TABLE 4

Permanent Camp Costs

Initial Costs:

Cafeteria/Bunkhouse Facilities (25 People)					
Bunkhouse	2,500 SF				
Cafeteria & Kitchen	1,500 SF				
Recreation	1,000 SF				
Shower	750 SF				
	5,750 SF	@ $ 85/SF		=	$ 488,750
Shop/Warehouse/Office					
Warehouse/Office	4,000 SF	@ $ 60/SF =	600,000		
Shop (3 Bay, 60′ X 100′)	6,000 SF	@ $120/SF =	720,000	=	960,000
Utilities					
Generator (2 - 150 KW); Smith Gear (2 - 50 KW)			150,000		
Transmission System			50,000		
Water Hookup			50,000		
Sewer Hookup			50,000	=	300,000
Fuel Tanks (Bladder)	125,000 GAL	@ $60/GAL		=	75,000
TOTAL INITIAL COST					$1,823,750
COST/YEAR FOR 30-YEAR LIFE					$ 60,792

Annual Costs:

Supplies (Food)	$20/Man-Day X 20 Men X 150 Days			$ 60,000
Electrical Generation				
Fuel	1. 15.0 Gal/Hr X 12 Hrs/Day X 150 Days X $1.25/Gal	33,750		
	2.5 Gal/Hr X 12 Hrs/Day X 150 Days X $1.25/Gal	5,625		
	2. 2.5 Gal/Hr X 24 Hrs/Day X 215 Days X $1.25/Gal	16,125		
		55,500		
Maintenance		27,750		
Reserve to Replace @ 10 Years		15,000	= 98,250	
Miscellaneous Maintenance				50,000
TOTAL ANNUAL COST				$ 208,250
+ 15% CONTINGENCY				31,240

	239,490
	60,792
TOTAL ANNUALIZED INITIAL COST + ANNUAL COST	$ 300,282

TABLE 5

Mining and Stripping Summary

Year	Months Operational	Coal Production (tons)	Pit	Stripping (cy)
1	5	BUILDING HAUL ROAD		
2	4			312,000
3	5	50,000	I	312,000
4	5	50,000	I	312,000
5	5	50,000	I	312,000
6	4	50,000	I	234,000
7	1	50,000	I	---
8	4	50,000	I	234,000
9	1	50,000	I	---
10	4	50,000	I	234,000
11	1	50,000	I	---
12	3	50,000	I	156,000
13	1	50,000	I	---
14	1	50,000	I	---
15	4	50,000	I	Coal Stockpile
16	4	50,000	I	234,000
17	5	50,000	I	312,000
18	5	50,000	I	312,000
19	5	50,000	I	312,000
20	5	35,950	I	
		14,150	II	312,000
21	5	50,000	II	312,000
22	5	50,000	II	312,000
23	4	50,000	II	234,000
24	4	50,000	II	234,000
25	5	50,000	II	312,000
26	5	50,000	II	312,000
27	4	12,750	II	
		37,250	IV	234,000
28	4	50,000	IV	234,000
29	3	50,000	IV	156,000
30	3	50,000	IV	156,000
31	2	50,000	IV	78,000
32	1	50,000	IV	

TABLE 6

Equipment Ownership & Operating Costs

	Purchase Price 1/	Cost/Hour 2/	Cost/Year 2/
350 Payhaulers			
4 - Operating	$1,467,720	$323.28	$323,280
1 - Standby	366,930	36.69	36,690
Cat 245 Backhoe	510,850	91.90	91,900
Cat D-9L (2 EA)	958,502	217.24	217,240
Cat D-7	217,350	54.00	54,000
Cat 16G Blade	296,100	55.74	55,740
Cat 988 Standby	90,000	9.00	9,000
Rotary Drill	269,000	60.00	30,000
Anfo Truck	55,000	15.00	7,500
Coal Drill	20,000		2,500
Lube-Welder Truck	88,000		10,000
Boom Truck	84,500		10,000
Fuel Truck	30,000		5,000
Lowboy	60,000		10,000
Pickups (4 EA)	60,000		14,000
Suburban (1 EA)	20,000		4,000
Miscellaneous Equipment	20,000		20,000
Shop Equipment	150,000		1,500
TOTAL YEARLY EQUIPMENT COST			$915,850

1/ FOB Willow Bay

2/ Does not include operators' wages, interest, taxes, or insurance, based on 1,000 hours per year.

TABLE 7

Powder Costs

Purchase @ Seattle	$.15/Lb.	
Freight to Willow Bay	.21/Lb.	
	$.36/Lb.	or $36.00/100 Lb.
Add 1 GAL Diesel @ $1.25/GAL		1.25
		$37.25/100 Lb.

At a power factor of 1, this yields $.37/cy

Yearly Cost = $.37/cy X 6,165,351 cy = $205,512 = $76,039

TABLE 8

Yearly Labor Costs

Summer Field Labor:

*	1	- Superintendent/Engineer
*	1	- Mining/Stripping Foreman
	4	- Truck Drivers
	4	- Operators
	1	- Laborer
*	1	- Shop Foreman
	2	- Mechanics
	1	- Cook
	2	- Cook Helpers/Bullcooks
	17	- TOTAL

17 X 1,000 Hrs Each X $35/Hr Avg	$595,000	
* Winter Salaries (3 X $4,500/Mo X 7 Mos)	94,500	
Winter Caretaker (1 X $1,500/Mo X 7 Mos)	10,500	
TOTAL MINE LABOR COSTS		$700,000
Home Office in Kotzebue (w/benefits):		
1 - Secretary/Receptionist	$30,000/Yr	
1 - Accountant	60,000/Yr	
1 - General Manager	80,000/Yr	
1 - Expediter	40,000/Yr	
TOTAL HOME OFFICE COST		$210,000/Yr

TOTAL ANNUAL HOME OFFICE + MINE LABOR COST = $910,000

TABLE 9

Summary of
Average Annual Costs for Chicago Creek Mine

	Rounded To Nearest Thousand
Developmental Cost	$ 144,000
Camp Cost	300,000
Mine Labor Cost	700,000
Home Office Labor Cost	210,000
Equipment Ownership & Operating Cost	916,000
Powder Cost	76,000
Air Transportation	50,000
Home Office Rent & Utilities	50,000
TOTAL ANNUAL COST	$2,446,000

ANNUAL COST PER TON OF COAL MINED = $2,446,000 / 50,000 TONS
= $48.92/TON

APPENDIX A

Volume Calculations

For each segment pit, typical cross-section refer to Figures ___, ___, and ___. Calculations are based on simple geometric shapes obtained therefrom.

I. Segment I Pit

True Coal Thickness = 88′
Dip = 45 Degrees
Horizontal Coal Thickness = 122′
Overburden Thickness = 25′
Vertical Depth of Coal Mined = 250′
Length of Pit = 700′

$$\text{Coal Volume} = \frac{[122' \text{ Wide X } 250' \text{ Deep} + (122 + 23)\ 12 \text{ X } 65] \text{ X } 80 \text{ Lb/CF X } 700' \text{Long}}{2{,}000\ \#/\text{Ton}}$$

= 985,950 Tons

Less 100,000 Tons Previously Mined Underground
= 885,950 Tons

Years Reserves @ 50,000 TPY = 17.7 Years

Stripping Volume:

Overburden 645′ Wide X 25′ Deep X 760′ Long / 27 = 453,889 CY

Access Slot:

88′ Wide (Avg.) X 25′ Deep X 333′ Long / 27 = 27,133 CY

Rock:

$$\frac{\frac{456 + 250}{2} \text{ X } 145' + \frac{220 + 170}{2} + 36 + \frac{136 + 15}{2}}{27} \text{ X } 84 \text{ X } 700' = 1{,}673{,}444 \text{ CY}$$

TOTAL STRIPPING 2,154,466 CY

Vertical Face Feet of Coal Required to Produce 1 Year′s Coal Supply:

$$50{,}000 \text{ T} = \frac{122' \text{ Wide X } 700' \text{ Long X D Depth X } 800\ \#/\text{CF}}{2{,}000\ \#/\text{Ton}}$$

D = 14.6 Feet

Pit Stripping Ratio = 2,154,466 CY / 885,950 T = 2.4:1

II. Segment II Pit

True Coal Thickness = 20′
Dip = 45 Degrees
Horizontal Coal Thickness = 28′
Overburden Thickness = 25′
Vertical Depth of Coal Mined = 250′
Length of Pit = 1,100′

$$\text{Coal Volume} = \frac{[28' \text{ Wide X } 250' \text{ Deep} + (28 + 15)\ 2 \text{ X } 20] \text{ X } 80 \text{ Lb/CF X } 1{,}100' \text{ Long}}{2{,}000\ \#/\text{Ton}}$$

= 326,900 Tons

Years Reserves @ 50,000 TPY = 6.5 Years

Stripping Volume:

Overburden 530′ Wide X 25′ Deep X 1,130′ Long / 27 = 554,537 CY

Rock:

$$\frac{\frac{420 + 370}{2} \text{ X } 30' + \frac{340 + 15}{2} \text{ X } 220}{27} \text{ X } 1{,}100' = 2{,}073{,}704 \text{ CY}$$

TOTAL STRIPPING 2,628,241 CY

Vertical Face Feet of Coal Required to Produce 1 Year′s Coal Supply:

$$50{,}000 \text{ T} = \frac{28' \text{ Wide X } 1{,}100' \text{ Long X D Depth X } 800\ \#/\text{CF}}{2{,}000\ \#/\text{Ton}}$$

D = 40.6 Feet

Pit Stripping Ratio = 2,628,241 CY / 326,900 T = 8.0:1

III. Segment IV Pit

True Coal Thickness = 28'
Dip = 45 Degrees
Horizontal Coal Thickness = 40'
Overburden Thickness = 25'
Vertical Depth of Coal Mined = 145'
Length of Pit = 1,200'

$$\text{Coal Volume} = \frac{[40' \text{ Wide X } 145' \text{ Deep} + (40 + 15)\ 12 \text{ X } 20] \text{ X } 80 \text{ Lb/CF X } 1{,}200' \text{Long}}{2{,}000\ \#/\text{Ton}}$$

= 304,800 Tons

Years Reserves @ 50,000 TPY = 6.1 Years

Stripping Volume:

Overburden 380' Wide X 25' Deep X 1,200' Long / 27 = 427,222 CY

Rock:

$$\frac{\frac{268 + 168}{2} \text{ X } 70' + \frac{138 + 15}{2} \text{ X } 83}{27} \text{ X } 1{,}200' = 960{,}422 \text{ CY}$$

TOTAL STRIPPING 1,382,644 CY

Vertical Face Feet of Coal Required to Produce 1 Year's Coal Supply:

$$50{,}000 \text{ T} = \frac{40' \text{ Wide X } 1{,}200' \text{ Long X D Depth X } 800\ \#/\text{CF}}{2{,}000\ \#/\text{Ton}}$$

D = 26.0 Feet

Pit Stripping Ratio = 1,382,644 CY / 304,800 T = 4:5:1

SUMMARY OF SEGMENT I, II, & IV PITS

	Stripping	Coal
Segment I Pit	2,154,466	885,950
Segment II Pit	2,628,241	326,900
Segment IV Pit	1,382,644	304,800
	6,165,351 CY	1,517,650 T

Stripping Ratio of 6,165,351 / 1,517,650 = 4.06:1

GEOTECHNICAL CONSIDERATIONS

This report addresses geotechnical considerations relating to the proposed Chicago Creek Coal Mine development. The aspects of this development that are subject to the influence of geotechnical factors include design and construction of the open pit mine, camp airstrip and haul road, an earthfill dam diversion structure for Chicago Creek, and the coal handling facilities at Willow Bay.

Open Pit Mine

The open pit mine is currently conceived as having a highwall slope of 1/2(H) to 1(V), with intermediate benches 15 to 30 feet wide. The footwall slope will be 45 degrees (the dip of the coal seam) unless slope failures cause it to become flatter.

Very little is known of the engineering characteristics of the soil and rock strata that will be exposed in the mining operation. What is known is qualitative in nature and may be summarized as follows.

Within the depths of interest, the soil and rock is permanently frozen, except for the active layer which is probably on the order of five feet thick in this area. The overburden averages about 25 feet in thickness and consists primarily of ice-rich silt and organics with occasional ice wedges. The underlying rock includes coal, lignite, shale, siltstone, claystone, and schist. The condition of the rock appears to vary from poorly cemented and/or weathered to intact.

The overburden soils will be unstable when thawed. However, the height of slopes in this material (about 25 feet) are such that the slopes may be self-healing or, at the worst, may require minor maintenance.

The stability of slopes in the rock is more difficult to assess. Poorly cemented, soil-like, rock might require much flatter slopes than planned to be stable when thawed. However, the thawing process will take place gradually so that, if slides occur, they will be in the form of shallow sloughing rather than deep-seated, massive slope failures. The thawing and sloughing process in such very weak rock could result in a retreat of the slope face on the order of five to ten feet per year.

The dip of the rock beds probably precludes any massive slope instability of the highwall, unless there are other major discontinuities that dip to the east. On the other hand, the bedding planes are unfavorably oriented with respect to stability of the footwall. In this case, sliding may occur if and when thawing reaches a weak discontinuity. However, unless sloughing or slides occur, the freeze-thaw cycle will only penetrate a limited distance into the slope. This phenomenon is equivalent to the surface active layer and should be limited to a distance of ten feet or less into the slope.

In summary, it appears that the planned highwall and footwall slopes are realistic. Even if the rock is very weak, the permafrost condition will limit the extent of slides that can occur at any one time. The amount of slide debris that is likely to be generated under these conditions should not significantly interfere with coal production.

Haul Road, Airstrip, and Gravel Pads

The haul road, airstrip, and pads will consist of 5-foot thick gravel fill. Source material for construction of these fills may be gravel from the Kugarok River bars and floodplains or crushed rock from nearby outcrops, or both. At this time, the volume of fill material available from rock outcrops has not been evaluated, nor has the relative economics of using river gravel versus crushed rock.

Summer construction is planned for these facilities. Depending upon the material source(s) used, whether the material is frozen or unfrozen and the mining plan, ripping and/or blasting may be required to obtain the necessary fill quantities. If river gravels are used, it may be possible to excavate some or all of the fill material by stripping relatively large areas to shallow depths. On the other hand, mining relatively confined areas to greater depths will probably require blasting and backhoe excavation. Rock outcrops may be rippable if the rock is poorly cemented or highly weathered; if not, blasting will be required. A more detailed investigation is required to evaluate the relative economics of the various potential fill material sources and develop a mining plan.

If unfrozen gravel or rock is available in sufficient quantities, it will be possible to construct compacted fills that will remain stable and require relatively little maintenance thereafter. However, if the fill material contains ice, compaction efforts will be largely ineffective. In this case, the fills will have to be regraded and recompacted after the ice melts. This process will occur throughout the construction season and during the following summer.

The 5-foot fill thickness will reduce, but not prevent, future thawing of the underlying in situ soil. However, for their intended use, these fills should function adequately with some maintenance. After one or two freeze-thaw cycles, the fills and the underlying in situ soils within the active zone should become quite stable. The long-term performance of the fills can be enhanced by minimizing disturbance to the surrounding tundra and maintaining good surface drainage.

Coal Handling Facilities at Willow Bay

The coal handling facilities at Willow Bay will include a gravel pad for stockpiling coal, a conveyor system, and a barge dock. The gravel pad will be constructed in the same manner as described in the preceding section, with additional provisions for the collection and treatment of runoff water and leachate from the stockpile.

Piles will be installed to support the conveyor system and to construct bresting dophins for the barges. Onshore, the piles will be installed in permafrost as adfreeze piles. Depending upon the nature of the permafrost (soil or rock type and ground temperature), the piles may either be driven or placed in augered holes with slurry backfill. Offshore, the piles will be driven into unfrozen soil. Design and installation methods for piles in these conditions are relatively straightforward but will require a more detailed plan of the facilities and site-specific geotechnical data.

Earthfill Dam and Diversion Ditch

Chicago Creek will be diverted around the mine by constructing an earthfill dam and diversion ditch. Material for construction of the earthfill dam will be obtained from the same sources as for the haul road and gravel pads. A dam constructed solely of this material is likely to leak excessively. Therefore, some type of impervious surfacing will probably be required on the upstream face. Natural impervious materials do not appear to be available locally, so it will probably be necessary to use geotextile material for this purpose.

Creation of a pool of water behind the dam and water flowing through the diversion ditch will degrade the permafrost in these areas. This will result in instability and erosion of the thawed soils and may require frequent maintenance until these areas adapt to the changed environment.

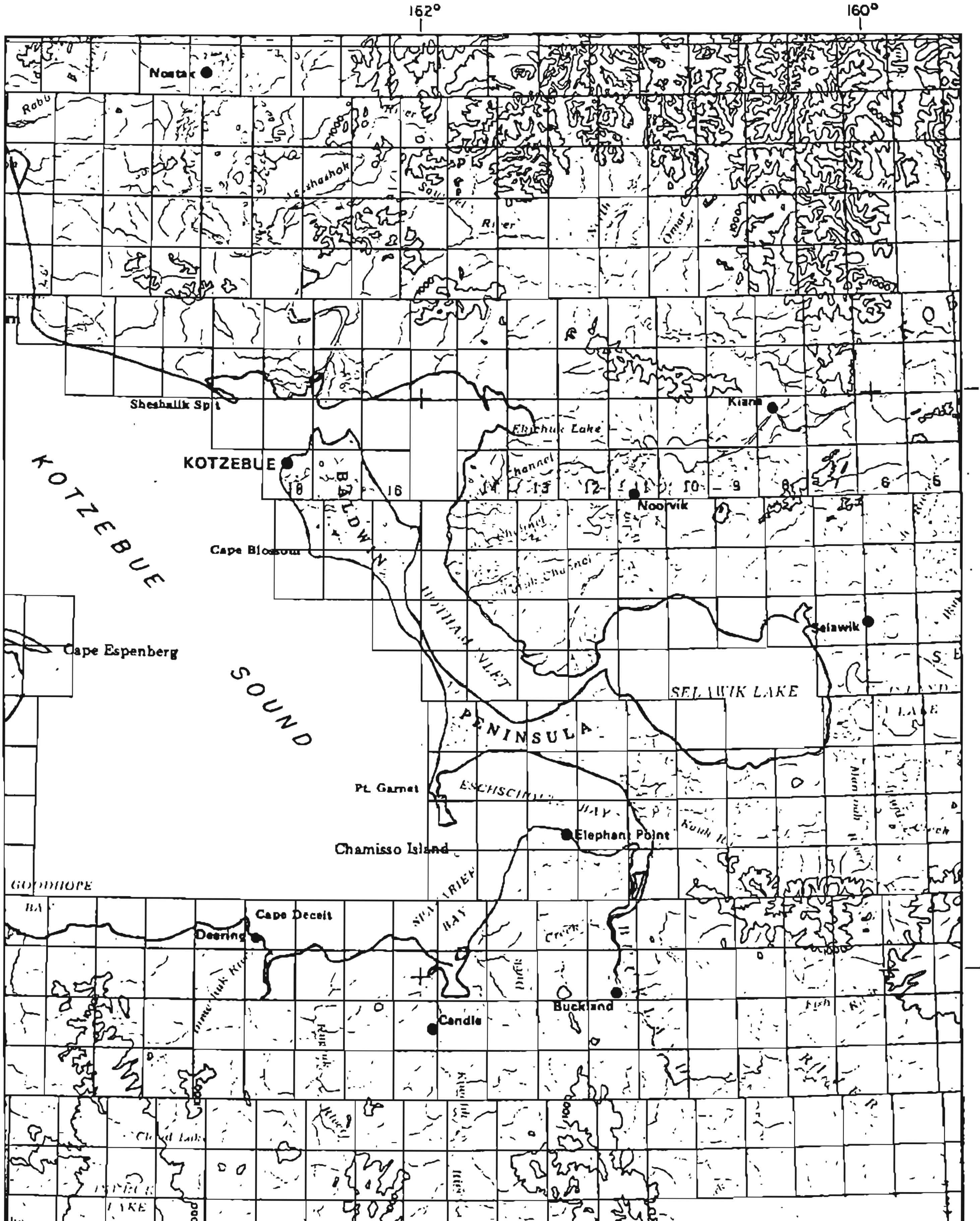
COAL HANDLING AND TRANSPORT

Kotzebue Plant Option

Assuming the power plant is built in the Kotzebue area, it will be necessary to transport the coal out of the mine area. There are several transportation options, including railroad, road, air transport, and hovercraft. Based on previous studies (Refs), these do not appear to be practical for a project on the scale of the Chicago Creek operation. A winter ice road would appear to be an ideal solution; however, the option has already been investigated, and it appears the pressure ridges and other ice deformation would be too extensive to permit keeping a route open.

The option chosen for consideration in this report, selected because it utilizes proven, existing technology, is a combination of truck transportation to Willow Bay and tug and barge transport from Willow Bay to Kotzebue. This option requires a road from the mine to the coast, but such a road would probably be required for bringing in equipment and supplies, regardless of the coal transportation option.

At the Willow Bay site, coal would be held in a stockpile area which would consist of a level gravel pad. It is possible that facilities for drainage and treatment of runoff water would be required. A pad of about 90,000 square feet would hold the entire season's production of 50,000 tons, piled to a depth of 30 feet, and allow 20 feet of working room on all sides. The coal would be hauled from the mine site using mine trucks and stockpiled by one of the mine's



Base map from AEIDC 'Northwest' Alaska, Scale 1:1,000,000

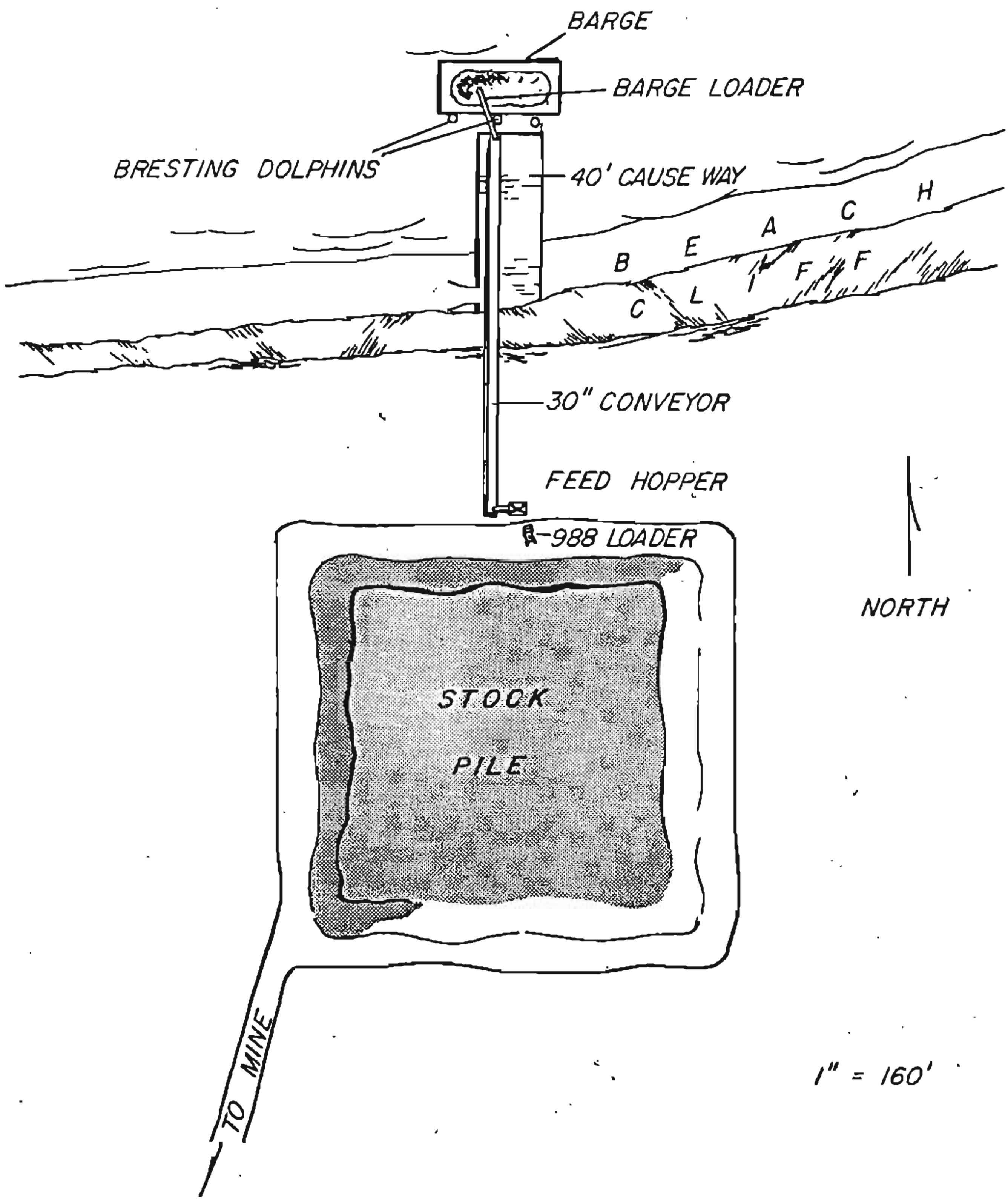
Figure 3
Transportation – Transmission infrastructure
do not mark on ORIGINAL

D-7 bulldozers. In this study, the costs of the stockpile and of stockpiling have been included in the mining costs.

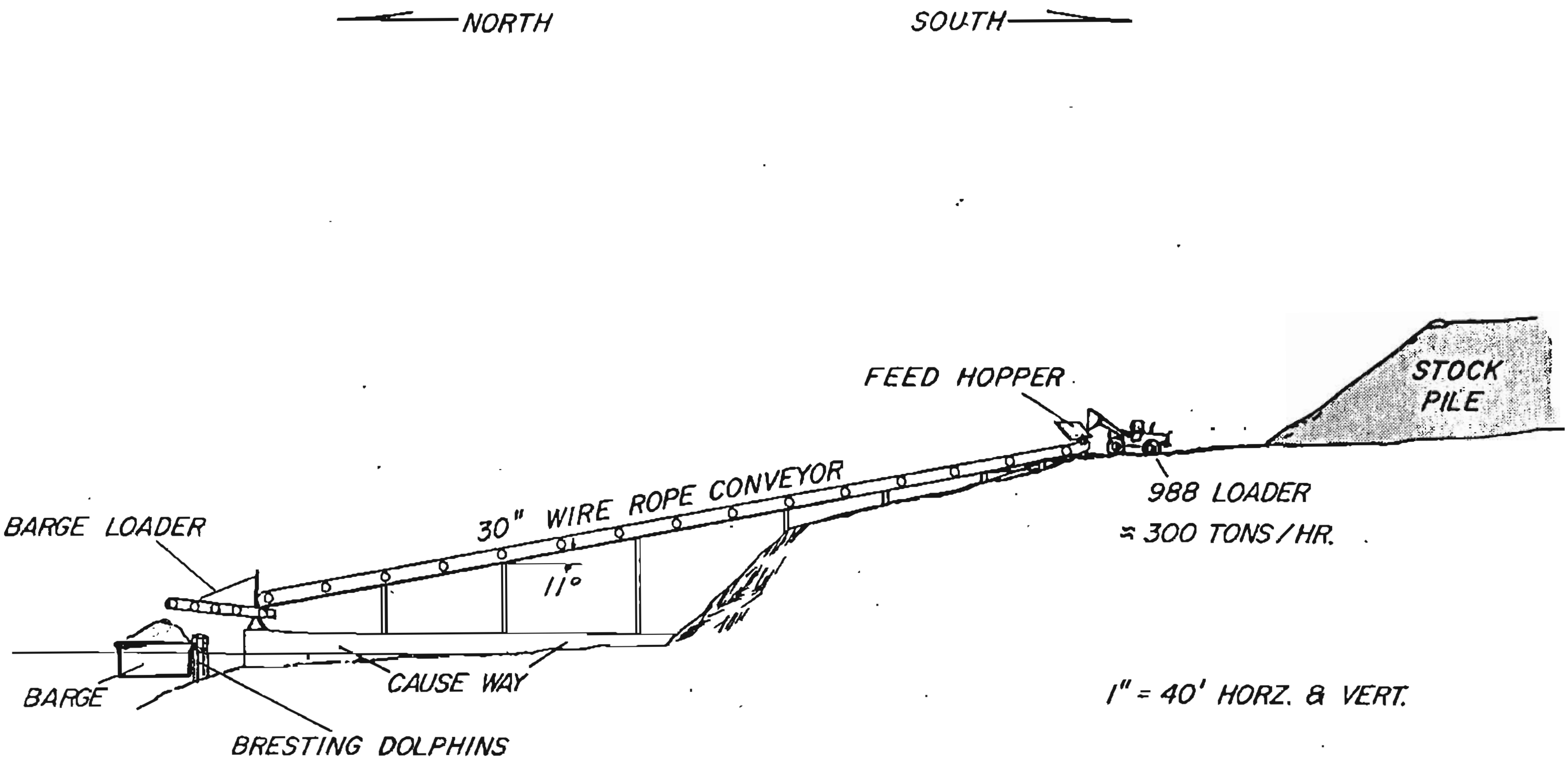
Loading of the coal at the Willow Bay site would be done using a conveyor system fed by a Cat 988 loader. It is assumed that the mine's loaders would be available at the time of the loading operation. Only operating costs are, therefore, included in loading expenses.

Barges would be moored at a dock facility to allow loading regardless of the tides. Rigorous design parameters for the conveyor system and the barge dock cannot be specified without on-site engineering studies. The sketch plans and profiles shown on Figure ___, however, drawn using topographic maps, oblique photographs, and input from the 1983 field crew, are accurate enough for preliminary cost estimates.

The docking facility would be kept as simple as possible to minimize costs. Mike Swalling, of Swalling Construction Company, an Anchorage-based firm with experience in marine construction, suggested dredging a slip in the beach, possibly in a notch previously faced with sheetpiling. This would probably have to be cleaned every year but would be relatively safe from ice damage. Swalling suggested a facility of this type could be constructed for approximately $750,000 or possibly less. If a more elaborate facility is required, an L- or T-shaped breakwater with sheetpile or piling berths, for instance, costs would be more on the order of $1,500,000 to $2,000,000. On-site engineering, oceanographic, and ice studies will be required before design specifications for a dock can be finalized. For this study, we have



PLAN VIEW WILLOW BAY PORT FACILITIES



SECTION WILLOW BAY PORT FACILITIES

chosen a conservative alternative of a short pier with dolphins at an approximate cost of $__________.

Prelimineary costs and design factors for the conveyor system obtained with the help of Van Ooteghem Equipment Company of Anchorage and their conveyor supplier, ______________________, of Toronto, Canada. The conveyor would be a 250-foot-long and 30-inch-wide wire rope system with a hopper feeder and a telescoping barge loader. Preliminary cost estimates are in the neighborhood of $1 million.

All barging would, of necessity, take place during the ice-free season, which typically extends from mid-July to mid-October. It is assumed that a commlercial marine transportation company will be used. A previous study (Arctic Slope Engineers, 1984) has concluded that purchase of a tug and barge might save money, particularly if used equipment is available. The uncertainties in that approach, however, make the costs difficult to identify, so for this study, a conservative approach using existing equipment known to be available was chosen.

Barging costs that have been quoted in previous studies range from $17.78 to $62.80 per ton. The lowest cited costs, given by Arctic Slope Technical Services and others (1982) are based on the use of two 9200 dwt barges and a 9000 horsepower tug with lighterage in three 1000 dwt barges, each with a 650 horsepower tug. Their scenario assumes transportation of 80,000 tons of coal annually and their estimates range from $17.78 to $19.88 per ton, depending on whether or not port construction costs are included.

The highest cost, $62.80 per ton, is quoted in a study by Dames and Moore (1981). They would use a 1200 horsepower tug with a single 500 dwt barge, eliminating the need for lighterage. They develop operating costs of $7714 underway and $5690 in port and assume a day to load, a day to unload, and an average travel rate of 100 miles per day while at sea. They comment that an additional barge would add 10% to the fuel costs but would have no other impact.

Using these assumptions, it would be impossible to move 50,000 tons in a single shipping season. With the equipment assumed in the present study, however, the barges could be loaded and unloaded at a rate of about 300 tons/hour. Taking this into consideration, two 500 dwt barges could be berthed and loaded or unloaded in about 4 hours. Using this figure and Dames and Moore's average speed and operating costs for a two-barge operation, the 50,000 tons could be moved in about 77 days at a cost of $12.00 per ton, providing the operation continues for 24 hours a day and there are no serious weather delays.

Two of the more recent studies (Dames and Moore, 1983 and Arctic Slope Engineers, 1984) use larger barges, achieving additional savings but still not requiring literage. The Dames and Moore study assumes that a tug and 7,000 dwt barge, underloaded to 2500 tons to reduce the draft, will cost $15,000 per day underway and $13,000 in port. The did not compute a cost per ton for the Willow Bay/Kotzebue route. Using their barge costs, with the present study's loading equipment and a speed of 100 miles per day, 50,000 tons of Chicago Creek coal could be transported for a cost of $11.70 per ton.

The Arctic Slope Engineers Study (1984) derives marine transportation costs based on a quote from a barge operator of $8,500/day underway and $5,500/day in port. They assume an unloading rate of 420 tons per hour using a method similar to that proposed in this study. They did not calculate a figure for Chicago Creek coal. Using their barging costs, and again assuming our unloading equipment and the 100-mile-per-day speed, the coal could be shipped in about 22 days of continuous operation for a cost of $375/ton.

The higher cost figures in the previous studies seem to be based on the inclusion of capital costs, the use of uneconomic sizes of barges, or the assumption of unrealistically slow loading and unloading times. Using the most recent figures and assuming a 25% contingency for weather delays and costs to and from the tug's home port, it should be possible to barge the coal for about $4.70 per ton.

Unloading at the Kotzebue end is assumed to be accomplished at a stockpile site located south of town. The unloading is assumed to be done by a wheeled loader similar to that used in the loading operation. Although in practice some sort of specialized barge unloading equipment may prove to be cost effective, proven existing technology was again chosen for the purpose of this study.

The loader and two trucks will accomplish the unloading and transport to a nearby stockpile site. The coal will be stacked by a D-7 Cat. In practice, if the barge transportation can be done after mid-August, the D-7 Cat and nine trucks may be available. For this study, however, we have assumed purchase of the loader and two trucks and rental of the Cat.

The stockpile site will be fenced and will have water-spray equipment to combat dust. The spray and natural precipitation will drain into a ditch which will be routed into a small settling pond to allow the coal fines to settle out.

Coal will have to be moved from the stockpile to the bunkers at the plant site in Kotzebue, using a 13-ton end dump truck. The truck will make about two trips per hour, assuming the truck driver operates the loader. Working for 8 hours, about 208 tons per day would be moved, and it would take about 1,925 hours or 240 days to move the 50,000 ton assual consumption from the stockpile to the plant's bunkers. The loader is assumed to work one-fourth of the time and the truck three-fourths. Feeding the plant would be a year-round job, assuming a normal work week.

Capital and operating costs are shown in Tables ___ and ___. Using these assumptions, coal could be loaded, offloaded, stockpiled, and delivered to the power plant for $3.85 per ton.

TABLE ___

Transportation Facilities Operating Costs

Willow Bay

988 Loader	$ 91/Hour) *	$14,560	
Conveyor/Barge Loader	$ 50/Hour)	1,600	$ 16,160

Kotzebue (Unloading)

988 Loader	($ 91/Hour)	14,560	
2 Trucks	($120/Hour)	19,200	
D-7 Cat	($ 68/Hour)	10,880	44,640

Kotzebue (Supplying Power Plant)

988 Loader	($ 94/Hour)	43,794	
Truck	($ 60/Hour)	99,900	130,419
			$191,219

COST PER TON = $3.82

* Operation costs include labor at $35/Hour.

TABLE ___

Transportation Facilities Capital Costs

Willow Bay

- Conveyor System
- Dock Facility

Kotzebue

- Dock Facility
- Stockpile Site
- Road
- Loader
- Truck

COAL-FIRED POWER PLANT

Of the several methods studied to provide energy for Kotzebue, Alaska with the use of coal from Chicago Creek, the generation of electricity from steam appears to be attractive and here is the method outlined:

Based on information presently available, a straight condensing steam cycle with automatic extraction for feed water make-up appears to have the simplicity and flexibility to follow the load variable to make it the first choice for this application.

The proposed facility, located near Kotzebue, will utilize coal from the Chicago Creek Mine which will be delivered by barge and then trucked to the site. The size of off-site would permit direct binned storage. A boiler and a steam turbine, operating at 650 psig/750oF to 3 inches of Hg mercury would convert the heat energy into electricity for load distribution. A once through system using salt water would be the most economical method of supplying cooling water to the condenser. Any adverse environmental impacts can be addressed when more information becomes available.

Air quality standards must be identified and at 0.10 grains/SDCF and 30% opacity, it may not be necessary to install expensive clean-up equipment in the gas stream if care is exercised in the preparation and handling of the fuel. Also, it may require the use of firing components which will avoid the discharge of toxic wastes.

SIZE OF FACILITY:

The load to be served, both present and future, will govern the size of the components selected. This load must be carefully identified, both as to its maximum and minimum size. Excessive oversizing must be avoided to be sure minimum loads can be reached without sacrificing clean combustion. Special attention must be given to firing methods to be sure of obtaining the necessary turn down ratio.

For purposes of the information contained herein, it will be assumed that a 10,000 Kw condensing generating capability will be needed. A small amount of additional output will be generated extraction at 10 psig to heat feed water. Total throttle flow to the turbine, under the steam conditions indicated in the foregoing, will be from 140,000 to 160,000 pounds per hour. To handle soot blowing, blow down and miscellaneous radiation and leakage losses, the size of boiler selected should have a steam capacity of about 180,000 pph. There should be stand-by capacity of 180,000 lbs/hr.

The size of air and gas handling equipment will depend on the amount of excess air needed for optimum firing. This in turn will depend on the moisture and general quality of the fuel. It is assumed that the gas flow will vary from 210,000 to 220,000 pounds per hour at full boiler output.

An air heater will be needed to furnish combustion at an elevated temperature of about 400oF. This could be of the regenerative plate type or of the tubular type, the latter being the more common. Additionally, the latter type will permit the installation of gas bypass damper between stages without the need for special ducting. In addition to facilitating permits, the automatic controlling of leaving gas temperatures to avoid dew point condensation.

By placing the heater between the boiler outlet and the mechanical dust collector, the size of the latter would be minimized. The basis for sizing would be a pressure drop of 4" w.c. at maximum design gas flow.

The sizing of the air heater to obtain heat recovery between gas temperature limits at the boiler outlet and the dew point approach eliminates the need for an economizer. The latter can add to plant maintenance problems, is somewhat complicated to operate, and can be hazardous if allowed to operate in a flashing mode unless specifically designed for such conditions.

FUEL SUPPLY:

The fuel would be obtained from the lands near areas which would require barging and trucking. The moisture content is assumed to vary between 50% and 60%, wet basis.

Site preparation at the site would be more energy efficient than "off site" preparation because of the availability of the generated electrical energy, but this advantage would be offset to a degree by reduced noise and direct off loading to storage bins when "off site" sizing is used.

The quality of fuel required will vary its moisture content, sample 30.06-25.66

and the temperature and quantity of the combustion air 400oF with which it is fired. A 30% moisture fuel, fired with low excess preheated combustion air should produce from 2.5(10o) to 3.0(10o) Btu at the steam outlet per pound fired.

PLANT LOADS:

The characteristics of a boiler-stem turbine-electrical generating facility are such that it must serve a continuous load, the more uniform the better. To obtain such loading will require that the residential load be implemented with an industrial load, ideally of a size to consume all of the surplus capacity available. Normally, such a surplus could be marketed to an energy short electrical utility, but this is not a realistic prospect at this location.

A better possibility may be to generate electrical energy on a noncondensing turbine cycle and use the exhaust steam for industrial heating. One possibility is the construction of heat exchangers to utilize waste heat recovery. Other load possibilities exist, of course, but their potential would require extensive investigation which is beyond the scope of this study, Red Dog Mine option.

COMBUSTION CONSIDERATIONS:

Combustion quality is closely related to the methods employed to control fuel quality and to the type of system selected for its firing. Fuel quality is adversely affected by high moisture content and by excessive containments of dirt, sand, and/or other inert materials.

Unless some form of drying is employed, little can be done about the fuel's initial moisture content. To avoid degradation, however, open storage should be avoided in favor of closed storage in bins. Closed conveyors are preferred to open types subject to weather.

The inclusion of dirt and inert materials in the fuel is largely a matter of care exercised in its handling. Usually, improvements can be obtained by properly instructing personnel involved in the handling.

The retention time needed for fuel particles to burn to completion in the furnace depend on their size, shape, and moisture content; the greater the latter, the longer the time required. The same is true of the size; the larger the particle, the longer the time. For this reason, those firing methods that provide longer retention times by keeping the fuel on the grates are to be preferred to those burning in suspension, especially where moisture contents are high.

High furnace temperatures are essential for clean combustion. These should be 1500o to 1600o range for optimum firing. Above this value, there is some danger of slagging the dirt and sand on tube surfaces. At lower values, gases are apt to enter the boiler convection section prior to complete burnout resulting in the issuance of smoke to atmosphere.

Firing with preheated air at low excess values helps to maintain temperature.

The furnace should contain an adequate amount of refractory surface to stabilize temperatures. The use of over-fire air jets is also helpful, but careful design is required to obtain adequate penetration and turbulence. The "spilling" of low pressure air into the furnace, especially if unheated, will lower combustion quality.

PROPOSED FACILITIES:

The type of firing best suited to the characteristics of the fuel would be one employing a chain grate stoker provided it were uniformly loaded with fuel across its entire width. By varying speed and the height of bed, simultaneously with the combustion air, the heat release from the grate would follow load requirements. A major advantage of this type of firing lies in its automatic and continuous discharge of ash off the end of the chain. Another advantage is its ability to handle clinker formation.

Another form of pile burning can be provided for by multiple fuel cells, four in number arranged two by two. These are limited to 50% moisture fuels with an ash and dirt content of about 3%. The cells are arranged to closely control the flow of both undergrate and overfire combustion air. Although ash removal is manual, the shutdown of one cell at a time for cleaning without disturbing the other cells permits removal to be accomplished with little or no change in pressure or release of pollutants to atmosphere.

The boiler would be of the field erected type, but at least one manufacturer makes such a unit in shop fabricated modules which can be shipped to the site and erected with a minimum of field labor. Complete flexibility can be obtained in the design to provide a unit best suited to the characteristics of the fuel.

A two pass vertical tubular air heater would be installed in the gas duct at the boiler outlet. The combustion air would enter and leave the unit in a cross flow pattern. A splitter type damper between the gas passes would be automatically modulated to control leaving gas temperatures at present values to prevent dew point corrosion.

A mechanical collector of the multi-tube type would be located between the air heater outlet and the inlet to the induced draft fan. To optimize separating capability, the unit would be sized for a pressure drop of 3.5" to 4.5" w.c. at maximum design gas flow. The need to include provisions for adjusting the velocities through the tubes will depend on expected variations in gas flows which must be determined later.

The turbine cycle, condensing or noncondensing, will depend on the variables in the load to be supplied. If condensing, the required cooling for the condenser can be supplied on a "once through" basis using salt water. Extraction requirements, if any, will also be somewhat dependent on load considerations.

Since the proposed facility will be isolated from a primary source of power as supplied by utility, the use of auxiliary steam turbine drives must receive careful consideration both from a startup and an emergency operating condition.

During the startup, the ability to supply fuel to the grates, water to the steam drum, and to have emergency lighting will be required. An unscheduled outage during normal operating will require a means of feeding water to the steam drum that is independent of the generated power supply. Black start capability will be essential in the location of the plant.

One possibility is to modify the existing diesel facility to provide the backup power in a reliable, automatic and rapid manner. A second possibility is to incorporate the backup provisions is the proposed facility; these to consist of some combination of auxiliary turbine drives and emergency electrical generating facilities.

ENVIRONMENTAL CONSIDERATIONS:

The standards to be met for air and water quality and for noise must be confirmed with the appropriate regulatory authorities.

Air quality standards are assumed to be 0.10 grains/standard dry cubic foot of gas corrected to 12% CO_2 for particulates and 30% opacity. It should be possible to meet these standards with the components outlined above if the fuel moisture content does not exceed 30%. If it does, options include the installation of fuel drying equipment, a dry charged bed scrubber, or a bag house. All are described later under "Optional Components." Because waste discharge problems are increased with the use of wet scrubbers, they will not be considered.

Water quality standards are primarily concerned with the discharge of toxic wastes. The major firms engaged in the treatment of water for boiler feed and other industrial purposes have developed complete lines of chemicals for controlling toxicity in the discharges to make them environmentally acceptable. Specific treatments relate to the chemistry of the water available for makeup.

A major discharge source from a facility generating power on a condensing cycle will come from the cooling tower blowdown where a closed loop is employed to obtain condenser cooling water. This waste water source can be eliminated if approval is obtained for the aforementioned "once through" cooling system using salt water.

In recent years, increasing attention has been focused on controlling noise levels. The proposed facilities will be designed to keep these levels to 90 decibles or less.

Historically, the reinjection of fly ash into the furnace pneumatically has been a common practice, justified on the basis of improving combustion. In reality, the improved combustion is hard to identify, but the increase in the particulate discharging from the stack is not. If reinjection is employed, it will be accomplished by feeding the ash and unburned combustibles uniformily into the fuel stream.

BUDGET COSTS:

The following costs are approximate only and must be revised to suit the design criteria as it becomes better identified. The electrical costs include the step-up transformer, but do not include the costs associated with the fuel and its movement, nor does it include the costs of covered storage.

The capital cost and generation cost summary show the nameplate dollars per KW as 2745, and the generation costs mills per KW as 39.63 respectively.

OPTIONAL COMPONENTS:

Additional control of the particulate discharge from the stack could be obtained by using a charged bed dry scrubber as manufactured by Combustion Power Company of Menlo Park, California. The charged media bed of selected gravel is contained within two concentric cylindrically shaped vertical vessels, specially constructed with louvres to permit the passage of the flue gases. The bed moves continuously downward where a small portion of it is removed and discharged pneumatically back into the top; the media being cleaned in the process.

Because of the continual recirculation of a portion of the media, it is claimed that the unit has a higher tolerance for operation at dew point temperatures than other types of dry cleaning devices--especially if a small exchanger is used to heat the re-circulating media. It is also claimed that availability will be virtually 100%, particularly if a spare blower is purchased for media recirculation.

The unit weighs 58,000 pounds and is charged with media weighing 300,000 pounds.

CAPITAL COST SUMMARY

CAPACITY 10 MW Plant DATE 3/28/85

ITEM	COST X 1000
Land, Land Rights	75
Roads	85
Site and Yard Improvements	95
Intake & Structures:	
Piling & Concrete Structures	100
Traveling Screen, Pumps, & Piping	85
Structural:	
Foundation & Sub-Structure	400
Building & Structural Steel	500
Concrete & Misc. Metal	400
Mechanical:	
Turbine Generator	2,000
Steam Generator (Boiler) & Auxiliaries	7,200
Machinery, Pumps, & Equipment	1,200
Instruments & Controls	780
Mechanical Work & Piping	1,700
Coal & Ash Handling	1,200
Circulating Water & Plumbing Systems	500
Water Treatment	420
Precipitator	2,500
Electrical:	
Switchgear & Control	400
Wire, Cable, Conduit & M.C.C.	300
Lighting & Distribution	300
Sub Station (Step-Up)	800
SUB TOTAL DIRECT COST	21,040
Engineering	4,000
Contingencies	500
SUB TOTAL DIRECT COST	25,540
Interest During Construction 3% Average	631
Construction Management 8,000 @ 60	480
Miscellaneous Expense & Freight	1,000
TOTAL INVESTMENT COST	27,451
$ Per KW Name Plate	2,745