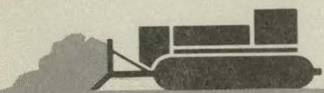
DOE/ET/11268-21
(DE82009400)

MASTER



LOGISTICS BACKGROUND STUDY — UNDERGROUND MINING

Final Report

Skelly and Loy
Harrisburg, Pennsylvania

February 1982

Contract No. U.S.D.O.E. AC01-79ET11268

DO NOT MICROFILM
COVER

U. S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Coal Mining

The following pages are an exact representation of what is in the original document folder.

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

Price: Printed Copy A15
Microfiche A01

Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts, (ERA); Government Reports Announcements* and Index (*GRA* and I); *Scientific and Technical Abstract Reports (STAR);* and publication, NTIS-PR-360 available from (NTIS) at the above address.

DOE/ET/11268-21
(DE82009400)
Distribution Category UC-88

DOE/ET/11268--21

DE82 009400

LOGISTICS BACKGROUND STUDY - UNDERGROUND MINING

FINAL REPORT

U.S. DOE Contract No. DE-AC01-79ET 11268
(Task Order Number 013)

Prepared for:

UNITED STATES DEPARTMENT OF ENERGY
Washington, D.C. 20545

FEBRUARY 1982

Prepared by:

SKELLY AND LOY
ENGINEERS-CONSULTANTS

2601 North Front Street
Harrisburg, Pennsylvania 17110

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.

4. Title and Subtitle

Logistics Background Study - Underground Mining

5. Report Date

February 1982

6.

7. Author(s)

Hanslovan, James J. and Richard G. Visovsky

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Skelly and Loy
2601 North Front Street
Harrisburg, Pennsylvania 17110

10. Project/Task/Work Unit No.

Task Order No. 13

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

U.S. Department of Energy
Office of Mining
Washington, D.C. 20545

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts

Logistical functions that are normally associated with U.S. underground coal mining are investigated and analyzed. These functions imply all activities and services that support the producing sections of the mine. The report provides a better understanding of how these functions impact coal production in terms of time, cost, and safety. Major underground logistics activities are analyzed and include: transportation of personnel, supplies and equipment; transportation of coal and rock; electrical distribution and communications systems; water handling; hydraulics; and ventilation systems. Recommended areas for future research are identified and prioritized.

17. Key Words and Document Analysis. 17a. Descriptors

Underground mining; logistics, logistics planning; logistics costs; mine capital costs; transportation-personnel, supplies, and equipment; R&D projects, face, panel, room and pillar, longwall

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages
	20. Security Class (This Page) UNCLASSIFIED	22. Price

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont'd.)

LIST OF APPENDIX TABLES

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

LIST OF APPENDIX TABLES (Cont'd.)

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Department of Energy has a continuing interest in developing and improving mining systems that not only directly produce coal, but indirectly impact the production of a mine. One such interest is that of underground mine logistics, which implies all activities and services that support the producing sections of the mine. These services are so essential that no coal would be produced without them. This study, in an effort to promote a better understanding of how these services impact coal production, offers an analyses of all aspects of underground mine logistics, investigates the cost of various logistical functions, presents industry views, and recommends future research areas. To further enhance the understanding of mine logistics and their impacts, this report reviews mine logistics by major categories. These areas, which comprise the majority of all logistics activities for the mining operation, are listed below:

1. Transportation of personnel, equipment, and supplies
2. Transportation of coal and rock
3. Electrical distribution and communications systems
4. Water handling systems
5. Hydraulic systems
6. Ventilation

The study first reviews current practices and problems associated with logistics activities, then presents views and comments from representatives of the mining industry on various logistics problems. An extensive and detailed cost analysis of each major logistics category of the

mining operation has been prepared to clearly identify their impacts on various equipment combinations and seam heights. This cost study, as well as identified industry concerns has been used to determine what research and development is needed to eliminate various logistics problems for the mining industry. The current Department of Energy logistics research and development program is reviewed and a suggested program designed to cover other problem areas is presented.

The recommended areas of future research are prioritized with respect to both short-term and long-term projects. Recommended short-term research efforts are:

- Improve the haulage capacity of batch-type haulage vehicles while eliminating the trailing cable.
- Investigate ways to provide more rapid transportation on existing transportation systems.
- Investigate ways to reduce personnel requirements in conveyor-belt mines.
- Develop improved stoppings and overcasts that are portable, re-usable, and have minimal personnel requirements.
- Develop a small portable hoist that lends itself to unloading and loading supplies where clearances are limited.
- Develop training programs to assist mine management in dealing with logistics problems.

Recommended long-term research is:

- Develop a reliable, flexible continuous face haulage system with minimal personnel requirements.

- Develop a rapid transportation system to move personnel safely and quickly in the mine regardless of seam pitch or undulations.

- Develop an outby haulage system with minimal personnel requirements that can function well in pitching seams.

- Develop hardware and techniques that will allow rapid shaft and slope construction.

- Investigate computerized mine operating systems such as MINOS for their effectiveness in improving management control.

INTRODUCTION

7-8

INTRODUCTION

Logistics, as applied to mining, is a multi-faceted term. It refers to the majority of functions that do not directly result in roof control or coal production but do have a direct effect on profitability of mining operations. The primary usage of the term is a military one. As such, it includes "the planning, handling, and implementation of personnel, material, facilities and other related factors (31)." Such functions, although only indirectly associated with the production of coal, provide support necessary for efficient production. The importance of logistical activities in mining is discussed by one source as follows:

> There were some 1,925 U.S. underground bituminous coal mines in 1979 that utilized more than $2-1/2 billion worth of equipment to transport 400 million ROM coal tonnage, 132,500 full time mine personnel, and supplies. This transport equipment included some 2,300 miles of belt conveyors, 3,500 mine locomotives, 44,000 mine cars and 9,700 various types of rubber-tired vehicles. Estimates indicate that 55% of all this ROM tonnage is transported to the portal via belt, 40% via rail and the balance by rubber-tired vehicles or other methods. Large operations utilized 40 miles of belt conveyor or 60 miles of trackage in a single mine. Total portal-face-portal travel time in many mines exceeded one hour or about 12% of an 8-hour working shift. Estimated annual mine costs to transport this coal, mine personnel, supplies and provide other logistical support to extraction centers totalled more than $3 billion.....
>
> For domestic underground coal mines, it now requires about $50 per ton of annual mine capacity in capitalization to open a new mine. That is, for a projected annual mine capacity of 1,000,000 tons of clean coal product, an initial capital investment of about $50,000,000 is required.

> The logistical component of this capital cost has been estimated to be 1/3 to 1/2 of this total capital cost. Thus, the initial selection of the best logistical equipment and methods for the mine are most significant and sensitive to overall mine capital costs. Daily mine operating costs are important to mine profitability. It has been estimated that the coal haulage (transport) component cost alone accounts for nearly 30% of the operating cost per ton of coal mined. When one includes all other logistical support functions in the daily operating costs, the daily operating costs become very sensitive to the logistical support element costs (31).

The various activities associated with mine logistics vary greatly in complexity, as does their relative effect on production. Since no two mines are identical, logistics problems are quite varied. Consequently, solutions unique to particular prob- lems are developed at each mine. Surface variables such as terrain, power availability, size of mine, coal processing facilities, coal quality, water availability, soil characteristics, and climate, can affect logistical practices. Underground logistics are especially dependent upon coal seam height, mine roof characteristics, floor characteristics, geology, coal seam depth, etc. The mine size itself can have a significant effect on the logistical requirements and is a major concern in the establishment of mine logistics systems.

Despite the varied nature of the many logistics activities, the efficiency of a given activity largely depends on planning. In fact, logistics planning can have a greater impact on the efficiency of an operation than the physical means of performing a logistics activity. The following section of the report will analyze present logistics practices at underground coal mines and the planning associated with these practices.

UNDERGROUND COAL MINE LOGISTICS AND PRACTICES

13-14.

UNDERGROUND COAL MINE LOGISTICS AND PRACTICES

The discussion of coal mine logistics and practices is divided into seven parts: transport of personnel, supplies, and equipment; coal and rock transportation; electrical distribution and communications systems; water handling system; hydraulics; ventilation; and logistics planning.

TRANSPORT OF PERSONNEL, SUPPLIES, AND EQUIPMENT

Personnel Transport

Mine personnel in the United States are generally paid "portal to portal," which includes travel time to and from the work area. However, because of mine size and transportation problems, it is not unusual for mine workers to spend 10 to 25 percent of the work day traveling to and from the face area. Personnel are transported by such varied methods as: trolley-powered track equipment, rubber-tire vehicles, shaft elevators, hoist-operated slope cars, conveyor belt, and walking or crawling. Combinations of transportation systems are generally the rule. A list of step-by-step activities associated with personnel transportation in a typical slope mine is included below:

1. Shortly after start of shift, mine personnel board slope car at top of slope in preparation for entry into mine.

2. Slope car is lowered into mine and stopped at slope bottom.

3. Personnel get off slope car and walk some distance before boarding the next mode of transportation, typically a trolley-powered personnel carrier that transports a crew of people.

4. Available personnel carriers are inspected for mechanical problems, fire extinguishers, jacks, bars, lights, brakes, etc.

5. Small maintenance items on personnel carriers are attended to or faulty personnel carriers are maneuvered out of the way of operational carriers.

6. Personnel carrier transports crew to end of track in their particular section of mine.

7. Personnel get off personnel carrier and either walk to face area or board a rubber-tire vehicle for transportation to face.

8. Personnel walk or crawl to their machines.

The sequence of activities is reversed when the crew leaves the face to go outside.

Different mine types require different logistics activities for personnel transportation. Where rubber-tire transportation is used, men are carried directly from outside to the face without a change in the means of transportation. In a few isolated instances, personnel transportation occurs via beltline into and out of the mine. In these cases, men must get on and off the belt at all belt drive locations. Finally, many of the large operations that mine deep coal seams use a shaft elevator for personnel transportation. Here transportation procedures are similar to those noted for slope mines, except that transportation in the slope car is replaced by the elevator (steps 1, 2, and 3).

Problems and delays associated with personnel transportation were covered in an earlier report (44) and were amended for inclusion in this report as Appendix I. Because of high labor costs and the potential for loss of valuable production time, most mine operators provide for the fastest, most efficient transportation possible.

Supplies Transport

The transportation of supplies into and throughout underground coal mines is a major activity that generally requires 5 to 20 percent of the total mine work force. This commitment is necessary because of numerous activities typical of most coal mine transportation systems. To examine the activities, one must first examine the mining situation.

One of the most common mining situations consists of a slope mine utilizing rail transportation. Such a mine typically has a life exceeding fifteen years and includes both medium and large-sized mining operations. The main transportation equipment used underground usually consists of trolley locomotives and rail supply cars. Activities associated with transportation of supplies begin outside in the warehouse or supply yard and end when supplies reach their final destination.

A list of step-by-step transportation activities for a typical slope mine follows:

1. Supplies needed are determined and warehouse personnel are contacted to send needed supplies into the mine.
2. Warehouse or yard personnel locate equipment required to transport supplies to supply car.

3. Supplies are located and loaded on a forklift, portable trucks, crane, or other available equipment.

4. Supplies are transported to a supply car and loaded into car.

5. After all supplies are loaded, yard personnel locate a locomotive or tractor to transport supply cars to the mine mouth.

6. Supply cars are transported to the mine mouth and necessary provisions are made to prepare cars for transport underground (i.e., safety chains are installed, supplies are rearranged on car, insulating materials are laid on top of car to guard against metallic contact with the trolley wire, etc.).

7. Slope car is then brought to top of slope and usually directed onto a sidetrack in preparation for connection to supply cars.

8. Supply cars are connected to slope car and positioned on the main slope track in preparation for entry into mine.

9. Supply cars are lowered into mine.

10. At bottom of slope, a track locomotive is used to disconnect supply cars from slope car in preparation for transit underground.

11. Supply cars are shifted and rearranged to put them in proper sequence for delivery to various sections in mine and to spot a locomotive on each end of train.

12. All loaded cars, as well as locomotives, are inspected to ensure that no safety hazards exist and that coupler connections between cars, as well as locomotive brakes, sanders, jacks, lights, trolley pole, etc., are in proper working order.

13. Supplies are delivered to sections or work areas where they will ultimately be used, typically at end of section supply track.

14. Once supplies are at end of track, there are several options: supplies can be unloaded; loaded supply cars can be transported to face; or supplies can be loaded into a scoop, tractor-trailer, or shuttle car.

15. Supplies are transported to either final destination or storage area at face.

16. Supplies positioned at face storage area are loaded onto a scoop or shuttle car and transported to final destination.

Other mine types usually require fewer activities. In drift mine situations, steps 6, 7, 8, and 9 are eliminated. In mine situations where battery-powered rubber-tire vehicles are used exclusively, steps 6 through 11 and 13 do not apply.

Battery-powered rubber-tire haulage vehicles offer an economic advantage for the small operator in that the initial capital investment required to purchase equipment is substantially less than that needed for track-bound haulage equipment. However, as mining operations grow in size, the economic advantage initially realized with battery-powered rubber-tire haulage equipment rapidly diminishes because of slow tramming speed and high maintenance requirements. As a result, development of many mines begins with rubber-tire vehicles, and rail transportation is added in later stages of production. What results is a hybrid transportation system combining the best aspects of each system in the operation. Oftentimes, rail haulage is used in the mains and/or submains, and rubber-tire haulage in the panels.

Problems and delays can occur during and between each of the supplies activities. A discussion of common problems in supplies transportation was covered in an earlier report (44), and has been amended for inclusion in this report in Appendix I.

It is obvious that transportation of supplies can contribute significantly to overall mining costs. Transportation of supplies increases the cost of production by adding to labor requirements, increasing safety expenses, and reducing or precluding production when the working face is not adequately supplied.

Equipment Transport

Equipment transportation in underground coal mines can be examined from two different perspectives. One involves equipment transportation from one place to another in the face area. The other involves equipment transportation from one place to another in the mine. Both are part of the total realm of logistics in mining.

Equipment transport in the face area is performed routinely during the mining cycle. With a continuous miner, two shuttle cars, and a roof bolter on a typical face, it is not uncommon for each equipment item to work in four or five places during a single shift. The logistics activities associated with moving equipment from one work area to another can be time consuming.

Transportation of equipment from one place to another in the mine is less frequently performed, but the logistics activities are much more complex. The equipment is usually transported by rail, and problems with clearances and trolley-wire shock hazards are common. In addition, equipment transport usually interrupts the transport of personnel and supplies. If the equipment item is very large, men are not permitted to work inby. Thus, production is interrupted.

COAL AND ROCK TRANSPORTATION

People within the coal mining industry often consider coal transportation to be a greater problem than coal extraction. A continuous miner can have a coal cutting rate of eight to 12 tons per minute; however, delays caused by face haulage reduce average production considerably. In fact, coal transportation at the face area is often the largest bottleneck in the mining system. Typically, electrified shuttle cars or battery-powered haulage units transport the coal from the face to a discharge point. Another method employed in many mining situations is continuous haulage, for which mobile belt or chain conveyors are usually employed. Continuous haulage is especially common in low-coal mines where mining conditions cause other coal transportation methods to be less efficient.

After the coal is transported to the discharge point or feeder, there are three methods for transporting coal from the face area to the surface. As stated earlier by a reference source (31), belt conveyors account for 55 percent of all ROM coal transported to the surface. Of the remainder, 40 percent moves by rail and 5 percent by rubber-tire vehicles or other methods, e.g., chain conveyor. Many mines will utilize two or more methods.

Generally, if track is used to transport coal, it is usually confined to the mains and submains. A belt conveyor will normally transport coal in the panels. At the belt discharge point, the coal is transferred into individual track-mounted coal cars. These haulage cars must be advanced as they are loaded, usually by automatically controlled hoists or jacks. Locomotives then transport the loaded coal cars out of the mine to a dump station. Two methods are common to unload the cars: rotary-dump and bottom-dump.

Regardless of how the coal is transported outside (rubber tire vehicles, belt, track, etc.) it is ultimately transported to a stockpile area. In some instances, the stockpile is contained in a silo. In other cases, the coal is simply piled in preparation for processing or shipment. Belt conveyors, stacking conveyors, chain conveyors, or front-end loaders are often used to stockpile coal.

ELECTRICAL DISTRIBUTION AND COMMUNICATIONS SYSTEMS

Electrical power distribution is an important logistics consideration since most mining machinery is electrically powered. Power usually enters the mine via high voltage cables from a substation located on the surface. Switchgear is located in the mine at locations specified by law and offer a means of disconnecting power. Equipment designed to provide personnel and equipment protection is often included in switchgear electrical boxes. From the switchgear electrical boxes, high voltage cable transmits power to load centers where the voltage is reduced to utilization levels. Flexible trailing cables usually carry power from the load center to the equipment. However, power for track equipment is usually transmitted on a bare uninsulated trolley wire. Logistics considerations for electrical power distribution include supply and maintenance of adequately sized power system components, advancing and retracting the electrical systems for each section in the mine, distribution and layout of electrical power cables, supply and distribution of maintenance and repair parts, etc.

In contrast to electrical power distribution, the communications system in a mine is much less complex. Typically the communications system, excluding track equipment, consists simply of all telephones in the mine being tied into a single two-wire communications line. Telephones on track equipment are usually connected to and utilize the trolley wire for communications purposes. However, a few mines are experimenting with a new communications system that utilizes a coaxial cable called leaky feeder. The concept is covered in an NTIS report (3).

WATER HANDLING SYSTEM

The logistics associated with water handling must be addressed from two different perspectives. One is supply and distribution of water into the mine for suppressing dust, providing drinking water, cooling motors, and providing a means for fire suppression. The second consideration is transporting water out of the mine to the surface. Logistics considerations include supply and maintenance of adequately sized water handling components, advancing and retracting of water handling systems for each section in the mine, distribution and layout of water pumping and handling components, supply of repair parts, etc.

HYDRAULICS

The discussion of hydraulics as related to logistics addresses longwall operations. The supply of lubricating oil to longwall supports is considered a logistics activity since hydraulic pumps used on longwall faces are separately located from the longwall supports. Hydraulic lines are used to transport lubricating oil to and from the longwall supports.

VENTILATION

Ventilation is the process of providing fresh air in sufficient quantities throughout the mine so as to support life and render gas and dust concentrations harmless. Air must be distributed in sufficient quantities throughout the mine to comply with mining regulations. A ventilation fan forces air through intake air entries to the face area, eventually drawing air into return entries for exhaust out of the mine. Stoppings and overcasts isolate intake air from return air and direct air flow. In large mines ventilation systems are very complicated because of interaction of multiple fans. Major logistics activities include construction, maintenance, and inspection of stoppings, overcasts, regulators, fans, etc., to ensure adequate ventilation of all working places.

LOGISTICS PLANNING

The above discussions illustrate that logistics activities in underground coal mines are numerous and varied. In fact, if one were to break down specific activities further, it would be possible to identify literally hundreds of activities that require logistics planning efforts. The coordination and communication required to perform these activities efficiently are very important. Given the number of people involved in these activities and the distances over which the activities are scattered, planning becomes a real managerial challenge, one that often requires a complex management structure.

A major problem at many mines involves implementation of decisions. Important decisions are frequently made by the superintendent and relayed down the chain of command to those individuals who actually perform the work. Since many logistics activities (such as belt moves, ventilation changes, and track work) are performed during down-shift periods of no production, time becomes an important consideration. For example, a decision to advance belt on the night shift might be made by the superintendent on the day shift. He instructs the underground mine foreman, who in turn discusses the decision with the afternoon shift foreman. The afternoon shift foreman then relays the instructions to the night shift foreman. The night shift foreman instructs the section foreman, who in turn instructs the persons who actually do the work. Thus, in this instance, the instructions involve people at six levels in the organization.

But perhaps even more importantly, numerous other logistics activities have to be planned and performed prior to the belt move. Included are activities such as: making sure supplies, equipment, and tools are available to make the move; making provisions to transport needed materials to the section where the belt move will take place; ensuring that the belt feeder is operational and ready to be moved; making sure that qualified people are available to perform the work; cleaning the entry of loose coal material prior to the move; extending water lines and fire sensing equipment; etc. Thus a single logistics activity may require detailed planning of many other complex activities.

With the exception of logistics planning, each of the above logistics activities can be easily identified in the underground work environment. Each activity has associated with it certain problems and benefits. Specific areas have been identified as problem areas and present major concerns to mine operators. The next section of this report examines these concerns.

INDUSTRY CONCERNS

INDUSTRY CONCERNS

Concerns of the coal mining industry have always played a significant role in the Research and Development Program of undergound mine logistics. Industry concerns were discussed during this study as part of a series of interviews and telephone conversations. Input was received from various coal mine operators and engineers as to the problem areas frequently encountered in their operations. Their input provided a clear understanding of the problems plaguing the mining industry. Some of these problems are more or less site specific; however, the majority of problems are generic in that they affect a large portion of the mining industry. No statistical significance can be placed on the results because no attempts were made to insure a representative cross-section of the industry. However, problems discussed are believed to be of concern to the coal mining industry in general.

The major areas of industry concern can be approached from two perspectives. Current problems or areas of immediate concern will be analyzed first. Then, based on industry perceptions of the future, anticipated problems will be reviewed. This approach will provide the information necessary to formulate a research and development program based on both short- and long-term industry needs.

CURRENT PROBLEMS OR AREAS OF IMMEDIATE CONCERN

Problems associated with the transportation of personnel, supplies, and equipment are common throughout the mining industry. They can have a major impact on the overall profitability of the entire mine. In many mines, the average production laborer can spend 20 percent or more of an eight-hour work day traveling to and from the working section. Not only is travel time expensive in terms of labor wages, but production losses are of even greater importance.

The magnitude of transportation problems varies with the mining situation. In thin-seam mines, problems usually result from lack of adequate clearance between the equipment and the roof. In addition, visibility and mobility problems characteristic of thin seams result in relatively slow transportation speeds. Current transportation systems in thin seams are not only less efficient than in high seams, but personnel operating and working around the equipment are exposed to more hazards (26). Such hazards on track transportation systems are related to trolley wires, trolley poles, lack of headroom, cramped working conditions, poor visibility, etc. These same hazards can also be present in high coal seams in varying degrees.

In addition to health and safety problems associated with underground transportation systems, the coal mine operators regarded the number of personnel that must be committed to the maintenance and operation of the transportation system a key problem area. Although automation is not presently characteristic of underground mining, industry representatives in general favor making a concerted effort to reduce labor requirements in non-productive areas such as transportation systems.

Depending on the mining operation, labor typically comprises 30 to 60 percent of the overall mining cost. Reductions in the manpower connected with the transportation system will have a two-fold impact. First, productivity is increased by removing personnel from a non-productive segment of the work force. Secondly, fewer people reduces the possibility of personnel injury.

In many underground mines, the transportation system consists of segments. Numerous delays, changes in the transportation system, interruptions, congestion, etc. often occur in transporting men and materials from outside to the face. (These problems are discussed in detail in Appendix 1.) One industry spokesman was quoted: "A mine operating 5,000 unit-shifts per year could be losing $1 million annually if each crew loses just five minutes per shift because of inefficient haulage" (31). In addition, another source has indicated that for a small 250,000 tons per year mine "saving about ten minutes in getting miners to and from the working face each day could save over 4,600 hours per year in non-productive time" (31). Industry people believe that a rapid, non-interrupted transportation system is needed to expeditiously transport men and materials from the surface and throughout the mine.

Another major area of concern for the coal mining industry is transportation of coal and rock. It is generally accepted that present transportation systems consisting of belt, track, or some combination of the two, are suitable for the majority of coal and rock transportation needs outby the face area. However, mine operators believe that a number of problems exist with both belt and track systems.

Track haulage systems demand relatively high capital investments. Yet, given the loads transported, it would be difficult to make existing track systems less expensive without compromising load capabilities. In mine situations where grading of the roof or bottom is required to attain adequate clearance, such grading is a major problem. The industry has long recognized the need for rock-mining machinery that can perform grading work efficiently and expeditiously.

Many mining personnel believe that belt haulage is becoming more popular than track haulage and will eventually replace track haulage. Belt haulage requires less capital investment and provides the potential for continuous haulage as opposed to batch-type track haulage. But belt haulage presents another problem in that the failure of a single belt system can interrupt production for much or all of the mine. Numerous safety devices on each belt system including sequence switches, speed switches, timers, emergency pull cords, etc., are all prone to failure and can interrupt belt operation.

Another industry problem with belt haulage is high labor requirements for installation and maintenance. It is not uncommon for an underground mining operation to have 10 or 20 miles of belt to maintain and operate. The labor force required for a long belt system can be approximately 15 to 20 percent of the entire work force.

One particular problem area occurs at the transfer points where coal spillages are common. The presence of water in the coal complicates the problem since wet coal tends to stick to the belt. The wet coal is not transferred to the outby belt at the transfer point but instead is carried inby on the bottom return belt. The coal finally falls off the belt when the belt rides over the belt idlers. Large accumulations of coal around the belt drive often result and eventually cause the belt to stop. Spilled coal is typically cleaned up by hand and contributes to the high labor requirements. Operators feel that to minimize problems with belt haulage, and thus increase its reliability, the number of transfer points must be reduced. Improvements in the belt and conveyor drives, as well as development of intermediate belt drives, could help alleviate this problem.

Another problem with a belt haulage system concerns rock transportation. Generally, underground coal mine belts are designed to transport only coal. The coal is transported directly to a preparation plant for processing, to the point of utilization if it is mine-mouth, or to the surface transportation system. Rock segregation from the coal is a problem and usually requires additional processing facilities, transportation systems, refuse facilities, and disposal areas. In addition, transport of rock on conveyor belts usually causes rapid belt deterioration and more frequent maintenance problems. The result is decreased belt system availability and reliability, difficulties which directly impact the overall productivity of the mine and, therefore, the profitability. An alternative to transporting the rock by belt is to use the track supply system; however, costs are usually prohibitively high.

Although all of these areas of coal and rock transportation are of concern to the mining industry, coal transportation at the face is considered most important. Most industry representatives agree that a continuous face haulage system would be most desirable. However, logistical problems of place changing, flexibility, mobility, and reach sometimes limit the application of such equipment. A continuous haulage system with the versatility and flexibility of rubber-tired haulage vehicles has not yet been developed.

The most popular face haulage methods utilize rubber-tire, batch-type haulage vehicles, namely shuttle cars. Major problems with shuttle cars have been related to the troublesome trailing cable and delays associated with shuttle-car change out. One study has revealed that the trailing cable accounts for more than 40 percent of shuttle car downtime (36). Payloads have also been a concern since one source reveals that:

> A 1975 computer study by the Department of Mining Engineering at Pennsylvania State University shows that productivity from a single mine section could be increased more by using haulage vehicles with high load capacity than by any other single factor. This study was documented in actual on-site underground mine studies (39).

The physical construction of shuttle cars limits payload to ensure manuverability.

One of the major areas of concern to mine personnel who deal with logistics problems is the mine electrical system. Lost production resulting from electrical downtime is a major problem. Specific areas of concern are covered in the following paragraphs.

One particular problem area is found in high voltage cable couplers. In large mines where power demands are high, voltages of 12,470 or 13,200 volts are required. The high voltages create corona problems in the wet and dusty mine environment, especially with the cable couplers. Catastrophic failures of couplers are not uncommon. Consequently, industry people have voiced concern for development of cable couplers capable of reliable operation in electrical systems greater than 12,000 volts.

Another major area of concern is low voltage cables. Low voltage cables are subjected to continuous physical, chemical, and electrical stresses, and must be capable of withstanding the harsh mine environment. However, cable life is less than six months at many mines. In fact, one study revealed that approximately 40 percent of shuttle car downtime is attributed to the trailing cable (36). Machine downtime could be greatly reduced if tougher cables would be developed that are better suited to operation in mine environments.

In addition to the cables themselves, low voltage cable splices can also present problems. By law, damaged cables must be repaired. This task usually necessitates cable splicing. However, the spliced cable is much less resistant to physical abuse and water infiltration than is an unspliced cable. Logically, then, improved cable splices would also lower machine downtime and thereby improve production.

Much of the electrical downtime in mines results from the inability to isolate and interrupt high voltage power to problem areas while at the same time providing power to unaffected areas. Coordination of breakers and relays to prevent such occurrences is often haphazard because detailed coordination studies are extremely complex, time consuming, and difficult. In fact, one expert in the field of mine power engineering admits that breaker and relay coordination is more an art than a science (32). Better hardware, techniques, and capabilities to provide for expeditious and proper breaker and relay coordination would certainly be an asset to the industry.

Specific components of some equipment have also been identified as problem areas. Included are ground monitors, disconnects, overcurrent devices, relaying equipment, circuit breakers, interlocks, surge arrestors, limit switches, contactor tips, timers, and undervoltage and shunt trip mechanisms in circuit breakers. Improved components that are more reliable and require less maintenance would also allow for increases in production.

The effects of electrical problems and downtime are substantial. In fact, one mining company has shown that approximately $250,000 is lost each month at one of its mines due to electrical outages. As a result of this high cost, the mine is now taking steps to reduce its distribution voltage from 13,000 volts to 7,200 volts (7, 19).

One other area of logistics that concerns at least one operator is the need for a practical training manual that can be used to train mine electricians. Several manuals are available from equipment manufacturers, but they address only specific types of equipment. A general but practical manual that covers essential elements of all electrical equipment components would greatly assist maintenance personnel.

Another area of coal mine logistics that concerns mine operators is mine ventilation. Personnel requirements and supplies costs associated with construction of stoppings and overcasts are major mine ventilation costs. Portable stoppings and overcasts that could be quickly assembled would significantly reduce these costs.

In addition to overcasts and stoppings, the high cost of installing ventilation shafts is of concern to mine operators. Mines that work in deep coal seams are forced to maximize the practical distance between shafts. However, a trade-off is reached in that ventilation costs become higher as the distance between shafts is increased. One alternative is to mine roof or bottom rock in the main ventilation entries to expand the area through which the air travels. By expanding this area, head losses are reduced and a larger volume of air is coursed through the mine, resulting in lower ventilation costs. Thus, trade-offs exist between the number of ventilation shafts, distances between shafts, and mining of roof or bottom rock. Industry spokesmen expressed a need to determine the cost relationship between the various alternatives in different mining situations and to identify actual trade-off points.

The cost and time associated with slope and shaft construction affects mine ventilation, coal and rock transportation, and transport of personnel and equipment. More efficient and less costly ways to construct slopes and shafts would significantly benefit the industry by lowering costs associated with all of these logistics activities.

FUTURE CONCERNS

In addition to the problems now facing the mining industry, there exist additional areas of concern for the mine operators as they begin to mine deeper, thinner, and more steeply pitching coal seams. These concerns in many instances run parallel to those previously explained. However, they are further complicated by the atypical mining conditions that will be encountered in future mining operations.

One particular area of concern, transportation of personnel and supplies, will be especially difficult under steeply pitching seam conditions. Typical track bound transportation systems now found in many mines are not capable of operating in seams that pitch in excess of five degrees. Rubber-tired transportation can be effective in seams up to approximately 10 to 12 degrees. However, maintenance requirements increase and corresponding reliability decreases as the equipment operates under increasingly steeper seams. Mine operators have expressed a concern that there is no readily available equipment for transporting supplies and personnel in pitching coal seams that has proven its capabilities to mine operators in the United States.

In the same light, coal and rock transportation will become more difficult as mining begins to occur in deeper, thinner, and more steeply pitching coal seams. The operators have indicated that a technology gap may exist, and new methods and equipment will need to be developed to successfully exploit reserves.

All of the above industry concerns are important in developing a research and development program. But in addition, the costs of various logistics activities will also have a bearing on a recommended research program. The next report section contains results of a detailed cost analysis of logistics activities.

LOGISTICS COST ANALYSIS

40 - 41

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

LOGISTICS COST ANALYSIS

The relative cost of logistics activities in underground coal mines has not been quantified adequately in the past. This report section contains results of a detailed analysis of logistics costs in different mine sizes, seam thicknesses, and mining situations. The costs examined in each scenario consisted of capital, depreciation, operating, power, labor, and labor benefits. Because of the complexity and multi-dimensional nature of this cost study, the study was divided into several stages. First, the cost of logistics activities in the face area and mine panels was developed for different seam thicknesses and types of sections. Next, the cost of logistics activities outby the faces and panels was determined for different mine sizes, haulage methods, and seam access techniques. The results of the two investigations were combined to yield logistics costs in different mine scenarios. Then, the percentage of total cost attributed to the operating, depreciation, power, labor, and labor benefits was determined. This entire cost analysis will be covered following the discussion of the various cost categories.

COST CATEGORIES

All the logistics activities associated with underground coal mining were grouped into six major logistics activities or cost categories:

Transport of Personnel, Supplies, and Equipment
Coal and Rock Transportation

Electrical Distribution and Communications Systems
Water Handling System
Hydraulics
Ventilation

The "Transport of Personnel, Supplies, and Equipment" category consisted of costs associated with the activities covered in the previous report section entitled "Underground Coal Mine Logistics and Practices." Included were costs of logistics activities occurring outside, but near the mine portal, and throughout the mine.

"Coal and Rock Transportation" consisted of transportation costs from the tail of the continuous miner to the outside coal-storage area. Included are the haulage costs associated with shuttle-cars, conveyor belts, slope belts, and an outside stacking conveyor. Transportation costs on the continuous miner itself, from the ripper head to the end of the conveyor boom, were not included because these costs were considered to be part of the coal extraction cost.

"Electrical Distribution and Communications Systems" consisted mostly of the costs associated with supplying electrical energy to perform other logistics activities. Power costs were not included because they were assigned to the logistics activities that required power. For example, the cost of power required to drive a water pump was assigned to the "Water Handling System" cost; however, the cost of the electrical distribution system to the pump (i.e. cables, transformers, starters, etc.) was assigned to "Electrical Distribution and Communications Systems." In this way a more accurate indication of specific costs associated with individual logistics activities was obtained. In addition to the electrical costs, communication costs were included in this category.

"Water Handling System" consisted of costs associated with performing the activities covered earlier in the report section entitled "Underground Coal Mine Logistics and Practices." Generally it included all those activities associated with transporting clean water into the mine from the surface and pumping excess mine water out of the mine. Water treatment costs were not included since they were not considered a logistics activity as defined earlier.

"Hydraulics" consisted of costs associated with transport and distribution of hydraulic or lubricating oil to and from longwall supports from the longwall hydraulic pump station.

"Ventilation" consisted of the costs associated with supplying, directing, distributing, and regulating air flow in the mine.

COST INVESTIGATION

Each of the above cost categories were inclusive of capital, operating, depreciation, power, labor, and labor benefit costs. Capital, operating, depreciation, and power costs were relatively easy to identify and quantify. However, labor and labor benefit costs were much more difficult. Most of the people employed at underground coal mines are involved in logistics activities in one form or another. This involvement exists if for no other reason than that they are transported to and from their work areas from outside. However, most of the employees are involved in logistics activities only part of the time. In addition, they can be involved in several of the cost categories identified. Thus, to determine the labor costs of various logistics activities, the percentage of time each employee was involved with each logistics activity had to be estimated. Premium pay, overtime rates, and annual hours worked were also considered in determining the labor cost for each cost category. Labor benefits were determined based on the hourly and salary labor costs. A detailed discussion and analysis of the labor and labor benefits costs are covered in Appendix II.

As discussed earlier, the entire cost investigation was addressed in stages for simplification purposes. Logistics costs in faces and panels were examined first and are covered in Appendix III. The variables considered in the different mining scenarios were:

Type of panel transportation
- Rubber tire
- Track

Type of mining method
- Longwall
- Room and Pillar

Coal seam thickness
- Less than four feet
- Four to six feet
- Greater than six feet

Table 1 summarizes the results of annual logistics costs for faces and panels.

TABLE 1

SUMMARY OF ANNUAL LOGISTICS COSTS FOR FACES AND PANELS*
($1000)

Section Type and Seam Thickness	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Room and Pillar Less than Four Feet	Belt-Track	341	411	158	42	0	76	1,028
	Rubber Tire	378	411	162	42	0	76	1,072
Room and Pillar Four to Six Feet	Belt-Track	362	424	164	46	0	79	1,075
	Rubber Tire	398	424	168	45	0	83	1,118
Room and Pillar Greater than Six Feet	Belt-Track	374	446	170	49	0	91	1,130
	Rubber Tire	410	446	174	49	0	91	1,170
Longwall Less than Four Feet		571	885	245	50	108	55	1,914
Longwall Four to Six Feet		665	1,037	271	58	114	64	2,209
Longwall Greater than Six Feet		577	1,025	246	50	127	56	2,136

* Costs are for individual faces and panels. Annual costs are representative of annual operating costs.

The investigation revealed that the type of panel transportation (i.e., track or rubber tire) had relatively little effect on total annual logistics costs for room and pillar operations (only track transportation was used for longwall operations). Thus, to simplify Table 1 for work to be performed later, a "general" cost table was developed where the effect of panel transportation was ignored. A "generalized" table is shown as Table 2. Logistics costs varied only slightly with changes in seam thickness. However, longwall face and panel costs were more than double the room and pillar face and panel logistics costs.

In addition to annual costs, capital costs were also developed and are shown as Table 3. In room and pillar faces and panels, capital costs associated with logistics activities amount to approximately 55 percent of total capital cost. In longwall faces and panels, roughly 25 percent of capital requirements are for logistics components. Items associated with coal and rock transportation account for most of the capital costs in the faces and panels. These include the shuttle cars, feeder, and conveyor belt on room and pillar sections and the face conveyor, stage loader, and conveyor belt on longwall sections.

Capital and annual costs outby the faces and panels were also investigated. A detailed analysis is contained in Appendix III. Variables investigated consisted of:

Method of seam access
- Slope
- Drift

TABLE 2

SUMMARY OF GENERALIZED ANNUAL LOGISTICS COSTS FOR FACES AND PANELS ($1000)

Seam Thickness	Section Type	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Less than Four Feet	Room and Pillar	312	371	144	36	0	66	929
	Longwall	571	885	245	50	108	55	1,914
Four to Six Feet	Room and Pillar	331	382	150	40	0	70	973
	Longwall	572	948	245	50	111	55	1,981
Greater than Six Feet	Room and Pillar	341	404	155	43	0	79	1,022
	Longwall	577	1,025	246	50	127	56	2,136

TABLE 3

SUMMARY OF LOGISTICS CAPITAL COSTS FOR FACES AND PANELS ($1000)

Section Type and Seam Thickness	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total Logistics Cost	Total Capital Cost	Percentage of Total Capital Costs Associated with Logistics Activities
Room and Pillar Less than Four Feet	Belt-Track	183	463	119	14	0	13	792	1,406	56
	Rubber Tire	157	463	120	14	0	13	767	1,382	55
Room and Pillar Four to Six Feet	Belt-Track	213	473	119	14	0	15	834	1,479	56
	Rubber Tire	187	473	120	14	0	15	809	1,455	56
Room and Pillar Greater than Six Feet	Belt-Track	213	513	125	14	0	20	885	1,549	57
	Rubber Tire	187	513	126	14	0	20	860	1,525	56
Longwall Less than Four Feet		183	938	354	20	145	0	1,640	5,868	28
Longwall Four to Six Feet		183	1,078	354	20	145	0	1,780	7,192	25
Longwall Greater than Six Feet		213	1,236	354	20	195	0	2,018	9,131	22

Coal haulage method
- Track
- Belt

Mine sizc
- Two sections
- Four sections
- Nine sections
- Five sections plus longwall
- Nine sections plus longwall

Table 4 summarizes the annual logistics costs, and Table 5 shows the capital costs.

Capital and annual logistics costs for mines that require a slope for seam access are considerably higher than those for drift mines. This situation is due in part to the fact that slope mines generally have much deeper ventilation shafts than do drift mines. The high depreciation and capital cost for shafts and slopes is a major contributor to the relatively high slope mine logistics costs.

Table 5 also reveals that capital costs for track haulage mines are greater than for belt-track mines. However, annual logistics costs are not necessarily higher, as shown by Table 4. In fact, logistics costs for large track haulage mines were found to be lower than for belt-track mines.

To estimate the cost per ton for each of the various logistics activities in different mine scenarios, the production figures shown in Table 6 were used. Although unit production per shift was assumed constant for a particular mine size and seam thickness, track haulage mines were assumed to have fewer productive shifts per year. Typically in

TABLE 4

SUMMARY OF ANNUAL LOGISTICS COSTS OUTBY THE FACES AND PANELS ($1000)

Mine Size	Mine Type	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Two Section	Slope	Belt-Track	697	457	176	92	0	182	1,604
		Track Haulage	673	562	192	92	0	182	1,701
	Drift	Belt-Track	618	409	174	82	0	128	1,411
		Track Haulage	594	515	190	82	0	128	1,509
Four Section	Slope	Belt-Track	1,297	910	366	197	0	358	3,128
		Track Haulage	1,210	1,108	367	196	0	358	3,239
	Drift	Belt-Track	1,206	848	364	185	0	235	2,838
		Track Haulage	1,119	1,045	365	185	0	235	2,949
Nine Section	Slope	Belt-Track	2,201	1,750	698	363	0	894	5,906
		Track Haulage	2,015	2,098	679	363	0	894	6,049
	Drift	Belt-Track	2,097	1,634	691	350	0	612	5,384
		Track Haulage	1,912	1,982	672	350	0	612	5,528
Five Section Plus Longwall	Slope	Belt-Track	2,160	2,475	801	398	12	999	6,845
		Track Haulage	1,958	2,238	768	398	12	1,000	6,374
	Drift	Belt-Track	2,078	2,316	789	372	12	641	6,208
		Track Haulage	1,875	2,079	755	372	12	641	5,734
Nine Section Plus Longwall	Slope	Belt-Track	2,618	2,979	992	489	14	1,166	8,258
		Track Haulage	2,410	2,796	1,054	489	14	1,167	7,930
	Drift	Belt-Track	2,531	2,810	978	462	14	747	7,542
		Track Haulage	2,323	2,627	1,041	463	14	748	7,216

TABLE 5

SUMMARY OF LOGISTICS CAPITAL COSTS OUTBY THE FACES AND PANELS ($1000)

Mine Size	Mine Type	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Ventilation	Total Logistics Cost	Total Capital Cost	Percentage of Total Capital Associated with Logistics
Two Section	Slope	Belt-Track	1,219	808	416	120	597	3,160	3,800	83
		Track Haulage	1,117	824	422	120	597	4,080	4,722	86
	Drift	Belt-Track	539	508	416	110	197	1,770	2,410	73
		Track Haulage	437	1,524	422	110	197	2,690	3,330	81
Four Section	Slope	Belt-Track	2,142	1,988	843	245	2,477	7,695	9,655	80
		Track Haulage	1,860	4,391	807	245	2,477	9,780	11,740	83
	Drift	Belt-Track	1,032	1,458	843	225	877	4,435	6,395	69
		Track Haulage	750	3,861	807	225	877	6,520	8,484	77
Nine Section	Slope	Belt-Track	3.584	3,804	1,659	424	7,621	17,092	20,452	84
		Track Haulage	2.955	8,985	1,509	424	7,621	21,494	24,854	86
	Drift	Belt-Track	1.784	2,754	1,659	424	2,971	9,592	12,952	74
		Track Haulage	1.155	7,935	1,509	424	2,971	13,994	17,354	81
Five Section Plus Longwall	Slope	Belt-Track	4.214	4,810	2,112	540	11,775	23,451	26,811	87
		Track Haulage	3.290	9,979	1,914	540	11,775	27,498	30,858	89
	Drift	Belt-Track	2.164	3,550	2,112	540	3,675	12,041	15,401	78
		Track Haulage	1,240	8,719	1,914	540	3,675	16,088	19,448	83
Nine Section Plus Longwall	Slope	Belt-Track	4,788	5,535	2,538	644	13,545	27,050	31,370	86
		Track Haulage	3,698	12,161	2,815	644	13,545	32,863	37,183	88
	Drift	Belt-Track	2,638	4,275	2,538	644	4,045	14,140	18,460	77
		Track Haulage	1,548	10,901	2,815	644	4,045	19,953	24,273	82

track haulage mines, as many as two or more complete continuous miner sections can be employed to grade the bottom and mine the roof in preparation for track installation. In higher coal seams, less grade work is required; and, consequently, annual production on a per unit basis is generally higher.

The production figures identified in Table 6 were used to determine the cost per ton for each logistics activity in different mine types and seam thicknesses. All continuous miner sections were assumed to produce coal two shifts per day, and the longwall sections were assumed to produce three shifts per day. Tables 7, 8, and 9 contain the results of the annual logistics cost analysis on a cost per ton basis. The cost per ton varies from $9.20 to $22.55 depending on seam thickness and mine characteristics. In general though, annual mine logistics costs range from $10 to $15 per ton except for the smaller mines operating in low coal (less than four feet) that utilized slopes and shafts, and several mines in high coal conditions. The cost categories entitled "Transport of Personnel, Supplies, and Equipment" and "Coal and Rock Transportation" were the two highest, each contributing about 35 percent to the total logistics cost. "Electrical Distribution and Communications System" accounted for another 15 percent of the total logistics cost.

With the cost of the various logistics activities identified, approximate operating, depreciation, power, labor, and labor benefit costs were investigated as a percentage of total logistics costs. Representative annual and capital costs for room-and-pillar and longwall faces were determined from summary data contained in Appendix II, and are shown in

TABLE 6

ESTIMATED ANNUAL PRODUCTION FROM VARIOUS MINE SIZES (Tons)

Seam Thickness	Mine Size	Estimated Annual Production: Belt-Track Mine	Estimated Annual Production: Track Haulage Mine
Less than Four Feet	Two Section	178,000	160,000
	Four Section	330,000	297,000
	Nine Section	682,000	614,000
	Five Section Plus Longwall	869,000	809,000
	Nine Section Plus Longwall	1,150,000	1,048,000
Four to Six Feet	Two Section	268,000	254,000
	Four Section	491,000	466,000
	Nine Section	1,048,000	996,000
	Five Section Plus Longwall	1,220,000	1,158,000
	Nine Section Plus Longwall	1,606,000	1,505,000
Greater than Six Feet	Two Section	357,000	346,000
	Four Section	642,000	623,000
	Nine Section	1,284,000	1,246,000
	Five Section Plus Longwall	1,383,000	1,344,000
	Nine Section Plus Longwall	1,887,000	1,822,000

TABLE 7

SUMMARY OF LOGISTICS COSTS PER TON FOR VARIOUS MINE SIZES IN COAL SEAMS LESS THAN FOUR FEET THICK

Mine Size	Mine Type	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Two Section	Slope	Belt-Track	$7.00	$6.49	$2.53	$0.88	$0.00	$1.70	$18.60
		Track Haulage	7.64	7.89	2.91	0.98	0.00	1.89	21.31
	Drift	Belt-Track	$6.56	$6.23	$2.52	$0.83	$0.00	$1.39	$17.53
		Track Haulage	7.15	7.60	2.89	0.92	0.00	1.55	20.11
Four Section	Slope	Belt-Track	$7.26	$6.99	$2.76	$0.97	$0.00	$1.83	$19.81
		Track Haulage	7.80	8.43	3.06	1.08	0.00	2.03	22.40
	Drift	Belt-Track	$6.98	$6.80	$2.75	$0.94	$0.00	$1.45	$18.92
		Track Haulage	7.49	8.22	3.05	1.04	0.00	1.62	21.42
Nine Section	Slope	Belt-Track	$6.96	$7.22	$2.84	$0.95	$0.00	$2.11	$20.08
		Track Haulage	7.45	8.58	3.12	1.05	0.00	2.35	22.55
	Drift	Belt-Track	$6.80	$7.05	$2.83	$0.93	$0.00	$1.70	$19.31
		Track Haulage	7.28	8.39	3.11	1.04	0.00	1.89	21.71
Five Section Plus Longwall	Slope	Belt-Track	$4.64	$5.73	$1.96	$0.68	$0.14	$1.54	$14.69
		Track Haulage	4.76	5.91	2.06	0.73	0.15	1.65	15.26
	Drift	Belt-Track	$4.54	$5.54	$1.95	$0.65	$0.14	$1.12	$13.94
		Track Haulage	4.56	5.72	2.05	0.70	0.15	1.21	14.49
Nine Section Plus Longwall	Slope	Belt-Track	$4.94	$6.02	$2.14	$0.71	$0.10	$1.53	$15.44
		Track Haulage	5.24	6.47	2.40	0.78	0.11	1.68	16.68
	Drift	Belt-Track	$4.86	$5.87	$2.13	$0.69	$0.10	$1.16	$14.81
		Track Haulage	5.16	6.31	2.39	0.76	0.11	1.27	16.00

TABLE 8

SUMMARY OF LOGISTICS COSTS PER TON FOR VARIOUS MINE SIZES IN COAL SEAMS FOUR TO SIX FEET THICK

Mine Size	Mine Type	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Two Section	Slope	Belt-Track	$4.79	$4.40	$1.72	$0.62	$0.00	$1.16	$12.69
		Track Haulage	4.96	5.06	1.88	0.65	0.00	1.22	13.77
	Drift	Belt-Track	$4.50	$4.22	$1.72	$0.58	$0.00	$0.96	$11.98
		Track Haulage	4.65	4.87	1.87	0.61	0.00	1.01	13.01
Four Section	Slope	Belt-Track	$5.03	$4.79	$1.91	$0.69	$0.00	$1.26	$13.68
		Track Haulage	5.13	5.47	2.00	0.72	0.00	1.33	14.65
	Drift	Belt-Track	$4.85	$4.66	$1.90	$0.66	$0.00	$1.01	$13.08
		Track Haulage	4.94	5.33	2.00	0.70	0.00	1.06	14.03
Nine Section	Slope	Belt-Track	$4.70	$4.79	$1.90	$0.65	$0.00	$1.41	$13.45
		Track Haulage	4.77	5.39	1.98	0.69	0.00	1.48	14.31
	Drift	Belt-Track	$4.59	$4.68	$1.89	$0.64	$0.00	$1.14	$12.94
		Track Haulage	4.66	5.27	1.97	0.68	0.00	1.20	13.78
Five Section Plus Longwall	Slope	Belt-Track	$3.38	$4.18	$1.42	$0.50	$0.10	$1.11	$10.69
		Track Haulage	3.41	4.23	1.47	0.53	0.10	1.17	10.91
	Drift	Belt-Track	$3.32	$4.05	$1.41	$0.48	$0.10	$0.82	$10.18
		Track Haulage	3.34	4.10	1.45	0.51	0.10	0.86	10.36
Nine Section Plus Longwall	Slope	Belt-Track	$3.64	$4.41	$1.56	$0.53	$0.08	$1.12	$11.34
		Track Haulage	3.77	4.61	1.71	0.57	0.08	1.19	11.93
	Drift	Belt-Track	$3.58	$4.30	$1.55	$0.51	$0.08	$0.85	$10.87
		Track Haulage	3.71	4.50	1.70	0.55	0.08	0.91	11.45

TABLE 9

SUMMARY OF LOGISTICS COSTS PER TON FOR VARIOUS MINE SIZES IN COAL SEAMS GREATER THAN SIX FEET THICK

Mine Size	Mine Type	Haulage	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Two Section	Slope	Belt-Track	$3.65	$3.42	$1.32	$0.48	$0.00	$0.92	$ 9.79
		Track Haulage	3.70	3.84	1.41	0.49	0.00	0.95	10.39
	Drift	Belt-Track	$3.43	$3.29	$1.32	$0.45	$0.00	$0.77	$ 9.26
		Track Haulage	3.47	3.71	1.40	0.47	0.00	0.79	9.84
Four Section	Slope	Belt-Track	$3.91	$3.80	$1.49	$0.54	$0.00	$1.02	$10.76
		Track Haulage	3.90	4.23	1.53	0.56	0.00	1.05	11.27
	Drift	Belt-Track	$3.77	$3.70	$1.48	$0.52	$0.00	$0.83	$10.30
		Track Haulage	3.76	4.13	1.53	0.54	0.00	0.85	10.81
Nine Section	Slope	Belt-Track	$3.90	$4.07	$1.59	$0.56	$0.00	$1.21	$11.33
		Track Haulage	3.88	4.46	1.61	0.57	0.00	1.25	11.77
	Drift	Belt-Track	$3.82	$3.97	$1.58	$0.55	$0.00	$0.99	$10.72
		Track Haulage	3.80	4.37	1.61	0.56	0.00	1.02	11.36
Five Section Plus Longwall	Slope	Belt-Track	$3.02	$3.82	$1.27	$0.45	$0.10	$1.01	$ 9.66
		Track Haulage	2.98	3.78	1.28	0.47	0.10	1.04	9.65
	Drift	Belt-Track	$2.96	$3.70	$1.27	$0.43	$0.10	$0.75	$ 9.21
		Track Haulage	2.92	3.67	1.28	0.45	0.10	0.78	9.20
Nine Section Plus Longwall	Slope	Belt-Track	$3.15	$3.90	$1.35	$0.47	$0.07	$0.99	$ 9.93
		Track Haulage	3.16	3.96	1.43	0.48	0.08	1.03	10.14
	Drift	Belt-Track	$3.1[illegible]	$3.81	$1.34	$0.45	$0.07	$0.77	$ 9.55
		Track Haulage	3.1[illegible]	3.86	1.43	0.47	0.08	0.80	9.75

Tables 10 and 11 respectively. Since most of the costs varied by less than 15 percent, the costs were averaged together to form Table 12. The costs shown approximate closely the costs in seam thicknesses of four to six feet and are believed to be a good indication of logistics costs in general.

For logistics costs outby the faces and panels, data from Appendix III were used to develop Tables 13 and 14. Information contained in Tables 12, 13, and 14 was used to develop the total logistics cost figures shown in Tables 15 and 16. Capital costs associated with logistics activities amount to a considerable portion of total costs as shown by Table 17. Approximately 73 percent of total capital cost for slope mines, and 65 percent for drift mines consists of logistics costs. In addition, track haulage mines have capital requirements about 10 percent higher than does belt haulage mines.

A generalized summary of annual costs is shown in Table 18. The table reveals that labor and labor benefits are by far the most costly items, amounting to roughly 71 percent of the total annual logistics cost. Depreciation accounts for roughly 16 percent, operating costs amount to 10 percent, and power comprises 3 percent of the total logistics cost.

The above discussion of logistics costs has pointed out the relative costs of logistics activities. These activities, in addition to areas of concern to industry representatives, offer potential areas where research and development may be required. The next report section covers industry needs based on the cost analysis and industry concerns.

TABLE 10

SUMMARY OF LOGISTICS COSTS
IN FACES AND PANELS FOR ROOM AND PILLAR OPERATIONS
IN VARIOUS SEAM THICKNESSES
($1000)

Cost Category	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt - Track	Rubber - Tire	Belt - Track	Rubber - Tire	Belt - Track	Rubber - Tire
Operating	104.8	106.8	110.9	112.9	117.0	119.0
Depreciation	131.3	131.6	139.1	139.5	149.3	149.7
Power	14.6	15.5	17.5	19.1	21.2	22.1
Labor	526.1	551.7	549.1	574.7	572.0	597.6
Labor Benefits	250.1	262.1	260.8	272.7	271.5	283.4
TOTAL	1,026.9	1,067.7	1,077.4	1,118.9	1,130.1	1,171.8
Logistics Capital Requirements	791.5	767.0	834.3	809.9	884.1	859.6
Total Capital Requirements	1,406.5	1,382.0	1,479.3	1,454.9	1,549.1	1,524.6
Percentage of Capital Costs Associated with Logistics	56	55	56	56	57	56

TABLE 11

SUMMARY OF LOGISTICS COSTS IN FACES AND PANELS FOR LONGWALL OPERATIONS IN VARIOUS SEAM THICKNESSES

($1000)

Cost Category	Less than Four Feet	Four to Six Feet	Greater than Six Feet
Operating	219.4	248.3	281.6
Depreciation	325.8	358.1	416.4
Power	67.0	72.6	82.4
Labor	1,040.5	1,040.5	1,040.5
Labor Benefits	260.8	489.7	260.8
TOTAL	1,913.5	2,209.2	2,081.7
Logistics Capital Requirements	1,640.0	1,780.0	2,018.0
Total Capital Requirements	5,868.0	7,192.0	9,131.0
Percentage of Capital Costs Associated with Logistics			

TABLE 12

REPRESENTATIVE COSTS OF MINING OPERATIONS IN FACES AND PANELS ($1000)

Cost Category	Room and Pillar Sections	Longwall Sections
Operating	112	250
Depreciation	140	367
Power	18	74
Labor	562	1,040
Labor Benefits	267	337
TOTAL	1,099	2,068
Capital Costs Associated with Logistics	824	1,812
Total Capital Requirements	1,466	7,397
Percentage of Capital Costs Associated with Logistics	56	24

TABLE 13

SUMMARY OF LOGISTICS COSTS OUTBY THE FACES AND PANELS FOR SLOPE MINES

($1000)

Cost Category	Two Section Mine		Four Section Mine		Nine Section Mine		Five Section Plus Longwall Mine		Nine Section Plus Longwall Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Operating	107.1	123.5	229.0	274.9	458.0	552.8	608.4	658.9	715.1	824.4
Depreciation	380.4	471.7	650.7	771.2	1,170.3	1,326.2	1,294.1	1,284.8	1,521.9	1,585.8
Power	93.1	88.3	155.4	151.5	382.7	351.0	551.2	477.9	700.5	607.5
Labor	680.4	676.3	1,392.3	1,359.7	2,592.0	2,541.2	2,930.8	2,632.5	3,547.2	3,274.4
Labor Benefits	341.8	340.0	701.2	681.9	1,302.1	1,277.0	1,461.0	1,318.9	1,772.9	1,639.6
TOTAL	1,602.8	1,699.9	3,128.6	3,239.2	5,905.1	6,048.2	6,845.5	6,373.0	8,257.6	7,931.7
Logistics Capital Requirements	3,160	4,080	7,695	9,780	17,092	21,494	23,451	27,498	27,050	32,863
Total Capital Requirements	3,800	4,722	9,655	11,740	20,452	24,854	26,811	30,858	31,370	37,183
Percentage of Capital Costs Associated with Logistics	83	86	80	83	84	86	87	89	86	88

TABLE 14

SUMMARY OF LOGISTICS COSTS OUTBY THE FACES AND PANELS FOR DRIFT MINES ($1000)

Cost Category	Two Section Mine		Four Section Mine		Nine Section Mine		Five Section Plus Longwall Mine		Nine Section Plus Longwall Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Operating	92.3	109.1	197.1	243.0	390.0	484.8	499.9	550.3	591.6	700.1
Depreciation	220.7	312.3	417.5	538.0	791.1	947.0	901.8	892.8	1,079.8	1,143.7
Power	76.9	72.2	129.4	125.4	308.5	276.9	413.6	340.4	551.1	458.1
Labor	680.4	676.3	1,392.3	1,359.7	2,592.0	2,541.2	2,930.8	2,632.5	3,547.2	3,274.4
Labor Benefits	341.8	340.1	701.2	681.9	1,302.1	1,277.0	1,460.9	1,318.9	1,772.9	1,639.6
TOTAL	1,412.1	1,510.0	2,837.5	2,943.0	5,383.7	5,526.9	6,207.0	5,734.9	7,542.6	7,215.9
Logistics Capital Requirements	1,770	2,690	4,435	6,520	9,592	13,994	12,041	16,088	14,140	19,953
Total Capital Requirements	2,410	3,330	6,395	8,484	12,952	17,354	15,401	19,448	18,460	24,273
Percentage of Capital Costs Associated with Logistics	73	81	69	77	74	81	78	83	77	82

TABLE 15

TOTAL LOGISTICS COSTS FOR SLOPE MINES
($1000)

Cost Category	Two Section Mine		Four Section Mine		Nine Section Mine		Five Section Plus Longwall Mine		Nine Section Plus Longwall Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Operating	331	347	677	723	1,466	1,561	1,418	1,469	1,973	2,082
Depreciation	660	752	1,211	1,331	2,430	2,586	2,361	2,352	3,149	3,213
Power	129	124	227	224	545	513	715	642	937	844
Labor	1,804	1,800	3,640	3,608	7,650	7,599	6,781	6,483	9,645	9,372
Labor Benefits	876	874	1,769	1,750	3,705	3,680	2,796	2,654	4,176	4,043
TOTAL	3,800	3,897	7,524	7,636	15,796	15,939	14,071	13,600	19,880	19,554
Logistics Capital Requirements	4,808	5,728	10,991	13,076	24,508	28,910	29,383	33,430	36,278	42,091
Total Capital Requirements	6,732	7,654	15,519	17,604	33,646	38,048	41,538	45,585	51,961	57,774
Percentage of Capital Costs Associated with Logistics	71	75	71	74	73	76	71	73	70	73

TABLE 16

TOTAL LOGISTICS COSTS FOR DRIFT MINES ($1000)

Cost Category	Two Section Mine		Four Section Mine		Nine Section Mine		Five Section Plus Longwall Mine		Nine Section Plus Longwall Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Operating	316	333	645	691	1,398	1,493	1,310	1,360	1,850	1,958
Depreciation	501	592	978	1,098	2,051	2,207	1,969	1,960	2,707	2,771
Power	113	108	201	197	471	439	578	504	787	694
Labor	1,804	1,800	3,640	3,608	7,650	7,599	6,781	6,483	9,645	9,372
Labor Benefits	876	874	1,769	1,750	3,705	3,680	2,796	2,654	4,176	4,043
TOTAL	3,610	3,707	7,233	7,344	15,275	15,418	13,434	12,961	19,165	18,838
Logistics Capital Requirements	3,418	4,338	7,731	9,816	17,008	21,410	17,973	22,020	23,368	29,187
Total Capital Requirements	5,342	6,262	12,259	14,348	26,146	30,548	30,128	34,175	39,051	44,864
Percentage of Capital Costs Associated with Logistics	64	69	63	68	65	70	60	64	60	65

TABLE 17

GENERALIZED SUMMARY OF
LOGISTICS CAPITAL COSTS
AS A PERCENTAGE OF
TOTAL CAPITAL COSTS

Mine Type	Haulage	Percentage of Total Capital Costs
Drift Mine	Belt-Track	62
	Track Haulage	67
Slope Mine	Belt-Track	71
	Track Haulage	74

TABLE 18

GENERALIZED SUMMARY OF
LOGISTICS COST CATEGORIES
AS A PERCENTAGE OF
TOTAL LOGISTICS COSTS

Cost Category	Slope Mines	Drift Mines
Operating	10	9
Depreciation	16	15
Power	4	3
Labor and Labor Benefits	70	73
TOTAL	100	100

INDUSTRY NEEDS

69-70

INDUSTRY NEEDS

The coal mining industry has long suffered from a lack of effort in the research and development areas. It has only been in the last 5 or 6 years that any major work has been concentrated in the research and development area. As a result, there has been virtually no change in the last 20 years in the operations and equipment utilized to transport coal supplies, personnel, etc.

The mining industry is now faced with rapidly rising labor, capital, and operating costs. Methods must be found to reduce the rate at which costs are rising, and make coal mining more productive. As part of this effort, mining companies, equipment manufacturers, and federal government agencies have been engaged in a substantial research and development effort to improve existing equipment and introduce new more effective equipment.

This section of the report is designed to identify industry needs in each of the seven major cost areas for underground mine logistics:

1. Transport of Personnel, Supplies, and Equipment
2. Coal and Rock Transportation
3. Electrical Distribution and Communications Systems
4. Water Handling
5. Hydraulics
6. Ventilation
7. Other Miscellaneous Areas

Industry needs are based on results of the "Industry Concerns" and "Logistics Cost Analysis" sections of this report. The industry needs will be used to formulate additional research and development in the area of underground mine logistics.

TRANSPORT OF PERSONNEL, SUPPLIES AND EQUIPMENT

The transportation of personnel, supplies, and equipment account for approximately 35 percent of the total logistics cost of an underground mining operation. The only phase of underground mine logistics with a comparable cost is coal and rock transportation, also at 35 percent. Of the total logistics cost, approximately 71 percent can be accounted for in labor and labor benefits.

These figures indicate that although the mining industry has not voiced a major concern over underground transport of personnel, supplies, and equipment, there is a definite need for research and development work in this area. This lack of concern appears to have arisen from the unavailability of a viable alternative to current transportation systems. These systems, namely rubber-tire or track bound, have been extensively utilized as the only major transportation methods. This is due in part to resistance by the mining industry to change from something that has been successful in the past.

With labor now comprising 71 percent of the cost of logistics, better labor utilization is paramount for reducing logistics costs. The transport of personnel, supplies, and equipment is especially labor intensive. Much of the labor costs in this area are incurred in transporting personnel to and from their work area. In addition, time consumed in transporting personnel results in production losses as well. It is evident that a more rapid and more efficient means of personnel transport is needed.

The technology is now available to transport people overland at speeds well in excess of 100 mph. This is not to say that a transportation system should be developed to operate at this high speed underground, but it is obvious that the technology is available to greatly increase the average speed of mantrips. One source has revealed: "A great deal has been written about a high speed locomotive installation at Easington colliery in the north east of England where speeds of 43 km/h (27 mph) have been achieved on "Thermit" welded track with 150 kW (200 hp) diesel locomotives (10, 13). In the USA modern locomotive speeds of 24 km/h (15 mph) are common and speeds of 64 km/h (40 mph) have been achieved. Far greaterspeeds can be obtained in safety in the USA becuase the roadways are generally larger and the track gauges are considerably wider than in the UK" (12).

Recent industry trends tend to illustrate industry's response to increasing logistics costs. Many mining companies are currently developing smaller mines to reduce logistics problems and minimize travel distances to the production section. In fact, a recent article in Coal Age magazine discussed Peabody Coal Company's viewpoint as stated by a Peabody official: "It's cheaper, more productive, and more efficient to operate several smaller mines than a single large one" (6). However, smaller mines generally require a greater cost for surface facilities and transportation per ton of coal mined. Preparation plants, shafts and slopes, coal loading facilities, supply facilities, maintenance facilities, etc., are either not utilized to their full extent or are minimized in their capabilities and size. Decreasing the time involved in underground travel would encourage development of larger mines and consequently, more efficient use of surface facilities.

A rapid underground transportation system will not only aid the large mining operations but it will enable the small operator to reduce mining costs. Productivity will increase due to more production time available. Labor cost will decrease since personnel will be available a greater percentage of time to perform productive work. Development costs should also decrease on an assigned cost per ton basis. A rapid transit system will enable mine operators to assign a larger reserve base, distributing the initial cost of development over a larger tonnage of coal. The basic industry need is summarized by one source as follows:

> "In many underground coal mining operations there is a sense of urgency concerning the reduction of travelling times for men to and from their place of work. The emphasis need not necessarily be placed on a high maximum speed whilst travelling but rather on a high average speed for the duration of the journey" (12).

Another research and development effort that should be pursued in addition to a rapid transportation system is the automation of a haulage system. Automation is the key to minimizing the impact of labor costs in the non-production areas. As labor costs continue to rise, automation, or a reduction in manpower needed to operate the transportation system, will continue to be the most effective way to reduce the overall cost of mining coal.

COAL AND ROCK TRANSPORTATION SYSTEMS

Industry representatives have indicated that coal and rock transportation is of paramount importance, especially in the face area. An official from Peabody Coal Company stated:

> "I believe this industry is 50 years behind the times in transporting coal from the face to the surface...We've looked at hydraulic-monitored movement of coal, panlines and many other things, but see nothing so far that works. We aren't giving up, though, because we believe there are ways that this can be done" (6).

This industry concern is supported by the logistics cost analysis. Coal and rock transportation account for roughly 35 percent of all costs associated with logistics in the mining operation. These high costs, and statements from industry representatives, indicate that a concentrated research and development effort is needed in this area. In response to this need, the Department of Energy has embarked on a substantial research and development effort to design and fabricate new equipment or improve the capabilities of existing coal and rock haulage equipment.

The area of greatest interest to operators appears to be the face haulage program. Continuous haulage systems that require only one or two laborers to operate, yet offer the potential for truly continuous mining, are very attractive and would satisfy an important industry need. In addition, delays associated with the cyclic nature of batch type haulage systems would be eliminated thereby increasing production and lowering mining costs.

The government's efforts to increase the haulage capacity of batch-type vehicles, and eliminate troublesome trailing cables, also offer potential for satisfying haulage problems. In addition, development of more flexible haulage vehicles would be advantageous, especially in low coal where clearance is a major problem.

The third significant area of industry needs for coal and rock transportation is in the secondary and mainline haulage system. The basic need is for a system with fewer manpower requirements. Hydraulic haulage offers a potential solution in that it will enable operators to utilize a totally enclosed transport system, thus minimizing the amount of labor needed to maintain, clean, and operate both belt and track haulage systems. The development of reliable intermediate belt drives would also reduce manpower requirements.

ELECTRICAL DISTRIBUTION AND COMMUNICATIONS SYSTEMS

Based on the logistics cost analysis, electrical distribution is the third most significant area of logistics costs. However, the coal mining industry, as noted in the section on "Industry Concerns," has placed electrical distribution systems on a higher level of importance. The industry costs study does not take into account the cost of lost production that occurs when there is a failure in the power distribution. As a result, the cost analysis alone may not be sufficient support for a major research and development effort. However, when one considers the effects electrical distribution problems have on the entire mine, it is evident that electrical distribution is a major logistics problem area.

The "Industry Concerns" section of this report outlined many of the electrical system problem areas confronting the industry. Low voltage cables and cable splices are perhaps the greatest concern. Physical deterioration of cables from tension, heat, abrasion, chemical attack, and water infiltration result in electrical failures. Cables and splices are needed by the industry that can better withstand physical stresses for longer periods of time without failure. Such improvements would significantly improve the availability of popular face equipment.

Another major problem area, as discussed by industry personnel, is electrical system protection and coordination. Improvements are needed in electrical system hardware that will eliminate nuisance tripping of breakers, and allow better coordination of electrical systems. In addition, development of methods that permit accurate and expeditious relay coordination studies are needed. Computer simulation of electrical systems is one way to conduct such studies; however, programs currently available are cumbersome, lengthy, and difficult to use. The industry needs better programs that are easier to use and interpret.

One particular problem especially evident in large mines is high voltage cable coupler failures. Several existing mines employing voltages above 12,000 volts have been plagued with coupler problems. Consequently, many large new mines, reluctant to contend with similar problems, have electrical systems that utilize lesser voltages. Resulting systems are generally more expensive and less efficient. Thus, improved cable couplers are needed that are less susceptable to corona-related problems and failures. Improvements in couplers would permit use of higher voltages that are more efficient than lower voltage systems.

The final area of need in mine electrical distribution systems is in electrical system components. Many of the necessary electrical system safety devices such as ground monitors, ground fault detectors, overcurrent devices, relaying equipment, timers, limit switches, interlocks, etc., are unreliable in the dusty, wet mine environment. Improvements in these areas will make the entire mine electrical system more reliable.

WATER HANDLING, HYDRAULICS, AND VENTILATION

The results of the cost analysis and industry concerns survey indicate that no major problems exist with current water handling and hydraulics systems. These two areas do not comprise a significant percentage of the mine's cost for logistics.

Mine ventilation accounts for approximately 10 percent of the total cost per ton of mine logistics. The relatively low cost reflects the small number of personnel needed to maintain an effective ventilation system for the mine. Industry representatives have indicated that there is a need for research and development work in the area of mine ventilation, but not to the extent of the other major areas of logistics. One particular area of interest has to do with determination of the economic trade-off between various alternatives for improving mine ventilation. These are: sinking a ventilation shaft; versus mining roof and bottom rock to increase the area of air flow; versus higher horsepower fans with greater ventilation pressures to increased airflow.

OTHER LOGISTICS NEEDS

Other logistics needs are not directly assignable to a particular logistics activity. Coal mine slopes and shafts are such an example. The high capital costs associated with slope and shaft construction is a major logistics cost. More efficient and rapid methods of slope and shaft construction are needed to reduce capital requirements for mine start-up and growth. The Department of Energy's work with the Blind Shaft Borer offers potential for reaching this end.

Another industry need that cannot be assigned to a particular logistics acitivity is training materials. A training manual is needed to assist management personnel in dealing with all of the various logistics problems. Such a manual is currently not available.

The above discussions present many of the industry needs regarding coal mine logistics. Some of these needs are being addressed by current research and development programs.

CURRENT RESEARCH AND DEVELOPMENT

81- 82

CURRENT RESEARCH AND DEVELOPMENT

It is apparent from the report sections on industry concerns and needs that the mining industry has not kept pace with other heavy industries in efforts to modernize and automate mining equipment. Modern mining equipment in effect has not undergone any significant improvements or design changes in the last 20 to 30 years. As a result, mining costs have increased and productivity has declined. This section of the report will review current research and development projects underway domestically and will highlight two haulage systems that are available internationally but are not extensively utilized in the United States.

DOMESTIC RESEARCH AND DEVELOPMENT

There is currently an extensive research and development program being conducted by the Department of Energy to improve certain aspects of mine logistics. The program has been developed in an attempt to improve transportation systems for coal haulage as well as personnel and supply transportation, and to optimize other support activities necessary for the coal extraction process. Improvements should result in lower mining costs, higher coal mine productivity, and more profitable mining operations.

Research and development sponsored by the government is concentrated on specific areas of mine logistics that were perceived as being the most critical when the program was formulated. Although the research and development program is constantly being updated and revised to reflect current or newly developed problem areas, the program is still heavily weighted toward specific areas of research, particularly that of coal transportation. Production equipment such as continuous miners, coal loaders, and longwall shearers can produce coal at a much faster rate than the transportation system can handle it. Therefore, current governmental research is aimed primarily at solving specific problems associated with coal transportation.

The following report section contains a review of the Department of Energy's Research and Development Program as it pertains to each of the areas previously developed in the report.

Transportation of Personnel, Supplies, and Equipment

Results of this study have shown that transportation of personnel, supplies, and equipment comprises a significant portion of logistics costs. Current research and development efforts in this area sponsored by the Department of Energy have included the movement of equipment.

The nature of the mining operation and the mine environment affects the moving of mine equipment. In mines with a seam height less than 6 feet, clearances between the equipment being moved and the mine roof are a major problem. Clearance limitations often prevent the equipment from being loaded on transport vehicles. As a result, equipment moves are slow, difficult, and expensive to accomplish and eventuate in production losses and the need for added manpower.

Equipment move problems are especially obvious in longwall operations. Many of today's longwall faces can produce in excess of 1500 tons per shift of run-of-mine coal. At this high production level, each shift lost during equipment moves has a significant effect on mine productivity and costs. One source reveals that the average longwall move time amounts to 77 shifts (33). Detailed planning and coordination of manpower and equipment are necessary to minimize move times.

The Department of Energy's research and development effort involves analyzing equipment moves under various mining situations and utilizing the data gathered to identify efficient methods. Efforts have centered primarily on moving longwalls since their impact on mine production is most significant. However, work is underway to improve room and pillar equipment moves as well.

Coal and Rock Transportation

The major effort in research and development by the Department of Energy has been in coal transportation. The program has concentrated on a number of distinct areas inby and outby the belt feeder. Research and development objectives inby the feeder are concerned with improving both continuous haulage systems and batch type systems such as shuttle cars, ram cars, etc. Outby the feeder, objectives include improving belt systems and developing alternative haulage systems for coal.

Extensive work is in progress to develop a high capacity, reliable, face continuous haulage system that minimizes manpower requirements.

Current approaches include both roof referenced or monorail continuous conveying systems and floor mounted mobile systems. The roof referenced systems are suspended from a beam. A continuous, flexible, belt-type conveyor is being developed that can negotiate curves and bends. A prototype called the flexible conveyor train has been tested underground and is currently available for seams as thin as 48 inches (see Figure 1).

Another continuous haulage system being developed and offering potential is the Auto-Track Bridge Conveyor Train (ABCT). The ABCT is unique in its design in that the inby bridge conveyor lays a special trailing cable on the mine bottom. Sensors in the other bridge conveyors follow the cable as the system is moved, thereby minimizing personnel requirements. An on-board microprocessing unit aligns each unit. Two units have been surface tested, with three additional units to be fabricated and tested underground.

A Multiple Unit Continuous Haulage System (MUCH) is also being developed and consists of a series of bridge conveyors (see Figure 2). Each conveyor carrier discharges onto an identical conveyor unit to form a chain of mobile conveyors between the continuous miner and the main conveyor system. Each unit, because of its unique hitching system, is capable of following the unit in front or behind it in the forward or reverse mode.

The three aforementioned projects have each shown potential for success in providing a truly continuous face haulage system. Each system

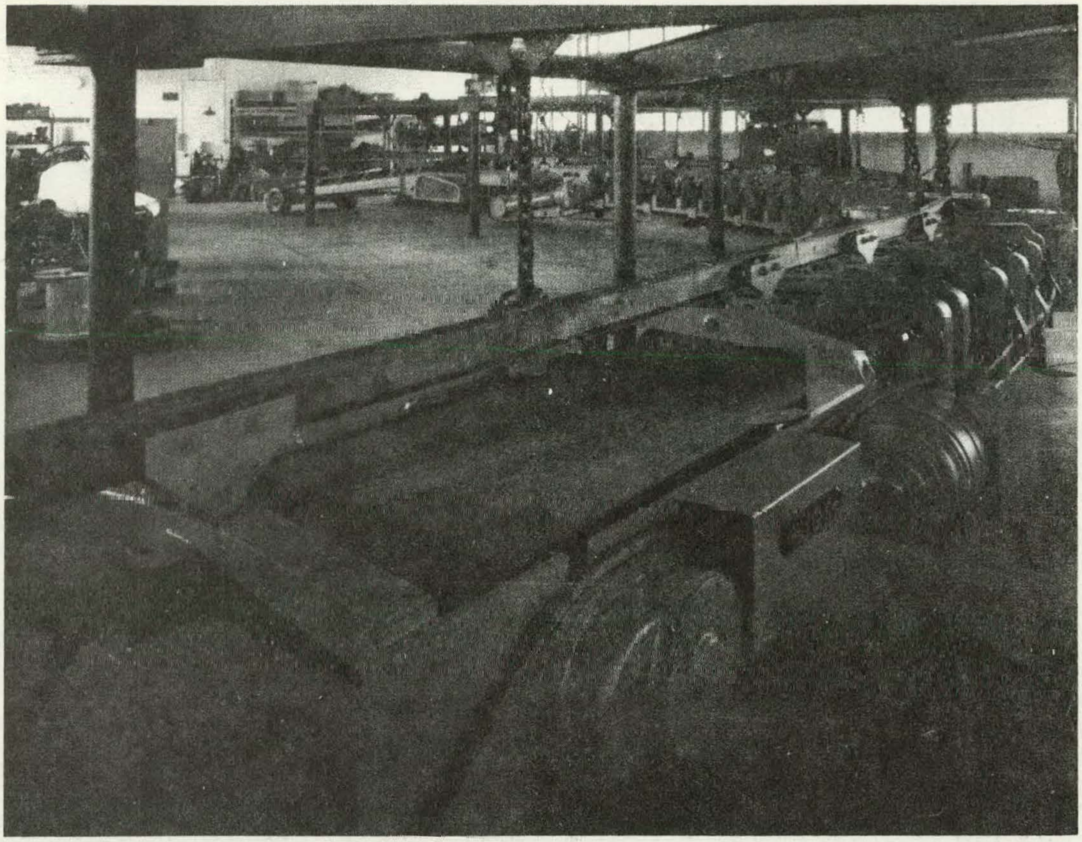


Figure 1. Flexible Conveyor Train.

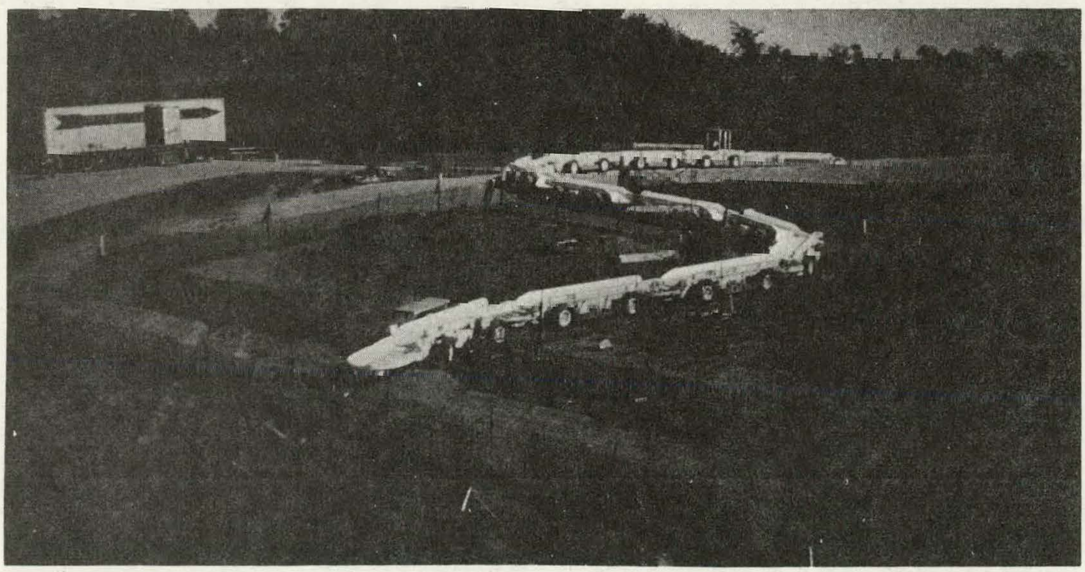


Figure 2. Multiple Unit Continuous
Haulage System (MUCH).

is designed to be highly reliable, and of high capacity with minimal personnel requirements. Initial projections show that each continuous haulage system will require two and possibly only one person to operate. These systems should result in higher production and productivity, thereby lowering overall mining costs.

Batch-type haulage systems are also currently undergoing extensive research and development efforts. Efforts in this area are concentrated on improving the overall design and performance of shuttle cars and developing alternative power sources to eliminate the need for the troublesome trailing cable.

Studies in both the government and private sectors have shown that the capacity of face haulage vehicles can have a significant effect on mine productivity. Two obvious ways to increase capacity are first, to increase load capacity of the haulage vehicle, and secondly, to increase the number of units so that the amount of time the continuous miner or loader must wait on haulage vehicles can be reduced. Physical limitations in the mine environment often prevent increasing the haulage vehicle capacities. In thick-seam mines where clearances are relatively great, manufacturers have already designed and produced haulage vehicles with capacities up to 25 tons. However, the problems with increasing shuttle car capacity in thin coal seams are more acute. Height limitations prevent manufacturers from incorporating side boards and other features into the design. Turning radius and maneuverability requirements prevent manufacturers from increasing length. Consequently, the development program was designed not to introduce radical design modifications, but to work within the existing framework of the haulage vehicles.

This program has led to development of a floating operators cab with an adjustable range of 8 inches. Floating cabs permit large shuttle cars to be used in thin seams. The body has a wide design to further increase the potential maximum payload, and the chain conveyor utilizes two chain conveyors instead of one. This modification results in chain conveyors that are 50 percent stronger than unmodified conveyors (see Figure 3).

The other method of increasing the haulage system capacity has involved increasing the number of haulage vehicles. Such an increase is difficult when the haulage vehicles use trailing cables because the cables can become tangled. Research and development in this area is concerned with eliminating the trailing cable on shuttle cars by providing alternative power sources. There are a number of programs currently underway to develop alternative power modes such as flywheel power, diesel power, steam power, and batteries. Each power source offers the potential of increasing machine flexibility and haulage system capacity. A corresponding increase in production can be expected.

The Department of Energy is also sponsoring development of a hopper feeder bolter designed to interface between the continuous miner and haulage system (see Figure 4). The project is designed to provide surge capacity for the continuous miner to achieve increased production.

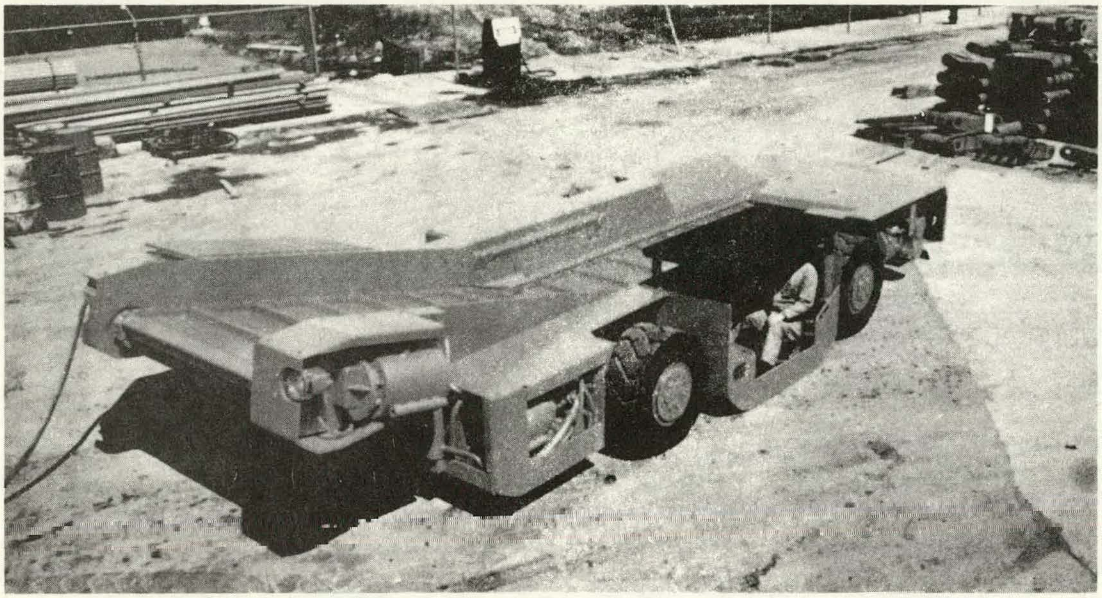


Figure 3. High Capacity Shuttle Car.

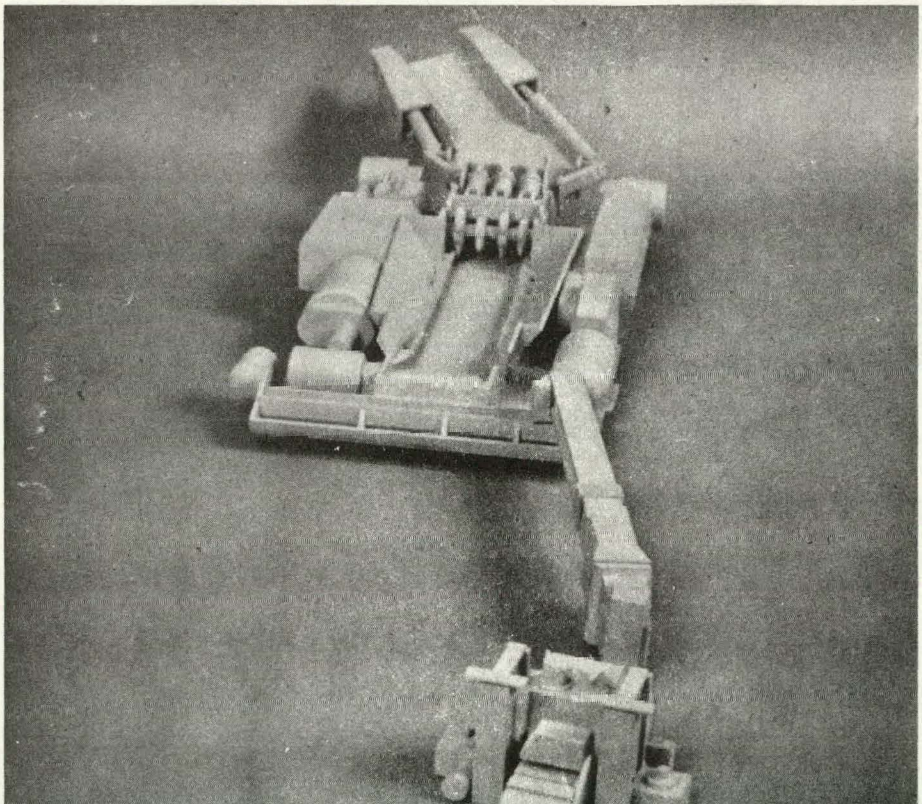


Figure 4. Hopper-Feeder-Bolter Model.

In addition, the unit will provide roof bolting to permit a mining advance distance of greater than 20 feet.

Development projects existing outby the feeder involve the development of a new mainline haulage system and improvements to existing belt transportation systems. The Department of Energy has sponsored design and construction of a hydraulic transport research facility. The facility will be used in engineering research to advance technology in hydraulic transportation systems. Development efforts are designed to eventually provide the mining industry with a fully enclosed, high capacity, low maintenance haulage system. By fully enclosing the system and utilizing water as a transportation medium, dust problems will be eliminated. The result will be a much safer mining environment.

Another transportation project invloves automating rail haulage. A detailed investigation has been made into the design of a totally automated rail haulage system using 18-ton locomotives. Each locomotive is controlled by an on-board computer.

Investigations into improving belt haulage systems are also underway. Belt haulage is typically a high-maintenance transportation system. Many of the inherent maintenance and labor requirements are associated with belt transfer points. Efforts are being made to improve belt transfer points in order to minimize coal spills. In addition, with current belt lengths limited to 4,000 or 5,000 feet, methods of extending the distance between transfer points are being sought. One project has involved investigation of intermediate belt drives that do not require that conveyed material be transferred from one belt to the next (see Figure 5).

One final area of development for coal haulage is a conveyor belt extender. The dynamic nature of mining requires that the belt system be advanced or retracted every few weeks. The process is a lengthy one requiring up to a shift of work time and the efforts of 6 to 8 laborers. Mine operators usually schedule this activity for a weekend so as not to disrupt production for an entire shift. A rubber-tired, battery-powered, conveyor belt service machine is being developed to advance or retract belt for a distance of 100 feet in 45 minutes with a crew of only 4 or 5 laborers (see Figure 6). In addition, the machine increases personnel safety by eliminating much of the manual labor associated with extending or retracting belts.

Electrical Distribution and Communications System

DOE research and development efforts in the electrical distribution and communications fields are not extensive at this time. However, other government agencies have explored electrical components for safety considerations. In particular, the Bureau of Mines has investigated trailing cables, cable splices, high voltage cable couplers, and molded case circuit breakers. Other items of lesser importance have also been researched and include permissible transformers. Many potential developments that could improve safety will also extend the life and reliability of electrical components. Thus, benefits involving logistics considerations are possible.

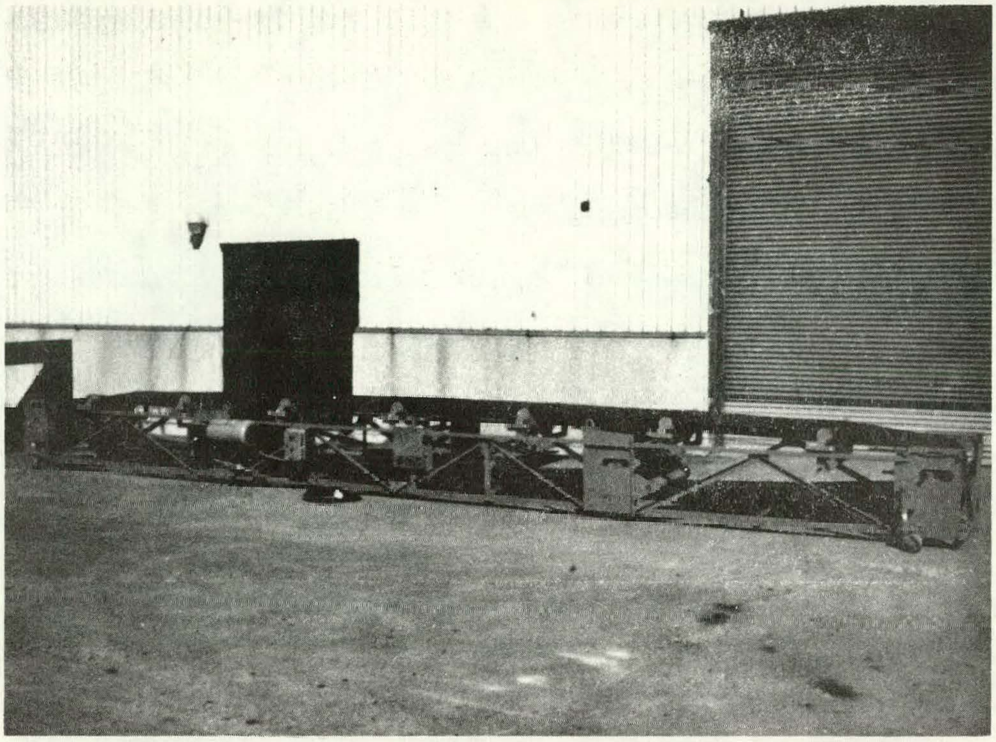


Figure 5. Intermediate Belt Drive.

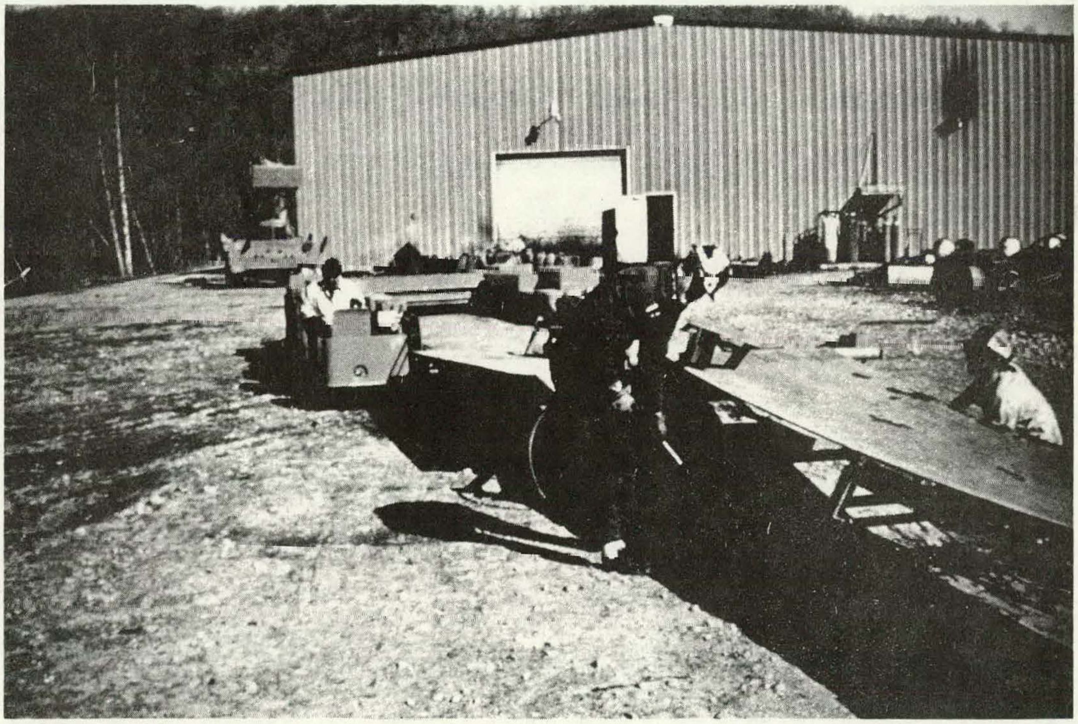


Figure 6. Conveyor Belt Service Machine.

Another improvement in mine logistics developed and recently perfected by the National Coal Board of Britain, is the computerized mine operating system called "MINOS." The system is currently being evaluated by DOE. This computer monitoring system receives signals from sensors in the equipment at the mine's faces, and displays updated information regarding machine performance and causes of delays. It also monitors conveyor movement and indicates when belts are carrying coal. The "MINOS" program has been developed to assist mine personnel in managing mining activities, performing logistics functions, and correcting problems. At the same time it offers a means of recording the causes and effects of various delays.

Other Areas

The Department of Energy has sponsored research and development in areas other than those mentioned previously in the report. The one such area is in shaft construction. The high costs and delays associated with conventional shaft sinking prompted the Department of Energy to develop a machine for use in boring large diameter shafts called the blind shaft borer. The machine was tested in a shaft in Alabama, and could potentially offer an attractive alternative to conventional shaft sinking methods.

Another area of research and development not mentioned previously involves the training of mine supervisors. Efforts are being made to develop a computer system that will allow supervisors to input various parameters such as shuttle-car paths, pillar sizes, and tram distances to determine optimal mining procedures prior to the start of a shift. The information provided will help mine personnel do the best possible planning of logistics activities.

These projects demonstrate the government's commitment to improving the logistics technology base. The developments cited should ultimately lead to a more highly productive and safer mining environment.

FOREIGN RESEARCH AND DEVELOPMENT

Logistical problems are not limited to U.S. operations. Foreign countries, notably European, have encountered many of the same problems and, in some cases, more severe problems than those found in U.S. coal mines. Although extensive investigations of foreign logistics considerations were not conducted for this report, several are worthy of discussion. Trapped rail haulage systems were developed in Europe and are designed to transport equipment, personnel, and supplies. The systems are either floor-mounted dual rail or roof-mounted monorail (see Figures 7 and 8). These systems have exhibited a capability to perform reliably in difficult or severe mining conditions. The positive gripping of the wheel units to the rail permits the systems to operate effectively in steeply pitching conditions. The high reliability and low maintenance requirements offer potential as an efficient system capable of satisfying the transportation needs of U.S. Mines. Previous studies have indicated that trapped rail systems can be competitive with systems currently used in

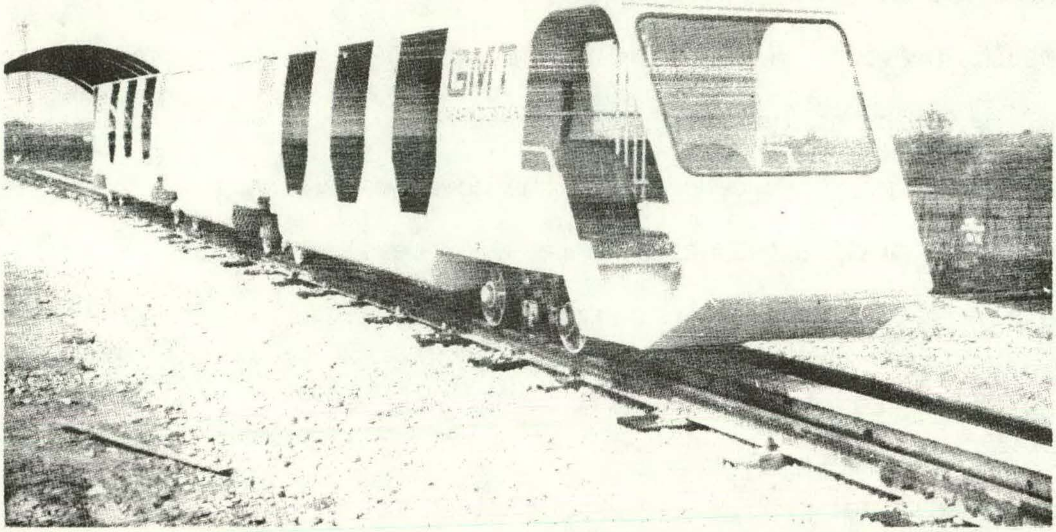


Figure 7. Floor-Mounted Trapped Rail Haulage System.

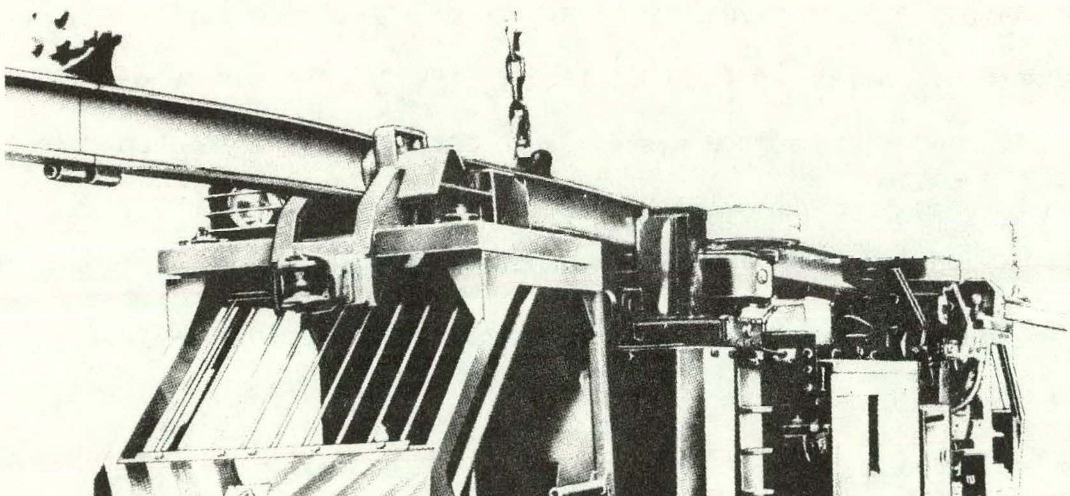


Figure 8. Roof-Mounted Monorail Haulage System.

horizontal mining conditions (44). There is currently one trapped rail haulage system in use in the United States at G.M.&.W. Coal Company's Grove No. 1 Mine in Jennerstown, Pennsylvania.

Another foreign development for mine logistics involves a high volume, low pressure pneumatic haulage system for rock. Pneumatic haulage is currently in use at Rochester and Pittsburgh (R & P) Coal Company's Urling No. 1 Mine near Shelocta, Pennsylvania. The system is used to transport clay, shale and sandstone to the surface. R & P incorporated pneumatic haulage into the mine as an alternative to gobbing the rock and congesting air courses or transporting the abrasive material on conveyor belts.

Because of the many advantages of using locomotives for personnel and supplies transport, the United Kingdom investigated improving locomotive performance on steep grades. According to a reference source:

> A standard locomotive which operates normally on conventional track has been modified so that it can engage a drive mechanism on a rack set between the rails on steep grades. Conventional drive through the wheels should operate on gradients up to 1 in 30 and the rack system should enable gradients of up to 1 in 3 to be negotiated (12).

Such a machine might also prove practical in U.S. pitching coal seams.

The above research and development projects are attempts to answer the needs of the mining industry. Periodically, research organizations such as the Department of Energy seek recommendations on how such research can be improved. The next section of this report contains conclusions drawn from the study, and recommends a research program that will best address the needs of the industry.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

One of the major goals in this investigation is to recommend future research in underground coal mine logistics. The recommendations are based on certain conclusions drawn from the discussions contained in the various report sections.

CONCLUSIONS

The "Logistics Cost Analysis" revealed that logistics costs in underground coal mines vary from roughly $10 to $15 per ton for typical operations. The transportation of personnel, supplies, and equipment, as well as coal and rock transportation, each account for approximately 35 percent of the total cost of logistics. Because of the costs involved, these two areas of mine logistics were identified as most important from an economics standpoint. The remaining 30 percent includes 15 percent for electrical distribution and communications, 10 percent for ventilation, and 5 percent for other logistics activities. Of the total logistics costs, approximately 71 percent is attributable to labor and labor benefits. Thus, one can conclude that the greatest potential for cost reductions in mine logistics lies in reducing labor in the two major areas of logistics costs - transport of personnel, supplies, and equipment; and, coal and rock transportation.

Recommendations for research and development in mine logistics are based on industry concerns and needs as well as logistics costs. The most important area of concern is in face haulage. Most industry personnel agree that the best face haulage system would be a continuous haulage system requiring minimal personnel for operation. However, logistical problems, flexibility, mobility, and reach sometimes limit the application of continuous haulage. The industry needs research and development of a continuous haulage system that satisfies industry needs.

Since development of such a haulage system is expected to take some time, improvements in existing haulage systems are needed. In particular, research to increase the payload of batch-type haulage vehicles and eliminate the trailing cable are primary industry needs.

Reducing personnel requirements associated with coal transportation outby the face area is also an area of concern and presents another important industry need.

In the area of transporting personnel, supplies, and equipment, the transport of personnel is most important. The industry needs a research program that borrows from existing technology to develop a rapid, low cost transportation system to transport personnel to and from work areas. Such a development would also make transportation of supplies more efficient and less costly. For the near term, research and development to improve existing transportation systems is needed. Such research should be concentrated in the major problem areas identified in this report. An artist's conception of one possible solution, a rapid transit vehicle on track, is shown in Figure 9.

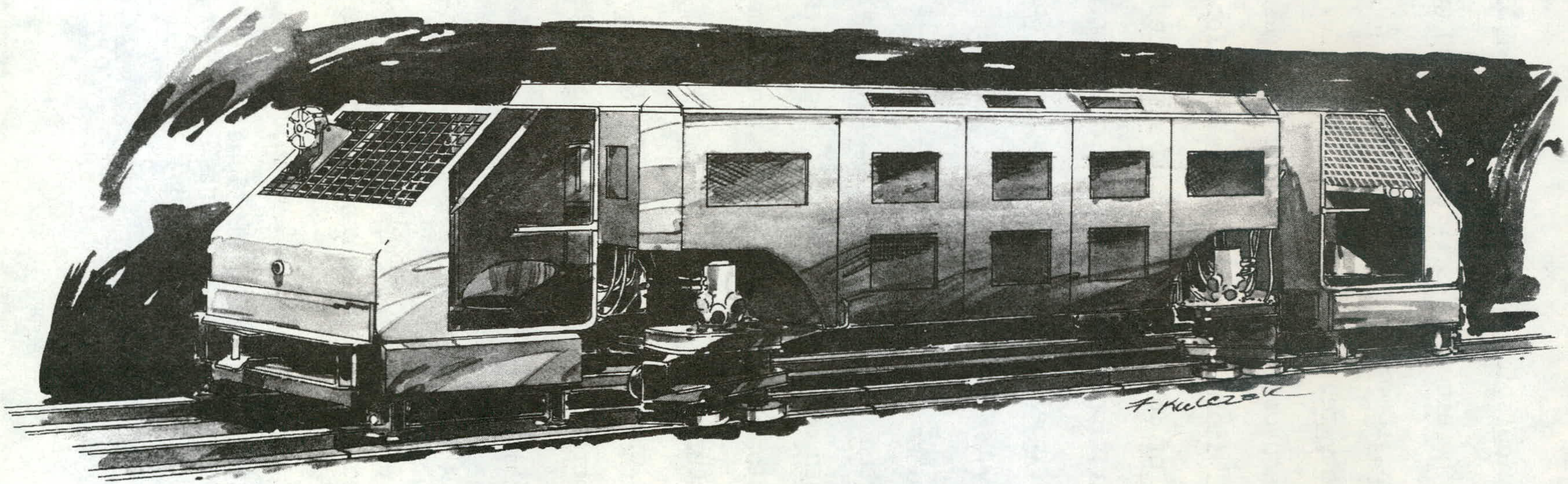


Figure 9. Rapid Transit Track Vehicle.

In the area of logistics entitled "Electrical Distribution and Communications System," numerous industry concerns and needs were identified. In addition, it was pointed out that the Bureau of Mines is pursuing health and safety research in most of the major problem areas. Due to the nature of the problems, improvements that result from health and safety research will improve logistics considerations as well.

No major areas of industry concern were related to water handling and hydraulics. However, improvements in system components such as pipe and hose couplers, pump impellers, valves, etc. would undoubtedly be welcomed by the industry.

The portion of this report dealing with ventilation revealed the major areas of concern and needs. In particular, personnel requirements and costs associated with overcast and stopping construction is a major problem area. In addition, shaft sinking costs and time requirements are also major areas of concern.

The above conclusions summarize the major cost areas and industry concerns related to underground coal mine logistics. Recommendations for improving the DOE logistics program were based on these conclusions.

RECOMMENDATIONS

The recommended areas of research are prioritized based on several considerations:

1. potential logistics cost reductions
2. potential production improvements
3. potential solution to industries' needs

Obviously, research activities that offer potential for satisfying all three areas of consideration are given highest priority. In addition, the recommendations are divided into two sections. In the first list, recommendations that offer potential solutions to specific short-term problem areas in existing mines and logistics systems are covered. Then in the second list, research that offers potential for development of new and better logistics systems over the long term are covered. Each list of recommendations is covered below.

Recommended short-term research:

- Improve the haulage capacity of batch-type haulage vehicles while eliminating the trailing cable.
  - develop batteries that have a longer life, are more reliable, require less maintenance, and weigh less than currently available batteries.
  - investigate alternative equipment designs to increase haulage capacity.
  - investigate alternative power sources for batch-type haulage vehicles.
- Investigate ways to provide more rapid transportation on existing transportation systems.
  - develop a better trolley pole harp that is less susceptible to coming off the trolley wire.
  - develop automatic track switches that are less expensive, simplier, and more reliable.
  - investigate basic track design to develop systems that are less expensive and that can be more rapidly installed.

- Investigate ways to reduce personnel requirements in conveyor-belt mines.
  - improve belt cleaners.
  - improve current methods of dust suppression.
  - develop bearings components that require less maintenance yet offer longer life.
  - develop reliable, low maintenance intermediate belt drives.
  - develop equipment better suited to rapid extension and retraction of conveyor belts.
  - develop better belt splices.
- Develop improved stoppings and overcasts that are portable, re-usable, and have minimal personnel requirements.
- Develop a small portable hoist that lends itself to unloading and loading supplies where clearances are limited.
- Develop training programs to assist mine management in dealing with logistics problems.

Recommended long-term research:

- Develop a reliable, flexible continuous face haulage system with minimal personnel requirements.
- Develop a rapid transportation system to move personnel safely and quickly in the mine regardless of seam pitch or undulations.
- Develop an outby haulage system with minimal personnel requirements that can function well in pitching seams.
- Develop hardware and techniques that will allow rapid shaft and slope construction.
- Investigate computerized mine operating systems such as MINOS for their effectiveness in improving management control.

One will note that the above list of recommendations does not address the electrical distribution and communications system. It is believed that the Bureau of Mines is adequately addressing the problems in this particular area of logistics. However, it is recommended that DOE monitor the Bureau of Mines' research and begin its own electrical research should the level of current research be reduced.

The above research program should significantly reduce the logistics costs associated with underground coal mining. But much more importantly, most of the recommended research offers the potential for significantly improving production as well. Potential reductions in total mining cost are at least indirectly proportional to improvements in production.

REFERENCES

109 – 110

REFERENCES

(1) Anonymous, "Mechanical, Hydraulic, Pneumatic, Options in Deep Mine Transport" Coal Age Magazine, July 1974.

(2) Arble, Meade, "The Continuous Haulage System Comes of Age," Coal Age Magazine, December 1977, pp. 108-112.

(3) Atlantic Research Corporation, "An Evaluation of Leaky Feeder Communication in Underground Mines," Report to the U.S. Bureau of Mines, June 1980.

(4) Bernhardt, Horst, KB/National Mine Company, Personal Communication and Technical Data, August 1981.

(5) Brezovec, David, "Continuous Haulage Aids Record Cut," Coal Age Magazine, April 1980, pp. 114-120.

(6) Brezovec, David, "Small Mines Bring Big Benefits," Coal Age Magazine, October 1980, pp. 116-122.

(7) Cernetich, John, North American Coal Corporation, Personal Communication, Seward, Pa., October 1981.

(8) Chironis, Nicholas P., "Peabody Mines Serpentix Boosts Mining Output," Coal Age Magazine, April 1977, pp. 58-64.

(9) Clark, J. and J. H. Caldon, "An Assessment of Thin Seam Mining System Technology," prepared for United States Department of Interior, Bureau of Mines, July 1980.

(10) Cleaver, E. E., "Transport of Materials and Men - Ancient and Modern," Colloquium on Transport, Institution of Mining Engineers, London, England, November-December 1973.

(11) Corl, Ron, Lunar Mining Company, Personal Communication and Mine Site Data, January 1981.

(12) Curl, S. J., Underground Transport in Coal Mines, IEA Coal Research, London, England, April 1978.

(13) Dunn, J., "High Speed Underground Locomotive Manriding," Mining Engineer Magazine, December 1976, January 1977.

(14) Dwosh, Douglas M., "Rubber-Tired Versus Rail Haulage as a Service Function," Mining Congress Journal Magazine, January 1978, pp. 39-43, 57.

(15) FMC Corporation, Product Information Literature, Personal Communication, Fairmont, W. Va., August 1981.

(16) Fairchild Incorporated, Product Information Literature, Personal Communication, Beckley, W. Va., August 1981.

(17) Fairmont Supply Company, Product Information Literature, Personal Communication, October 1981.

(18) Hanslovan, James W., Superintendent, Lady Jane Collieries, Personal Communication, Penfield, Pa., November 1981.

(19) Hastings, Gary, North American Coal Corporation, Seward, Pa., Personal Communication, October 1981.

(20) Heywood, Perry, McGraw-Hill World News, "British Mines Monitor for Face Delays," Coal Age Magazine, February 1982, pp. 114-117.

(21) Hunter, Donald and Stephen Hatfield, "Continuous Haulage at Island Creek," Mining Congress Journal Magazine, April 1980, pp. 22-25.

(22) Jeffrey Mining Machinery Division, Dresser Industries, Inc., Product Information Literature, Personal Communication, Columbus, Ohio, October 1981.

(23) Jones, Eugene, Vice President of Operations, R&P Coal Company, Personal Communication, Indiana, Pa., October 1981.

(24) Joy Manufacturing Company, Product Information Literature, Personal Communication, Pittsburgh, Pa., October 1981.

(25) Kersey, Product Information Literature, Personal Communication, Bluefield, Virginia, October 1981.

(26) KETRON, Inc., Analysis of U.S. Underground Thin-Seam Mining Potential Volume I - Text, from draft input to the MOPPS Interagency Task Force, prepared for the U.S. Bureau of Mines, June 1977.

(27) Lee Norse, Product Information Literature, Personal Communication, Pittsburgh, Pa., October 1981.

(28) Link, James M., "Hydraulic Transport of Coal from the Face," Mining Congress Journal Magazine, September 1976, pp. 37-42.

(29) Marshall, Gary, Joy Manufacturing Company, Personal Communication, Franklin, Pa., October 1981.

(30) Mayercheck, William D., "Continuous Haulage Update" Paper Presented at the SME/AIME Fall Meeting and Exhibit, Denver, Colorado, November 18-20, 1981.

(31) Mayercheck, William A., Mine Logistics, Underground Coal Mining Division of the U.S. Department of Energy.

(32) Morley, Lloyd A. Professor of Mining Engineering, Pennsylvania State University, Personal Communication and Instruction, 1977.

(33) Mundell, R. Linday, Bituminous Coal Research, Inc., Monroeville, PA, Personal Communication, July 1981.

(34) National Mine Service Company, Product Information Literature, Personal Communication, Pittsburgh, Pa., October 1981.

(35) "New Concepts in Today's Track Mines," Engineering and Mining Journal Magazine, June 1970, 164-167.

(36) Patterson, William N. and Fidel Orona, Face Haulage Equipment Failure Analysis, Final Report to the U.S. Department of Energy, Woodward Associates, Inc. November 1980.

(37) S & S Corporation, Product Information Literature, Personal Communication, Cedar Bluff, Virginia, November 1981.

(38) Schroder, John L., "Transportation of Men Underground," SME Mining Engineering Handbook, Vol. 1, Chapter 14.9, 1973.

(39) Smith, J. W. and R. L. Blohm, "Haulage Technology Increases Low-Seam Output by 50%," Coal Mining and Processing Magazine, February 1978, pp. 52-55 and 88-89.

(40) Spinka, H., Trapped Rail Transport, Information Symposium, Underground Transport in Coal Mines, Vol. 1, Commission of the European Communities, May 24 to 26, 1978.

(41) Stefanko, Robert and Edmund H. Watkins, "Monorail Haulage System," Mining Congress Journal Magazine, Vol. 56, No. 6 (June 1970), pp. 45-49.

(42) "Suspended Monorail System Provides Effective Haulage," Coal Mining and Processing Magazine, Vol. 6, No. 7, (July 1969), pp. 38-41.

(43) Tolksdorf, Manfred A., Scharf Company, Personal Communication and Technical Data, August 1981.

(44) Visovsky, Richard G., James J. Hanslovan, and Ernest Hilton, "Evaluation of Novel Underground Transport Systems," U.S. Department of Energy, Contract No. DE-AC01-79 ET 11268, June 1981.

(45) Watt, R. G. and J. H. Northard, "Transport of Men and Materials," Mining Engineer Magazine, Vol. 137, No. 196, (October 1977), pp. 57-70.

(46) West Virginia Armature Company, Product Information Literature, Personal Communication, Glen Lyn, Virginia, July 1981.

(47) Yonkoske, John, Greenwich Collieriers, Personal Communication, Ebensburg, Pa., July 1981.

APPENDICES

APPENDIX I
PERSONNEL AND SUPPLIES TRANSPORTATION PROBLEMS

APPENDIX I
PERSONNEL AND SUPPLIES TRANSPORTATION PROBLEMS

A major factor impacting mining costs is the movement of men, materials, and supplies from the surface into and throughout the mine. Various transportation systems including man-trains, supply trains, hoists, belt lines, and rubber-tired vehicles are used to transport men and supplies in underground coal mines. In many mines, it is not uncommon for a worker to spend 20 percent of his eight-hour working day traveling from the bathhouse or lamphouse on the surface to his work area and returning to the surface. This time is costly in terms of lost production and wages.

Typically, 10 to 15 percent of the underground work force is involved in the movement of supplies. In addition, hazards associated with the transportation of men and supplies can result in time lost caused by accidents and fatalities. These labor requirements, safety considerations, and lost production associated with the transportation of men and supplies, contribute significantly to mining costs. Many of the health and safety issues discussed in this section are related to the small but significant percentage of the accidents in U.S. coal mines. There exists a need to identify transportation problem areas so that possible solutions can be investigated.

Each mine is unique in the type and performance of its transportation systems. Generally, shaft and slope hoists, track vehicles and/or rubber-tired vehicles are used to transport men and materials. In shaft or slope mines, transportation to or from the working face usually consists of four elements: transportation of men and materials from the surface to the mine entrance; transportation from surface elevation to coal seam elevation; transportation from the slope or shaft "bottom" to the end of the track system near the working face; and transportation from the end of the track to the working face. In drift mines, the transportation system consists of only three major elements with transportation in the slope or shaft not required. In the discussions that follow, personnel transportation during each element is covered first, followed by a discussion of supplies transportation.

PERSONNEL TRANSPORTATION

Problems in transporting men and materials to the top of the mine shaft or slope vary considerably from mine to mine. Most mines have portals near the bathhouse and lamphouse buildings. At shift-start time, men are usually required to be at the top of the slope or shaft and ready to enter the mine.

After reaching the mine portal, the men climb into mantrips in preparation for entering the mine. The mantrip can be a cage in a shaft, a rail-mounted car in a slope or drift mine, or a trailer or skid pulled by a rubber-tired vehicle. Since many mantrips are not large enough to transport all the men at once, men typically enter the mine in cycles. For example, a shaft or slope mine that consists of six working sections might require lowering the men into the mine in three separate groups. The first group of men experiences no delays since they board the cage shortly after shift-start time and have ready access to an available mantrip at the bottom. Men lowered in subsequent cage trips may be delayed ten minutes or more while waiting for the cage to return to the surface.

Having left the cage, the men may walk some distance to board a rail-mounted self-propelled mantrip carrier. In large drift mines, men board the rail-mounted mantrip at the mine entrance. Often, because of the presence of water at the shaft or slope bottom, the mine bottom can be quite muddy and slippery. During winter, the mud and water freezes, making conditions even more hazardous to walking.

Another problem often develops that can result in delays. Frequently it is discovered that a rail-mounted mantrip is inoperative due to lack of safety equipment or inoperative brakes. A disabled mantrip will often block outby mantrips. Delays result while the disabled mantrip is switched-out onto a side track to allow other mantrips to pass.

Once a mantrip is found that is operational and all the men are seated, the mantrip operator requests permission from the dispatcher to proceed to the mine section. If there are no late-comers from the previous shift trying to get out of the mine, the dispatcher will grant the mantrip operator permission to proceed into the mine.

Depending on track and trolley conditions, the journey from the mine bottom to the section can be plagued with delays. When the track and trolley conditions are substandard (as is often the case), the trolley pole has a tendency to jump off the trolley wire. The trolley pole bounces and whips about as it hits the mine roof, cross bars, headers and overcasts. Until the mantrip can be stopped, the whipping trolley pole presents a serious hazard to men in the mantrip. Instances of arm, leg, shoulder, and skull fractures have occurred when the trolley pole struck the operator or a passenger.

To correct the situation, the mantrip must be stopped and the trolley pole put back on the trolley wire before the mantrip can proceed. The voltage of the trolley wire creates a shock hazard when personnel attempt to put the pole back on the wire. Given certain conditions, such a shock can be fatal as demonstrated by accidents in the past. In addition, the relative proximity of the trolley wire to the mantrip and the mantrip operator presents a continuous hazard during the entire journey in the mantrip. This hazard is especially acute when men board or get off the mantrips and are carrying any type of metallic tools or supplies that may come in contact with the trolley wire. A short circuit in the DC trolley line to the tracked vehicle frame can create a severe shock hazard.

Aside from the personnel hazards associated with substandard trolley conditions, other significant delays often result. It is not uncommon for the trolley pole to jump the wire four or five times between the mine bottom and the section. Time is lost each time in stopping the mantrip and putting the pole back on the wire. More importantly, the trolley pole or harp can be damaged from hitting cross bars, overcasts, pipes, the mine roof, etc. At that point, mechanics with tools and replacement parts must be called to the scene for repairs. An entire crew can be delayed for hours.

In addition to poor trolley conditions, poor track conditions can also account for safety hazards and delays because of derailments. Derailments can easily result in personnel injury. After they occur, passengers are faced with the task of getting the mantrip back on the track-an equally hazardous task. This process involves jacking the mantrip up so the wheels are higher than the top of the track, then slewing it one way or the other in an attempt to make it fall back on the rails. The entire activity takes place near the trolley wire, and consequently, there exists a constant shock hazard. The delays which result from derailment can be lengthy since after derailment, the mantrip may need to be jacked up two or three times before it can finally be repositioned to fall on the rails. Problems with the jack, an inability to find "blocking" to block-up the mantrip, and poor bottom conditions, can mean long delays in getting the mantrip back onto the track.

Other delays may occur from the necessity to travel at reduced speeds over certain sections of track and switching areas. Such reduced speeds stem from a desire to avoid derailment, to keep the trolley pole from bouncing of the wire, or other hazards. This delay becomes significant in those mines where the travel distance to the section is several miles long.

After the rail-mounted mantrip arrives at the end of the section track, personnel usually either walk into the section or crawl to a rubber-tired mode of transportation in low seams. An uncovered skid or trailer is typically dragged by a rubber-tired vehicle to the section "dinner-hole." (The "dinner-hole" is that location on the section where the men eat their lunch.) Since the vehicle is usually uncovered, personnel are subjected to hazards similar to those associated with an uncovered rail mantrip. Significant delays will occur should the vehicle become stuck where poor bottom conditions exist. Usually, provided there are no significant delays in any aspect of the transportation system, personnel will arrive at the section dinner-hole within 30 to 60 minutes after shift start time.

SUPPLIES TRANSPORTATION

Supplies are usually stored near the mine entrance where they are easily accessible to either rail-mounted supply cars or rubber-tired supply cars. The cars are customarily loaded with a forklift, or occasionally by hand, and are pushed from one storage area to another until all the required supplies have been loaded.

Some problems and delays are common to this first step of supplying the underground mining sections. First, a significant personnel hazard exists in loading supplies by hand. Pinched, cut, and broken fingers and wrists are not uncommon. In addition, back injuries associated with lifting heavy materials are possible.

Delays are especially prevalent during the winter months. Track switches can freeze and become difficult to operate. Frozen mud and ice near the track may cause the cars to jump the track and cause personnel to slip and fall. Supplies can become frozen in-place so that extra efforts must be made to "free" the supplies prior to loading. Each of these problems introduces delays into the loading and transportation process.

Once the materials are loaded, the loaded cars are taken to the mine entrance in preparation for going underground. Delays are again encountered at this point since, for slope or shaft mines, hoisting facilities must be made available for transportation of supplies. Most mines maintain a high priority on keeping the hoist facilities available for personnel and "emergency parts" transportation. In the case of slopes and shafts, preparations must be made at the mine bottom to receive the supplies and minimize the time hoisting facilities are used for supply transportation.

After the necessary arrangements are made, the loaded supply cars are prepared for entrance into the mine. For drift mines, the supply cars are connected to locomotives. In slope mines, the cars are usually attached to a slope car. In shaft mines, the cars are ordinarily lowered individually in a cage.

After reaching the mine bottom (in shaft and slope mines), the cars are connected to locomotives in preparation for distribution in the mine. Several efforts are generally required in this step: disconnecting cars from the slope car and removing all the safety chains between cars, (for slope lowered cars), ensuring flexible connections between cars to help prevent derailing, and connecting all the cars between two locomotives. The presence of mud, water, and ice at the bottom can make this series of tasks difficult and dangerous. In addition, since personnel are often required to stand between the cars to make connections, pinched hands and legs are possible.

Prior to distributing a "trip" of cars in the mine, the locomotives are usually inspected. The inspection should include the brakes (both primary and emergency), jacks, bars, fire extinguishers, warning bells, tram speeds, sanders, lights, trolley pole, and harp.

Mine locomotives are often robbed of safety supplies, such as jacks and fire extinguishers, to equip personnel carriers at the beginning of the shift. Consequently, once supply personnel finally enter the mine, delays are often encountered in reequipping the locomotives with necessary safety gear. In addition, other safety features including sanders, trolley pole, etc., need servicing and account for certain delays.

Eventually the entire supply train is made ready for travel underground. At this point, supply personnel typically contact the dispatcher and request permission to proceed. When the track system is clear of coal haulage trips and personnel carriers traveling out of the mine, the supply train sets out for its destination. Oftentimes, delays result when the supply train waits for personnel carriers to "clear" at the mine bottom or at switches located throughout the mine.

As the supply train proceeds into the mine, train operators must frequently slow down and carefully negotiate any track curves and switches known to be in poor condition. This situation prevails in particular off the mainline, and derailments are frequent at these locations. In a few mines, one or two derailments can be expected per trip. When a derailment does occur, the train is usually disconnected at the derailed car. The car is carefully jacked up and "slewed" to fall back on the rails. Hazards and delays are similar to those encountered in putting a derailed personnel carrier back on the track. However, the weights involved in this instance are usually greater. Consequently, delays and hazards are also greater. Derailments can damage the track and thus cause future derailments at the same location.

Most locomotives are of the open type, and the operator is exposed to hazards associated with rock falls, dust, the trolley pole, and the trolley wire. In addition to delays associated with placing the trolley pole on the trolley wire, operators of electrified mine locomotives can encounter various other hazardous situations. When the trolley pole leaves the wire the locomotive has a sudden loss of power and use of the electric brakes. The operator must react rapidly to regain control of the locomotive by utilizing a hydraulic and a mechanical brake.

Some additional hazards are introduced by the supply cars. Their weight can cause problems in negotiating hills. Fatalities have occurred in the past when a train started sliding or skidding down a track, and the fast speed caused the train to derail at a curve. In addition, loaded supply cars can contact the trolley wire creating shock hazards or fires. Major mine fires have originated in the past because of sparks or arcs associated with the trolley wire.

Once the supply train reaches its destination, different techniques for storing the supplies are employed. In cases where empty supply cars are left at the end of the track, the leading locomotive is usually disconnected to remove the cars. If there are no empty supply cars, the leading locomotive must still be switched out before the supply cars can be advanced. After the cars are pushed to the end of the track, they are usually chained to the rail and blocked in place.

From this point, depending on the relative closeness of the track to the face, the supplies can be handled in a number of ways. Some mines use supply cars equipped with rubber tires. At the end of the track, the rubber tires are lowered, and the supply cars are pulled off the track with rubber-tired vehicles. They can then be pulled up to the face area for supplies distribution at the face. When the cars are empty, they are put back on the track (usually with some degree of difficulty and delay), the rubber tires are raised, and the cars are again chained to the rail and blocked to await the return of the locomotives.

In other mines, the supplies are unloaded off the supply cars at the end of the track. Most of this work is done by hand, oftentimes where height restrictions make the job difficult and dangerous. In addition, the presence of water and mud can complicate the problems. Back injuries and pinched and broken fingers are common types of injuries.

Once the supplies are delivered to the end of the track, they are usually taken to the face area by rubber-tired vehicles, such as scoops or tractors. If all the supplies left at the end of the track are not used before the track is advanced again, the remaining supplies must once again be loaded and transported. Such rehandling is time consuming and costly.

In small drift mines, supplies are transported from the outside all the way to the face by rubber-tired vehicles. As in transporting personnel, this method of supplies transportation is relatively slow. Rubber-tired vehicles often become stuck in poor bottom conditions. Another rubber-tired vehicle can be employed to push out the stuck vehicle, but equipment damage in these circumstances is frequent.

Supplies delivered to the face area are usually distributed to those locations where they are easily accessible and unloaded. Then, when they are needed, they are loaded one last time and taken to the machine or area where they will finally be used.

Because of the delays and problems associated with supplies transportation, supply trips are usually taken into the mine only once a day. Oftentimes, shortages of supplies and the need for emergency parts require that needed supplies be rushed to the face area. In this instance, personnel carriers are usually sent from the section to get the supplies or parts. Since such emergency trips are frequently given a high priority, the normal transportation of men and materials is disrupted.

The evaluation of the supplies transportation system typical of many mines yields some very interesting points:

1. The transportation system can vary considerably from mine to mine.

2. Many personnel hazards and delays are inherent in present-day transportation systems.

3. Some of the loading and much of the unloading of supplies is done by hand.

4. From the time supplies are delivered on the mine property to the time they are used at the face, it is not uncommon for the supplies to be unloaded and loaded three or four times.

5. Supply trips are usually taken into the mine only once a day. Localized shortages of parts and materials are common and often necessitate that personnel carriers be used for immediate supply of urgently needed materials.

APPENDIX II
LABOR AND BENEFITS COST ANALYSIS

II-1 – II-2

APPENDIX II
LABOR AND BENEFITS COST ANALYSIS

One of the major efforts in the logistics background study had to do with determination of the cost of various logistics activities. Since personnel can be involved in numerous logistics activities, labor cost figures were derived from estimates of time that personnel perform work associated with each of the various logistics activities. Labor costs for each logistics activity were developed for each labor classification. Labor benefit costs were developed by a similar technique. Such a detailed approach to development of labor and labor benefit costs assured reliable cost figures for each logistics activity.

The labor cost analysis began with development of Table II-1 for hourly personnel. The number of days worked and the number of days paid for hourly labor were determined. Then, based on hourly labor costs for union employees, the yearly straight-time labor cost was determined for various labor classifications. Note that floating days, vacation days, holidays, etc., were calculated as part of the labor costs. Next, Table II-2 was developed to determine premium labor costs based on estimates of the overtime hours worked per year and to determine the average premium rate. The end calculation yielded the premium labor cost for each labor classification. The straight-time and premium time labor costs for each labor classification were combined in Table II-3 to yield the total yearly labor cost per employee classification. A similar table illustrating the yearly hours worked by each labor classification was developed as Table II-4. The yearly hours will be used later in labor benefit calculations.

TABLE II-1

LABOR COSTS ANALYSIS

Days Worked Per Year:

Total days per year =	365
Less Saturdays and Sundays =	-102
Less Holidays =	- 11
Less Vacation Days =	- 10
Less Floating Days =	- 4
Less Sick Leave =	- 5
Total straight-time days worked =	233
Total straight-time hours worked =	1,864

Days Paid Per Year:

Actual straight-time days worked =	233
Plus Sick Leave =	+ 5
Plus Floating Days =	+ 4
Plus Vacation Days =	+ 12
Plus Holidays =	+ 11
Total straight=time days paid =	265
Total straight-time hours paid =	2,120

Straight-Time Labor Cost Analysis:

Grade	Straight-Time Rate Per Hour (Estimated Average)	Yearly Straight-Time Labor Cost (265 paid days)
5	$11.86	$25,143
4	11.56	24,507
3	11.19	23,723
2	10.97	23,256
1	10.90	23,108

TABLE II-2

PREMIUM PAY LABOR COST ANALYSIS
FOR HOURLY PERSONNEL
(1,864 Hour Base)

Job Classification	Estimated Percentage Premium Pay	Premium Hours Worked	Premium Rate Percentage (Average)	Yearly Premium Labor Cost
Miner Operator	12	224	155	4,118
Miner Helper	12	224	155	4,118
Bolter Operator	12	224	155	4,118
Bolter Helper	12	224	155	4,118
Shuttle Car Operator	12	224	155	3,885
Mechanic/ Electrician	20	373	165	7,299
Supply Man	10	186	155	3,226
Faceman	10	186	155	3,226
Beltman	8	149	155	2,517
Motorman	5	93	155	1,581
General Laborer	8	149	155	2,517
Pumper	20	373	170	6,912
Trackman	8	149	155	2,517
Welder	15	280	155	5,147
Dispatcher	5	93	155	1,666
Bratticeman	10	186	155	3,142
Shear Operator	15	280	160	5,313
Shear Operator Helper	15	280	160	5,313
Longwall Support Operator	15	280	160	5,013
Headgate Operator	15	280	160	5,179
Tailgate Operator	15	280	160	5,179
Longwall Operator	15	280	160	5,313
Conveyor Snaker	15	280	160	5,013

TABLE II-3

LABOR COSTS SUMMARY
FOR HOURLY PERSONNEL
(Dollars)

Job Classification	Yearly Straight-Time Labor Cost Per Employee	Yearly Premium Labor Cost Per Employee	Total Yearly Labor Cost Per Employee
Miner Operator	25,143	4,118	29,261
Miner Helper	25,143	4,118	29,261
Bolter Operator	25,143	4,118	29,261
Bolter Helper	25,143	4,118	29,261
Shuttle Car Operator	23,723	3,885	27,608
Mechanic/Electrician	25,143	7,299	32,442
Supply Man	23,723	3,226	26,949
Faceman	23,723	3,226	26,949
Beltman	23,108	2,517	25,625
Motorman	23,256	1,581	24,837
General Labor	23,108	2,517	25,625
Pumper	23,108	6,912	30,020
Trackman	23,108	2,517	25,625
Welder	25,143	5,147	30,290
Dispatcher	24,507	1,666	26,173
Bratticeman	23,108	3,142	26,250
Shear Operator	25,143	5,313	30,456
Shear Operator Helper	25,143	5,313	30,456
Longwall Support Operator	23,723	5,013	28,736
Headgate Operator	24,507	5,179	29,686
Tailgate Operator	24,507	5,179	29,686
Longwall Operator	25,143	5,313	30,456
Conveyor Snaker	23,723	5,013	28,736

TABLE II-4

HOURS WORKED PER JOB CLASSIFICATION

Job Classification	Yearly Straight-Time Hours Worked Per Employee	Yearly Premium Hours Worked Per Employee	Total Yearly Hours Worked Per Employee
Miner Operator	1864	224	2088
Miner Helper	1864	224	2088
Bolter Operator	1864	224	2088
Bolter Helper	1864	224	2088
Shuttle Car Operator	1864	224	2088
Mechanic/Electrician	1864	373	2237
Supply Man	1864	186	2050
Faceman	1864	186	2050
Beltman	1864	149	2013
Motorman	1864	93	1957
General Labor	1864	149	2013
Pumper	1864	373	2237
Trackman	1864	149	2013
Welder	1864	280	2144
Dispatcher	1864	93	1957
Bratticeman	1864	186	2050
Shear Operator	1864	280	2144
Shear Operator Helper	1864	280	2144
Longwall Support Operator	1864	280	2144
Headgate Operator	1864	280	2144
Tailgate Operator	1864	280	2144
Longwall Operator	1864	280	2144
Longwall Snaker	1864	280	2144

The next effort involved actual determination of the amount of time each labor classification is involved with each of the various logistics activities. Table II-5 illustrates the estimated percentage of time devoted to each logistics activity by each labor classification. The results of Table II-5 are used in both labor and labor benefits determinations in Appendices III and IV.

Following the labor cost analysis, labor benefit costs were developed. The labor benefits consisted of four categories: social security, health and retirement, sickness and accident, and additional benefits. The technique used to calculate costs in each category is described as follows:

Social Security (estimated):

Hourly personnel = 6.7 percent of annual wage

Salary personnel = 6.2 percent of annual salary

Health and Retirement Benefits:

Hourly personnel = $1.037 per hour worked

Salary personnel (estimated) = 15 percent of annual salary

Sickness and Accident Insurance (estimated) =

8 percent of annual wage or salary

Additional Benefits (estimated):

Hourly personnel = 2.0 percent of annual wage

Salary personnel = 4.0 percent of annual wage

Workmens' Compensation (estimated)

22 percent of annual wage and salary

TABLE II-5

YEARLY PERCENTAGE OF TIME ASSOCIATED WITH VARIOUS LOGISTICS ACTIVITIES

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Production Foreman	25	20	10	5	0	10	70
Miner Operator	30	5	0	5	0	5	45
Miner Helper	30	5	10	10	0	15	70
Bolter Operator	25	5	5	0	0	5	40
Bolter Helper	35	15	10	0	0	10	70
Shuttle Car Operator	30	60	5	0	0	0	95
Mechanic/Electrician	25	15	20	0	0	0	60
Face Supply Man	85	0	10	0	0	0	95
Outside Supply Man	95	0	0	0	0	0	95
Faceman	30	20	10	10	0	15	85
Beltman	20	70	5	0	0	0	95
Motorman (Supplies)	85	5	5	0	0	0	95
Motorman (Track Haulage)	10	80	5	0	0	0	95
General Labor	30	20	5	10	0	10	75
Pumper	45	0	5	40	0	0	90
Trackman (Belt-Track)	70	5	15	0	0	0	90
Trackman (Track Haulage)	25	55	10	0	0	0	90
Welder	40	0	10	0	0	0	50
Dispatcher/Hoistman	75	15	0	0	0	0	90
Bratticeman	30	0	0	0	0	60	90
Shear Operator	25	5	5	5	0	0	40
Shear Operator Helper	25	5	5	5	0	0	40

TABLE II-5 (Cont'd.)

YEARLY PERCENTAGE OF TIME ASSOCIATED WITH VARIOUS LOGISTICS ACTIVITIES

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Longwall Support Operator	35	5	0	0	0	0	40
Headgate Operator	40	45	5	0	0	0	90
Tailgate Operator	40	45	5	0	0	0	90
Longwall Operator	30	10	40	5	0	5	90
Conveyor Snaker	30	60	0	0	0	0	90
Longwall Maintenance Foreman	25	20	10	0	20	0	75
Longwall Coordinator	60	10	10	0	10	0	90
Longwall Superintendent	25	20	10	0	10	10	75
Longwall Mechanic	25	20	10	5	20	0	80
General Manager	15	5	0	0	0	0	20
Mine Superintendent	20	10	5	0	0	5	40
Assistant Mine Superintendent	20	10	5	0	0	5	40
Mine Foreman	35	25	10	5	0	10	85
Assistant Mine Foreman	40	30	10	5	0	5	90
Maintenance Foreman	30	15	10	0	0	0	55
Assistant Maintenance Foreman	30	20	10	5	0	0	65
Construction Foreman	25	20	10	5	0	5	65
Assistant Construction Foreman	25	20	10	5	0	5	65
Track Foreman (Track Haulage)	25	45	20	0	0	0	90
Track Foreman (Supplies)	70	0	20	0	0	0	90
Assistant Track Foreman	30	45	20	0	0	0	95

TABLE II-5 (Cont'd.)

YEARLY PERCENTAGE OF TIME ASSOCIATED WITH VARIOUS LOGISTICS ACTIVITIES

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation	Total
Belt Foreman	30	60	0	0	0	0	90
Assistant Belt Foreman	40	55	0	0	0	0	95
Ventilation Foreman	25	0	0	0	0	70	95
Safety Director	25	10	10	5	5	5	60
Assistant Safety Director	25	10	10	5	5	5	60
Outside Foreman	25	10	0	5	0	0	40
Assistant Outside Foreman	25	10	0	5	0	0	40
Chief Engineer	10	10	5	5	5	10	45
Engineer	10	5	5	5	5	5	35
Surveyor	20	0	0	0	0	0	20
Draftsman/Technician	10	5	0	0	0	10	25
Purchasing Agent	25	0	0	0	0	0	25
Assistant Purchasing Agent	25	0	0	0	0	0	25
Warehouseman	50	0	0	0	0	0	50
Outside Supply Man	90	0	0	0	0	0	90
Clerk	10	10	0	0	5	5	30
Secretary	10	10	0	0	0	0	20
Shop Foreman	20	30	10	10	0	0	70
Assistant Shop Foreman	20	30	10	10	0	0	70
Chief Electrician	30	10	40	5	0	5	90
Assistant Chief Electrician	30	10	40	5	0	5	90
Training Supervisor	20	15	10	5	0	10	60

APPENDIX III
LOGISTICS COST ANALYSIS FOR FACES AND PANELS

III-1 - III-2

ANALYSIS III
LOGISTICS COST ANALYSIS FOR FACES AND PANELS

As discussed in the text, logistics costs for various mining situations in faces and panels were investigated. The variables taken into account included seam thickness, type of mining operation, and type of section supply system. The cost categories analyzed included capital, operating, depreciation, power, labor, and labor benefits.

The costs assigned to faces and panels include the costs of all those logistics activities that occur inby the panel entrance. The only exceptions were overcast costs and ventilation costs. Overcasts used to direct air to a particular panel were included in the face and panel costs. The cost of power and fans required to move air in a particular panel was not included. These costs are addressed in Appendix IV under costs for different mine sizes. However, costs associated with directing, distributing, and regulating air in the faces and panels are included in this section.

Most of the input data used in the analysis were developed based on information gathered from industry sources. In cases where information was not available directly from mine operators or suppliers, costs were calculated based on related information. For example, average power costs for operating various equipment items were not available from mine operators or suppliers. However, average power consumption rates were available from academic sources. The average power consumption information was used to calculate estimated power costs.

The various costs investigated are presented in the form of tables by cost categories. Capital costs for room and pillar faces and panels are shown in Table III-1. A summary is shown in Table III-2. Most of the equipment items in faces and panels are associated with logistics activities. The exceptions are the continuous miner, which was considered to provide coal and rock extraction, and the roof bolter, which was considered to provide roof support. Activities associated with coal and rock extraction and roof support are two major activities in the underground mine environment not considered as being logistics activities.

Capital costs for longwall faces and panels are shown in Table III-3. A summary is shown in Table III-4. Nonlogistical activities in this case include coal and rock extraction (shear), roof support (supports), coal fragmentation (impact breaker), and lighting. The analysis of these activities revealed that they are not part of underground coal mine logistics as defined earlier.

The same approach and format used for capital costs analysis was used in calculating operating costs. Operating costs for room and pillar operations are shown in Table III-5. A summary is shown in Table III-6. Costs for longwall operations are shown in Table III-7, and a summary is shown in Table III-8.

A similar format was used for depreciation costs. The depreciated life of various logistics items was based on the estimated time the equipment is used before major overhauls are required. It was assumed that major overhaul costs are equal to new equipment costs. The

TABLE III-1

CAPITAL COSTS FOR FACES AND PANELS
IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
(Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment						
Track						
Rail	27,400	-	27,400	-	27,400	-
Ties, Joint Bars, Bolts, Etc.	11,010	-	11,010	-	11,010	-
Switches, Frogs, Etc.	3,000	-	3,000	-	3,000	-
Mantrips						
Mantrip Tractor, Battery, and Charger	-	55,000	-	55,000	-	55,000
Personnel Track Mantrip	39,000	-	39,000	-	39,000	-
Supply Equipment						
Scoop, Battery, and Charger	75,000	75,000	105,000	105,000	105,000	105,000
Section Supply Cars	27,200	27,200	27,200	27,200	27,200	27,200
Subtotal	182,610	157,200	212,610	187,200	212,610	187,200
Coal and Rock Transportation						
Shuttle Cars	250,000	250,000	250,000	250,000	270,000	270,000
Feeder	70,000	70,000	80,000	80,000	100,000	100,000
Conveyor Belt	54,000	54,000	54,000	54,000	54,000	54,000
Conveyor Belt Structure, Rope, Idlers, Etc.	39,000	39,000	39,000	39,000	39,000	39,000
Conveyor Belt Drive	35,000	35,000	35,000	35,000	35,000	35,000
Conveyor Take-Up	10,000	10,000	10,000	10,000	10,000	10,000
Conveyor Belt Tailpiece	5,000	5,000	5,000	5,000	5,000	5,000
Subtotal	463,000	463,000	473,000	473,000	513,000	513,000

TABLE III-1 (Cont'd.)

CAPITAL COSTS FOR FACES AND PANELS
IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
(Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Electrical Distribution and Communications System						
Communications	3,000	3,000	3,000	3,000	3,000	3,000
Section Power Box	35,000	35,000	35,000	35,000	40,000	40,000
High Voltage Cable						
Plugs	5,000	5,000	5,000	5,000	5,000	5,000
Cable	24,000	24,000	24,000	24,000	24,000	24,000
Low Voltage Cable						
Miner	6,755	6,755	6,755	6,755	6,755	6,755
Shuttle Cars	1,950	1,950	2,400	2,400	2,800	2,800
Roof Bolter	1,410	1,410	1,410	1,410	1,410	1,410
Feeder	2,600	2,600	2,600	2,600	2,600	2,600
Charger	950	1,900	950	1,900	950	1,900
Pump	950	950	950	950	950	950
Belt Drive						
Power Box	26,000	26,000	26,000	26,000	26,000	26,000
Cable	2,880	2,880	2,880	2,880	2,880	2,880
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	8,400	8,400	8,400	8,400	8,400	8,400
Subtotal	118,895	119,845	119,345	120,295	124,745	125,695

TABLE III-1 (Cont'd.)

CAPITAL COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Water Handling System						
Pump	4,000	4,000	4,000	4,000	4,000	4,000
Discharge Water Line	2,500	2,500	2,500	2,500	2,500	2,500
Fresh Water Line and Hose	7,500	7,500	7,500	7,500	7,500	7,500
Subtotal	14,000	14,000	14,000	14,000	14,000	14,000
Ventilation						
Block Walls	8,679	8,679	10,607	10,607	14,464	14,464
Overcasts	3,000	3,000	3,500	3,500	4,000	4,000
Mandoors	1,286	1,286	1,286	1,286	1,286	1,286
Subtotal	12,965	12,965	15,393	15,393	19,750	19,750
TOTAL CAPITAL COSTS ASSOCIATED WITH LOGISTICS	791,470	767,010	834,348	809,888	884,105	859,645
Other Capital Items						
Continuous Miner	490,000	490,000	520,000	520,000	540,000	540,000
Roof Bolter	125,000	125,000	125,000	125,000	125,000	125,000
TOTAL OTHER CAPITAL ITEMS	615,000	615,000	645,000	645,000	665,000	665,000

TABLE III-2

SUMMARY OF CAPITAL COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
($1000)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track-	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment	182.6	157.2	212.6	187.2	212.6	187.2
Coal and Rock Transportation	463.0	463.0	473.0	473.0	513.0	513.0
Electrical Distribution and Communications System	118.9	119.8	119.3	120.3	124.7	125.7
Water Handling System	14.0	14.0	14.0	14.0	14.0	14.0
Ventilation	13.0	13.0	15.4	15.4	19.8	19.8
TOTAL LOGISTICS	791.5	767.0	834.3	809.9	884.1	859.6
Other	615.0	615.0	645.0	645.0	665.0	665.0
TOTAL CAPITAL	1,406.5	1,382.0	1,479.3	1,454.9	1,549.1	1,524.6

TABLE III-3

CAPITAL COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Transport of Personnel, Supplies, and Equipment			
Track			
Rail	36,534	36,534	36,534
Ties, Joint Bars, Bolts, Etc.	14,680	14,680	14,680
Switches, Frogs, Etc.	4,000	4,000	4,000
Mantrip	39,000	39,000	39,000
Supply Equipment			
Scoop, Battery, and Charger	75,000	75,000	105,000
Supply Cars	13,600	13,600	13,600
Subtotal	182,814	182,814	212,814
Coal and Rock Transportation			
Face Conveyor	350,000	450,000	550,000
Head and Tail Conveyor Drives	290,000	300,000	350,000
Stage Loader	100,000	120,000	140,000
Tailpiece	60,000	70,000	80,000
Conveyor Belt	54,000	54,000	54,000
Conveyor Belt Structure, Rope, Idlers, Etc.	39,000	39,000	39,000
Conveyor Belt Drive	35,000	35,000	35,000
Conveyor Take-Up	10,000	10,000	10,000
Subtotal	938,000	1,078,000	1,236,000
Electrical Distribution and Communications System			
Communications	4,000	4,000	4,000
Section Power Center and Plugs	250,000	250,000	250,000
High Voltage Cable			
Plugs	7,000	7,000	7,000
Cable	32,000	32,000	32,000

TABLE III-3 (Cont'd.)

CAPITAL COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Low Voltage Cable			
Shear	10,400	10,400	10,400
Pumps, Motors, Etc.	6,400	6,400	6,400
Bolt Drive			
Power Center	30,000	30,000	30,000
Cable	2,880	2,880	2,880
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	11,200	11,200	11,200
Subtotal	353,880	353,880	353,880
Water Handling System			
Pump	4,000	4,000	4,000
Discharge Water Line	5,000	5,000	5,000
Fresh Water Line and Hose	11,250	11,250	11,250
Subtotal	20,250	20,250	20,250
Hydraulics			
Hydraulic Power Pack	140,000	140,000	190,000
Hoses and Fittings	5,000	5,000	5,000
Subtotal	145,000	145,000	195,000
Ventilation	0	0	0
TOTAL CAPITAL COSTS ASSOCIATED WITH LOGISTICS	1,639,944	1,779,944	2,017,944
Other Capital Items			
Shear	1,300,000	1,600,000	2,200,000
Shield Supports	2,708,000	3,542,000	4,583,000
Single Supports	50,000	70,000	90,000
Impact Breaker	100,000	130,000	160,000
Lighting	70,000	70,000	80,000
TOTAL OTHER CAPITAL ITEMS	4,228,000	5,412,000	7,113,000

TABLE III-4

SUMMARY OF CAPITAL COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES ($1000)

Logistics Activity	Less than Four Feet	Four to Six Feet	Greater than Six Feet
Transport of Personnel, Supplies, and Equipment	182.8	182.8	212.8
Coal and Rock Transportation	938.0	1,078.0	1,236.0
Electrical Distribution and Communications System	353.9	353.9	353.9
Water Handling System	20.3	20.3	20.3
Hydraulics	145.0	145.0	195.0
Ventilation	0	0	0
TOTAL LOGISTICS	1,640.0	1,780.0	2,018.0
Other	4,228.0	5,412.0	7,113.0
TOTAL CAPITAL	5,868.0	7,192.0	9,131.0

TABLE III-5

OPERATING COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR VARIOUS SEAM THICKNESSES

(Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment						
Track						
Rail	1,370	-	1,370	-	1,370	-
Ties, Joint Bars, Bolts, Etc.	1,101	-	1,101	-	1,101	-
Switches, Frogs, Etc.	150	-	150	-	150	-
Mantrips						
Mantrip Tractor, Battery, and Charger	-	6,600	-	6,600	-	6,600
Personnel Track Mantrip	1,950	-	1,950	-	1,950	-
Supply Equipment						
Scoop, Battery, and Charger	9,000	9,000	12,600	12,600	12,600	12,600
Section Supply Cars	816	816	816	816	816	816
Subtotal	14,387	16,416	17,987	20,016	17,987	20,016
Coal and Rock Transportation						
Shuttle Cars	37,500	37,500	37,500	37,500	40,500	40,500
Feeder	3,500	3,500	4,000	4,000	5,000	5,000
Conveyor Belt	2,700	2,700	2,700	2,700	2,700	2,700
Conveyor Belt Structure, Rope, Idlers, Etc.	3,900	3,900	3,900	3,900	3,900	3,900
Conveyor Belt Drive	1,750	1,750	1,750	1,750	1,750	1,750
Conveyor Take-Up	800	800	800	800	800	800
Conveyor Tailpiece	400	400	400	400	400	400
Subtotal	50,550	50,550	51,050	51,050	55,050	55,050

TABLE III-5 (Cont'd.)

OPERATING COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR VARIOUS SEAM THICKNESSES

(Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Electrical Distribution and Communications System						
Communications	600	600	600	600	600	600
Section Power Box	1,750	1,750	1,750	1,750	2,000	2,000
High Voltage Cable						
Plugs	600	600	600	600	600	600
Insulators, Hangers, Splices, Etc.	500	500	500	500	500	500
Low Voltage Cable						
Miner	8,444	8,444	8,444	8,444	8,444	8,444
Shuttle Cars	5,850	5,850	7,200	7,200	8,400	8,400
Roof Bolter	1,762	1,762	1,762	1,762	1,762	1,762
Feeder	1,300	1,300	1,300	1,300	1,300	1,300
Charger	475	475	475	475	475	475
Pump	475	475	475	475	475	475
Plugs	400	400	400	400	400	400
Splices	10,252	10,252	10,252	10,252	10,252	10,252
Belt Drive						
Power Box	1,300	1,300	1,300	1,300	1,300	1,300
Cable	864	864	864	864	864	864
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	1,260	1,260	1,260	1,260	1,260	1,260
Subtotal	35,832	35,832	37,182	37,182	38,632	38,632

TABLE III-5 (Cont'd.)

OPERATING COSTS FOR FACES AND PANELS
IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
(Dollars)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Water Handling System						
Pump	400	400	400	400	400	400
Discharge Water Line	250	250	250	250	250	250
Fresh Water Line and Hose	750	750	750	750	750	750
Subtotal	1,400	1,400	1,400	1,400	1,400	1,400
Ventilation						
Block Walls	434	434	530	530	723	723
Overcasts	150	150	175	175	200	200
Mandoors	–	–	–	–	–	–
Brattice Cloth	2,000	2,000	2,500	2,500	3,000	3,000
Subtotal	2,584	2,584	3,205	3,205	3,923	3,923
TOTALS	103,353	105,382	110,824	112,853	116,992	119,021

TABLE III-6

SUMMARY OF OPERATING COSTS FOR
FACE AND PANEL EQUIPMENT IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
($1000)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment	14.4	16.4	18.0	20.0	18.0	20.0
Coal and Rock Transportation	50.6	50.6	51.1	51.1	55.1	55.1
Electrical Distribution and Communications System	35.8	35.8	37.2	37.2	38.6	38.6
Water Handling System	1.4	1.4	1.4	1.4	1.4	1.4
Ventilation	2.6	2.6	3.2	3.2	3.9	3.9
TOTAL	104.8	106.8	110.9	112.9	117.0	119.0

TABLE III-7

OPERATING COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Transport of Personnel, Supplies, and Equipment			
Track			
Rail	1,827	1,827	1,827
Ties, Joint Bars, Bolts, Etc.	1,468	1,468	1,468
Switches, Frogs, Etc.	200	200	200
Mantrip	1,950	1,950	1,950
Supply Equipment			
Scoop, Battery, and Charger	9,000	9,000	12,600
Supply Cars	408	408	408
Subtotal	14,853	14,853	18,453
Coal and Rock Transportation			
Face Conveyor	87,500	112,500	137,500
Head and Tail Conveyor Drives	29,000	30,000	35,000
Stage Loader	10,000	12,000	14,000
Tailpiece	3,000	3,500	4,000
Conveyor Belt	2,700	2,700	2,700
Conveyor Belt Structure, Rope, Idlers, Etc.	3,900	3,900	3,900
Conveyor Belt Drive	1,750	1,750	2,000
Conveyor Take-Up	800	800	800
Subtotal	138,650	167,150	199,900
Electrical Distribution and Communications System			
Communications	800	800	800
Section Power Center and Plugs	7,500	7,500	7,500
High Voltage Cable			
Plugs	800	800	800
Insulators, Hangers, Splices, Etc.	100	100	100

TABLE III-7 (Cont'd.)

OPERATING COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activitiy	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Low Voltage Cable			
Shear	10,400	10,400	10,400
Pumps, Motors, Etc.	3,200	3,200	3,200
Belt Drive			
Power Center	1,500	1,500	1,500
Cable	864	864	864
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	560	560	560
Subtotal	25,724	25,724	25,724
Water Handling System			
Pump	400	400	400
Discharge Water Line	500	500	500
Fresh Water Line and Hose	562	562	562
Subtotal	1,462	1,462	1,462
Hydraulics			
Hydraulic Power Pack	35,000	35,000	35,000
Hoses and Fittings	2,500	2,500	2,500
Subtotal	37,500	37,500	37,500
Ventilation			
Brattice Cloth	500	700	1,000
Block Walls	300	500	800
Overcasts	300	300	300
Subtotal	1,100	1,500	2,100

TABLE III-8

SUMMARY OF OPERATING COSTS
FOR LONGWALL FACES AND PANELS
IN VARIOUS SEAM THICKNESSES
($1000)

Logistics Activity	Less Than Four Feet	Four to Six Feet	Greater than Six Feet
Transport of Personnel, Supplies, and Equipment	14.9	14.9	14.9
Coal and Rock Transportation	138.7	167.2	199.9
Electrical Distribution and Communications System	25.7	25.7	25.7
Water Handling System	1.5	1.5	1.5
Hydraulics	37.5	37.5	37.5
Ventilation	1.1	1.5	2.1
TOTAL	219.4	248.3	281.6

depreciation costs for room and pillar operations are shown in Table III-9. A summary is shown in Table III-10. Depreciation costs for longwall sections are shown in Table III-11, and a summary is shown in Table III-12.

Power costs in various mining situations were also calculated and are based on the average power consumption rates for the equipment. Tables III-13 through III-15 illustrate the calculation procedure and power costs for equipment in various seam thicknesses. A summary is shown in Table III-16. Power costs for longwall operations are shown in Table III-17, and a summary is contained in Table III-18.

Labor costs for different mining situations were determined based on the cost analysis performed in Appendix II. The costs for different seam thicknesses and mine conditions in room and pillar operations are shown in Table III-19. Labor costs in longwall operations are shown in Table III-20.

Labor benefits were calculated by the procedure outlined in Appendix II. First, however, the number of hours worked by hourly personnel was determined. Hours worked in room and pillar operations are shown in Table III-21. For longwall operations, hours worked are shown in Table III-22. Labor benefit costs for room and pillar operations and for longwall operations are shown as calculated in Tables III-23 and III-24 respectively.

The labor and labor benefit costs were then determined for each logistics activity. The percentages of time each labor classification is involved with each logistics activity (Table II-5) were multiplied by the

TABLE III-9

DEPRECIATION COSTS FOR FACES AND PANELS
IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
(Dollars)

Logistics Activity	Depreciated Life (Years)	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
		Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment							
Track							
Rail	10	2,740	-	2,740	-	2,740	-
Ties, Joint Bars, Bolts, Etc.	10	1,101	-	1,101	-	1,101	-
Switches, Frogs, Etc.	10	300	-	300	-	300	-
Mantrip							
Mantrip Tractor, Battery and Charger	6	-	9,167	-	9,167	-	9,167
Personnel Track Mantrip	8	4,875	-	4,875	-	4,875	-
Supply Equipment							
Scoop, Battery, and Charger	6	12,500	12,500	17,500	17,500	17,500	17,500
Section Supply Cars	10	2,720	2,720	2,720	2,720	2,720	2,720
Subtotal		24,236	24,387	29,236	29,387	29,236	29,387
Coal and Rock Transportation							
Shuttle Cars	5	50,000	50,000	50,000	50,000	54,000	54,000
Feeder	5	14,000	14,000	16,000	16,000	20,000	20,000
Conveyor Belt	8	6,750	6,750	6,750	6,750	6,750	6,750

TABLE III-9 (Cont'd.)

DEPRECIATION COSTS FOR FACES AND PANELS
IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
(Dollars)

Logistics Activity	Depreciated Life (Years)	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
		Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Coal and Rock Transportation (Cont'd.)							
Conveyor Belt Structure, Rope, Idlers, Etc.	8	4,875	4,875	4,875	4,875	4,875	4,875
Conveyor Belt Drive	8	4,375	4,375	4,375	4,375	4,375	4,375
Conveyor Take-Up	8	1,250	1,250	1,250	1,250	1,250	1,250
Conveyor Belt Tailpiece	8	625	625	625	625	625	625
Subtotal		81,875	81,875	83,875	83,875	91,875	91,875
Electrical Distribution and Communications System							
Communications	3	1,000	1,000	1,000	1,000	1,000	1,000
Section Power Center	7	5,000	5,000	5,000	5,000	5,714	5,714
High Voltage Cable							
Plugs	7	714	714	714	714	714	714
Cable	7	3,429	3,429	3,429	3,429	3,429	3,429
Low Voltage Cable							
Miner	4	1,689	1,689	1,689	1,689	1,689	1,689
Shuttle Cars	5	390	390	480	480	560	560
Roof Bolter	5	282	282	282	282	282	282
Feeder	5	520	520	520	520	520	520
Charger	7	136	271	136	271	136	271
Pump	7	136	136	136	136	136	136

TABLE III-9 (Cont'd.)

DEPRECIATION COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Depreciated Life (Years)	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
		Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Electrical Distribution and Communications System (Cont'd.)							
Belt Drive							
Power Center	8	3,250	3,250	3,250	3,250	3,250	3,250
Cable	8	360	360	360	360	360	360
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	8	1,050	1,050	1,050	1,050	1,050	1,050
Subtotal		17,956	18,091	18,046	18,181	18,840	18,975
Water Handling System							
Pump	4	1,000	1,000	1,000	1,000	1,000	1,000
Discharge Water Line	5	500	500	500	500	500	500
Fresh Water Line and Hose	5	1,500	1,500	1,500	1,500	1,500	1,500
Subtotal		3,000	3,000	3,000	3,000	3,000	3,000
Ventilation							
Block Walls	3	2,893	2,893	3,536	3,536	4,821	4,821
Overcasts	3	1,000	1,000	1,167	1,167	1,333	1,333
Mandoors	5	257	257	257	257	257	257
Subtotal		4,150	4,150	4,960	4,960	6,411	6,411

TABLE III-10

SUMMARY OF DEPRECIATION COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR VARIOUS SEAM THICKNESSES
($1000)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment	24.2	24.4	29.2	29.4	29.2	29.4
Coal and Rock Transportation	81.9	81.9	83.9	83.9	91.9	91.9
Electrical Distribution and Communications System	18.0	18.1	18.0	18.2	18.8	19.0
Water Handling System	3.0	3.0	3.0	3.0	3.0	3.0
Ventilation	4.2	4.2	5.0	5.0	6.4	6.4
TOTAL	131.3	131.6	139.1	139.5	149.3	149.7

TABLE III-11

DEPRECIATION COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Depreciated Life (Years)	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Transport of Personnel, Supplies, and Equipment				
Track				
Rail	10	3,653	3,653	3,653
Ties, Joint Bars, Bolts, Etc.	10	1,468	1,468	1,468
Switches, Frogs, Etc.	10	400	400	400
Mantrip	8	4,875	4,875	4,875
Supply Equipment				
Scoop, Battery, and Charger	6	12,500	12,500	17,500
Supply Cars	10	1,360	1,360	1,360
Subtotal		24,256	24,256	29,256
Coal and Rock Transportation				
Face Conveyor	4	87,500	112,500	137,500
Head and Tail Conveyor Drives	5	58,000	60,000	70,000
Stage Loader	5	20,000	24,000	28,000
Tailpiece	8	7,500	8,750	10,000
Conveyor Belt	6	9,000	9,000	9,000
Conveyor Belt Structure, Rope, Idlers, Etc.	8	4,875	4,875	4,875
Conveyor Belt Drive	8	4,375	4,375	5,000
Conveyor Take-Up	8	1,250	1,250	1,250
Subtotal		192,500	224,750	265,625
Electrical Distribution and Communications System				
Communications	3	1,333	1,333	1,333
Section Power Center and Plugs	5	50,000	50,000	50,000
High Voltage Cable				
Plugs	7	1,000	1,000	1,000
Cable	7	4,571	4,571	4,571

TABLE III-11 (Cont'd.)

DEPRECIATION COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Depreciated Life (Years)	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Low Voltage Cable				
Shear	3	3,467	3,467	3,467
Pumps, Motors, Etc.	3	2,133	2,133	2,133
Belt Drive				
Power Center	8	3,750	3,750	3,750
Cable	8	360	360	360
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	8	1,400	1,400	1,400
Subtotal		68,014	68,014	68,014
Water Handling System				
Pump	4	1,000	1,000	1,000
Discharge Water Line	5	1,000	1,000	1,000
Fresh Water Line and Hose	5	2,250	2,250	2,250
Subtotal		4,250	4,250	4,250
Hydraulics				
Hydraulic Power Pack	4	35,000	35,000	47,500
Hoses and Fittings	3	1,667	1,667	1,667
Subtotal		36,667	36,667	49,167
Ventilation		0	0	0

TABLE III-12

SUMMARY OF DEPRECIATION COSTS FOR LONGWALL FACES AND PANELS IN VARIOUS SEAM THICKNESSES ($1000)

Logistics Activity	Less than Four Feet	Four to Six Feet	Greater than Six Feet
Transport of Personnel, Supplies, and Equipment	24.3	24.3	29.3
Coal and Rock Transportation	192.5	224.8	265.6
Electrical Distribution and Communications System	68.0	68.0	68.0
Water Handling System	4.3	4.3	4.3
Hydraulics	36.7	36.7	49.2
TOTAL	325.8	358.1	416.4

TABLE III-13

POWER COSTS FOR FACE AND PANEL EQUIPMENT
IN ROOM AND PILLAR OPERATIONS WITH
LESS THAN FOUR FEET SEAM THICKNESS
(Dollars)

Logistics Activity	Belt-Track				Rubber-Tire			
	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrip Tractor	-	-	-		10	12	120	
Personnel Mantrip	6	6	36		-	-	-	
Scoop, Battery, Charger	10	12	120		10	12	120	
Total			156	$ 1,498			240	$ 2,304
Coal and Rock Transportation								
Shuttle Cars	10	12	120		10	12	120	
Feeder	26	10	260		26	10	260	
Conveyor Belt Drive	52	15	780		52	15	780	
Total			1,160	$ 11,136			1,160	$ 11,136
Electrical Distribution and Communications System				$ 1,334				$ 1,414
Water Handling System	4	12	48	$ 701	4	12	48	$ 701

TABLE III-14

POWER COSTS FOR FACE AND PANEL EQUIPMENT
IN ROOM AND PILLAR OPERATIONS WITH
FOUR TO SIX FEET SEAM THICKNESS
(Dollars)

Logistics Activity	Belt-Track				Rubber-Tire			
	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrip Tractor	-	-	-		10	12	120	
Personnel Mantrip	5	6	36		-	-	-	
Scoop, Battery, Charger	13	12	156		13	12	156	
Total			192	$ 1,843			276	$ 2,650
Coal and Rock Transportation								
Shuttle Cars	13	12	156		13	12	156	
Feeder	33	10	330		33	10	330	
Conveyor Belt Drive	65	14	910		65	15	975	
Total			1,396	$ 13,402			1,461	$ 14,026
Electrical Distribution and Communications System				$ 1,595				$ 1,738
Water Handling System	4	12	48	$ 701	4	12	48	$ 701

TABLE III-15

POWER COSTS FOR FACE AND PANEL EQUIPMENT IN ROOM AND PILLAR OPERATIONS WITH GREATER THAN SIX FEET SEAM THICKNESS

(Dollars)

Logistics Activity	Belt-Track				Rubber-Tire			
	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrip Tractor	-	-	-		10	12	120	
Personnel Mantrip	6	6	36		-	-	-	
Scoop, Battery, Charger	15	12	180		15	12	180	
Total			216	$ 2,074			300	$ 2,880
Coal and Rock Transportation								
Shuttle Cars	15	12	180		15	12	180	
Feeder	37	10	370		37	10	370	
Conveyor Belt Drive	78	15	1,170		78	15	1,170	
Total			1,720	$ 16,512			1,720	$ 16,512
Electrical Distribution and Communications System				$ 1,929				$ 2,009
Water Handling System	4	12	48	$ 701	4	12	48	$ 701

TABLE III-16

SUMMARY OF POWER COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR VARIOUS SEAM THICKNESSES ($1000)

Logistics Activity	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Transport of Personnel, Supplies, and Equipment	1.5	2.3	1.8	2.7	2.1	2.9
Coal and Rock Transportation	11.1	11.1	13.4	14.0	16.5	16.5
Electrical Distribution and Communications System	1.3	1.4	1.6	1.7	1.9	2.0
Water Handling System	0.7	0.7	0.7	0.7	0.7	0.7
Hydraulics	–	–	–	–	–	–
TOTAL	14.6	15.5	17.5	19.1	21.2	22.1

TABLE III-17

POWER COSTS FOR LONGWALL OPERATIONS IN VARIOUS SEAM THICKNESSES (Dollars)

Logistics Activity	Less than Four Feet				Four to Six Feet				Greater than Six Feet			
	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Power Cost Per Year
Transport of Personnel, Supplies, and Equipment												
Personnel Mantrip	6	6	36		6	6	36		6	6	36	
Scoop, Battery, Charger	10	12	120		13	12	156		15	12	180	
Total			156	$ 1,498			192	$ 1,843			216	$ 2,074
Coal and Rock Transportation												
Face Conveyor Head and Tail Drive	150	15	2,250	$ 21,600	150	15	2,250	$ 21,600	170	15	2,550	$ 24,480
Stage Loader	80	15	1,200	11,520	80	15	1,200	11,520	90	15	1,350	12,960
Total			3,450	$ 33,120			3,450	$ 33,120			3,900	$ 37,440
Electrical Distribution and Communications System				$ 4,972				$ 5,294				$ 6,182
Water Handling System	4	12	48	$ 701	4	12	48	$ 701	4	12	48	$ 701
Hydraulics Power Pack	100	15	1,500	$ 14,400	120	15	1,800	$ 17,280	150	15	2,250	$ 21,600

TABLE III-18

SUMMARY OF POWER COSTS
FOR LONGWALL FACES AND PANELS
IN VARIOUS SEAM THICKNESSES
($1000)

Logistics Activity	Less Than Four Feet	Four to Six Feet	Greater Than Six Feet
Transport of Personnel, Supplies, and Equipment	1.5	1.8	2.1
Coal and Rock Transportation	33.1	33.1	37.4
Electrical Distribution and Communications System	5.0	5.3	6.2
Water Handling System	0.7	0.7	0.7
Hydraulics	14.4	17.3	21.6
TOTAL	54.7	58.2	68.0

TABLE III-19

LABOR COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS (Dollars)

Job Classification	Yearly Logistics Cost	Number of People	Yearly Cost in Seam Less than Four Feet		Yearly Cost in Seam Four to Six Feet		Yearly Cost in Seam Greater than Six Feet	
			Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Salary								
Foreman	$23,800	3	$ 71,400	$ 71,400	$ 71,400	$ 71,400	$ 71,400	$ 71,400
Hourly Labor								
Miner Operator	$13,167	2	$ 26,334	$ 26,334	$ 26,334	$ 26,334	$ 26,334	$ 26,334
Miner Helper	20,482	2	40,964	40,964	40,964	40,964	40,964	40,964
Bolter Operator	11,704	2	23,408	23,408	23,408	23,408	23,408	23,408
Bolter Helper	20,482	2	40,964	40,964	40,964	40,964	40,964	40,964
Shuttle Car Operator	26,226	4	104,904	104,904	104,904	104,904	104,904	104,904
Mechanic/ Electrician	19,464	4	77,856	77,856	77,856	77,856	77,856	77,856
Face Supply Man	25,602	0,1	0	25,602	0	25,602	0	25,602
Faceman	22,907	4,5,6*	91,628	91,628	114,535	114,535	137,442	137,442
Beltman	24,344	2	48,688	48,688	48,688	48,688	48,688	48,688
Subtotal Hourly			$454,746	$480,348	$477,653	$503,255	$500,560	$526,162
TOTAL			$526,146	$551,748	$549,053	$574,655	$571,960	$597,562

*Four men for coal seams less than four feet, five men for four to six feet, and six men for greater than six feet.

TABLE III-20

LABOR COSTS
IN LONGWALL FACES AND PANELS
(Dollars)

Job Classification	Yearly Logistics Cost	Number of People	Yearly Cost
Salary			
Production Foreman	23,800	3	71,400
Maintenance Foreman	25,500	1	25,500
Longwall Coordinator	28,800	1	28,800
Longwall Superintendent	28,500	1	28,500
Subtotal			154,200
Hourly			
Shear Operator	12,183	3	36,549
Shear Operator Helper	12,183	3	36,549
Longwall Support Operator	11,495	6	68,970
Headgate Operator	26,717	3	80,151
Tailgate Operator	26,717	3	80,151
Longwall Operator	27,411	3	82,233
Conveyor Snaker	53,273	3	159,819
Faceman	22,907	6	137,442
Mechanic/Electrician	19,464	3	58,392
Beltman	24,344	6	146,064
Subtotal			886,320
TOTAL			1,040,520

TABLE III-21

HOURS WORKED BY HOURLY PERSONNEL IN FACES AND PANELS FOR ROOM AND PILLAR OPERATIONS IN VARIOUS SEAM THICKNESSES

Job Classification	Yearly Hours Worked	Number of People	Yearly Hours in Seam Less than Four Feet		Yearly Hours in Seam Four to Six Feet		Yearly Hours in Seam Greater than Six Feet	
			Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Miner Operator	938	2	1,876	1,876	1,876	1,876	1,876	1,876
Miner Helper	1,461	2	2,922	2,922	2,922	2,922	2,922	2,922
Bolter Operator	835	2	1,670	1,670	1,670	1,670	1,670	1,670
Bolter Helper	1,462	2	2,924	2,924	2,924	2,924	2,924	2,924
Shuttle Car Operator	1,983	4	7,932	7,932	7,932	7,932	7,932	7,932
Mechanic/Electrician	1,342	4	5,368	5,368	5,368	5,368	5,368	5,368
Face Supply Man	1,948	0,1	0	1,948	0	1,948	0	1,948
Faceman	1,743	4,5,6	6,972	6,972	8,715	8,715	10,458	10,458
Beltman	1,913	2	3,826	3,826	3,826	3,826	3,826	3,826
TOTAL			33,490	35,438	35,233	37,181	36,976	38,924

TABLE III-22

HOURS WORKED BY HOURLY PERSONNEL IN LONGWALL OPERATIONS

Job Classification	Number of People	Yearly Hours Worked Per Employee	Yearly Hours Worked Per Classification
Shear Operator	3	857	2,571
Shear Helper	3	857	2,571
Longwall Support Operator	6	857	5,142
Headgate Operator	3	1,930	5,790
Tailgate Operator	3	1,930	5,790
Longwall Operator	3	1,929	5,787
Conveyor Snaker	3	1,929	5,787
Faceman	6	1,743	10,458
Mechanic/Electrician	3	1,342	4,026
Beltman/Cribman	6	1,913	11,478
TOTAL			59,400

TABLE III-23

LABOR BENEFIT COSTS IN FACES AND PANELS FOR ROOM AND PILLAR OPERATIONS IN VARIOUS SEAM THICKNESSES

(Dollars)

Labor Benefit Items	Yearly Cost in Seam Less than Four Feet		Yearly Cost in Seam Four to Six Feet		Yearly Cost in Seam Greater than Six Feet	
	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire	Belt-Track	Rubber-Tire
Social Security						
Hourly (6.7%)	30,468	32,183	32,003	33,718	33,538	35,253
Salary (6.2%)	4,427	4,427	4,427	4,427	4,427	4,427
Health and Retirement						
Hourly ($1.037/Hr.)	34,729	36,749	36,537	38,557	38,344	40,364
Salary (15%)	10,710	10,710	10,710	10,710	10,710	10,710
Sickness and Accident (8%)	42,092	44,140	43,924	45,972	45,757	47,805
Additional Benefits						
Hourly (2%)	9,095	9,607	9,553	10,065	10,011	10,523
Salary (4%)	2,856	2,856	2,856	2,856	2,856	2,856
Workmens Comp. (22½)	115,752	121,385	120,792	126,424	125,831	131,464
TOTAL	250,129	262,057	260,802	272,729	271,474	283,402

TABLE III-24

LABOR BENEFIT COSTS FOR LONGWALL FACES AND PANELS (Dollars)

Labor Benefit Items	Yearly Cost
Social Security	
Hourly (6.7%)	59,384
Salary (6.2%)	9,560
Health and Retirement	
Hourly ($1.037/Hr.)	61,598
Salary (15%)	23,130
Sickness and Accident (8%)	83,242
Additional Benefits	
Hourly (2%)	17,727
Salary (4%)	6,168
Workmens Compensation (22%)	228,914
TOTAL	489,723

annual labor cost (Table II-3). The results for room and pillar operations are shown in Tables III-25 through III-30. The labor benefits cost calculated in Table III-23 was proportioned among the various logistics activities in the same proportion as the labor cost. The labor costs for longwall operations were calculated in the same manner and are shown in Table III-31. Information from Table III-24 was used to determine labor benefits for each logistics activity.

The above calculations and tables yielded the capital, operating, depreciation, power, labor, and labor benefits costs for various seam thicknesses and mine situations. The results for room and pillar operations are condensed and summarized in Tables III-32 through III-37. A summary of results for longwall operations is shown in Tables III-38 and III-39. Finally, results of the investigation are condensed even further into Tables III-40 and III-41.

TABLE III-25

LABOR AND BENEFIT COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR COAL SEAMS LESS THAN FOUR FEET THICK WITH BELT-TRACK TRANSPORTATION (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	0	0	0	0	0	0
Faceman	32,340	21,560	10,780	10,780	0	16,168
TOTAL LABOR	203,882	181,112	69,644	24,658	0	46,850
LABOR BENEFITS	96,925	86,100	33,109	11,722	0	22,272

TABLE III-26

LABOR AND BENEFIT COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR COAL SEAMS LESS THAN FOUR FEET THICK
WITH RUBBER-TIRE TRANSPORTATION
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	22,907	0	2,695	0	0	0
Faceman	32,340	21,560	10,780	10,780	0	16,168
TOTAL LABOR	226,789	181,112	72,339	24,658	0	46,850
LABOR BENEFITS	107,715	86,021	34,357	11,712	0	22,252

TABLE III-27

LABOR AND BENEFIT COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR COAL SEAMS FOUR TO SIX FEET THICK
WITH BELT-TRACK TRANSPORTATION
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	0	0	0	0	0	0
Faceman	40,425	26,950	13,475	13,475	0	20,210
TOTAL LABOR	211,967	186,502	72,339	27,353	0	50,892
LABOR BENEFITS	100,685	88,589	34,361	12,993	0	24,174

TABLE III-28

LABOR AND BENEFIT COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR COAL SEAMS FOUR TO SIX FEET THICK
WITH RUBBER-TIRE TRANSPORTATION
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	22,907	0	2,695	0	0	0
Faceman	40,425	26,950	13,475	13,475	0	20,210
TOTAL LABOR	234,874	186,502	75,034	27,353	0	50,892
LABOR BENEFITS	111,470	88,513	35,612	12,982	0	24,153

TABLE III-29

LABOR AND BENEFIT COSTS
FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS
FOR COAL SEAMS GREATER THAN SIX FEET THICK
WITH BELT-TRACK TRANSPORTATION
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	0	0	0	0	0	0
Facemen	48,510	32,340	16,170	16,170	0	24,252
TOTAL LABOR	220,052	191,892	75,034	30,048	0	54,934
LABOR BENEFITS	104,445	91,079	35,614	14,262	0	26,074

TABLE III-30

LABOR AND BENEFIT COSTS FOR FACES AND PANELS IN ROOM AND PILLAR OPERATIONS FOR COAL SEAMS GREATER THAN SIX FEET THICK WITH RUBBER-TIRE TRANSPORTATION (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Foreman	25,500	20,400	10,200	5,100	0	10,200
Miner Operator	17,556	2,926	0	2,926	0	2,926
Miner Helper	17,556	2,926	5,852	5,852	0	8,778
Bolter Operator	14,630	2,926	2,926	0	0	2,926
Bolter Helper	20,482	8,778	5,852	0	0	5,852
Shuttle Car Operator	33,128	66,256	5,520	0	0	0
Mechanic/Electrician	32,440	19,464	25,952	0	0	0
Beltman	10,250	35,876	2,562	0	0	0
Face Supply Man	22,907	0	2,695	0	0	0
Facemen	48,510	32,340	16,170	16,170	0	24,252
TOTAL LABOR	242,959	191,892	77,729	30,048	0	54,934
LABOR BENEFITS	115,227	91,007	36,864	14,251	0	26,053

TABLE III-31

LABOR AND BENEFIT COSTS FOR LONGWALL FACES AND PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Production Foreman	25,500	20,400	10,200	5,100	0	10,200
Maintenance Foreman	8,500	6,800	6,800	0	3,400	0
Longwall Coordinator	19,200	3,200	3,200	0	3,200	0
Longwall Superintendent	9,500	7,600	3,800	0	3,800	3,800
Shear Operator	22,842	4,569	4,569	4,569	0	0
Shear Operator Helper	22,842	4,569	4,569	4,569	0	0
Longwall Support Operator	60,348	8,622	0	0	0	0
Headgate Operator	35,622	40,077	4,452	0	0	0
Tailgate Operator	35,622	40,077	4,452	0	0	0
Longwall Operator	27,411	9,[illegible]38	36,546	4,569	0	4,569
Conveyor Snaker	53,274	106,545	0	0	0	0
Faceman	48,510	32,340	16,170	16,170	0	24,252
Mechanic/Electrician	24,330	14,598	14,598	0	4,866	0
Beltman	30,750	107,628	7,686	0	0	0
TOTAL LABOR	424,251	406,163	117,042	34,977	15,266	42,821
LABOR BENEFITS	199,675	191,161	55,086	16,462	7,185	20,154

TABLE III-32

SUMMARY OF FACE AND PANEL COSTS
FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS
LESS THAN FOUR FEET THICK WITH BELT-TRACK TRANSPORTATION
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	14.4	50.6	35.8	1.4	0	2.6
Depreciation	24.2	81.9	18.0	3.0	0	4.2
Power	1.5	11.1	1.3	0.7	0	0
Labor	203.9	181.1	69.6	24.7	0	46.9
Labor Benefits	96.9	86.1	33.1	11.7	0	22.3
TOTAL	340.9	410.8	157.8	41.5	0	76.0

TABLE III-33

SUMMARY OF FACE AND PANEL COSTS FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS LESS THAN FOUR FEET THICK WITH RUBBER-TIRE TRANSPORTATION ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	16.4	50.6	35.8	1.4	0	2.6
Depreciation	24.4	81.9	18.1	3.0	0	4.2
Power	2.3	11.1	1.4	0.7	0	0
Labor	226.8	181.1	72.3	24.7	0	46.9
Labor Benefits	107.7	86.0	34.4	11.7	0	22.3
TOTAL	377.6	410.7	162.0	41.5	0	76.0

TABLE III-34

SUMMARY OF FACE AND PANEL COSTS
FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS
FOUR TO SIX FEET THICK WITH BELT-TRACK TRANSPORTATION
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	18.0	51.1	37.2	1.4	0	3.2
Depreciation	29.2	83.9	18.0	3.0	0	5.0
Power	1.8	13.4	1.6	0.7	0	0
Labor	212.0	186.5	72.3	27.4	0	46.9
Labor Benefits	100.7	88.6	34.4	13.0	0	24.2
TOTAL	361.7	423.5	163.5	45.5	0	79.3

TABLE III-35

SUMMARY OF FACE AND PANEL COSTS FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS FOUR TO SIX FEET THICK WITH RUBBER-TIRE TRANSPORTATION ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	20.0	51.1	37.2	1.4	0	3.2
Depreciation	29.4	83.9	18.2	3.0	0	5.0
Power	2.7	14.0	1.7	0.7	0	0
Labor	234.9	186.5	75.0	27.4	0	50.9
Labor Benefits	111.5	88.5	35.6	12.9	0	24.2
TOTAL	398.5	424.0	167.7	45.4	0	83.3

TABLE III-36

SUMMARY OF FACE AND PANEL COSTS
FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS
GREATER THAN SIX FEET THICK WITH BELT-TRACK TRANSPORTATION
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	18.0	55.1	38.6	1.4	0	3.9
Depreciation	29.2	91.9	18.8	3.0	0	6.4
Power	2.1	16.5	1.9	0.7	0	0
Labor	220.1	191.9	75.0	30.0	0	54.9
Labor Benefits	104.4	91.1	35.6	14.3	0	26.1
TOTAL	373.8	446.5	169.9	49.4	0	91.3

TABLE III-37

SUMMARY OF FACE AND PANEL COSTS
FOR ROOM AND PILLAR OPERATIONS IN COAL SEAMS
GREATER THAN SIX FEET THICK WITH RUBBER-TIRE TRANSPORTATION
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	20.0	55.1	38.6	1.4	0	3.9
Depreciation	29.4	91.9	19.0	3.0	0	6.4
Power	2.9	16.5	2.0	0.7	0	0
Labor	243.0	191.9	77.7	30.0	0	54.9
Labor Benefits	115.2	91.0	36.8	14.3	0	26.1
TOTAL	410.5	446.4	174.1	49.4	0	91.3

TABLE III-38

SUMMARY OF FACE AND PANEL COSTS FOR LONGWALL OPERATIONS IN COAL SEAMS LESS THAN FOUR FEET THICK ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	14.9	138.7	25.7	1.5	37.5	1.1
Depreciation	24.3	192.5	68.0	4.3	36.7	0
Power	1.5	45.4	5.0	0.7	14.4	0
Labor	424.3	406.2	117.0	35.0	15.3	42.8
Labor Benefits	106.3	101.8	29.3	8.8	3.8	10.7
TOTAL	571.3	884.6	245.0	50.3	107.7	54.6

TABLE III-39

SUMMARY OF FACE AND PANEL COSTS
FOR LONGWALL OPERATIONS
IN COAL SEAMS FOUR TO SIX FEET THICK
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	14.9	167.2	25.7	1.5	37.5	1.5
Depreciation	24.3	224.8	68.0	4.3	36.7	0
Power	1.8	47.5	5.3	0.7	17.3	0
Labor	424.3	406.2	117.0	35.0	15.3	42.8
Labor Benefits	199.7	191.1	55.1	16.5	7.2	20.1
TOTAL	665.0	1,035.8	271.1	58.0	114.0	64.4

TABLE III-40

SUMMARY OF FACE AND PANEL COSTS
FOR LONGWALL OPERATIONS
IN COAL SEAMS GREATER THAN SIX FEET THICK
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	14.9	199.9	25.7	1.5	37.5	2.1
Depreciation	29.3	265.6	68.0	4.3	49.2	0
Power	2.1	51.8	6.2	0.7	21.6	0
Labor	424.3	406.2	117.0	35.0	15.3	42.8
Labor Benefits	106.3	101.8	29.3	8.8	3.8	10.7
TOTAL	576.9	1,025.3	246.2	50.3	127.4	55.6

TABLE III-41

SUMMARY OF LOGISTICS COSTS IN FACES AND PANELS FOR ROOM AND PILLAR OPERATIONS IN VARIOUS SEAM THICKNESSES ($1000)

Cost Category	Less than Four Feet		Four to Six Feet		Greater than Six Feet	
	Belt - Track	Rubber - Tire	Belt - Track	Rubber - Tire	Belt - Track	Rubber - Tire
Operating	104.8	106.8	110.9	112.9	117.0	119.0
Depreciation	131.3	131.6	139.1	139.5	149.3	149.7
Power	14.6	15.5	17.5	19.1	21.2	22.1
Labor	526.1	551.7	549.1	574.7	572.0	597.6
Labor Benefits	250.1	262.1	260.8	272.7	271.5	283.4
TOTAL	1,026.9	1,067.7	1,077.4	1,118.9	1,131.0	1,171.8
Logistics Capital Requirements	791.5	767.0	834.3	809.9	884.1	859.6
Total Capital Requirements	1,406.5	1,382.0	1,479.3	1,454.9	1,549.1	1,524.6
Percentage of Capital Costs Associated with Logistics	56	55	56	56	57	56

TABLE III-42

SUMMARY OF LOGISTICS COSTS
IN LONGWALL OPERATIONS
FOR VARIOUS SEAM THICKNESSES
($1000)

Cost Category	Less than Four Feet	Four to Six Feet	Greater than Six Feet
Operating	219.4	248.3	281.6
Depreciation	325.8	358.1	416.4
Power	67.0	72.6	82.4
Labor	1,040.5	1,040.5	1,040.5
Labor Benefits	260.8	489.7	260.8
TOTAL	1,913.5	2,209.2	2,081.7
Logistics Capital Requirements	1,640.0	1,780.0	2,018.0
Total Capital Requirements	5,868.0	7,192.0	9,131.0
Percentage of Capital Costs Associated with Logistics	28	25	22

APPENDIX IV
LOGISTICS COST ANALYSIS
OUTBY THE PANELS

APPENDIX IV
LOGISTICS COST ANALYSIS OUTBY THE PANELS

The second major phase of the logistics cost analysis dealt with determination of logistics costs outby the panels. The variables taken into account included mine size, type of main line haulage, and method of seam access. The cost categories analyzed again included capital, operating, depreciation, power, labor, and labor benefits.

The costs assigned as mine support costs included the costs of all those logistics activities that occur outby the panel entrances to the surface area near the mine portal. The only exception was overcast cost which was assigned to the face and panel costs as discussed in Appendix III. Most of the input data was obtained from industry sources, as described in Appendix III.

Because of the many possible variables associated with different mine types, certain assumptions were made to minimize the variables. Table III-1 contains some of the more important assumptions. It was also assumed that the costs included items near the surface area such as: raw coal stockpiling equipment, surface electrical systems feeding the mine, water handling facilities into and out of the mine, supply yard, etc. Costs associated with the mine slope were divided equally between coal and rock transportation, and transport of personnel, supplies, and equipment. All other costs were assigned to the major logistics activity with which they are associated.

TABLE IV-1

ASSUMPTIONS USED IN ANALYSIS OF DIFFERENT MINE SIZES

Mine Type	Life (Years)	Average Length of Main Line Haulage (Feet)	Slope Mine: Number of Air Shafts	Slope Mine: Length of Air Shafts (Feet)	Drift Mine: Number of Air Shafts	Drift Mine: Length of Air Shafts (Feet)
Two Sections	8	8,000	1	100	0	—
Four Sections	12	18,000	3	250	1	100
Nine Sections	20	34,000	5	500	3	200
Five Sections Plus Longwall	30	50,000	6	600	3	200
Nine Sections Plus Longwall	30	59,000	7	600	3	200

The various costs investigated are presented in the form of tables by cost categories. Capital costs for various mine types outby the panels are shown in Tables IV-2 through IV-6. Nonlogistical activities in this case include rock extraction, roof support, and lighting. (These activities were not considered to be within the realm of logistics as defined earlier.)

The same approach was used in the calculation of operating costs. Tables IV-7 through IV-11 illustrate the operating cost analysis for various mine types and mine sizes.

The depreciation costs were also performed using the same general format. The depreciated life was based on the estimated time the equipment is used before major overhauls are required. In the case of such items as slopes, shafts, etc., the depreciated life was assumed to be life of mine. The results are contained in Tables IV-12 through IV-16.

As in Appendix III, power costs in various mining situations outby the panels are based on the average power consumption rates for the equipment. Fuel costs for surface equipment used in logistics activities were also included. Tables IV-17 through IV-26 contain the results for different mine sizes and types of operations.

Labor costs for different mining situations outby the panels were determined based on the cost analysis performed in Appendix II. Results are contained in Tables IV-27 through IV-31.

Labor benefits were calculated by the procedure outlined in Appendix II. The number of hours worked by hourly personnel was determined first. Then the labor benefit costs were calculated. Tables IV-32 through IV-41 contain the results.

The labor and labor benefit costs were then determined for each logistics activity. The percentages of time each labor classification is involved with each logistics activity (Table II-5) were multiplied by the annual labor cost (Table II-3). Labor benefit costs were then proportioned among the various logistics activities in the same proportion as the labor cost. The results are shown in Tables IV-42 through IV-51.

The above calculations and tables yielded the capital, operating, depreciation, power and fuel, labor, and labor benefits costs for various mine sizes and situations. The results of the annual cost investigations were summarized into Tables IV-52 through IV-71.

TABLE IV-2

CAPITAL COSTS FOR A TWO-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Slope Construction	200	200	-	-
Track and Ballast	102	-	102	-
Mantrips and Jeeps	50	50	50	50
Locomotives	200	200	200	200
Supply Cars	12	12	12	12
Forklift	-	-	-	-
Front-end Loader	50	50	50	50
Scoops and Chargers	75	75	75	75
Tractors and Chargers	-	-	-	-
Hoists	405	405	-	-
Hoist Car	75	75	-	-
Miscellaneous and Spare	50	50	50	50
Subtotal	1,219	1,117	539	437
Coal and Rock Transportation:				
Slope Construction	200	200	-	-
Conveyor Belt	176	-	176	-
Conveyor Belt Structure, Rope, Etc.	112	-	112	-
Conveyor Belt Drives	75	-	75	-
Conveyor Take-ups	30	-	30	-
Conveyor Belt Tailpieces	15	-	15	-
Track and Ballast	-	296	-	296
Locomotives	-	378	-	378
Coal Cars	-	300	-	300
Rotary Dump	-	400	-	400
Slope Belt, Drive, Take-up, and Tailpiece	100	100	-	-
Stacking Conveyor	50	50	50	50
Car Spotters, Hoists, Etc.	-	50	-	50
Miscellaneous and Spare	50	50	50	50
Subtotal	808	1,824	508	1,524

TABLE IV-2 (Cont'd.)

CAPITAL COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	4	4	4	4
Power Centers	–	–	–	–
High Voltage Cable:				
Plugs	10	10	10	10
Cable	64	64	64	64
Low Voltage Cable	4	4	4	4
Belt Drives:				
Power Boxes	75	–	75	–
Cable	4	–	4	–
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	25	50	25	50
Rectifiers	60	120	60	120
Switchgear	40	40	40	40
Outside Substation	80	80	80	80
Outside Distribution	30	30	30	30
Miscellaneous and Spare	20	20	20	20
Subtotal	416	422	416	422
Water Handling System:				
Pumps	30	30	20	20
Discharge Water Line	20	20	20	20
Fresh Water Line	20	20	20	20
Fresh Water Storage and Pump Facilities	40	40	40	40
Miscellaneous and Spare	10	10	10	10
Subtotal	120	120	110	110
Ventilation:				
Block Walls	52	52	52	52
Overcasts	50	50	50	50
Mandoors	5	5	5	5
Air Shafts	400	400	–	–
Fans and Fan Houses	60	60	60	60
Miscellaneous and Spare	30	30	30	30
Subtotal	597	597	197	197

TABLE IV-2 (Cont'd.)

CAPITAL COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Total Capital Costs Associated with Logistics	3,160	4,080	1,770	2,690
Other Capital Items				
Construction Equipment	20	20	20	20
Welders	20	20	20	20
Air Compressors	30	30	30	30
Rock Dust Equipment	30	30	30	30
Rock Support Equipment	40	40	40	40
Exploration, Engineering and Permitting	80	80	80	80
Site Development	80	80	80	80
Offices and Bathhouse	30	30	30	30
Shop and Facilities	40	40	40	40
Warehouse	20	20	20	20
Supplies Inventory	200	200	200	200
Miscellaneous and Spare	50	50	50	50
Total Other Capital Items	640	640	640	640
TOTAL CAPITAL	3,800	4,722	2,410	3,330
Percentage of Total Capital Associated with Logistics	83	86	73	81

TABLE IV-3

CAPITAL COSTS FOR A FOUR-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Slope Construction	400	400	-	-
Track and Ballast	282	-	282	-
Mantrips and Jeeps	100	100	100	100
Locomotives	300	300	300	300
Supply Cars	20	20	20	20
Forklift	30	30	30	30
Front-end Loader	100	100	100	100
Scoops and Chargers	75	75	75	75
Tractors and Chargers	65	65	65	65
Hoists	600	600	-	-
Hoist Car	100	100	-	-
Miscellaneous and Spare	70	70	60	60
Subtotal	2,142	1,860	1,032	750
Coal and Rock Transportation:				
Slope Construction	400	400	-	-
Conveyor Belt	306	-	306	-
Conveyor Belt Structure, Rope, Etc.	282		202	-
Conveyor Belt Drives	180	-	180	-
Conveyor Take-ups	60	-	60	-
Conveyor Belt Tailpieces	30	-	30	-
Track and Ballast	-	766	-	766
Locomotives	-	1,095	-	1,095
Coal Cars	-	800	-	800
Rotary Dump	-	400	-	400
Slope Belt, Drive, Take-up, and Tailpiece	130	130	-	-
Stacking Conveyor	100	100	100	100
Car Spotters, Hoists, Etc.	-	100	-	100
Miscellaneous and Spare	500	600	500	600
Subtotal	1,988	4,391	1,458	3,861

TABLE IV-3 (Cont'd.)

CAPITAL COSTS FOR A FOUR-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	7	7	7	7
Power Centers	50	50	50	50
High Voltage Cable:				
Plugs	20	20	20	20
Cable	125	125	125	125
Low Voltage Cable	7	7	7	7
Belt Drives:				
Power Boxes	180	–	180	–
Cable	10	–	10	–
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	54	108	54	108
Rectifiers	100	200	100	200
Switchgear	80	80	80	80
Outside Substation	100	100	100	100
Outside Distribution	50	50	50	50
Miscellaneous and Spare	60	60	60	60
Subtotal	843	807	843	807
Water Handling System:				
Pumps	50	50	30	30
Discharge Water Line	45	45	45	45
Fresh Water Line	45	45	45	45
Fresh Water Storage and Pump Facilities	60	60	60	60
Miscellaneous and Spare	45	45	45	45
Subtotal	245	245	225	225
Ventilation:				
Block Walls	117	117	117	117
Overcasts	200	200	200	200
Mandoors	10	10	10	10
Air Shafts	2,000	2,000	400	400
Fans and Fan Houses	100	100	100	100
Miscellaneous and Spare	50	50	50	50
Subtotal	2,477	2,477	877	877

TABLE IV-3 (Cont'd.)

CAPITAL COSTS FOR A FOUR-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Total Capital Costs Associated with Logistics	7,695	9,780	4,435	6,520
Other Capital Items				
Construction Equipment	40	40	40	40
Welders	40	40	40	40
Air Compressors	50	50	50	50
Rock Dust Equipment	40	40	40	40
Rock Support Equipment	50	50	50	50
Exploration, Engineering and Permitting	150	150	150	150
Site Development	180	180	180	180
Offices and Bathhouse	60	60	60	60
Shop and Facilities	100	100	100	100
Warehouse	50	50	50	50
Supplies Inventory	500	500	500	500
Miscellaneous and Spare	700	700	700	700
Total Other Capital Items	1,960	1,960	1,960	1,960
TOTAL CAPITAL	9,655	11,740	6,395	8,484
Percentage of Total Capital Associated with Logistics	80	83	69	77

TABLE IV-4

CAPITAL COSTS FOR A NINE-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Slope Construction	850	850	–	–
Track and Ballast	629	–	629	–
Mantrips and Jeeps	165	165	165	165
Locomotives	400	400	400	400
Supply Cars	30	30	30	30
Forklift	40	40	40	40
Front-end Loader	120	120	120	120
Scoops and Chargers	150	150	150	150
Tractors and Chargers	130	130	130	130
Hoists	800	800	–	–
Hoist Car	150	150	–	–
Miscellaneous and Spare	120	120	120	120
Subtotal	3,584	2,955	1,784	1,155
Coal and Rock Transportation:				
Slope Construction	850	850	–	–
Conveyor Belt	602	–	602	–
Conveyor Belt Structure, Rope, Etc.	502	–	502	–
Conveyor Belt Drives	300	–	300	–
Conveyor Take-ups	100	–	100	–
Conveyor Belt Tailpieces	50	–	50	–
Track and Ballast	–	1,770	–	1,770
Locomotives	–	2,095	–	2,095
Coal Cars	–	1,970	–	1,970
Rotary Dump	–	500	–	500
Slope Belt, Drive, Take-up, and Tailpiece	200	200	–	–
Stacking Conveyor	200	200	200	200
Car Spotters, Hoists, Etc.	–	200	–	200
Miscellaneous and Spare	1,000	1,200	1,000	1,200
Subtotal	3,804	8,985	2,754	7,935

TABLE IV-4 (Cont'd.)

CAPITAL COSTS FOR A NINE-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Electrical Distribution and Communications:				
Communications	10	10	10	10
Power Centers	100	100	100	100
High Voltage Cable:				
Plugs	35	35	35	35
Cable	240	240	240	240
Low Voltage Cable	10	10	10	10
Belt Drives:				
Power Boxes	330	-	330	-
Cable	22	-	22	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	102	204	102	204
Rectifiers	250	350	250	350
Switchgear	140	140	140	140
Outside Substation	200	200	200	200
Outside Distribution	100	100	100	100
Miscellaneous and Spare	120	120	120	120
Subtotal	1,659	1,509	1,659	1,509
Water Handling System:				
Pumps	80	80	80	80
Discharge Water Line	102	102	102	102
Fresh Water Line	102	102	102	102
Fresh Water Storage and Pump Facilities	80	80	80	80
Miscellaneous and Spare	60	60	60	60
Subtotal	424	424	424	424
Ventilation:				
Block Walls	221	221	221	221
Overcasts	900	900	900	900
Mandoors	20	20	20	20
Air Shafts	6,000	6,000	1,400	1,400
Fans and Fan Houses	400	400	350	350
Miscellaneous and Spare	80	80	80	80
Subtotal	7,621	7,621	2,971	2,971

TABLE IV-4 (Cont'd.)

CAPITAL COSTS FOR A NINE-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Total Capital Costs Associated with Logistics	17,092	21,494	9,592	13,994
Other Capital Items				
Construction Equipment	100	100	100	100
Welders	60	60	60	60
Air Compressors	100	100	100	100
Rock Dust Equipment	80	80	80	80
Rock Support Equipment	150	150	150	150
Exploration, Engineering and Permitting	300	300	300	300
Site Development	200	200	200	200
Offices and Bathhouse	100	100	100	100
Shop and Facilities	200	200	200	200
Warehouse	70	70	70	70
Supplies Inventory	1,000	1,000	1,000	1,000
Miscellaneous and Spare	1,000	1,000	1,000	1,000
Total Other Capital Items	3,360	3,360	3,360	3,360
TOTAL CAPITAL	20,452	24,854	12,952	17,354
Percentage of Total Capital Associated with Logistics	84	86	74	81

TABLE IV-5

CAPITAL COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Slope Construction	1,000	1,000	-	-
Track and Ballast	924	-	924	-
Mantrips and Jeeps	165	165	165	165
Locomotives	400	400	400	400
Supply Cars	30	30	30	30
Forklift	40	40	40	40
Front-end Loader	150	150	150	150
Scoops and Chargers	225	225	225	225
Tractors and Chargers	130	130	130	130
Hoists	900	900	-	-
Hoist Car	150	150	-	-
Miscellaneous and Spare	100	100	100	100
Subtotal	4,214	3,290	2,164	1,240
Coal and Rock Transportation:				
Slope Construction	1,000	1,000	-	-
Conveyor Belt	1,000	-	1,000	-
Conveyor Belt Structure, Rope, Etc.	750	-	750	-
Conveyor Belt Drives	490	-	490	-
Conveyor Take-ups	140	-	140	-
Conveyor Belt Tailpieces	70	-	70	-
Track and Ballast	-	2,604	-	2,604
Locomotives	-	2,095	-	2,095
Coal Cars	-	1,970	-	1,970
Rotary Dump	-	500	-	500
Slope Belt, Drive, Take-up, and Tailpiece	260	260	-	-
Stacking Conveyor	300	300	300	300
Car Spotters, Hoists, Etc.	-	250	-	250
Miscellaneous and Spare	800	1,000	800	1,000
Subtotal	4,810	9,979	3,550	8,719

TABLE IV-5 (Cont'd.)

CAPITAL COSTS FOR A FIVE-SECTION
PLUS LONGWALL MINE OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	12	12	12	12
Power Centers	50	50	50	50
High Voltage Cable:				
Plugs	50	50	50	50
Cable	350	350	350	350
Low Voltage Cable	12	12	12	12
Belt Drives:				
Power Boxes	420	-	420	-
Cable	28	-	28	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	150	300	150	300
Rectifiers	350	450	350	450
Switchgear	220	220	220	220
Outside Substation	200	200	200	200
Outside Distribution	100	100	100	100
Miscellaneous and Spare	170	170	170	170
Subtotal	2,112	1,914	2,112	1,914
Water Handling System:				
Pumps	100	100	100	100
Discharge Water Line	150	150	150	150
Fresh Water Line	150	150	150	150
Fresh Water Storage and Pump Facilities	80	80	80	80
Miscellaneous and Spare	60	60	60	60
Subtotal	540	540	540	540
Ventilation:				
Block Walls	325	325	325	325
Overcasts	900	900	900	900
Mandoors	30	30	30	30
Air Shafts	9,800	9,800	1,800	1,800
Fans and Fan Houses	600	600	500	500
Miscellaneous and Spare	120	120	120	120
Subtotal	11,775	11,775	3,675	3,675

TABLE IV-5 (Cont'd.)

CAPITAL COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Total Capital Costs Associated with Logistics	23,451	27,498	12,041	16,088
Other Capital Items				
Construction Equipment	100	100	100	100
Welders	60	60	60	60
Air Compressors	100	100	100	100
Rock Dust Equipment	80	80	80	80
Rock Support Equipment	150	150	150	150
Exploration, Engineering and Permitting	300	300	300	300
Site Development	200	200	200	200
Offices and Bathhouse	100	100	100	100
Shop and Facilities	200	200	200	200
Warehouse	70	70	70	70
Supplies Inventory	1,000	1,000	1,000	1,000
Miscellaneous and Spare	1,000	1,000	1,000	1,000
Total Other Capital Items	3,360	3,360	3,360	3,360
TOTAL CAPITAL	26,811	30,858	15,401	19,448
Percentage of Total Capital Associated with Logistics	87	89	78	83

TABLE IV-6

CAPITAL COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Slope Construction	1,000	1,000	-	-
Track and Ballast	1,090	-	1,090	-
Mantrips and Jeeps	198	198	198	198
Locomotives	500	500	500	500
Supply Cars	40	40	40	40
Forklift	40	40	40	40
Front-end Loader	150	150	150	150
Scoops and Chargers	225	225	225	225
Tractors and Chargers	195	195	195	195
Hoists	1,000	1,000	-	-
Hoist Car	150	150	-	-
Miscellaneous and Spare	200	200	200	200
Subtotal	4,788	3,698	2,638	1,548
Coal and Rock Transportation:				
Slope Construction	1,000	1,000	-	-
Conveyor Belt	1,215	-	1,215	-
Conveyor Belt Structure, Rope, Etc.	850	-	850	-
Conveyor Belt Drives	540	-	540	-
Conveyor Take-ups	180	-	180	-
Conveyor Belt Tailpieces	90	-	90	-
Track and Ballast	-	3,306	-	3,306
Locomotives	-	2,595	-	2,595
Coal Cars	-	2,550	-	2,550
Rotary Dump	-	600	-	600
Slope Belt, Drive, Take-up, and Tailpiece	260	260	-	-
Stacking Conveyor	300	300	300	300
Car Spotters, Hoists, Etc.	-	250	-	250
Miscellaneous and Spare	1,100	1,300	1,100	1,300
Subtotal	5,535	12,161	4,275	10,901

TABLE IV-6 (Cont'd.)

CAPITAL COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	13	13	13	13
Power Centers	100	100	100	100
High Voltage Cable:				
Plugs	59	59	59	59
Cable	410	410	410	410
Low Voltage Cable	13	13	13	13
Belt Drives:				
Power Boxes	540	540	540	540
Cable	36	36	36	36
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	177	354	177	354
Rectifiers	380	480	380	480
Switchgear	240	240	240	240
Outside Substation	250	250	250	250
Outside Distribution	120	120	120	120
Miscellaneous and Spare	200	200	200	200
Subtotal	2,538	2,815	2,538	2,815
Water Handling System:				
Pumps	120	120	120	120
Discharge Water Line	177	177	177	177
Fresh Water Line	177	177	177	177
Fresh Water Storage and Pump Facilities	90	90	90	90
Miscellaneous and Spare	80	80	80	80
Subtotal	644	644	644	644
Ventilation:				
Block Walls	325	325	325	325
Overcasts	1,200	1,200	1,200	1,200
Mandoors	40	40	40	40
Air Shafts	11,200	11,200	1,800	1,800
Fans and Fan Houses	650	650	550	550
Miscellaneous and Spare	130	130	130	130
Subtotal	13,545	13,545	4,045	4,045

TABLE IV-6 (Cont'd.)

CAPITAL COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Total Capital Costs Associated with Logistics	27,050	32,863	14,140	19,953
Other Capital Items				
Construction Equipment	120	120	120	120
Welders	80	80	80	80
Air Compressors	120	120	120	120
Rock Dust Equipment	80	80	80	80
Rock Support Equipment	200	200	200	200
Exploration, Engineering and Permitting	350	350	350	350
Site Development	250	250	250	250
Offices and Bathhouse	120	120	120	120
Shop and Facilities	220	220	220	220
Warehouse	80	80	80	80
Supplies Inventory	1,200	1,200	1,200	1,200
Miscellaneous and Spare	1,500	1,500	1,500	1,500
Total Other Capital Items	4,320	4,320	4,320	4,320
TOTAL CAPITAL	31,370	37,183	18,460	24,273
Percentage of Total Capital Associated with Logistics	86	88	77	82

TABLE IV-7

OPERATING COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Track and Ballast	2.0	-	2.0	-
Mantrips and Jeeps	3.5	2.5	3.5	2.5
Locomotives	10.0	6.0	10.0	6.0
Supply Cars	0.4	0.4	0.4	0.4
Forklift	-	-	-	-
Front-end Loader	5.0	5.0	5.0	5.0
Scoops and Chargers	9.0	9.0	9.0	9.0
Tractors and Chargers	-	-	-	-
Hoists	4.0	4.0	-	-
Hoist Car	0.8	0.8	-	-
Miscellaneous and Spare	2.5	2.5	2.5	2.5
Subtotal	37.2	30.2	32.4	25.4
Coal and Rock Transportation:				
Conveyor Belt	8.8	-	8.8	-
Conveyor Belt Structure, Rope, Etc.	5.6	-	5.6	-
Conveyor Belt Drives	3.8	-	3.8	-
Conveyor Take-ups	1.5	-	1.5	-
Conveyor Belt Tailpieces	0.8	-	0.8	-
Track and Ballast	-	3.0	-	3.0
Locomotives	-	22.6	-	22.6
Coal Cars	-	6.0	-	6.0
Rotary Dump	-	12.0	-	12.0
Slope Belt, Drive, Take-up, and Tailpiece	5.0	5.0	-	-
Stacking Conveyor	2.5	2.5	2.5	2.5
Car Spotters, Hoists, Etc.	-	2.5	-	2.5
Miscellaneous and Spare	2.5	2.5	2.5	2.5
Subtotal	30.5	56.1	25.5	51.1

TABLE IV-7 (Cont'd.)

OPERATING COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	1.0	1.0	1.0	1.0
Power Centers	-	-	-	-
High Voltage Cable:				
Plugs	0.2	0.2	0.2	0.2
Splices	-	-	-	-
Low Voltage Cable	1.0	1.0	1.0	1.0
Belt Drives:				
Power Boxes	5.2	-	5.2	-
Cable	-	-	-	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	1.2	1.2	1.2	1.2
Rectifiers	3.0	6.0	3.0	6.0
Switchgear	2.0	2.0	2.0	2.0
Outside Substation	4.0	4.0	4.0	4.0
Outside Distribution	1.5	1.5	1.5	1.5
Miscellaneous and Spare	1.0	1.0	1.0	1.0
Subtotal	20.1	17.9	20.1	17.9
Water Handling System:				
Pumps	3.0	3.0	2.0	2.0
Discharge Water Line	1.0	1.0	1.0	1.0
Fresh Water Line	1.0	1.0	1.0	1.0
Fresh Water Storage and Pump Facilities	2.0	2.0	2.0	2.0
Miscellaneous and Spare	0.5	0.5	0.5	0.5
Subtotal	7.5	7.5	6.5	6.5
Ventilation:				
Block Walls	1.6	1.6	1.6	1.6
Overcasts	1.5	1.5	1.5	1.5
Mandoors	0.2	0.2	0.2	0.2
Air Shafts	4.0	4.0	-	-
Fans and Fan Houses	3.0	3.0	3.0	3.0
Miscellaneous and Spare	1.5	1.5	1.5	1.5
Subtotal	11.8	11.8	7.8	7.8

TABLE IV-8

OPERATING COSTS FOR A FOUR-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Track and Ballast	5.6	-	5.6	-
Mantrips and Jeeps	7.0	5.0	7.0	5.0
Locomotives	15.0	9.0	15.0	9.0
Supply Cars	0.6	0.6	0.6	0.6
Forklift	3.0	3.0	3.0	3.0
Front-end Loader	10.0	10.0	10.0	10.0
Scoops and Chargers	9.0	9.0	9.0	9.0
Tractors and Chargers	7.8	7.8	7.8	7.8
Hoists	6.0	6.0	-	-
Hoist Car	1.0	1.0	-	-
Miscellaneous and Spare	2.8	2.8	2.4	2.4
Subtotal	67.8	54.2	60.4	46.8
Coal and Rock Transportation:				
Conveyor Belt	15.3	-	15.3	-
Conveyor Belt Structure, Rope, Etc.	14.1	-	14.1	-
Conveyor Belt Drives	9.0	-	9.0	-
Conveyor Take-ups	3.0	-	3.0	-
Conveyor Belt Tailpieces	1.5	-	1.5	-
Track and Ballast	-	7.7	-	7.7
Locomotives	-	65.6	-	65.6
Coal Cars	-	16.0	-	16.0
Rotary Dump	-	12.0	-	12.0
Slope Belt, Drive, Take-up, and Tailpiece	6.5	6.5	-	-
Stacking Conveyor	5.0	5.0	5.0	5.0
Car Spotters, Hoists, Etc.	-	5.0	-	5.0
Miscellaneous and Spare	10.0	12.0	10.0	12.0
Subtotal	64.4	129.8	57.9	123.3

TABLE IV-8 (Cont'd.)

OPERATING COSTS FOR A FOUR-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Electrical Distribution and Communications:				
Communications	1.4	1.4	1.4	1.4
Power Centers	2.5	2.5	2.5	2.5
High Voltage Cable:				
Plugs	0.4	0.4	0.4	0.4
Splices	6.2	6.2	6.2	6.2
Low Voltage Cable	1.0	1.0	1.0	1.0
Belt Drives:				
Power Boxes	12.6	-	12.6	-
Cable	1.0	-	1.0	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	2.7	5.4	2.7	5.4
Rectifiers	5.0	10.0	5.0	10.0
Switchgear	4.0	4.0	4.0	4.0
Outside Substation	5.0	5.0	5.0	5.0
Outside Distribution	2.5	2.5	2.5	2.5
Miscellaneous and Spare	1.8	1.8	1.8	1.8
Subtotal	46.1	40.2	46.1	40.2
Water Handling System:				
Pumps	5.0	5.0	3.0	3.0
Discharge Water Line	2.2	2.2	2.2	2.2
Fresh Water Line	2.2	2.2	2.2	2.2
Fresh Water Storage and Pump Facilities	3.0	3.0	3.0	3.0
Miscellaneous and Spare	1.8	1.8	1.8	1.8
Subtotal	14.2	14.2	12.2	12.2
Ventilation:				
Block Walls	3.5	3.5	3.5	3.5
Overcasts	6.0	6.0	6.0	6.0
Mandoors	0.5	0.5	0.5	0.5
Air Shafts	20.0	20.0	4.0	4.0
Fans and Fan Houses	5.0	5.0	5.0	5.0
Miscellaneous and Spare	1.5	1.5	1.5	1.5
Subtotal	36.5	36.5	20.5	20.5

TABLE IV-9

OPERATING COSTS FOR A NINE-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Track and Ballast	12.6	-	12.6	-
Mantrips and Jeeps	11.6	8.2	11.6	8.2
Locomotives	20.0	12.0	20.0	12.0
Supply Cars	0.9	0.9	0.9	0.9
Forklift	4.0	4.0	4.0	4.0
Front-end Loader	12.0	12.0	12.0	12.0
Scoops and Chargers	18.0	18.0	18.0	18.0
Tractors and Chargers	15.6	15.6	15.6	15.6
Hoists	8.0	8.0	-	-
Hoist Car	1.5	1.5	-	-
Miscellaneous and Spare	4.8	4.8	4.8	4.8
Subtotal	109.0	85.0	99.5	75.5
Coal and Rock Transportation:				
Conveyor Belt	30.1	-	30.1	
Conveyor Belt Structure, Rope, Etc.	25.1	-	25.1	-
Conveyor Belt Drives	15.0	-	15.0	-
Conveyor Take-ups	5.0	-	5.0	-
Conveyor Belt Tailpieces	2.5	-	2.5	-
Track and Ballast	-	17.7	-	17.7
Locomotives	-	125.6	-	125.6
Coal Cars	-	39.4	-	39.4
Rotary Dump	-	15.0	-	15.0
Slope Belt, Drive, Take-up, and Tailpiece	10.0	10.0	-	-
Stacking Conveyor	10.0	10.0	10.0	10.0
Car Spotters, Hoists, Etc.	-	10.0	-	10.0
Miscellaneous and Spare	20.0	24.0	20.0	24.0
Subtotal	117.7	251.7	107.7	241.7

TABLE IV-9 (Cont'd.)

OPERATING COSTS FOR A NINE-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	2.0	2.0	2.0	2.0
Power Centers	5.0	5.0	5.0	5.0
High Voltage Cable:				
Plugs	0.7	0.7	0.7	0.7
Splices	12.0	12.0	12.0	12.0
Low Voltage Cable	1.5	1.5	1.5	1.5
Belt Drives:				
Power Boxes	23.1	-	23.1	-
Cable	2.2	-	2.2	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	5.1	10.2	5.1	10.2
Rectifiers	12.5	17.5	12.5	17.5
Switchgear	7.0	7.0	7.0	7.0
Outside Substation	10.0	10.0	10.0	10.0
Outside Distribution	5.0	5.0	5.0	5.0
Miscellaneous and Spare	3.6	3.6	3.6	3.6
Subtotal	89.7	74.5	89.7	74.5
Water Handling System:				
Pumps	8.0	8.0	8.0	8.0
Discharge Water Line	5.1	5.1	5.1	5.1
Fresh Water Line	5.1	5.1	5.1	5.1
Fresh Water Storage and Pump Facilities	4.0	4.0	4.0	4.0
Miscellaneous and Spare	2.4	2.4	2.4	2.4
Subtotal	24.6	24.6	24.6	24.6
Ventilation:				
Block Walls	6.6	6.6	6.6	6.6
Overcasts	27.0	27.0	27.0	27.0
Mandoors	1.0	1.0	1.0	1.0
Air Shafts	60.0	60.0	14.0	14.0
Fans and Fan Houses	20.0	20.0	17.5	17.5
Miscellaneous and Spare	2.4	2.4	2.4	2.4
Subtotal	117.0	117.0	68.5	68.5

TABLE IV-10

OPERATING COSTS FOR A FIVE-SECTION MINE PLUS LONGWALL OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Track and Ballast	18.5	-	18.5	-
Mantrips and Jeeps	11.6	8.2	11.6	8.2
Locomotives	20.0	12.0	20.0	12.0
Supply Cars	0.9	0.9	0.9	0.9
Forklift	4.0	4.0	4.0	4.0
Front-end Loader	15.0	15.0	15.0	15.0
Scoops and Chargers	27.0	27.0	27.0	27.0
Tractors and Chargers	15.6	15.6	15.6	15.6
Hoists	9.0	9.0	-	-
Hoist Car	1.5	1.5	-	-
Miscellaneous and Spare	4.0	4.0	4.0	4.0
Subtotal	127.1	97.2	116.6	86.7
Coal and Rock Transportation:				
Conveyor Belt	50.0	-	50.0	-
Conveyor Belt Structure, Rope, Etc.	37.5	-	37.5	-
Conveyor Belt Drives	24.5	-	24.5	-
Conveyor Take-ups	7.0	-	7.0	-
Conveyor Belt Tailpieces	3.5	-	3.5	-
Track and Ballast	-	26.0	-	26.0
Locomotives	-	125.6	-	125.6
Coal Cars	-	39.4	-	39.4
Rotary Dump	-	15.0	-	15.0
Slope Belt, Drive, Take-up, and Tailpiece	13.0	13.0	-	-
Stacking Conveyor	15.0	15.0	15.0	15.0
Car Spotters, Hoists, Etc.	-	12.5	-	12.5
Miscellaneous and Spare	16.0	20.0	16.0	20.0
Subtotal	166.5	266.5	153.5	253.5

TABLE IV-10 (Cont'd.)

OPERATING COSTS FOR A FIVE-SECTION MINE
PLUS LONGWALL OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Electrical Distribution and Communications:				
Communications	2.4	2.4	2.4	2.4
Power Centers	2.5	2.5	2.5	2.5
High Voltage Cable:				
Plugs	1.0	1.0	1.0	1.0
Splices	17.5	17.5	17.5	17.5
Low Voltage Cable	1.8	1.8	1.8	1.8
Belt Drives:				
Power Boxes	29.4	-	29.4	-
Cable	2.8	-	2.8	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	7.5	15.0	7.5	15.0
Rectifiers	17.5	22.5	17.5	22.5
Switchgear	11.0	11.0	11.0	11.0
Outside Substation	10.0	10.0	10.0	10.0
Outside Distribution	5.0	5.0	5.0	5.0
Miscellaneous and Spare	5.1	5.1	5.1	5.1
Subtotal	113.5	93.8	113.5	93.8
Water Handling System:				
Pumps	10.0	10.0	10.0	10.0
Discharge Water Line	7.5	7.5	7.5	7.5
Fresh Water Line	7.5	7.5	7.5	7.5
Fresh Water Storage and Pump Facilities	4.0	4.0	4.0	4.0
Miscellaneous and Spare	2.4	2.4	2.4	2.4
Subtotal	31.4	31.4	31.4	31.4
Ventilation:				
Block Walls	9.8	9.8	9.8	9.8
Overcasts	27.0	27.0	27.0	27.0
Mandoors	1.5	1.5	1.5	1.5
Air Shafts	98.0	98.0	18.0	18.0
Fans and Fan Houses	30.0	30.0	25.0	25.0
Miscellaneous and Spare	3.6	3.6	3.6	3.6
Subtotal	169.9	169.9	84.9	84.9

TABLE IV-11

OPERATING COSTS FOR A NINE-SECTION MINE
PLUS LONGWALL OUTBY THE PANELS
($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment:				
Track and Ballast	21.8	-	21.8	-
Mantrips and Jeeps	13.9	9.9	13.9	9.9
Locomotives	25.0	15.0	25.0	15.0
Supply Cars	1.2	1.2	1.2	1.2
Forklift	4.0	4.0	4.0	4.0
Front-end Loader	15.0	15.0	15.0	15.0
Scoops and Chargers	27.0	27.0	27.0	27.0
Tractors and Chargers	23.4	23.4	23.4	23.4
Hoists	10.0	10.0	-	-
Hoist Car	1.5	1.5	-	-
Miscellaneous and Spare	8.0	8.0	8.0	8.0
Subtotal	150.8	115.0	139.3	103.5
Coal and Rock Transportation:				
Conveyor Belt	60.8	-	60.8	-
Conveyor Belt Structure, Rope, Etc.	42.5	-	42.5	-
Conveyor Belt Drives	27.0	-	27.0	-
Conveyor Take-ups	9.0	-	9.0	-
Conveyor Belt Tailpieces	4.5	-	4.5	-
Track and Ballast	-	33.1	-	33.1
Locomotives	-	155.6	-	155.6
Coal Cars	-	51.0	-	51.0
Rotary Dump	-	18.0	-	18.0
Slope Belt, Drive, Take-up, and Tailpiece	13.0	13.0	-	
Stacking Conveyor	15.0	15.0	15.0	15.0
Car Spotters, Hoists, Etc.	-	12.5	-	12.5
Miscellaneous and Spare	22.0	26.0	22.0	26.0
Subtotal	193.8	324.2	180.8	311.2

TABLE IV-11 (Cont'd.)

OPERATING COSTS FOR A NINE-SECTION MINE PLUS LONGWALL OUTBY THE PANELS ($1000)

Logistics Activity	Slope Mine		Drift Mine	
	Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications:				
Communications	2.6	2.6	2.6	2.6
Power Centers	5.0	5.0	5.0	5.0
High Voltage Cable:				
Plugs	1.2	1.2	1.2	1.2
Splices	20.5	20.5	20.5	20.5
Low Voltage Cable	2.0	2.0	2.0	2.0
Belt Drives:				
Power Boxes	37.8	37.8	37.8	37.8
Cable	3.6	3.6	3.6	3.6
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	8.8	17.7	8.8	17.7
Rectifiers	19.0	24.0	19.0	24.0
Switchgear	12.0	12.0	12.0	12.0
Outside Substation	12.5	12.5	12.5	12.5
Outside Distribution	6.0	6.0	6.0	6.0
Miscellaneous and Spare	6.0	6.0	6.0	6.0
Subtotal	137.0	150.9	137.0	150.9
Water Handling System:				
Pumps	12.0	12.0	12.0	12.0
Discharge Water Line	8.8	8.8	8.8	8.8
Fresh Water Line	8.8	8.8	8.8	8.8
Fresh Water Storage and Pump Facilities	4.5	4.5	4.5	4.5
Miscellaneous and Spare	3.2	3.2	3.2	3.2
Subtotal	37.3	37.3	37.3	37.3
Ventilation:				
Block Walls	9.8	9.8	9.8	9.8
Overcasts	36.0	36.0	36.0	36.0
Mandoors	2.0	2.0	2.0	2.0
Air Shafts	112.0	112.0	18.0	18.0
Fans and Fan Houses	32.5	32.5	27.5	27.5
Miscellaneous and Spare	3.9	3.9	3.9	3.9
Subtotal	196.2	196.2	97.2	97.2

TABLE IV-12

DEPRECIATION COSTS FOR A TWO-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment					
Slope Construction	8	25.0	25.0	-	-
Track and Ballast	10	10.2	-	10.2	-
Mantrips and Jeeps	8	6.2	6.2	6.2	6.2
Locomotives	10	20.0	20.0	20.0	20.0
Supply Cars	10	1.2	1.2	1.2	1.2
Forklift	5	-	-	-	-
Front-end Loader	5	10.0	10.0	10.0	10.0
Scoops and Chargers	6	12.5	12.5	12.5	12.5
Tractors and Chargers	6	-	-	-	-
Hoists	10	40.5	40.5	-	-
Hoist Car	10	7.5	7.5	-	-
Miscellaneous and Spare	7	7.1	7.1	7.1	7.1
Subtotal		140.2	130.0	67.2	57.0
Coal and Rock Transportation:					
Slope Construction	8	25.0	25.0	-	-
Conveyor Belt	8	22.0	-	22.0	-
Conveyor Belt Structure, Rope, Etc.	10	11.2	-	11.2	-
Conveyor Belt Drives	10	7.5	-	7.5	-
Conveyor Take-ups	10	3.0	-	3.0	-
Conveyor Belt Tailpieces	10	1.5	-	1.5	-

TABLE IV-12 (Cont'd.)

DEPRECIATION COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Coal and Rock Transportation (cont'd.)					
Track and Ballast	10	-	29.6	-	29.6
Locomotives	10	-	37.8	-	37.8
Coal Cars	10	-	30.0	-	30.0
Rotary Dump	10	-	40.0	-	40.0
Slope Belt, Drive, Take-up, and Tailpiece	10	10.0	10.0	-	-
Stacking Conveyor	10	5.0	5.0	5.0	5.0
Car Spotters, Hoists, Etc.	10	-	5.0	-	5.0
Miscellaneous and Spare	8	6.2	6.2	6.2	6.2
Subtotal		91.4	188.3	56.4	153.6
Electrical Distribution and Communications:					
Communications	3	1.3	1.3	1.3	1.3
Power Centers	5	-	-	-	-
High Voltage Cable:					
Plugs	8	1.2	1.2	1.2	1.2
Cable	8	8.0	8.0	8.0	8.0
Low Voltage Cable	4	1.0	1.0	1.0	1.0
Belt Drives:					
Power Boxes	8	9.4	-	9.4	-
Cable	8	0.5	-	0.5	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	10	2.5	5.0	2.5	5.0
Rectifiers	5	12.0	24.0	12.0	24.0
Switchgear	5	8.0	8.0	8.0	8.0

TABLE IV-12 (Cont'd.)

DEPRECIATION COSTS FOR A TWO-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications (cont'd.)					
Outside Substation	10	8.0	8.0	8.0	8.0
Outside Distribution	8	3.8	3.8	3.8	3.8
Miscellaneous and Spare	6	3.3	3.3	3.3	3.3
Subtotal		59.0	63.6	59.0	63.6
Water Handling System:					
Pumps	6	5.0	5.0	3.3	3.3
Discharge Water Line	8	2.5	2.5	2.5	2.5
Fresh Water Line	8	2.5	2.5	2.5	2.5
Fresh Water Storage and Pump Facilities	8	5.0	5.0	5.0	5.0
Miscellaneous and Spare	6	1.7	1.7	1.7	1.7
Subtotal		16.7	16.7	15.0	15.0
Ventilation:					
Block Walls	8	6.5	6.5	6.5	6.5
Overcasts	8	6.2	6.2	6.2	6.2
Mandoors	8	0.6	0.6	0.6	0.6
Air Shafts	8	50.0	50.0	–	–
Fans and Fan Houses	10	6.0	6.0	6.0	6.0
Miscellaneous and Spare	8	3.8	3.8	3.8	3.8
Subtotal		73.1	73.1	23.1	23.1

TABLE IV-13

DEPRECIATION COSTS FOR A FOUR-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Transport of Personnel, Supplies, and Equipment					
Slope Construction	12	33.3	33.3	-	-
Track and Ballast	15	18.8	-	18.8	-
Mantrips and Jeeps	8	12.5	12.5	12.5	12.5
Locomotives	15	20.0	20.0	20.0	20.0
Supply Cars	15	1.3	1.3	1.3	1.3
Forklift	5	6.0	6.0	6.0	6.0
Front-end Loader	5	20.0	20.0	20.0	20.0
Scoops and Chargers	6	12.5	12.5	12.5	12.5
Tractors and Chargers	6	10.8	10.8	10.8	10.8
Hoists	15	40.0	40.0	-	-
Hoist Car	15	6.7	6.7	-	-
Miscellaneous and Spare	8	8.8	8.8	7.5	7.5
Subtotal		190.7	171.9	109.4	90.6
Coal and Rock Transportation:					
Slope Construction	12	33.3	33.3	-	-
Conveyor Belt	8	38.2	-	38.2	-
Conveyor Belt Structure, Rope, Etc.	15	18.8	-	18.8	-
Conveyor Belt Drives	15	12.0	-	12.0	-
Conveyor Take-ups	10	6.0	-	6.0	-
Conveyor Belt Tailpieces	15	2.0	-	2.0	-

TABLE IV-13 (Cont'd.)

DEPRECIATION COSTS FOR A FOUR-SECTION MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Coal and Rock Transportation (cont'd.)					
Track and Ballast	15	-	51.0	-	51.0
Locomotives	15	-	73.0	-	73.0
Coal Cars	15	-	53.3	-	53.3
Rotary Dump	15	-	26.7	-	26.7
Slope Belt, Drive, Take-up, and Tailpiece	15	8.7	8.7	-	-
Stacking Conveyor	15	6.7	6.7	6.7	6.7
Car Spotters, Hoists, Etc.	15	-	6.7	-	6.7
Miscellaneous and Spare	10	50.0	60.0	50.0	60.0
Subtotal		175.7	319.4	133.7	277.4
Electrical Distribution and Communications:					
Communications	3	2.3	2.3	2.3	2.3
Power Centers	6	8.3	8.3	8.3	8.3
High Voltage Cable:					
Plugs	8	2.5	2.5	2.5	2.5
Cable	15	8.3	8.3	8.3	8.3
Low Voltage Cable	8	0.9	0.9	0.9	0.9
Belt Drives:					
Power Boxes	8	22.5	-	22.5	-
Cable	8	1.2	-	1.2	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	20	2.7	5.4	2.7	5.4
Rectifiers	6	16.7	33.3	16.7	33.3
Switchgear	6	13.3	13.3	13.3	13.3

TABLE IV-13 (Cont'd.)

DEPRECIATION COSTS FOR A FOUR-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications (cont'd.)					
Outside Substation	15	6.7	6.7	6.7	6.7
Outside Distribution	10	5.0	5.0	5.0	5.0
Miscellaneous and Spare	10	6.0	6.0	6.0	6.0
Subtotal		96.4	92.0	96.4	92.0
Water Handling System:					
Pumps	6	8.3	8.3	5.0	5.0
Discharge Water Line	15	3.0	3.0	3.0	3.0
Fresh Water Line	15	3.0	3.0	3.0	3.0
Fresh Water Storage and Pump Facilities	15	4.0	4.0	4.0	4.0
Miscellaneous and Spare	10	4.5	4.5	4.5	4.5
Subtotal		22.8	22.8	19.5	19.5
Ventilation:					
Block Walls	15	7.8	7.8	7.8	7.8
Overcasts	15	13.3	13.3	13.3	13.3
Mandoors	15	0.7	0.7	0.7	0.7
Air Shafts	15	133.3	133.3	26.7	26.7
Fans and Fan Houses	15	6.7	6.7	6.7	6.7
Miscellaneous and Spare	15	3.3	3.3	3.3	3.3
Subtotal		165.1	165.1	58.5	58.5

TABLE IV-14

DEPRECIATION COSTS FOR A NINE-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment					
Slope Construction	20	42.5	42.5	-	-
Track and Ballast	20	31.4	-	31.4	-
Mantrips and Jeeps	8	20.6	20.6	20.6	20.6
Locomotives	20	20.0	20.0	20.0	20.0
Supply Cars	20	1.5	1.5	1.5	1.5
Forklift	5	8.0	8.0	8.0	8.0
Front-end Loader	5	24.0	24.0	24.0	24.0
Scoops and Chargers	6	25.0	25.0	25.0	25.0
Tractors and Chargers	6	21.7	21.7	21.7	21.7
Hoists	20	40.0	40.0	-	-
Hoist Car	20	7.5	7.5	-	-
Miscellaneous and Spare	8	15.0	15.0	15.0	15.0
Subtotal		257.2	225.8	167.2	135.8
Coal and Rock Transportation:					
Slope Construction	20	42.5	42.5	-	-
Conveyor Belt	8	75.3	-	75.3	-
Conveyor Belt Structure, Rope, Etc.	15	33.5	-	33.5	-
Conveyor Belt Drives	20	15.0	-	15.0	-
Conveyor Take-ups	10	10.0	-	10.0	-
Conveyor Belt Tailpieces	15	3.3	-	3.3	-

TABLE IV-14 (Cont'd.)

DEPRECIATION COSTS FOR A NINE-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Coal and Rock Transportation (cont'd.)					
Track and Ballast	20	-	88.4	-	88.4
Locomotives	20	-	104.8	-	104.8
Coal Cars	20	-	98.5	-	98.5
Rotary Dump	20	-	25.0	-	25.0
Slope Belt, Drive, Take-up, and Tailpiece	15	13.3	13.3	-	-
Stacking Conveyor	20	10.0	10.0	10.0	10.0
Car Spotters, Hoists, Etc.	20	-	10.0	-	10.0
Miscellaneous and Spare	10	100.0	120.0	100.0	120.0
Subtotal		302.9	512.5	247.1	456.7
Electrical Distribution and Communications:					
Communications	3	3.3	3.3	3.3	3.3
Power Centers	5	20.0	20.0	20.0	20.0
High Voltage Cable:					
Plugs	8	4.4	4.4	4.4	4.4
Cable	15	16.0	16.0	16.0	16.0
Low Voltage Cable	8	1.2	1.2	1.2	1.2
Belt Drives:					
Power Boxes	8	41.2	-	41.2	-
Cable	8	2.8	-	2.8	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	20	5.1	10.2	5.1	10.2
Rectifiers	6	41.7	58.3	41.7	58.3
Switchgear	6	23.3	23.3	23.3	23.3

TABLE IV-14 (Cont'd.)

DEPRECIATION COSTS FOR A NINE-SECTION MINE
OUTBY THE PANELS
($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Electrical Distribution and Communications (cont'd.)					
Outside Substation	20	10.0	10.0	10.0	10.0
Outside Distribution	20	5.0	5.0	5.0	5.0
Miscellaneous and Spare	10	12.0	12.0	12.0	12.0
Subtotal		186.0	163.7	186.0	163.7
Water Handling System:					
Pumps	6	13.3	13.3	13.3	13.3
Discharge Water Line	15	6.8	6.8	6.8	6.8
Fresh Water Line	20	5.1	5.1	5.1	5.1
Fresh Water Storage and Pump Facilities	20	4.0	4.0	4.0	4.0
Miscellaneous and Spare	10	6.0	6.0	6.0	6.0
Subtotal		35.2	35.2	35.2	35.2
Ventilation:					
Block Walls	20	11.0	11.0	11.0	11.0
Overcasts	20	45.0	45.0	45.0	45.0
Mandoors	20	1.0	1.0	1.0	1.0
Air Shafts	20	300.0	300.0	70.0	70.0
Fans and Fan Houses	15	26.7	26.7	23.3	23.3
Miscellaneous and Spare	15	5.3	5.3	5.3	5.3
Subtotal		389.0	389.0	155.6	155.6

TABLE IV-15

DEPRECIATION COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment					
Slope Construction	30	33.3	33.3	-	-
Track and Ballast	30	30.8	-	30.8	-
Mantrips and Jeeps	8	20.6	20.6	20.6	20.6
Locomotives	30	13.3	13.3	13.3	13.3
Supply Cars	30	1.0	1.0	1.0	1.0
Forklift	5	8.0	8.0	8.0	8.0
Front-end Loader	5	30.0	30.0	30.0	30.0
Scoops and Chargers	6	37.5	37.5	37.5	37.5
Tractors and Chargers	6	21.7	21.7	21.7	21.7
Hoists	30	30.0	30.0	-	-
Hoist Car	30	5.0	5.0	-	-
Miscellaneous and Spare	8	12.5	12.5	12.5	12.5
Subtotal		243.7	212.9	175.4	144.6
Coal and Rock Transportation:					
Slope Construction	30	33.3	33.3	-	-
Conveyor Belt	8	125.0	-	125.0	-
Conveyor Belt Structure, Rope, Etc.	15	50.0	-	50.0	-
Conveyor Belt Drives	20	24.5	-	24.5	-
Conveyor Take-ups	10	14.0	-	14.0	-
Conveyor Belt Tailpieces	15	4.7	-	4.7	-

TABLE IV-15 (Cont'd.)

DEPRECIATION COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Coal and Rock Transportation (cont'd.)					
Track and Ballast	30	-	86.8	-	86.8
Locomotives	30	-	69.8	-	69.8
Coal Cars	30	-	65.7	-	65.7
Rotary Dump	30	-	16.7	-	16.7
Slope Belt, Drive, Take-up, and Tailpiece	15	17.3	17.3	-	-
Stacking Conveyor	30	10.0	10.0	10.0	10.0
Car Spotters, Hoists, Etc.	20	-	12.5	-	12.5
Miscellaneous and Spare	10	80.0	100.0	80.0	100.0
Subtotal		358.8	412.1	308.2	361.8
Electrical Distribution and Communications:					
Communications	3	4.0	4.0	4.0	4.0
Power Centers	5	10.0	10.0	10.0	10.0
High Voltage Cable:					
Plugs	8	6.2	6.2	6.2	6.2
Cable	15	23.3	23.3	23.3	23.3
Low Voltage Cable	8	1.5	1.5	1.5	1.5
Belt Drives:					
Power Boxes	8	52.5	-	52.5	-
Cable	8	3.5	-	3.5	-
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	20	7.5	15.0	7.5	15.0
Rectifiers	6	58.3	75.0	58.3	75.0
Switchgear	6	36.7	36.7	36.7	36.7

TABLE IV-15 (Cont'd.)

DEPRECIATION COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Electrical Distribution and Communications (cont'd.)					
Outside Substation	30	6.7	6.7	6.7	6.7
Outside Distribution	20	5.0	5.0	5.0	5.0
Miscellaneous and Spare	10	17.0	17.0	17.0	17.0
Subtotal		232.2	200.4	232.2	200.4
Water Handling System:					
Pumps	6	16.7	16.7	16.7	16.7
Discharge Water Line	15	10.0	10.0	10.0	10.0
Fresh Water Line	20	7.5	7.5	7.5	7.5
Fresh Water Storage and Pump Facilities	30	2.7	2.7	2.7	2.7
Miscellaneous and Spare	10	6.0	6.0	6.0	6.0
Subtotal		42.9	42.9	42.9	42.9
Ventilation:					
Block Walls	30	10.8	10.8	10.8	10.8
Overcasts	30	30.0	30.0	30.0	30.0
Mandoors	30	1.0	1.0	1.0	1.0
Air Shafts	30	326.7	326.7	60.0	60.0
Fans and Fan Houses	15	40.0	40.0	33.3	33.3
Miscellaneous and Spare	15	8.0	8.0	8.0	8.0
Subtotal		416.5	416.5	143.1	143.1

TABLE IV-16

DEPRECIATION COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Transport of Personnel, Supplies, and Equipment					
Slope Construction	30	33.3	33.3	-	-
Track and Ballast	30	36.3	-	36.3	-
Mantrips and Jeeps	8	24.8	24.8	24.8	24.8
Locomotives	30	16.7	16.7	16.7	16.7
Supply Cars	30	1.3	1.3	1.3	1.3
Forklift	5	8.0	8.0	8.0	8.0
Front-end Loader	5	30.0	30.0	30.0	30.0
Scoops and Chargers	6	37.5	37.5	37.5	37.5
Tractors and Chargers	6	32.5	32.5	32.5	32.5
Hoists	30	33.3	33.3	-	-
Hoist Car	30	5.0	5.0	-	-
Miscellaneous and Spare	8	25.0	25.0	25.0	25.0
Subtotal		283.7	247.4	212.1	175.8
Coal and Rock Transportation:					
Slope Construction	30	33.3	33.3	-	-
Conveyor Belt	8	151.9	-	151.9	-
Conveyor Belt Structure, Rope, Etc.	15	56.7	-	56.7	-
Conveyor Belt Drives	20	27.0	-	27.0	-
Conveyor Take-ups	10	18.0	-	18.0	-
Conveyor Belt Tailpieces	15	6.0	-	6.0	-

TABLE IV-16 (Cont'd.)

DEPRECIATION COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine		Drift Mine	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Coal and Rock Transportation (cont'd.)					
Track and Ballast	30	-	110.2	-	110.2
Locomotives	30	-	86.5	-	86.5
Coal Cars	30	-	85.0	-	85.0
Rotary Dump	30	-	20.0	-	20.0
Slope Belt, Drive, Take-up, and Tailpiece	15	17.3	17.3	-	-
Stacking Conveyor	30	10.0	10.0	10.0	10.0
Car Spotters, Hoists, Etc.	20	-	12.5	-	12.5
Miscellaneous and Spare	10	110.0	130.0	110.0	130.0
Subtotal		430.2	504.8	379.6	454.2
Electrical Distribution and Communications:					
Communications	3	4.3	4.3	4.3	4.3
Power Centers	5	20.0	20.0	20.0	20.0
High Voltage Cable:					
Plugs	8	7.4	7.4	7.4	7.4
Cable	15	27.3	27.3	27.3	27.3
Low Voltage Cable	8	1.6	1.6	1.6	1.6
Belt Drives:					
Power Boxes	8	67.5	67.5	67.5	67.5
Cable	8	4.5	4.5	4.5	4.5
Trolley Wire, Insulators, Disconnects, Bonds, Etc.	20	8.8	17.7	8.8	17.7
Rectifiers	6	63.3	80.0	63.3	80.0
Switchgear	6	40.0	40.0	40.0	40.0

TABLE IV-16 (Cont'd.)

DEPRECIATION COSTS FOR A NINE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS ($1000)

Logistics Activity	Depreciated Life (Years)	Slope Mine Belt-Track	Slope Mine Track Haulage	Drift Mine Belt-Track	Drift Mine Track Haulage
Electrical Distribution and Communications (cont'd.)					
Outside Substation	30	8.3	8.3	8.3	8.3
Outside Distribution	20	6.0	6.0	6.0	6.0
Miscellaneous and Spare	10	20.0	20.0	20.0	20.0
Subtotal		279.0	304.6	279.0	304.6
Water Handling System:					
Pumps	6	20.0	20.0	20.0	20.0
Discharge Water Line	15	11.8	11.8	11.8	11.8
Fresh Water Line	20	8.8	8.8	8.8	8.8
Fresh Water Storage and Pump Facilities	30	3.0	3.0	3.0	3.0
Miscellaneous and Spare	10	8.0	8.0	8.0	8.0
Subtotal		51.6	51.6	51.6	51.6
Ventilation:					
Block Walls	30	10.8	10.8	10.8	10.8
Overcasts	30	40.0	40.0	40.0	40.0
Mandoors	30	1.3	1.3	1.3	1.3
Air Shafts	30	373.3	373.3	60.0	60.0
Fans and Fan Houses	15	43.3	43.3	36.7	36.7
Miscellaneous and Spare	15	8.7	8.7	8.7	8.7
Subtotal		477.4	477.4	157.5	157.5

TABLE IV-17

POWER AND FUEL COSTS FOR A TWO-SECTION DRIFT MINE OUTBY THE PANELS

(Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	6	8	48	$ 461	6	8	48	$ 461
Locomotives	36	7	252	2,419	36	7	252	2,419
Forklift	-	-	-	800	-	-	-	800
Front-end Loader	-	-	-	2,500	-	-	-	2,500
Scoops and Chargers	10	6	60	576	10	6	60	576
Tractors and Chargers	-	-	-	-	-	-	-	-
Hoist	-	-	-	-	-	-	-	-
Subtotal				$ 6,756				$ 6,756
Coal and Rock Transportation								
Conveyor Belt Drives	250	15	3,750	$ 36,000	40	15	600	$ 5,760
Locomotives	-	-	-	-	150	15	2,250	21,600
Rotary Dump and Car Movers	-	-	-	-	30	15	450	4,320
Subtotal				$ 36,000				$ 31,680
Electrical Distribution and Communications				$ 6,991				$ 6,559
Water Handling System	50	18	900	$ 13,140	50	18	900	$ 13,140
Ventilation	40	24	960	$ 14,016	40	24	960	$ 14,016
TOTAL				$ 76,903				$ 72,151

TABLE IV-18

POWER AND FUEL COSTS FOR A TWO-SECTION SLOPE MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	6	8	48	$ 461	6	8	48	$ 461
Locomotives	36	7	252	2,419	36	7	252	2,419
Forklift	-	-	-	800	-	-	-	800
Front-end Loader	-	-	-	2,500	-	-	-	2,500
Scoops and Chargers	10	6	60	576	10	6	60	576
Tractors and Chargers	-	-	-	-	-	-	-	-
Hoist	50	2	100	960	50	2	100	960
Subtotal				$ 7,716				$ 7,716
Coal and Rock Transportation								
Conveyor Belt Drives	250	15	3,750	$ 36,000	40	15	600	$ 5,760
Slope Belt	50	15	750	7,200	50	15	750	7,200
Locomotives	-	-	-	-	150	15	2,250	21,600
Rotary Dump and Car Movers	-	-	-	-	30	15	450	4,320
Subtotal				$ 43,200				$ 38,880
Electrical Distribution and Communications				$ 8,464				$ 8,032
Water Handling System	75	18	1,350	$ 19,710	75	18	1,350	$ 19,710
Ventilation	40	24	960	$ 14,016	40	24	960	$ 14,016
TOTAL				$ 93,106				$ 88,354

TABLE IV-19

POWER AND FUEL COSTS FOR A FOUR-SECTION DRIFT MINE OUTBY THE PANELS

(Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	12	8	96	$ 922	12	8	96	$ 922
Locomotives	45	10	450	4,320	45	10	450	4,320
Forklift	-	-	-	1,600	-	-	-	1,600
Front-end Loaders	-	-	-	3,500	-	-	-	3,500
Scoops and Chargers	10	10	100	960	10	10	100	960
Tractors and Chargers	10	10	100	960	10	10	100	960
Hoist	-	-	-	-	-	-	-	-
Subtotal				$ 12,262				$ 12,262
Coal and Rock Transportation								
Conveyor Belt Drives	400	15	6,000	$ 57,600	60	15	900	$ 8,640
Slope Belt	-	-	-	-	-	-	-	-
Locomotives	-	-	-	-	275	15	4,125	39,600
Rotary Dump and Car Movers	-	-	-	-	40	15	600	5,760
Subtotal				$ 57,600				$ 54,000
Electrical Distribution and Communications				$ 11,760				$ 11,400
Water Handling System	75	18	1,350	$ 19,710	75	18	1,350	$ 19,710
Ventilation	80	24	1,920	$ 28,032	80	24	1,920	$ 28,032
TOTAL				$ 129,364				$ 125,404

TABLE IV-20

POWER AND FUEL COSTS FOR A FOUR-SECTION SLOPE MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	12	8	96	$ 922	12	8	96	$ 922
Locomotives	45	10	450	4,320	45	10	450	4,320
Forklift	-	-	-	1,600	-	-	-	1,600
Front-end Loader	-	-	-	3,500	-	-	-	3,500
Scoops and Chargers	10	10	100	960	10	10	100	960
Tractors and Chargers	10	10	100	960	10	10	100	960
Hoist	70	4	280	2,688	70	4	280	2,688
Subtotal				$ 14,950				$ 14,950
Coal and Rock Transportation								
Conveyor Belt Drives	400	15	6,000	$ 57,600	60	15	900	$ 8,640
Slope Belt	100	15	1,500	14,400	100	15	1,500	14,400
Locomotives	-	-	-	-	275	15	4,125	39,600
Rotary Dump and Car Movers	-	-	-	-	40	15	600	5,760
Subtotal				$ 72,000				$ 68,400
Electrical Distribution and Communications				$ 14,126				$ 13,766
Water Handling System	100	18	1,800	$ 26,280	100	18	1,800	$ 26,280
Ventilation	80	24	1,920	$ 28,032	80	24	1,920	$ 28,032
TOTAL				$ 155,388				$ 151,428

TABLE IV-21

POWER AND FUEL COSTS FOR A NINE-SECTION DRIFT MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	35	8	280	$ 2,688	35	8	280	$ 2,688
Locomotives	100	12	1,200	11,520	100	12	1,200	11,520
Forklift	-	-	-	2,000	-	-	-	2,000
Front-end Loader	-	-	-	5,000	-	-	-	5,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	30	10	300	2,880	30	10	300	2,880
Hoist	-	-	-	-	-	-	-	-
Subtotal				$ 26,968				$ 26,968
Coal and Rock Transportation								
Conveyor Belt Drives	1,000	15	15,000	$ 144,000	100	15	1,500	$ 14,400
Slope Belt	-	-	-	-	-	-	-	-
Locomotives	-	-	-	-	600	15	9,000	86,400
Rotary Dump and Car Movers	-	-	-	-	100	15	1,500	14,400
Subtotal				$ 144,000				$ 115,200
Electrical Distribution and Communications				$ 28,047				$ 25,167
Water Handling System	150	18	2,700	$ 39,420	150	18	2,700	$ 39,420
Ventilation	200	24	4,800	$ 70,080	200	24	4,800	$ 70,080
TOTAL				$ 308,515				$ 276,835

TABLE IV-22

POWER AND FUEL COSTS FOR A NINE-SECTION SLOPE MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine KW Average	Belt-Track Mine Hours of Use Per Day	Belt-Track Mine KWH Per Day	Belt-Track Mine Cost Per Year	Track-Haulage Mine KW Average	Track-Haulage Mine Hours of Use Per Day	Track-Haulage Mine KWH Per Day	Track-Haulage Mine Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	35	8	280	$ 2,688	35	8	280	$ 2,688
Locomotives	100	12	1,200	11,520	100	12	1,200	11,520
Forklift	–	–	–	2,000	–	–	–	2,000
Front-end Loader	–	–	–	5,000	–	–	–	5,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	30	10	300	2,880	30	10	300	2,880
Hoist	80	5	400	3,840	80	5	400	3,840
Subtotal				$ 30,808				$ 30,808
Coal and Rock Transportation								
Conveyor Belt Drives	1,000	15	15,000	$ 144,000	100	15	1,500	$ 14,400
Slope Belt	350	15	5,250	50,400	350	15	5,250	50,400
Locomotives	–	–	–	–	600	15	9,000	86,400
Rotary Dump and Car Mover	–	–	–	–	100	15	1,500	14,400
Subtotal				$ 194,400				$ 165,600
Electrical Distribution and Communications				$ 34,785				$ 31,905
Water Handling System	200	18	3,600	$ 52,560	200	18	3,600	$ 52,560
Ventilation	200	24	4,800	$ 70,080	200	24	4,800	$ 70,080
TOTAL				$ 382,633				$ 350,953

TABLE IV-23

POWER AND FUEL COSTS FOR A FIVE-SECTION
PLUS LONGWALL DRIFT MINE OUTBY THE PANELS
(Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	30	8	240	$ 2,304	30	8	240	$ 2,304
Locomotives	70	12	840	8,064	70	12	840	8,064
Forklift	-	-	-	1,800	-	-	-	1,800
Front-end Loader	-	-	-	4,000	-	-	-	4,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	20	10	200	1,920	20	10	200	1,920
Hoist	-	-	-	-	-	-	-	-
Subtotal				$ 20,968				$ 20,968
Coal and Rock Transportation								
Conveyor Belt Drives	1,100	22	24,200	$ 232,320	100	22	2,200	$ 21,120
Slope Belt	-	-	-	-	-	-	-	-
Locomotives	-	-	-	-	600	22	13,200	126,720
Rotary Dump and Car Movers	-	-	-	-	85	22	1,870	17,952
Subtotal				$ 232,320				$ 165,792
Electrical Distribution and Communications				$ 37,593				$ 30,940
Water Handling System	200	18	3,600	$ 52,560	200	18	3,600	$ 52,560
Ventilation	200	24	4,800	$ 70,080	200	24	4,800	$ 70,080
TOTAL				$ 413,521				$ 340,340

TABLE IV-24

POWER AND FUEL COSTS FOR A FIVE-SECTION PLUS LONGWALL SLOPE MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	30	8	240	$ 2,304	30	8	240	$ 2,304
Locomotives	70	12	840	8,064	70	12	840	8,064
Forklift	-	-	-	1,800	-	-	-	1,800
Front-end Loader	-	-	-	4,000	-	-	-	4,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	20	10	200	1,920	20	10	200	1,920
Hoist	80	5	400	3,840	80	5	400	3,840
Subtotal				$ 24,808				$ 24,808
Coal and Rock Transportation								
Conveyor Belt Drives	1,100	22	24,200	$ 232,320	100	22	2,200	$ 21,120
Slope Belt	450	22	9,900	95,040	450	22	9,900	95,040
Locomotives	-	-	-	-	600	22	13,200	126,720
Rotary Dump and Car Movers	-	-	-	-	85	22	1,870	17,952
Subtotal				$ 327,360				$ 260,832
Electrical Distribution and Communications				$ 50,109				$ 43,456
Water Handling System	300	18	5,400	$ 78,840	300	18	5,400	$ 78,840
Ventilation	200	24	4,800	$ 70,080	200	24	4,800	$ 70,080
TOTAL				$ 551,197				$ 478,016

TABLE IV-25

POWER AND FUEL COSTS FOR A NINE-SECTION PLUS LONGWALL DRIFT MINE OUTBY THE PANELS (Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	40	10	400	$ 3,840	40	10	400	$ 3,840
Locomotives	120	12	1,440	13,824	120	12	1,440	13,824
Forklift	-	-	-	2,500	-	-	-	2,500
Front-end Loader	-	-	-	5,000	-	-	-	5,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	30	10	300	2,880	30	10	300	2,880
Hoist	-	-	-	-	-	-	-	-
Subtotal				$ 30,924				$ 30,924
Coal and Rock Transportation								
Conveyor Belt Drives	1,500	22	33,000	$ 316,800	150	22	3,300	$ 31,680
Slope Belt	-	-	-	-	-	-	-	-
Locomotives	-	-	-	-	800	22	17,600	168,960
Rotary Dump and Car Movers	-	-	-	-	150	22	3,300	31,680
Subtotal				$ 316,800				$ 232,320
Electrical Distribution and Communications				$ 50,102				$ 41,654
Water Handling System	250	18	4,500	$ 65,700	250	18	4,500	$ 65,700
Ventilation	250	24	6,000	$ 87,600	250	24	6,000	$ 87,600
TOTAL				$ 551,126				$ 458,198

TABLE IV-26

POWER AND FUEL COSTS FOR A NINE-SECTION PLUS LONGWALL SLOPE MINE OUTBY THE PANELS
(Dollars)

Logistics Activity	Belt-Track Mine				Track-Haulage Mine			
	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year	KW Average	Hours of Use Per Day	KWH Per Day	Cost Per Year
Transport of Personnel, Supplies, and Equipment								
Mantrips and Jeeps	40	10	400	$ 3,840	40	10	400	$ 3,840
Locomotives	120	12	1,440	13,824	120	12	1,440	13,824
Forklift	-	-	-	2,500	-	-	-	2,500
Front-end Loaders	-	-	-	5,000	-	-	-	5,000
Scoops and Chargers	30	10	300	2,880	30	10	300	2,880
Tractors and Chargers	30	10	300	2,880	30	10	300	2,880
Hoist	80	5	400	3,840	80	5	400	3,840
Subtotal				$ 34,764				$ 34,764
Coal and Rock Transportation								
Conveyor Belt Drives	1,500	22	33,000	$ 316,800	150	22	3,300	$ 31,680
Slope Belt	500	22	11,000	105,600	500	22	11,000	105,600
Locomotives	-	-	-	-	800	22	17,600	168,960
Rotary Dump and Car Movers	-	-	-	-	150	22	3,300	31,680
Subtotal				$ 422,400				$ 337,920
Electrical Distribution and Communications				$ 63,674				$ 55,226
Water Handling System	350	18	6,300	$ 91,980	350	18	6,300	$ 91,980
Ventilation	250	24	6,000	$ 87,600	250	24	6,000	$ 87,600
TOTAL				$ 700,418				$ 607,490

TABLE IV-27

LABOR COSTS FOR A TWO-SECTION MINE OUTBY THE PANELS (Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People: Belt-Track	Number of People: Track Haulage	Yearly Logistics Costs: Belt-Track	Yearly Logistics Costs: Track Haulage
Salary						
Superintendent	$ 46,000	40	1	1	$ 18,400	$ 18,400
Mine Foreman	40,000	85	1	1	34,000	34,000
Assistant Mine Foreman	37,000	90	1	1	33,300	33,300
Maintenance Foreman	38,000	55	1	1	20,900	20,900
Assistant Maintenance Foreman	34,000	65	1	1	22,100	22,100
Outside Foreman	30,000	40	1	1	12,000	12,000
Warehouseman	18,000	50	1	1	9,000	9,000
Surveyor	22,000	20	1	1	4,400	4,400
Draftsman/Technician	26,000	25	1	1	6,500	6,500
Track Foreman	34,000	90	-	1	-	30,600
Belt Foreman	34,000	90	1	-	30,600	-
Subtotal					$191,200	$191,200
Hourly Labor						
Beltman	$ 25,625	95	4	-	$ 97,375	-
Motorman (Supplies)	24,837	95	2	2	47,190	$ 47,190
Motorman (Track Haulage)	24,837	95	-	2	-	47,190
General Labor	25,625	75	5	5	96,094	96,094
Pumper	30,020	90	1	1	27,018	27,018
Bratticeman	26,250	90	2	2	47,250	47,250
Trackman	25,625	90	-	2	-	46,125
Outside Supply Man	26,949	95	1	1	25,602	25,602
Mechanic/Electrician	32,442	60	4	4	77,861	77,861
Dispatcher/Hoistman	26,173	90	3	3	70,667	70,667
Subtotal					$489,057	$484,997
TOTAL					$680,257	$676,197

TABLE IV-28

LABOR COSTS FOR A FOUR-SECTION MINE OUTBY THE PANELS (Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Salary						
Superintendent	$ 52,000	40	1	1	$ 20,800	$ 20,800
Mine Foreman	45,000	85	1	1	38,250	38,250
Assistant Mine Foreman	40,000	90	3	3	108,000	108,000
Maintenance Foreman	42,000	55	1	1	23,100	23,100
Assistant Maintenance Foreman	36,000	65	1	1	23,400	23,400
Outside Foreman	32,000	40	2	2	25,600	25,600
Chief Electrician	36,000	90	1	1	32,400	32,400
Purchasing Agent	30,000	25	1	1	7,500	7,500
Warehouseman	17,000	50	3	3	25,500	25,500
Surveyor	26,000	20	1	1	5,200	5,200
Engineer	32,000	35	1	1	11,200	11,200
Draftsman/Technician	20,000	25	2	2	10,000	10,000
Track Foreman	34,000	90	-	1	-	30,600
Belt Foreman	34,000	90	1	-	30,600	-
Clerk	17,000	30	1	1	5,100	5,100
Secretary	15,000	20	1	1	3,200	3,200
Shop Foreman	36,000	70	1	1	25,200	25,200
Safety Director	34,000	60	1	1	20,400	20,400
Subtotal					$ 415,450	$ 415,450

TABLE IV-28 (Cont'd.)

LABOR COSTS FOR A FOUR-SECTION MINE
OUTBY THE PANELS
(Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Hourly Labor						
Beltman	$ 25,625	95	9	-	$ 219,094	-
Motorman (Supplies)	24,837	95	4	4	94,381	$ 94,381
Motorman (Track Haulage)	24,837	95	-	4	-	94,381
General Labor	25,625	75	12	12	230,625	230,625
Pumper	30,020	90	3	3	81,054	81,054
Bratticeman	26,250	90	2	2	47,250	47,250
Trackman	25,625	90	2	6	46,125	138,375
Supply Man	26,949	95	2	2	51,203	51,203
Mechanic/Electrician	32,442	60	7	7	136,256	136,256
Dispatcher/Hoistman	26,173	90	3	3	70,667	70,667
Subtotal					$ 976,655	$ 944,192
TOTAL					$1,392,105	$1,359,642

TABLE IV-29

LABOR COSTS FOR A NINE-SECTION MINE OUTBY THE PANELS (Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Salary						
Superintendent	$ 56,000	40	1	1	$ 22,400	$ 22,400
Mine Foreman	48,000	85	1	1	40,800	40,800
Assistant Mine Foreman	40,000	90	3	3	108,000	108,000
Maintenance Foreman	46,000	55	1	1	25,300	25,300
Assistant Maintenance Foreman	38,000	65	2	2	49,400	49,400
Outside Foreman	34,000	40	3	3	40,800	40,800
Chief Electrician	42,000	90	1	1	37,800	37,800
Assistant Chief Electrician	38,000	90	1	1	34,200	34,200
Chief Purchasing Agent	32,000	25	1	1	8,000	8,000
Assistant Purchasing Agent	27,000	25	1	1	6,750	6,750
Ventilation Foreman	34,000	95	1	1	32,300	32,300
Warehouseman	17,000	50	4	4	34,000	34,000
Surveyor	26,000	20	2	2	10,400	10,400
Chief Engineer	36,000	45	1	1	16,200	16,200
Engineer	30,000	35	1	1	10,500	10,500
Draftsman/Technician	20,000	25	2	2	10,000	10,000
Track Foreman	34,000	90	1	2	30,600	61,200
Belt Foreman	34,000	90	2	–	61,200	–
Clerk	17,000	30	2	2	10,200	10,200
Secretary	16,000	20	2	2	6,400	6,400
Shop Foreman	38,000	70	1	1	26,600	26,600
Assistant Shop Foreman	34,000	70	1	1	23,800	23,800
Safety Director	34,000	60	1	1	20,400	20,400
Assistant Safety Director	30,000	60	1	1	18,000	18,000
Training Supervisor	30,000	60	1	1	18,000	18,000
Subtotal					$ 738,050	$ 707,450

TABLE IV-29 (Cont'd.)

LABOR COSTS FOR A NINE-SECTION MINE OUTBY THE PANELS
(Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People: Belt-Track	Number of People: Track Haulage	Yearly Logistics Costs: Belt-Track	Yearly Logistics Costs: Track Haulage
Hourly Labor						
Beltman	$ 25,625	95	20	-	$ 486,875	-
Motorman (Supplies)	24,837	95	6	6	141,571	$ 141,571
Motorman (Track Haulage)	24,837	95	-	10	-	235,952
General Labor	25,625	75	22	22	422,812	422,812
Pumper	30,020	90	6	6	162,108	162,108
Bratticeman	26,250	90	6	6	141,750	141,750
Trackman	25,625	90	4	14	92,250	322,875
Outside Supply Man	26,949	95	4	4	102,406	102,406
Mechanic/Electrician	32,442	60	12	12	233,582	233,582
Dispatcher/Hoistman	26,173	90	3	3	70,667	70,667
Subtotal					$1,854,021	$1,833,723
TOTAL					$2,592,071	$2,541,173

TABLE IV-30

LABOR COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS (Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People: Belt-Track	Number of People: Track Haulage	Yearly Logistics Costs: Belt-Track	Yearly Logistics Costs: Track Haulage
Salary						
Superintendent	$ 56,000	40	1	1	$ 22,400	$ 22,400
Mine Foreman	48,000	85	1	1	40,800	40,800
Assistant Mine Foreman	40,000	90	3	3	108,000	108,000
Maintenance Foreman	46,000	55	1	1	25,300	25,300
Assistant Maintenance Foreman	38,000	65	2	2	49,400	49,400
Outside Foreman	34,000	40	3	3	40,800	40,800
Chief Electrician	42,000	90	1	1	37,800	37,800
Assistant Chief Electrician	38,000	90	1	1	34,200	34,200
Purchasing Agent	32,000	25	1	1	8,000	8,000
Warehouseman	17,000	50	3	3	25,500	25,500
Ventilation Foreman	34,000	95	1	1	32,300	32,300
Surveyor	26,000	20	1	1	5,200	5,200
Chief Engineer	36,000	45	1	1	16,200	16,200
Engineer	30,000	35	1	1	10,500	10,500
Draftsman/Technician	20,000	25	3	3	15,000	15,000
Track Foreman	34,000	90	1	3	30,600	91,800
Belt Foreman	34,000	90	3	-	91,800	-
Construction Foreman	34,000	65	1	1	22,100	22,100
Clerk	17,000	30	2	2	10,200	10,200
Secretary	16,000	20	2	2	6,400	6,400
Shop Foreman	38,000	70	1	1	26,600	26,600
Safety Director	34,000	60	1	1	20,400	20,400
Assistant Safety Director	30,000	60	1	1	18,000	18,000
Training Supervisor	30,000	60	1	1	18,000	18,000
Subtotal					$ 715,500	$ 684,900

TABLE IV-30 (Cont'd.)

LABOR COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE
OUTBY THE PANELS
(Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Hourly Labor						
Beltman	$ 25,625	95	34	-	$ 827,688	$ -
Motorman (Supplies)	24,837	95	5	5	117,976	117,976
Motorman (Track Haulage)	24,837	95	-	12	-	283,142
General Labor	25,625	75	22	22	422,812	422,812
Pumper	30,020	90	6	6	162,108	162,108
Bratticeman	26,250	90	7	7	165,375	165,375
Trackman	25,625	90	6	18	138,375	415,125
Outside Supply Man	26,949	95	3	3	76,805	76,805
Mechanic/Electrician	32,442	60	12	12	233,582	233,582
Dispatcher/Hoistman	26,173	90	3	3	70,667	70,667
Subtotal					$2,215,388	$1,947,593
TOTAL					$2,930,888	$2,632,493

TABLE IV-31

LABOR COSTS FOR A NINE-SECTION PLUS LONGWALL MINE
OUTBY THE PANELS
(Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Salary:						
Superintendent	$ 60,000	40	1	1	$ 24,000	$ 24,000
Mine Foreman	50,000	85	1	1	42,500	42,500
Assistant Mine Foreman	42,000	90	3	3	113,400	113,400
Maintenance Foreman	48,000	55	1	1	26,400	26,400
Assistant Maintenance Foreman	40,000	65	3	3	78,000	78,000
Outside Foreman	34,000	40	3	3	40,800	40,800
Chief Electrician	44,000	90	1	1	39,600	39,600
Assistant Chief Electrician	40,000	90	2	2	72,000	72,000
Chief Purchasing Agent	32,000	25	1	1	8,000	8,000
Assistant Purchasing Agent	27,000	25	1	1	6,750	6,750
Warehouseman	17,000	50	5	5	42,500	42,500
Ventilation Foreman	34,000	95	1	1	32,300	32,300
Surveyor	26,000	20	2	2	10,400	10,400
Chief Engineer	36,000	45	1	1	16,200	16,200
Engineer	30,000	35	2	2	21,000	21,000
Draftsman/Technician	17,000	25	4	4	17,000	17,000
Track Foreman	34,000	90	1	3	30,600	91,800
Belt Foreman	34,000	90	3	-	91,800	-
Construction Foreman	34,000	65	1	1	22,100	22,100
Clerk	17,000	30	2	2	10,200	10,200
Secretary	16,000	20	2	2	6,400	6,400
Shop Foreman	38,000	70	1	1	26,600	26,600
Assistant Shop Foreman	34,000	70	1	1	23,800	23,800
Safety Director	34,000	60	1	1	20,400	20,400
Assistant Safety Director	30,000	60	1	1	18,000	18,000
Training Supervisor	30,000	60	1	1	18,000	18,000
Subtotal					$ 858,750	$ 828,150

TABLE IV-31 (Cont'd.)

LABOR COSTS FOR A NINE-SECTION PLUS LONGWALL MINE
OUTBY THE PANELS
(Dollars)

Job Classification	Yearly Cost	Percentage of Time Associated with Logistics	Number of People		Yearly Logistics Costs	
			Belt-Track	Track Haulage	Belt-Track	Track Haulage
Hourly Labor:						
Beltman	$ 25,625	95	40	-	$ 973,750	-
Motorman (Supplies)	24,837	95	6	6	141,571	$ 141,571
Motorman (Track Haulage)	24,837	95	-	16	-	377,522
General Labor	25,625	75	30	30	576,562	576,562
Pumper	30,020	90	7	7	189,126	189,126
Bratticeman	26,250	90	8	8	189,000	189,000
Trackman	25,625	90	7	22	161,438	507,375
Outside Supply Man	26,949	95	4	4	102,407	102,407
Mechanic/Electrician	32,442	60	15	15	291,978	291,978
Dispatcher/Hoistman	26,173	90	3	3	70,667	70,667
Subtotal					$2,696,498	$2,446,208
TOTAL					$3,555,248	$3,274,358

TABLE IV-32

HOURS WORKED BY HOURLY PERSONNEL FOR A TWO-SECTION MINE OUTBY THE PANELS

Job Classification	Yearly Hours Worked	Number of People		Total Yearly Hours	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Beltman	2,013	4	-	8.052	-
Motorman (Supplies)	1,957	2	2	3,914	3,914
Motorman (Track Haulage)	1,957	-	2	-	3,914
General Labor	2,013	5	5	10,065	10,065
Pumper	2,237	1	1	2,237	2,237
Bratticeman	2,050	2	2	4,100	4,100
Trackman	2,013	-	2	-	4,026
Outside Supply Man	2,050	1	1	2,050	2,050
Mechanic/Electrician	2,237	4	4	8,948	8,948
Dispatcher/Hoistman	1,957	3	3	5,871	5,871
TOTAL				45,237	45,125

TABLE IV-33

LABOR BENEFIT COSTS FOR
A TWO-SECTION MINE OUTBY THE PANELS

Labor Benefit Items	Yearly Cost Belt-Track	Yearly Cost Track Haulage
Social Security		
Hourly (6.7%)	32,767	32,495
Salary (6.2%)	11,854	11,854
Health and Retirement		
Hourly ($1.037/Hr.)	46,911	46,795
Salary (15%)	28,680	28,680
Sickness and Accident (8%)	54,421	54,096
Additional Benefits		
Hourly (2%)	9,781	9,700
Salary (4%)	7,648	7,648
Workmens Compensation (22%)	149,657	148,763
TOTAL	341,719	340,031

TABLE IV-34

HOURS WORKED BY HOURLY PERSONNEL FOR A FOUR-SECTION MINE OUTBY THE PANELS

Job Classification	Yearly Hours Worked	Number of People		Total Yearly Hours	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Beltman	2,013	9	-	18,117	-
Motorman (Supplies)	1,957	4	4	7,828	7,828
Motorman (Track Haulage)	1,957	-	4	-	7,828
General Labor	2,013	12	12	24,156	24,156
Pumper	2,237	3	3	6,711	6,711
Bratticeman	2,050	2	2	4,100	6,150
Trackman	2,013	2	6	4,026	12,078
Outside Supply Man	2,050	2	2	4,100	4,100
Mechanic/Electrician	2,237	7	7	15,659	15,659
Dispatcher/Hoistman	1,957	3	3	5,871	5,871
TOTAL				90,568	90,381

TABLE IV-35

LABOR BENEFIT COSTS FOR
A FOUR-SECTION MINE OUTBY THE PANELS

Labor Benefit Items	Yearly Cost	
	Belt-Track	Track Haulage
Social Security		
Hourly (6.7%)	65,436	63,261
Salary (6.2%)	25,758	25,758
Health and Retirement		
Hourly ($1.037/Hr.)	93,919	87,156
Salary (15%)	62,317	62,317
Sickness and Accident (8%)	111,368	108,771
Additional Benefits		
Hourly (2%)	19,533	18,884
Salary (4%)	16,618	16,618
Workmens Compensation (22%)	306,263	299,121
TOTAL	701,212	681,886

TABLE IV-36

HOURS WORKED BY HOURLY PERSONNEL FOR A NINE-SECTION MINE OUTBY THE PANELS

Job Classification	Yearly Hours Worked	Number of People		Total Yearly Hours	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Beltman	2,013	20	-	40,260	-
Motorman (Supplies)	1,957	6	6	11,742	11,742
Motorman (Track Haulage)	1,957	-	10	-	19,570
General Labor	2,013	22	22	44,286	44,286
Pumper	2,237	6	6	13,422	13,422
Bratticeman	2,050	6	6	12,300	12,300
Trackman	2,013	4	14	8,052	28,182
Outside Supply Man	2,050	4	4	8,200	8,200
Mechanic/Electrician	2,237	12	12	26,844	26,844
Dispatcher/Hoistman	1,957	3	3	5,871	5,871
TOTAL				170,977	170,417

TABLE IV-37

LABOR BENEFIT COSTS FOR
A NINE-SECTION MINE OUTBY THE PANELS

Labor Benefit Items	Yearly Costs	
	Belt-Track	Track Haulage
Social Security		
Hourly (6.7%)	124,219	122,859
Salary (6.2%)	45,759	43,862
Health and Retirement		
Hourly ($1.037/Hr.)	177,303	176,722
Salary (15%)	110,708	106,118
Sickness and Accident (8%)	207,366	203,294
Additional Benefits		
Hourly (2%)	37,080	36,674
Salary (4%)	29,522	28,298
Workmens Compensation (22%)	570,256	559,058
TOTAL	1,302,213	1,276,885

TABLE IV-38

HOURS WORKED BY HOURLY PERSONNEL FOR
A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS

Job Classification	Yearly Hours Worked	Number of People		Total Yearly Hours	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Beltman	2,013	34	-	68,442	-
Motorman (Supplies)	1,957	5	5	9,785	9,785
Motorman (Track Haulage)	1,957	-	12	-	23,484
General Labor	2,013	22	22	44,286	44,286
Pumper	2,237	6	6	13,422	13,422
Bratticeman	2,050	7	7	14,350	14,350
Trackman	2,013	6	18	12,078	36,234
Outside Supply Man	2,050	3	3	6,150	6,150
Mechanic/Electrician	2,237	12	12	26,844	26,844
Dispatcher/Hoistman	1,957	3	3	5,871	5,871
TOTAL				201,228	180,426

TABLE IV-39

LABOR BENEFIT COSTS FOR A FIVE-SECTION PLUS LONGWALL MINE OUTBY THE PANELS

Labor Benefit Items	Yearly Cost Belt-Track	Yearly Cost Track Haulage
Social Security		
Hourly (6.7%)	148,431	130,489
Salary (6.2%)	44,361	42,464
Health and Retirement		
Hourly ($1.037/Hr.)	208,673	187,102
Salary (15%)	107,325	102,735
Sickness and Accident (8%)	234,471	210,599
Additional Benefits		
Hourly (2%)	44,308	38,952
Salary (4%)	28,620	27,396
Workmens Compensation (22%)	644,795	579,148
TOTAL	1,460,984	1,318,885

TABLE IV-40

HOURS WORKED BY HOURLY PERSONNEL FOR A NINE-SECTION PLUS LONGWALL

Job Classification	Yearly Hours Worked	Number of People		Total Yearly Hours	
		Belt-Track	Track Haulage	Belt-Track	Track Haulage
Beltman	2,013	40	-	80,520	-
Motorman (Supplies)	1,957	6	6	11,742	11,742
Motorman (Track Haulage)	1,957	-	16	-	31,312
General Labor	2,013	30	30	60,390	60,390
Pumper	2,237	7	7	15,659	15,659
Bratticeman	2,050	8	8	16,400	16,400
Trackman	2,013	7	22	14,091	44,286
Outside Supply Man	2,050	4	4	8,200	8,200
Mechanic/Electrician	2,237	15	15	33,555	33,555
Dispatcher/Hoistman	1,957	3	3	5,871	5,871
TOTAL				246,428	227,415

TABLE IV-41

LABOR BENEFIT COSTS FOR
A NINE-SECTION PLUS LONGWALL MINE OUTBY
THE PANELS

Labor Benefit Items	Yearly Costs Belt-Track	 Track Haulage
Social Security		
Hourly (6.7%)	180,665	163,896
Salary (6.2%)	53,242	51,345
Health and Retirement		
Hourly ($1.037/Hr.)	255,546	235,829
Salary (15%)	128,812	124,222
Sickness and Accident (8%)	284,420	261,949
Additional Benefits		
Hourly (2%)	53,930	48,924
Salary (4%)	34,350	33,126
Workmens Compensation (22%)	782,154	720,359
TOTAL	1,773,119	1,639,650

TABLE IV-42

LABOR AND BENEFIT COSTS FOR A TWO-SECTION BELT-TRACK MINE OUTBY THE PANELS
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 9,200	$ 4,600	$ 2,300	0	0	$ 2,300
Mine Foreman	14,000	10,000	4,000	$ 2,000	0	4,000
Assistant Mine Foreman	14,800	11,100	3,700	1,850	0	1,850
Maintenance Foreman	11,400	5,700	3,800	0	0	0
Assistant Maintenance Foreman	10,200	6,800	3,400	1,700	0	0
Outside Foreman	7,500	3,000	0	1,500	0	0
Warehouseman	9,000	0	0	0	0	0
Surveyor	4,400	0	0	0	0	0
Draftsman/Technician	2,600	1,300	0	0	0	2,600
Belt Foreman	10,200	20,400	0	0	0	0
Subtotal	$ 93,300	$ 62,900	$ 17,200	$ 7,050	0	$ 10,750
Hourly Labor:						
Beltman	$ 20,500	$ 71,750	$ 5,125	0	0	0
Motorman (Supplies)	42,223	2,484	2,484	0	0	0
General Labor	38,438	25,625	6,406	$ 12,812	0	$ 12,812
Pumper	13,509	0	1,501	12,008	0	0
Bratticeman	15,750	0	0	0	0	31,500
Outside Supply Man	25,602	0	0	0	0	0
Mechanic/Electrician	32,442	19,465	25,954	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 247,353	$ 131,102	$ 41,470	$ 24,820	0	$ 44,312
TOTAL LABOR	$ 340,653	$ 194,002	$ 58,670	$ 31,870	0	$ 55,062
LABOR BENEFITS	$ 171,123	$ 97,455	$ 29,472	$ 16,010	0	$ 27,659

TABLE IV-43

LABOR AND BENEFIT COSTS FOR A TWO-SECTION TRACK HAULAGE MINE OUTBY THE PANELS
(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 9,200	$ 4,600	$ 2,300	0	0	$ 2,300
Mine Foreman	14,000	10,000	4,000	$ 2,000	0	4,000
Assistant Mine Foreman	14,800	11,100	3,700	1,850	0	1,850
Maintenance Foreman	11,400	5,700	3,800	0	0	0
Assistant Maintenance Foreman	10,200	6,800	3,400	1,700	0	0
Outside Foreman	7,500	3,000	0	1,500	0	0
Warehouseman	9,000	0	0	0	0	0
Surveyor	4,400	0	0	0	0	0
Draftsman/Technician	2,600	1,300	0	0	0	2,600
Track Foreman (Track Haulage)	8,500	15,300	6,800	0	0	0
Subtotal	$ 91,600	$ 57,800	$ 24,000	$ 7,050	0	$ 10,750
Hourly Labor:						
Motorman (Supplies)	$ 42,223	$ 2,484	$ 2,484	0	0	0
Motorman (Track Haulage)	4,967	39,739	2,484	0	0	0
General Labor	38,438	25,625	6,406	$ 12,812	0	$ 12,812
Pumper	13,509	0	1,501	12,008	0	0
Bratticeman	15,750	0	0	0	0	31,500
Trackman (Track Haulage)	12,812	28,188	5,125	0	0	0
Outside Supply Man	25,602	0	0	0	0	0
Mechanic/Electrician	32,442	19,465	25,954	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 244,632	$ 127,279	$ 43,954	$ 24,820	0	$ 44,312
TOTAL LABOR	$ 336,232	$ 185,079	$ 67,954	$ 31,870	0	$ 55,062
LABOR BENEFITS	$ 169,077	$ 93,068	$ 34,171	$ 16,026	0	$ 27,688

TABLE IV-44

LABOR AND BENEFIT COSTS FOR A FOUR-SECTION BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 10,400	$ 5,200	$ 2,600	0	0	$ 2,600
Mine Foreman	15,750	11,250	4,500	$ 2,250	0	4,500
Assistant Mine Foreman	48,000	36,000	12,000	6,000	0	6,000
Maintenance Foreman	12,500	6,300	4,200	0	0	0
Assistant Maintenance Foreman	10,300	7,200	3,600	1,800	0	0
Outside Foreman	16,000	6,400	0	3,200	0	0
Chief Electrician	10,300	3,600	14,400	1,800	0	1,800
Purchasing Agent	7,500	0	0	0	0	0
Warehouseman	25,500	0	0	0	0	0
Surveyor	5,200	0	0	0	0	0
Engineer	3,200	3,200	1,600	1,600	0	1,600
Draftsman/Technician	4,000	2,000	0	0	0	4,000
Belt Foreman	10,200	20,400	0	0	0	0
Clerk	1,700	2,550	0	0	0	850
Secretary	1,600	1,600	0	0	0	0
Shop Foreman	7,200	10,800	3,600	3,600	0	0
Safety Director	8,500	5,100	3,400	1,700	0	1,700
Subtotal	$ 198,950	$ 121,600	$ 49,900	$ 21,950	0	$ 23,050
Hourly Labor:						
Beltman	$ 46,125	$ 161,438	$ 11,531	0	0	0
Motorman (Supplies)	84,446	4,967	4,967	0	0	0
Motorman (Track Haulage)	0	0	0	0	0	0
General Labor	92,250	61,500	15,375	$ 30,750	0	$ 30,750
Pumper	40,527	0	4,503	36,024	0	0
Bratticeman	15,750	0	0	0	0	31,500
Trackman (Belt-Track)	35,875	2,562	7,688	0	0	0
Outside Supply Man	51,203	0	0	0	0	0
Mechanic/Electrician	56,774	34,064	45,419	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 481,839	$ 276,309	$ 89,483	$ 66,774	0	$ 62,250
TOTAL LABOR	$ 680,789	$ 397,909	$ 139,383	$ 88,724	0	$ 85,300
LABOR BENEFITS	$ 342,918	$ 200,429	$ 70,208	$ 44,691	0	$ 42,966

TABLE IV-45

LABOR AND BENEFIT COSTS FOR A FOUR-SECTION TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 10,400	$ 5,200	$ 2,600	0	0	$ 2,600
Mine Foreman	15,750	11,250	4,500	$ 2,250	0	4,500
Assistant Mine Foreman	48,000	36,000	12,000	6,000	0	6,000
Maintenance Foreman	12,600	6,300	4,200	0	0	0
Assistant Maintenance Foreman	10,800	7,200	3,600	1,800	0	0
Outside Foreman	16,000	6,400	0	3,200	0	0
Chief Electrician	10,800	3,600	14,400	1,800	0	1,800
Purchasing Agent	7,500	0	0	0	0	0
Warehouseman	25,500	0	0	0	0	0
Surveyor	5,200	0	0	0	0	0
Engineer	3,200	3,200	1,600	1,600	0	1,600
Draftsman/Technician	4,000	2,000	0	0	0	4,000
Track Foreman (Track Haulage)	8,500	15,300	6,800	0	0	0
Belt Foreman	0	0	0	0	0	0
Clerk	1,700	2,550	0	0	0	850
Secretary	1,600	1,600	0	0	0	0
Shop Foreman	7,200	10,800	3,600	3,600	0	0
Safety Director	8,500	5,100	3,400	1,700	0	1,700
Subtotal	$ 197,250	$ 116,500	$ 56,700	$ 21,950	0	$ 23,050
Hourly Labor:						
Motorman (Supplies)	$ 84,446	$ 4,967	$ 4,967	0	0	0
Motorman (Track Haulage)	9,935	79,478	4,967	0	0	0
General Labor	92,250	61,500	15,375	$ 30,750	0	$ 30,750
Pumper	40,527	0	4,503	36,024	0	0
Bratticeman	15,750	0	0	0	0	31,500
Trackman (Track Haulage)	38,438	84,562	15,375	0	0	0
Outside Supply Man	51,203	0	0	0	0	0
Mechanic/Electrician	56,774	34,064	45,419	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 448,212	$ 276,349	$ 90,606	$ 66,774	0	$ 62,250
TOTAL LABOR	$ 645,462	$ 392,849	$ 147,306	$ 88,724	0	$ 85,300
LABOR BENEFITS	$ 323,711	$ 197,021	$ 73,877	$ 44,497	0	$ 42,780

TABLE IV-46

LABOR AND BENEFIT COSTS FOR A NINE-SECTION BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 11,200	$ 5,600	$ 2,800	0	0	$ 2,800
Mine Foreman	16,800	12,000	4,800	$ 2,400	0	4,800
Assistant Mine Foreman	64,000	48,000	16,000	8,000	0	8,000
Maintenance Foreman	13,800	6,900	4,600	0	0	0
Assistant Maintenance Foreman	22,800	15,200	7,600	3,800	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	12,600	4,200	16,800	2,100	0	2,100
Assistant Chief Electrician	11,400	3,800	15,200	1,900	0	1,900
Chief Purchasing Agent	8,000	0	0	0	0	0
Assistant Purchasing Agent	6,750	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Warehouseman	34,000	0	0	0	0	0
Surveyor	10,400	0	0	0	0	0
Chief Engineer	3,600	5,400	1,800	1,800	0	3,600
Engineer	3,000	3,000	1,500	1,500	0	1,500
Draftsman/Technician	4,000	2,000	0	0	0	4,000
Track Foreman (Supplies)	23,800	0	6,800	0	0	0
Belt Foreman	20,400	40,800	0	0	0	0
Clerk	3,400	5,100	0	0	0	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Assistant Shop Foreman	6,800	10,200	3,400	3,400	0	0
Safety Director	8,500	5,100	3,400	1,700	0	1,700
Assistant Safety Director	7,500	4,500	3,000	1,500	0	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 343,550	$ 201,100	$ 94,500	$ 38,500	0	$ 60,400

TABLE IV-46 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A NINE-SECTION BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	$ 102,500	$ 358,751	$ 25,625	0	0	0
Motorman (Supplies)	126,669	7,450	7,451	0	0	0
Motorman (Track Haulage)	0	0	0	0	0	0
General Labor	169,125	112,750	28,188	$ 56,375	0	$ 56,375
Pumper	81,054	0	9,006	72,048	0	0
Bratticeman	47,250	0	0	0	0	94,500
Trackman (Belt-Track)	71,750	5,124	15,376	0	0	0
Outside Supply Man	102,406	0	0	0	0	0
Mechanic/Electrician	97,327	58,395	77,861	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 856,900	$ 554,248	$ 163,506	$ 128,423	0	$ 150,875
TOTAL LABOR	$1,200,520	$ 755,348	$ 253,006	$ 166,923	0	$ 211,275
LABOR BENEFITS	$ 603,121	$ 379,474	$ 129,617	$ 83,859	0	$ 106,141

TABLE IV-47

LABOR AND BENEFIT COSTS FOR A NINE-SECTION TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 11,200	$ 5,600	$ 2,800	0	0	$ 2,800
Mine Foreman	16,800	12,000	4,800	$ 2,400	0	4,800
Assistant Mine Foreman	64,000	48,000	16,000	8,000	0	8,000
Maintenance Foreman	13,800	6,900	4,600	0	0	0
Assistant Maintenance Foreman	22,800	15,200	7,600	3,800	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	12,600	4,200	16,800	2,100	0	2,100
Assistant Chief Electrician	11,400	3,800	15,200	1,900	0	1,900
Chief Purchasing Agent	8,000	0	0	0	0	0
Assistant Purchasing Agent	6,750	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Warehouseman	34,000	0	0	0	0	0
Surveyor	10,400	0	0	0	0	0
Chief Engineer	3,600	5,400	1,800	1,800	0	3,600
Engineer	3,000	3,000	1,500	1,500	0	1,500
Draftsman/Technician	4,000	2,000	0	0	0	4,000
Track Foreman (Track Haulage)	17,000	30,600	13,600	0	0	0
Belt Foreman	0	0	0	0	0	0
Clerk	3,400	5,100	0	0	0	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Assistant Shop Foreman	6,800	10,200	3,400	3,400	0	0
Safety Director	8,500	5,100	3,400	1,700	0	1,700
Assistant Safety Director	7,500	4,500	3,000	1,500	0	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 316,350	$ 190,900	$ 101,300	$ 38,500	0	$ 60,400

TABLE IV-47 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A NINE-SECTION TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	0	0	0	0	0	0
Motorman (Supplies)	$ 126,669	$ 7,450	$ 7,451	0	0	0
Motorman (Track Haulage)	24,838	198,695	12,417	0	0	0
General Labor	169,125	112,750	28,188	$ 56,375	0	$ 56,375
Pumper	81,054	0	9,006	72,048	0	0
Bratticeman	47,250	0	0	0	0	94,500
Trackman (Track Haulage)	89,689	197,311	35,875	0	0	0
Outside Supply Man	102,406	0	0	0	0	0
Mechanic/Electrician	97,327	58,395	77,861	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 797,247	$ 586,379	$ 170,797	$ 128,423	0	$ 150,875
TOTAL LABOR	$1,113,597	$ 777,279	$ 272,097	$ 166,923	0	$ 211,275
LABOR BENEFITS	$ 559,559	$ 390,566	$ 136,723	$ 83,875	0	$ 106,161

TABLE IV-48

LABOR AND BENEFIT COSTS FOR A FIVE-SECTION PLUS LONGWALL BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 11,200	$ 5,600	$ 2,800	0	0	$ 2,800
Mine Foreman	16,800	12,000	4,800	$ 2,400	0	4,800
Assistant Mine Foreman	48,000	36,000	12,000	6,000	0	6,000
Maintenance Foreman	13,800	6,900	4,600	0	0	0
Assistant Maintenance Foreman	22,800	15,200	7,600	3,800	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	12,600	4,200	16,800	2,100	0	2,100
Assistant Chief Electrician	11,400	3,800	15,200	1,900	0	1,900
Purchasing Agent	8,000	0	0	0	0	0
Warehouseman	25,500	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Surveyor	5,200	0	0	0	0	0
Chief Engineer	3,600	3,600	1,800	1,800	$ 1,800	3,600
Engineer	3,000	1,500	1,500	1,500	1,500	1,500
Draftsman/Technician	6,000	3,000	0	0	0	6,000
Track Foreman (Supplies)	23,800	0	6,800	0	0	0
Belt Foreman	30,600	61,200	0	0	0	0
Construction Foreman	8,500	6,800	3,400	1,700	0	1,700
Clerk	3,400	3,400	0	0	1,700	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Safety Director	8,500	3,400	3,400	1,700	1,700	1,700
Assistant Safety Director	7,500	3,000	3,000	1,500	1,500	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 321,000	$ 198,900	$ 90,500	$ 34,800	$ 8,200	$ 62,100

TABLE IV-48 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A FIVE-SECTION PLUS LONGWALL BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	$ 174,250	$ 609,875	$ 43,562	0	0	0
Motorman (Supplies)	105,557	6,209	6,209	0	0	0
Motorman (Track Haulage)	0	0	0	0	0	0
General Labor	169,125	112,750	28,187	$ 56,375	0	$ 56,375
Pumper	81,054	0	9,006	72,048	0	0
Bratticeman	55,125	0	0	0	0	110,250
Trackman (Belt-Track)	38,438	84,562	15,375	0	0	0
Outside Supply Man	76,805	0	0	0	0	0
Mechanic/Electrician	97,326	58,396	77,861	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 856,569	$ 883,570	$ 180,200	$ 128,423	0	$ 166,625
TOTAL LABOR	$ 1,177,569	$1,082,470	$ 270,700	$ 163,223	$ 8,200	$ 228,725
LABOR BENEFITS	$ 586,993	$ 539,588	$ 134,938	$ 81,363	$ 4,088	$ 114,014

TABLE IV-49

LABOR AND BENEFIT COSTS FOR A FIVE-SECTION PLUS LONGWALL TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 11,200	$ 5,600	$ 2,800	0	0	$ 2,800
Mine Foreman	16,800	12,000	4,800	$ 2,400	0	4,800
Assistant Mine Foreman	48,000	36,000	12,000	6,000	0	6,000
Maintenance Foreman	13,800	6,900	4,600	0	0	0
Assistant Maintenance Foreman	22,800	15,200	7,600	3,800	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	12,600	4,200	16,800	2,100	0	2,100
Assistant Chief Electrician	11,400	3,800	15,200	1,900	0	1,900
Purchasing Agent	8,000	0	0	0	0	0
Warehouseman	25,500	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Surveyor	5,200	0	0	0	0	0
Chief Engineer	3,600	3,600	1,800	1,800	$ 1,800	3,600
Engineer	3,000	1,500	1,500	1,500	1,500	1,500
Draftsman/Technician	6,000	3,000	0	0	0	6,000
Track Foreman (Track Haulage)	25,500	45,900	20,400	0	0	0
Belt Foreman	0	0	0	0	0	0
Construction Foreman	8,500	6,800	3,400	1,700	0	1,700
Clerk	3,400	3,400	0	0	1,700	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Safety Director	8,500	3,400	3,400	1,700	1,700	1,700
Assistant Safety Director	7,500	3,000	3,000	1,500	1,500	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 292,[illegible]00	$ 183,600	$ 104,100	$ 34,800	$ 8,200	$ 62,100

TABLE IV-49 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A FIVE-SECTION PLUS LONGWALL TRACK HAULAGE MINE OUTBY THE PANELS

(Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	0	0	0	0	0	0
Motorman (Supplies)	$ 105,557	$ 6,209	$ 6,209	0	0	0
Motorman (Track Haulage)	29,804	238,435	14,902	0	0	0
General Labor	169,125	112,750	28,187	$ 56,375	0	$ 56,375
Pumper	81,054	0	9,006	72,048	0	0
Bratticeman	55,125	0	0	0	0	110,250
Trackman (Track Haulage)	115,312	253,688	46,125	0	0	0
Outside Supply Man	76,805	0	0	0	0	0
Mechanic/Electrician	97,326	58,396	77,861	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 788,997	$ 681,256	$ 182,290	$ 128,423	0	$ 166,625
TOTAL LABOR	$1,081,097	$ 864,856	$ 286,390	$ 163,223	$ 8,200	$ 228,725
LABOR BENEFITS	$ 541,632	$ 433,295	$ 143,482	$ 81,775	$ 4,108	$ 114,592

TABLE IV-50

LABOR AND BENEFIT COSTS FOR A NINE-SECTION PLUS LONGWALL BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 12,000	$ 6,000	$ 3,000	0	0	$ 3,000
Mine Foreman	17,500	12,500	5,000	$ 2,500	0	5,000
Assistant Mine Foreman	50,400	37,800	12,600	6,300	0	6,300
Maintenance Foreman	14,400	7,200	4,800	0	0	0
Assistant Maintenance Foreman	36,000	24,000	12,000	6,000	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	13,200	4,400	17,600	2,200	0	2,200
Assistant Chief Electrician	24,000	8,000	32,000	4,000	0	4,000
Chief Purchasing Agent	8,000	0	0	0	0	0
Assistant Purchasing Agent	6,750	0	0	0	0	0
Warehouseman	42,500	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Surveyor	10,400	0	0	0	0	0
Chief Engineer	3,600	3,600	1,800	1,800	$ 1,800	3,600
Engineer	6,000	3,000	3,000	3,000	3,000	3,000
Draftsman/Technician	6,800	3,400	0	0	0	6,800
Track Foreman (Supplies)	23,800	0	6,800	0	0	0
Belt Foreman	30,600	61,200	0	0	0	0
Construction Foreman	8,500	6,800	3,400	1,700	0	1,700
Clerk	3,400	3,400	0	0	1,700	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Assistant Shop Foreman	6,800	10,200	3,400	3,400	0	0
Safety Director	8,500	3,400	3,400	1,700	1,700	1,700
Assistant Safety Director	7,500	3,000	3,000	1,500	1,500	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 391,450	$ 227,200	$ 118,600	$ 44,500	$ 9,700	$ 67,300

TABLE IV-50 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A NINE-SECTION PLUS LONGWALL BELT-TRACK MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	$ 205,000	$ 717,500	$ 51,249	0	0	0
Motorman (Supplies)	126,668	7,451	7,451	0	0	0
Motorman (Track Haulage)	0	0	0	0	0	0
General Labor	230,625	153,750	38,437	$ 76,875	0	$ 76,875
Pumper	94,563	0	10,507	84,056	0	0
Bratticeman	63,000	0	0	0	0	126,000
Trackman (Belt-Track)	44,844	98,656	17,938	0	0	0
Outside Supply Man	102,407	0	0	0	0	0
Mechanic/Electrician	121,658	72,995	97,326	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$1,047,654	$1,062,130	$ 222,908	$ 160,931	0	$ 202,875
TOTAL LABOR	$1,439,104	$1,289,330	$ 341,508	$ 205,431	$ 9,700	$ 270,175
LABOR BENEFITS	$ 717,728	$ 643,031	$ 170,321	$ 102,455	$ 4,838	$ 134,745

TABLE IV-51

LABOR AND BENEFIT COSTS FOR A NINE-SECTION PLUS LONGWALL TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Salary:						
Superintendent	$ 12,000	$ 6,000	$ 3,000	0	0	$ 3,000
Mine Foreman	17,500	12,500	5,000	$ 2,500	0	5,000
Assistant Mine Foreman	50,400	37,800	12,600	6,200	0	6,200
Maintenance Foreman	14,400	7,200	4,800	0	0	0
Assistant Maintenance Foreman	36,000	24,000	12,000	6,000	0	0
Outside Foreman	25,500	10,200	0	5,100	0	0
Chief Electrician	13,200	4,400	17,600	2,200	0	2,200
Assistant Chief Electrician	24,000	8,000	32,000	4,000	0	4,000
Chief Purchasing Agent	8,000	0	0	0	0	0
Assistant Purchasing Agent	6,750	0	0	0	0	0
Warehouseman	42,500	0	0	0	0	0
Ventilation Foreman	8,500	0	0	0	0	23,800
Surveyor	10,400	0	0	0	0	0
Chief Engineer	3,600	3,600	1,800	1,800	$ 1,800	3,600
Engineer	6,000	3,000	3,000	3,000	3,000	3,000
Draftsman/Technician	6,800	3,400	0	0	0	6,800
Track Foreman (Track Haulage)	25,500	45,900	20,400	0	0	0
Belt Foreman	0	0	0	0	0	0
Construction Foreman	8,500	6,800	3,400	1,700	0	1,700
Clerk	3,400	3,400	0	0	1,700	1,700
Secretary	3,200	3,200	0	0	0	0
Shop Foreman	7,600	11,400	3,800	3,800	0	0
Assistant Shop Foreman	6,800	10,200	3,400	3,400	0	0
Safety Director	8,500	3,400	3,400	1,700	1,700	1,700
Assistant Safety Director	7,500	3,000	3,000	1,500	1,500	1,500
Training Supervisor	6,000	4,500	3,000	1,500	0	3,000
Subtotal	$ 362,550	$ 211,900	$ 132,200	$ 44,500	$ 9,700	$ 67,300

TABLE IV-51 (Cont'd.)

LABOR AND BENEFIT COSTS FOR A NINE-SECTION PLUS LONGWALL TRACK HAULAGE MINE OUTBY THE PANELS (Dollars)

Job Classification	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Hourly Labor:						
Beltman	0	0	0	0	0	0
Motorman (Supplies)	$ 126,668	$ 7,451	$ 7,451	0	0	0
Motorman (Track Haulage)	39,739	317,914	19,870	0	0	0
General Labor	230,625	153,750	38,437	$ 76,875	0	$ 76,875
Pumper	94,563	0	10,507	84,056	0	0
Bratticeman	63,000	0	0	0	0	126,000
Trackman (Track Haulage)	140,938	310,062	56,375	0	0	0
Outside Supply Man	102,407	0	0	0	0	0
Mechanic/Electrician	121,658	72,995	97,326	0	0	0
Dispatcher/Hoistman	58,889	11,778	0	0	0	0
Subtotal	$ 978,487	$ 873,950	$ 229,966	$ 160,931	0	$ 202,875
TOTAL LABOR	$1,341,037	$1,085,850	$ 362,166	$ 205,431	$ 9,700	$ 270,175
LABOR BENEFITS	$ 671,530	$ 543,744	$ 181,356	$ 102,870	$ 4,857	$ 135,291

TABLE IV-52

SUMMARY OF OUTBY PANEL COSTS FOR TWO-SECTION SLOPE MINE WITH BELT-TRACK SYSTEM

($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	37.2	30.5	20.1	7.5	0	11.8
Depreciation	140.2	91.4	59.0	16.7	0	73.1
Power	7.7	43.2	8.5	19.7	0	14.0
Labor	340.7	194.0	58.7	31.9	0	55.1
Labor Benefits	171.1	97.5	29.5	16.0	0	27.7
TOTAL	696.9	456.6	175.8	91.8	0	181.7

TABLE IV-53

SUMMARY OF OUTBY PANEL COSTS FOR TWO-SECTION SLOPE MINE WITH TRACK HAULAGE ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	30.2	56.1	17.9	7.5	0	11.8
Depreciation	130.0	188.3	63.6	16.7	0	73.1
Power	7.7	38.9	8.0	19.7	0	14.0
Labor	336.2	185.1	68.0	31.9	0	55.1
Labor Benefits	169.1	93.1	34.2	16.0	0	27.7
TOTAL	673.2	561.5	191.7	91.8	0	181.7

TABLE IV-54

SUMMARY OF OUTBY PANEL COSTS FOR TWO-SECTION DRIFT MINE WITH BELT-TRACK SYSTEM ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	32.4	25.5	20.1	6.5	0	7.8
Depreciation	67.2	56.4	59.0	15.0	0	23.1
Power	6.8	36.0	7.0	13.1	0	14.0
Labor	340.7	194.0	58.7	31.9	0	55.1
Labor Benefits	171.1	97.5	29.5	16.0	0	27.7
TOTAL	618.2	409.4	174.3	82.5	0	127.7

TABLE IV-55

SUMMARY OF OUTBY PANEL COSTS FOR TWO-SECTION DRIFT MINE WITH TRACK HAULAGE ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	25.4	51.5	17.9	6.5	0	7.8
Depreciation	57.0	153.6	63.6	15.0	0	23.1
Power	6.8	31.7	6.6	13.1	0	14.0
Labor	336.2	185.1	68.0	31.9	0	55.1
Labor Benefits	169.1	93.1	34.2	16.0	0	27.7
TOTAL	594.5	515.0	190.3	82.5	0	127.7

TABLE IV-56

SUMMARY OF OUTBY PANEL COSTS
FOR A FOUR-SECTION SLOPE MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	67.8	64.4	46.1	14.2	0	36.5
Depreciation	190.7	175.7	96.4	22.8	0	165.1
Power	15.0	72.0	14.1	26.3	0	28.0
Labor	680.8	398.0	139.4	88.8	0	85.3
Labor Benefits	342.9	200.4	70.2	44.7	0	43.0
TOTAL	1,297.2	910.5	366.2	196.8	0	357.9

TABLE IV-57

SUMMARY OF OUTBY PANEL COSTS
FOR A FOUR-SECTION SLOPE MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	54.2	129.8	40.2	14.2	0	36.5
Depreciation	171.9	319.4	92.0	22.8	0	165.1
Power	15.0	68.4	13.8	26.3	0	28.0
Labor	645.5	392.9	147.3	88.7	0	85.3
Labor Benefits	323.7	197.0	73.9	44.5	0	42.8
TOTAL	1,210.3	1,107.5	367.2	196.5	0	357.7

TABLE IV-58

SUMMARY OF OUTBY PANEL COSTS FOR A FOUR-SECTION DRIFT MINE WITH A BELT-TRACK SYSTEM ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	60.4	57.9	46.1	12.2	0	20.5
Depreciation	109.4	133.7	96.4	19.5	0	58.5
Power	12.3	57.6	11.8	19.7	0	28.0
Labor	680.8	398.0	139.4	38.8	0	85.3
Labor Benefits	342.9	200.4	70.2	44.7	0	43.0
TOTAL	1,205.8	847.6	363.9	184.9	0	235.3

TABLE IV-59

SUMMARY OF OUTBY PANEL COSTS FOR A FOUR-SECTION DRIFT MINE WITH TRACK HAULAGE ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	46.8	123.3	40.2	12.2	0	20.5
Depreciation	90.6	277.4	92.0	19.5	0	58.5
Power	12.3	54.0	11.4	19.7	0	28.0
Labor	645.5	392.9	147.3	88.7	0	85.3
Labor Benefits	323.7	197.0	73.9	44.5	0	42.8
TOTAL	1,118.9	1,044.6	364.8	184.6	0	235.1

TABLE IV-60

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION SLOPE MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	109.0	117.7	89.7	24.6	0	117.0
Depreciation	257.2	302.9	186.0	35.2	0	389.0
Power	30.8	194.4	34.8	52.6	0	70.1
Labor	1,200.5	755.3	258.0	166.9	0	211.3
Labor Benefits	603.1	379.5	129.6	83.8	0	106.1
TOTAL	2,200.6	1,749.8	698.1	363.1	0	893.5

TABLE IV-61

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION SLOPE MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	85.0	251.7	74.5	24.6	0	117.0
Depreciation	225.8	512.5	163.7	35.2	0	389.0
Power	30.8	165.6	31.9	52.6	0	70.1
Labor	1,113.6	777.3	272.1	166.9	0	211.3
Labor Benefits	559.6	390.6	136.7	83.9	0	106.2
TOTAL	2,014.8	2,097.7	678.9	363.2	0	893.6

TABLE IV-62

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION DRIFT MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	99.5	107.7	89.7	24.6	0	68.5
Depreciation	167.2	247.1	186.0	35.2	0	155.6
Power	27.0	144.0	28.0	39.4	0	70.1
Labor	1,200.5	755.3	258.0	166.9	0	211.3
Labor Benefits	603.1	379.5	129.6	83.8	0	106.1
TOTAL	2,097.3	1,633.6	691.3	349.9	0	611.6

TABLE IV-63

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION DRIFT MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	75.5	241.7	74.5	24.6	0	68.5
Depreciation	135.8	456.7	163.7	35.2	0	155.6
Power	27.0	115.2	25.2	39.4	0	70.1
Labor	1,113.6	777.3	272.1	166.9	0	211.3
Labor Benefits	559.6	390.6	136.7	83.9	0	106.2
TOTAL	1,911.5	1,981.5	672.2	350.0	0	611.7

TABLE IV-64

SUMMARY OF OUTBY PANEL COSTS
FOR A FIVE-SECTION PLUS LONGWALL SLOPE MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	127.1	166.5	113.5	31.4	0	169.9
Depreciation	243.7	358.8	232.2	42.9	0	416.5
Power	24.8	327.4	50.1	78.8	0	70.1
Labor	1,177.6	1,082.4	270.7	163.2	8.2	228.7
Labor Benefits	587.0	539.6	134.9	81.4	4.1	114.0
TOTAL	2,160.2	2,474.7	801.4	397.7	12.3	999.2

TABLE IV-65

SUMMARY OF OUTBY PANEL COSTS
FOR A FIVE-SECTION PLUS LONGWALL SLOPE MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	97.2	266.6	93.8	31.4	0	169.9
Depreciation	212.9	412.1	200.4	42.9	0	416.5
Power	24.8	260.8	43.4	78.8	0	70.1
Labor	1,081.1	864.9	286.4	163.2	8.2	228.7
Labor Benefits	541.6	433.3	143.5	81.8	4.1	114.6
TOTAL	1,957.6	2,237.7	767.5	398.1	12.3	999.8

TABLE IV-66

SUMMARY OF OUTBY PANEL COSTS
FOR A FIVE-SECTION PLUS LONGWALL DRIFT MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	116.6	153.5	113.5	31.4	0	84.9
Depreciation	175.4	308.2	232.2	42.9	0	143.1
Power	21.0	232.3	37.6	52.6	0	70.1
Labor	1,177.6	1,082.4	270.7	163.2	8.2	228.7
Labor Benefits	587.0	539.6	134.9	81.4	4.1	114.0
TOTAL	2,077.6	2,316.0	788.9	371.5	12.3	640.8

TABLE IV-67

SUMMARY OF OUTBY PANEL COSTS
FOR A FIVE-SECTION PLUS LONGWALL DRIFT MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	86.7	253.5	93.8	31.4	0	84.9
Depreciation	144.6	361.8	200.4	42.9	0	143.1
Power	21.0	165.8	30.9	52.6	0	70.1
Labor	1,081.1	864.9	286.4	163.2	8.2	228.7
Labor Benefits	541.6	433.3	143.5	81.8	4.1	114.6
TOTAL	1,875.0	2,079.3	755.0	371.9	12.3	641.4

TABLE IV-68

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION PLUS LONGWALL SLOPE MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	150.8	193.8	137.0	37.3	0	196.2
Depreciation	283.7	430.2	279.0	51.6	0	477.4
Power	34.8	422.4	63.7	92.0	0	87.6
Labor	1,431.1	1,289.3	341.5	205.4	9.7	270.2
Labor Benefits	717.7	643.0	170.3	102.4	4.8	134.7
TOTAL	2,618.1	2,978.7	991.5	488.7	14.5	1,166.1

TABLE IV-69

SUMMARY OF OUTBY PANEL COSTS FOR A NINE-SECTION PLUS LONGWALL SLOPE MINE WITH TRACK HAULAGE ($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	115.8	324.2	150.9	37.3	0	196.2
Depreciation	247.4	504.8	304.6	51.6	0	477.4
Power	34.8	337.9	55.2	92.0	0	87.6
Labor	1,341.0	1,085.9	362.2	205.4	9.7	270.2
Labor Benefits	671.5	543.7	181.4	102.9	4.8	135.3
TOTAL	2,410.5	2,796.5	1,054.3	489.2	14.5	1,166.7

TABLE IV-70

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION PLUS LONGWALL DRIFT MINE
WITH A BELT-TRACK SYSTEM
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	139.3	180.8	137.0	37.3	0	97.2
Depreciation	212.1	379.6	279.0	51.6	0	157.5
Power	30.9	316.8	50.1	65.7	0	87.6
Labor	1,431.1	1,289.3	341.5	205.4	9.7	270.2
Labor Benefits	717.7	643.0	170.3	102.4	4.8	134.7
TOTAL	2,531.1	2,809.5	977.9	462.4	14.5	747.2

TABLE IV-71

SUMMARY OF OUTBY PANEL COSTS
FOR A NINE-SECTION PLUS LONGWALL DRIFT MINE
WITH TRACK HAULAGE
($1000)

Cost Category	Transport of Personnel, Supplies, and Equipment	Coal and Rock Transportation	Electrical Distribution and Communications System	Water Handling System	Hydraulics	Ventilation
Operating	103.5	311.2	150.9	37.3	0	97.2
Depreciation	175.8	454.2	304.6	51.6	0	157.5
Power	30.9	232.3	41.6	65.7	0	87.6
Labor	1,341.0	1,085.9	362.2	205.4	9.7	270.2
Labor Benefits	671.5	543.7	181.4	102.9	4.8	135.3
TOTAL	2,322.7	2,627.3	1,040.7	462.9	14.5	747.8

*U.S. GOVERNMENT PRINTING OFFICE: 1982-546-085/3260