



Friday JUL 20, 1979 12:45

COMMERCIAL PLANT - WESTERN COAL - INFLATED AT 10%/year

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1993	1998	1999	2000	2001	TOTAL
PRODUCTIVE VOLUM	0	0	0	6940	6940	6940	6940	6940	6940	6940	6940	6940	6940	6940	6940	138794
PROJECTED P&L																
REVENUE	0	0	0	62903	69193	76112	83723	92095	101305	111435	179467	289032	317935	349728	384701	3602705
SEMI-VAR. COST	0	0	0	10903	11903	13193	14512	15963	17560	19315	31108	50099	55109	60620	66682	624471
VARIABLE COSTS	0	0	0	31294	34424	37906	41653	45818	50400	55839	89285	143795	158174	173991	191390	1792358
OPERATING PROFIT	0	0	0	20705	22776	25052	27558	30314	33346	36680	59074	95138	104652	115118	125629	1185876
OTHER INCOME	0	0	0	2969	3266	3593	3952	4347	4742	5260	8471	13643	15007	16508	18159	170058
DEPRECIATION	0	0	0	4397	8793	8793	8793	8793	8793	8793	8793	8793	546	546	546	134356
PRETAX PROFIT	0	0	0	19278	17248	19853	22717	25868	29334	33147	58752	108236	119114	131080	144242	1221578
TAX-CURRENT	0	0	0	6874	3835	6220	8337	10598	13015	15606	31821	54145	59594	65567	72148	610235
TAX-DEFERRED	0	0	0	2765	4789	3707	3021	2336	1652	963	-2445	-27	-27	-27	-27	554
NET INCOME	0	0	0	9639	8624	9926	11359	12934	14667	16574	29376	54118	59557	65540	72121	610789

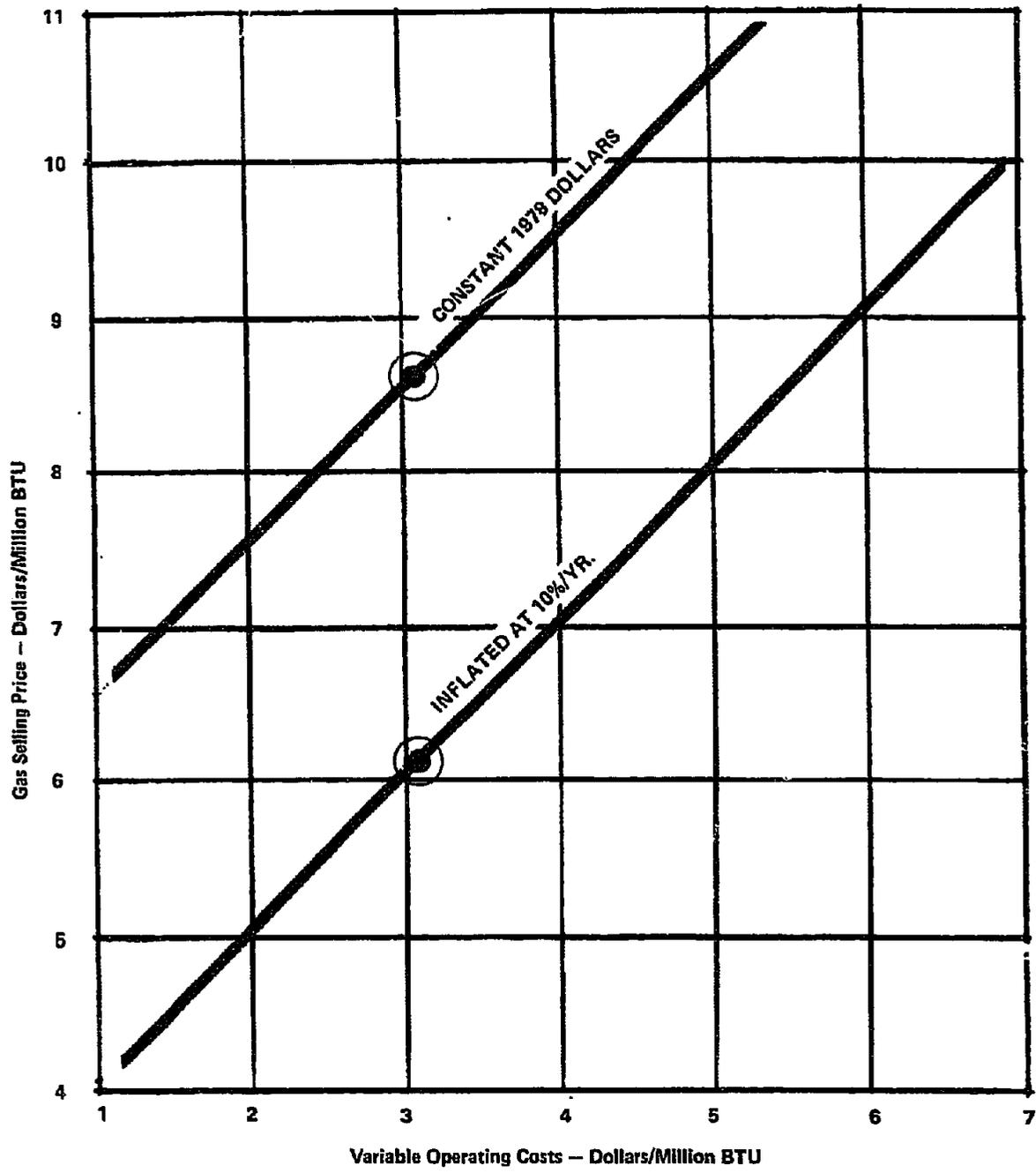
CASH FLOW																
NET INCOME	0	0	0	9539	8624	9926	11359	12934	14667	16574	29376	54118	59557	65540	72121	610789
DEPRECIATION	0	0	0	4397	8793	8793	8793	8793	8793	8793	8793	8793	546	546	546	134356
TAX-DEFERRED	0	0	0	2765	4789	3707	3021	2336	1652	968	-2445	-27	-27	-27	-27	554
RESIDUAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14690
CAPITAL EXPENDIT	48515	48515	48515	6493	0	0	0	0	0	0	0	0	0	0	0	152038
CASH FLOW	-48515	-48515	-48515	10307	22207	22426	23173	24064	25112	26335	35724	54637	60076	66059	87330	608351

DCFROR 14.99

ASSUMPTIONS

SELLING PRICE	6.81	7.49	8.24	9.06	9.97	10.97	12.06	13.27	14.60	16.06	25.86	41.65	45.81	50.39	55.43
VARIABLE COST RATE	3.39	3.73	4.10	4.51	4.96	5.46	6.00	6.60	7.26	7.99	12.87	20.72	22.79	25.07	27.58
COST OF BUILDING	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24	7277.24
COST OF EQUIP.	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74	41237.74
CHANGE IN NMC															

6492.80



**GAS SELLING PRICE VS. VARIABLE OPERATING COSTS**

**COMMERCIAL PLANT  
WESTERN COAL**

**CONSTANT IRR - 15%**

**VI-57**



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

The gas selling price was determined for a range of variable operating cost levels, assuming a required internal rate of return of 15%.

The analysis was performed utilizing a constant dollar and inflated dollar approach. The constant dollar approach assumed 1978 dollars over the entire time frame, while the inflated method is based upon the escalation of the capital expenditure and the inflation of revenues and costs at 10% annually.

At the most likely variable operating cost level, \$3.08/M Btu (in 1978 dollars), the selling price necessary to achieve the desired IRR is (in 1978 dollars):

CONSTANT	\$8.67/M Btu
INFLATED	\$6.19/M Btu



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

BASE CASE

WESTERN COAL

VARIABLE OPERATING COST VS. SELLING PRICE

<u>VARIABLE OPERATING COSTS</u> (\$/M Btu)	<u>SELLING PRICE</u> (\$/M Btu)
1.00	6.59
1.50	7.09
2.00	7.59
2.50	8.09
3.00	8.59
3.50	9.09
4.00	9.59
4.50	10.09
5.00	10.59
MOST LIKELY IRR 15%	3.08 8.67



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

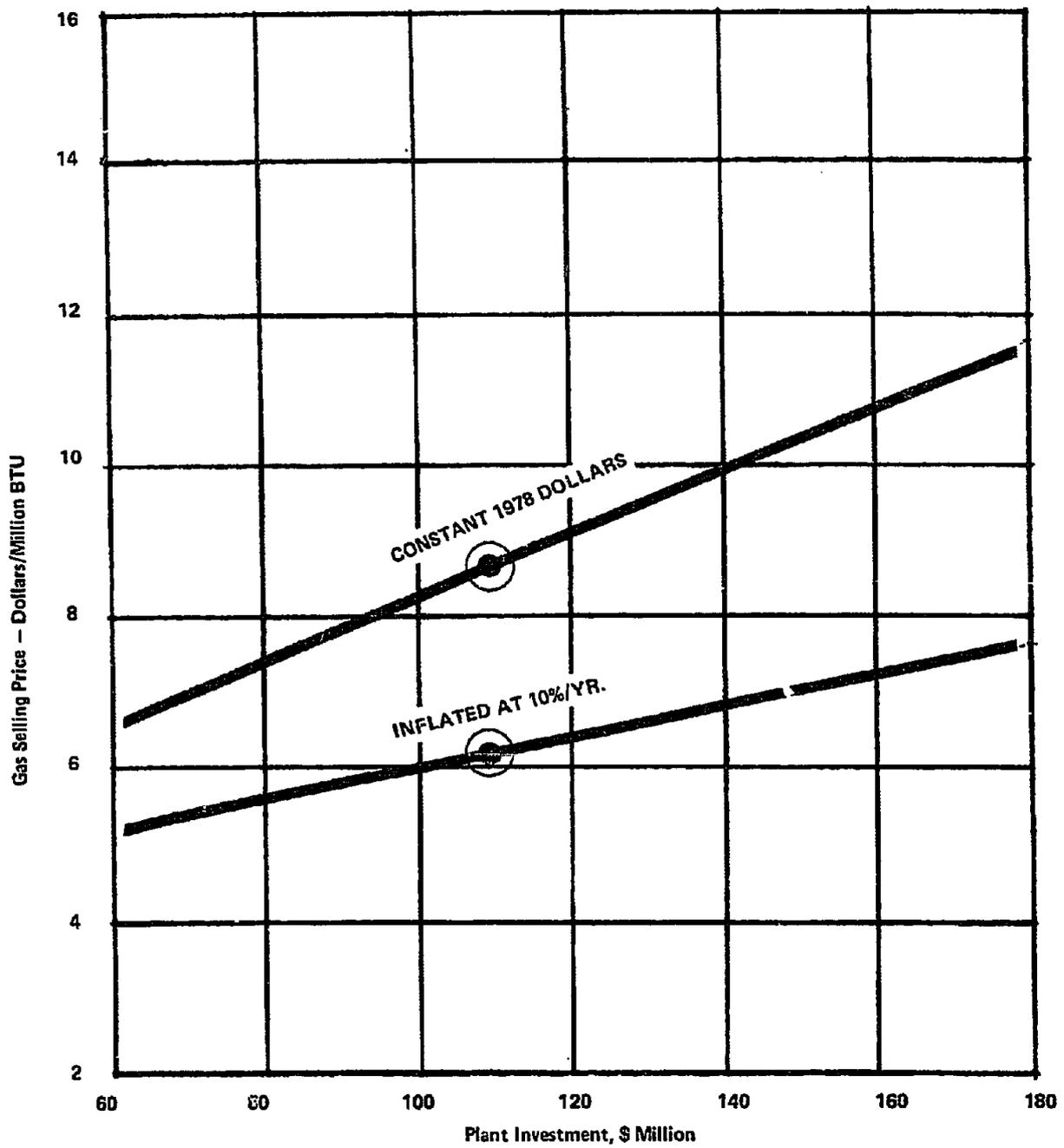
ESCALATED CASE

WESTERN COAL

VARIABLE OPERATING COST VS. SELLING PRICE  
(\$/M Btu)

VO\$		SELLING PRICE		
1978	1979	1978	1979	
1.00	1.10	4.11	4.52	
1.50	1.65	4.61	5.07	
2.00	2.20	5.11	5.62	
2.50	2.75	5.61	6.17	
3.00	3.30	6.11	6.72	
3.50	3.85	6.61	7.27	
4.00	4.40	7.11	7.82	
4.50	4.95	7.61	8.37	
5.00	5.50	8.11	8.92	
Most Likely	3.08	3.388	6.10	6.61

IRR 15%



**GAS SELLING PRICE VS. PLANT INVESTMENT**

**COMMERCIAL PLANT  
WESTERN COAL**

**CONSTANT IRR - 15%**

**VI-61**



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

The gas selling price was determined for a range of plant investments, assuming a required internal rate of return of 15%.

The analysis was performed utilizing a constant dollar and inflated dollar approach. The constant dollar approach assumed 1978 dollars over the entire time frame, while the inflated method is based upon the escalation of the capital expenditure and the inflation of revenues and costs at 10% annually.

At the most likely level of plant investment--\$109,337,000 (in 1978 dollars) and \$145,545,000 (escalated)--the selling price required to achieve the desired IRR is (in 1978 dollars):

CONSTANT	\$8.67/M Btu
INFLATED	\$6.19/M Btu



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

BASE CASE

WESTERN COAL

PLANT INVESTMENT VS. SELLING PRICE

<u>PLANT INVESTMENT</u> (\$000 omitted)	<u>SELLING PRICE</u> (\$/M Btu)
60,000	6.58
80,000	7.43
100,000	8.27
120,000	9.12
140,000	9.97
160,000	10.82
180,000	11.67

MOST LIKELY: 109,337

IRR 15%



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

ESCALATED CASE

WESTERN COAL

PLANT INVESTMENT VS. SELLING PRICE

PLANT INVESTMENT (\$000 omitted)		SELLING PRICE (\$/M Btu)	
1978	1979	1978	1979
60,000	79,800	5.18	5.70
80,000	106,400	5.59	6.15
100,000	133,000	6.00	6.60
120,000	159,600	6.41	7.05
140,000	186,200	6.82	7.50
160,000	212,800	7.23	7.95
180,000	239,400	7.64	8.40
MOST LIKELY	109,337	145,545	
IRR 15%			



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)

**AREA 00**  
**GENERAL PLANT AREA**

**DESCRIPTION**

The plant is sited on Erie Mining Company property west of and adjacent to the battery limits of the existing pellet plant. It is in a hollow, at an elevation lower than that of the pelletizing facilities.

The plant layout is based on the sequential material flow pattern, and incorporates generally accepted equipment spacing standards and safety precautions.

The layout requirements are integrated into the selected site in accordance with good engineering practice. Allowances are made throughout for later expansion of the Demonstration Plant to the Commercial Plant.

The track arrangement is designed for unloading and handling 50 car segments of unit trains, taking into account the specified spacing requirements between the commercial railroad and the Erie Mining Company railroad.

The layout is designed to supply coal to the gasifiers at an approximate rate to sustain the design capacity of 7.4 billion Btu/day (HHV), to handle Eastern or Western coals delivered to the site by unit train to a stockpile of 180 day capacity, and to handle fines produced during the sizing process to a fines loadout area.

RAILROAD FREIGHT RATES

Pig Iron  
Rates in cents per ton of 2240 lbs., unless otherwise noted  
X-357-A

MINNESOTA

Page No. 21  
Issue No. 1  
Date issued 7-25-78

FROM:

C H I C A G O  
T O L E D O  
S S M A R I E  
P O R T S M O U T H  
M I L W A U K E E

TO:

O N

Albert Lea	A	2060			
	B	1865	2921		3443
Duluth	B	2283	3083		
Fairmont	A	2819			
	B	2427	3035		3502
	C		2836		3273
Faribault	B	1865	2977		3502
	C		2782		3273
Lake City	A	2060		2440	
	B	1865	2867		
Mankato	A	2284		2864	
	B	2072	3035	2613	
Medford	B	1865	2977		
Minneapolis	A	2060			
	B	1865	2977		3502 1865
	C		2782		3273
St. Cloud	A				
	B	2520	3140		
St. Paul	A	2060			
	B	1865	2977		3502
	C		2782		3273
Stillwater	B	1865	2977		3502
	C		2782		3273
Virginia	B	2520	3253		3772
	C		3040		3273
Winona	A	1558		2440	
	B	1417	2702		3195
	C		2525		2896

REFERENCE MARKS

A—56,000 lbs. min. wgt.

B—112,000 lbs. min. wgt.

C—Rate only applies on 12,000 lbs. min. wgt. via AA car ferry only.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 01**  
**MATERIAL HANDLING - \$15,984,000**

**Coal Handling and Preparation**

**DESCRIPTION**

Unit trains will be delivered to the materials handling area in 50 car maximum unit lengths. Entering the plant site loop, the cars will be spotted and automatically positioned in a rotary car dump, and the coal will be discharged into a hopper below the dumper. Coal will be discharged from the hopper via a 60" belt feeder to an active storage pile, from which it may be drawn by front end loader and a reclaim hopper for use at the gasifier, being processed enroute by crushing and sizing screens. Oversize will report to the gasifier surge hopper, and undersize will report to an active fines storage pile of 500 ton capacity where it may be reclaimed by front end loader and loaded into trucks or railroad cars. Alternately, the coal as received may be reclaimed from the initial active storage and transported by truck to a 180 day storage pile.

Dust suppression techniques will be practiced throughout the materials handling system.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

MAJOR EQUIPMENT

- . Thaw Shed and Heaters
- . Rotary Car Dumper and Train Positioner
- . Conveyors, Crushers, Screening Plant, Conveyor Scales
- . Mobile Equipment



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 02**  
**GASIFICATION - \$19,507,000**

**Five Stirred Gasifiers**  
**Gasifier Building**

**DESCRIPTION**

Sized coal from the materials handling system will be received in storage bunkers of 12 hours live storage capacity, capable of expansion to 20 hours. Additional capacity will permit charging of the bunkers on a one shift per day basis.

Coal is discharged from the bunkers via a system of lock hoppers, conveyors, coal tubes and distributors at the top of, and supplying, the gasifiers.

The gasifiers are classified as two stage. Sized coal enters the top of the gasifiers, and progresses vertically down the column that is formed by the refractory lined walls of the cylindrical furnace. While descending the column, the coal is heated in a controlled atmosphere created by the introduction of steam and air into the bottom of the furnace, and volatile matter and moisture are carried upward, counterflow to coal descent.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

Top gas at about 250<sup>o</sup> F is emitted at the top of the gasifier and is subsequently passed through an electrostatic precipitator, where tar is precipitated from the gas stream, cooled to precipitate oils and water at about 95<sup>o</sup> F, and is combined with the clear gas stream.

Bottom gas, or clear gas, is relatively clean and is de-dusted in a cyclone, to remove carbon and ash particulate matter, and has its temperature reduced from about 1200<sup>o</sup> F to about 95<sup>o</sup> F, and its "waste heat" recuperated, in a heat exchanger. The clear gas combined downstream with the top gas for oil and water removal by electrostatic precipitator. A Stretford process is to be used to remove hydrogen sulphide from sulphur bearing Eastern coals.

A stirring mechanism will be used to achieve and maintain maximum gasification efficiency.

#### MAJOR EQUIPMENT

- . Five Gasifiers (one stirred initially)
- . Coal Bunkers, Feeders, Conveyors, etc.
- . Air Blowers
- . Cyclones - Dust - Tar
- . Heat Exchangers
- . Pumps - Oil, Sludge, Water, Ejector, Hydraulic
- . Precipitators - Electrostatic, Tar and Oil
- . Flare Stacks



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 03**  
**SULPHUR REMOVAL - \$4,537,000**

**DESCRIPTION**

The Stretford process utilizes a gas scrubber, reaction tanks and a series of oxidation tanks and ancillary equipment to subject the gas to chemicals used in the process. Elemental sulphur byproduct and a producer gas are produced. The gas, containing less than 50 ppm hydrogen sulphide is compressed and transported via gas transmission line to the pellet plant.

**MAJOR EQUIPMENT**

- . Venturi Scrubber, Knockout Drum
- . Reaction Tanks, Oxidizing Air Blowers, Agitators, Froth Tank, Balance Tank, Chemical Addition Tank, Pumps and Heat Exchanger
- . Slurry Accumulator, Pumps, Sulphur Melter, Sulphur Decanter, Molten Sulphur Storage, Sulphur Pump, Cooler, Flaker
- . Purge Evaporator, Incinerator Feed Pump, Incinerator



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EM-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

#### AREA 04

### GAS COMPRESSION AND TRANSMISSION - \$2,075,000

#### DESCRIPTION

Process gas will have a temperature of about 100<sup>0</sup> F at the compressor, and 5" H<sub>2</sub>O pressure. The gas will be compressed to a nominal 12 psig, and transmitted to the pellet plant. Pellet plant shaft furnaces (12 only) will be retrofitted to accept the fuel gas. Three of the twelve will also accept tars as fuel.

#### MAJOR EQUIPMENT

Coal Gas Booster Compressor



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 05**

**WASTE WATER TREATMENT - \$787,000**

**DESCRIPTION**

Wastewater will be evaporated to the maximum degree possible. The balance will be incinerated.

Sanitary waste will be handled in the existing pellet plant system.

**MAJOR EQUIPMENT**

- . Combustion Air Blowers
- . Wastewater Evaporator, Tanks, Pumps, Heaters
- . Pumps, Dirty Oil, Dirty Water, Oil/Water Separation
- . Wastewater Incinerator Package
- . Incinerator Stack



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 06**  
**UTILITIES - \$12,655,000**

**DESCRIPTION**

- A. Electric power will be supplied through an existing substation located on the east side of the pellet plant concentrator. The source voltage will be 13.8 kv. New transformers, as required, will be provided for the coal gasification plant. An emergency electrical backup system will be installed.
- B. An inert gas generation system with dryers will be installed. The generator will be fired with low Btu gas. A liquid nitrogen system will be installed as a backup to the inert gas generator.
- C. Packaged steam boilers will be utilized for startup and supplemental use. They will be fired with product tar and/or fuel oil.
- D. Plant and instrument air, including driers for the instrument air, will be supplied from a new air compressor installation independent of existing facilities. Plant air will not be dried.
- E. Cooling water will be supplied through a tie-in to an existing line below the concentrator head tanks. Cooling water will be returned to the concentrator tailings sump.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

- F. Boiler feedwater will be supplied by treating water from the existing freshwater source in the pellet plant concentrator building.

Potable water will be supplied from the existing pellet plant system.

The firewater system will tie into the existing plant reservoir and will include new firewater pumps and piping.

- G. A control room suitable for controlling the facilities for coal gasification, Stretford H<sub>2</sub>S removal and gas compression will be included in one main control center. The coal handling, utility, and wastewater incinerator control centers will be located in their three respective areas.
- H. Wash and change rooms, laboratory facilities and limited work shop facilities will be provided in the plant area.
- I. Conveyor galleries, coal crushing and screening stations, coal gasification facilities, gas and air compression, pumps, and utility service facilities will all be enclosed. The Stretford unit will also be enclosed, with the exception of the venturi scrubbers and knockout drums.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

MAJOR EQUIPMENT

- . Chemical Feed Tanks and Agitators
- . Inert Gas, Generator Airblowers, Gas Compressors, Storage Drum, etc.
- . System Complete
- . Instrument Air System
- . Emergency Power Control System
- . Boiler Feed Water System



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 07**  
**SAFETY SYSTEMS - \$143,000**

**DESCRIPTION**

Effluent containing contaminants, namely phenols, cyanide and chlorides, and which is the balance of the process waste water not evaporated will be disposed of by incineration. Along with the effluent (above noted), will be effluent from the inert gas generating system, and water from the flare seal drum.

To ensure safe operation during upset, startup and controlled shutdown, the design of the plant includes a flare system, independent of those provided for the gasifiers. The flare will provide relief in the event of over pressure conditions on the suction side of the gas compressor.

**MAJOR EQUIPMENT**

- . Flare Seal Drum
- . Safety System Flare Tip



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)

**AREA 08**  
**RETROFIT - \$1,367,000**

Burners  
Agglomerator Piping  
Instrumentation

**DESCRIPTION**

The Erie Mining Company will retrofit twelve furnaces to accept the fuel gas produced by the Demonstration plant. Three of the furnaces will also be retrofitted to accept the tars produced.

**MAJOR EQUIPMENT**

Burners for East and West Combustion Chambers on  
Twelve Indurating Furnaces



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

**AREA 09**  
**EMPLOYEE FACILITIES - \$189,000**

**DESCRIPTION**

Locker room, lunch room, shower and toilet facilities, etc. will be provided for the use of gasification plant employees. The building will be 50' x 50' in area.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)

**AREA 10**  
**ASH-SULPHUR DISPOSAL - \$1,750,000**

**DESCRIPTION**

Erie have located and studied a site away from the gasification plant, but on their property, for ash and sulphur disposal.

Environmental studies indicate that environmental regulations can be met.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

## VII. RECOMMENDATION

The estimated costs, as summarized in accordance with the contractual requirements and this final report, are considerable higher than the estimated capital and operating costs expected at the initiation of Phase I.

	<u>Contract</u>	<u>Final Estimate</u>	<u>Variance</u>
Phase II Construction	\$ 24,768	\$ 80,351	\$ 55,583
Phase III Operation	\$ 20,426	\$ 23,839	\$ 3,413

NOTE: 1978 Dollars, No Contingency or Escalation, 000 Omitted.  
(REF VI-19)

In addition to the "high" cost considerations, Erie has outlined several areas of technical and environmental risks.

### Technical Risks (REF. Section B2)

1. Western Coal Operation - Briquetting  
((\$5/ton of feedstock added operating cost)  
(Unproven technology - Gasification of Briquets)
2. Eastern Coal Operation - Stirred gasifier  
(Unproven technology - Increased capital and operating costs)



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

Environmental Risks (REF. Section A2)

1. Will Best Available Control Technology (BACT) be required on the "end-use" equipment; in Erie's case, the pelletizing plant?  
We estimate that 50-70 million dollars in capital and (as yet un-defined) additional operating costs would be incurred as a result of such a ruling.
2. How will regulations concerning present "unknowns" affect the economics of the process, e.g. gas combustion, ash-sulfur and other by-product disposal or storage.

Each of these risks areas can significantly affect the cost and viability of both the Demonstration and Commercial Plant.

A significant potential exists for increases in both operating and capital costs in addition to current cost estimates which in themselves are considerably above current and projected alternate costs.

Erie indicated in its' correspondence of December 13, 1978, (ERDA-335) that "proceeding with the demonstration or commercial plant is not practicable and not in the best interests of the Government or Erie."  
We also in the same correspondence, recommended a reduced scope of activities in light of the above statements.



Final Report  
Erie Mining Company  
Coal Gasification Project  
DOE Contract EW-78-C-02-5066  
(ET-78-C-01-2578)  
Revised August 1, 1979

As a result of the Erie/DOE cost meeting on January 19, 1979, a final reduced scope of deliverables was mutually agreed upon the plans to finalize Phase I deliverables were agreed to. (REF. ERDA-349)

Erie continues to assert that proceeding with the demonstration plant or commercial plant is not practicable, and therefore, not in the best interests of the Government of Erie.

Further, Erie recommends that DOE and Erie mutually agree to terminate their contract with the finalization of Phase I activities, as per the mutually reduced scope of work.