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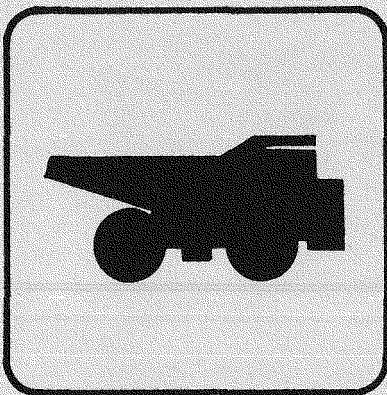
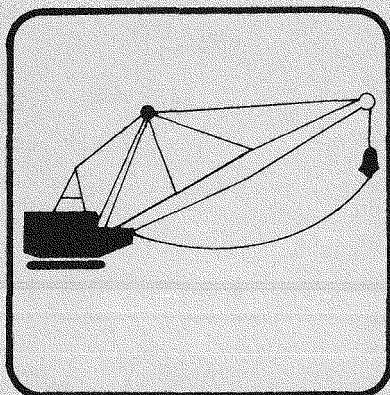
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FINAL REPORT
VOLUME 6

Economics of Large-Scale Surface Coal Mining Using Simulation Modes


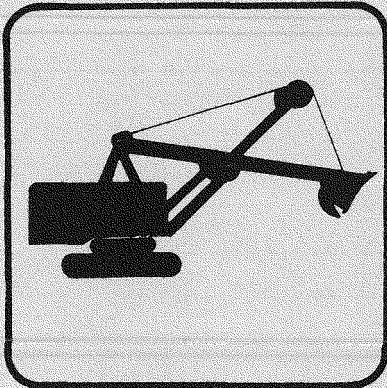
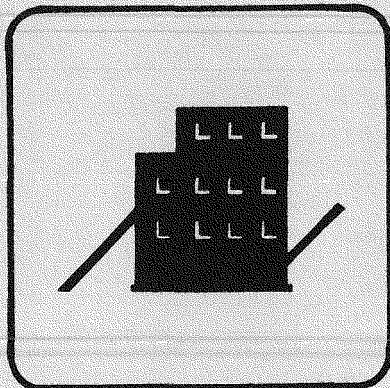
Contour Stripping with Draglines
Using Appalachia-Ohio Region Test Case

MASTER



ENERGY RESEARCH &
DEVELOPMENT
ADMINISTRATION

OFFICE OF
FOSSIL ENERGY

WORK PERFORMED UNDER
CONTRACT NO.
EX-76-C-01-1520

FLUOR UTAH, INC.
SAN MATEO, CALIF.

BONNER & MOORE
ASSOCIATES, INC.
HOUSTON, TEXAS

MARCH, 1977

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Final Report

Volume 6

ECONOMICS OF LARGE-SCALE SURFACE COAL MINING
USING SIMULATION MODELS

Contour Stripping with Draglines
Using Appalachia-Ohio Region Test Case

FLUOR UTAH, INC.
San Mateo, CA 94402

and

BONNER & MOORE ASSOCIATES, INC.
Houston, TX 77002

MASTER

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PREPARED FOR THE UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Under Contract No. EX-76-C-01-1520

ECONOMIC SYSTEM ANALYSIS OF
COAL PRECONVERSION TECHNOLOGY

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ABSTRACT

Large-scale surface coal mining will play a key role in meeting the future energy needs of the United States, especially in affecting the costs of coal conversion and advanced combustion processes being developed by the U.S. Energy Research and Development Administration (ERDA). Fluor Utah, Inc., with Bonner & Moore Associates, Inc. as subcontractor, was contracted by ERDA to study the costs and problems of large-scale surface coal mining. This project resulted in a series of computer models for use by the industry in mine planning and analysis, and by government in estimating future energy costs.

This report describes the simulation models representative of contour stripping with dragline mining techniques which were developed, documented and tested. Two types of models were developed: detailed micromodels, which provide detailed information on mining systems and equipment to assist in mine design and equipment selection; and broad macromodels, which provide a first-order evaluation of deposits and new ventures for an entire mining complex.

The Appalachia (Ohio) Strippable Coal Resource Region was used to test the models. A hypothetical mining situation representative of typical mining problems and conditions encountered in the Appalachia (Ohio) Region was selected.

The models were used to estimate mining costs for the hypothetical baseline situation and for sensitivity analysis varying both mining parameters and financial assumptions. The results of the test case indicate potential coal prices for a range of geologic and economic assumptions.

The models are part of a series developed for mine planning and economic analysis of surface coal mines. The complete series designed for use by government or private industry, permits examination of large-scale surface coal mining under a variety of terrain conditions and overburden depths. Each major operation in the coal mining process is represented in these models so that the best methods and equipment may be selected and so that the impact of such selection will be reflected in estimates of capital investment, operating costs, and sales price.

1.0 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to describe the development of simulation models for large-scale surface coal mining projects using the contour stripping with draglines mining method. A hypothetical test situation in the Appalachia (Ohio) Region is described, and simulation results for this test situation are presented.

1.2 PROJECT OVERVIEW

Realizing that large-scale surface coal mines would be needed to supply feedstocks for conversion processes currently under development, the U.S. Energy Research and Development Administration sponsored this project to be better able

to determine expected costs for future energy, and

to provide the industry with planning and analysis models to aid in meeting future increased production needs.

The project encompassed 42 months of work at a cost of \$2.5 million involving both the mining and process engineering staff of Fluor Utah, Inc. as prime contractor and the consulting and computer programming staff of Bonner & Moore Associates, Inc. as the major subcontractor.

Successful completion of the project has provided the following immediate benefits:

Scientific planning for coal deposit exploitation by the U.S. coal industry has taken a significant step forward in this project.

Both government and industry, as a result of this project, have a number of powerful tools at their disposal for use in future expansion of surface coal mining.

Information provided by the models will aid in proper planning, equipment selection and exploitation techniques so the coal industry can efficiently scale up to meet the energy needs of the United States.

1.3 PROJECT OBJECTIVES

The first objective of this project is to develop, test and document simulation models representative of current surface mining techniques. The models provide mine designers, policy planners, and engineering managers with the ability to analyze a surface coal mine at two levels of detail. To achieve this goal two types of computer models have been developed:

Detailed Micromodels. These models provide estimates for a detailed part of a large-scale surface mining complex. Individual models allow the user to separately analyze overburden removal, overburden drilling and blasting, coal drilling and blasting, coal loading and hauling, coal preparation and handling, land reclamation, and premining, facilities, and administrative expenses.

Broad Macromodels. These models provide a first order estimate for an entire mining complex. All the detailed operations considered separately by the micromodels are contained as subroutines in the macromodel. In several cases simplified macromodel relationships were derived from detailed micromodel studies. Macromodels have been developed for three mining methods identified by the method of removing overburden: area stripping with draglines, area stripping with shovels and trucks, and contour mining with draglines.

These detailed micromodels and broad macromodels plus supporting information and user manuals, are available to all interested private and public organizations.

The second objective is to use these computer models to estimate mining costs for hypothetical test situations in the eight major United States coal resource regions where coal is likely to be surface mined. The coal resource regions investigated are shown on Figure 1. Results of these analyses, including the sensitivity of coal costs to different mining and financial parameters, are presented in eight separate reports listed in Appendix A.

The objective of Phase I was to delineate the large deposits of surface minable coal in the United States, collect equipment costs and performance data needed to calculate surface coal mining costs, describe major surface mining and coal preparation methods, and investigate the socioeconomic impact of large mining complexes. This information provided a framework for achieving the project objectives. A six-volume Phase I report listed in Appendix B, was issued.

A total of fifteen models have been developed: eleven detailed micromodels, three simplified macromodels, and one economic analysis model. Table 1 shows the mining functions analyzed by each model as well as the types of mining that can be studied.

1.4 COMPARISON OF BROAD MACROMODEL AND DETAILED MICROMODELS

Figure 2 is a flow diagram of the micromodeling and macromodeling systems as applied to the area stripping with draglines mining method. The diagram would have the same form for the other mining methods but would show different models as appropriate to the mining operations. It can be seen that the micromodel system involves using up to seven models, while the macromodel system involves a single model preceding the cash flow analysis. With the micromodel system the user must analyze the model results and prepare the cash flow input, whereas that input is developed directly by the macromodel system.

Both systems begin with a tract description and end with the results of a cash flow analysis. The main difference between the types of models is the number of steps required to reach a solution.

The macromodel system requires only one manual step, i.e., defining case study parameters. The computer programs perform all calculations required to obtain a solution. Thus, first-order estimates can be obtained in a single step. The macromodels are designed to provide answers even for cases where little verified field data are available about the site or region under study. The macromodel user may define all mining and financial parameters; however, each model uses default values, typical of the mining method and region, for all parameters not supplied by the user.

In contrast, the micromodel system requires several manual steps since each mining function is examined separately with the user interpreting the results from each model. This procedure permits interactive use of the computer with decisions being made by the user at each stage of the analysis. The micromodels are designed for use where considerable field data are available. They may be used in less well defined situations since each micromodel also has default values which may be acceptable substitutes for unavailable field data.

Table 1. Computer Models for Simulation of Surface Coal Mining

	Detailed Micromodels		Broad Macromodels		
	Dragline Mining	Shovel Truck Mining	Area Dragline Mining	Shovel Truck Mining	Contour Dragline Mining
Overburden Removal	Basic Stripping Method (BSM) Extended Bench Method (EBM) Contour Stripping Dragline (CSD) (Ref: Report FE-1520-114)	Shovel Truck Stripping (STS) Multiple Dipping Seams (MDS) Mountain Top Removal (MTR) (Ref: Report FE-1520-115)	Area Dragline Macromodel (ADM) (Ref: Report FE-1520-110)	Area Shovel Truck (AST) (Ref: Report FE-1529-111)	Contour Dragline Macromodel (CDM) (Ref: Report FE-1520-112)
Coal Load and Haul	Haul Unit Simulation (HUS) Coal Load/Haul (CLH) (Ref: Report FE-1520-116)				
Overburden Drilling & Blasting	Drilling And Blasting (DAB) (Ref: Report FE-1520-116)				
Coal Drilling & Blasting	Drilling And Blasting (DAB) (Ref: Report FE-1520-116)				
Land Reclamation	Land Reclamation Simulation (LRS) (Ref: Report FE-1520-116)				
Coal Handling and Preparation	Preparation/General Administrative (PGA) (Ref: Report FE-1520-116)				
Premining, Facilities and Administrative	Preparation/General Administrative (PGA) (Ref: Report FE-1520-116)				
Economic Analysis	Cash Flow Analysis (CFA) (Ref: Report FE-1520-113)				

Thus, the type of model used depends on the following factors:

1. Availability of field data:
If little, use broad macromodel.
If great, use detailed micromodels.
2. Desired interaction between user and computer:
If little, use broad macromodel.
If great, use detailed micromodels.
3. Desired detail of analysis:
If little, use broad macromodel.
If great, use detailed micromodels.

Once equipment selections have been made the next step is to develop equipment and manpower lists and investment and operating costs. These data are manually compiled when the micromodels are used but developed directly by the macromodel. The final step is the estimation of the coal sales price required to yield a specified return on investment or the return that could be expected from a specified sales price. The Cash Flow Analysis (CFA) model is used for this final step. It develops a complete discounted cash flow analysis of the project and prepares the following reports:

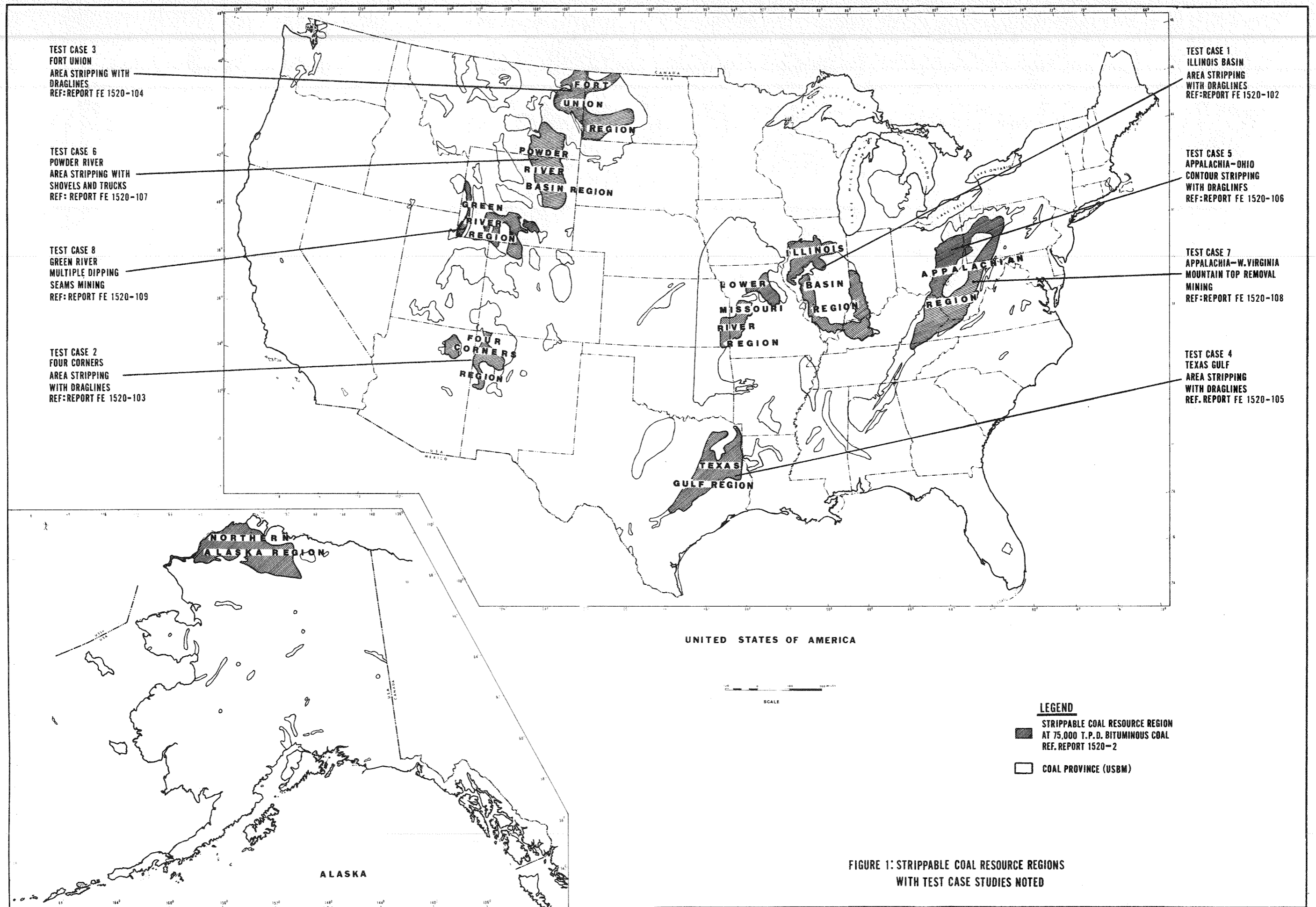
- Financial Summary Report
- Case Description
- Investment List
- Operating Personnel List
- Maintenance Personnel List
- Services and Materials List
- Infrastructure Report
- Production and Cash Expenditure Table
- Financial Statements.

These reports provide the user with a wide range of information useful in evaluating a large-scale surface coal mining project in terms of capital investment, operating costs, and profitability.

1.5 POTENTIAL APPLICATIONS

1.5.1 DETERMINATION OF COAL COSTS FOR COAL CONVERSION AND COMBUSTION

The cost of coal comprises a significant portion of the selling price of synthetic gas, liquid products or electricity produced from coal. Because the competitiveness of these energy options depends so strongly on coal costs, it is important to make reasonably accurate estimates of mining costs. This is particularly true for surface coal mines



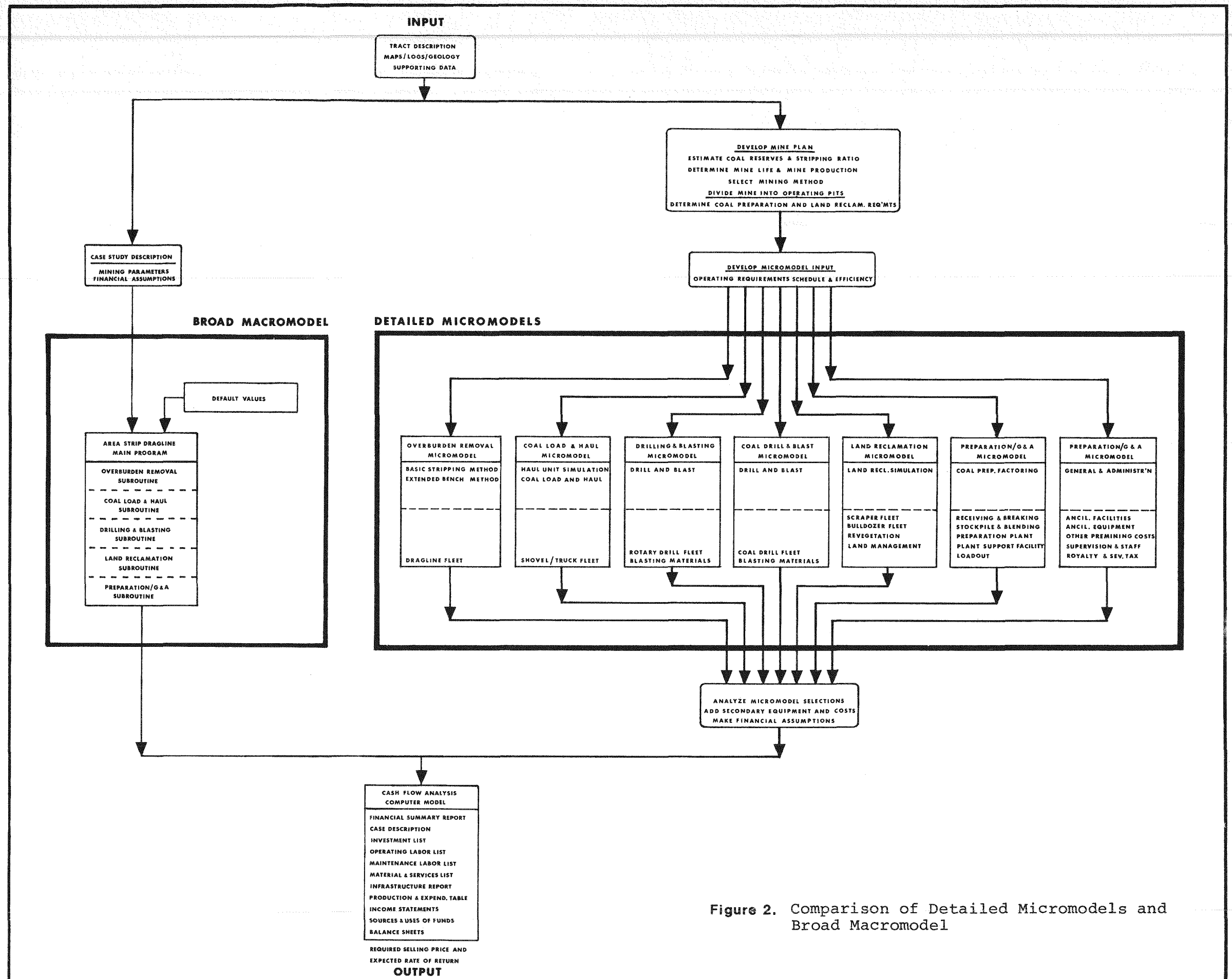


Figure 2. Comparison of Detailed Micromodels and Broad Macromodel

which currently supply approximately one-half of U.S. coal production and are expected to supply even more of the U.S. coal demand in the future.*

The macromodels can be used to develop first-order costs for coal conversion process evaluation. The detailed micromodels can be used for more precise cost determination for specific plants.

1.5.2 MINE EVALUATION

Mine evaluation typically progresses through a series of steps from initial order-of-magnitude estimates through final engineering and start-up as follows:

- Order-of-Magnitude Estimate
- Preliminary Estimate
- Basic Engineering
- Detailed Engineering
- Procurement
- Construction
- Start-up.

The broad macromodels can be used to inexpensively obtain order-of-magnitude estimates for initial reserve evaluation.

As more field data is collected, preliminary estimates can be made using: 1) the macromodels for analyzing the overall mining complex, and 2) the detailed micromodels for analyzing critical mining functions.

In the basic engineering stage the computerized models can be used to examine a wide range of alternatives for both mining and processing prior to committing large expenditures for the preparation of detailed engineering drawings, specifications, calculations, and estimates. Using the results of field investigation and testing to further refine model default values with actual realistic data, a great many cases can be run rapidly and inexpensively to examine many alternative mining methods, mining plans, processing methods, equipment types, and equipment sizes.

*REFERENCE: Cyril W. Draffin, Martin R. Adams, Paul O. Hedman and Christian W. Knudsen, "Economic Analysis of Coal Conversion Processes," presented at Third International Conference on Coal Research, Sidney, Australia, October 6-8, 1976. (Available from ERDA Fossil Energy, Washington, D.C. 20545).

The detailed micromodels can be used as an aid in preparing year-by-year mine plans.

The cash flow analysis model can be used to update profitable projections as construction and purchase commitments are made.

1.5.3 EVALUATION OF GOVERNMENT POLICY

Government policies affecting coal mining costs that could be evaluated include: leasing of federal lands, alternative land reclamation requirements, various depreciation methods, increased labor and equipment costs due to safety requirements, state severance taxes, royalty costs, price subsidies, and construction grants.

The models can also be valuable in estimating long term coal price projections. Curves representing the cost of coal as a function of the cumulative amount of coal mined (coal supply curves) could be constructed for coal resource regions.

1.5.4 ENVIRONMENTAL IMPACT ASSESSMENT AND EVALUATION

The infrastructure report printed by the Cash Flow Analysis model presents information in four categories:

- Physical Effects
- Economic Impact
- Utility Requirements
- Manpower Requirements.

This type of information can be used to assess environmental and socioeconomic impact.

1.5.5 PUBLIC ACCESS TO THE SIMULATION MODELS

The simulation models are on line on a Xerox Sigma Seven computer as of the completion of the project. They can be run either in time share (remote terminal) or batch mode. The ultimate method of continued public access to the models has not been decided. Those desiring an up-to-date status of the availability of the models should contact one or more of the following as appropriate:

1. The Fossil Energy Office of the Energy Research and Development Administration in Washington, D.C., which sponsored the project, should be contacted for questions regarding government participation and government agency use.

2. Fluor Utah, Inc., San Mateo, California, which supplied the mining and process engineering expertise for the project, should be contacted for questions regarding the formulation of mining problems, equipment selection logic, and interpretation of simulation results.
3. Bonner & Moore Associates, Inc., Houston, Texas, which supplied the simulation modeling and consulting expertise for the project should be contacted for questions regarding mathematical modeling techniques and details of time share or batch use of the models.

1.6 TEST CASE RESULTS

The first step in analyzing the test case was to develop a baseline solution using both the detailed micromodels and the broad macromodel for a mining complex producing coal with sufficient Btu content to nominally supply a 250 million cubic feet per day gasification plant, a 40,000 barrel per day liquefaction plant, or a 1500 megawatt power plant.

The result was a mining complex with six pits and three preparation plants producing approximately 5.1 million tons of prepared coal per year. A 4-foot coal seam with a stripping ratio of approximately 12.5 bank cubic yards of overburden per ton of run-of-mine coal was assumed.

The situation was selected for the test case to describe conditions that would represent practical mining problems typical of the region. The geologic and topographic situation chosen is representative of a typical situation, not a statistical average nor an actual situation.

The next step in analyzing the test case was to determine the sensitivity of solution values to the following mining and financial parameters:

Mining Parameters

Coal Preparation Requirements (Crush and Screen, Baum Jig, or Heavey Media)	Annual Energy Demand for Complex
Height of Overburden	Run-of-Mine Coal Heat Value
Height of Topsoil Saved	Reclamation Cost Per Acre for Dozing, Revegetation, and Land Management
Height of Coal	

Financial Parameters

Capital/Debt Ratio	Federal Income Tax
Mineral Rights	Rate
Surface Rights	Long-Term Interest
Royalty Payment	Rate
Severance Taxes	Short-Term Interest
Cash Flow Discount Rate	Rate

The parameters were varied one at a time through a range of values from extreme low to extreme high. The range of values used represents practical limits for each variable based on operating experience and field investigation. The results illustrate the relative sensitivity of the coal price to changes in the primary input parameters. These results are reported in detail in Section 6 of this report.

Regional studies, which are recommended for future study, were not considered as part of the current project. Nevertheless the test case results are of interest because they provide a first-order estimate of the costs and problems of mining in a given region using a specified mining method. With the caution in mind that the values shown represent only hypothetical test situations, it is of interest to compare results in the following key areas:

- Coal Price
- Capital Investment
- Annual Direct Operating Cost
- Requirements for Individual Mining Functions.

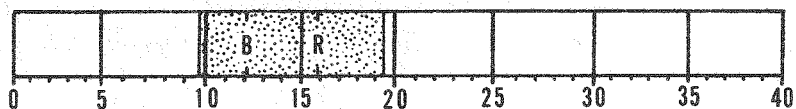
1.6.1 COAL PRICE

The required coal price can be expressed in two ways: 1) dollars per ton of coal shipped, or 2) dollars per million Btu of heat value of coal shipped. As shown in Figure 3, the coal price varies from approximately \$10.00/ton to \$19.50/ton with a baseline value of approximately \$12.70/ton (no escalation, 10 percent rate of return). The ranges shown in Figure 3 are based on the highest and lowest values resulting from variation of mining parameters only.

TEST CASE 5
IN OHIO

EXAMPLE TEST CASE RESULTS

ESTIMATED PRICE (DOLLARS PER TON OF COAL) *
TO ACHIEVE SPECIFIED RETURN ON INVESTMENT



DOLLARS PER TON

(ALL COSTS IN JANUARY 1975 DOLLARS WITH NO ESCALATION)

ESTIMATED PRICE (DOLLARS PER MILLION BTU's) *
TO ACHIEVE SPECIFIED RETURN ON INVESTMENT



DOLLARS PER MILLION BTU's

(ALL COSTS IN JANUARY 1975 DOLLARS WITH NO ESCALATION)

* COVERS COST OF MINING AND PROCESSING;
TRANSPORTATION NOT INCLUDED

B= BASELINE SOLUTION, RETURN ON INVESTMENT

R= RETURN ON INVESTMENT SET TO 15%

Figure 3. Estimated Price of Coal

The most important financial parameters affecting coal price are return on investment and escalation. The effect of changing return on investment from 10 percent to 15 percent, as an example, is shown in Figure 3. To underscore the impact of escalation, an additional set of example sensitivity studies were made to compare baseline results (no escalation) with 5 percent escalation of all investment and operating costs holding price constant, and with 5 percent escalation allowing price to escalate at 5 percent also. The results are shown in the following tabulation:

Estimated Price (Dollars per ton)

<u>No Escalation</u> <u>Price Constant</u>	<u>5% Cost Escalation</u> <u>Price Constant</u>	<u>5% Cost Escalation</u> <u>5% Price Escalation</u>
all years 12.70	all years 24.82	first year last year 14.45 to 65.57

1.6.2 CAPITAL INVESTMENT

The range of capital investment resulting from variation of mining parameters is shown in Figure 4. Capital investment includes all equipment, premining, and facilities costs. For the Appalachia (Ohio) test case the capital investment varies from approximately \$125 million to approximately \$245 million with a baseline value of approximately \$160 million.

1.6.3 ANNUAL DIRECT OPERATING COST

The range of annual direct operating costs resulting from variation of mining parameters is also shown in Figure 4. Operating costs vary from approximately \$20 million/year to approximately \$39 million/year with a baseline value of approximately \$26 million/year.

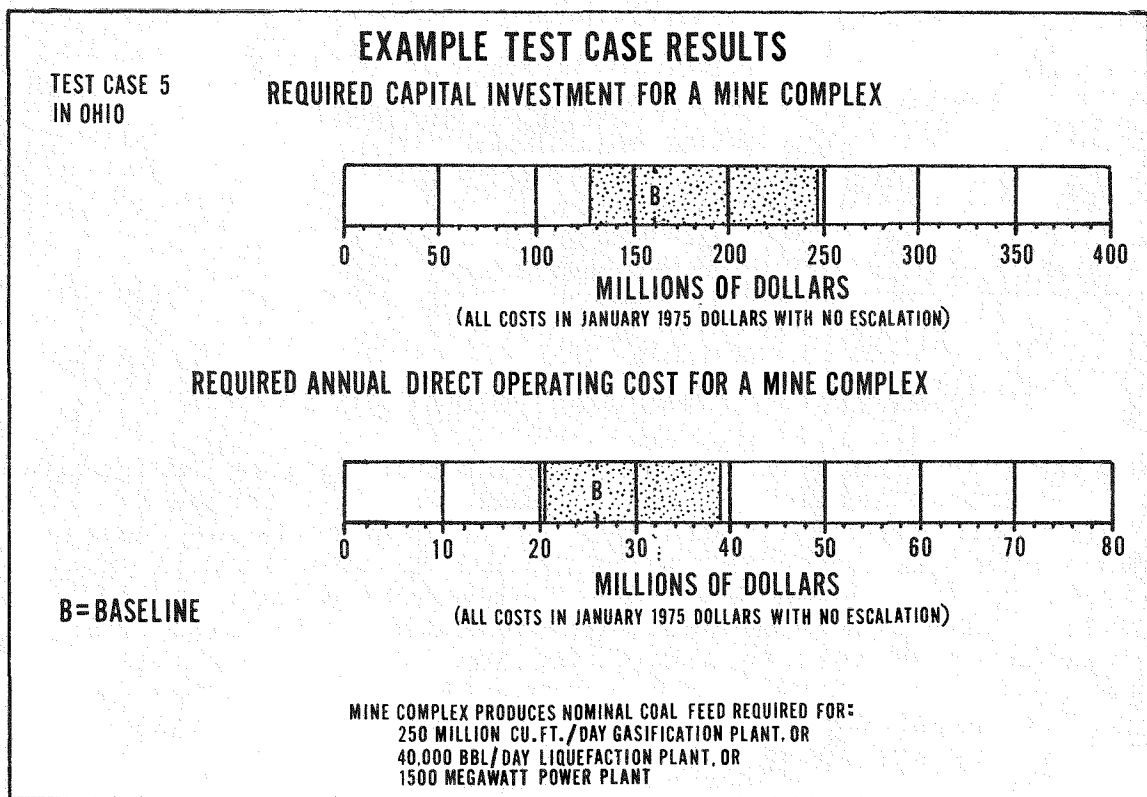


Figure 4. Comparison of Required Capital Investment and Operating Cost

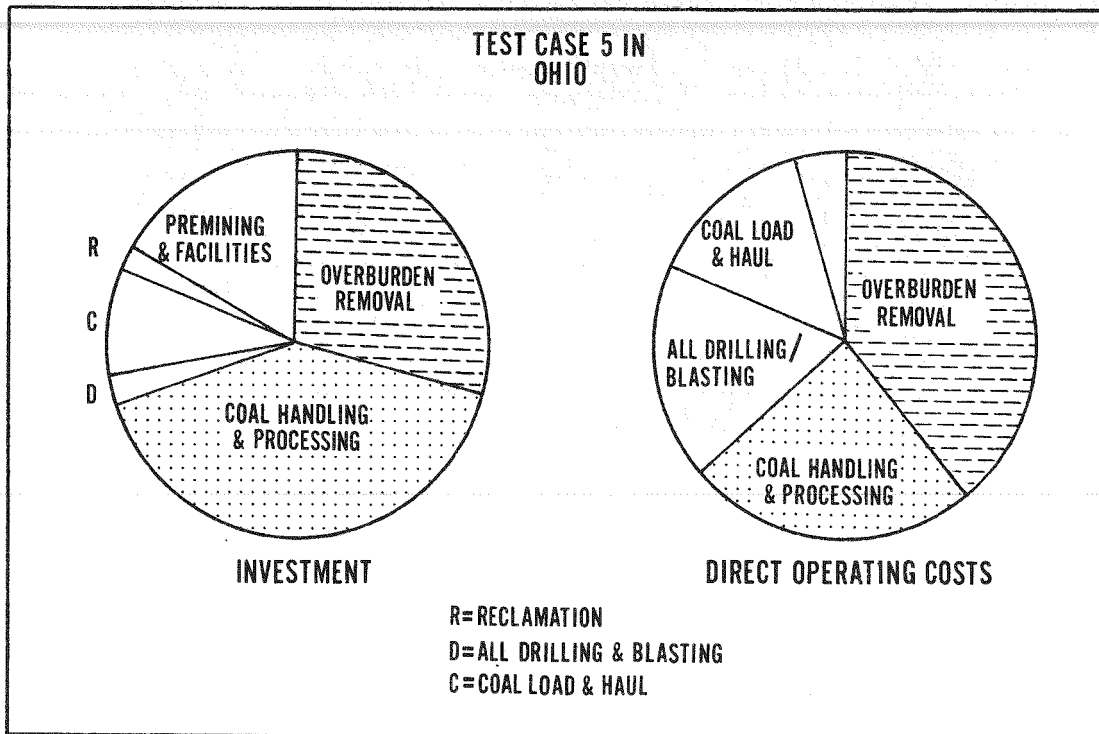


Figure 5. Percent of Capital Investment and Operating Cost by Mining Function

1.6.4 RELATIVE IMPORTANCE OF MINING FUNCTIONS

The percentage of capital investment and operating costs for each mining function is shown in Figure 5. Overburden removal accounts for approximately 29 percent of investment and 39 percent of operating costs. Coal handling and processing accounts for approximately 41 percent of investment and 25 percent of operating costs.

One reason for the high percentage of capital cost for coal handling and processing is the extensive blending and stockpiling facilities which may be required to provide a uniform, stable feedstock to a coal conversion plant.

This comparison of capital investment and annual operating costs underscores the fact that in large-scale surface coal mining, especially to produce feedstock for a coal conversion plant, it is not the extraction of the coal that has the greatest impact on cost. Rather, it is the removal of the overburden and the processing of the coal to meet feedstock requirements that account for the major costs.

2.0 DESCRIPTION OF THE MINING METHOD - CONTOUR STRIPPING WITH DRAGLINES

2.1 MINING OPERATIONS AT EACH PIT

A mining complex may consist of one or more pits. A pit is the active working area where coal is being uncovered and loaded. When the area stripping with draglines mining method is employed, the following activities are part of the mining operations at each pit:

- Overburden drilling and blasting
- Overburden removal
- Coal drilling and blasting (not required for Appalachia-Ohio)
- Coal loading and hauling
- Land reclamation.

These mining operations are largely independent activities, but must be coordinated to avoid delays or bottlenecks. All operations must advance at the same annual rate to provide uniform progress through the mine property. The physical relationship of the various operations is shown schematically in Figure 6, the plan view of a hypothetical area stripping pit. A detailed discussion of large-scale surface mining methods and equipment can be found in Volume 3 of the Phase I Report (Ref: FE-1520-3).

2.1.1 OVERBURDEN DRILLING AND BLASTING

A pattern of vertical blast holes is drilled with a rotary drill and the blast holes loaded with the specified amount of blasting agents, primers, and detonating cord. The blasting agent and primer fills only a portion of the blast hole; fine drill cuttings or other suitable material (termed stemming) fills the remainder of the blast hole. Blast holes are detonated according to a planned sequence or series designed to obtain efficient fragmentation of the overburden. A typical self-propelled rotary drill used for drilling overburden blast holes is shown in Figure 7.

Drilling and blasting is performed following land clearing and topsoil removal and prior to overburden removal.

2.1.2 OVERBURDEN REMOVAL

Overburden is excavated by a walking dragline one panel at a time and cast to spoil piles occupying the panel mined previously. A typical walking dragline is shown in Figure 8.

With the removal of the overburden, the coal seam is exposed and ready for loading and hauling.

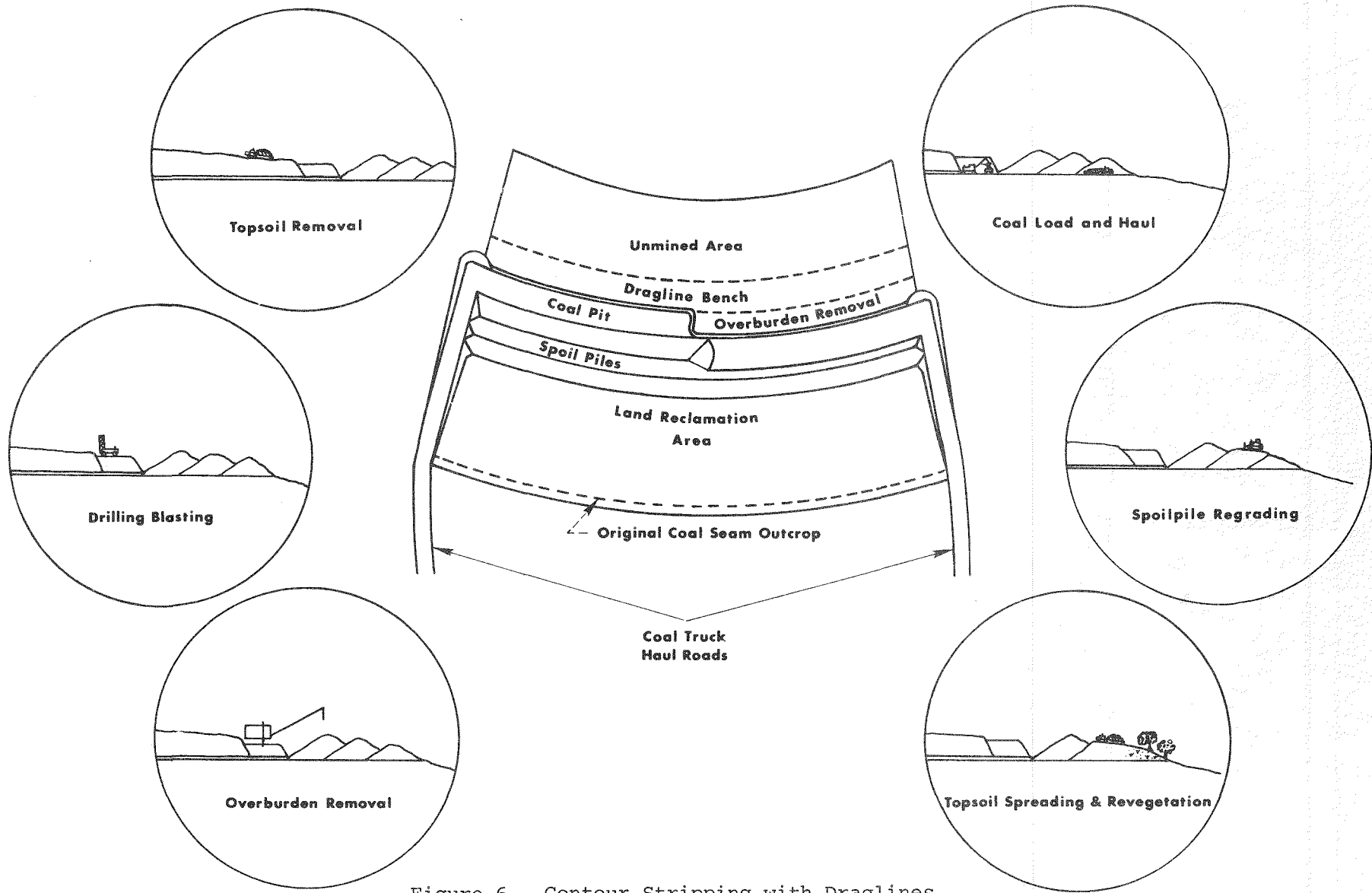


Figure 6. Contour Stripping with Draglines
Hypothetical Pit



Figure 7. Rotary Drill for Overburden Drilling

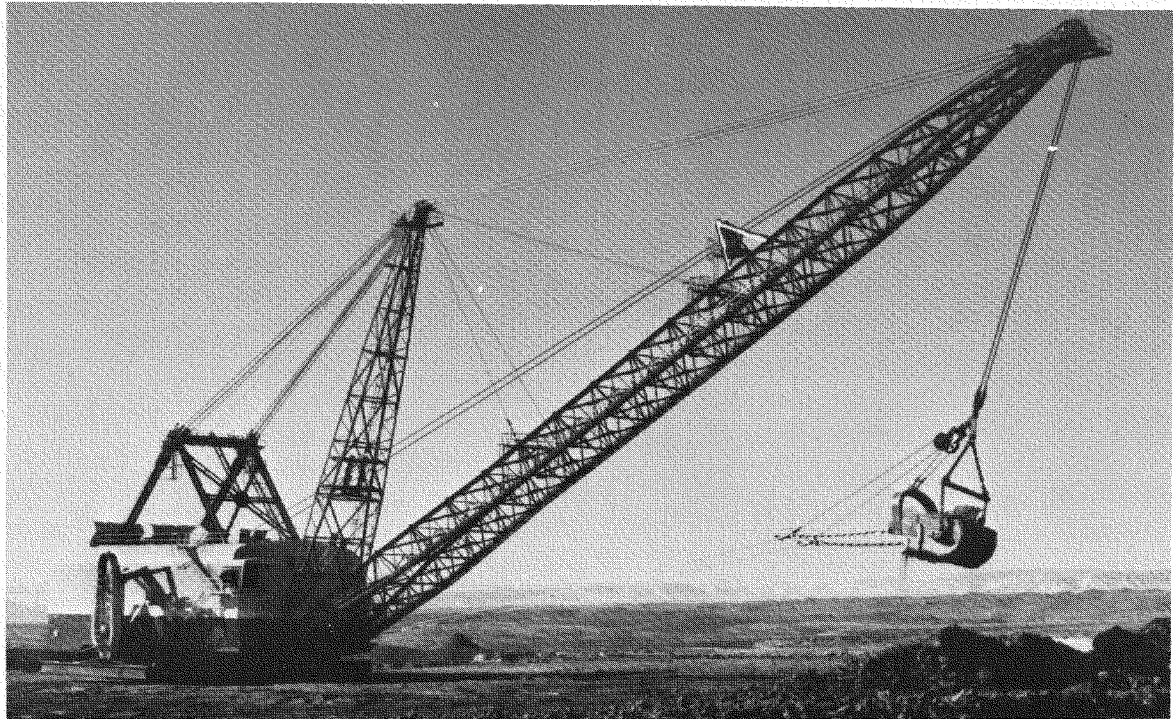


Figure 8. Walking Dragline for Overburden Stripping

2.1.3 COAL LOADING AND HAULING

Coal is loaded by a shovel located in the pit bottom and hauled by a fleet of bottom dump trucks which shuttle between the pit and the receiving station at the preparation plant. The shovel loads the coal from the exposed seam into waiting trucks adjacent to the point of excavation. The trucks will travel either on top of the coal seam or on the pit bottom. The trucks have access to the pit via ramps through the spoil piles. A typical coal shovel and bottom dump coal truck are shown in Figures 9 and 10.

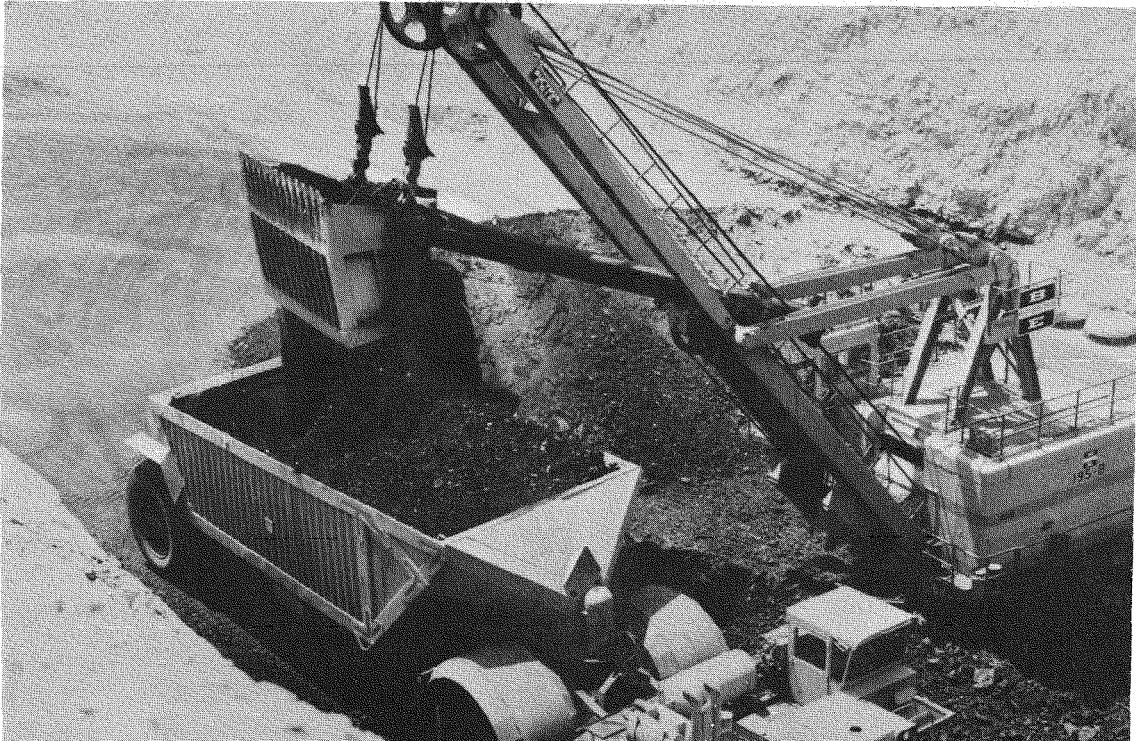


Figure 9. Coal Loading Shovel

2.1.4 LAND RECLAMATION

Land reclamation includes the following operations:

- Topsoil removal
- Topsoil spreading
- Spoil pile regrading
- General dozing
- Revegetation
- Land management.



Figure 10. Bottom Dump Coal Hauling Truck

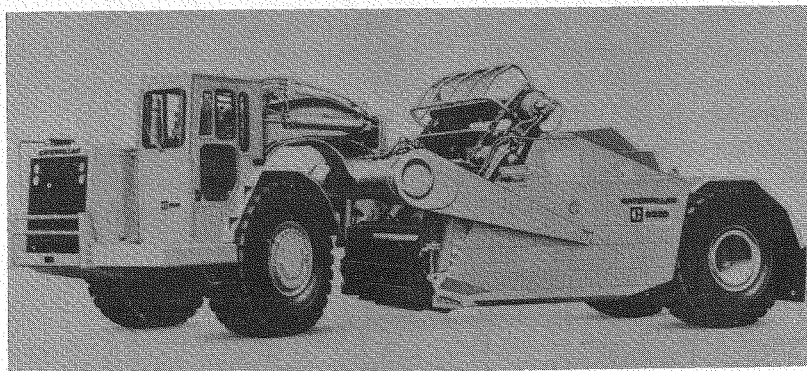


Figure 11. Self-Loading Scraper for Removal and Redistribution of Topsoil

Topsoil removal is accomplished by a fleet of self-loading elevating scrapers. The scraper fleet hauls the topsoil from the cleared area, ahead of drilling and blasting, to the regraded area on the spoil piles on the other side of the pit. Scrapers are also used to spread the topsoil prior to revegetation. A typical self-loading scraper is shown in Figure 11.

Spoil piles are regraded by a fleet of bulldozers which level the peaks and valleys left behind by the dragline. Bulldozers are also required for general reclamation activities, including recontouring, drainage control, erosion control, ditching, and dam work. A typical track-type tractor with bulldozer is shown in Figure 12.

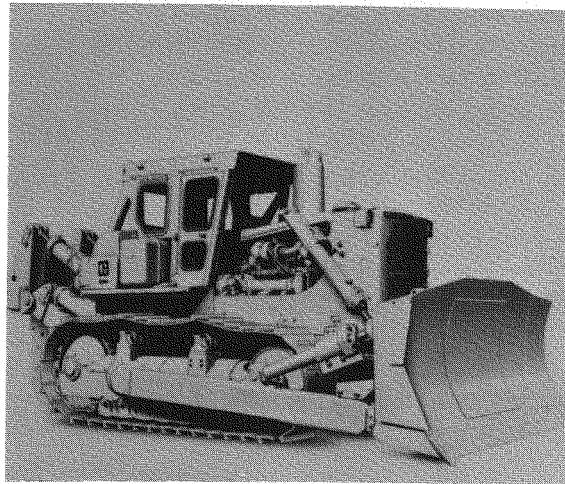


Figure 12. Track-Type Tractor with Bulldozer for Regrading Spoil Piles and General Reclamation

Revegetation includes preparation of the soil prior to planting, the addition of required soil amendments, and reseeding.

Land management costs include follow-up activities to ensure long-term revegetation (including reseeding of areas remaining barren following initial revegetation effort), plus interest on posted land reclamation bonds.

2.1.5 SUPPORT EQUIPMENT FOR MINING OPERATIONS AT EACH PIT

Several types of support equipment are required for the primary operations at each pit:

Overburden drilling and blasting:

- Bulldozer to prepare bench for drill
- Bulldozer to push cuttings into holes
- Prill truck to deliver blasting agents and supplies.

Overburden removal:

- Bulldozer to clean up bench for dragline movement
- Loader with cable reel to handle dragline power supply cable
- Secondary dragline with small bucket to remove high spots, build level bench for primary machine, control drainage, etc.

Coal loading and hauling:

- Loader to clean the top of coal
- Grader to maintain the haul road
- Water truck to maintain the haul road
- Pumps to remove water from pit.

It is assumed that no major road-building equipment is required.

2.2 CENTRAL OPERATIONS FOR THE MINE COMPLEX

A mine complex consists of one or more pits, each providing coal to a central preparation and loadout facility. The central operations serving the entire complex provide two basic functions: coal handling and preparation, and general and administrative activities.

2.2.1 COAL HANDLING AND PREPARATION

Coal preparation is a process for treating run-of-mine or raw coal to meet market specifications. Commonly, this is accomplished by mechanical sorting of particles in a medium of water. (Chemical processes are currently under investigation.) Prepared coal normally has defined physical property specifications, higher calorific value, and lower moisture, sulfur and ash contents than raw coal. It is a premium quality coal which has advantages in the conversion process.

Coals, as they occur in the ground, are extremely heterogeneous with characteristics that vary widely from seam to seam and within an individual seam. They tend to be adulterated with "deleterious dirt" which results in ash or sulfur products upon conversion. Complicating the inherent complexity and heterogeneity of coals is the mining process which introduces additional adulterants, including waste rock, mineral partings within the seam, and tramp materials. Therefore, run-of-mine coal usually requires preparation.

Three Levels of Preparation Difficulty

Through the use of developed flowsheets, equipment lists and arrangement drawings, capital costs have been determined for three different coal preparation plants. The plants represent levels of preparation difficulty which provide three cost alternatives for study, as shown in Table 2.

TABLE 2. THREE TYPES OF PREPARATION PLANTS

DIFFICULTY OF PREPARATION	THEORETICAL WASHABILITY DATA REQUIRED	PLANT DESIGN (FLOWSHEET)
Slight	Size consist	Crushing and screening plant
Moderate	Size consist Sink/float Washability curves	Baum jig plant
Great	Size consist Sink/float Washability curves	Heavy media plant

Coal conversion and combustion processes are expected to require different degrees of preparation; however, the benefits and extent of coal preparation are likely to be more fully recognized and defined as more becomes known about the conversion processes.

In an actual situation, the coal preparation plant is designed based on detailed knowledge of the properties of the run-of-mine coal (plant input) and the feedstock specifications of the prepared coal (plant output). For the generalized or hypothetical situation, neither coal properties nor the feedstock specifications are known.

Therefore, to provide three alternatives which would indicate the relative cost of hypothetical coal preparation approaches that might be considered in the future, the following plants have been examined:

Crushing and screening plant
Baum jig plant
Heavy media plant.

These plants have been designed based on assumed properties for the incoming coal. A coal that requires slight preparation effort was chosen as the basis for a crushing and screening plant; a coal that requires a moderate preparation effort was chosen as the basis for a Baum jig plant, and a coal that requires a great preparation effort was chosen as the basis for design of a plant requiring two-stage heavy media separation and flotation.

For each of the three hypothetical plants being studied, the following general specifications and costs have been estimated for a plant with a baseline rated capacity of 75,000 tons per day (TPD) of run-of-mine coal:

1. Capital cost
2. Yield factor $\frac{(\text{tons output of prepared coal})}{(\text{tons input of run-of-mine coal})}$
3. Rated capacity.

Cost extrapolation factors have been developed to establish preparation plant costs as shown in the following formula:

$$\begin{array}{l} \text{Cost for plant} \\ \text{of specified} \\ \text{capacity} \end{array} = \begin{array}{l} \text{Cost for plant} \\ \text{of baseline} \\ \text{capacity} \end{array} \times \frac{\begin{array}{l} \text{Rated Production} \\ \text{Specified Plant} \\ \text{Rated Production} \\ \text{Baseline Plant} \end{array}}{\begin{array}{l} \text{Rated Production} \\ \text{Baseline Plant} \end{array}} \quad Y$$

Where: Y = plant cost scaling factor.

Other facilities may be required in addition to the preparation plant:

- Raw coal receiving and breaking
- Blending and stockpiling
- Prepared coal loadout
- Support facilities.

Capital costs have been estimated for hypothetical designs of each of the additional facilities.

A hypothetical overall plot plan for the coal handling and preparation facility is shown in Figure 13.

The estimated costs are hypothetical and would vary widely in actual situations. Many alternate process steps, such as grinding, briquetting, thermal drying, etc., that may be required to feed a specific conversion process with a particular coal are not included in the general hypothetical plant designs.

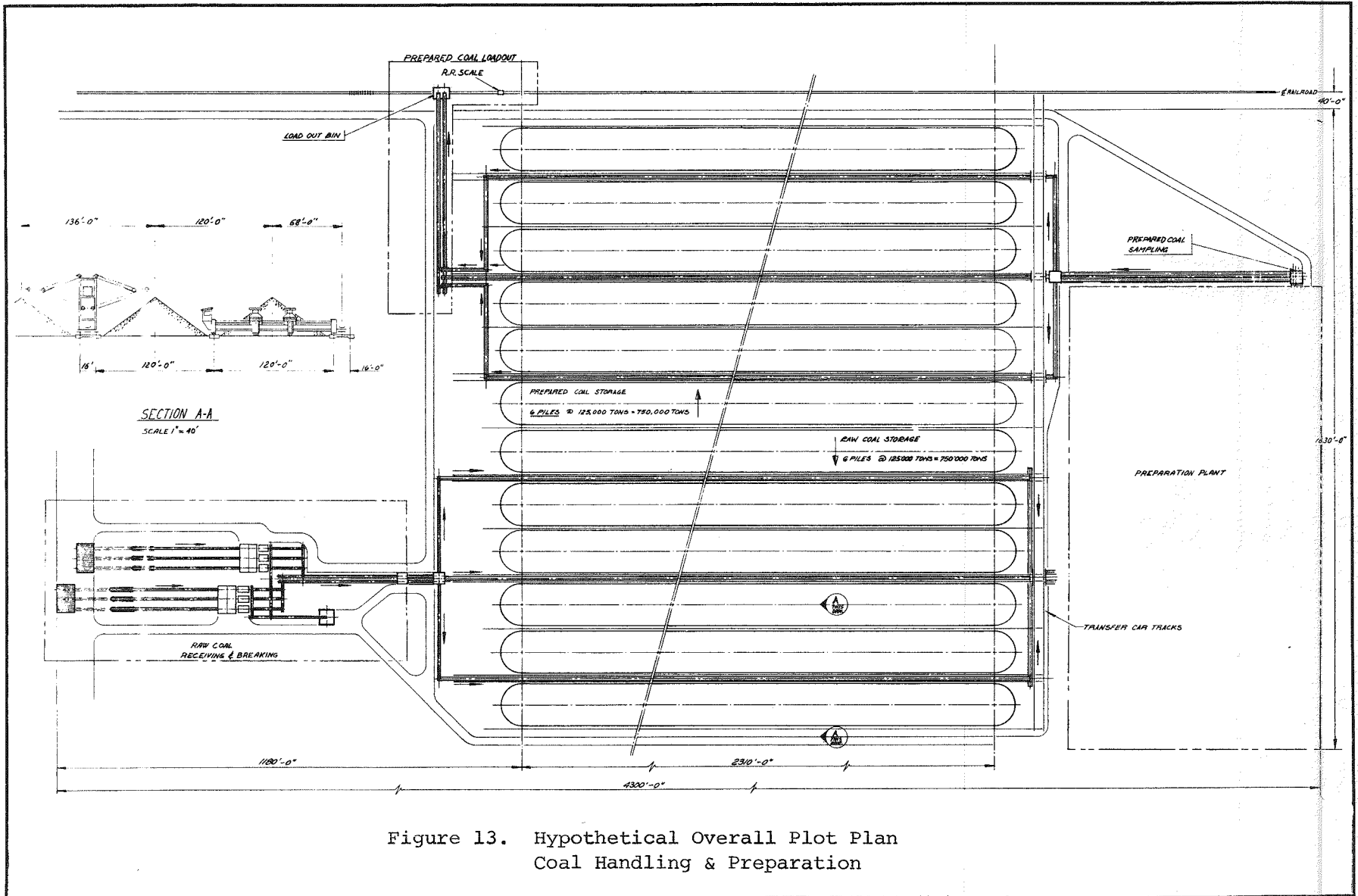


Figure 13. Hypothetical Overall Plot Plan Coal Handling & Preparation

Any one of the hypothetical plants can be combined with one or more of the required additional support facilities to form a complete preparation unit to provide coal for conversion into synthetic fuels. In order to adjust for different production rates, factoring formulas are available for each of the three plants or four facilities. However, due to the different assumptions used in the development of the plants and facilities, the probability of an actual situation matching a theoretical combination is very low; therefore, any final results should be used with great caution.

A detailed discussion of large-scale coal processing for coal conversion including process flow diagrams and equipment descriptions can be found in Volume 4 of the Phase I Report (Ref: FE-1520-4).

2.2.2 GENERAL AND ADMINISTRATIVE FUNCTIONS

The centralized general and administrative functions serving the entire mining complex have been divided into five categories:

- Ancillary facilities
- Ancillary equipment
- Other premining costs
- Supervisory and support staff
- Miscellaneous overhead costs.

Ancillary facilities include roads and site work, buildings (shops, warehouses, offices, laboratories, and other facilities), electric power system, water system, and communications system.

Ancillary equipment includes mobile equipment such as utility trucks and cranes, as well as shop equipment for maintenance operations such as machine tools and overhead cranes.

Other premining costs include initial payments for land rights, exploration drilling costs, contract engineering costs (feasibility study plus final design), and environmental impact statement costs.

The supervisory and support staff consists of mine management, supervision, technical staff, safety, administration, and purchasing.

Miscellaneous overhead costs include a cash reserve, home office expenses, royalty and severance taxes, insurance and property taxes, and inventories of spare parts, supplies, and stockpiled coal.

3.0 HYPOTHETICAL TEST CASE - APPALACHIA (OHIO)

3.1 MINING SITUATION DESCRIPTION

In order to develop a macromodel for contour stripping with draglines, a representative test situation was selected for the detailed analysis that would eventually form the foundation of the generalized macromodel relationships. The Appalachia (Ohio) Strippable Coal Resource Region, described in detail in Volume 2 of the Phase I Report (Ref: FE-1520-2) was selected for the test case, and a hypothetical situation was constructed. While this hypothetical situation does not represent an actual site, every effort has been made to describe a situation which would present itself to practical mining problems typical of the Appalachia (Ohio) region.

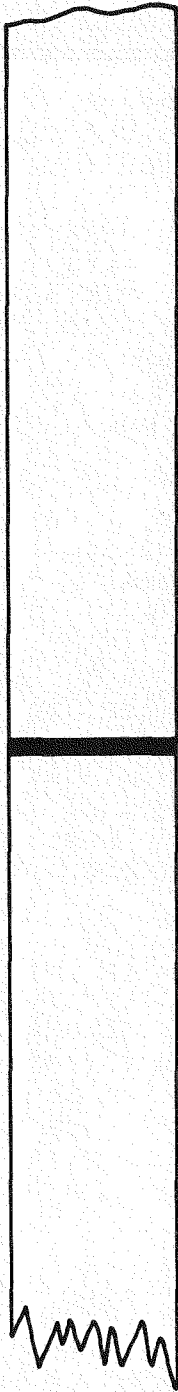
In order to fully document the underlying problems and assumptions related to the test case, the following paragraphs describe in detail the test case geology, mining complex requirements, and individual pit requirements.

3.1.1 GEOLOGY FOR TEST CASE

The geologic and topographic situation chosen for the Appalachia (Ohio) test case is representative of a majority of the conditions encountered in the region. It is not a statistical average nor an actual condition, but only a typical situation. The topography chosen for the test case was taken from U.S. Geological Survey 1:24,000 scale topographic maps of the region.

The base case geology is patterned after the Sewickly (meigs Creek No. 9) coal. Overburden thickness and characteristics, and coal seam thickness and quality are composites of data taken from the geology data base described in Volume 2 of the Phase I Report (Ref: FE-1520-2), and information obtained during field visits. The geologic situation chosen is summarized in a stratigraphic column (Figure 14), which was used in compiling a hypothetical geology map of the area.

The key geologic parameters are summarized in Table 3. The overburden density was determined by taking a weighted average of the density of the materials shown in the stratigraphic column. The overburden height was determined by the average distance between the top of coal and the surface. The swell factors, highwall angle, spoil angle and topsoil thickness are based on data gathered during field visits.



SOIL: Gray-Brown Podzolic soil 0-3 feet thick.

ROCK INTERVAL: Sandstone and shale with two thick beds of limestone (75') and sandstone (20').

0-250'

4'

COAL: Bituminous coal. Typical analysis shows Btu/lb 12,600, sulfur 4%, moisture 7%, and ash 10%.

ROCK INTERVAL: Sandstone and shale.

FLUOR UTAH, INC.

APPROVED :

FLUOR UTAH DATE

CLIENT DATE

DESIGNED BY

DRAWN BY RELAYER

CHECKED BY

APP'D

OFFICE SM

DATE 10/75

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STRATIGRAPHY

Case Study - Contour Stripping with Draglines

Figure 14

Table 3.

GEOLOGY FOR APPALACHIA (OHIO) TEST CASE

Coal Height	ft	4
Coal Heat Value	Btu/lb	12,600
Coal Density	lb/bank yd ³	2160
Coal Swell Factor		.35
Coal Face Angle	degrees	76
Burden Height Avg	ft	49.27
Burden Density	lb/bank yd ³	4300
Burden Swell Factor		.35
Burden Highwall Angle	degrees	63.43
Burden Spoil Angle	degrees	33.69
Topsoil Thickness Saved	ft	.5

3.1.2 MINING COMPLEX REQUIREMENTS FOR TEST CASE

The prime factor in determining the overall size of a mining complex is the annual amount of energy in the form of prepared coal that must be shipped from the complex. For the test case, an energy demand of 130 trillion Btu's per year was selected. This energy demand is roughly equivalent to the annual feedstock requirement for a 250 million standard cubic feet per day coal gasification plant, a 40,000 barrel per day coal liquefaction plant, or a 1500 megawatt power plant.

Assuming a 30 year life for the project and assuming that the combination of feedstock specifications and coal characteristics allow a low degree of coal preparation as represented by a crushing and screening plant, the overall production requirements for the mining complex can be determined as shown in Table 4.

3.1.3 INDIVIDUAL PIT REQUIREMENTS FOR TEST CASE

The mining complex has been divided into three identical adjacent operating pits which feed run-of-mine coal into a single crushing and screening plant. In an actual practical situation the size of each pit would vary depending on the geologic variations and land ownership patterns. For similar reasons the pits would not necessarily be adjacent to one another. Note that the rail system for long distance shipping is not included as part of the cost of the mining complex (i.e., costs carried through to the unit train loadout point).

Each individual pit in the hypothetical mining complex contains approximately 28 million tons of coal in place. The detailed individual pit requirements for a 30-year pit life are shown in Table 5.

Table 4.

MINING COMPLEX REQUIREMENTS FOR APPALACHIA (OHIO) TEST CASE

Energy Demand	Btu/yr	1.3×10^{14}
Coal Delivered	Prep tons/yr	5,140,021
Preparation Plant Type		Crushing & Screening
Preparation Plant Recovery	Prep tons/ROM tons	.99
Coal Demand	ROM tons/yr	5,191,940
Expected Coal Recovery in Mine		.92
Production Life	Years	30
Total Coal in Place	Tons	169,302,390
Stripping Ratio		
Burden bank yd^3 /ton of recovered coal		12.40
Burden Demand	Bank yd^3 /yr	64,368,113
Total Pits in Complex		6
Years in Each Pit		30
No. of Active Pits		6
Total Preparation Plants		
in Complex		3
Rated Capacity of Preparation		
Plants (Combined Total)	ROM tons/day	20,768

Table 5.

INDIVIDUAL PIT OPERATING REQUIREMENTS
FOR APPALACHIA (OHIO) TEST CASE

Overburden Drilling & Blasting	Bank yd^3 /yr	10,728,018
Overburden Removal	Bank yd^3 /yr	10,728,018
Coal Drilling & Blasting	Bank yd^3 /yr	None
Coal Loading & Hauling	ROM tons/yr	865,323
Coal Handling & Preparation (Each Plant)	ROM tons/day (250 days/yr)	6,923
Land Reclamation	Acres recl./yr	150

3.2 MINE OPERATION SCHEDULE AND EFFICIENCY

Once annual operating requirements for each pit have been established, the operating schedules and efficiency for each function are determined. In Table 6, the following six factors are defined for each mining operation:

SHY = Scheduled Hours per Year

Total number of hours in a year

(365 days x 24 hours per day = 8760 hours

less days, shifts, or hours not worked due to the following:

- a. Holidays
- b. Weekends
- c. Strikes
- d. Vacation shutdown
- e. Severe weather seasonal shutdown
- f. Preventative maintenance shifts during week
- g. Idle shifts during day
- h. Less than 8-hour shift (work rules).

AEF = Annual Efficiency Factor

Discount factor used to account for lost scheduled hours during a year due to the following:

- a. Unscheduled minor repair
- b. Unscheduled major repair
- c. Scheduled overhaul.

PHY = Productive Hours per Year

Scheduled hours per year times annual efficiency factor

ESO = Efficiency of Simulated Operation

Discount factor (sometimes expressed as minutes per hour) used to account for lost production due to:

- a. Shift startup and shutdown
- b. On-shift routine preventative maintenance
- c. Fueling
- d. Breaks
- e. Operator skill
- f. Job conditions
- g. Weather
- h. Mobility
- i. Difficulty of material
- j. Job supervision
- k. Interfaces with other operations
- l. Short moves to reposition within work area.

PTF = Propel Time Factor

Discount factor used to account for lost production due to:

- a. Moving to a working position on a new panel
- b. Moving to a working position on a new bench
- c. Moving to a working position in a new mine.

FF = Fill Factor

Discount factor used to account for lost or extra production due to:

- a. Inability of machine to carry 100% of its rated capacity
- b. Ability of machine to carry in excess of 100% of its rated capacity.

The schedules and efficiencies shown in Table 6 were used for the test case to compute machine annual production capabilities to meet pit annual production requirements. A user could vary these values to match his own field experience and production needs.

Table 6.

MINE OPERATION SCHEDULE AND EFFICIENCY

	Overburden Drill	Stripping Dragline	Coal Shovel	Coal Truck	Topsoil Scraper	Regrading Bulldozer
Scheduled Hours Per Year	3625	8297	3625	3625	2000	2000
Annual Efficiency Factor	.90	.90	.90	.90	.90	.90
Productive Hours Per Year	3262.5	7467	3262.5	3262.5	1800	1800
Efficiency of Simulated Oper.	1.00*	.833	.833	.833	.833	.75
Propel Time Factor	1.00*	.98	N/A	N/A	N/A	N/A
Fill Factor	N/A	.95	.95	1.10**	N/A	N/A

*Drilling rate specified accounts for efficiency and propel time.

**Indicates 10% overload is allowable.

3.3 BASELINE SOLUTION USING MICROMODELS

During Phase I of the project, a series of computerized micromodels was developed to analyze separately the various required mining operations. These micromodels require detailed input to define a problem, and are intended for a user who desires a high degree of interaction with the models.

The following micromodels are pertinent to the Appalachia (Ohio) test case:

Contour Stripping Method (BSM)
Drilling and Blasting (DAB)
Coal Load and Haul (CLH)
Haul Unit Simulation (HUS)
Land Reclamation Simulation (LRS)
Preparation/General Administrative (PGA)
Cash Flow Analysis (CFA).

In brief, each model uses input based on the mining situation, schedule and efficiency, and the user's judgment to select a combination of equipment with the least ownership and operating cost for each function. The selections are reviewed by the user, and with the addition of suitable support equipment, a cash flow analysis is used to estimate a required price for the coal in the deposit. The use of the micromodels to solve a mining problem is shown schematically in Figure 15. A solution to a mining problem using the micromodels is developed in six steps:

1. Tract Description (user)
2. Develop Mine Plan (user)
3. Develop Micromodel Input (user)
4. Run Micromodel Solutions (computer)
5. Analyze Micromodel Selections, Add Secondary Equipment, and Make Financial Assumptions (user)
6. Cash Flow Analysis (computer).

As previously described, the macromodels are intended to require a brief set of input data and little interaction by the user. In order to develop such a macromodel, a baseline or reference point is developed against which eventual macromodel results are tested. This reference point has been established by running a detailed micromodel solution for the hypothetical situation in the Appalachia (Ohio) as defined by the test case mining situation description. The test case mine operation schedules and efficiencies were also used. The results of the test case baseline solution using micromodels are described in the following paragraphs.

3.3.1 CONTOUR STRIPPING WITH DRAGLINES

The Contour Stripping with Draglines (CSD) computer micromodel simulates contour stripping with a single dragline. The CSD model assumes that the dragline operations will

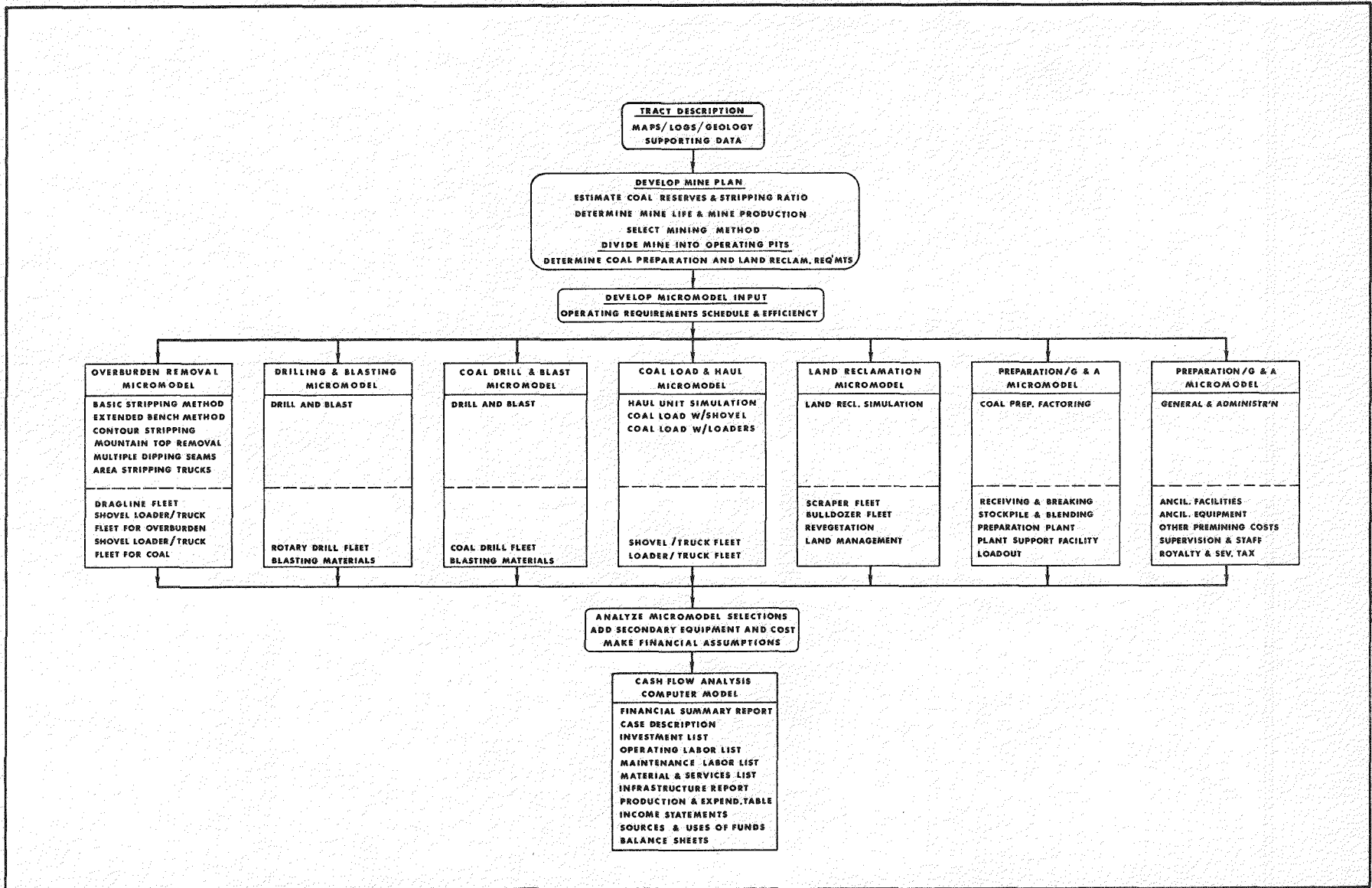


Figure 15. The Micromodeling System

proceed along the outcrop line of the coal, and that the line will be described as a series of sections. Each section in this series comprises a single straight-line segment or an arc with a specified radius of curvature and angle. The number of sections can vary from one to thirty (this limit can be increased, if needed). A single cross-section description (hillside contour) is permitted for each section in the problem statement. Thus, the user sections the property to be studied to represent both the variations in the outcrop line and the contour of the material overlying the coal.

The user sets the working panel widths for each section. He may direct the use of a particular dragline by entering the appropriate specifications from the data book, or he may let the model "synthesize" a dragline that will have a specific effective dumping radius. The user may also specify different panel widths for different sections. He could use different draglines for each section; but the calculated costs would probably be incorrect, since the model would cost on the basis of the machine used for the last section.

For each section, the model analyzes the geometry and determines the number of panels that can be stripped before an operating limit is reached. Generally, the operating limit is reached when the spoils overlap the coal.

The user can set the overlap limit for any specified amount of overlap (including "none"). The model then computes both the amount of coal covered and the rehandle costs that would be incurred if the overlapped coal were recovered. It also draws a cross-section plot to graphically display the geometry; and calculates volumes.

After all sections are processed, the model develops overall totals and costs and draws a plan-view plot. This plan view is a stylized contour map showing the outcrop line, the limit of the spoils, and the final highwall.

Forty-five input parameters plus the profile of each section must be defined in order to run the Contour Stripping with Draglines micromodel. These parameters are listed with definitions and baseline values in Appendix B.1.

The Contour Stripping with Draglines output indicates that a dragline with a 304-foot boom and 43-cubic-yard bucket would provide the least cost solution of \$2.487 per ton of recoverable coal uncovered at the desired rate of production. An abbreviated listing of the computer output is shown in Appendix B.2. All costs are in January 1975 dollars (no escalation).

In addition, a plotter can be used in conjunction with the computer to draw a cross section and a plan view of the pit showing successive mining panels and spoil piles to scale. Such a plot of the baseline solution is shown in Figure 16.

3.3.2 DRILLING AND BLASTING

The Drilling and Blasting (DAB) computer micromodel simulates the drilling of vertical blast holes and determines the required amounts of blasting materials related to overburden drilling and blasting.

Three types of cases can be run:

1. Spacing, burden, and drill diameter not specified
2. Drill diameter specified
3. Spacing, burden, and drill diameter specified.

In addition, a variety of blasting materials can be chosen.

The program determines the number of holes that must be drilled per year. This is used to determine the required quantity of machines and blasting materials. Costs are determined and a least cost solution is selected.

Up to 26 input parameters must be defined in order to run the Drilling and Blasting micromodel. These parameters are listed with definitions and baseline values in Appendix B.3.

The Drilling and Blasting output indicates that .59 (or 1) No. 16 rotary drill would provide the least cost solution of \$.657 per ton of recoverable coal (i.e., $\frac{\$568,190}{865,300 \text{ tons}}$).

An abbreviated listing of the computer output is shown in Appendix B.4. All costs are in January 1975 dollars (no escalation).

3.3.3 HAUL UNIT SIMULATION AND COAL LOAD AND HAUL

Two separate micromodels, Haul Unit Simulation (HUS) and Coal Load and Haul (CLH), are used in the selection of the shovel/truck combination for loading the coal in the pit and transportation from the pit to the receiving station of the preparation plant.

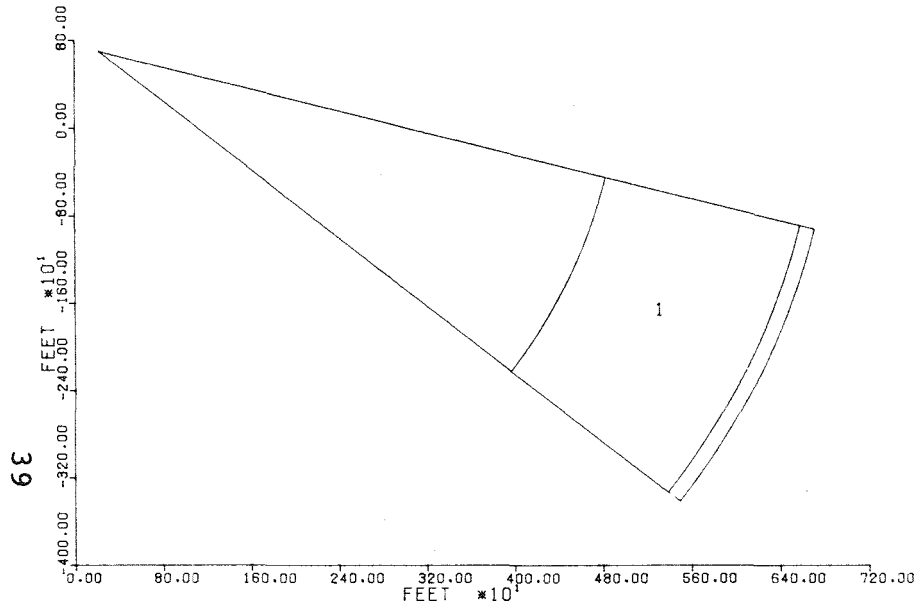
The HUS model simulates the performance of an off-highway truck on a given haul road. The model evaluates the ability of a truck according to the following criteria:

Possible truck speed and time to travel the haul road

CSD PLAN VIEW

CASE NO 503

(CSD00503) CONTOUR STRIPPING



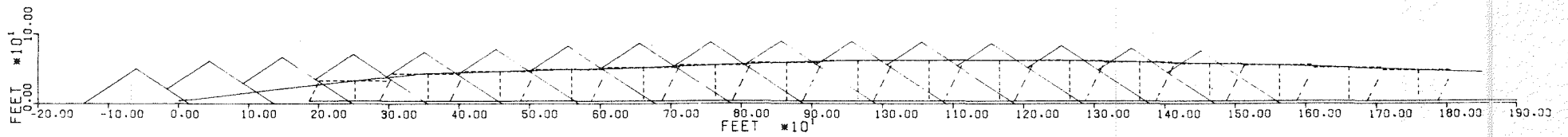
12/03/76

SCALE = 800 FEET TO 1 INCH

CSD CROSS SECTION

CASE NO 503 SECT NO 1

MODEL SIZES THE DRAGLINE BUCKET



12/03/76

SCALE = 100 FEET TO 1 INCH

Figure 16. Computer Drawn Baseline Solution for Contour Stripping with Draglines

Possible coal production (tons/hour) that could be sustained by one truck

Size of the fleet required to maintain a given coal production rate

Cost of ownership and operation of each truck in the fleet

Cost of haulage for each truck (\$/ton of coal).

The equipment data base contains all the parameters required by the HUS model. The following parameters are used for each truck to be studied:

- Weight capacity
- Performance data
- Braking data
- Ownership and operating cost data
- Number and size of tires
- Engine characteristics.

The HUS model begins with a specification of the mine and the haul road, from pit to tipple. The road is described in segments with distance, grade, speed limits, stop, etc., defined for each segment. The model simulates the hauling operation, and calculates operating statistics and operating and investment costs. Input and output for the HUS model are shown in Appendices B.5 and B.6.

The data developed with the HUS model is used in running the CLH model. The CLH model processes shovel and truck files to evaluate the ability of the shovel and truck in combination, to meet the requirements of physical dimensions and production during the coal loading operation. Production and cost information are calculated and printed for the user.

The model operates the shovel and truck separately, at full capacities, to determine possible production. Then the combination of shovel and truck is evaluated, taking into account the necessary losses in possible production due to waiting time for the truck to spot at the shovel.

Twenty input parameters plus a description of each segment of the haul road are required to run the HUS micromodel. In addition, 24 input parameters must be defined to run the CLH micromodel. These parameters are listed with definitions and baseline values in Appendix B.7.

The CLH output indicates that one No. 31 shovel (12-yd³ bucket) with a fleet of four No. 53 trucks (150-ton payload) would provide a least cost solution of \$.684 per ton of recoverable coal. An abbreviated listing of the computer output is shown in Appendix B.8. All costs are in January 1975 dollars (no escalation).

3.3.4 LAND RECLAMATION

The Land Reclamation Simulation (LRS) micromodel analyzes four separate operations: required scraper fleet for topsoil removal and redistribution; required bulldozer fleet for spoil pile regrading and for general dozer work; costs of revegetation; and land management.

Input to the LRS program requires both a definition of the geometry and desired production and a definition of the performance specifications of the equipment to be used. The input parameters and baseline values are shown in Appendix B.9.

The LRS output indicates that a fleet of .66 (or 1) scrapers would be required for topsoil removal and a fleet of 2.03 bulldozers (or 3) would be required for spoil pile regrading and general dozing. Combining scraper and bulldozer fleet costs with revegetation and land management yields a cost of \$.334/recoverable ton of coal. An abbreviated listing of the computer output is shown in Appendix B.10. All costs are in January 1975 dollars (no escalation).

3.3.5 COAL PREPARATION FACTORING

The Preparation/General Administrative (PGA) micromodel determines the coal handling and processing costs by means of extrapolation from a standard size facility. In addition, it allows plant selection based on three levels of difficulty of preparation effort: crushing and screening, Baum jig, and heavy media. The micromodel separates ownership and operating costs into five categories:

- Receiving and Breaking
- Blending and Stockpiling
- Coal Loadout
- Preparation Plant
- Preparation Plant Support.

The input parameters for the PGA model are used to define the costs of the standard size facility and the extrapolation factors for determining the costs of a new size facility. The key input parameters are energy demand and plant type which are used to determine the daily rated capacity of the new plant in run-of-mine tons of coal. Coal washability curves are not directly considered.

Abbreviated listings of the input and output of the PGA model when used for coal preparation factoring are shown in Appendices B.11, B.12, and B.13. The output indicates that the cost of coal handling and preparation in three plant facilities, each plant rated at 6,922 TPD run-of-mine coal, would be \$2.285/ton of recoverable coal. All costs are in January 1975 dollars (no escalation).

3.3.6 GENERAL AND ADMINISTRATIVE

The Preparation/General Administrative (PGA) micromodel determines the central facilities, staff, and premining costs by means of extrapolation from a standard size facility. The micromodel separates ownership and operating costs into thirteen categories:

- Roads and Site Work
- Buildings
- Electric Power System
- Water System
- Communications System
- Mobile Support Equipment
- Shop Equipment
- Land Rights
- Exploration Drilling
- Contract Engineering
- Environmental Impact Statement
- Supervisory and Support Personnel
- Royalty and Severance Tax.

The input parameters for the PGA model are used mainly to define the general and administrative costs for the standard size mine and to define the extrapolation factors. The key input parameters are energy demand and stripping ratio which are used to determine the size of premining costs, facilities, and administration for the new mine. An abbreviated list of input variables is shown in Appendices B.14 and B.15.

The output of the PGA model indicates that a General and Administrative cost of \$1.24/ton of recoverable coal would be required. An abbreviated listing of the computer output is shown in Appendix B.16. All costs are in January 1975 dollars (no escalation).

3.3.7 CASH FLOW ANALYSIS

The Cash Flow Analysis (CFA) computer model is used to determine the required selling price of coal for a required return on investment. The CFA model takes into account the time value of money, as well as such financial parameters as

interest rates, tax rates, and escalation rates. All expenditures and revenues are compiled each year for the project. In addition, initial investment, deferred investment, and replacement investment requirements are determined.

Three types of input data are required to run the CFA model:

- Mining operation data
- Personnel data
- Case description parameters, financial assumptions, and default values.

The mining operation data defines the performance and cost of all items required for the mining complex. For each item in a mine operation approximately 40 parameters must be input to provide sufficient data for the cash flow analysis. Data from micromodel results are transferred to cash flow input, using the form shown in Appendix C.1.

The personnel data defines the classifications, salary grades, schedules, effective hours per year, and dollars per effective hour for all types of manpower required for the mine complex. The baseline input classifications and work schedules are shown in Appendix C.2.

The financial assumptions and default values define the economic conditions and accounting provisions for the project. More than 30 financial assumptions must be input to provide sufficient data for the cash flow analysis as shown in Appendix C.3.

The output generated by the CFA model is contained in eight reports:

1. Financial Summary Report and Case Description
2. Investment List
3. Operating Personnel List
4. Maintenance Personnel List
5. Services and Materials List
6. Infrastructure Report
7. Production and Cash Expenditure Table
8. Financial Statements.

These reports are discussed in detail in Section 6.0.

4.0 DEVELOPMENT OF MACROMODEL RELATIONSHIPS

4.1 MACROMODEL SUBROUTINES

In order to provide a macromodel computer modeling system requiring little interaction by the user, simplified subroutines were developed which provide similar solutions to those provided by the micromodels described previously. Table 7 shows the macromodel subroutines required to solve an contour dragline mining problem along with the equivalent micromodels. A detailed description of the macromodel subroutines is contained in the macromodel user's manual (Final Report Volume 12, ref: FE-1520-112). The following paragraphs briefly describe how the simplified macromodel relationships were derived from micromodel data.

Table 7. REQUIRED MACROMODEL SUBROUTINES AND MICROMODEL EQUIVALENTS

Macromodel Subroutine	Micromodel Equivalent	Modeling Method
1. Dragline	Contour Stripping Method (CSM)	Simulation
2. Drilling and Blasting	Drilling and Blasting (DAB) Drilling/Blasting Coal (DBC)	Simulation Simulation
3. Coal Load and Haul	Haul Unit Simulation (HUS) Coal Load and Haul (CLH)	Simulation
4. Land Reclamation	Land Reclamation Simulation (LRS)	Simulation
5. Coal Preparation	Coal Prep Factoring (CPF)	Extrapolation
6. General and Administrative	General and Administrative (GAA)	Extrapolation

4.2 SUBROUTINES FOR SIMULATED FUNCTIONS

To develop the relationships used in the simplified macromodel subroutines for simulated functions, the equivalent micromodels were run varying all key parameters through an expected range of values. The resulting sets of solutions were used along with a knowledge of the micromodel mathematical relationships for curve fitting to develop formulas that would yield macromodel solutions in close approximation to solutions generated by the equivalent micromodel.

The Least-Squares Fit (LSF) program was used to develop the equations that are used in the macromodel in place of the more complex micromodel logic. The equation forms were developed from the micromodel logic. The model parameters were transformed as required to fit a linear equation of the form:

$$a_1x_1 + a_2x_2 + a_3x_3 + \dots + a_mx_m = y$$

The LSF program processes the results from the micromodel cases, determines the coefficients, resolves the expression for each case, and displays the calculated deviation between the recalculated values and the micromodel solution values. In most cases, it was possible to transform the model parameters into a truly linear equation, and the R squared term for these cases is .99 or better. In a few cases, the response was almost linear and for these cases, the R squared term drops to around .95. Note that the R squared term denotes degree of fit between micro and macro solutions and should not be used to imply accuracy versus actual situations. R² equal to 1.00 implies a perfect curve fit.

To develop the equations for the subroutines, a single parameter was varied for each micromodel case with all other parameters held at baseline values to obtain the set of observations for curve fitting. This approach would not be valid for general regression analysis since interactions between variables could be masked by the procedure itself. Masking is not considered to be a problem in this situation since the potential interactions are known from the micromodel logic. However, several of the fits were verified by runs in which the model parameter values were randomly varied. The LSF results did not differ materially between the random selection process and the structured selection process.

4.2.1 DRAGLINE SUBROUTINE

The dragline size is determined by the production required (bucket size) and by the dumping distance required by the pit geometry (boom length). Unless oversize is specified, it is assumed that a dragline could be built that would match the required size. The cost for the resulting synthesized dragline of the required size is based on correlation using the dragline "DLX" value as the input variable where "DLX" is defined as:

$$DLX = \frac{DLRMA * DLSW}{1000}$$

where DLRMA = boom length * cosine boom angle
DLSW = bucket size

An iterative solution is used to determine the boom length required to meet the dumping distance resulting from the pit geometry.

The derivation of the following dragline formula is shown in Appendix D.1.

Base price of synthesized machine (DLCA):

$$DLCA = 981.71 + 410.6 * DLX$$

4.2.2 DRILLING AND BLASTING OVERBURDEN SUBROUTINE

In the drilling and blasting subroutine the drill size and powder ratio are held constant. The quantity of drills and the cost of blasting materials are based on curve fitting. The derivation of the following formulas for drill quantities and blasting materials costs for overburden are shown in Appendices D.2 and D.3.

Quantity of drills for overburden (RNDR):

$$RNDR = 5.609 * (CDRTY * HB) / (1E6 * HC * DRSMFH)$$

where HC = height of coal in feet

CDRTY = coal demand recoverable tons per year

HB = height of burden in feet

DRSMFH = drilling rate in soft material in feet per hour

Cost of blasting materials for overburden (CEMDY):

$$CEMDY = 111 + 109.22 (CDRTY * HB * PR) / 1E6 * HC$$

where PR = powder ratio pounds per bank cubic yard

4.2.3 DRILLING AND BLASTING COAL SUBROUTINE

Curve fitting was not used in the derivation of the following formulas for drill quantities and blasting materials cost for coal. The formula for quantity of drills is based on baseline data showing a need for approximately .3 drills per million tons of coal recovered. The formula for cost of blasting materials is based on baseline data showing a need for approximately \$.05 for blasting materials per ton of recovered coal.

Quantity of drills for coal (RNOQD):

$$RNOQD = .3 * QBCD / 1E6 * 3263 / QDCROH$$

where QBCD = coal demand recoverable tons per year

QDCROH = coal drilling operating hours per year

Cost of blasting materials for coal (QBTEC):

$$QBTEC = .05 * QBCD * QLCRLO$$

where QLCRLO = life of mining operation in years

4.2.4 COAL LOAD AND HAUL SUBROUTINE

In the coal load and haul subroutine the shovel size and the truck size are preselected. The required quantity of shovels and trucks is based on the required production and on a truck cycle time derived from curve fitting. The derivation of the following formula for truck cycle time is shown in Appendix D.4.

Truck cycle time (TDCT):

$$TDCT = 7.41 + CHCT * SPL + 0.26673 * \frac{CHHD}{5280} + \frac{20.434 * TDSL * \frac{CHHD}{5280}}{TDSC}$$

where CHCT = shovel cycle time in minutes

SPL = no. of swings to load truck

CHHD = haul distance in feet

TDSL = truck payload in thousands of pounds

TDSC = truck horsepower

4.2.5 LAND RECLAMATION SUBROUTINE

In the land reclamation subroutine the scraper size and bulldozer size are held constant. The required quantities of scrapers and bulldozers are based on curve fitting. The derivation of the following two formulas is shown in Appendices D.5 and D.6.

Quantity of scrapers (TSCR):

$$TSCR = \left[.0157046 + 5.43198 * \frac{CDRTY}{HC} + 7.36661 * \left(\frac{CDRTY}{HC} \right)^2 \right] * HBT$$

Quantity of bulldozers (RNØCD):

$$\begin{aligned} RNØCD = & - .00384704 * \frac{CDRTY * TAN ABSD * PWF}{1 E6 * HC} \\ & + .000618961 * \frac{CDRTY * TAN ABSD * PWF^2}{1 E6 * HC} \\ & + .00660554 * \frac{CDRTY * CGD}{1 E6 * HC} \end{aligned}$$

where CDRTY = coal demand
 HC = height of coal
 HBT = height of topsoil
 CGD = cost for general dozing
 PWF = panel width in feet
 ABSD = angle of burden spoils in degrees

4.3 SUBROUTINES FOR EXTRAPOLATED FUNCTIONS

The macromodel subroutines for extrapolated functions are a direct adaptation of the equivalent micromodels. These micromodels determine quantities and costs using the following general type of formula:

$$\text{New Qty} = \text{Baseline Qty} \times \left(\frac{\text{New Size}}{\text{Baseline Size}} \right)^Y$$

$$\text{New Cost} = \text{Baseline Cost} \times \left(\frac{\text{New Size}}{\text{Baseline Size}} \right)^Y$$

The baseline values are based on estimates made for a specific size operation. The exponent "Y" is the scaling factor used to scale up or down from the baseline size.

4.3.1 COAL PREPARATION SUBROUTINE

The baseline size for the coal preparation facilities is 75,000 TPD as described in Volume 4 of the Phase I Report (Ref: FE-1520-4). A detailed description of the various extrapolation formulas for ownership and operating costs, personnel, etc., is contained in the user's manual (ref: Report FE-1520-116).

4.3.2 GENERAL AND ADMINISTRATIVE COSTS

The baseline size for the mining complex for which the general and administrative costs were estimated is 185,617,000 tons of material moved per year. A detailed description of the various extrapolation formulas for ownership and operating costs, personnel, etc., is contained in the user's manual (ref: Report FE-1520-116).

4.4 SUPPORT EQUIPMENT

Several of the mining operations require supplementary equipment to be used in support of the primary equipment. For the baseline case, support equipment requirements were determined for each pit. These requirements have been programmed as part of the subroutines as follows.

4.4.1 SUPPORT EQUIPMENT FOR DRAGLINE

Based on field observation and experience, it was determined that each primary dragline requires one each of the following support equipment:

- | | |
|--------------------|--|
| Track-type Tractor | - 300 HP (General Dozing, Bench Prep) |
| Wheeled Loader | - 325 HP (Cable Handling) |
| Secondary Dragline | - (Remove High Spots, Bench Building, and Drainage Control). |

An initial box cut excavation is required to open the first panel.

4.4.2 SUPPORT EQUIPMENT FOR DRILLING AND BLASTING

Based on field observation and experience, it was determined that each pit requires one each of the following equipment:

- | | |
|--------------------|---------------------------------------|
| Track-type Tractor | - 300 HP (General Dozing, Bench Prep) |
| Wheeled Loader | - 80 HP (Handle Cuttings) |
| Prill Truck | - (Haul Blasting Agents). |

4.4.3 SUPPORT EQUIPMENT FOR COAL LOADING AND HAULING

Each pit requires one each of the following equipment:

- | | |
|----------------|------------------------------------|
| Wheeled Loader | - 325 HP (Clean Top of Coal) |
| Grader | - 180 HP (Maintain Haul Road) |
| Pump Set | - 125,000 GPH (Clear Pit of Water) |
| Water Truck | - 5000 GAL (Maintain Haul Road). |

This selection of support equipment assumes that the construction and maintenance of haul roads will not require such items as air track drills, rollers, or a materials crushing plant. The user may wish to add to or modify the support equipment shown to better match his personal experience or preference.

5.0 MACROMODEL DESCRIPTION

5.1 ELEMENTS OF THE MACROMODEL

The basic elements of the macromodel for contour stripping with draglines include a case study description, a main program, subroutines, and a cash flow analysis. The macromodel is described in greater detail in the macromodel user's manual (Final Report Volume 12, ref: FE-1520-112).

5.1.1 CASE STUDY DESCRIPTION

In order to maintain minimum interaction between the user and the macromodel, only a few key parameters are required to describe a case study. Two types of input are included in the case study description:

Mining Parameters

Prep. Plant Type Based on Difficulty of Preparation
(1=crush & screen; 2=Baum jig; 3=heavy media)
Topsoil Thickness Saved (ft)
Height of Burden Average (ft)
Height of Coal (ft)
Energy Demand for Mine Complex (Btu/yr)
Run-of-Mine Coal Heat Value (Btu/lb)
Other Reclamation Costs (\$/acre)

Financial Assumptions

Paid in Capital Long-Term Debt Ratio
Land Rights-Surface (\$/acre)
Land Rights-Mineral (\$/acre)
Royalty (\$/ton)
State and Local Severance Tax (\$/ton)
*Desired Rate of Return (percent)
Federal Income Tax Rate (percent)
Long-Term Interest Rate (percent)
Short-Term Interest Rate (percent)
*Required Selling Price (\$/prepared ton)

*Specify one parameter and set the other (which is to be calculated) to zero.

5.1.2 MAIN PROGRAM

The main program of the macromodel develops the production requirements for each function using the mining parameters, along with many built-in default values and assumptions.

The main program sets the life for each mining operation. It then sizes the preparation plant based on the required energy demand, the run-of-mine coal heat value, and the difficulty of preparation effort.

Next, the annual run-of-mine coal production for the mining complex is established and divided among one or more pits. The volume of coal and overburden, the stripping ratio, and the number of acres are calculated for each pit.

Finally, the main program calls the subroutines which establish the equipment requirements for each function.

5.1.3 SUBROUTINES

As discussed in Section 4.0, the subroutines are based on equivalent micromodels for each of the following mining functions:

- Dragline
- Drilling and Blasting of Overburden
- Drilling and Blasting of Coal
- Coal Load and Haul
- Land Reclamation
- Coal Preparation
- General and Administrative.

These subroutines generate three types of data: size and quantity of primary equipment and facilities; size and quantity of support equipment; and a cash flow input data file containing all equipment and facilities data required to run the Cash Flow Analysis program.

5.1.4 CASH FLOW ANALYSIS

The Cash Flow Analysis program described previously as part of the micromodeling system, Section 3.3.7, is also used in the macromodeling system. Manual transfer of data to the cash flow program is not required, as is the case for the micromodeling system, because the macromodel and the cash flow program can be run in sequence. Thus, no interaction is required on the part of the user between the point of defining the input parameters and receiving the cash flow output. Specified case description parameters and financial assumptions are input to the macromodel and passed through to the cash flow program.

5.2 UNDERLYING ASSUMPTIONS

Because the macromodeling system is designed to require minimum interaction between the user and the computer, there are, by necessity, many assumptions built into programs.

5.2.1 MINING PARAMETERS

Many parameters which describe the mining situation are assumed to be constant in the macromodel at the baseline values established for the test case. For example, the safe working angle of the highwall, the panel width, the swell factor, and spoil angle of repose are all assumed constant in the macromodel.

Similarly, the basic physiography and stratigraphy of the site and the desired production per pit are assumed constant at baseline values.

5.2.2 SCHEDULE AND EFFICIENCY

The macromodel also assumes that the pit operation schedule and efficiency are held constant at the test case baseline values.

5.2.3 FINANCIAL ASSUMPTIONS

As with the mining parameters, many financial assumptions are also held constant in the macromodel. For example, the long-term borrowing repayment rate, regional adjustments for costs, assumptions concerning accounts payable, accounts receivable and inventory, home office costs, and insurance costs are all assumed constant at the test case baseline values.

It should also be noted that only the costs directly associated with the project are included. Costs are not included for a construction camp, infrastructure improvements in surrounding communities, etc. However, local property and severance taxes are included which could be used for community development.

5.2.4 REASONABLE RANGE OF VALUES

The macromodel will make calculations based on the input provided. Thus, it is assumed that when the user specifies the mining parameters and the financial assumptions, he has chosen values which define a practical, realistic problem. The values used in the macromodel sensitivity analysis can be used as a general guide to the reasonable range of values that will yield good results with the macromodel.

5.3 INTENDED USE

The macromodeling system is intended to provide useful information related to macroeconomic studies and energy planning and policy analysis. The macromodel can be used for regional studies and to analyze a specific property at an early stage when little field data is available.

Because the macromodel is based on many simplified relationships and contains many built-in assumptions, the user should be aware of possible shortcomings in the results when the problem is beyond the flexibility of the macromodel to analyze. (Such a problem might require use of one or more micromodels to reach a reasonable solution.) In addition, the user should not imply an accuracy to the result solely due to the quantity and detail of the output. The accuracy is influenced by how well the case being studied matches the built-in assumptions. As long as the user bears in mind that the model is intended to provide first-order estimates of costs which can be used for planning purposes, the macromodel can be used to generate valuable information for a variety of decision making situations.

The use of the macromodels and micromodels at various stages of a large-scale surface coal mining project is shown in Figure 17. The macromodels are most useful for early estimating while the micromodels are most useful in more detailed estimating and engineering. At the latter stages of a project the bulk of the engineering and estimating is done by traditional methods.

A macromodel needs only seven mining parameters and nine financial parameters as input. All other parameters are set at default values generally descriptive of the region being studied. The user who desires little or no interaction with the model can obtain an answer quickly by defining only the needed input and accepting all other parameters at the default values. The user also has the option of changing any or all the default values to match his own field data or operating experience.

The accuracy of results when using either the macromodel or the micromodels depends in large part on two factors:

Quantity and accuracy of field data describing the deposit.

Accuracy of financial assumptions describing future economic conditions.

LARGE-SCALE MINING PROJECT STAGES OF DEVELOPMENT

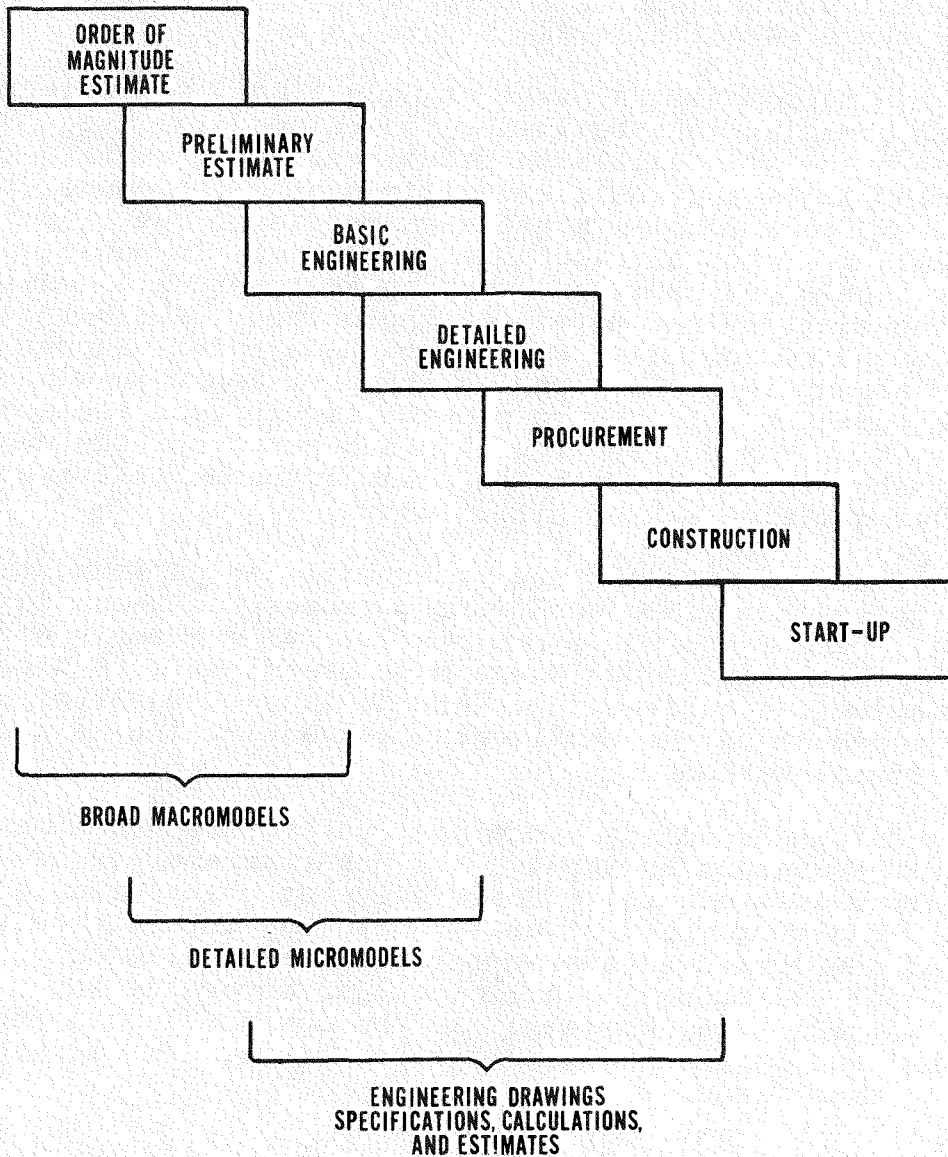


Figure 17. Typical Mining Project Stages of Development

Generally, as a large-scale mining project progresses from the order-of-magnitude stage through start-up, the accuracy of the estimates improves due to better field data and more time and depth spent in analysis.

The Area Dragline Macromodel has been tested for representative cases not only in the Illinois Basin but also in the Four Corners Region (Final Report Volume 3), the Fort Union Region (Final Report Volume 4), and the Texas Gulf Region (Final Report Volume 5). The default values used by the macromodel are different for each region. Thus, if the model were to be used for other regions, such as the Powder River Region, a new set of default values would be required.

The prerequisite for using a macromodel for a specific site in any region is the suitability of the mining method to the characteristics of the deposit. While dragline stripping is an economical mining method, its application must be tempered with the following considerations:

- Flexibility of operation
- Savings on initial investment
- Irregular topography
- Greater mining selectivity
- Safety from catastrophic slope failures
- Pit geometry exceeds capacity of draglines.

6.0 MACROMODEL TEST CASE AND SENSITIVITY ANALYSIS

6.1 TEST CASE SOLUTION

The baseline solution for a hypothetical mine complex in the Appalachia (Ohio) Region, producing 5,140,000 tons per year of prepared coal from six pits and processed in three coal preparation plant, is shown in detail in the eight reports contained in Appendix E:

1. Financial Summary Report and Case Description
2. Investment List
3. Operating Personnel List
4. Maintenance Personnel List
5. Services and Materials List
6. Infrastructure Report
7. Production and Cash Expenditure Table
8. Financial Statements.

The Financial Summary Report lists key financial information and the Case Description records the basic mining parameters and financial assumptions as shown in Appendix E.1 and summarized as follows:

FINANCIAL SUMMARY REPORT

Sales price in base dollars	: \$/prepared ton	12.70
	: \$/million Btu	.50
Return on investment	: Percent	10.00*
Return on paid-in capital	: Percent	10.88**
Cummulative investment to steady state: M\$		161752.
Cummulative investment total project : M\$		222268.
Annual operating cost at steady state : M\$		26135.
Base year is	1975	
Project begins	1976	
First coal production in	1982	
Steady state begins in	1985	
Steady state ends in	2011	
Last coal production in	2013	
Project ends in	2015	

*Discounted cash flow internal rate of return assuming project is financed completely by internal capital.

**Discounted cash flow internal rate of return assuming project is financed by user-set combination of internal capital and external debt.

CASE DESCRIPTION

Mining Parameters

Index to Plant Type***	1
Coal Demand ROM Tons/Year (Complex)	5,191,800
Stripping Ratio (Bank Yards/Recovered Ton)	12.3977
Height of Topsoil in Feet	.5
Height of Coal in Feet	4.0
Prepared Coal Tons/Year	5,139,880
Energy Demand for Complex Trillion Btu/Year	130
ROM Coal Heat Value Btu/lb	12600
Reclamation - Other Costs - \$/Acre	900

FINANCIAL ASSUMPTIONS

Capital/Debt Ratio	2
GAA-Mineral Rights (\$/Acre)	50.00
GAA-Royalty Amount (\$/Ton)	.25
GAA-Surface Rights (\$/Acre)	250.00
GAA-Severance Tax (\$/Ton)	0
Rate - Cash Flow Discount	.10
Rate - Federal Income Tax	.48
Rate - Long Term Interest	.08
Rate - Short Term Interest	.10
Value - Req. Price of Coal - \$/Ton	0

***Preparation Plant Types:

- 1 = Crushing and Screening
- 2 = Baum Jig
- 3 = Heavy Media

The coal price for the baseline solution may be considerably different from current prices for Appalachia (Ohio) coals for several reasons:

1. Costs of equipment have increased drastically over the last decade.
2. Operating costs have increased drastically over the last decade.
3. Some long-term contracts had low profit margins and little or no escalation.
4. The market price for coals varies widely (for example: steam coal versus metallurgical coal).
5. Higher stripping ratios are being encountered (i.e., the thickest seams with the least overburden were mined first).
6. Some coals are sold with little or no blending, stockpiling, or preparation.

In addition, the sensitivity analysis shows a wide range of prices in response to mining parameters and financial assumptions.

To underscore the impact of financial assumptions on required coal price, a set of alternative studies were run to compare with baseline results.

Baseline -----	\$12.70/ton
(No escalation, 10% Rate of Return, price constant for all project years)	
Alternate 1 -----	\$16.29/ton
(No escalation, 15% Rate of Return, price constant for all project years)	
Alternate 2 -----	\$24.82/ton
(5% Cost Escalation, 10% Rate of Return, price constant for all project years)	
Alternate 3 -----	first year \$14.45/ton; last year \$65.57/ton
(5% Cost Escalation, 10% Rate of Return, Price Escalates at 5%)	

The Investment List shows all required equipment, facilities, and premining costs. The total investment is divided into initial investment (required to reach steady state production), deferred investment (required additions as mining proceeds), and replacement capital (required to replace worn out equipment) as shown in Appendix E.2.

The initial capital investment requirements for the baseline solution are shown in detail in Table 8. Note that overburden removal plus coal handling and preparation together account for nearly 70 percent of the initial investment while general and administrative items (including premining costs) account for nearly 17 percent of the initial investment.

Table 8. INITIAL CAPITAL INVESTMENT FOR HYPOTHETICAL TEST CASE IN APPALACHIA (OHIO)**

MINING STEP	BASELINE INVESTMENT*	PERCENT
Drilling & Blasting	3,891,000	2.4
Overburden Removal	46,748,000	29.0
Coal Load & Haul	14,507,000	9.0
Coal Handle & Prep	65,735,000	40.8
Land Reclamation	3,114,000	1.9
Premining and Facilities	27,216,000	16.9
TOTAL	\$161,211,000	100.0

*Baseline investment from Investment List (Appendix E). All costs are in January 1975 dollars (no escalation).

Table 9. ANNUAL DIRECT OPERATING COST FOR HYPOTHETICAL TEST CASE IN APPALACHIA (OHIO)**

MINING STEP	BASELINE ANNUAL* OPERATING COST	PERCENT
Drilling & Blasting	4,658,000	17.8
Overburden Removal	10,188,000	39.0
Coal Load & Haul	3,731,000	14.3
Coal Handle & Prep	6,403,000	24.5
Land Reclamation	1,155,000	4.4
TOTAL	\$26,135,000	100.0

*Baseline annual operating cost from operating personnel table, maintenance personnel table, and materials and services table (Appendix E). General and administrative not included. All costs are in January 1975 dollars (no escalation).

**Mine complex with 6 pits and 3 preparation plants produces nominal coal feed required for:
 250 million cu.ft./day gasification plant, or
 40,000 BBL/day liquefaction plant, or
 1500 megawatt power plant

The Operating Personnel List shows all equipment/plant operating crews plus the general and administrative staff. As shown in Appendix E.3, the baseline solution indicates that an initial operating staff of 463 people would be required with an annual payroll of \$9,323,100 (January 1975 dollars with no escalation).

The Maintenance Personnel List shows all personnel required to maintain the equipment fleet and the plant. As shown in Appendix E.4, the baseline solution indicates that an initial maintenance staff of 276 people would be required with an annual payroll of \$5,458,500 (January 1975 dollars with no escalation).

The Services and Materials List shows all required contract services, spare parts, and consumable items. Power, water, and fuel quantities are compiled. As shown in Appendix E.5, the baseline solution indicates an annual services and materials cost of \$22,910,200 (January 1975 dollars with no escalation).

The annual direct operating costs (labor plus materials and services) are shown in detail in Table 9. Overburden removal accounts for about 39 percent of the total operating costs while drilling and blasting accounts for nearly 18 percent and coal handling and preparation over 24 percent of the total operating costs.

Note that the total initial investment and the total annual operating costs shown in Tables 8 and 9 are derived from the investment list, operating manpower list, maintenance manpower list, and materials and services list, while the steady state values in the financial summary are derived from the pro forma financial statements for the first year of rated production. Therefore, the values found in Tables 8 and 9 will be approximately, but not exactly, the same as the values found in the financial summary.

The Infrastructure Report (Appendix D.6) contains items of interest with regard to environmental impact statements and socioeconomic studies under the following headings:

- Physical Effects
- Economic Impact
- Utility Requirements
- Manpower Requirements

The environmental and socioeconomic impact of the mine complex can be summarized as follows:

Acres Disturbed:	898 acres/yr
Payrolls, Purchases and Taxes:	\$35,484,000/yr
Water Requirements:	313-acre-ft/yr
Electric Power:	144,929 megawatt hrs/yr
Manpower - Operating:	463
- Maintenance:	276

The Production and Cash Expenditure Table (Appendix E.7) shows the year by year production for each mining operation as well as the cash expenditure for equipment, manpower, and services and materials.

The Financial Statements show yearly pro forma income statements, sources and uses of funds, and balance sheets for the life of the project (Appendix E.8).

Default values for Appalachia (Ohio) mining parameters and financial assumptions are shown in Appendix E.9.

6.2 CONTRIBUTION OF INDIVIDUAL MINING FUNCTIONS TO PRICE OF COAL

To investigate the portion of the total price of coal attributable to each mining function, a series of cases was run with the macromodel. Each case utilized all baseline values except that only one mining operation's investment and operating costs were included each time. The results, presented in Table 10, show overburden removal and coal handling and preparation each contributing nearly 30 percent of the price and premining and facilities contributing about 19 percent. The sum of the individual baseline solutions does not equal the exact combined baseline solution due to the combined effects of taxes, etc.

Table 10. CONTRIBUTION OF MINING FUNCTIONS TO COAL PRICE FOR APPALACHIA (OHIO) BASELINE CASE

INDIVIDUAL BASELINE SOLUTION	PRICE \$/TON	PERCENT
Drilling & Blasting	1.08	8.8
Overburden Removal	3.63	29.7
Coal Load & Haul	1.18	9.6
Coal Handle & Prep	3.68	30.1
Land Reclamation	.34	2.8
Premining, Facilities, & Admin	2.33	19.0
	<u>12.24</u>	<u>100.0</u>
COMBINED BASELINE SOLUTION	12.61	

6.3 SENSITIVITY ANALYSIS - MINING PARAMETERS

The mining parameters used in the sensitivity analysis were selected because of their significant impact on cost or because of policy issues that might be related to them. The seven mining parameters selected are as follows:

- Energy Demand for Mine Complex (Btu/yr)
- Run-of-Mine Coal Heat Value (Btu/ft)
- Height of Burden Average (ft)
- Height of Coal (ft)
- Preparation Plant Type
- Topsoil Thickness Saved
- Other Reclamation Costs

The sensitivity range for these mining parameters is shown in Table 11. The baseline values were selected to be representative of a typical mining situation in the Appalachia (Ohio) Region. The expected low and expected high values represent the range of situations commonly found in the Appalachia (Ohio) Region. The extreme low and extreme high values represent the range of situations that would be unlikely or marginal situations for mining. All values were selected based on a review of data collected during mine visits and a review of coal resource and reserve data compiled during Phase I (Ref: Report FE-1520-2).

The results of the mining parameter sensitivity analysis are tabulated in Appendix F.1. Coal price versus sensitivity range is plotted in Figure 18. An analysis of Figure 18 shows that four parameters have a major effect on coal price and three have less effect (under 10 percent) as follows:

Major Effect:

1. Preparation Plant Type
2. Energy Demand for Mine Complex
3. Height of Burden Average
4. Height of Coal

Less Effect:

1. Run-of-Mine Coal Heat Value
2. Topsoil Thickness Saved
3. Other Reclamation Costs

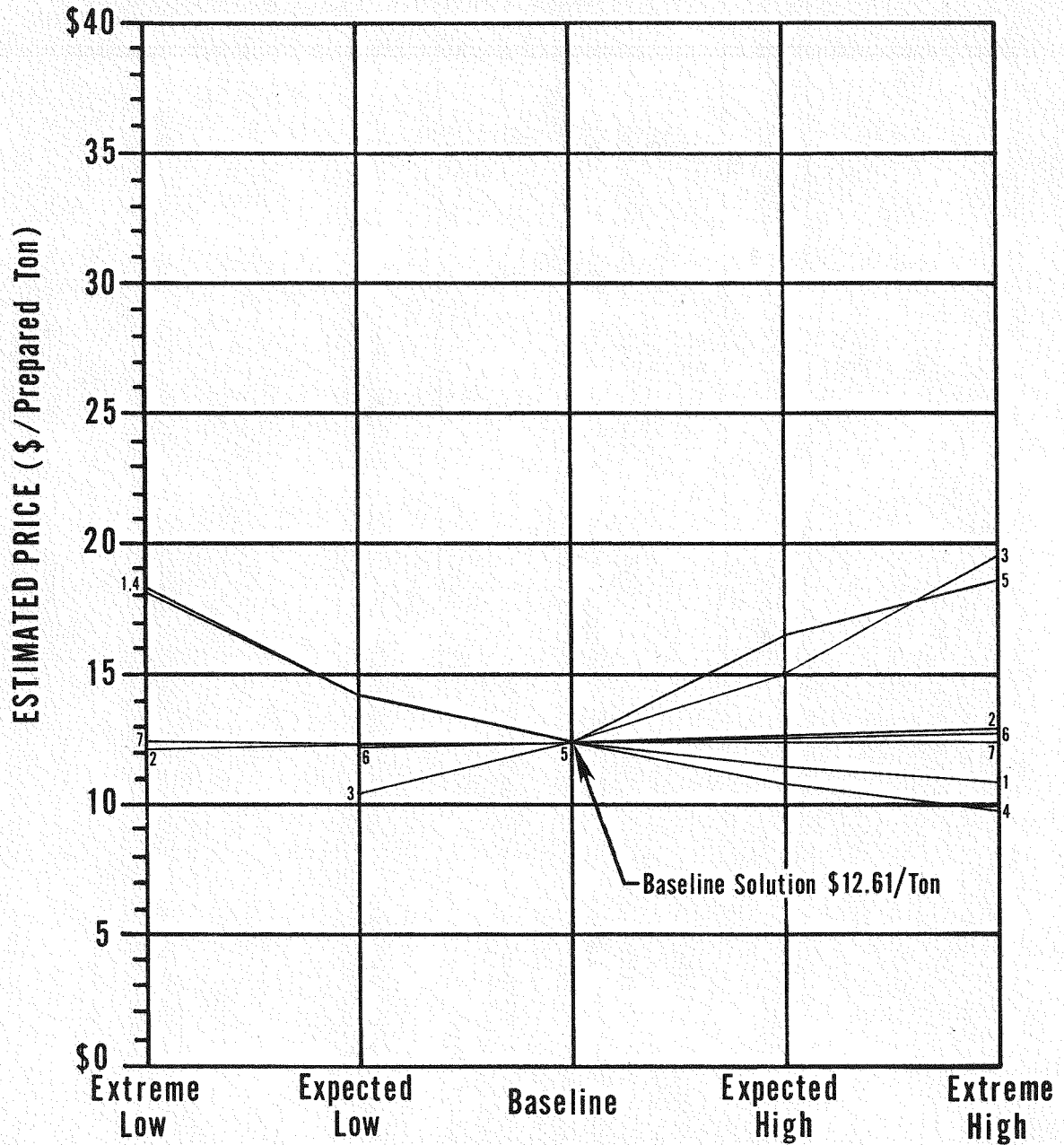
Thus, the first group of mining parameters deserves to be studied and determined with relatively more emphasis than the second group when analyzing a mining situation or region. The user should also keep in mind that at a production of several million tons per year, items affecting costs by less than 1¢ per ton can represent savings or losses of hundreds

Table 11. MINING PARAMETERS SENSITIVITY RANGE
APPALACHIA (OHIO) TEST CASE

	Sensitivity Range				
	5 Extreme Low	4 Expected Low	3 Baseline Value	2 Expected High	1 Extreme High
Mining Parameters					
Energy Demand for Mine Complex (Trillion Btu/yr)	32.5	81.3	130	195	243.8
Run-of-Mine Coal Heat Value (Btu/lb)	10,200	11,400	12,600	13,400	14,200
Height of Burden Average (ft)	-	50	71	85	100
Height of Coal (ft)	2	3	4	8	10
Prep Plant Type Based on Difficulty (1=crush & screen; 2=Baum jig; 3=heavy media)	-	-	1	2	3
Topsoil Thickness Saved (ft)	0	.5	1.0	1.75	2.5
Other Reclamation Costs (\$/acre)	450	675	900	1125	1350

Note: These values apply to the range of coal prices shown on Figure 18.

OHIO



SENSITIVITY RANGE

(WITH BASELINE VALUES SHOWN IN PARENTHESIS)

- 1 - Energy Demand (130 Trillion BTU's)
- 2 - ROM Coal Heat Value (12,600 BTU's/lb.)
- 3 - Height Of Burden (49.27 ft.)
- 4 - Height Of Coal (4 ft.)
- 5 - Prep. Plant Type (Crush & Screen)
- 6 - Height Of Topsoil (0.5 ft.)
- 7 - Other Reclamation Cost (\$900/acre)

(All Costs in January 1975 dollars
with no escalation)

Figure 18. Mining Parameter Sensitivity Analysis

of thousands of dollars for an actual operating mine. Therefore, even items which have "less effect" when making an order of magnitude study, can be of considerable importance during actual mine operations.

6.4 SENSITIVITY ANALYSIS - FINANCIAL ASSUMPTIONS

The financial assumptions used in the sensitivity analysis were also selected because of their significant impact on cost or because of policy issues that might be related to them. The twelve financial assumptions selected are as follows:

- Long-Term Interest Rate (percent)
- Desired Return on Investment (Cash Flow Discount Rate) (percent)
- Federal Income Tax Rate (percent)
- Paid-in Capital/Long-Term Debt Ratio
- Labor Escalation Rate
- Materials and Services Escalation Rate
- Equipment Investment Escalation Rate
- Depreciation Method
- Land Rights-Surface (\$/acre)
- Land Rights-Mineral (\$/acre)
- Royalty (\$/ton)
- State and Local Severance Tax (\$/ton)

The sensitivity range for these financial assumptions is shown in Table 12. The baseline values represent average conditions with no inflation using straight line depreciation. The expected low and expected high values represent a range of common economic conditions (note that negative numbers are not shown for the expected low value of inflation, that is, deflationary conditions are not included). The extreme high and extreme low values represent a range of economic conditions that are possible but not likely. The variation of depreciation method represents a comparison of alternatives rather than a range of expected values.

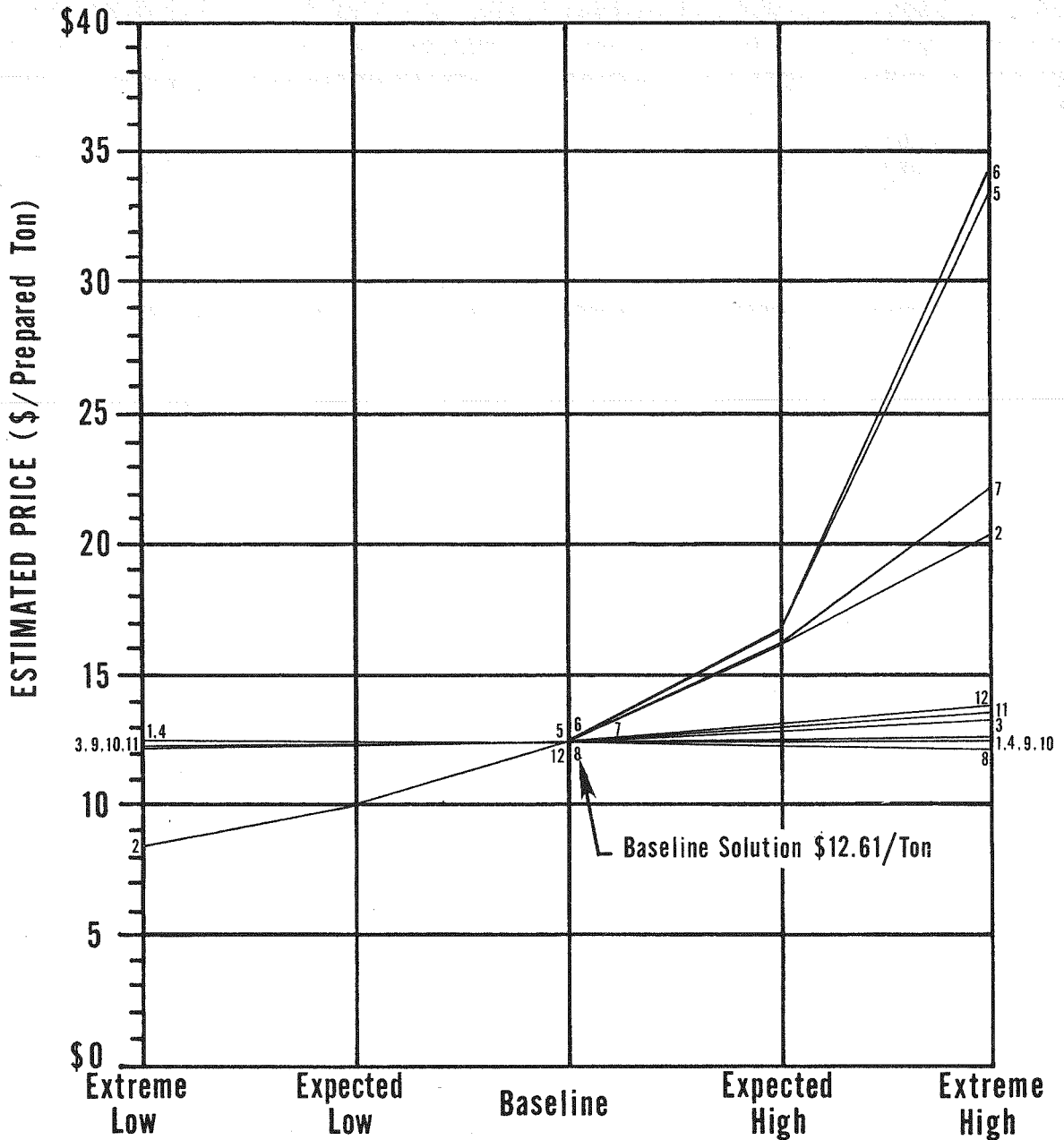
The results of financial assumption sensitivity analysis are tabulated in Appendix F.2. Coal price versus sensitivity range is plotted in Figure 19. An analysis of Figure 19 shows that four assumptions have a major effect on coal price and eight have less effect (under 10 percent) as follows:

Table 12. FINANCIAL ASSUMPTIONS SENSITIVITY RANGE
APPALACHIA (OHIO) TEST CASE

	Sensitivity Range				
	5	4	3	2	1
	Extreme Low	Expected Low	Baseline Value	Expected High	Extreme High
Financial Assumptions					
Long-Term Interest Rate (percent)	-	6.0	8.0	10.0	12.0
Desired Return on Investment (Cash Flow Discount Rate) (percent)	0	5.0	10.0	15.0	20.0
Federal Income Tax Rate (percent)	38.4	43.2	48.0	52.8	57.6
Paid-in Capital/Long-Term Debt Ratio	.00	1	2	4	99
Labor Escalation Rate	-	-	.00	.05	.10
Materials and Services Escalation Rate	-	-	.00	.05	.10
Equipment Investment Escalation Rate	-	-	.00	.05	.10
Depreciation Method	-	-	St.Line	Decl.Bal.	Dbl.Decl.
Land Rights-Surface (\$/acre)	0	125	250	375	500
Land Rights-Mineral (\$/acre)	0	25	50	75	100
Royalty (\$/ton)	-	0	.25	.50	1.00
State and Local Severance Tax (\$/ton)	-	-	0	.50	1.00

Note: These values apply to the range of coal prices shown on Figure 19.

OHIO



SENSITIVITY RANGE

(WITH BASELINE VALUES SHOWN IN PARENTHESIS)

- | | |
|---|---|
| 1 - Long Term Interest Rate (8%) | 7 - Equipment Investment Escalation Rate (0%) |
| 2 - Return On Investment (10%) | 8 - Depreciation Method (Straight Line) |
| 3 - Federal Income Tax Rate (48%) | 9 - Surface Rights (\$250/acre) |
| 4 - Paid-in Capital/Debt Ratio (2:1) | 10 - Mineral Rights (\$50/acre) |
| 5 - Labor Escalation Rate (0%) | 11 - Royalty (\$.25/ton) |
| 6 - Materials & Services Escalation Rate (0%) | 12 - Severance Tax (\$0/ton) |

(All baseline costs in January 1975 dollars with no escalation)

Figure 19. Financial Assumption Sensitivity Analysis

Major Effect:

1. Materials and Services Escalation Rate
2. Labor Escalation Rate
3. Equipment Investment Escalation Rate
4. Desired Return on Investment (Cash Flow Discount Rate)

Less Effect:

1. Federal Income Tax Rate
2. State and Local Severance Tax
3. Royalty
4. Land Rights-Surface
5. Land Rights-Mineral
6. Depreciation Method
7. Long-Term Interest Rate
8. Paid-in Capital/Long-Term Debt Ratio

Thus, the user should be aware of the major impact of projected escalation rates. And, as with the mining parameters, it should be noted that financial assumptions which have "less effect" can be very important to operating mine management.

APPENDICES

- A. List of Final Reports and Phase I Reports
 - B. Micromodel Test Case Analysis Input and Results
 - C. Cash Flow Analysis Input
 - D. Curve Fitting Analysis
 - E. Macromodel Baseline Solution
 - F. Macromodel Sensitivity Analysis
-

APPENDIX A

A.1 Final Report List (Phase II Report)

A.2 Phase I Report List

The Final Report consists of sixteen volumes which include a one volume executive summary; eight volumes, documenting example applications of the simulation models for hypothetical test situations; and seven volumes giving user documentation on how each model operates.

The Phase I Report consists of six volumes documenting data gathering activities and modeling efforts completed during the first 24 months of the project.

Appendix A.1 Final Report List (Phase II Report)

Economics of Large-Scale Surface Coal Mining
Using Simulation Models

SUMMARY

Volume 1: Executive Summary (ref: FE-1520-101).

REGIONAL TEST CASES

- Volume 2: Area Stripping with Draglines Using Illinois Basin Region Test Case (ref: FE-1520-102).
Volume 3: Area Stripping with Draglines Using Four Corners Region Test Case (ref: FE-1520-103).
Volume 4: Area Stripping with Draglines Using Fort Union Region Test Case (ref: FE-1520-104).
Volume 5: Area Stripping with Draglines Using Texas Gulf Region Test Case (ref: FE-1520-105).
Volume 6: Contour Stripping with Draglines Using Appalachia-Ohio Region Test Case (ref: FE-1520-106).
Volume 7: Area Stripping with Shovels and Trucks Using Powder River Region Test Case (ref: FE-1520-107).
Volume 8: Mountain Top Removal Mining Using Appalachia-West Virginia Region Test Case (ref: FE-1520-108).
Volume 9: Multiple Dipping Seam Mining Using Green River Region Test Case (ref: FE-1520-109).

USER'S MANUALS FOR COMPUTER MODELS

- Volume 10: User's Manual for Area Dragline Macromodel (ref: FE-1520-110).
Volume 11: User's Manual for Area Shovel Truck Macromodel (ref: FE-1520-111).
Volume 12: User's Manual for Contour Stripping with Draglines Macromodel (ref: FE-1520-112).
Volume 13: User's Manual for Cash Flow Analysis Model (ref: FE-1520-113).
Volume 14: User's Manual for Dragline Stripping Micro-models (ref: FE-1520-114).
Volume 15: User's Manual for Shovel Truck Mining Micro-models (ref: FE-1520-115).
Volume 16: User's Manual for Nonstripping Mining Function Micromodels (ref: FE-1520-116).

All volumes available from:

National Technical Information Service
U.S. Department of Commerce
Springfield, Virginia 22161

Appendix A.2 Phase I Report List

Volume 1: Introduction, Summary, Conclusions, and Recommendations for Research.

Summary of Phase I results (31 pages, ref: FE-1520-1).

Volume 2: Characterization of Coal Deposits for Large-Scale Surface Mining.

Delineates strippable coal resource regions of the U.S. and describes their physiography, surficial deposits, soils, structural geology, general stratigraphy, and coal stratigraphy (346 pages, ref: FE-1520-2).

Volume 3: Surface Coal Mining Methods and Equipment.

Describes mining methods and equipment used in large scale surface coal mining (109 pages, ref: FE-1520-3).

Volume 4: Large-Scale Coal Processing for Coal Conversion.

Discusses coal preparation plant design related to producing feedstocks for coal conversion and describes hypothetical plants for three types of coal preparation (80 pages, ref: FE-1520-4).

Volume 5: Survey of Socioeconomics, Financial Statistics, and Legal Aspects.

Provides an overview of the socioeconomic, financial, and legal factors which affect surface coal mining (121 pages, ref: FE-1520-5).

Volume 6: Computer Systems to Support Mine Planning.

Describes the status of the simulation models and supporting data files at the end of Phase I (307 pages, ref: FE-1520-6).

Available from the National Technical Information Service,
U.S. Department of Commerce,
Springfield, Virginia 22161.

Further information not contained in these volumes can be obtained from Fluor Utah, Inc., in San Mateo, California or the Fossil Energy Office of the Energy Research and Development Administration in Washington, D.C.

APPENDIX B

Micromodel Test Case Analysis Input and Results

- B.1 Basic Stripping Method (BSM) Input
- B.2 Basic Stripping Method (BSM) Output
- B.3 Drilling and Blasting (DAB) Input
- B.4 Drilling and Blasting (DAB) Output
- B.5 Haul Unit Simulation (HUS) Input
- B.6 Haul Unit Simulation (HUS) Output
- B.7 Coal Load and Haul (CLH) Input
- B.8 Coal Load and Haul (CLH) Output
- B.9 Land Reclamation Simulation (LRS) Input
- B.10 Land Reclamation Simulation (LRS) Output
- B.11 Preparation/General Administrative (PGA) Input
(Coal Preparation Factoring)
- B.12 Preparation/General Administrative (PGA) Default
Values (Coal Preparation Factoring)
- B.13 Preparation/General Administrative (PGA) Output
(Coal Preparation Factoring)
- B.14 Preparation/General Administrative (PGA) Input
(Premining, Facilities, and Administration)
- B.15 Preparation/General Administrative (PGA) Default
Values (Premining, Facilities, and Administration)
- B.16 Preparation/General Administrative (PGA) Output
(Premining, Facilities, and Administration)

User's manuals for the above micromodels are contained in Volumes 14 and 16 of the Final Report (ref: FE-1520-114 and FE-1520-116).

Appendix B.1 & B.2 Basic Stripping Method Input and Output

The Basic Stripping Method (BSM) computer model simulates area stripping with a single dragline. The model determines the range and production requirements based on input for the pit geometry and required coal production. It then processes the Dragline Data File to compare the requirements to the capabilities of the full range of machines commercially available.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 6 pages.

B.1 Contour Stripping with Draglines (CSD) Input

CSD - RUN DATE 12/03/76
CASE NO 503 (CSD00503) CONTOUR STRIPPING
SECT NO 1 MODEL SIZES THE DRAGLINE BUCKET

PAGE NO 1.1

<u>Y</u>	<u>X</u>
200.	23.
350.	40.
650.	47.
950.	58.
1250.	58.
1550.	52.
1850.	41.
9000000.	0.

Profile of
Section

77

I ISDLS	1	SYNTHESIZES DRAGLINE IF 1	I INCX	0	INCREMENTAL EX DATA IF 1
I CDRTY	865300.	COAL DEMAND RECOVERABLE TONS/YEAR	I LOGG	0	PRINTS ELEVATION GRID IF 1
I CPH	60.0000	CYCLES PER HOUR	I LOGS1	1	PRINTS SECTION PAGE .1 IF 1
I DLJHY	7467.00	DL - OPERATING HOURS/YEAR	I LOGS2	1	PRINTS SECTION PAGE .2 IF 1
I DLRND	60.0000	DRAGLINE REFERENCE NUMBER	I LOGS3	1	PRINTS SECTION PAGE .3 IF 1
I DLSB	30.0000	DRAGLINE BOOM ANGLE - DEGREES	I LOGS4	1	PRINTS SECTION PAGE .4 IF 1
I ESD	.833000	EFFICIENCY OF STRIPPING OPERATION	I LOGXS	1	DRAWNS CROSS-SECTION PLOT IF 1
I FFP	.950000	FILL FACTOR	I LOGXY	1	BUILDS X,Y FILE FOR TERMINAL PLOTTING IF 1
I PTF	.950000	PROPEL TIME FACTOR	I ABHD	63.4350	ANGLE OF OVERBURDEN HIGHWALL IN DEGREES
I TMY	30.0000	TOTAL MINING YEARS	I ABSD	33.6890	ANGLE SPOIL IN DEGREES
			I ACFD	76.0000	ANGLE OF COAL FACE IN DEGREES
			I ANGLE	23.9700	INTERIOR ANGLE (0 FOR STRAIGHT SEGMENT)
			I AZ	104.000	AZIMUTH FROM NORTH TO OUTSIDE RADIUS
			I BCE	.000000	ELEVATION OF TOP OF COAL
			C COTA	.500000	SLOPE OF HIGHWALL - HORIZONTAL/VERTICAL
I KSS	1	KEEPS SECTIONS SEPARATE ON PLAN	C COTB	.249328	SLOPE OF COAL HORIZONTAL/VERTICAL
I LJGCM	1	DRAWNS PLAN-VIEW PLOT IF 1	C COTT	1.50006	SLOPE OF SPOIL HORIZONTAL/VERTICAL
I LOGDL	1	LOG DRAGLINE STATISTICS IF 1	I CPX	224.380	CENTER POINT X COORDINATE
I CSCL	800.000	SCALE FACTOR FOR PLAN-VIEW PLOT	I CPY	697.550	CENTER POINT Y COORDINATE
			I DBBPY	4330.00	DENSITY OF BURDEN - BANK POUNDS/YARD
			I DCBPY	2160.00	DENSITY OF COAL - BANK POUNDS/YARD
			I DOM	1.00000	DIRECTION OF DRAGLINE MOVEMENT
			I ECR	.920000	EXPECTED COAL RECOVERY
			* EDR	260.000	EFFECTIVE DUMPING RADIUS
			I EFH	23.4600	ELEVATION OF FIRST HIGHWALL
			I HC	4.00000	HEIGHT OF COAL
			I PJ	2.00000	ALLOWABLE OVERLAP
			I RADISJ	6550.00	RADIUS OR LENGTH OF SEGMENT
			I SCL	100.000	SCALE FACTOR FOR CROSS-SECTION PLOT
			I SFB	.350000	SWELL FACTOR FOR OVERBURDEN
			I SWDH	3.00000	SAFE WORKING DISTANCE FROM EDGE OF HIGHWALL
			C TANA	2.00000	SLOPE OF HIGHWALL - VERTICAL/HORIZONTAL
			C TANB	4.01078	SLOPE OF COAL VERTICAL/HORIZONTAL
			C TANT	.666640	SLOPE OF SPOIL VERTICAL/HORIZONTAL

* VALUE IS CALCULATED WHEN ISDLS = 1

B.2 Contour Stripping with Draglines (CSD) Output

Dragline Data

C BPRY	.107277E 08	BURDEN PRODN. BANK YARDS/YEAR
* DLCA	6081.99	DRAGLINE PURCHASE PRICE
* DLCI	7471.77	DRAGLINE TOTAL INVESTMENT COST
* DLCL	105.171	DRAGLINE HOURLY OWNERSHIP COST
* DLCR	183.004	DRAGLINE HOURLY OPERATING COST
C DLRMA	262.996	RADIUS MEASURED FROM BOOM FOOT
* DLSA	304.000	DRAGLINE BOOM LENGTH
* DLSH	302.647	DRAGLINE DUMPING RADIUS
* DLSJ	79.2952	DRAGLINE WIDTH OVER BOTH SHOES
* DLSW	42.9983	DRAGLINE BUCKET SIZE
C DLX	12.4215	CORRELATION FACTOR
C TODF	129776.	TOTAL CUTCROP DISTANCE - FEET

78

NPITS	YP	NDL	ACRES	TOTC				
47.359	.633	1.000	4490.29	.259590E 08				
#	YRS	TCL	ACR	TCR	DAO	\$/A		\$/T
1.	30.000	.235594E 08	.136649E 07	.409947E 08	.645542E 08	14376.4	2.48678	\$/T
#	YRS	TCL	ACR	TCR	DAO	\$/A		\$/T
1.	30.000	.235594E 08	.136649E 07	.409947E 08	.645541E 08	14376.4	2.48677	\$/T

(See next page for definitions.)

- NPITS = The number of pits (as defined by all sections in the problem definition) that would be needed to provide the coal demand.
- YP = The number of calendar years the dragline must operate in this pit to strip all overburden.
- NDL = The number of draglines required to uncover the coal demand.
- ACRES = The number of surface acres disturbed in this pit. Acres are measured from the outslope of the first spoil bank to the top of the final highwall, using the distance along the coal center line.
- TOTC = The total recovered coal demand (i.e., CDRTY * TMY).
- # = Number of draglines that must be purchased to meet the coal demand. It is NDL rounded up to the next integer.
- YRS = The years of dragline operation.
- TCL = Total ownership costs for the draglines when operating for YRS years, with salvage value equal to the non-depreciated value at the end.
- ACR = Annual operating costs for the draglines.
- TCR = Total operating costs associated with YRS years of operation.
- OAO = Total Ownership plus total operating costs for YRS years.
- \$/A = Total ownership plus total operating costs, divided by acres.
- \$/T = Total ownership plus total operating costs, divided by total recovered tons of coal.

B.2 Contour Stripping with Draglines (CSD) Output - Continued

CSD - RUN DATE 12/03/76 PAGE NO 1.3
CASE NO 503 (CSD00503) CONTOUR STRIPPING
SECT NO 1 MODEL SIZES THE DRAGLINE BUCKET

A	B	C	D	E							
NS	RAD	CHORD	G	ARC							
1.	6550.0	2720.3	23.970	2740.2							
F	G	H	I	J	K	L	M	N	O	P	
NP	RADS	RADC	RADB	ARCS	ARCC	ARCB	VOLB	RHW	TONC	CTC	
1.	6610.	6313.	6305.	2765.	2641.	2638.	.28428E 06	.00000	42257.	.00000	
2.	6506.	6213.	6203.	2722.	2599.	2595.	.37512E 06	.00000	41588.	.00000	
3.	6402.	6113.	6102.	2678.	2557.	2553.	.40210E 06	.00000	40918.	.00000	
4.	6301.	6013.	6002.	2636.	2515.	2511.	.41977E 06	.00000	40249.	.00000	
5.	6200.	5913.	5901.	2594.	2474.	2469.	.43842E 06	.00000	39580.	.00000	
6.	6098.	5813.	5800.	2551.	2432.	2426.	.46291E 06	.00000	38910.	.00000	
7.	5996.	5713.	5699.	2508.	2390.	2384.	.48684E 06	.00000	38241.	.00000	
8.	5895.	5613.	5599.	2466.	2348.	2342.	.50284E 06	.00000	37572.	.00000	
9.	5794.	5513.	5498.	2424.	2306.	2300.	.49587E 06	.00000	36902.	.00000	
10.	5694.	5413.	5398.	2382.	2265.	2258.	.48702E 06	.00000	36233.	.00000	
11.	5594.	5313.	5299.	2340.	2223.	2217.	.47444E 06	.00000	35564.	.00000	
12.	5495.	5213.	5199.	2299.	2181.	2175.	.44975E 06	.00000	34894.	.00000	
13.	5396.	5113.	5100.	2257.	2139.	2134.	.42466E 06	.00000	34225.	.00000	
14.	5297.	5013.	5000.	2216.	2097.	2092.	.39792E 06	.00000	33555.	.00000	
15.	5198.	4913.	4901.	2175.	2055.	2050.	.36370E 06	.00000	32886.	.00000	
16.	5100.	4813.	4802.	2134.	2014.	2009.	.32991E 06	.00000	32217.	.00000	

OVERBURDEN BANK CUBIC YARDS (THOUSANDS)

WITH REHANDLE

	1	2	3	4	5	6	7	8	9	10	11
12	284.3	375.1	402.1	419.8	438.4	462.9	486.8	502.8	495.9	487.0	474.4
1	449.7	424.7	397.9	363.7	329.9	6795.5					
COAL RECOVERED TONS											
WITH REHANDLE											

	1	2	3	4	5	6	7	8	9	10	11
12	38877.	38261.	37645.	37029.	36413.	35798.	35182.	34566.	33950.	33334.	32718.
1	32103.	31487.	30871.	30255.	29639.	548127.					

STRIPPING RATIO

WITH REHANDLE

	1	2	3	4	5	6	7	8	9	10	11
12	7.31	9.80	10.68	11.34	12.04	12.93	13.84	14.55	14.61	14.61	14.50
1	14.01	13.49	12.89	12.02	11.13	12.40					
DAYS IN PANEL											
WITH REHANDLE											

	1	2	3	4	5	6	7	8	9	10	11
12	9.7	12.8	13.7	14.3	14.9	15.8	16.6	17.1	16.9	16.6	16.1
1	15.3	14.4	13.5	12.4	11.2	231.2					

(See next page for definition of Columns A through P.)

B.2 Contour Stripping with Draglines (CSD)
Output - Definitions

- Column A The section number.
- B Radius or length of segment.
- C The calculated length of the chord connecting the ends of the radii describing this section. CHORD is set to zero for straight-line segments.
- D The angle enclosed by the two radii.
- E The calculated arc length connecting the two radii. This is the length of the coal outcrop that has been defined for this section and it has the same value as RAD for straight-line segments.
- F The panels are numbered from the first highwall in the direction of panel advance.
- G The radius of the spoils is calculated to the crest of the pile.
- H The coal radius is calculated to the centerline of the coal panel.
- I The calculated overburden radius is measured to the center of mass of the material excavated.
- J The arc length is calculated along the crest of the spoils.
- K The arc length is calculated along the coal panel centerline.
- L The overburden arc is calculated along the center of mass.
- M The overburden, in bank cubic yards, that is spoiled from this panel.
- N The rehandle volume is measured in bank cubic yards. It is the volume of spoils that must be rehandled when coal is recovered. When this value is zero, no coal is covered.
- O The recoverable tons of coal in this panel.

B.2 Contour Stripping with Draglines (CSD)
Output - Definitions (Continued)

P The recoverable tons of coal that have been covered by spoils. This value is zero when the spoils do not overlap the coal. A nonzero value is the amount of coal that would be left in place if the spoils were not rehandled.

Appendix B.3 & B.4 Drilling and Blasting
Input and Output

The Drilling and Blasting (DAB) computer model simulates the drilling of vertical blast holes and determines the required amounts of blasting materials related to overburden drilling and blasting.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 3 pages.

B.3 Drilling and Blasting (DAB) Input

DRILLING AND BLASTING SIMULATION
INPUT PARAMETERS

12/02/76

0503 (0DAB0503) OHIC
1 DRILLING AND BLASTING OVERBURDEN

KMED	1.	MEDIUM FOR DRILLING, 0=COAL 1=0.8.
ICASE	2.	ICASE = 1, NO S,B,SDDI SPECIFIED ICASE = 2, SDDI SPECIFIED ICASE = 3, S,B, AND SDDI SPECIFIED
OSRHY	3625.00	SCHEDULED OPERATING HOURS PER YEAR
OPRHY	3262.50	PRODUCTIVE OPERATING HOURS PER YEAR
EDD	1.000	EFFICIENCY OF DRILLING OPERATIONS - FRACTION
PTF	1.00	PROPEL TIME FACTOR - FRACTION
P	100.00	PANEL WIDTH - FEET
HBMF	2.00	HOLE BOTTOM MARGIN - FEET
DPGCC	1.50	DENSITY OF PRIMER - GRAM / CC
DAGCC	.80	DENSITY OF ANFO - GRAM / CC
OSGCC	1.50	DENSITY OF SLURRY - GRAM / CC
PRPY	.30	PCWDER RATIO - LBS. / YARD
PDM	.50	PERCENTAGE DRY HOLES
PWH	.10	PERCENTAGE WET HOLES
HPF	.50	HEIGHT OF PRIMER - FEET
PEBC	.05	% EX. BLASTING CAPS/CAST BOOSTERS
CRDC	130.00	COST OF BLASTING CAPS/CAST BOOSTERS - \$/100
CPDP	.40	COST OF PRIMER - \$ / LB.
CADP	.08	COST OF ANFO - \$ / LB.
CSDP	.32	COST OF SLURRY - \$ / LB.
PLY	30.00	PROJECT LIFE - YEARS
DRSMFH	100.	DRILLING RATE IN SOFT MAT'L - FT./HR.
BDBY	.1073E C8	BURDEN DEMAND - BANK YDS/YR
H8	49.27	HEIGHT OF BURDEN - FEET
SDDI	15.000	SPECIFIED DRILL DIAMETER - INCHES

B.4 Drilling and Blasting (DAB) Output

DRILLING AND BLASTING SIMULATION
INTERMEDIATE VARIABLES

12/02/76

0503 (00A80503) OHIO
I DRILLING AND BLASTING OVERBURDEN

S	38.00	SPACING - FT.
B	38.00	BURDEN - FT.
SAF	4048.86	BURDEN ACRE FEET
ABBY	.32184E 09	AREA BURDEN - BANK YDS
RLADFY	58789.48	RATE OF LINEAR ADVANCE - FT. / YR.
RHLF	47.27	REQUIRED HOLE LENGTH - FT.
VCFYH	53.48	VOLUME EFFECTED - CU. YD. / FOOT OF HOLE
PEH	791.00	POUNDS OF EXPLOSIVE PER HOLE
VECYH	2635.03	VOLUME EFFECTED - CU. YD. / HOLE
NHY	4C71.00	NUMBER OF HOLES PER YEAR
WAPFH	61.29	WEIGHT OF ANFO - LBS. / FT. OF HOLE
WSPFH	114.92	WEIGHT OF SLURRY - LBS. / FT. OF HOLE
WPPFH	114.92	WEIGHT OF PRIMER - LBS. / FT. OF HOLE
HAF	11.97	HEIGHT OF ANFO IN HOLE - FT.
H5F	6.38	HEIGHT OF SLURRY IN HOLE - FT.
SHDF	34.80	STEMMING HEIGHT FOR DRY HOLES - FT.
SHWF	40.39	STEMMING HEIGHT FOR WET HOLES - FT.
NBCY	4274.00	NO. OF BLASTING CAPS/CAST BOOSTERS / YEAR
CBCDY	5556.20	COST OF BLASTING CAPS/CAST BOOSTERS - \$/YR
WPPY	233919.44	WEIGHT OF PRIMER - LBS. / YR.
CPDY	93567.75	COST OF PRIMER - \$ / YR.
WAPY	2687616.00	WEIGHT OF ANFO - LBS. / YR.
CADY	215009.19	CCST OF ANFO - \$ / YR.
WSPY	298624.12	WEIGHT OF SLURRY - LBS. / YR.
CSDY	95559.69	COST OF SLURRY - \$ / YR.
APRPY	.30	ACTUAL POWDER RATIO - LBS. / CU. YD.
CEDY	409692.81	COST OF EXPLOSIVES - \$ / YR.
CEFH	2.13	COST OF EXPLOSIVES - \$ / FT. OF HOLE
CEUB	.04	COST OF EXPLOSIVES - \$ / UNIT BLASTED

85

	Drills						Explosives			Combined				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		NDR	M\$OWN	M\$OPN	M\$O&O	\$/FT	\$/UNIT	M\$/YR	\$/FT	\$/UNIT	CMS/YR	C\$/FT	C\$/UNIT	C\$/AFT
16	.590	63.59	94.91	158.50	.82	.015	409.69	2.13	.038	568.19	2.95	.053	4209.99	
19	.590	75.04	103.85	178.89	.93	.017	409.69	2.13	.038	588.58	3.06	.055	4361.08	
22	.590	118.43	130.55	248.98	1.29	.023	409.69	2.13	.038	658.68	3.42	.061	4880.46	

LEAST COST MACHINE - 16

(See next page for definition of Columns A through N.)

B.4 Drilling and Blasting (DAB) Output - Definitions

Column A Rotary drill data base identification number
B Number of drills required
C Annual ownership cost for drills (thousands of dollars)
D Annual operating cost for drills (thousands of dollars)
E Annual ownership and operating cost for drills (thousands of dollars)
F Drilling cost (\$/foot of hole drilled)
G Drilling cost (\$/cubic yard of overburden drilled and blasted)
H Annual operating cost for explosives (thousands of dollars)
I Explosives cost (\$/foot of hole drilled)
J Explosives cost (\$/cubic yard of overburden drilled and blasted)
K Combined annual ownership and operating costs for drilling and explosives
(thousands of dollars)
L Combined cost (\$/foot of hole drilled)
M Combined cost (\$/cubic yard of overburden drilled and blasted)
N Combined cost (\$/acre of coal uncovered)

Appendix B.5 and B.6 Haul Unit Simulation
Input and Output

The HUS model simulates the performance of an off-highway truck on a given haul road. The model evaluates the ability of a truck according to the following criteria:

Possible truck speed and time to travel the haul road

Possible coal production (tons/hour) that could be sustained by one truck

Size of the fleet required to maintain a given coal production rate

Cost of ownership and operation of each truck in the fleet

Cost of haulage for each truck (\$/ton of coal).

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 2 pages.

B.5 Haul Unit Simulation (HUS) Input

INPUT FACTORS USED IN HAUL UNIT CALCULATIONS

HAULING MEDIUM - 0=COAL,1=O.B.	0. KMED
TRUCK TYPE - 1=REAR,2=TRAILER,3=BOTH	2. KTT
TRUCK SPOT AND WAIT - 0=NO,1=YES	0. KSWT
AVERAGE SITE TEMPERATURE	75.00 AST
ALTITUDE	1700.00 ATF
COAL PRODUCTION DEMAND	530.47 CDRTH
DENSITY OF BANK COAL	2160.00 DCBPY
SWELL FACTOR CF CCAL	.35 SFC
EFFICIENCY OF LOADER OPERATION	.833 EQO
EFFICIENCY OF TRUCK OPERATION	.833 ETO
FILL FACTOR	.95 FF
EMPTY SPEED FACTOR-LONG HAUL	.95 RSFLH
EMPTY SPEED FACTOR-SHORT HAUL	.80 RSFSH
COST OF FUEL PER GAL.	.30 CF
TRUCK AVAILABILITY FACTOR	1.00 TA
OIL AND LUBE FACTOR	.30 OLF
SCHEDULED OPERATING HOURS PER DAY	7.25 OSTHD
PRODUCTIVE OPERATING HOURS PER DAY	6.52 OPTHD
INDEX FOR JGB CONDITIONS	2.00 IJC
TOLERANCE FOR PAYLOAD OVERLOAD	.10 PLT

----- LOADED -----

SEG NO	LENGTH (FT.)	GRADE (%)	ROLLING RES.(%)	SPEED LIMIT	SAS IND	SAE IND
1.	2000.0	.0	7.5	12.0	1.	0.
2.	4600.0	.0	5.0	30.0	0.	0.
3.	27720.0	-.2	3.0	30.0	0.	1.
34320.0						

SAS IND = Stop at start of segment
SAE IND = Stop at end of segment

----- EMPTY -----

SEG NO	LENGTH (FT.)	GRADE (%)	ROLLING RES.(%)	SPEED LIMIT	SAS IND	SAE IND
3.	27720.0	.2	3.0	30.0	1.	0.
2.	4600.0	.0	5.0	30.0	0.	0.
1.	2000.0	.0	7.5	12.0	0.	1.
34320.0						
68640.0 TOTAL						

B.6 Haul Unit Simulation (HUS) Output

Truck 53

----- LOADED -----

SEG NO	LENGTH (FT.)	GRADE (%)	ROLLING RES. (%)	SPEED LIMIT	SAS IND	SAE IND	ACTUAL SPEED (MIN)	TIME
1.	2000.0	.0	7.5	12.0	1.	0.	7.1	3.2
2.	4600.0	.0	5.0	30.0	0.	0.	10.3	5.1
3.	27720.0	-.2	3.0	30.0	0.	1.	14.8	21.3
								29.6

----- EMPTY -----

SEG NO	LENGTH (FT.)	GRADE (%)	ROLLING RES. (%)	SPEED LIMIT	SAS IND	SAE IND	ACTUAL SPEED (MIN)	TIME
3.	27720.0	.2	3.0	30.0	1.	0.	30.0	10.5
2.	4600.0	.0	5.0	30.0	0.	0.	22.1	2.4
1.	2000.0	.0	7.5	12.0	0.	1.	12.0	1.9
								14.8
68640.0 TOTAL MOVING TIME & LENGTH								44.3

-----CYCLE TIME-----

LOADED TIME	29.57
EMPTY TIME	14.75
LOADING TIME	3.60
WAIT TIME AT LOADER	1.80
TIME TO SPCT AT LOADER	.00
TURN AND DUMP TIME	.60

-----TOTAL CYCLE TIME----- 50.32

-----PRODUCTION DATA-----

EFFECTIVE MINUTES / HOUR	50.0	
NO. OF TRIPS / HOUR	1.0	
ACTUAL - CAPACITY PAYLOAD IN TONS	150.0	155.2
NO. OF TCNS / HOUR	149.0	
NO. OF HAUL UNITS NEEDED	4.0	

-----COST DATA-----

APPLICATION - RATED TCN MILES PER HOUR	188.68	235.00
EFFECTIVE TIRE LIFE-HRS	5000.0	
FUEL CONSUMPTION-GAL/HR	24.0	
OWNERSHIP COST - \$/HR	21.94	

-----OPERATING COST-----

MAINTENANCE - MAT'L	12.39
LABOR	8.26
FUEL COST	9.36
LABOR	11.26
TIRE COST	13.75
OPERATING COST - \$/HR	55.01

TOTAL OWNERSHIP & OPERATING COST 76.94
0 & 0 DOLLARS PER TON .52

Appendix B.7 and B.8 Coal Load and Haul Input and Output

The data developed with the HUS model is used in running the CLH model. The CLH model processes shovel and truck files to evaluate the ability of the shovel and truck, in combination, to meet the requirements of physical dimensions and production during the coal loading operation. Production and cost information is calculated and printed for the user.

The model operates the shovel and truck separately, at full capacities, to determine possible production. Then the combination of shovel and truck is evaluated, taking into account the necessary losses in possible production due to waiting time for the truck to spot at the shovel.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 3 pages.

B.7 Coal Load and Haul (CLH) Input

INPUT FACTORS USED IN COAL LOAD AND HAUL SIMULATION

0503 (OCLH0503) OHIO

1

COAL LOAD AND HAUL SIMULATION

LOAD AND HAUL MEDIUM - 0=COAL, 1=G.B.	0. KMED
SHOVEL-SCHEDULED HOURS PER YEAR	1812.50 OSQHY
SHOVEL-PRODUCTIVE HOURS PER YEAR	1631.25 OPQHY
SHOVEL CYCLE TIME IN MINUTES	.50 QCTM
EFFICIENCY OF SHOVEL OPERATIONS	.83 EQD
SHOVEL DIPPER FILL FACTOR	.95 FF
MINIMUM NUMBER OF SHOVEL SWINGS TO LOAD	4.0 MINNC
MAXIMUM NUMBER OF SHOVEL SWINGS TO LOAD	20.0 MAXNC
PANEL WIDTH	100.00 P
HEIGHT OF COAL	4.00 HC
EXPECTED COAL RECOVERY	.92 ECR
AREA COAL IN RECOVERABLE MILLION TONS	25.96 ACRT
COAL DEMAND	865323. CDRTY
DENSITY OF COAL - BANK	2160.00 DCBPY
SWELL FACTOR OF COAL	.35 SFC
CLEARANCE OF OPERATION	2.00 CLO
EFFICIENCY OF TRUCK OPERATION	.83 ETO
TRUCK AVAILABILITY	1.00 TA
TRUCK-SCHEDULED HOURS PER YEAR	1812.50 OSTHY
TRUCK-PRODUCTIVE HOURS PER YEAR	1631.25 OPTHY
PAYLOAD TOLERANCE	.10 PLT
METHOD OF OPERATION	2.00 ICASE
NUMBER OF CLTS TO REMOVE MATERIAL	1.0 NCS
DEPRECIATION SWITCH	.0 IDEP

CASE = 2 ---TRUCK LOADED ON SIDE OF SHOVEL

B.8 Coal Load and Haul (CLH) Output

INTERMEDIATE VARIABLES CALCULATED BY SIMULATION 12/02/76 RUN NO. = 1

0503 (DCLH0503) OHIO
1 CCAL LOAD AND HAUL SIMULATION

ACTUAL ANGLE OF SWING	90.0 AANGS
ACTUAL SHOVEL CYCLE TIME	.50 QCTMA
SHOVEL EFFECTIVE MINUTES PER HOUR	50.0 SEMH
NUMBER OF SHOVEL SWINGS PER HOUR	100.0 SNSH
HEIGHT OF BERM ABOVE FLOOR - CASE 1	4.0 CLH
COAL ACRES	4048.63 CAF

Shovels				Combined			Trucks					
A	B	C	D	E	F	G	H	I	J	K	L	M
SEQ	#	I MM\$	O MM\$	\$/TON	C\$/TON	C\$/AFT	\$/TON	I MM\$	O MM\$	#	#	SEQ
23	1.00	1.764	2.444	.162	.760	4871.	.598	4.678	10.834	6.43	7	1
23	1.00	1.764	2.444	.162	.758	4860.	.596	4.666	10.802	6.42	7	2
23	1.00	1.764	2.444	.162	.914	5862.	.752	6.973	12.552	5.61	6	5
.												
31	1.00	1.017	2.290	.127	.713	4572.	.586	4.678	10.524	6.25	7	1
31	1.00	1.017	2.290	.127	.711	4561.	.584	4.666	10.494	6.23	7	2
31	1.00	1.017	2.290	.127	.868	5566.	.741	6.973	12.255	5.48	6	5
31	1.00	1.017	2.290	.127	.850	5448.	.722	7.091	11.658	5.04	6	6
31	1.00	1.017	2.290	.127	.746	4784.	.619	5.691	10.371	5.15	6	45
31	1.00	1.017	2.290	.127	.746	4784.	.619	5.691	10.371	5.15	6	46
31	1.00	1.017	2.290	.127	.713	4570.	.585	4.524	10.671	4.82	5	51
31	1.00	1.017	2.290	.127	.713	4570.	.585	4.524	10.671	4.82	5	52
31	1.00	1.017	2.290	.127	.684	4389.	.557	4.294	10.168	3.78	4	53
34	1.00	2.005	2.688	.181	.752	4823.	.571	4.678	10.157	6.03	7	1
34	1.00	2.005	2.688	.181	.751	4813.	.570	4.666	10.127	6.02	7	2
34	1.00	2.005	2.688	.181	.903	5788.	.722	6.973	11.767	5.26	6	5
34	1.00	2.005	2.688	.181	.902	5784.	.721	7.091	11.635	5.03	6	6
34	1.00	2.005	2.688	.181	.645	4138.	.465	3.349	8.710	3.01	3	18
34	1.00	2.005	2.688	.181	.746	4784.	.565	4.742	9.932	4.94	5	45
34	1.00	2.005	2.688	.181	.746	4784.	.565	4.742	9.932	4.94	5	46
34	1.00	2.005	2.688	.181	.764	4901.	.584	4.524	10.625	4.80	5	51
34	1.00	2.005	2.688	.181	.764	4901.	.584	4.524	10.625	4.80	5	52
34	1.00	2.005	2.688	.181	.727	4661.	.546	4.294	9.881	3.67	4	53
.												
36	1.00	2.388	2.994	.207	.755	4844.	.548	4.524	9.706	4.39	5	51
36	1.00	2.388	2.994	.207	.755	4844.	.548	4.524	9.706	4.39	5	52
36	1.00	2.388	2.994	.207	.719	4611.	.512	4.294	8.993	3.34	4	53

LEAST COST COMBINATION - 34 18

(See next page for definition of Columns A through M.)

B.8 Coal Load and Haul (CLH) Output - Definitions

Column A Shovel data base identification number
B Number of shovels required (rounded to integer)
C Total project ownership cost for shovels (millions of dollars)
D Total project operating cost for shovels (millions of dollars)
E Shovel cost (\$/ton of coal recovered)
F Combined cost for shovels and trucks (\$/ton of coal recovered)
G Combined cost (\$/acre of coal uncovered)
H Truck cost (\$/ton of coal recovered)
I Total project ownership cost for trucks (in millions of dollars)
J Total project operating cost for trucks (in millions of dollars)
K Number of trucks required
L Number of trucks required (rounded to integer)
M Truck data base identification number

Appendix B.9 and B.10 Land Reclamation Simulation
Input and Output

The Land Reclamation Simulation (LRS) micromodel analyzes four separate operations: required scraper fleet for top-soil removal and redistribution; required bulldozer fleet for spoil pile regrading and for general dozer work; costs of revegetation; and land management.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 4 pages.

B.9 Land Reclamation Simulation (LRS) Input

LAND RECLAMATION SIMULATION
LOG PARAMETERS

12/02/76

0503 (OLR5C503) OHIO
1 LAND RECLAMATION SIMULATION

I KAC	4	METHOD OF INPUT - 1, 2, 3, OR 4
I KSR	1	SPOIL REGRADE - 1=YES, 0=NO
I LOGPA	1	PRINT INPUT VARIABLES IF = 1
* ACRES	4490.29	ACRES ON PROPERTY
* ACRT	.259597E 08	AREA COAL IN RECOVERABLE TONS
I CDRTY	865323.	COAL DEMAND - RECOVERED TONS / YEAR
I CGD	600.000	COST FOR GENERAL DOZING - \$/ACRE
I CLM	100.000	COST FOR LAND MANAGEMENT - \$/ACRE
I CRV	200.000	COST FOR REVEGETATION - \$/ACRE
C EMH	49.9800	EFFECTIVE MINUTES PER HOUR
I ERO	.833000	EFFICIENCY OF LAND RECLAMATION - FRACTION
I HBT	.500000	HEIGHT OF TOPSOIL - FEET
I PLRHY	1665.00	PRODUCTIVE LAND RECLAMATION - HRS / YR
* PWF	100.000	PANEL WIDTH - FEET
C RAY	149.676	RECLAMATION ACRES PER YEAR
C TANT	.666641	TANGENT OF ANGLE OF SPOILS
C TMY	30.0000	TOTAL MINING YEARS
I DTRPY	2320.00	DENSITY OF TOPSOIL - BANK LBS / YD
I SCA	1.00000	SCRAPER AVAILABILITY - FRACTION
I SCCN	38.2100	SCRAPER HOURLY OPERATING COST - \$/HR
I SCCP	22.2600	SCRAPER HOURLY OWNERSHIP COST - \$/HR
I SCPA	-.318100	SCRAPER PERF. COEF. A
I SCPB	126.400	SCRAPER PERF. COEF. B
I SCPC	33.5000	SCRAPER MAXIMUM PERF. SPEED - MPH
I SCPD	.225400	SCRAPER BRAKING COEF. A
I SCPE	247.800	SCRAPER BRAKING COEF. B
I SCPF	33.0000	SCRAPER MAXIMUM BRAKING SPEED - MPH
I SCSA	32.0000	SCRAPER HEAPED CAPACITY - CU YDS
I SCSC	91.2000	SCRAPER EMPTY WEIGHT - M LBS
I SCSD	72.0000	SCRAPER PAYLOAD - M LBS
I SFT	.430000	SWELL FACTOR OF TOPSOIL - FRACTION
I TMSM	.700000	TIME TO MANUEVER AND SPREAD - MINUTES
I TRF	.600000E-01	TOTAL RESISTANCE ON HAUL - FRACTION
C TRMY	120.739	TOPSOIL REMOVAL DEMAND M YDS/YR - BANK
C TRSAY	149.676	T.S. REM. & SPRD. ACRES / YR
C TRSPY	24.6966	T.S. REM. & SPRD. NO. OF PANELS / YR
* TPTDF	3200.00	TOPSOIL REMOVAL DISTANCE MOVED - FEET
C TSMY	172.656	TOPSOIL SPREAD DEMAND M YDS/YR - LOOSE
* TSTDF	1600.00	TOPSOIL SPREAD DISTANCE MOVED - FEET
I TTLM	.900000	TIME TO LOAD SCRAPER - MINUTES
I ABSD	33.6890	ANGLE OF BURDEN SPOILS - DEGREES
I CDA	1.00000	DOZER AVAILABILITY - FRACTION
I CDCN	31.1800	DOZER HOURLY OPERATING COST - \$/HR
I CDCP	21.3000	DOZER HOURLY OWNERSHIP COST - \$/HR
I CDPA	-.49.5700	DOZER PRODUCTION COEF. A
I CDPB	158000.	DOZER PRODUCTION COEF. B
I CDPHY	1665.00	DOZER PRODUCTIVE HOURS PER YEAR
C DDMF	150.000	DOZING DISTANCE - FEET
I DMNDF	50.0000	DOZING MINIMUM DISTANCE - FEET
I DMXDF	600.000	DOZING MAXIMUM DISTANCE - FEET
I ECDO	.750000	EFFICIENCY OF DOZER OPERATION
I FPW	1.50000	FRACTION PANEL WIDTH DOZED MAT'L MOVED
I FR	.250000	FRACTION OF DOZED MAT'L REHANDLED

B.9 Land Reclamation Simulation (LRS) Input - Continued

C SRAY	149.676	SPOIL REGRADE ACRES PER YFAR
C SRMY	1257.65	SPOIL REGRADE DEMAND M YDS / YR
C SRYA	6721.96	SPOIL REGRADE YARDS / ACRE
C SRYAR	8402.45	SPOIL REGRADE YDS / ACRE INCL. R/H

I = Input Parameter
C = Calculated Parameter
* = Calculated if not Input

B.10 Land Reclamation Simulation (LRS) Output

LAND RECLAMATION SIMULATION
CALCULATED RESULTS

12/02/76

0503 (OLRS0503) OHIO
1 LAND RECLAMATION SIMULATION

SCRAPER	A CUYD	B P-MLBS	C A-MLBS									
	32.00	72.00	51.92									
DOZER	D DMF	E CUYD/HR										
	150.00	1003.76										
	F L-MPH	G E-MPH	H CTM	I TPH	J MCRY	K #	L I-M\$/YR	M O-M\$/YR	N IOM\$/YR	O \$/CY	P \$/A	Q \$/TON
TS REMOVAL	11.95	22.78	6.24	8.01	298.51	.40	14.99	25.73	40.72	.337	272.074	.047
TS SPREAD	11.23	22.78	4.02	12.44	662.98	.26	9.65	16.57	26.22	.152	175.181	.030
						.66					447.255	.077
SPOIL REGRADE					1253.45	1.00	35.58	52.09	87.67	.070	585.742	.101
GENERAL DOZING						1.03			89.81		600.000	.104
						2.03					1185.742	.205
REVEGETATION									29.94		200.000	.035
LAND MANAGEMENT									14.97		100.000	.017
TOTAL LAND RECLAMATION									289.32		1932.997	.334
STOP 0												

(See next page for definition of Columns A through Q.)

B.10 Land Reclamation Simulation (LRS) Output - Definitions

Column A Scraper rated capacity (cubic yards)
B Scraper rated payload (thousands of pounds)
C Scraper actual payload (thousands of pounds)
D Dozing distance (feet)
E Dozing hourly capacity (cubic yards/hr)
F Scraper average speed loaded (miles/hr)
G Scraper average speed empty (miles/hr)
H Scraper cycle time (minutes)
I Scraper production (tons/hr)
J Scraper production (thousands cubic yards/year)
K Number of scrapers required
Number of dozers required
L Annual ownership costs (thousands of dollars)
M Annual operating costs (thousands of dollars)
N Annual ownership and operating costs (thousands of dollars)
O Cost (\$/cubic yard of topsoil)
P Cost (\$/acre)
Q Cost (\$/ton of coal recovered)

Appendix B.11, B.12 and B.13 Coal Preparation Factoring
Input and Output

The Preparation/General Administrative (PGA) micromodel determines the coal handling and processing costs by means of extrapolation from a standard size facility. In addition, it allows plant selection based on three levels of difficulty of preparation effort: crushing and screening, Baum jig, and heavy media. The micromodel separates ownership and operating costs into five categories:

- Receiving and Breaking
- Blending and Stockpiling
- Coal Loadout
- Preparation Plant
- Preparation Plant Support.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 4 pages.

B.11 Preparation/General Administrative (PGA) Input
(Coal Preparation Factoring)

PGA MODEL ECONOMIC SUMMARY

RUN DATE 14:08 DEC 02, '76 PAGE NO. 1.1

CASE NO. 503 TITLE (PGAG0503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION

ALT. NO. 503 TITLE APPALACHIA - OHIO

1975 DOLLARS

I	IMOGA		0		INCLUDE GENERAL & ADMINISTRATIVE
I	IMOPP		1		INCLUDE PREP PLANT
I	IPPT		1		PP - INDEX TO PLANT TYPE
I	LOGCF		1		WRITES CFA CONTROL FILE IF 1
I	LOGEC		1		WRITES CFA EQUIPMENT FILE IF 1
I	LOGPA		1		PRINTS PARAMETERS IF 1
I	LOGSD		1		WRITES SPECIFICATION DATA IF 1
I	LOGSM		1		WRITES ECONOMIC SUMMARY IF ONE
I	NY		3		NO. OF YEARS TO STARTUP
I	PPRED	.409500E	15		PP - BASE ENERGY BTU/YEAR
I	PPBT	75000.0			PP - BASE TONS/DAY
I	PPNED	.130000E	15		PP - COMPLEX ENERGY DEMAND BTU/YEAR
I	PPNHV	12600.0			PP - COAL HEAT VALUE BTU/LB
I	PPODY	250.000			PP - OPERATING DAYS/YEAR
I	TMY	30.0000			TOTAL MINING YEARS

B.12 Preparation / General Administrative (PGA) Default Values
(Coal Preparation Factoring)

PGA MODEL ECONOMIC SUMMARY

RUN DATE 14:08 DEC 02,'76 PAGE NO. 1.3

CASE NO. 503 TITLE (PGAC0503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION
ALT. NO. 503 TITLE APPALACHIA - OHIO

1975 DOLLARS

PPBHV	BASE HEAT VALUES	10990.	12760.	13084.						
PPBSF	BASE SIZE FACTORS	.9900	.8250	.7870						
PPBHF	BASE HEAT FACTORS	1.0036	1.0373	1.0600						
PPCCF	CAP. COST FACTORS	17700.	67400.	3600.	9500.	8100.	52100.	8100.	70200.	8100.
PPCCX	CAP. COST EXP.	.80	.80	1.00	.80	.50	.75	.50	.70	.50
PPPSF	OPER. PER. FRACTIONS	2.00	8.50	2.00	2.00	9.60	6.00	9.60	6.00	9.60
		2.00	2.00	2.00	2.00	4.80	2.00	7.20	6.00	9.60
		3.00	.00	1.00	3.00	.00	3.00	.00	3.00	.00
		.00	.00	.00	1.00	.00	3.00	.00	5.00	.00
		.00	.00	.00	.00	.00	2.00	.00	2.00	.00
		.00	.00	.00	.00	.00	.00	.00	2.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00
PPPSX	OPER. PER. EXP.	.35	.35	.35	.35	.35	.35	.35	.35	.35
PPCS	OPER. SCHED. CCDES	5.	9.	12.	9.	5.	9.	5.	9.	5.
PPCC	OPER. CLASS CODES	13.	13.	13.	13.	11.	13.	11.	13.	11.
		18.	23.	18.	18.	22.	17.	22.	17.	22.
		23.	0.	23.	22.	0.	22.	0.	22.	0.
		0.	0.	0.	23.	0.	23.	0.	5.	0.
		0.	0.	0.	0.	0.	10.	0.	23.	0.
		0.	0.	0.	0.	0.	0.	0.	10.	0.
		0.	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.	0.
PPMLF	MAINT. LABOR COST F.	71.52	81.09	30.56	54.31	174.02	184.13	215.38	249.38	232.32
PPMLX	MAINT. LABOR EXP.	.35	.35	.35	.35	.35	.35	.35	.35	.35
PPMMF	MAINT. MATL. COST F.	122.07	309.86	10.33	43.67	101.25	287.42	101.25	516.37	101.25
PPMMX	MAINT. MATL. EXP.	.80	.80	.80	.80	.50	.75	.50	.70	.50
PPFCF	FUEL COST FACTORS	.00	.00	.00	12.41	.00	15.45	.00	17.93	.00
PPFCX	FUEL COST EXP.	.00	.00	.00	.80	.00	.75	.00	.70	.00
PPWCF	WATER COST FACTORS	.00	.00	.00	.00	.00	2.40	.00	4.20	.00
PPWCX	WATER COST EXP.	.00	.00	.00	.00	.00	1.00	.00	1.00	.00
PPECF	ELEC. COST FACTORS	45.05	99.87	22.12	19.08	128.12	185.00	128.12	314.65	128.12
PPECX	ELEC. COST EXP.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TOI

B.12 Preparation/General Administrative (PGA) Default Values - continued
(Coal Preparation Factoring)

PGA MODEL ECONOMIC SUMMARY		RUN DATE 14:08 DEC 02,'76 PAGE NO. 1.4								
CASE NO. 503 TITLE (PGA00503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION										
ALT. NO. 503 TITLE APPALACHIA - CHIO										
1975 DOLLARS										
PPLCF	LABOR COST FACTORS	68.78	105.53	55.83	79.24	143.62	161.06	166.80	220.21	189.99
PPLCX	LABOR COST EXP.	.35	.35	.35	.35	.35	.35	.35	.35	.35
PPQWCF	OWN. COST FACTORS	3625.	5438.	8712.	5438.	2000.	5438.	2000.	5438.	2000.
PPDTF	OPER. HOURS/DAY	14.50	21.75	38.45	21.75	8.00	21.75	8.00	21.75	8.00
PPEQTY	UNIT QUANTITIES	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
PPMS	MAINT. SCHED. CODES	5.	5.	5.	5.	5.	5.	5.	5.	5.
PPMC	MAINT. CLASS CODES	4.	4.	4.	4.	4.	4.	4.	4.	4.
		5.	5.	5.	5.	5.	5.	5.	5.	5.
		6.	6.	6.	6.	6.	6.	6.	6.	6.
		14.	14.	14.	14.	12.	14.	12.	14.	12.
		12.	12.	12.	12.	13.	12.	13.	12.	13.
		18.	18.	18.	18.	22.	18.	22.	18.	22.
		23.	23.	23.	23.	0.	23.	0.	23.	0.
		0.	0.	0.	0.	0.	0.	0.	0.	0.
PPMF	MAINT. FRACTIONS	.074	.087	.069	.131	.097	.096	.118	.113	.146
		.074	.044	.069	.064	.195	.096	.157	.099	.146
		.296	.261	.278	.259	.292	.288	.315	.311	.328
		.071	.042	.066	.061	.233	.092	.226	.068	.210
		.212	.125	.199	.187	.093	.128	.075	.122	.070
		.205	.401	.256	.239	.090	.248	.109	.248	.100
		.068	.040	.063	.059	.000	.052	.000	.039	.000
		.000	.000	.000	.000	.000	.000	.000	.000	.000
PPCRSY	START YEAR	7.								
PPCRNY	NO. YEAR STARTUP	3.								
PPCRSE	STARTUP EFF.	1.								
PPCRPL	PURCHASE LEAD TIME	3.								
PPCRLO	LIFE OF OPERN.	30.								
PPD2SF	SALVAGE FRACTION	.00								
PPD2DM	DEPREC. METHOD	0.								
PPD2PC	PURCHASE CODE	5.								
PPD2RA	REGIONAL ADJ.	1.00								
PPD2EF	ESCAL. FACTOR	.00								
PPD2CO	CONSTRUCTION CODE	1.								

B.13 Preparation/General Administrative (PGA) Output
(Coal Preparation Factoring)

PGA MODEL ECONOMIC SUMMARY RUN DATE 14:08 DEC 02,'76 PAGE NO. 1.2

CASE NO. 503 TITLE (PGAC0503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION
ALT. NO. 503 TITLE APPALACHIA - OHIO

1975 DOLLARS

PREPARATION PLANT STATISTICS

TYPE	SIZE TONS/DAY	BTU/LB	DELIVERED COAL		O&O \$/TON
			TONS/YEAR	BTU/YEAR	
1	20767.2	12645.4	.513988E 07	.130000E 15	
			UNIT INVESTMENT	LABOR OWNERSHIP OPERATING \$/HOUR	
REC & BREAK	PREP. PLANT		.789316E 07	89.62 230.08	249.72 .335
BLEND-STOCK	PREP. PLANT		.300564E 08	137.50 584.03	409.00 1.040
COAL LOADCUT	PREP. PLANT		996824.	72.75 12.09	123.30 .251
CRUSH-SCREEN	PREP. PLANT		.423644E 07	103.25 82.32	204.31 .300
CS SUPPORT	PREP. PLANT		.738251E 07	187.13 390.04	541.64 .359
			.505653E 08		2.285

C PPFHV	12645.4	PP - FINAL HEAT VALUE
C PPFTY	.513988E 07	PP - FINISHED COAL TONS/YEAR
C PPHF	1.00360	PP - HEAT VALUE FACTOR FOR IPPT
C PPHV	10990.0	PP - BASE HEAT VALUE FOR IPPT
C PPN5	20767.2	PP - COMPLEX SIZE TONS/DAY
C PPSF	.9900C0	PP - SIZE FACTOR FOR IPPT

Appendix B.14, B.15 and B.16 Premining, Facilities, and
Administration input and output

The Preparation/General Administrative (PGA) micromodel determines the central facilities, staff, and premining costs by means of extrapolation from a standard size facility. The micromodel separates ownership and operating costs into thirteen categories:

- Roads and Site Work
- Buildings
- Electric Power System
- Water System
- Communications System
- Mobile Support Equipment
- Shop Equipment
- Land Rights
- Exploration Drilling
- Contract Engineering
- Environmental Impact Statement
- Supervisory and Support Personnel
- Royalty and Severance Tax.

Computer input and output for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 3 pages.

B.14 Preparation/General Administrative (PGA) Input
(Premining, Facilities and Administration)

PGA MODEL ECONOMIC SUMMARY

RUN DATE 14:08 DEC 02, '76 PAGE NO. 1.1

CASE NO. 503 TITLE (PGAG0503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION
ALT. NO. 503 TITLE APPALACHIA - OHIO

1975 DOLLARS

I	IMOGA	1	INCLUDE GENERAL & ADMINISTRATIVE
I	IMOPP	1	INCLUDE PREP PLANT
I	IPPT	1	PP - INDEX TO PLANT TYPE
I	LOGCF	1	WRITES CFA CONTROL FILE IF 1
I	LOGEC	1	WRITES CFA EQUIPMENT FILE IF 1
I	LOGPA	1	PRINTS PARAMETERS IF 1
I	LOGSD	1	WRITES SPECIFICATION DATA IF 1
I	LOGSM	1	WRITES ECONOMIC SUMMARY IF ONE
I	NY	3	NO. OF YEARS TO STARTUP
I	DRBPY	4330.00	DENSITY OF OVERBURDEN BANK LBS/YARD
I	G4MR	50.0000	GAA - MINERAL RIGHTS (\$/ACRE)
I	GARA	.250000	GAA - ROYALTY AMOUNT (\$/TON)
I	GASR	250.0000	GAA - SURFACE RIGHTS (\$/ACRE)
I	GAST	.000000	GAA - SEVERANCE TAX (\$/TON)
I	GATA0	26941.7	TOTAL ACRES DISTURBED IN COMPLEX
I	GATYB	144.545	GAA - TCNS/YEAR - BASELINE
I	GAUP	.110000	GAA - UNION PAYMENT (\$/TON)
I	SRYT	12.3977	STRIPPING RATIO YARDS/ROM TONS
I	TMY	30.0000	TOTAL MINING YEARS

B.16 Preparation/General Administrative (PGA) Output
(Premining, Facilities, and Administration)

PGA MODEL ECONOMIC SUMMARY

RUN DATE 14:08 DEC 02, '76 PAGE NO. 1.5

CASE NO. 503 TITLE (PGAC0503) HYPOTHETICAL MINE STUDY - BASELINE SOLUTION
ALT. NO. 503 TITLE APPALACHIA - OHIO

1975 DOLLARS

GENERAL & ADMINISTRATIVE COSTS

	UNIT INVESTMENT	OWNERSHIP \$/HOUR	OPERATING \$/HOUR	O&D \$/TON
ROADS & SITE ANC. FAC.	.300000E 07	155.16	.00	.064
BUILDINGS ANC. FAC.	.489375E 07	253.10	32.60	.117
ELECT. SYS. ANC. FAC.	.450000E 07	232.73	.00	.096
WATER SYS. ANC. FAC.	200000.	10.34	.00	.004
COMMUN. SYS. ANC. FAC.	125000.	6.46	.00	.003
MOBILE SUP. ANC. FAC.	.120000E 07	62.06	.00	.026
EQUIP. SHOP ANC. FAC.	.100000E 07	51.72	.00	.021
LAND RIGHTS PREMINE	808251.	41.80	121.24	.067
EXPL. DRILL. PREMINE	673542.	34.83	.00	.014
CONT. ENG. PREMINE	.600000E 07	310.31	.00	.128
E. I. S. PREMINE	.100000E 07	51.72	.00	.021
SUPERV. PER.	.000000	.00	776.82	.319
ROY-SEV. TAX	.000000	.00	876.12	.360
	.234005E 08	1210.24	1806.77	1.240

TOTAL MM TONS/YEAR 144.545
TOTAL ACRES DISTURBED 26941.7

C BPBY	.643664E 08	COMPLEX OVERBURDEN PROD. YARDS/YEAR
C COPTYX	.519180E 07	COMPLEX COAL DEMAND ROM TONS/YEAR
C V8BY	.193099E 10	VOL. OVERBURDEN BANK YARDS
C VCRT	.155754E 09	VOL. COAL ROM TONS

APPENDIX C

Cash Flow Analysis Input

- C.1 Definition of Equipment and Facilities Requirements for the Project.
- C.2 Definition of Personnel Data.
- C.3 Definition of Case Description Parameters, Financial Assumptions, and Default Values.

A User's Manual for the Cash Flow Analysis Model is contained in Volume 13 of the Final Report (ref: FE-1520-113). The following examples of manually prepared input data are for the hypothetical baseline situation for the Appalachia (Ohio) test case.

The equipment data (Appendix C.1) is prepared manually by the user based on the results of the micromodel analysis shown in Appendix B.

The personnel data (Appendix C.2) establishes wage categories and work schedules for all employees.

The case description, financial parameters, and default values (Appendix C.3) record the values used for the major mining and economic variables.

Appendix C.1 Definition of Equipment and Facilities

Each item of equipment, facilities, or premining costs must be defined on a series of input cards as follows:

- 1) ECRG Card: Defines the mining operation code; the equipment identification number from the equipment data base; the initial quantity required; the quantity of fleet spares; the operating hours per year; the steady state annual production in 1000's; the start year (first year of production); the number of years to complete startup (time from first production to reach steady state production); the startup efficiency (discounts production in early years); the purchase lead time in years; deferred purchase; life of operation in years; and scheduled hours per year.
- 2) EDI Card; Defines equipment type and size.
- 3) ED2 Card: Defines equipment investment cost; depreciation (replacement) life; salvage fraction; depreciation method; purchase code for progress payment schedule; investment base year; investment regional adjustment; investment escalation; construction and tax credit treatment.
- 4) ED3 Card: Defines the equipment operating costs for maintenance labor, maintenance material, fuel, tires, electric power, water, and other.
- 5) ED01 Card: Defines the personnel wage classification, personnel work schedule basis, and quantity of operating personnel required for the equipment.
- 6) EPM1 Card: Defines the personnel wage classification for personnel work schedule basis and fractional proportion of maintenance expenditure for that classification required for the equipment.
- 7) EMSU Card: Defines the usage adjustment, if any, to the operating costs shown on the ED3 card to account for any variation from the assumed conditions used in the equipment data file.

A worksheet, as shown on the following page, is used to code the equipment and facilities information for entry into a computerized data file for the cash flow program.

CASE IDENTIFICATION
 Project Name CONTOUR STRIPPING
 Location APPALACHIA - OHIO
 Run No. CFAO 0503

USER IDENTIFICATION
 Name T. BOYCE
 Organization FLUOR UTAH
 Date 10/20/76

NOTES Page 1 of 36
 HYPOTHETICAL MINE STUDY
 BASELINE SOLUTION

EQUIPMENT AND FACILITIES WORKSHEET- EXAMPLE

	MO	ID	QT	FS	OH	CP	SY	NY	SE	PL	DP	LO	SH
Equip. Common Row Guide	Mining Operation	Equipment Identification	Equipment Quantity	Fleet Spares	Operating Hrs/Yr	Steady State Production (1000s)	Annual Start Year	No. Yrs. Startup	Start up Efficiency	Purchase Lead Time	Defer'd Purch'se	Life of Operat'n	Scheduled Hrs/Yr
ECRG	01	D60	6	0	7467	64617	7	3	.80	4	0	30	8297

	MO	ID	TEXT										
Equip. Data Card 1	Mining Operation	Equipment Identification	Equipment Type		Equipment Size				Equipment Data File Code				
ED1	01	D60	DRAGLINE		52 CY 320 FT								

	MO	ID	UI	DH	SF	DM	PC	BY	RA	EF	C
Equip. Data Card 2	Mining Operation	Equipment Identification	Unit Investment	Depreciation Life in Hours	Salvage Fraction	Dep'n Method	Purchase Code	Investment Base Year	Investment Regional Adjustmt	Investment Escalation	Construct. & Tax Credit
ED2	01	D60	8420.1	224010	.000	1	5	1	1.000	.000	0

	MO	ID	ML	MM	FU	TI	EL	WA	OT
Equip. Data Card 3	Mining Operation	Equipment Identification	Maintenance Hourly Cost (\$)	Labor Item 1 Maintenance Mat'l Hourly Cost (\$)	Fuel Item 2 Hourly Cost (\$)	Tires Item 3 Hourly Cost (\$)	Elect Power Item 4 Hourly Cost (\$)	Water Item 5 Hourly Cost (\$)	Other Item 6 Hourly Cost (\$)
ED3	01	D60	53.27	80.54	.00	.00	24.62	.00	.00

	MO	ID	C1	S1	Q1	C2	S2	Q2	C3	S3	Q3	C4	S4	Q4	C5	S5	Q5
Eq. Personnel Operators	Mining Operation	Equipment Identification	Class	Sched	Qty	Class	Sched	Qty	Class	Sched	Qty	Class	Sched	Qty	Class	Sched	Qty
EP01	01	D60	2	12	1	8	12	1	9	12	1						

	MO	ID	C1	S1	F1	C2	S2	F2	C3	S3	F3	C4	S4	F4	C5	S5	F5
Eq. Personnel Maintenance	Mining Operation	Equipment Identification	Class	Sched	Fraction	Class	Sched	Fraction	Class	Sched	Fraction	Class	Sched	Fraction	Class	Sched	Fraction
EPM1	01	D60	6	10	1.0												
EPM2																	

	MO	ID	I1	F1	I2	F2	I3	F3	I4	F4	I5	F5	I6	F6
Eq. Material & Suppl. Usage	Mining Operation	Equipment Identification	Hourly Item	Adjust Factor	Hourly Item	Adjust Factor	Hourly Item	Adjust Factor	Hourly Item	Adjust Factor	Hourly Item	Adjust Factor	Hourly Item	Adjust Factor
EMSU														

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Appendix C.2 Definition of Personnel Data

All operating and maintenance personnel must be identified by two codes:

- 1) PWC: Personnel Wage Classification which identifies the person's union pay grade and work description.
- 2) PSB: Personnel Schedule Basis which identifies the possible work schedules (shifts per day, hours per shift, and shifts per week).

Two additional parameters are defined for each combination of wage classification and schedule basis:

- 1) EHPY: Effective Hours Per Year which is an estimate of the annual number of hours the person is expected to be on the job ready to work (accounts for overtime, holidays, etc.).
- 2) PDPH: Personnel Dollars Per Hour which is an estimate of the total wages plus overtime, pre-mining and payroll added costs per hour. This personnel data is organized into a computerized file for the cash flow program.

The personnel wage classifications schedules used for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 3 pages.

C.2 Definition of Personnel Data

<u>Personnel</u> <u>Wage</u> <u>Classification</u>	<u>Grade</u>	<u>and Work Description</u>	<u>Personnel</u> <u>Schedule</u> <u>Basis</u>	<u>Shifts</u> <u>Per</u> <u>Day</u>	<u>Hours</u> <u>Per</u> <u>Shift</u>	<u>Days</u> <u>Per</u> <u>Week</u>
PWC 1	5	Coal Loading Operator	PSB 1	1	7.25	5
PWC 2	5	Strip Mach Operator	PSB 2	1	7.25	6
PWC 3	5	Master Electrician	PSB 3	1	8.00	5
PWC 4	4	Electrician	PSB 4	1	8.00	6
PWC 5	4	Machinist	PSB 5	2	7.25	5
PWC 6	4	Mechanic	PSB 6	2	7.25	6
PWC 7	4	Welder 1st Class	PSB 7	2	8.00	5
PWC 8	4	Oiler	PSB 8	2	8.00	6
PWC 9	4	Groundman	PSB 9	3	7.25	5
PWC 10	4	Central Control	PSB 10	3	7.25	6
PWC 11	3	Mobile Equip Operator	PSB 11	3	8.00	5
PWC 12	3	Repairman	PSB 12	3	8.00	6
PWC 13	3	Stat Equip Operator				
PWC 14	3	Welder				
PWC 15	3	Driller & Shooter				
PWC 16	3	Car Loader				
PWC 17	2	Tipple Attendant				
PWC 18	2	Helper				
PWC 19	1	Car Operation				
PWC 20	1	Sampler				
PWC 21	1	Svc Vehicle Driver				
PWC 22	1	Utility Man				
PWC 23	1	Laborer				
PWC 24	S	Gen & Adm Staff				

Personnel Effective Hours Per Year

Personnel

Wage

Personnel Schedule Basis

<u>Classification Grade</u>		<u>PSB 1</u>	<u>PSB 3</u>	<u>PSB 5</u>	<u>PSB 6</u>	<u>PSB 9</u>	<u>PSB 10</u>	<u>PSB 12</u>
PWC 1	5	1618		1618	1942	1618	1942	2269
PWC 2	5	1618		1618	1942	1618	1942	2269
PWC 3	5	1618		1618	1942	1618	1942	2269
PWC 4	4	1618		1618	1942	1618	1942	2269
PWC 5	4	1618		1618	1942	1618	1942	2269
PWC 6	4	1618		1618	1942	1618	1942	2269
PWC 7	4	1618		1618	1942	1618	1942	2269
PWC 8	4	1618		1618	1942	1618	1942	2269
PWC 9	4	1618		1618	1942	1618	1942	2269
PWC 10	4	1618		1618	1942	1618	1942	2269
PWC 11	3	1618		1618	1942	1618	1942	2269
PWS 12	3	1618		1618	1942	1618	1942	2269
PWC 13	3	1618		1618	1942	1618	1942	2269
PWC 14	3	1618		1618	1942	1618	1942	2269
PWC 15	3	1618		1618	1942	1618	1942	2269
PWC 16	3	1618		1618	1942	1618	1942	2269
PWC 17	2	1618		1618	1942	1618	1942	2269
PWC 18	2	1618		1618	1942	1618	1942	2269
PWC 19	1	1618		1618	1942	1618	1942	2269
PWC 20	1	1618		1618	1942	1618	1942	2269
PWC 21	1	1618		1618	1942	1618	1942	2269
PWC 22	1	1618		1618	1942	1618	1942	2269
PWC 23	1	1618		1618	1942	1618	1942	2269
PWC 24	S		2000					

Personnel Dollars Per Hour

Personnel

Wage

Personnel Schedule Basis

<u>Classification Grade</u>		<u>PSB 1</u>	<u>PSB 3</u>	<u>PSB 5</u>	<u>PSB 6</u>	<u>PSB 9</u>	<u>PSB 10</u>	<u>PSB 12</u>
PWC 1	5	11.32		11.42	12.37	11.52	12.48	12.90
PWC 2	5	11.32		11.42	12.37	11.52	12.48	12.90
PWC 3	5	11.32		11.42	12.37	11.52	12.48	12.90
PWC 4	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 5	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 6	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 7	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 8	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 9	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 10	4	10.49		10.59	11.47	10.69	11.58	12.10
PWC 11	3	10.03		10.13	10.97	10.23	11.08	11.46
PWS 12	3	10.03		10.13	10.97	10.23	11.08	11.46
PWC 13	3	10.03		10.13	10.97	10.23	11.08	11.46
PWC 14	3	10.03		10.13	10.97	10.23	11.08	11.46
PWC 15	3	10.03		10.13	10.97	10.23	11.08	11.46
PWC 16	3	10.03		10.13	10.97	10.23	11.08	11.46
PWC 17	2	9.67		9.77	10.58	9.87	10.69	11.07
PWC 18	2	9.67		9.77	10.58	9.87	10.69	11.07
PWC 19	1	9.56		9.66	10.46	9.76	10.57	10.77
PWC 20	1	9.56		9.66	10.46	9.76	10.57	10.77
PWC 21	1	9.56		9.66	10.46	9.76	10.57	10.77
PWC 22	1	9.56		9.66	10.46	9.76	10.57	10.77
PWC 23	1	9.56		9.66	10.46	9.76	10.57	10.77
PWC 24	S		10.28					

Appendix C.3 Definition of Case Description Parameters, Financial Assumptions, and Default Values

The parameters to be defined are in three categories as follows:

- 1) Mining Parameters which provide identifying information for the case description report but which do not directly affect the cash flow calculations.
- 2) Financial Assumptions and Control Parameters which define the major items that determine the method and cost of financing the project and that determine the revenue and profitability. Depreciation method, escalation rate, and purchase method are also defined.
- 3) Default Values which define the major items needed to create yearly pro-forma financial statements for the project. Regional adjustment factors are also defined.

The mining parameters, financial assumptions, and default values for the hypothetical baseline situation for the Appalachia (Ohio) test case are shown on the following 2 pages.

CASE DESCRIPTION

MINING PARAMETERS

IPPT\$	1	INDEX TO PLANT TYPE
CDRTY\$	.519180E 07	COAL DEMAND ROM TONS/YEAR (COMPLEX)
SRYS\$	12.3977	STRIPPING RATIO YARDS/ROM TONS
HBT\$	.500000	HEIGHT OF TOPSOIL - FEET
HC\$	4.000000	HEIGHT OF COAL IN FEET
PPFTY\$	.513988E 07	PREPARED COAL TONS/YEAR
PPNED\$	.130000E 15	ENERGY DEMAND FOR COMPLEX BTU/YEAR
PPN4V\$	12600.0	ROM COAL HEAT VALUE BTU/LB
ROC\$	900.000	RECLAMATION - OTHER COSTS - \$/ACRE
VCBP	12645.4	VALUE - COAL BTU/POUND

FINANCIAL ASSUMPTIONS

CJR	2.00000	CAPITAL/DEBT RATIO
GAMR\$	50.0000	GAA - MINERAL RIGHTS (\$/ACRE)
GAR\$	.250000	GAA - ROYALTY AMOUNT (\$/TON)
GASR\$	250.000	GAA - SURFACE RIGHTS (\$/ACRE)
GAST\$	.000000	GAA - SEVERANCE TAX (\$/TON)
RCFD	.100000	RATE - CASH FLOW DISCOUNT
RFIT	.480000	RATE - FEDERAL INCOME TAX
RLTI	.800000E-01	RATE - LONG TERM INTEREST
RSTI	.100000	RATE - SHORT TERM INTEREST
VSPC	.000000	VALUE - REQ. PRICE OF COAL - \$/TON

FINANCIAL CONTROL PARAMETERS

DM1	.000000	RESET DEP. METHOD 1 TO NONZERO VALUE
DM2	.000000	RESET DEP. METHOD 2 TO NONZERO VALUE
DM3	.000000	RESET DEP. METHOD 3 TO NONZERO VALUE
ERAEI	.000000	ESCAL. RATE - ALL EQUIP. INVEST.
EREL	.000000	ESCAL. RATE - ELECTRICITY
ERFU	.000000	ESCAL. RATE - FUELS
ERM	.000000	ESCAL. RATE - MAINTENANCE LABOR
ERMM	.000000	ESCAL. RATE - MAINTENANCE MATERIALS
ERDL	.000000	ESCAL. RATE - OPERATING LABOR
EROT	.000000	ESCAL. RATE - OTHER COSTS
ERSPC	.000000	ESCAL. RATE - SELLING PRICE OF COAL
ERTI	.000000	ESCAL. RATE - TIRES
ERWA	.000000	ESCAL. RATE - WATER
ESPC	.000000	FSC. COAL PRICE PER COST FSC. IF 1
PC1	.000000	RESETS PUR. CODE 1 TO NONZERO VALUE
PC2	.000000	RESETS PUR. CODE 2 TO NONZERO VALUE
PC3	.000000	RESETS PUR. CODE 3 TO NONZERO VALUE
PC4	.000000	RESETS PUR. CODE 4 TO NONZERO VALUE
PC5	.000000	RESETS PUR. CODE 5 TO NONZERO VALUE
PC6	.000000	RESETS PUR. CODE 6 TO NONZERO VALUE
PC7	.000000	RESETS PUR. CODE 7 TO NONZERO VALUE

\$ IN NAME INDICATES A MEMO ITEM FOR CFA

PARAMETER LIST		
LCFCJ	1	BUILDS CORRELATION DATA FILE IF 1
LCFDB	0	LOGS DEBUG ARRAYS IF 1
LCFFP	1	PRINTS THE FINANCIAL PARAMETERS IF 1
LCFFSR	1	PRINTS FINANCIAL SUMMARY REPORT IF 1
LCFIL	1	PRINTS INVESTMENT LIST IF 1
LCFIR	1	PRINTS INFRASTRUCTURE REPORT IF 1
LCFMPL	1	PRINTS MAINTENANCE MANPOWER LIST IF 1
LCFOPL	1	PRINTS OPERATING MANPOWER LIST IF 1
LCFPCE	1	PRINTS PRODN. & CASH EXP. REPORT IF 1
LCFPFS	1	PRINTS PRO-FORMA STATEMENTS IF 1
LCFSML	1	PRINTS SERVICE & MATERIALS LIST IF 1
LCFX	1	BUILDS X,Y PLOT FILE IF 1
NEDNC	0	NEW EQUIP. DATA FOR NEXT CASE IF 1
CEYH	10.0000	COST OF ELECTRICITY - \$/MEGAWATT HOJR
CFDMG	300.000	COST OF FUEL - \$/M GALS.
CWJMS	.500000E-01	COST OF WATER - \$/M GALS
DAPG	.100000	DEPLETION ALLOWANCE - PERCENT OF GROSS
DAPN	.500000	DEPLETION ALLOWANCE - PERCENT OF NET
DEC	.000000	DEBT/EQUITY RATIO CONTROL
DER	1.000000	DEBT/EQUITY RATIO
DERT	.100000	DEBT/EQUITY RATIO TOLERANCE
EYAEI	.000000	ESCAL. YEAR - ALL EQUIP. INVEST.
EYHC	.000000	ESCAL. YEAR - HOURLY COSTS
EYML	.000000	ESCAL. YEAR - MAINTENANCE LABOR
EYDL	.000000	ESCAL. YEAR - OPERATING LABOR
EYSPC	.000000	ESCAL. YEAR - SELLING PRICE OF COAL
FALC	1.20000	FACTOR - ANNUAL LEASE COSTS
FCR	.250000	FACTOR - CASH REQUIREMENTS
F1JC	.200000E-01	FACTOR - HOME OFFICE COSTS
F1PT	.500000E-01	FACTOR - INSURANCE & PROPERTY TAX
F5I	.100000	FACTOR - SUPPLIES INVENTORY
FWI	.625000E-01	FACTOR - WAREHOUSE INVENTORY
RAAEI	1.00000	REGIONAL ADJ. - ALL EQUIP. INVEST.
RAEL	1.00000	REGIONAL ADJ. - ELECTRICITY
RAFJ	1.00000	REGIONAL ADJ. - FUELS
RAML	1.00000	REGIONAL ADJ. - MAINTENANCE LABOR
RAMM	1.00000	REGIONAL ADJ. - MAINTENANCE MATERIALS
RAOL	1.00000	REGIONAL ADJ. - OPERATING LABOR
RAJT	1.00000	REGIONAL ADJ. - OTHER COSTS
RAT1	1.00000	REGIONAL ADJ. - TIRES
RAWA	1.00000	REGIONAL ADJ. - WATER
RCC	.000000	RATE - CASH DIVIDENDS
RCI	.120000	RATE - CONSTRUCTION INTEREST
RITC	.700000E-01	RATE - INVESTMENT TAX CREDIT
RLTJR	10.0000	RATE - L-T DEBT REPAYMENT (YEARS)
VCDY	365.000	VALUE - CALENDAR DAYS/YEAR
VJAP	20.0000	VALUE - DAYS ACCOUNTS PAYABLE
VDAR	45.0000	VALUE - DAYS ACCOUNTS RECEIVABLE
VDCI	10.0000	VALUE - DAYS OF COAL INVENTORY
VFCY	1976.00	VALUE - FIRST CALENDAR YEAR
VDDY	250.000	VALUE - OPERATING DAYS/YEAR
VSC	.000000	VALUE - STARTING CASH
VJPDH	.000000	VALUE - UNION PENSION \$/HOUR

APPENDIX D

Curve Fitting Analysis

- D.1 Dragline Price
- D.2 Quantity of Drills for Overburden
- D.3 Cost of Blasting Materials for Overburden
- D.4 Truck Cycle Time for Coal Hauling
- D.5 Quantity of Scrapers for Land Reclamation
- D.6 Quantity of Bulldozers for Land Reclamation

This appendix presents the results of work done with the micromodels and the Least-Squares Fit (LSF) program to develop the equations that are used in the macromodel in place of the more complex micromodel logic. The equation forms were developed from the micromodel logic. The model parameters were transformed as required to fit a linear equation of the form:

$$a_1x_1 + a_2x_2 + a_3x_3 + \dots + a_mx_m = y$$

The LSF program processes the results from the micromodel cases, determines the coefficients, resolves the expression for each case, and displays the calculated deviation between the recalculated values and the micromodel solution values. In most cases, it was possible to transform the model parameters into a truly linear equation, and the R squared term for these cases is .99 or better. In a few cases, the response was almost linear and for these cases, the R squared term drops to around .95.

For all equations presented here, a single parameter is varied for each micromodel case with all other parameters held at baseline values to obtain the set of observations for curve fitting. This approach would not be valid for general regression analysis since interactions between variables could be masked by the procedure itself. Masking is not considered to be a problem in this situation since the potential interactions are known from the micromodel logic. However, several of the fits were verified by runs in which the model parameter values were randomly varied. The LSF results did not differ materially between the random selection process and the structured selection process.

Initially, the LSF program did not develop an Analysis of Variance report since the primary objective was to see how well the fitted curve reproduced the micromodel results. This fit is demonstrated by the recalculated values and

deviations; the Standard Deviation of the deviations between micromodel results and recalculated values is used as the criterion of fit. However, the LSF program was modified to print an Analysis of Variance report for those interested in regression analysis statistics. The method used is described by N. R. Draper and H. Smith in APPLIED REGRESSION ANALYSES (John Wiley & Sons, New York, 1968).

Appendix D.1

Dragline Price

Base Price of Synthetized Machine:

$$DLCA = 981.71 + 410.6 * DLX$$

where DLCA = Dragline Base Price

$$DLX = \frac{DLRMA * DLSW}{1000}$$

DLRMA = Boom length in feet * cosine boom angle

DLSW = Bucket size in cubic yards

The following sheet shows the curve fitting results for the above equation.

D.1 Dragline - Base Price of Synthetized Machine
(Curve Fitting Results)

Equation:

$$DLCA = A + B * DLX$$

Coefficients: A = 981.71 B = 410.60

COUNT	Data File	Curve Fit	Comparison between	
	<u>Solution</u>	<u>Solution</u>	<u>Data File & Curve Fit</u>	
	INPUT Y	CALC Y	DEV	% DEV
1	2039.60010	2039.62305	-.023	-.001
2	2784.60010	2784.57568	.024	.001
3	4182.10156	4182.05469	.047	.001
4	4742.10156	4742.11328	-.012	-.000
5	5440.89844	5440.83203	.066	.001
6	8189.80078	8189.80469	-.004	-.000
7	7366.39844	7366.55078	-.152	-.002
8	8481.19922	8481.33203	-.133	-.002
9	9793.30078	9793.20313	.098	.001
10	12140.00000	12139.78516	.215	.002
11	15475.00000	15474.68359	.316	.002
12	22139.00000	22138.73437	.266	.001
13	2424.60010	2424.60205	-.002	-.000
14	3572.19995	3572.23120	-.031	-.001
15	4916.80078	4916.82422	-.023	-.000
16	6137.00000	6137.21094	-.211	-.003
17	7160.10156	7160.01953	.082	.001
18	7482.89844	7482.75000	.148	.002
19	8973.69922	8973.64062	.059	.001
20	9832.30078	9832.20703	.094	.001
21	13292.00000	13292.33984	-.340	-.003
22	18382.00000	18382.55859	-.559	-.003
23	2226.30005	2226.28198	.018	.001
24	2781.00000	2781.00366	-.004	-.000
25	3353.50000	3353.54517	-.045	-.001
26	4971.50000	4971.47656	.023	.000
27	7800.19922	7800.14453	.055	.001
28	4182.10156	4182.05469	.047	.001
AVER.	7509.35156	7509.34375	.172	.002

Appendix D.2

Quantity of Drills for Overburden

Quantity of Drills for Overburden:

$$\text{RNDR} = 5.609 * (\text{CDRTY} * \text{HB}) / (1\text{E}6 * \text{HC} * \text{DRSMFH})$$

where RNDR = Required number of drills

HC = Height of coal in feet

CDRTY = Coal demand recovered tons per year

HB = Height of burden in feet

DRSMFH = Drilling rate in soft material in feet per hour

The following sheets show the curve fitting results for the above equation and the supporting variation of parameters and resulting micromodel solutions.

D.2 Quantity of Drills for Overburden
(Curve Fitting Results)

Equation:

$$RNDR = A * CDRTY/1E6/HC * HB/DRSMFH$$

Coefficients: A = 5.60855

COUNT	Micromodel Solution	Curve Fit Solution	Comparison Between Micromodel & Curve Fit	
	INPUT Y	CALC Y	DEV	% DEV
1	3.61600	3.61771	-.002	-.047
2	2.41100	2.41156	-.001	-.023
3	1.80800	1.80886	-.001	-.047
4	.90400	.904429	-.000	-.947
5	.72300	.723542	-.001	-.075
6	.45200	.451965	.000	.008
7	1.13000	1.13091	-.001	-.080
8	1.80800	1.80886	-.001	-.047
9	2.71300	2.71378	-.001	-.029
10	3.39000	3.39178	-.002	-.051
11	.47200	.509537	-.038	-7.953
12	1.25800	1.27384	-.016	-1.259
13	1.80800	1.80886	-.001	-.047
14	2.17500	2.16553	.009	.435
15	2.56800	2.54768	.020	.791
16	3.61600	3.61771	-.002	-.047
17	2.41100	2.41121	-.000	-.009
18	1.80800	1.80886	-.001	-.047
19	1.44600	1.44708	-.001	-.075
20	1.20500	1.20596	-.001	-.080

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS
TOTAL (CORRECTED)	19	18.0521	
REGRESSION	0	18.0499	.723701E 76
RESIDUAL	19	.217846E-02	.114656E-03
R SQUARED		.999879	

AVERAGE INPUT Y = 1.88610
 STD. DEV. OF RESIDUAL = .107078E-01
 S.D. AS PCT OF AV. Y = .57

D.2 Quantity of Drills for Overburden (Variation of Parameters and Micromodel Results)

COUNT	Equation Parameters				Micromodel
	1/HC	CDRTY/1E6	HB	1/DRSMFH	Solution
1	.50000	1.8170	71.000	.10000E-01	3.6160
2	.33333	1.8170	71.000	.10000E-01	2.4110
3	.25000	1.8170	71.000	.10000E-01	1.8080
4	.12500	1.8170	71.000	.10000E-01	.90400
5	.10000	1.8170	71.000	.10000E-01	.72300
6	.25000	.45400	71.000	.10000E-01	.45200
7	.25000	1.1360	71.000	.10000E-01	1.1300
8	.25000	1.8170	71.000	.10000E-01	1.8080
9	.25000	2.7260	71.000	.10000E-01	2.7130
10	.25000	3.4070	71.000	.10000E-01	3.3900
11	.25000	1.8170	20.000	.10000E-01	.47200
12	.25000	1.8170	50.000	.10000E-01	1.2580
13	.25000	1.8170	71.000	.10000E-01	1.8080
14	.25000	1.8170	85.000	.10000E-01	2.1750
15	.2500	1.8170	100.00	.10000E-01	2.5680
16	.2500	1.8170	71.000	.20000E-01	3.6160
17	.25000	1.8170	71.000	.13333E-01	2.4110
18	.25000	1.8170	71.000	.10000E-01	1.8080
19	.25000	1.8170	71.000	.80000E-02	1.4460
20	.25000	1.8170	71.000	.66667E-02	1.2050

Appendix D.3

Cost of Blasting Materials for Overburden

Cost of Blasting Materials for Overburden:

$$\text{CEMDY} = 111 + 109.22 * (\text{CDRTY} * \text{HB} * \text{PRPY}) / (1\text{E}6 * \text{HC})$$

where CEMDY = Cost of explosives in thousands of dollars per year

HC = Height of coal in feet

CDRTY = Coal demand recovered tons per year

HB = Height of burden in feet

PRPY = Powder ratio pounds per bank cubic yard

The following sheets show the curve fitting results for the above equation and the supporting variation of parameters and resulting micromodel solutions.

D.3 Cost of Blasting Materials for Overburden
(Curve Fitting Results)

Equation:

$$\text{CEMDY} = A+B * \text{CDRTY}/1\text{E}6/\text{HC} * \text{HB} * \text{PRPY}$$

Coefficients: A = 111.033 B = 109.220

COUNT	Micromodel	Curve Fit	Comparison Between	
	Solution	Solution	Micromodel & Curve Fit	
	INPUT Y	CALC Y	DEV	% DEV
1	2341.10	2224.54	116.559	4.979
2	1560.80	1519.90	40.900	2.620
3	1170.50	1167.79	2.709	.231
4	585.250	639.411	-54.161	-9.254
5	468.170	533.736	-65.566	-14.005
6	292.490	375.077	-82.587	-28.236
7	731.770	771.724	-39.954	-5.460
8	1170.50	1167.79	2.709	.231
9	1756.20	1696.45	59.746	3.402
10	2194.90	2092.53	102.373	4.664
11	442.420	408.711	33.709	7.619
12	870.910	855.228	15.682	1.801
13	1170.50	1167.79	2.709	.231
14	1369.60	1376.17	-6.597	-.479
15	1583.90	1599.42	-15.523	-.980
16	494.870	463.286	31.584	6.382
17	832.690	815.538	17.152	2.060
18	1170.50	1167.79	2.709	.231
19	2688.90	2752.92	-64.023	-2.381
20	3533.40	3633.56	-100.161	-2.835

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS
TOTAL (CORRECTED)	19	.135482E 08	
REGRESSION	1	.134862E 08	.134862E 08
RESIDUAL	18	62076.5	3448.69
R SQUARED		.995418	

AVERAGE INPUT Y = 1321.47
 STD. DEV. OF RESIDUALS = 58.7256
 S.D. AS PCT OF AV. Y = 4.44

D.3 Cost of Blasting Materials for Overburden
(Variation of Parameters and Micromodel Results)

COUNT	Equation Parameters				Micromodel
	I/HC	CDRTY/1E6	HB	PRPY	CEMDY
1	.50000	1.8170	71.000	.30000	2341.1
2	.33333	1.8170	71.000	.30000	1560.8
3	.25000	1.8170	71.000	.30000	1170.5
4	.12500	1.8170	71.000	.30000	585.25
5	.10000	1.8170	71.000	.30000	468.17
6	.25000	.45400	71.000	.30000	292.49
7	.25000	1.1360	71.000	.30000	731.77
8	.25000	1.8170	71.000	.30000	1170.5
9	.25000	2.7260	71.000	.30000	1756.2
10	.25000	3.4070	71.000	.30000	2194.9
11	.25000	1.8170	20.000	.30000	442.42
12	.25000	1.8170	50.000	.30000	870.91
13	.25000	1.8170	71.000	.30000	1170.5
14	.25000	1.8170	85.000	.30000	1369.6
15	.25000	1.8170	100.00	.30000	1583.9
16	.25000	1.8170	71.000	.10000	949.87
17	.25000	1.8170	71.000	.20000	832.69
18	.25000	1.8170	71.000	.30000	1170.5
19	.25000	1.8170	71.000	.75000	2688.9
20	.25000	1.8170	71.000	1.0000	3533.4

Appendix D.4

Truck Cycle Time for Coal Hauling

Truck Cycle Time:

$$TCDT = 7.41 + CHCT * 0.26673 * \frac{CHHD}{5280} + \frac{20.434 * TDSL * \frac{CHHD}{5280}}{TDSC}$$

where TDCT = Truck cycle time in minutes
CHCT = Shovel cycle time in minutes
SPL = Number of swings to load truck
CHHD = Coal haul distance in feet
TDSL = Truck payload in thousands of pounds
TDSC = Truck horsepower

All correlations were made for an assumed shovel cycle time = .5 and number of swings to load truck = 6. Therefore, the initial term in the equation for cycle time is 10.41

$$(i.e., 7.41 + CHCT * SPL = 10.41 \\ \text{when } CHCT = .5 \text{ and } SPL = 6).$$

The test cases were run with haul roads varying in length from 13,239 feet to 42,164 feet (six haul roads) using 32 coal haulers. The result was 192 data points to be used in the correlations.

The following sheets show the curve fitting results and the supporting variation of parameters.

D.4 Truck Cycle Time
(Curve Fitting Results)

Equation:

$$CTM = A + (B * DIST) + (C * (PL * DIST / HP))$$

Coefficients: A = 10.410 B = .26673 C = 20.434

COUNT	Micromodel	Curve Fit	Comparison Between		
	Solution	Solution	Micromodel	& Curve Fit	
	INPUT Y	CALC Y	DEV	% DEV	
1	77.66	70.82	6.85	8.81	
2	69.48	62.53	6.95	10.00	
3	61.29	54.24	7.05	11.50	Truck A
4	53.10	45.95	7.15	13.46	Haul Road
5	44.91	37.67	7.25	16.14	1-6
6	36.80	29.38	7.42	20.16	
7	77.43	70.82	6.61	8.54	
8	69.26	62.53	6.73	9.72	
9	61.09	54.24	6.85	11.21	Truck B
10	52.92	45.95	6.97	13.16	Haul Road
11	44.75	37.67	7.08	15.83	1-6
12	36.65	29.38	7.27	19.84	
13	65.55	59.16	6.39	9.74	
14	58.72	52.47	6.25	10.64	
15	51.89	45.79	6.10	11.76	Truck C
16	45.06	39.10	5.96	13.23	Haul Road
17	38.23	32.41	5.82	15.23	1-6
18	31.45	25.72	5.74	18.24	
19	70.45	68.49	1.96	2.78	
20	63.24	60.52	2.73	4.31	
21	56.04	52.55	3.49	6.23	Truck D
22	48.84	44.58	4.26	8.72	Haul Road
23	41.64	36.61	5.02	12.06	1-6
24	34.50	28.65	5.85	16.96	
25	43.50	40.51	2.98	6.86	
26	38.84	36.38	2.46	6.33	
27	34.19	32.25	1.93	5.66	Truck E
28	29.53	28.12	1.41	4.77	Haul Road
29	24.88	23.99	.89	3.56	1-6
30	20.25	19.86	.39	1.93	
31	45.37	43.62	1.75	3.86	
32	40.54	39.07	1.47	3.63	
33	35.70	34.51	1.19	3.34	Truck F
34	30.87	29.95	.91	2.96	Haul Road
35	26.03	25.40	.63	2.44	1-6
36	21.23	20.84	.39	1.82	

37	44.71	41.68	3.03	6.78	
38	39.81	37.39	2.42	6.08	
39	34.91	33.10	1.81	5.19	Truck G
40	30.01	28.81	1.20	4.01	Haul Road
41	25.11	24.52	.59	2.37	1-6
42	20.25	20.23	.02	.09	
43	44.50	41.68	2.82	6.33	
44	39.61	37.39	2.22	5.62	
45	34.73	33.10	1.63	4.70	Truck H
46	29.85	28.81	1.04	3.48	Haul Road
47	24.96	24.52	.44	1.78	1-6
48	20.11	20.23	-.12	-.58	
49	42.25	45.18	-2.92	-6.92	
50	37.35	40.41	-3.06	-8.18	
51	32.45	35.64	-3.19	-9.82	Truck I
52	27.55	30.87	-3.32	-12.05	Haul Road
53	22.64	26.10	-3.45	-15.25	1-6
54	17.77	21.33	-3.55	-19.99	
55	42.21	45.18	-2.96	-7.02	
56	37.36	40.41	-3.05	-8.17	
57	32.50	35.64	-3.14	-9.66	Truck J
58	27.64	30.87	-3.23	-11.67	Haul Road
59	22.78	26.10	-3.31	-14.54	1-6
60	17.96	21.33	-3.37	-18.75	
61	45.95	51.70	-5.75	-12.51	
62	40.69	46.04	-5.34	-13.13	
63	35.44	40.37	-4.94	-13.93	Truck K
64	30.18	34.71	-4.53	-15.00	Haul Road
65	24.92	29.04	-4.12	-16.53	1-6
66	19.70	23.38	-3.67	-18.65	
67	47.80	51.70	-3.90	-8.16	
68	42.40	46.04	-3.64	-8.59	
69	36.99	40.37	-3.38	-9.14	Truck L
70	31.58	34.71	-3.12	-9.89	Haul Road
71	26.18	29.04	-2.86	-10.93	1-6
72	20.81	23.38	-2.56	-12.32	
73	43.55	47.90	-4.34	-9.97	
74	38.54	42.75	-4.21	-10.92	
75	33.53	37.61	-4.08	-12.16	Truck M
76	28.52	32.47	-3.95	-13.84	Haul Road
77	23.51	27.32	-3.82	-16.23	1-6
78	18.53	22.18	-3.65	-19.70	
79	40.88	43.14	-2.26	-5.53	
80	36.38	38.65	-2.27	-6.24	
81	31.88	34.16	-2.28	-7.16	Truck N
82	27.38	29.67	-2.29	-8.37	Haul Road
83	22.88	25.18	-2.30	-10.06	1-6
84	18.40	20.69	-2.28	-12.40	

85	42.79	47.22	-4.42	-10.33	
86	38.19	42.17	-3.97	-10.40	
87	33.59	37.12	-3.52	-10.49	Truck Ø
88	28.99	32.07	-3.08	-10.61	Haul Road
89	24.39	27.02	-2.63	-10.77	1-6
90	19.82	21.97	-2.15	-10.84	
91	57.18	62.02	-4.84	-8.47	
92	50.87	54.94	-4.07	-8.00	
93	44.57	47.86	-3.29	-7.39	Truck P
94	38.26	40.78	-2.52	-6.58	Haul Road
95	31.96	33.70	-1.74	-5.44	1-6
96	25.70	26.62	-.91	-3.56	
97	46.87	39.74	7.13	15.21	
98	41.65	35.71	5.93	14.25	
99	36.42	31.69	4.74	13.00	Truck Q
100	31.20	27.67	3.54	11.34	Haul Road
101	25.98	23.64	2.34	9.01	1-6
102	20.80	19.62	1.18	5.67	
103	43.32	36.59	6.73	15.53	
104	38.50	33.00	5.50	14.29	
105	33.67	29.40	4.27	12.68	Truck R
106	28.85	25.81	3.04	10.54	Haul Road
107	24.03	22.22	1.81	7.53	1-6
108	19.24	18.63	.61	3.18	
109	41.61	38.24	3.38	8.11	
110	37.05	34.42	2.63	7.11	
111	32.50	30.60	1.89	5.83	Truck S
112	27.94	26.78	1.15	4.12	Haul Road
113	23.38	22.97	.41	1.76	1-6
114	18.85	19.15	-.30	-1.60	
115	43.98	38.24	5.75	13.06	
116	39.13	34.42	4.71	12.04	
117	34.28	30.60	3.67	10.72	Truck T
118	29.42	26.78	2.64	8.96	Haul Road
119	24.57	22.97	1.60	6.51	1-6
120	19.74	19.15	.60	3.02	
121	46.30	51.09	-4.79	-10.35	
122	40.92	45.51	-4.59	-11.21	
123	35.54	39.93	-4.38	-12.34	Truck U
124	30.16	34.34	-4.18	-13.86	Haul Road
125	24.78	28.76	-3.98	-16.05	1-6
126	19.44	23.18	-3.74	-19.22	
127	45.50	47.51	-2.01	-4.42	
128	40.25	42.42	-2.17	-5.39	
129	35.00	37.33	-2.33	-6.66	Truck V
130	29.75	32.24	-2.49	-8.38	Haul Road
131	24.50	27.15	-2.65	-10.83	1-6
132	19.28	22.06	-2.78	-14.40	

133	45.50	47.51	-2.01	-4.42	
134	40.25	42.42	-2.17	-5.39	
135	35.00	37.33	-2.33	-6.66	Truck W
136	29.75	32.24	-2.49	-8.38	Haul Road
137	24.50	27.15	-2.65	-10.83	1-6
138	19.28	22.06	-2.78	-14.40	
139	53.20	51.09	2.12	3.98	
140	47.47	45.51	1.97	4.14	
141	41.74	39.93	1.82	4.35	Truck X
142	36.01	34.34	1.66	4.62	Haul Road
143	30.28	28.76	1.51	5.00	1-6
144	24.59	23.18	1.40	5.71	
145	51.25	52.17	-.92	-1.79	
146	45.46	46.44	-.98	-2.15	
147	39.68	40.71	-1.04	-2.61	Truck Y
148	33.89	34.98	-1.09	-3.23	Haul Road
149	28.10	29.25	-1.15	-4.10	1-6
150	22.36	23.52	-1.17	-5.22	
151	48.48	47.22	1.27	2.61	
152	43.00	42.17	.83	1.94	
153	37.52	37.12	.40	1.07	Truck Z
154	32.04	32.07	-.03	-.09	Haul Road
155	26.55	27.02	-.46	-1.74	1-6
156	21.11	21.97	-.85	-4.05	
157	46.22	45.18	1.05	2.27	
158	41.10	40.41	.70	1.70	
159	35.98	35.64	.35	.96	Truck 0
160	30.86	30.87	-.00	-.01	Haul Road
161	25.74	26.10	-.35	-1.38	1-6
162	20.66	21.33	-.67	-3.25	
163	62.97	63.94	-.96	-1.53	
164	56.45	56.59	-.14	-.26	
165	49.92	49.25	.68	1.35	Truck 1
166	43.40	41.90	1.49	3.44	Haul Road
167	36.88	34.56	2.31	6.28	1-6
168	30.40	27.22	3.19	10.48	
169	62.97	63.94	-.96	-1.53	
170	56.45	56.59	-.14	-.26	
171	49.92	49.25	.68	1.35	Truck 2
172	43.40	41.90	1.49	3.44	Haul Road
173	36.88	34.56	2.31	6.28	1-6
174	30.40	27.22	3.19	10.48	
175	61.04	68.49	-7.44	-12.19	
176	54.07	60.52	-6.45	-11.94	
177	47.09	52.55	-5.46	-11.60	Truck 3
178	40.11	44.58	-4.47	-11.15	Haul Road
179	33.13	36.61	-3.48	-10.51	1-6
180	26.21	28.65	-2.44	-9.29	

181	61.04	68.49	-7.44	-12.19	
182	54.07	60.52	-6.45	-11.94	
183	47.09	52.55	-5.46	-11.60	Truck 4
184	40.11	44.58	-4.47	-11.15	Haul Road
185	33.13	36.61	-3.48	-10.51	1-6
186	26.21	28.65	-2.44	-9.29	
187	72.15	73.73	-1.59	-2.20	
188	64.33	65.04	-.72	-1.11	
189	56.51	56.36	.15	.27	Truck 5
190	48.69	47.67	1.02	2.10	Haul Road
191	40.88	38.98	1.89	4.64	1-6
192	33.13	30.29	2.83	8.55	
AVER.	37.73	37.73	3.60	9.03	

D.4 Truck Cycle Time
(Variation of Truck Size and Haul Distance)

<u>Truck</u>	<u>Payload</u>	<u>Horsepower</u>	<u>Road</u>	<u>Haul Distance</u>
A	200.	560.	1	42,164
B	200.	560.	2	36,379
C	200.	700.	3	30,594
D	240.	700.	4	24,809
E	72.	420.	5	19,024
F	80.	420.	6	13,239
G	100.	560.		
H	100.	560.		
I	170.	850.		
J	200.	1000.		
K	240.	1000.		
L	240.	1000.		
M	260.	1200.		
N	300.	1600.		
Ø	340.	1600.		
P	364.	1200.		
Q	70.	420.		
R	70.	475.		
S	100.	635.		
T	100.	635.		
U	150.	635.		
V	150.	700.		
W	150.	700.		
X	150.	635.		
Y	170.	700.		
Z	170.	800.		
0	170.	850.		
1	200.	635.		
2	200.	635.		
3	240.	700.		
4	240.	700.		
5	300.	800.		

Appendix D.5

Quantity of Scrapers for Land Reclamation

Quantity of Scrapers:

$$\text{TSCR} = \left[.0157046 + 5.43198 \times \text{CD}/\text{HC} + 7.36661 \times (\text{CD}/\text{HC})^2 \right] \times \text{HBT}$$

where TSCR = Required number of scrapers

CD = Coal demand recovered tons per year

HC = Height of coal in feet

HBT = Height of topsoil in feet

Note: HBT was not included in the correlation because all coefficients are equally affected by the HBT value.

The following sheets show the curve fitting results for the above equation and the supporting variation of parameters and resulting micromodel solutions.

D.5 Quantity of Scrapers
(Curve Fitting Results)

Equation:

$$TSCR = A + B * CD/HC + C * (CD/HC) ** 2$$

Coefficients A = .157046E-01 B = 5.43198 C = 7.36661

COUNT	Micromodel	Curve Fit	Comparison Between	
	<u>Solution</u>	<u>Solution</u>	<u>Micromodel & Curve Fit</u>	
	INPUT Y	CALC Y	DEV	% DEV
1	.720000	.727133	-.007	-.991
2	2.15000	2.15255	-.003	-.119
3	4.00000	4.00378	-.004	-.094
4	7.14000	7.13896	.001	.015
5	9.99000	9.98671	.003	.033
6	11.0300	11.0325	-.003	-.023
7	6.01000	6.00885	.001	.019
8	4.00000	4.00378	-.004	-.094
9	1.64000	1.62965	.010	.631
10	1.25000	1.24605	.004	.316

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS
TOTAL (CORRECTED)	9	120.225	
REGRESSION	2	120.225	60.1123
RESIDUAL	7	.228335E-03	.326194E-04
R SQUARED		.999998	

AVERAGE INPUT Y = 4.79300
 STD. DEV. OF RESIDUALS = .571133E-02
 S.D. AS PCT OF AV. Y = .12

D.5 Quantity of Scrapers

(Variation of Parameters and Micromodel Results)

COUNT	Equation Parameters		Micromodel Solution
	CD/HC	(CD/HC) ²	TSCR
1	.113500	.128822E-01	.720000
2	.284000	.806559E-01	2.15000
3	Vary Coal Demand	.454295	.206384
4		.681500	.464442
5		.851750	.725478
6		.908590	.825535
7	Vary Height of Coal	.605727	.366905
8		.454295	.206384
9		.227147	.515960E-01
10		.181718	.330214E-01

Appendix D.6

Quantity of Bulldozers for Land Reclamation

Quantity of Bulldozers:

$$\begin{aligned} \text{RN}\emptyset\text{CD} &= -.00384704 * \frac{\text{CDRTY} * \tan \text{ABSD} * \text{PWF}}{1\text{E}6 * \text{HC}} \\ &+ .000618961 * \frac{\text{CDRTY} * \tan \text{ABSD} * \text{PWF}^2}{1\text{E}6 * \text{HC}} \\ &+ .00660554 * \frac{\text{CDRTY} * \text{CGD}}{1\text{E}6 * \text{HC}} \end{aligned}$$

where RN \emptyset CD = Required number of dozers
CDRTY = Coal demand recovered tons per year
ABSD = Angle of burden spoils in degrees
PWF = Panel width in feet
HC = Height of coal in feet
CGD = Cost of general dozing in \$/acre

The following sheets show the curve fitting results for the above equation and the supporting variation of parameters and resulting micromodel solutions.

D.6 Quantity of Bulldozers
(Curve Fitting Results)

Equation:

$$\begin{aligned} \text{TCDR} &= A * \text{CDRTY}/1\text{E}6/\text{HC} * \text{TABSD} * \text{PWF} \\ &+ B * \text{CDRTY}/1\text{E}6/\text{HC} * \text{TABSD} * \text{PWF} ** 2 \\ &+ C * \text{CDRTY}/1\text{E}6/\text{HC} * \text{CGD} \end{aligned}$$

Coefficients: A = -.384704E-02 B = .618961E-03 C = .660554E-02

COUNT	Micromodel	Curve Fit	Comparison Between	
	<u>Solution</u>	<u>Solution</u>	<u>Micromodel & Curve Fit</u>	
	INPUT Y	CALC Y	DEV	% DEV
1	.889000	.889097	-.000	-.011
2	2.22400	2.22470	-.001	-.032
3	3.55700	3.55834	-.001	-.038
4	5.33600	5.33849	-.002	-.047
5	6.67000	6.67214	-.002	-.032
6	2.20700	2.20809	-.001	-.049
7	2.65700	2.65817	-.001	-.044
8	5.35700	5.35868	-.002	-.031
9	8.95700	8.95936	-.002	-.026
10	3.06100	3.06209	-.001	-.036
11	3.30600	3.30679	-.001	-.024
12	3.71700	3.71814	-.001	-.031
13	3.90800	3.90984	-.002	-.047
14	7.11500	7.11669	-.002	-.024
15	4.74300	4.74399	-.001	-.021
16	1.77900	1.77917	-.000	-.010
17	1.42300	1.42334	-.000	-.024
18	2.22900	2.21072	.018	.820
19	2.77600	2.76737	.009	.311
20	4.58000	4.58363	-.004	-.079
21	5.85300	5.84324	.010	.167

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS
TOTAL (CORRECTED)	20	84.9297	
REGRESSION	2	84.9291	42.4646
RESIDUAL	18	.551891E-03	.306606E-04
R SQUARED		.999993	

AVERAGE INPUT Y = 3.92114
 STD. DEV. OF RESIDUALS = .553720E-02
 S.D. AS PCT OF AV. Y = .14

D.6 Quantity of Bulldozers

(Variation of Parameters and Micromodel Results)

COUNT	Equation Parameters					Micromodel
	CDRTY/1E6	CGD	TAN A	1/HC	PWF	Solution
1	.454	600.	.6667	.2500	100.	.889
2	1.136	600.	.6667	.2500	100.	2.224
3	1.817	600.	.6667	.2500	100.	3.557
4	2.726	600.	.6667	.2500	100.	5.336
5	3.407	600.	.6667	.2500	100.	6.670
6	1.817	150.	.6667	.2500	100.	2.207
7	1.817	300.	.6667	.2500	100.	2.657
8	1.817	1200.	.6667	.2500	100.	5.357
9	1.817	2400.	.6667	.2500	100.	8.957
10	1.817	600.	.4785	.2500	100.	3.061
11	1.817	600.	.5713	.2500	100.	3.306
12	1.817	600.	.7273	.2500	100.	3.717
13	1.817	600.	.8000	.2500	100.	3.908
14	1.817	600.	.6667	.5000	100.	7.115
15	1.817	600.	.6667	.3333	100.	4.743
16	1.817	600.	.6667	.1250	100.	1.779
17	1.817	600.	.6667	.1000	100.	1.423
18	1.817	600.	.6667	.2500	50.	2.229
19	1.817	600.	.6667	.2500	75.	2.776
20	1.817	600.	.6667	.2500	125.	4.580
21	1.817	600.	.6667	.2500	150.	5.853

APPENDIX E

Macromodel Baseline Solution

- E.1 Report 1 Financial Summary Report - provides economic highlights such as required investment, selling price, and rate of return.
- Case Description - identifies the case being analyzed, including mining parameters and financial assumptions.
- E.2 Report 2 Investment List - identifies all equipment facilities, and other premining costs; shows total investment and replacement capital.
- E.3 Report 3 Operating Personnel List - identifies all operating personnel, including supervision and staff; shows total manpower needs and payroll.
- E.4 Report 4 Maintenance Personnel List - identifies all maintenance personnel; shows total manpower needs and payroll.
- E.5 Report 5 Services and Materials List - identifies all services and materials; shows annual cost; shows annual quantity of electric power, water, and fuel.
- E.6 Report 6 Infrastructure Report - summarizes physical effects, economic impact, utility requirements, and manpower requirements.
- E.7 Report 7 Production and Cash Expenditure Table - for each year of the project shows production and cash expenditure.
- E.8 Report 8 Financial Statements - for each year of the project compiles an income statement, sources and uses of funds statement, and a balance sheet.
- E.9 Default values for Appalachia (Ohio).

All costs are in January 1975 dollars (no escalation).

Appendix E.1 Financial Summary Report and Case Description

The Financial Summary report provides economic highlights including required investment, selling price, and rate of return.

The Case Description identifies the case being analyzed, including mining parameters and financial assumptions.

FINANCIAL SUMMARY REPORT

SALES PRICE IN BASE DOLLARS	: \$/PREPARED TON	12.70
	: \$/MILLION BTU	.50
RETURN ON INVESTMENT	: PERCENT	10.00 *
RETURN ON PAID-IN CAPITAL	: PERCENT	10.88 **
CUMMULATIVE INVESTMENT TO STEADY STATE	: M\$	161752.
CUMMULATIVE INVESTMENT TOTAL PROJECT	: M\$	222268.
ANNUAL OPERATING COST AT STEADY STATE	: M\$	26135.

BASE YEAR IS	1975
PROJECT BEGINS IN	1976
FIRST COAL PRODUCTION IN	1982
STEADY STATE BEGINS IN	1985
STEADY STATE ENDS IN	2011
LAST COAL PRODUCTION IN	2013
PROJECT ENDS IN	2015

* DISCOUNTED CASH FLOW INTERNAL RATE OF RETURN ASSUMING
PROJECT IS FINANCED COMPLETELY BY INTERNAL CAPITAL.

** DISCOUNTED CASH FLOW INTERNAL RATE OF RETURN ASSUMING
PROJECT IS FINANCED BY USER-SET COMBINATION OF
INTERNAL CAPITAL AND EXTERNAL DEBT.

CASE DESCRIPTION

MINING PARAMETERS

IPPT\$	1	INDEX TO PLANT TYPE
CORTY\$	.519190E 07	COAL DEMAND ROM TONS/YEAR (COMPLEX)
SRYT\$	12.3977	STRIPPING RATIO YARDS/ROM TONS
HBT\$	.500000	HEIGHT OF TOPSOIL - FEET
HCS\$	4.000000	HEIGHT OF COAL IN FEET
PRTY\$	.513988E 07	PREPARED COAL TONS/YEAR
PPNED\$	.130000E 15	ENRGY DEMAND FOR COMPLEX BTU/YEAR
PPNIV\$	12600.0	ROM COAL HEAT VALUE BTU/LB
ROCS\$	900.000	RECLAMATION - OTHER COSTS - \$/ACRE
VCAP	12645.4	VALUE - COAL BTU/POUND

FINANCIAL ASSUMPTIONS

COR	2.00000	CAPITAL/DEBT RATIO
GAMRS	50.0000	GAA - MINERAL RIGHTS (\$/ACRE)
GARAS	.250000	GAA - ROYALTY AMOUNT (\$/TON)
GASR\$	250.000	GAA - SURFACE RIGHTS (\$/ACRE)
GAST\$	.000000	GAA - SEVERANCE TAX (\$/TON)
RCFJ	.100000	RATE - CASH FLOW DISCOUNT
RFIT	.480000	RATE - FEDERAL INCOME TAX
RLTI	.300000E-01	RATE - LONG TERM INTEREST
RSTI	.100000	RATE - SHORT TERM INTEREST
VSPC	.000000	VALUE - REQ. PRICE OF COAL - \$/TON

FINANCIAL CONTROL PARAMETERS

DM1	.000000	RESET DEP. METHOD 1 TO NONZERO VALUE
DM2	.000000	RESET DEP. METHOD 2 TO NONZERO VALUE
DM3	.000000	RESET DEP. METHOD 3 TO NONZERO VALUE
ERAEI	.000000	ESCAL. RATE - ALL EQUIP. INVEST.
EREL	.000000	ESCAL. RATE - ELECTRICITY
ERFU	.000000	ESCAL. RATE - FUELS
ERM	.000000	ESCAL. RATE - MAINTENANCE LABOR
ERMM	.000000	ESCAL. RATE - MAINTENANCE MATERIALS
ERJL	.000000	ESCAL. RATE - OPERATING LABOR
EROT	.000000	ESCAL. RATE - OTHER COSTS
ERSPC	.000000	ESCAL. RATE - SELLING PRICE OF COAL
ERTI	.000000	ESCAL. RATE - TIRES
ERWA	.000000	ESCAL. RATE - WATER
ESPC	.000000	FSC. COAL PRICE PER COST FSC. IF 1
PC1	.000000	RESETS PUR. CODE 1 TO NONZERO VALUE
PC2	.000000	RESETS PUR. CODE 2 TO NONZERO VALUE
PC3	.000000	RESETS PUR. CODE 3 TO NONZERO VALUE
PC4	.000000	RESETS PUR. CODE 4 TO NONZERO VALUE
PC5	.000000	RESETS PUR. CODE 5 TO NONZERO VALUE
PC6	.000000	RESETS PUR. CODE 6 TO NONZERO VALUE
PC7	.000000	RESETS PUR. CODE 7 TO NONZERO VALUE

\$ IN NAME INDICATES A MEMO ITEM FOR CFA

Appendix E.2 Investment List

The investment list identifies all equipment facilities, and other premining costs; shows total investment and replacement capital. Columns A through R of the investment list are defined as follows:

- Column A: For each mining operation the steady state annual production requirement is given followed by a list of equipment or facilities giving the equipment file number, type, and size. Note that the general and administrative operation includes ancillary facilities, ancillary equipment (including mobile equipment, such as pick-ups, service vehicles, and maintenance vehicles), and premining costs.
- Column B: Original quantity of equipment required to reach steady state production.
- Column C: Fleet Spares.
- Column D: Total quantity equals original quantity plus fleet spares.
- Column E: Unit investment is the regionally adjusted base year required investment per item.
- Column F: Total investment equals total quantity times unit investment. Note that items with an asterisk are deferred purchases which are additional equipment required as the mine development becomes further away from the central plant.
- Column G: Productive hours per year for the equipment.
- Column H: Depreciation life in hours.
- Column I: Replacement years equals depreciation life divided by productive hours per year.
- Column J: Replacement quantity is the number of new machines that must be purchased at intervals later in the project to replace worn out machines.
- Column K: Replacement capital equals replacement quantity times unit investment.

- Column L: Salvage fraction is the portion of the purchase price which can be recovered when the equipment is replaced.
- Column M: Depreciation method
1 = straight line
2 = declining balance
3 = double declining balance.
- Column N: Purchase year is the project year in which a commitment must be made to purchase equipment (takes into account purchase lead time).
Purchase plan is the method of progress payments for the equipment.
1 = Lump sum with order
2 = Lump sum at delivery
3 = 25% with order, 75% at delivery
4 = 50% with order, 50% at delivery
5 = Equal payments each year
6 = Lease
- Column O: Base year for escalation of unit investment determined by subtracting the calendar year of the cost file from the calendar year of the start of the project.
- Column P: Escalation rate as an annual fraction.
- Column Q: Regional adjustment as a multiplier for base costs.
- Column R: Beginning and ending operating year of the machines.

A		B C D			E		F		G		H		I		J		K		L		M		N		O		P		Q		R			
MINING		: DRIG SPR TOT			UNIT		TOTAL		PROD		DEPREC		REPL		REPL		REPL		SAL		DP		PUR		BAS		INFL		REG		OPR			
OPERATION		: QTY QTY QTY			INVEST		INVEST		HRS		HOURS		YRS		QTY		CAPITAL		FRC		MD		YR		PL		YR		RATE		ADJ		1ST-LAST	
					(M\$)		(M\$)		(H/YR)						(M\$)																			
OVER. DRILL & BLAST (THOUSAND CU YDS)		64366																																
RD16	ROTRY DRILL 15.000 IN 70 HP	6	0	6	440.8	2645.	3263	20000	6.1	24	10579.	.00	1	6	2	0	.00	1.00	7-38															
CD3A	TR TRACTOR 300 HP	6	0	6	135.3	812.	3263	12000	3.7	48	6494.	.00	1	6	2	0	.00	1.00	7-38															
LD1	WH LOADER 1.5 YD 80 HP	6	0	6	36.4	218.	1631	12000	7.4	24	874.	.00	1	6	2	0	.00	1.00	7-38															
TDX1	PRILL TRUCK	6	0	6	36.0	216.	1631	20000	12.3	12	432.	.00	1	6	2	0	.00	1.00	7-38															
TOTAL (LESS DEFERRED)							3891.								18379.																			
OVERBURDEN REMOVAL (THOUSAND CU YDS)		64366																																
DL1	DRAGLINE 43. CY 307 FT	6	0	6	7533.1	45199.	7467	224010	30.0	0	0.	.00	1	3	5	0	.00	1.00	7-38															
CD3	TR TRACTOR 300 HP	6	0	6	135.3	812.	7467	24000	3.2	54	7306.	.00	1	6	2	0	.00	1.00	7-38															
LD16	WH LOADER 325 HP	6	0	6	123.0	738.	2374	12000	5.1	30	3690.	.00	1	6	2	0	.00	1.00	7-38															
TOTAL (LESS DEFERRED)							46748.								10996.																			
COAL LOAD & HAUL (THOUSAND ROM TONS)		5191																																
SD31	SHOVEL 12 CU. YD.	6	0	6	763.4	4580.	1631	60000	36.8	0	0.	.00	1	5	5	0	.00	1.00	7-38															
TD53	TRUCK 150 TON	24	3	27	292.6	7900.	1631	20000	12.3	48	14045.	.00	1	6	2	0	.00	1.00	7-38															
L16	WH LOADER 325 HP	6	0	6	123.0	738.	1631	12000	7.4	24	2952.	.00	1	6	2	0	.00	1.00	7-38															
GD5	GRADER 180 HP	6	0	6	80.1	481.	1631	15000	9.2	18	1442.	.00	1	6	2	0	.00	1.00	7-38															
PUMP	PUMP SET 125000 GPH	6	0	6	10.0	60.	1440	21600	15.0	6	60.	.00	1	6	2	0	.00	1.00	7-38															
TDX2	H2O TRUCK 5000 GAL	6	0	6	124.6	748.	1631	20000	12.3	12	1495.	.00	1	6	2	0	.00	1.00	7-38															
TOTAL (LESS DEFERRED)							14507.								19994.																			
COAL HANDLE & PREP (THOUSAND CLEAN TONS)		5140																																
CONSTRUCTION INTEREST							15170.																											
PRRB	REC & BREAK PREP. PLANT	3	0	3	2631.0	7893.	3625	108750	30.0	0	0.	.00	1	4	5	0	.00	1.00	7-38															
PRBS	BLEND-STOCK PREP. PLANT	3	0	3	10018.8	30056.	5438	163140	30.0	0	0.	.00	1	4	5	0	.00	1.00	7-38															
PRCL	COAL LOADOUT PREP. PLANT	3	0	3	332.3	997.	8712	261360	30.0	0	0.	.00	1	4	5	0	.00	1.00	7-38															
PRCS	CRUSH-SCREEN PREP. PLANT	3	0	3	1412.1	4236.	5438	163140	30.0	0	0.	.00	1	4	5	0	.00	1.00	7-38															
PRSI	CS SUPPORT PREP. PLANT	3	0	3	2460.8	7383.	2000	60000	30.0	0	0.	.00	1	4	5	0	.00	1.00	7-38															
TOTAL (LESS DEFERRED)							65735.								0.																			
LAND RECLAMATION (ACRES)		898																																
CD 5	TR TRACTOR 410 HP	11	1	12	192.5	2310.	1665	12000	7.2	44	8470.	.00	1	6	2	0	.00	1.00	7-38															
SC 5	SCRAPER 32 CY 415 HP	4	0	4	201.1	804.	1665	12000	7.2	16	3218.	.00	1	6	2	0	.00	1.00	7-38															
TOTAL (LESS DEFERRED)							3114.								11688.																			

A B C D E F G H I J K L M N O P Q R

GENERAL & ADMINISTRATION																				
CONSTRUCTION INTEREST																				
SITE	ROADS & SITE	ANC. FAC.	1	0	1	3000.0	3000.	2000	64000	32.0	0	0.	.00	1	4	5	0	.00	1.00	7-38
BLDG	BJLDINGS	ANC. FAC.	1	0	1	4893.7	4894.	2000	64000	32.0	0	0.	.00	1	4	5	0	.00	1.00	7-38
PWP	ELECT. SYS.	ANC. FAC.	1	0	1	4500.0	4500.	2000	64000	32.0	0	0.	.00	1	4	5	0	.00	1.00	7-38
H2O	WATER SYS.	ANC. FAC.	1	0	1	200.0	200.	2000	64000	32.0	0	0.	.00	1	4	5	0	.00	1.00	7-38
COM	COMMUN. SYS.	ANC. FAC.	1	0	1	125.0	125.	2000	64000	32.0	0	0.	.00	1	4	5	0	.00	1.00	7-38
MBEQ	MOBILE SUP.	ANC. FAC.	1	0	1	1200.0	1200.	2000	64000	32.0	0	0.	.00	1	5	5	0	.00	1.00	7-38
SHEQ	EQUIP. SHOP	ANC. FAC.	1	0	1	1000.0	1000.	2000	64000	32.0	0	0.	.00	1	5	5	0	.00	1.00	7-38
LAND	LAND RIGHTS	PREMINE	1	0	1	808.3	808.	2000	64000	32.0	0	0.	.00	1	2	1	0	.00	1.00	7-38
XDRL	EXPL. DRILL.	PREMINE	1	0	1	673.5	674.	2000	64000	32.0	0	0.	.00	1	2	1	0	.00	1.00	7-38
ENG	CONT. ENG.	PREMINE	1	0	1	6000.0	6000.	2000	64000	32.0	0	0.	.00	1	1	5	0	.00	1.00	7-38
EIS	E. I. S.	PREMINE	1	0	1	1000.0	1000.	2000	64000	32.0	0	0.	.00	1	3	1	0	.00	1.00	7-38
TOTAL (LESS DEFERRED)						27216.						0.								
TOTALS						161211.						61057.								

Appendix E.3 Operating Personnel List

The operating personnel list identifies all operating personnel, including supervision and staff; shows total manpower needs and payroll. Columns A through M of the operating personnel list are defined as follows:

- Column A: For each mining operation the equipment file number and type is given as well as the operator's wage classification description.
- Column B: Union pay grade.
- Column C: Personnel schedule basis (shifts per day - hours per shift - days per week).
- Column D: Quantity of operators required per machine shift.
- Column E: Quantity of machines requiring operators.
- Column F: Scheduled machine hours per year.
- Column G: Total scheduled hours equals quantity of machines times scheduled machine hours.
- Column H: Effective hours per year (hours on the job per man) for the personnel schedule basis.
- Column I: Manpower needs represent the total number of men that must be hired to have men on the job for every scheduled hour for the machine.
- Column J: Base year dollars per hour per man based on wage table plus regional adjustment and additional union pension.
- Column K: Annual payroll in base year dollars for steady state production.
- Column L: Manpower required to operate the deferred equipment.
- Column M: Annual payroll for operators of deferred equipment.

A	B	C	D	E	F	G	H	I	J	K	L	M
M I N I N G O P E R A T I O N	: : GD	OPERATING PERSONNEL SCHEDULE	PERSONNEL QTY	PERSONNEL EQP QTY	LIST SCHED HR/YR	TOTAL SCHED HR	EFF HR/YR	MANPOWER NEEDS	PAYRL RATE	INITIAL PAYROLL (M\$/YR)	DEFR MANP (MAX)	DEFR PAYROLL (M\$/YR)
OVER. DRILL & BLAST												
RJ16 RJTRY DRILL		DRILLER & SHOOTER	3	2-7.25-5	1.00	6	3625	21750	1618	13.4	10.13	220.3
		HELPER	2	2-7.25-5	1.00	6	3625	21750	1618	13.4	9.77	212.5
RLST BLASTING		DRILLER & SHOOTER	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
CD3A TR TRACTOR		MOBILE EQUIP OPERAT	3	2-7.25-5	1.00	5	3625	21750	1618	13.4	10.13	220.3
LD1 4H LOADER		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
TDX1 PRILL TRUCK		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
OVERBURDEN REMOVAL												
DL1 DRAGLINE		STRIP MACH OPERATOR	5	3-8.00-6	1.00	6	8297	49782	2269	21.9	12.90	642.2
		OILER	4	3-8.00-6	2.00	6	8297	49782	2269	43.9	12.10	1204.7
CD3 TR TRACTOR		STRIP MACH OPERATOR	5	3-8.00-6	1.00	6	8297	49782	2269	21.9	12.90	642.2
LD16 MH LOADER		STRIP MACH OPERATOR	5	3-8.00-6	1.00	6	2638	15828	2269	7.0	12.90	204.2
COAL LOAD & HAUL												
SD31 SHVEL		COAL LOADING OPERAT	5	1-7.25-5	1.00	5	1813	10878	1618	6.7	11.32	123.1
		OILER	4	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.49	114.1
TD53 TRUCK		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	24	1813	43512	1618	26.9	10.03	436.4
L16 4H LOADER		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
GD5 GRADER		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
PUMP PUMP SET		UTILITY MAN	1	1-7.25-5	1.00	6	1440	8640	1618	5.3	9.56	82.6
TDX2 H2O TRUCK		MOBILE EQUIP OPERAT	3	1-7.25-5	1.00	6	1813	10878	1618	6.7	10.03	109.1
CJAL HANDLE & PREP												
PRRB REC & BREAK		STAT EQUIP OPERATOR	3	2-7.25-5	.87	3	3625	10875	1618	5.8	10.13	95.8
		HELPER	2	2-7.25-5	.87	3	3625	10875	1618	5.8	9.77	92.4
		LABORER	1	2-7.25-5	1.30	3	3625	10875	1618	8.7	9.66	136.6
PRBS BLEND-STOCK		STAT EQUIP OPERATOR	3	3-7.25-5	3.69	3	5438	16314	1618	37.2	10.23	615.8
		LABORER	1	3-7.25-5	.87	3	5438	16314	1618	8.8	9.76	138.5
PRCL COAL LOADOJT		STAT EQUIP OPERATOR	3	3-8.00-6	.87	3	8712	26136	2269	10.0	11.46	260.6
		HELPER	2	3-8.00-6	.87	3	8712	26136	2269	10.0	11.07	251.7
		LABORER	1	3-8.00-6	.43	3	8712	26136	2269	5.0	10.77	121.0
PRCS CRUSH-SCREEN		STAT EQUIP OPERATOR	3	3-7.25-5	.87	3	5438	16314	1618	8.8	10.23	145.2
		HELPER	2	3-7.25-5	.87	3	5438	16314	1618	8.8	9.87	140.1
		UTILITY MAN	1	3-7.25-5	1.30	3	5438	16314	1618	13.1	9.76	207.0
PRSI CS SUPPRT		LABORER	1	3-7.25-5	.43	3	5438	16314	1618	4.3	9.76	68.5
		MOBILE EQUIP OPERAT	3	2-7.25-5	4.17	3	2000	6000	1618	15.5	10.13	253.5
		UTILITY MAN	1	2-7.25-5	2.08	3	2000	6000	1618	7.7	9.66	120.6
LAND RECLAMATION												
CD 5 TR TRACTOR		MOBILE EQUIP OPERAT	3	2-7.25-6	1.00	11	1850	20350	1942	10.5	10.97	223.2
SC 6 SCRAPER		STRIP MACH OPERATOR	5	2-7.25-6	1.00	4	1850	7400	1942	3.8	12.37	91.5
GENERAL & ADMINISTRATION												
STF SUPERV. PER. GEN & ADM STAFF	S		5	1-8.00-5	78.00	1	2000	2000	2000	78.0	10.28	1603.7
TOTALS									462.9	9323.1	.0*	.0

INFLATION ESCALATION RATE = .00
REGIONAL ADJUSTMENT FACTOR = 1.00

Appendix E.4 Maintenance Personnel List

The maintenance personnel list identifies all maintenance personnel; shows total manpower needs and payroll. Columns A through M of the maintenance personnel list are defined as follows:

- Column A: For each mining operation the equipment file number and type is given as well as the maintenance wage classification description.
- Column B: Union pay grade.
- Column C: Personnel schedule basis (shifts per day-hours per shift-days per week).
- Column D: Fraction of maintenance labor hourly cost to be allocated to a particular maintenance wage classification type.
- Column E: Base year maintenance hourly cost including regional adjustment.
- Column F: Total productive hours equals the number of machines times productive machine hours.
- Column G: Effective hours per year (hours on the job per man) for the personnel schedule basis.
- Column H: Manpower needs represents the total number of men that must be hired to have men on the job for every maintenance labor hour required for the machine.
- Column I: Base year dollars per hour per man based on wage table plus regional adjustment and additional union pension.
- Column J: Required maintenance labor hours equals the hourly cost times total productive hours divided by payroll rate.
- Column L: Manpower required to maintain the deferred equipment.
- Column M: Annual payroll for maintenance of deferred equipment.

CFA MODEL:

503 (CDMD0503) HYPOTHETICAL MINE STUDY - JH13
1 BASELINE SOLUTION

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A MINING OPERATION	B : GO	MAINTENANCE PERSONNEL LIST			F TOTAL PROG HRS	G EFF HR/YR	H MANPOWER NEEDS	I PAYR RATE	J REQD HOURS	K INITIAL PAYROLL (M\$/YR)	L DEFR MANP (MAX)	M DEFR PAYROLL (M\$/YR)
		C PERSONNEL SCHEDULE	D FRAC	E HOURLY CJST								
OVER. DRILL & BLAST												
RD15 RJTRY DRIL. MECHANIC	4	3-7.25-6	1.00	10.14	19578	1942	8.8	11.58	17143	198.5		
CD3A TR TRACTOP MECHANIC	4	3-7.25-6	1.00	3.96	19578	1942	3.4	11.58	6695	77.5		
LD1 W4 LADDER MECHANIC	4	3-7.25-6	1.00	1.06	9786	1942	.5	11.58	895	10.4		
TDX1 PRILL TRUCK MECHANIC	4	3-7.25-6	1.00	.95	9786	1942	.4	11.58	802	9.3		
OVERBURDEN REMOVAL												
DL1 DRAGLINE MECHANIC	4	3-7.25-6	1.00	47.99	44802	1942	95.6	11.58	185669	2150.0		
CD3 TR TRACTOR MECHANIC	4	3-7.25-6	1.00	3.96	44802	1942	7.9	11.58	15320	177.4		
LD16 W4 LOADER MECHANIC	4	3-7.25-6	1.00	3.81	14244	1942	2.4	11.58	4686	54.3		
COAL LOAD & HAUL												
SD31 SHJVEL MECHANIC	4	3-7.25-6	1.00	5.01	9786	1942	2.2	11.58	4233	49.0		
TD53 TRUCK MECHANIC	4	3-7.25-6	1.00	8.26	39144	1942	14.4	11.58	27921	323.3		
L16 W4 LOADER MECHANIC	4	3-7.25-6	1.00	3.81	9786	1942	1.7	11.58	3219	37.3		
GD5 GRADER MECHANIC	4	3-7.25-6	1.00	1.61	9786	1942	.7	11.58	1360	15.8		
PUMP PUMP SET MECHANIC	4	3-7.25-6	1.00	3.65	8640	1942	1.4	11.58	2723	31.5		
TDX2 H2O TRUCK MECHANIC	4	3-7.25-6	1.00	6.35	9786	1942	2.8	11.58	5366	62.1		
COAL HANDLE & PREP												
PRRB REC & BREAK												
ELECTRICIAN	4	2-7.25-5	.07	31.06	10875	1618	1.5	10.59	2360	25.0		
MACHINIST	4	2-7.25-5	.07	31.06	10875	1618	1.5	10.59	2360	25.0		
MECHANIC	4	2-7.25-5	.30	31.06	10875	1618	5.8	10.59	9441	100.0		
WELDER	3	2-7.25-5	.07	31.06	10875	1618	1.5	10.13	2367	24.0		
REPAIRMAN	3	2-7.25-5	.21	31.06	10875	1618	4.4	10.13	7068	71.6		
HELPER	2	2-7.25-5	.20	31.06	10875	1618	4.4	9.77	7087	69.2		
LABORER	1	2-7.25-5	.07	31.06	10875	1618	1.5	9.66	2377	23.0		
PRBS BLEND-STOCK												
ELECTRICIAN	4	2-7.25-5	.09	35.22	16314	1618	2.9	10.59	4720	50.0		
MACHINIST	4	2-7.25-5	.04	35.22	16314	1618	1.5	10.59	2387	25.3		
MECHANIC	4	2-7.25-5	.26	35.22	16314	1618	8.8	10.59	14161	150.0		
WELDER	3	2-7.25-5	.04	35.22	16314	1618	1.5	10.13	2382	24.1		
REPAIRMAN	3	2-7.25-5	.12	35.22	16314	1618	4.4	10.13	7090	71.8		
HELPER	2	2-7.25-5	.40	35.22	16314	1618	14.6	9.77	23583	230.4		
LABORER	1	2-7.25-5	.04	35.22	16314	1618	1.5	9.66	2379	23.0		
PRCL COAL LOADOUT												
ELECTRICIAN	4	2-7.25-5	.07	13.27	26136	1618	1.4	10.59	2259	23.9		
MACHINIST	4	2-7.25-5	.07	13.27	26136	1618	1.4	10.59	2259	23.9		
MECHANIC	4	2-7.25-5	.28	13.27	26136	1618	5.6	10.59	9104	96.4		
WELDER	3	2-7.25-5	.07	13.27	26136	1618	1.4	10.13	2259	22.9		
REPAIRMAN	3	2-7.25-5	.20	13.27	26136	1618	4.2	10.13	6813	69.0		
HELPER	2	2-7.25-5	.26	13.27	26136	1618	5.6	9.77	9087	88.8		
LABORER	1	2-7.25-5	.06	13.27	26136	1618	1.4	9.66	2261	21.8		
PRCS CRUSH-SCREEN												
ELECTRICIAN	4	2-7.25-5	.13	23.59	16314	1618	2.9	10.59	4760	50.4		
MACHINIST	4	2-7.25-5	.06	23.59	16314	1618	1.4	10.59	2325	24.6		
MECHANIC	4	2-7.25-5	.26	23.59	16314	1618	5.8	10.59	9412	99.7		
WELDER	3	2-7.25-5	.06	23.59	16314	1618	1.4	10.13	2317	23.5		
REPAIRMAN	3	2-7.25-5	.19	23.59	16314	1618	4.4	10.13	7104	72.0		
HELPER	2	2-7.25-5	.24	23.59	16314	1618	5.8	9.77	9414	92.0		
LABORER	1	2-7.25-5	.06	23.59	16314	1618	1.5	9.66	2350	22.7		
PRSI CS SUPPORT												
ELECTRICIAN	4	2-7.25-5	.10	75.58	6000	1618	2.6	10.59	4153	44.0		
MACHINIST	4	2-7.25-5	.19	75.58	6000	1618	5.2	10.59	8350	88.4		

A	B	C	D	E	F	G	H	I	J	K
MECHANIC	4	2-7.25-5	.29	75.58	6000	1618	7.7	10.59	12503	132.4
REPAIRMAN	3	2-7.25-5	.23	75.58	6000	1618	6.4	10.13	10430	105.7
STAT EQUIP OPERATOR	3	2-7.25-5	.09	75.58	6000	1618	2.6	10.13	4163	42.2
UTILITY MAN	1	2-7.25-5	.09	75.58	6000	1618	2.6	9.66	4224	40.8
LAND RECLAMATION										
CD 5 TR TRACTOR MECHANIC	4	3-7.25-6	1.00	5.64	18315	1942	4.6	11.58	8920	103.3
SC 5 SCRAPER MECHANIC	4	3-7.25-6	1.00	9.19	6660	1942	2.7	11.58	5285	61.2
GENERAL & ADMINISTRATION										
TOTALS							276.4		5458.5	.0*
INFLATION ESCALATION RATE = .00										
REGIONAL ADJUSTMENT FACTOR = 1.00										

Appendix E.5 Services and Materials List

The services and materials list identifies all services and materials; shows annual cost; shows annual quantity of electric power, water, and fuel. Columns A through K of the services and materials list are defined as follows:

- Column A: For each mining operation the equipment file number and type is given as well as a listing of the types of hourly services and materials costs associated with the equipment.
- Column B: Total productive hours equals the number of machines times productive machine hours.
- Column C: Base year materials and services hourly cost including regional adjustment.
- Column D: Usage adjustment to account for any variation from the assumed conditions used in the equipment data file.
- Column E: Annual cost equals total productive hours times hourly cost times use factor.
- Column F: Annual steady state electric power requirements.
- Column G: Annual steady state water requirements.
- Column H: Annual steady state fuel requirements.
- Column I: Electric power for deferred equipment.
- Column J: Water for deferred equipment.
- Column K: Fuel for deferred equipment.

MINING OPERATION		B	C	SERVICES AND MATERIALS LIST			QUANTITY			ANNUAL QUANTITY		
		TOTAL PROD (HR/YR)	HOURLY COST	D USE FACTR (ADJ)	E ANNUAL COST (M\$)	F ANNUAL COST E-MWH	G QUANTITY W-MGAL	H QUANTITY F-MGAL	I DEFR. ANNUAL QUANTITY E-MWH	J ANNUAL QUANTITY W-MGAL	K ANNUAL QUANTITY F-MGAL	
OVER. DRILL & BLAST												
RD16	ROTARY DRILL 15.000 IN 70 HP											
	MATERIAL	19578	6.76	1.000	132.3	0	0	0	0	0	0	
	ELECTRIC	19578	2.87	1.000	56.2	5618	0	0	0	0	0	
	OTHER	19578	7.04	1.000	137.8	0	0	0	0	0	0	
BLST	BLASTING OTHER	9786	282.13	1.000	2760.9	0	0	0	0	0	0	
CD3A	TR TRACTOR 300 HP											
	MATERIAL	19578	7.00	1.000	137.0	0	0	0	0	0	0	
	FUELS	19578	3.71	1.000	72.6	0	0	242	0	0	0	
LD1	WH LOADER 1.5 YD 80 HP											
	MATERIAL	9786	4.73	1.000	46.3	0	0	0	0	0	0	
	FUELS	9786	1.07	1.000	10.5	0	0	34	0	0	0	
	TIRES	9786	.32	1.000	3.1	0	0	0	0	0	0	
TDX1	DRILL TRUCK											
	MATERIAL	9786	1.31	1.000	12.8	0	0	0	0	0	0	
	FUELS	9786	.66	1.000	6.5	0	0	21	0	0	0	
	TIRES	9786	.57	1.000	5.6	0	0	0	0	0	0	
TOTALS (LESS DEFERRED)					3381.7							
OVERBURDEN REMOVAL												
DL1	DRAGLINE 43. CY 307 FT											
	MATERIAL	44802	71.98	1.000	3224.8	0	0	0	0	0	0	
	ELECTRIC	44802	22.81	1.000	1021.9	102193	0	0	0	0	0	
CD3	TR TRACTOR 300 HP											
	MATERIAL	44802	7.00	1.000	313.6	0	0	0	0	0	0	
	FUELS	44802	3.71	1.000	166.2	0	0	554	0	0	0	
LD16	WH LOADER 325 HP											
	MATERIAL	14244	20.49	1.000	291.9	0	0	0	0	0	0	
	FUELS	14244	3.93	1.000	56.0	0	0	186	0	0	0	
	TIRES	14244	2.75	1.000	39.2	0	0	0	0	0	0	
TOTALS (LESS DEFERRED)					5113.6							
COAL LOAD & HAUL												
SD31	SHOVEL 12 CU. YD.											
	MATERIAL	9786	15.03	1.000	147.1	0	0	0	0	0	0	
	ELECTRIC	9786	2.30	1.000	22.5	2250	0	0	0	0	0	
TD53	TRUCK 150 TON											
	MATERIAL	39144	12.39	1.000	485.0	0	0	0	0	0	0	
	FUELS	39144	9.36	1.000	366.4	0	0	1221	0	0	0	
	TIRES	39144	13.75	1.000	538.2	0	0	0	0	0	0	
L16	WH LOADER 325 HP											
	MATERIAL	9786	20.49	1.000	200.5	0	0	0	0	0	0	
	FUELS	9786	3.93	1.000	38.5	0	0	128	0	0	0	
	TIRES	9786	2.75	1.000	26.9	0	0	0	0	0	0	
G05	GRADER 180 HP											
	MATERIAL	9786	12.93	1.000	126.5	0	0	0	0	0	0	
	FUELS	9786	2.14	1.000	20.9	0	0	69	0	0	0	

	A	B	C	D	E	F	G	H	I	J	K
EIS	E. I. S.	PREMINE									
STF	SUPERV. PER.										
	MATERIAL	2000	78.72	1.000	157.4	0	0	0	0	0	0
RLTX	ROY-SEV. TAX										
	OTHER	2000	876.12	1.000	1752.2	0	0	0	0	0	0
	INSURANCE & PROP. TAX				6982.0						
	HOME OFFICE COSTS				753.8						
	TOTALS (LESS DEFERRED)				9953.2						
	TOTALS (LESS DEFERRED)				22910.2	144929	101859	3431	0	0	0
	TOTAL DEFERRED				.0*						

		REGIONAL	INFLATION								
		ADJUSTMENT	ESCALATION								
		FACTOR	RATE								
MATERIAL :		1.00	.00								
FUELS :		1.00	.00								
TIRES :		1.00	.00								
ELECTRIC :		1.00	.00								
WATER :		1.00	.00								
OTHER :		1.00	.00								

Appendix E.6 Infrastructure Report

The infrastructure report summarizes the physical effects, economic impact, utility requirements, and manpower requirements as follows:

- 1) **Physical Effects:** Gives the steady state annual amount and the total for the project life for acreage disturbed, preparation plant reject material, prepared coal production, and overburden handled.
- 2) **Economic Impact:** Gives the steady state annual amount and the maximum annual amount for the payroll (operating and maintenance personnel), fuel purchases, tire purchases, other materials and services purchases, insurance and property tax and royalty and severance tax.
- 3) **Utility Requirements:** Gives the steady state annual water and electric power requirements.
- 4) **Manpower Requirements:** Gives the steady state annual manpower requirements and the maximum annual manpower requirements for both operating and maintenance personnel.

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INFRASTRUCTURE REPORT

ALL FIGURES IN BASE DOLLARS

PHYSICAL EFFECTS :

	UNITS	ANNUAL	PROJECT TOTAL
ACREAGE DISTURBED	ACRES	898	26760
PREP PLANT REJECT	MTONS	51	1523
COAL PRODUCTION	MTONS	5139	153168
OVERBURDEN HANDLED	MCYDS	64366	1918112

ECONOMIC IMPACT :

	UNITS	ANNUAL	+ DEF
PAYROLL	M\$	14782.	14782.
FUEL PURCHASES	M\$	1029.	1029.
TIRE PURCHASES	M\$	654.	654.
MATL & OTHER SERVICES	M\$	10284.	10284.
INS. & PROP. TAXES	M\$	6982.	6982.
ROYALTY & SEVR. TAXES	M\$	1752.	1752.
TOTAL		35484.	35484.

UTILITY REQUIREMENTS :

	UNITS	ANNUAL
WATER	ACRE-FEET	313.
ELECTRICITY	MEGA WH	144929.

MANPOWER REQUIREMENTS :

GRADE	OPERATING		MAINTENANCE	
	ANNUAL	+ DEF	ANNUAL	+ DEF
5	78.0	78.0	.0	.0
1	53.0	53.0	8.4	8.4
5	61.4	61.4	.0	.0
2	38.1	38.1	30.4	30.4
4	50.6	50.6	205.4	205.4
3	181.9	181.9	32.1	32.1
TOTAL	462.9	462.9	276.4	276.4

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Appendix E.7 Production and Cash Expenditure Table

The production and cash expenditure table shows for each year of the project the production and cash expenditure as follows:

- 1) **Production:** For each mining operation the total production is shown for each year and summarized for the total project. The total energy content of the prepared coal is also shown for each year.
- 2) **Expenditures:** For each mining operation the expenditures are shown for three categories. The equipment expenditures include all progress payments and final payments for the original quantity, fleet spares, replacements, and deferred purchases. The manpower expenditures include the payroll for both operating and maintenance personnel. The services and materials expenditures include the costs of maintenance materials, fuel, tires, electric power, water, and other services and materials.

PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	1976	1977	1978	1979	1980	1981	1982	1983
	*****	*****	*****	*****	*****	*****	*****	*****
OVER. DRILLING & BLASTING (MILLION CU YDS)	0	0	0	0	0	0	17	39
EQUIPMENT	0	0	0	0	0	0	1297	1297
MANPOWER	0	0	0	0	0	0	425	851
SERVICES & MATERIALS	0	0	0	0	0	0	1127	2254
OVERBURDEN REMOVAL (MILLION CU YDS)	0	0	0	0	0	0	17	39
EQUIPMENT	0	0	3013	6026	9040	9040	9556	6543
MANPOWER	0	0	0	0	0	0	1692	3383
SERVICES & MATERIALS	0	0	0	0	0	0	1705	3409
COAL LOADING & HAULING (THOUSAND ROM TONS)	0	0	0	0	0	0	1384	3115
EQUIPMENT	0	0	0	0	509	1018	4836	4327
MANPOWER	0	0	0	0	0	0	534	1068
SERVICES & MATERIALS	0	0	0	0	0	0	709	1419
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	0	0	0	0	0	0	1371	3084
EQUIPMENT	0	0	0	0	0	0	21912	21912
MANPOWER	0	0	0	0	0	0	1582	3163
SERVICES & MATERIALS	0	0	0	0	0	0	553	1105
LAND RECLAMATION (ACRES)	0	0	0	0	0	0	239	538
EQUIPMENT	0	0	0	0	0	0	1038	1038
MANPOWER	0	0	0	0	0	0	160	320
SERVICES & MATERIALS	0	0	0	0	0	0	135	360
GENERAL & ADMINISTRATIVE								
EQUIPMENT	857	2339	1857	857	1590	1590	18125	0
MANPOWER	178	356	535	713	891	1069	1247	1425
SERVICES & MATERIALS	17	35	52	70	87	105	430	448
MISCELLANEOUS	4	8	12	16	20	24	5517	7722
TOTAL EXPENDITURE	1056	2738	5469	7682	12137	12846	72580	62044
BILLION BTU PRODUCED	0	0	0	0	0	0	34664	77995

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PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	1984	1985	1986	1987	1988	1989	1990	1991
	-----	-----	-----	-----	-----	-----	-----	-----
OVER. DRILLING & BLASTING (MILLION CU YDS)	60	64	64	64	64	64	64	64
EQUIPMENT	1297	271	271	271	882	1225	1225	343
MANPOWER	1276	1276	1276	1276	1276	1276	1276	1276
SERVICES & MATERIALS	3382	3382	3382	3382	3382	3382	3382	3382
OVERBURDEN REMOVAL (MILLION CU YDS)	60	64	64	64	64	64	64	64
EQUIPMENT	3530	271	271	517	517	517	271	271
MANPOWER	5075	5075	5075	5075	5075	5075	5075	5075
SERVICES & MATERIALS	5114	5114	5114	5114	5114	5114	5114	5114
COAL LOADING & HAULING (THOUSAND ROM TONS)	4845	5191	5191	5191	5191	5191	5191	5191
EQUIPMENT	3818	0	0	0	0	246	246	406
MANPOWER	1603	1603	1603	1603	1603	1603	1603	1603
SERVICES & MATERIALS	2128	2128	2128	2128	2128	2128	2128	2128
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	4797	5140	5140	5140	5140	5140	5140	5140
EQUIPMENT	21912	0	0	0	0	0	0	0
MANPOWER	4745	4745	4745	4745	4745	4745	4745	4745
SERVICES & MATERIALS	1658	1658	1658	1658	1658	1658	1658	1658
LAND RECLAMATION (ACRES)	838	898	898	898	898	898	898	898
EQUIPMENT	1038	0	0	0	0	974	974	974
MANPOWER	479	479	479	479	479	479	479	479
SERVICES & MATERIALS	566	675	675	675	675	675	675	675
GENERAL & ADMINISTRATIVE EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	1604	1604	1604	1604	1604	1604	1604	1604
SERVICES & MATERIALS	465	465	465	465	465	465	465	465
MISCELLANEOUS	9823	9488	9152	8828	8538	8326	8102	7841
TOTAL EXPENDITURE	69533	38234	37898	37820	38141	39492	39022	38039
BILLION BTU PRODUCED	121325	129992	129992	129992	129992	129992	129992	129992

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PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	1992	1993	1994	1995	1996	1997	1998	1999
	*****	*****	*****	*****	*****	*****	*****	*****
OVER. DRILLING & BLASTING (MILLION CU YDS)	64	64	64	64	64	64	64	64
EQUIPMENT	0	271	1224	1224	1297	343	343	0
MANPOWER	1276	1276	1276	1276	1276	1276	1276	1276
SERVICES & MATERIALS	3382	3382	3382	3382	3382	3382	3382	3382
OVERBURDEN REMOVAL (MILLION CU YDS)	64	64	64	64	64	64	64	64
EQUIPMENT	517	517	517	271	271	246	517	517
MANPOWER	5075	5075	5075	5075	5075	5075	5075	5075
SERVICES & MATERIALS	5114	5114	5114	5114	5114	5114	5114	5114
COAL LOADING & HAULING (THOUSAND ROM TONS)	5191	5191	5191	5191	5191	5191	5191	5191
EQUIPMENT	160	160	2590	2590	2836	266	266	20
MANPOWER	1603	1603	1603	1603	1603	1603	1603	1603
SERVICES & MATERIALS	2128	2128	2128	2128	2128	2128	2128	2128
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	5140	5140	5140	5140	5140	5140	5140	5140
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	4745	4745	4745	4745	4745	4745	4745	4745
SERVICES & MATERIALS	1658	1658	1658	1658	1658	1658	1658	1658
LAND RECLAMATION (ACRES)	898	898	898	898	898	898	898	898
EQUIPMENT	0	0	0	0	974	974	974	0
MANPOWER	479	479	479	479	479	479	479	479
SERVICES & MATERIALS	675	675	675	675	675	675	675	675
GENERAL & ADMINISTRATIVE								
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	1604	1604	1604	1604	1604	1604	1604	1604
SERVICES & MATERIALS	465	465	465	465	465	465	465	465
MISCELLANEOUS	7517	7206	7065	6912	6821	6557	6307	5984
TOTAL EXPENDITURE	***** 36398	***** 36358	***** 39600	***** 39201	***** 40403	***** 36590	***** 36611	***** 34725
BILLION BTU PRODUCED	129992	129992	129992	129992	129992	129992	129992	129992

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PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	2000	2001	2002	2003	2004	2005	2006	2007
	=====	=====	=====	=====	=====	=====	=====	=====
OVER. DRILLING & BLASTING (MILLION CU YDS)	64	64	64	64	64	64	64	64
EQUIPMENT	1152	1152	1152	0	343	343	1297	1224
MANPOWER	1276	1276	1276	1276	1276	1276	1276	1276
SERVICES & MATERIALS	3382	3382	3382	3382	3382	3382	3382	3382
OVERBURDEN REMOVAL (MILLION CU YDS)	64	64	64	64	64	64	64	64
EQUIPMENT	271	271	517	517	517	271	271	517
MANPOWER	5075	5075	5075	5075	5075	5075	5075	5075
SERVICES & MATERIALS	5114	5114	5114	5114	5114	5114	5114	5114
COAL LOADING & HAULING (THOUSAND ROM TONS)	5191	5191	5191	5191	5191	5191	5191	5191
EQUIPMENT	160	160	160	0	246	246	2836	2590
MANPOWER	1603	1603	1603	1603	1603	1603	1603	1603
SERVICES & MATERIALS	2128	2128	2128	2128	2128	2128	2128	2128
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	5140	5140	5140	5140	5140	5140	5140	5140
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	4745	4745	4745	4745	4745	4745	4745	4745
SERVICES & MATERIALS	1658	1658	1658	1658	1658	1658	1658	1658
LAND RECLAMATION (ACRES)	898	898	898	898	898	898	898	898
EQUIPMENT	0	0	0	974	974	974	0	0
MANPOWER	479	479	479	479	479	479	479	479
SERVICES & MATERIALS	675	675	675	675	675	675	675	675
GENERAL & ADMINISTRATIVE								
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	1604	1604	1604	1604	1604	1604	1604	1604
SERVICES & MATERIALS	465	465	465	465	465	465	465	465
MISCELLANEOUS	5709	5434	5169	4890	4641	4379	4244	4102
TOTAL EXPENDITURE	=====	=====	=====	=====	=====	=====	=====	=====
	35496	35221	35202	34585	34925	34417	36852	36637
BILLION BTU PRODUCED	129992	129992	129992	129992	129992	129992	129992	129992

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PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	2008	2009	2010	2011	2012	2013	2014	2015
	*****	*****	*****	*****	*****	*****	*****	*****
OVER. DRILLING & BLASTING (MILLION CU YDS)	64	64	64	64	43	21	0	0
EQUIPMENT	1224	271	0	343	343	343	0	0
MANPOWER	1276	1276	1276	1276	851	425	0	0
SERVICES & MATERIALS	3382	3382	3382	3382	2254	1127	0	0
OVERBURDEN REMOVAL (MILLION CU YDS)	64	64	64	64	43	21	0	0
EQUIPMENT	517	517	271	271	271	0	0	0
MANPOWER	5075	5075	5075	5075	3383	1692	0	0
SERVICES & MATERIALS	5114	5114	5114	5114	3409	1705	0	0
COAL LOADING & HAULING (THOUSAND ROM TONS)	5191	5191	5191	5191	3461	1730	0	0
EQUIPMENT	2590	160	160	406	246	246	0	0
MANPOWER	1603	1603	1603	1603	1068	534	0	0
SERVICES & MATERIALS	2128	2128	2128	2128	1419	709	0	0
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	5140	5140	5140	5140	3427	1713	0	0
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	4745	4745	4745	4745	3163	1582	0	0
SERVICES & MATERIALS	1658	1658	1658	1658	1105	553	0	0
LAND RECLAMATION (ACRES)	898	898	898	898	598	299	0	0
EQUIPMENT	0	0	974	974	974	0	0	0
MANPOWER	479	479	479	479	320	160	0	0
SERVICES & MATERIALS	675	675	675	675	540	315	90	0
GENERAL & ADMINISTRATIVE								
EQUIPMENT	0	0	0	0	0	0	0	0
MANPOWER	1425	1247	1069	891	713	535	356	178
SERVICES & MATERIALS	448	430	413	395	378	360	35	17
MISCELLANEOUS	3956	3641	3352	3092	2720	2360	379	374
TOTAL EXPENDITURE	*****	*****	*****	*****	*****	*****	*****	*****
	36295	32401	32374	32507	23157	12646	860	569
BILLION BTU PRODUCED	129992	129992	129992	129992	86661	43330	0	0

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PRODUCTION AND CASH EXPENDITURE TABLE (\$M)

	TOTALS

OVER. DRILLING & BLASTING (MILLION CU YDS)	1918
EQUIPMENT	22270
MANPOWER	38285
SERVICES & MATERIALS	101451

	162007
OVERBURDEN REMOVAL (MILLION CU YDS)	1918
EQUIPMENT	57744
MANPOWER	152250
SERVICES & MATERIALS	153408

	363403
COAL LOADING & HAULING (THOUSAND ROM TONS)	154692
EQUIPMENT	34500
MANPOWER	48080
SERVICES & MATERIALS	63843

	146424
COAL HANDLING & PREP. (THOUSAND CLEAN TONS)	153168
EQUIPMENT	65735
MANPOWER	142344
SERVICES & MATERIALS	49745

	257823
LAND RECLAMATION (ACRES)	26760
EQUIPMENT	14802
MANPOWER	14378
SERVICES & MATERIALS	20263

	49443
GENERAL & ADMINISTRATIVE	
EQUIPMENT	27216
MANPOWER	51317
SERVICES & MATERIALS	14884
MISCELLANEOUS	196230

	289647

TOTAL EXPENDITURE	1268745
BILLION BTU PRODUCED	3873736

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Appendix E.8 Financial Statements

Pro-forma financial statements are prepared for each year of the project as follows:

- 1) **Income Statement:** Shows selling price and resulting revenue, costs, net income, federal (accounts for depletion and investment tax credit), and net earnings.
- 2) **Sources and Uses of Funds:** Shows from where funds are derived balanced against how they are utilized.
- 3) **Balance Sheet:** Shows year end financial status balancing assets against liabilities and net worth.

ALL FIGURES IN THOUSANDS OF DOLLARS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
INCOME STATEMENT										
SALES PRICE \$/TON	.00	.00	.00	.00	.00	.00	12.70	12.70	12.70	12.70
REVENUES (NET)	0	0	0	0	0	0	17404	39158	60913	65264
COSTS										
MANPOWER	0	0	0	0	0	0	4393	8785	13178	13178
SERVICES & MATERIALS	0	0	0	0	0	0	4229	8548	12867	12957
LEASING COSTS	0	0	0	0	0	0	0	0	0	0
G & A	200	399	599	799	998	1198	7194	9595	11891	11557
INTEREST	54	184	436	796	1366	2017	4545	5184	4742	3043
DEPRECIATION	0	0	0	0	0	0	2922	4993	7065	7133
TOTAL COSTS	253	584	1035	1595	2364	3215	23283	37106	49744	47868
NET INCOME	-252	-583	-1034	-1594	-2363	-3214	-5879	2052	11169	17396
TAXES	0	0	0	0	0	0	0	0	0	0
NET EARNINGS	-252	-583	-1034	-1594	-2363	-3214	-5879	2052	11169	17396
MEMO : FOR THIS PROBLEM, PERCENTAGE DEPLETION IS	0	0	0	0	0	0	0	1026	5585	6526
SOURCE AND USE OF FUNDS										
SOURCE										
NET EARNINGS	-252	-583	-1034	-1594	-2363	-3214	-5879	2052	11169	17396
DEPRECIATION	0	0	0	0	0	0	2922	4993	7065	7133
SALE OF ASSETS	0	0	0	0	0	0	0	0	0	0
INCREASE IN DEBT	286	780	1623	2295	3713	3883	18921	11705	10531	180
INCREASE IN CAPITAL	571	1559	3247	4589	7426	7765	37842	23411	21063	361
TOTAL SOURCE	604	1755	3836	5289	8775	8433	53806	42162	49828	25070
USE										
SURPLUS CASH	0	0	0	0	0	0	0	0	0	7338
SHORT TERM BORROWING	308	706	1300	1991	3129	4118	11181	-401	-9286	-13042
A/R, INV, A/P, CASH CHAN	26	15	-2	-102	-104	-355	5073	2323	3573	-1243
INC OR DEC(-) IN WORK C	-281	-689	-1302	-2092	-3233	-4472	-6107	2725	12860	19137
FIXED ASSET PURCHASE	857	2339	4870	6884	11139	11648	56763	35116	31594	541
REDUCTION IN DEBT	29	107	269	498	870	1258	3150	4321	5374	5392
PAYMENT OF DIVIDEND	0	0	0	0	0	0	0	0	0	0
TOTAL USE	604	1755	3836	5289	8775	8433	53806	42162	49828	25070

ALL FIGURES IN THOUSANDS OF DOLLARS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
BALANCE SHEET										
CURRENT ASSETS										
CASH	0	0	0	0	0	0	1098	2196	3294	3294
SURPLUS CASH	0	0	0	0	0	0	0	0	0	7338
ACCOUNTS RECEIVABLE	0	0	0	0	0	0	2146	4828	7510	8046
INVENTORY	55	150	310	437	705	738	4710	4661	5744	3987
TOTAL CURRENT ASSETS	55	150	310	437	705	738	7954	11685	16549	22666
FIXED ASSETS										
DEPRECIABLE ASSETS	0	0	0	0	0	0	71881	116546	161211	161752
LESS DEPRECIATION	0	0	0	0	0	0	2922	7915	14980	22113
NET DEPRECIABLE ASSET	0	0	0	0	0	0	68959	108631	146231	139639
NON-DEPRECIABLE ASSET	0	0	0	0	0	0	0	0	0	0
FIXED ASSET PROG. PAY	857	3196	8066	14950	26089	37737	22619	13071	0	0
TOTAL FIXED ASSETS	857	3196	8066	14950	26089	37737	91579	121702	146231	139640
TOTAL ASSETS	912	3346	8376	15387	26794	38476	99532	133386	162780	162305
CURRENT LIABILITIES										
ACCOUNTS PAYABLE	1	2	3	4	5	6	255	493	731	735
SHORT TERM BORROW	308	1013	2313	4304	7433	11551	22732	22330	13043	0
CURRENT PORTION OF DEBT	29	107	269	498	870	1258	3150	4321	5374	5392
TOTAL CURRENT LIAB.	337	1122	2585	4806	8308	12814	26137	27143	19147	6127
LONG TERM DEBT	257	930	2285	4081	6924	9549	25320	32705	37863	32652
TOTAL LIABILITIES	594	2052	4870	8887	15232	22364	51457	59849	57010	38779
NET WORTH										
PAID-IN CAPITAL	571	2131	5378	9967	17393	25158	63000	86411	107474	107835
RETAINED EARNINGS	-252	-836	-1870	-3466	-5830	-9045	-14925	-12872	-1703	15691
TOTAL NET WORTH	318	1294	3506	5500	11562	16112	48075	73538	105770	123526
TOTAL LIAB + NET	912	3346	8376	15387	26794	38476	99532	133386	162780	162305

ALL FIGURES IN THOUSANDS OF DOLLARS

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
INCOME STATEMENT										
SALES PRICE \$/TON	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70
REVENUES (NET)	65264	65264	65264	65264	65264	65264	65264	65264	65264	65264
COSTS										
MANPOWER	13178	13178	13178	13178	13178	13178	13178	13178	13178	13178
SERVICES & MATERIALS	12957	12957	12957	12957	12957	12957	12957	12957	12957	12957
LEASING COSTS	0	0	0	0	0	0	0	0	0	0
G & A	11221	10897	10607	10395	10171	5910	9585	9275	9134	8980
INTEREST	2627	2217	1828	1490	1156	825	484	301	298	362
DEPRECIATION	7133	7135	7080	7117	7105	7105	7038	7038	7093	7090
TOTAL COSTS	47115	46384	45650	45136	44567	43975	43243	42749	42660	42568
NET INCOME	18149	18880	19614	20127	20697	21289	22021	22515	22604	22696
TAXES	1910	5678	6042	6198	6692	6970	7418	7610	7652	7685
NET EARNINGS	16239	13202	13572	13930	14005	14319	14603	14905	14952	15011
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
MEMO : FOR THIS PROBLEM, PERCENTAGE DEPLETION IS	6526	6526	6526	6526	6526	6526	6526	6526	6526	6526
SOURCE AND USE OF FUNDS										
SOURCE										
NET EARNINGS	16239	13202	13572	13930	14005	14319	14603	14905	14952	15011
DEPRECIATION	7133	7135	7080	7117	7105	7105	7038	7038	7093	7090
SALE OF ASSETS	0	0	0	0	0	0	0	0	0	0
INCREASE IN DEBT	180	262	466	987	905	665	226	316	1444	1362
INCREASE IN CAPITAL	361	525	932	1974	1810	1329	451	632	2887	2723
TOTAL SOURCE	23913	21124	22050	24008	23826	23418	22318	22891	26375	26186
USE										
SURPLUS CASH	17980	14940	15285	15735	16042	16666	17243	19316	20361	21553
SHORT TERM BORROWING	0	0	0	0	0	0	0	0	0	0
A/R, INV, A/P, CASH CHAN	11	67	154	228	265	277	1787	1156	1120	-133
INC OR DEC (-) IN WORK C	17991	15008	15438	15963	16308	16943	19030	20472	21481	21420
FIXED ASSET PURCHASE	541	787	1398	2962	2716	1994	677	947	4331	4085
REDUCTION IN DEBT	5381	5329	5214	5083	4802	4480	2611	1472	563	681
PAYMENT OF DIVIDEND	0	0	0	0	0	0	0	0	0	0
TOTAL USE	23913	21124	22050	24008	23826	23418	22318	22891	26375	26186

ALL FIGURES IN THOUSANDS OF DOLLARS

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
BALANCE SHEET										
CURRENT ASSETS										
CASH	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294
SURPLUS CASH	25319	40259	55544	71278	87321	103987	121230	140546	160908	182461
ACCOUNTS RECEIVABLE	8046	8046	8046	3046	8046	8046	8046	8046	8046	8046
INVENTORY	3987	4002	4040	4138	4122	4077	3995	4012	4223	4208
TOTAL CURRENT ASSETS	40646	55602	70925	86757	102784	119406	136566	155899	176472	198010
FIXED ASSETS										
DEPRECIABLE ASSETS	162293	163081	164479	167440	170156	172150	172827	173774	178105	182190
LESS DEPRECIATION	29245	36381	43461	50578	57683	64788	71826	78865	85958	93048
NET DEPRECIABLE ASSET	133048	126700	121018	116862	112473	107362	101000	94909	92147	89142
NON-DEPRECIABLE ASSET	0	0	0	0	0	0	0	0	0	0
FIXED ASSET PROG. PAY	0	0	0	0	0	0	0	0	0	0
TOTAL FIXED ASSETS	133048	126700	121018	116863	112473	107362	101001	94910	92147	89142
TOTAL ASSETS	173694	182302	191942	203620	215257	226768	237567	250809	268619	287152
CURRENT LIABILITIES										
ACCOUNTS PAYABLE	735	735	735	735	735	735	735	735	735	735
SHORT TERM BORROW	0	0	0	0	0	0	0	0	0	0
CURRENT PORTION OF DEBT	5381	5329	5214	5083	4802	4480	2611	1472	563	681
TOTAL CURRENT LIAB.	6117	6065	5949	5818	5538	5216	3346	2207	1299	1417
LONG TERM DEBT	27451	22384	17636	13540	9643	5827	3442	2286	3166	3847
TOTAL LIABILITIES	33567	28449	23585	19359	15181	11043	6788	4493	4465	5263
NET WORTH										
PAID-IN CAPITAL	108196	108721	109653	111627	113437	114767	115218	115850	118737	121460
RETAINED EARNINGS	31931	45133	58705	72634	86639	100958	115561	130466	145418	160429
TOTAL NET WORTH	140127	153853	168357	184261	200076	215725	230779	246316	264154	281889
TOTAL LIAB + NET	173694	182302	191942	203620	215257	226768	237567	250809	268619	287152

ALL FIGURES IN THOUSANDS OF DOLLARS

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
INCOME STATEMENT										
SALES PRICE \$/TON	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70
REVENUES (NET)	65264	65264	65264	65264	65264	65264	65264	65264	65264	65264
COSTS										
MANPOWER	13178	13178	13178	13178	13178	13178	13178	13178	13178	13178
SERVICES & MATERIALS	12957	12957	12957	12957	12957	12957	12957	12957	12957	12957
LEASING COSTS	0	0	0	0	0	0	0	0	0	0
G & A	8890	8626	8376	8052	7778	7502	7238	6959	6710	6448
INTEREST	451	433	418	361	337	317	304	279	269	258
DEPRECIATION	7160	6996	6996	6879	6965	6983	7009	6964	6964	6961
TOTAL COSTS	42635	42190	41926	41427	41215	40937	40686	40337	40077	39802
NET INCOME	22628	23074	23338	23836	24049	24327	24577	24927	25187	25462
TAXES	7643	7828	7966	8108	8221	8355	8637	8829	8953	9089
NET EARNINGS	14985	15246	15372	15728	15828	15972	15941	16098	16233	16373
MEMO : FOR THIS PROBLEM, PERCENTAGE DEPLETION IS										
	6526	6526	6526	6526	6526	6526	6526	6526	6526	6526
SOURCE AND USE OF FUNDS										
SOURCE										
NET EARNINGS	14985	15246	15372	15728	15828	15972	15941	16098	16233	16373
DEPRECIATION	7160	6996	6996	6879	6965	6983	7009	6964	6964	6961
SALE OF ASSETS	0	0	0	0	0	0	0	0	0	0
INCREASE IN DEBT	1793	610	700	179	528	528	610	497	693	611
INCREASE IN CAPITAL	3585	1220	1400	358	1055	1055	1219	994	1387	1223
TOTAL SOURCE	27523	24071	24468	23144	24375	24538	24779	24553	25277	25168
USE										
SURPLUS CASH	21383	21622	21474	21804	21907	22173	22166	22276	22335	22599
SHORT TERM BORROWING	0	0	0	0	0	0	0	0	0	0
A/R, INV, A/P, CASH CHAN	-79	-255	-5	-16	103	14	-22	-38	112	60
INC OR DEC (-) IN WORK C	21302	21365	21467	21787	22010	22187	22143	22237	22447	22659
FIXED ASSET PURCHASE	5378	1829	2100	537	1583	1583	1829	1491	2080	1834
REDUCTION IN DEBT	842	877	901	820	782	768	807	825	750	675
PAYMENT OF DIVIDEND	0	0	0	0	0	0	0	0	0	0
TOTAL USE	27523	24072	24468	23144	24375	24538	24779	24552	25277	25168

ALL FIGURES IN THOUSANDS OF DOLLARS

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BALANCE SHEET										
CURRENT ASSETS										
CASH	3294	3294	3294	3294	3294	3294	3294	3294	3294	3294
SURPLUS CASH	203844	225466	246939	268743	290651	312824	334990	357266	379601	402200
ACCOUNTS RECEIVABLE	8046	8046	8046	8046	8046	8046	8046	8046	8046	8046
INVENTORY	4289	4067	4084	3986	4052	4052	4067	4046	4083	4067
TOTAL CURRENT ASSETS	219473	240873	262364	284070	306043	328216	350397	372653	395024	417608
FIXED ASSETS										
DEPRECIABLE ASSETS	187567	189397	191497	192033	193616	195199	197028	198519	200599	202433
LESS DEPRECIATION	100208	107204	114200	121080	128045	135027	142037	149000	155964	162925
NET DEPRECIABLE ASSET	87360	82193	77296	70954	65572	60172	54992	49519	44635	39508
NON-DEPRECIABLE ASSET	0	0	0	0	0	0	0	0	0	0
FIXED ASSET PROG. PAY	0	0	0	0	0	0	0	0	0	0
TOTAL FIXED ASSETS	87360	82193	77296	70954	65572	60172	54992	49519	44635	39508
TOTAL ASSETS	306833	323066	339660	355024	371615	388388	405389	422171	439659	457116
CURRENT LIABILITIES										
ACCOUNTS PAYABLE	735	735	735	735	735	735	735	735	735	735
SHORT TERM BORROW	0	0	0	0	0	0	0	0	0	0
CURRENT PORTION OF DEBT	842	877	901	820	782	768	807	825	750	675
TOTAL CURRENT LIAB.	1578	1613	1636	1555	1517	1504	1542	1560	1485	1410
LONG TERM DEBT	4797	4529	4329	3688	3434	3193	2996	2668	2611	2548
TOTAL LIABILITIES	6375	6142	5965	5243	4951	4697	4538	4228	4097	3958
NET WORTH										
PAID-IN CAPITAL	125045	126265	127665	128022	129078	130133	131352	132346	133733	134955
RETAINED EARNINGS	175414	190660	206031	221759	237587	253559	269499	285598	301831	318204
TOTAL NET WORTH	300459	316924	333696	349782	366664	383692	400851	417944	435564	453159
TOTAL LIAB + NET	306833	323066	339661	355024	371615	388388	405389	422172	439660	457117

CFA MODEL:

503 (CMD0503) HYPOTHETICAL MINE STUDY - JHID
1 BASELINE SOLUTION

DATE: 13:34 JAN 18, '77 PAGE NO. 8.07

ALL FIGURES IN THOUSANDS OF DOLLARS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
INCOME STATEMENT										
SALES PRICE \$/TON	12.70	12.70	12.70	12.70	12.70	12.70	12.70	12.70	-00	-00
REVENUES (NET)	55264	65264	65264	65264	65264	65264	43509	21755	0	0
COSTS										
MANPOWER	13178	13178	13178	13178	13178	13178	8785	4393	0	0
SERVICES & MATERIALS	12957	12957	12957	12957	12957	12957	8728	4409	90	0
LEASING COSTS	0	0	0	0	0	0	0	0	0	0
G & A	6313	6171	5829	5318	4834	4378	3811	3255	771	569
INTEREST	321	385	443	404	376	365	348	298	235	177
DEPRECIATION	7060	7113	7113	7040	6992	7008	5599	4084	89	0
TOTAL COSTS	39829	39804	39519	38898	38337	37886	27271	16439	1185	746
NET INCOME	25435	25460	25744	26366	26926	27378	16238	5316	-1184	-745
TAXES	9076	9088	9225	9523	9792	10009	5706	1507	0	0
NET EARNINGS	16359	16372	16520	16843	17134	17369	10532	3809	-1184	-745
MEMO : FOR THIS PROBLEM, PERCENTAGE DEPLETION IS										
	6526	6526	6526	6526	6526	6526	4351	2175	0	0
SOURCE AND USE OF FUNDS										
SOURCE										
NET EARNINGS	16359	16372	16520	16843	17134	17369	10532	3809	-1184	-745
DEPRECIATION	7060	7113	7113	7040	6992	7008	5599	4084	89	0
SALE OF ASSETS	0	0	0	0	0	0	0	7244	0	0
INCREASE IN DEBT	1468	1444	1444	316	468	665	611	196	0	0
INCREASE IN CAPITAL	2936	2887	2887	632	936	1329	1223	393	0	0
TOTAL SOURCE	27822	27815	27963	24831	25531	26371	17965	15726	-1094	-745
USE										
SURPLUS CASH	22583	22847	22907	23295	23285	23533	20162	19239	3010	-1463
SHORT TERM BORROWING	0	0	0	0	0	0	0	0	0	0
A/R, INV, A/P, CASH CHAN	193	-87	-74	-225	34	22	-4852	-4893	-4827	56
INC OR DEC(-) IN WORK C	22776	22759	22832	23070	23319	23555	15310	14345	-1817	-1407
FIXED ASSET PURCHASE	4404	4331	4331	947	1405	1994	1834	589	0	0
REDUCTION IN DEBT	642	726	800	814	808	821	822	792	722	661
PAYMENT OF DIVIDEND	0	0	0	0	0	0	0	0	0	0
TOTAL USE	27822	27815	27963	24831	25531	26371	17965	15726	-1095	-746

ALL FIGURES IN THOUSANDS OF DOLLARS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
BALANCE SHEET										
CURRENT ASSETS										
CASH	3294	3294	3294	3294	3294	3294	2196	1098	0	0
SHORT-TERM CASH	424784	447630	470537	493833	517118	540651	560813	580052	583063	581598
ACCOUNTS RECEIVABLE	8046	8046	8046	8046	8046	8046	5364	2682	0	0
INVENTORY	4228	4223	4222	4008	4035	4070	2766	1384	12	2
TOTAL CURRENT ASSETS	440352	463194	486100	509182	532494	556062	571139	585217	583075	581600
FIXED ASSETS										
DEPRECIABLE ASSETS	206836	211167	215498	216445	217850	219844	221678	215023	215023	215023
LESS DEPRECIATION	169985	177097	184210	191251	198243	205250	210850	214934	215023	215023
NET DEPRECIABLE ASSET	36851	34070	31288	25195	19607	14594	10828	90	0	0
NON-DEPRECIABLE ASSET	0	0	0	0	0	0	0	0	0	0
FIXED ASSET PROG. PAY	0	0	0	0	0	0	0	0	0	0
TOTAL FIXED ASSETS	36852	34070	31288	25195	19607	14594	10829	90	1	1
TOTAL ASSETS	477204	497264	517388	534377	552101	570655	581967	585306	583075	581600
CURRENT LIABILITIES										
ACCOUNTS PAYABLE	735	735	735	734	733	732	499	261	7	1
SHORT TERM BORROW	0	0	0	0	0	0	0	0	0	0
CURRENT PORTION OF DEBT	642	726	800	814	808	821	822	792	722	661
TOTAL CURRENT LIAB.	1378	1461	1535	1547	1540	1553	1321	1053	729	662
LONG TERM DEBT	3373	4091	4735	4237	3897	3741	3530	2935	2213	1552
TOTAL LIABILITIES	4751	5552	6269	5784	5438	5294	4851	3988	2942	2214
NET WORTH										
PAID-IN CAPITAL	137891	140778	143665	144297	145233	146563	147786	148178	148178	148178
RETAINED EARNINGS	334562	350934	367454	384296	401431	418800	429332	433140	431956	431209
TOTAL NET WORTH	472453	491712	511119	528593	546664	565363	577117	581319	580134	579388
TOTAL LIAB + NET	477204	497264	517388	534377	552102	570656	581968	585307	583076	581601

STOP 0

Appendix E.9 Default Values for Appalachia (Ohio)

Mining parameters and financial assumptions which are not input values but which are required by the macromodel are assigned default values appropriate to the region being studied. Macromodel control parameters are also set at default values.

Appendix E.9 Default Values for Appalachia-Ohio

CDM MODEL ECONOMIC SUMMARY

RUN DATE 13:34 JAN 18, '77 PAGE NO. 1.5

RUN NO. 503 TITLE (CDM00503) HYPOTHETICAL MINE STUDY - OHIO
 CASE NO. 1 TITLE BASELINE SOLUTION

1975 DOLLARS; FINANCIAL PARAMETERS AS PER MICRO MODEL ASSUMPTIONS

I IMCC4	1	INCLUDE COAL LOAD AND HAUL
I IM07B	1	INCLUDE ROCK DRILL AND BLAST
I IM0DL	1	INCLUDE OVERBURDEN REMOVAL W/ DRAGLINES
I IMJGA	1	INCLUDE GENERAL & ADMINISTRATIVE
I IMOLR	1	INCLUDE RECLAMATION
I IM0PP	1	INCLUDE PREP PLANT
I IMJQB	0	INCLUDE COAL DRILL AND BLAST
I IPPT	1	PP - INDEX TO PLANT TYPE
I L3SCF	1	WRITES CFA CONTROL FILE IF 1
I LOGDV	1	PRINTS DEFAULT VARIABLES IF 1
I L3SEC	1	WRITES CFA EQUIPMENT FILE IF 1
I L3GPA	1	PRINTS PARAMETERS IF 1
I LOGRD	1	PRINTS REGRESS. DATA FILE IF 1
I L3SSD	1	WRITES SPECIFICATION DATA IF 1
I LOGSM	1	WRITES ECONOMIC SUMMARY IF ONE
I EDR	260.000	EFFECTIVE DJMPING RADIUS
I GAJP	.110000	GAA - UNION PAYMENT (\$/TJV)
D ABHD	63.4350	ANGLE BURDEN HIGHWALL (DEGREES)
D ABSD	33.6890	ANGLE BURDEN SPOILS (DEGREES)
D ACFD	76.0000	ANGLE COAL FACE (DEGREES)
D CDRTYD	865000.	COAL DEMAND ROM TONS/YEAR
D C4JF	6600.00	COAL HAUL DISTANCE IN FEET - AVERAGE
D DBRPY	4330.00	DENSITY OF OVERBURDEN BANK LBS/YARD
D DCBPY	2160.00	DENSITY COAL BANK LBS/YARD
D DRSMF4	100.000	DRILLING RATE IN SOFT MAT'L. - FT/HR
D ECR	.920000	EXPECTED COAL RECOVERY FACTOR
D GATY3	144.545	GAA - TONS/YEAR - BASELINE
D PPBED	.409500E 15	PP - BASE ENERGY BTU/YEAR
D PPBT	75000.0	PP - BASE TJNS/DAY
D PPJJY	250.000	PP - OPERATING DAYS/YEAR
D PRPY	.300000	POWDER RATIO - POUNDS / CU. YD.
D PWF	100.000	PANEL WIDTH (FEET)
D SFB	.350000	SWELL FACTOR FOR BURDEN
D SFC	.350000	SWELL FACTOR FOR COAL
D TMY	30.0000	TOTAL MINING YEARS
D TRF	.600000E-01	TOTAL RESISTANCE ON TOPSOIL HAUL ROAD

PARAMETER LIST

D LCFCC	1	BUILDS CORRELATION DATA FILE IF 1
D LCFDB	0	LOGS DEBUG ARRAYS IF 1
D LCFFP	1	PRINTS THE FINANCIAL PARAMETERS IF 1
D LCFFS1	1	PRINTS FINANCIAL SUMMARY REPORT IF 1
D LCFIL	1	PRINTS INVESTMENT LIST IF 1
D LCFIR	1	PRINTS INFRASTRUCTURE REPORT IF 1
D LCFMPL	1	PRINTS MAINTENANCE MANPOWER LIST IF 1
D LCFOPL	1	PRINTS OPERATING MANPOWER LIST IF 1
D LCFPCE	1	PRINTS PRODN. & CASH EXP. REPORT IF 1
D LCFPFS	1	PRINTS PRO-FORMA STATEMENTS IF 1
D LCFSMI	1	PRINTS SERVICE & MATERIALS LIST IF 1
D LCFXY	1	BUILDS X,Y PLOT FILE IF 1
D NEDNC	0	NEW EQUIP. DATA FOR NEXT CASE IF 1
D CE3M4	10.0000	COST OF ELECTRICITY - \$/MEGAWATT HOJR
D CDFMG	300.0000	COST OF FUEL - \$/M GALS.
D CW3M3	.500000E-01	COST OF WATER - \$/M GALS
D DAPG	.100000	DEPLETION ALLOWANCE - PERCENT OF GROSS
D DAPN	.500000	DEPLETION ALLOWANCE - PERCENT OF NET
D DEC	.000000	DEBT/EQUITY RATIO CONTROL
D DER	1.00000	DEBT/EQUITY RATIO
D DERT	.100000	DEBT/EQUITY RATIO TOLERANCE
D EYAEI	.000000	ESCAL. YEAR - ALL EQUIP. INVEST.
D EYHC	.000000	ESCAL. YEAR - HOURLY COSTS
D EYML	.000000	ESCAL. YEAR - MAINTENANCE LABOR
D EYOL	.000000	ESCAL. YEAR - OPERATING LABOR
D EYSPC	.000000	ESCAL. YEAR - SELLING PRICE OF COAL
D FALC	1.20000	FACTOR - ANNUAL LEASE COSTS
D FCR	.250000	FACTOR - CASH REQUIREMENTS
D F4JC	.200000E-01	FACTOR - HOME OFFICE COSTS
D FIPT	.500000E-01	FACTOR - INSURANCE & PROPERTY TAX
D FSI	.100000	FACTOR - SUPPLIES INVENTORY
D FWI	.625000E-01	FACTOR - WAREHOUSE INVENTORY
D RAAEI	1.00000	REGIONAL ADJ. - ALL EQUIP. INVEST.
D RAEL	1.00000	REGIONAL ADJ. - ELECTRICITY
D RAFJ	1.00000	REGIONAL ADJ. - FUELS
D RAML	1.00000	REGIONAL ADJ. - MAINTENANCE LABOR
D RAMM	1.00000	REGIONAL ADJ. - MAINTENANCE MATERIALS
D RAOL	1.00000	REGIONAL ADJ. - OPERATING LABOR
D RAJT	1.00000	REGIONAL ADJ. - OTHER COSTS
D RATI	1.00000	REGIONAL ADJ. - TIRES
D RAWA	1.00000	REGIONAL ADJ. - WATER
D RCJ	.000000	RATE - CASH DIVIDENDS
D RCI	.120000	RATE - CONSTRUCTION INTEREST
D RITC	.700000E-01	RATE - INVESTMENT TAX CREDIT
D RLTR	10.0000	RATE - L-T DEBT REPAYMENT (YEARS)
D VCDY	365.000	VALUE - CALENDAR DAYS/YEAR
D VDAP	20.0000	VALUE - DAYS ACCOUNTS PAYABLE
D VDAR	45.0000	VALUE - DAYS ACCOUNTS RECEIVABLE
D VDCI	10.0000	VALUE - DAYS OF COAL INVENTORY
D VFCY	1976.00	VALUE - FIRST CALENDAR YEAR
D VODY	250.000	VALUE - OPERATING DAYS/YEAR
D VSC	.000000	VALUE - STARTING CASH
D VJPDH	.000000	VALUE - UNION PENSION \$/HOUR

APPENDIX F

Macromodel Sensitivity Analysis

F.1 Vary Mining Parameters

- Energy Demand
- ROM Coal Heat Value
- Height of Burden Average
- Height of Coal
- Difficulty of Preparation Effort
- Topsoil Thickness Saved
- Other Reclamation Costs

F.2 Vary Financial Assumptions

- Long-Term Interest Rate
- Desired Return on Investment
(Cash Flow Discount Rate)
- Federal Income Tax Rate
- Paid in Capital/Long Term Debt Ratio
- Labor Escalation Rate
- Materials and Services Cost Escalation Rate
- Equipment Investment Escalation Rate
- Depreciation Method
- Land Rights - Surface
- Land Rights - Mineral
- Royalty
- State and Local Severance Tax

The mining parameters and financial assumptions were varied one at a time through a range of values from extreme high to extreme low for the Appalachia (Ohio) test case to indicate the impact of each on the following:

Sales Price in Base Dollars:	\$/prepared ton
Sales Price in Base Dollars:	\$/million Btu
Return on Investment:	percent
Return on Paid-in-Capital:	percent
Cummulative Investment to Steady State:	M\$
Cummulative Investment Total Project:	M\$
Annual Operating Cost at Steady State:	M\$

The range of values used and the results for each are shown on the following 4 pages.

Appendix F.1

Mining Parameter Sensitivity Analysis (Appalachia-Ohio)

	Dollars Prep'd Ton	Dollars Million BTU	Return on Invest.	Return on Paid Capital	Invest. to steady State	Invest. Total Project	Annual Operate Cost
Energy Demand for Mine Complex (Btu/yr)							
.243800E 15	10.92	.43	10.00	10.81	281124.	397115.	46947.
.195000E 15	11.67	.46	10.00	10.84	232917.	330473.	39162.
.130000E 15	12.70	.50	10.00	10.88	161752.	222268.	26135.
.813000E 14	14.34	.57	10.00	10.89	110575.	150749.	17987.
.325000E 14	18.22	.72	10.00	10.88	54171.	72030.	9169.
Run-Of-Mine Coal Heat Value (Btu/lb)							
14200.0	13.30	.47	10.00	10.88	148721.	207697.	24789.
13400.0	12.99	.48	10.00	10.88	154570.	214316.	25408.
12600.0	12.70	.50	10.00	10.88	161752.	222268.	26135.
11400.0	12.61	.55	10.00	10.88	179860.	253183.	30376.
10200.0	12.19	.60	10.00	10.88	195760.	274535.	32483.
Height of Burden Average (ft)							
31.5221	19.55	.77	10.00	10.85	247688.	318780.	38339.
19.1527	15.18	.60	10.00	10.86	191641.	252156.	30829.
12.3977	12.70	.50	10.00	10.88	161752.	222268.	26135.
6.38885	10.44	.41	10.00	10.90	134396.	194912.	21956.
Height of Coal (ft)							
8.00000	9.95	.39	10.00	10.90	129231.	180006.	20714.
6.00000	10.95	.43	10.00	10.89	141294.	197925.	22684.
4.00000	12.70	.50	10.00	10.88	161752.	222268.	26135.
3.00000	14.48	.57	10.00	10.87	183339.	251284.	29535.
2.00000	18.26	.72	10.00	10.85	226904.	315936.	37383.
Prep. Plant Type Based on Difficulty*							
3.00000	18.72	.70	10.00	10.88	243697.	322470.	37255.
2.00000	16.83	.64	10.00	10.88	220162.	298166.	34493.
1.00000	12.70	.50	10.00	10.88	161752.	222268.	26135.

*(1=Crush & Screen; 2=Baum Jig; 3=Heavy Media)

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Appendix F.1 (Continued)

	<u>Dollars Prep'd Ton</u>	<u>Dollars Million BTU</u>	<u>Return on Invest.</u>	<u>Return on Paid Capital</u>	<u>Invest. to steady State</u>	<u>Invest. Total Project</u>	<u>Annual Operate Cost</u>
Topsoil Thickness Saved (ft)							
2.00000	12.97	.51	10.00	10.88	164166.	234334.	26950.
1.00000	12.79	.51	10.00	10.88	162557.	226290.	26407.
.500000	12.70	.50	10.00	10.88	161752.	222268.	26135.
.250000	12.65	.50	10.00	10.88	161350.	220257.	25999.
Other Reclamation Costs (\$/acre)							
1350.00	12.76	.50	10.00	10.88	162330.	224385.	26381.
1125.00	12.73	.50	10.00	10.88	162138.	223423.	26258.
900.000	12.73	.50	10.00	10.88	162138.	223423.	26258.
675.000	12.65	.50	10.00	10.88	161367.	220343.	25956.
450.000	12.62	.50	10.00	10.88	161175.	219389.	25833.

Appendix F.2

Financial Assumption Sensitivity Analysis (Appalachia-Ohio)

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	<u>Dollars Prep'd Ton</u>	<u>Dollars Million BTU</u>	<u>Return on Invest.</u>	<u>Return on Paid Capital</u>	<u>Invest. to steady State</u>	<u>Invest. Total Project</u>	<u>Annual Operate Cost</u>
Long Term Interest Rate (percent)							
.120	12.70	.50	10.00	10.73	161752.	222268.	26135.
.100	12.70	.50	10.00	10.80	161752.	222268.	26135.
.080	12.70	.50	10.00	10.88	161752.	222268.	26135.
.060	12.70	.50	10.00	10.94	161752.	222268.	26135.
Desired Return on Investment (percent)							
.200	20.53	.81	10.00	21.06	161752.	222268.	26135.
.150	16.29	.64	15.00	15.98	161752.	222268.	26135.
.100	12.70	.50	10.00	10.88	161752.	222268.	26135.
.050	10.03	.40	5.01	5.50	161752.	222268.	26135.
.000	8.44	.33	.04	999.99	161752.	222268.	26135.
Federal Income Tax Rate (percent)							
.576	13.20	.52	10.00	10.93	161752.	222268.	26135.
.528	12.93	.51	10.00	10.91	161752.	222268.	26135.
.480	12.70	.50	10.00	10.88	161752.	222268.	26135.
.432	12.50	.49	10.00	10.85	161752.	222268.	26135.
.384	12.32	.49	10.00	10.82	161752.	222268.	26135.
Paid in Capital/Long Term Debt Ratio							
99.000	12.70	.50	10.00	10.00	161752.	222268.	26135.
4.000	12.70	.50	10.00	10.48	161752.	222268.	26135.
2.000	12.70	.50	10.00	10.88	161752.	222268.	26135.
1.000	12.70	.50	10.00	11.51	161752.	222268.	26135.
.000	12.70	.50	10.00	999.99	161752.	222268.	26135.
Labor Escalation Rate							
.100	32.74	1.29	10.00	10.85	161752.	222268.	47137.
.050	16.75	.66	10.00	10.91	161752.	222268.	34422.
.000	12.70	.50	10.00	10.88	161752.	222268.	26135.
Materials and Services Escalation Rate							
.100	33.58	1.33	10.07	10.93	161752.	222268.	46785.
.050	16.90	.67	10.01	10.93	161752.	222268.	34283.
.000	12.70	.50	10.00	10.88	161752.	222268.	26135.

(Continued next page)

Appendix F.2 (Continued)

	Dollars Prep'd Ton	Dollars Million BTU	Return on Invest.	Return on Paid Capital	Invest. to steady State	Invest. Total Project	Annual Operate Cost
Equipment Escalation Rate							
.100	22.36	.88	10.00	10.93	342540	1157320.	26135.
.050	16.27	.64	10.00	10.92	237305.	453891.	26135.
.000	12.70	.50	10.00	10.88	161752.	222268.	26135.
Depreciation Method*							
3.000	12.38	.49	10.00	10.31	161752.	222268.	26135.
2.000	12.62	.50	10.00	10.85	161752.	222268.	26135.
1.000	12.70	.50	10.00	10.88	161752.	222268.	26135.
Land Rights-Surface (\$/acre)							
500.000	12.78	.51	10.00	10.88	162426.	222941.	26135.
375.000	12.74	.50	10.00	10.88	162089.	222604.	26135.
250.000	12.70	.50	10.00	10.88	161752.	222268.	26135.
125.000	12.65	.50	10.00	10.88	161416.	221931.	26135.
.000000	12.61	.50	10.00	10.88	161079.	221594.	26135.
Land Rights-Mineral (\$/acre)							
100.000	12.72	.50	10.00	10.88	161887.	222402.	26135.
75.0000	12.71	.50	10.00	10.88	161820.	222335.	26135.
50.0000	12.70	.50	10.00	10.88	161752.	222268.	26135.
25.0000	12.69	.50	10.00	10.88	161685.	222200.	26135.
.000000	12.68	.50	10.00	10.88	161618.	222133.	26135.
Royalty (R/ton)							
1.00000	13.51	.53	10.00	10.85	161752.	222268.	26135.
.500000	12.97	.51	10.00	10.87	161752.	222268.	26135.
.250000	12.70	.50	20.00	10.88	161752.	222268.	26135.
.000000	12.43.	.49	10.00	10.89	161752.	222268.	26135.
State and Local Severance Tax (\$/ton)							
1.00000	13.78	.54	10.01	10.85	161752.	222268.	26135.
.500000	13.24	.52	10.00	10.86	161752.	222268.	26135.
.000000	12.70	.50	10.00	10.88	161752.	222268.	26135.

* (1=St. Line, 2=Decl. Bal, 3=Dbl. Decl)

