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Conservation and Development In-House and Contract Research in Fiscal Year 1984

By Staff, Bureau of Mines

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CONSERVATION AND DEVELOPMENT IN-HOUSE AND CONTRACT RESEARCH IN FISCAL YEAR 1984

By Staff, Bureau of Mines

ABSTRACT

This publication summarizes the in-house and contract research projects programmed for fiscal year 1984 by the Bureau of Mines under its Conservation and Development activity. The document provides a mechanism for interested parties to gain insight into projects of the Bureau's Conservation and Development research program.

The objective of the Conservation and Development Program is to provide the technological advances needed to stimulate the mining of domestic deposits containing critical, strategic, and other essential minerals in compliance with existing regulations and at costs sufficiently low to be competitive in world markets. Research efforts are directed toward improving the fundamental understanding of processes and procedures involved in the production of minerals. The overall goals will be accomplished by investigating alternative mining methods to increase domestic production of critical and strategic minerals from low-grade deposits; expanding the technology for the economic and efficient extraction of minerals consistent with cost-effective compliance with environmental regulations; and advancing the technologies needed to insure an adequate supply of coal.

INTRODUCTION

To achieve the Bureau's Conservation and Development Program objective, the fiscal year 1984 program is structured into two subprograms: Mining Technology and Resource Conservation Technology.

The Mining Technology subprogram addresses metal and nonmetal mining technology and coal mining productivity. Research relating to metal and nonmetal mining is focused on advancing the technology in areas that will improve the competitive position of the domestic industry with respect to imported minerals, especially strategic and critical minerals. Coal mining research addresses technologies directed toward reducing the cost of production through improved mining systems, and conserving nonrenewable coal resources through improved recovery.

The Resource Conservation Technology subprogram includes research to investigate problems in the handling, disposing, and treatment of mine wastes and mine water in an economic and environmentally acceptable manner and to improve technology to minimize the adverse impacts of subsidence and other surface effects of mining.

This project annotation summarizes the fiscal year 1984 in-house and contract research projects supported by the Bureau of Mines under its Conservation and Development Program activity. The report provides a mechanism for interested parties to gain insight into ongoing research efforts. The projects presented were programmed prior to the beginning of the fiscal year and are subject to change based on emerging priorities and availability of funds.

Contracting in the Bureau of Mines is conducted in strict accordance with Federal Procurement Regulations, and solicitation is conducted by formal advertisement in the Commerce Business Daily. No additional information will be supplied on new contract projects until after the requests for proposal (RFP's) are made available.

Each active project name is followed, in parentheses, by the abbreviation of the research center responsible for technical performance. In the case of active contract projects, the center designation is followed by the name of the contractor and the contract number. Abbreviations for research centers are as follows:

DRC - Denver Research Center
PRC - Pittsburgh Research Center
RORC - Rolla Research Center
SLRC - Salt Lake Research Center
SRC - Spokane Research Center
TCRC - Twin Cities Research Center
TURC - Tuscaloosa Research Center
WO - Washington Office

For additional information regarding this research program, contact the Bureau's Division of Conservation and Development, Washington, DC.

PROGRAM OUTLINE

The Conservation and Development Program is the Federal Government's mining research program aimed at assisting the advancement of technologies needed to allow mining of domestic deposits containing critical, strategic, and other essential minerals in compliance with all existing regulations and at costs sufficiently low to be competitive in world and domestic markets. It also addresses technologies needed to insure an adequate and economic supply of coal to meet the U.S. demand.

The program is conducted by means of both in-house and contract efforts. The in-house effort develops technology through projects that are more efficiently conducted internally and maintains the necessary Bureau expertise to develop, monitor, and guide the contract research to assure the most efficient overall effect.

The Conservation and Development Program for FY 1984 contains two

subprograms: Mining Technology and Resource Conservation Technology. Research activities of these programs are described.

MINING TECHNOLOGY

METAL-NONMETAL MINING TECHNOLOGY

In-House Projects

1. Geotechnical Technology To Reduce Mine Development Lead Time for Strategic Minerals Production (DRC)

Objective: To investigate innovative premining and mining technologies needed to support the rapid development of strategic and critical mineral deposits in the event of supply disruptions. Included in these investigations are the evaluation of potential technologies for the determination of the location of mineralized zones; the delineation and characterization of the mineral deposits; the determination of the geotechnical characterization of both the mineralized zone and surrounding rock; and the evaluation of alternative mining technologies best suited for the most rapid recovery methods in light of mineral availibility situations and existing environmental and economic conditions.

2. Structural Characterization for Deep Mine Accessways (SRC)

Objective: To provide mine operators with a data base and design approach for evaluating the structural response of deep mine openings to various ground conditions, stress levels, and support mechanisms. Research efforts will be directed toward data collection and analysis, devising mathematical modeling techniques to predict behavior, and conducting in situ measurement studies to verify design approaches.

3. Mining With Backfill (SRC)

Objective: To investigate the technologies required to obtain a greater extraction rate from metal deposits by using mine waste as backfill. The purpose of using mine waste as backfill is twofold. First, as an environmentally sound means of disposing of such solid waste; and second, as a support medium in underground openings, which permits the extraction of valuable ores left in pillars or as support. Such use of mine backfill would increase the recovery of the mineral resources in large ore bodies, and would stabilize the underground workings once mining operations cease, thereby minimizing the impacts from subsidence. Fundamental investigations will be conducted to improve the understanding of the behavior of backfill structures and to improve their load carrying abilities.

4. Continuous Linings for Mine Haulageways (SRC)

Objective: To investigate innovative techniques for providing more effective and more economical support for underground mine haulageways. Emphasis will be on new concepts and low-cost materials for wide generic application to various mining situations in order to provide increased productivity in soft, caving, or squeezing ground.

5. Advanced Concepts for Mining Deep Ore Bodies (SRC)

Objective: To identify major technological barriers that currently prevent the mining of deep ore bodies. Investigations will evaluate the rock mechanics parameters associated with the deep deposits, determine innovative materials-handling concepts necessary for transporting ore and waste underground and to the surface, and provide mine design criteria for various mining methods, including stope and accessway designs.

6. Flexible Tendon Ground Stabilization Concepts (SRC)

Objective: To investigate concepts for using grouted cables for improving the stability of underground stopes and

pillars and thereby enhancing recovery and production. Laboratory tests will be conducted to determine strength properties of various grouts, epoxies, and support cables. A test site will be selected, and rock property and stress data obtained. A finite-element model will be constructed to analyze the support potential of various cable-grout-rock combinations.

7. Innovative Materials Transport Concepts (SRC)

Objective: To investigate innovative surface mine haulage concepts for handling large volumes of ore and waste rock, which will be required to mine deeper and lower grade deposits in the future. Various concepts, such as air-film transport, flywheel power, and pneumatic plug flow will be assessed for applicability to mining conditions.

8. Fragmentation of Hard Abrasive Rock (TCRC)

Objective: To investigate the fundamental parameters that influence efficient cutting of hard abrasive rock. Using both a small- and large-scale linear cutting test bed, the role of cutting geometry, bit geometry, and rate of cutting will be investigated to determine conditions required for effective cutting and excavating in hard abrasive rock. This project is also associated with a Health and Safety Technology Program project concerned with minimizing dust emissions in cutting operations.

9. Application of Water Jet Technology for Selective Mining in Underground Mines (TCRC)

Objective: To investigate the technologies required to permit the use of low-pressure (10,000 psi or 690 bars) abrasive slurries (water jet concepts) for making deep narrow kerfs in hard rock. Research is intended to determine the optimum parameters to make such a cutting concept feasible in underground mining operations.

10. Optimized Equipment Use in Surface Mines (TCRC)

Objective: To lower the operating costs in surface mines by completing the analysis and evaluation of an on-board continuous maintenance prognostics, alert, and diagnostic system for surface mining haulage trucks. Baseline documentation supporting the concept will be provided, technology gaps will be identified, and preliminary economic analyses will be performed.

11. Enhanced Drilling Concepts (TCRC)

Objective: To investigate and determine the chemical and electrochemical mechanisms involved in drilling operations. Laboratory experiments will be conducted to determine the role of chemical and/or electrochemical reactions among drill materials, lubricants, and minerals in changing the performance in drilling operations.

12. Thermal Fragmentation Concepts (TCRC)

Objective: To investigate the potential of thermally induced stresses to improve the fragmentation of hard rock in mining operations. Research is investigating operating conditions that allow the use of electromagnetic energy to induce fragmentation in various mineral formations and rocks. Parameters such as the energy levels and the power densities of lasers and/or microwaves will be studied to determine how to obtain optimium fragmentation in underground mining operations.

13. Well Construction and Completion Techniques for In Situ Leaching (TCRC)

Objective: To investigate branch well and horizontal drain hole concepts for in situ leaching of deep deposits. Laboratory tests will be conducted to determine the feasibility of modified whipstocking concepts and the suitability of various casing materials. Investigations

will establish basic engineering parameters necessary to advance two branch well concepts to the design layout stage.

14. Fluid Flow, Detection and Control (TCRC)

Objective: To investigate the fundamental relationships of fluid flow in unsaturated zones and analyze the effectiveness of exploiting marginal hard-rock mineral deposits through in situ mining methods. Through laboratory testing, determine permeability values and solution flow capabilities and coverage in deposits above the water table, and produce basic computer simulation models to represent such conditions. Cost-benefit analyses relating to exploitation of marginal mineral resources will be conducted.

15. Investigation of Use of Acoustics To Determine Geophysical and Geotechnical Properties of Rock (TCRC)

Objective: To investigate fundamental relationships between the acoustic properties of rock mass and the in situ state of stress in order to increase the understanding of the geophysical and geotechnical properties of rock mass and to lead to improved techniques for determining in situ stress.

16. Efficient Design Criteria for Improved Blast Initiation (TCRC)

Objective: To investigate parameters influencing the effectiveness of blasting in surface rock. The research will determine the fundamental properties of blasting dynamics, including close-in source characterization, blasthole interactions, stress wave generation, fracture radiation patterns, and the influence of controlled, precise initiation timing over a wide range of intervals on these factors. An understanding of blasting performance criteria will be incorporated into production designs for improved fragmentation.

Contract Projects

1. Demonstration of Raise Driving at the Schwartzwalder Mine Using the Swedish Long-Hole Technique (SRC, Colorado School of Mines, J0205025)

Objective: To demonstrate the Swedish long-hole raise driving technique in a U.S. mine to improve the operational, economic, and environmental factors of conventional raise driving.

2. Compact Service Hoist System for Underground Metal and Nonmetal Mines (SRC, Foster-Miller Associates, H0202019)

Objective: To develop a smaller and more portable personnel-rated hoist capable of hoisting small supplies or one or two persons into stopes. Small underground hoists presently available are either not person-rated, require a hoist person if person-rated, or require extensive raise structure such as guides or tracks. The hoist system has been completed and will be field tested at an appropriate underground site.

3. Compact Loader-Trammer for Underground Metal and Nonmetal Mines (SRC, Foster-Miller Associates, J0205037)

Objective: To design and build a small load-tram unit that is capable of maneuvering in narrow veins and can be easily transported through existing raises. The machine has been completed and will be field tested at an appropriate underground site.

4. Testing of a Mine Run Rock Conveying System (SRC, R. A. Hanson Co., J0295075)

Objective: To design, fabricate, and test a conveying system capable of handling rock with a maximum lump size of 50 to 60 in.

5. Open Pit Ore Pass Design Manual (SRC, Engineers International, J0205041)

Objective: To write a manual for design, construction, and maintenance of vertical and inclined ore pass systems for use in underground haulage from open-pit mines.

6. Pillar Design for Vertical Crater Retreat Mining (SRC, University of Utah, J0215043)

Objective: To provide design criteria for using the vertical crater retreat (VCR) method of mining in the United States. Investigations will evaluate the various rock types and geologic formations applicable to the VCR method. Research results will provide design criteria for optimizing stope and pillar size in VCR mining while maximizing resource recovery and productivity.

7. Placement and Evaluation of High-Modulus Backfill (SRC, Montana Tech, J0295052)

Objective: To develop and test a method for placing high-modulus backfill in underground stopes and to evaluate its potential for supporting heavy ground and minimizing rock bursts. Tailings and waste rock were tested and a mining and filling plan developed. By use of this plan and computer modeling, mining and filling will be simulated to compare high-modulus backfill support with conventional uncemented backfill support. Emphasis will be placed on modeling the stresses exerted in mine supports and raise structure as well as the stress concentrations surrounding the stope.

8. Kinetic Modeling of Uranium Solution Mining (TCRC, Pennsylvania State University, J0100065)

Objective: To define quantitative models, based on laboratory experiments, for the solution mining of uranium with an acidic lixiviant. The solubility of uranium peroxide and the oxidation of uraninite and pyrite by hydrogen peroxide under specific conditions will be investigated and described. A simulation model of the in situ leaching process, which combines a quantitative geochemical model with a one-dimensional fluid flow simulation, will be produced and validated.

9. Geologic Factors Effecting Vibrations From Surface Mine Blasting (TCRC, Vibratech Engineers Inc., H0222009)

Objective: To evaluate the geologic and soil conditions that create abnormal and severe transmission of blast vibrations. To gather data on vibration transmission characteristics for various geological conditions and to utilize such data in developing improved blast design criteria that minimize the impact of blasting in the local environment while improving the efficiency of the blast in its mining objective.

10. Oversize Breaker for Use With Portable Crushers (TCRC, Foster-Miller Associates, J0295063)

Objective: To determine currently available technology for impact tools, and to evaluate the best concept for an oversize breaker system to be used with a portable underground crusher. A machine incorporating the optimum design will be constructed and tested. Components will be modified as needed.

11. Study and Evaluation of Geologic Site Investigations for Tunnels (WO, Department of Transportation, J0113036)

Objective: To investigate technologies required to improve the planning and the construction of tunnels in a more cost-effective manner. Pretunneling site investigation of the geology is a major area of emphasis of this interagency sponsored research. The Bureau contributes to this Department of Transportation coordinated study being conducted by the U.S. National Committee on Tunneling Technology.

12. Support of the Continuing Activities of the U.S. National Committee on Tunneling Technology (WO, National Academy of Science, National Academy of Engineering, J0199025)

Objective: To provide a continuing assessment of the state-of-the-art of tunneling, and to identify technical needs that might be met through research and development. The Bureau, along with other interested Government agencies, contributes support for the continuing activities of the U.S. National Committee on Tunneling Technology, which operates as part of the Assembly of Engineering, National Academy of Science and the National Academy of Engineering.

13. Support of the Continuing Activities of the U.S. National Committee for Rock Mechanics (WO, National Academy of Science, J0199030)

Objective: To recommend courses of action to governmental, industrial, and academic organizations in the rock mechanics area. The Bureau is 1 of 14 Governmental bureaus that contribute to the support of the continuing activities of the U.S. National Committee for Rock Mechanics, which operates as part of the National Research Council of the National Academy of Science.

14. Participation in the Maintenance of the Cold Regions Research and Engineering Laboratory at Fox, AK (WO, U.S. Army, J0134044, formerly S0188062)

Objective: To provide operational and maintenance support of a unique facility that provides an experimental laboratory to test technologies important to recovering the mineral potential in the permafrost conditions found in Alaska. The U.S. Army cold region facility located at Fox, AK, approximately 10 miles north of Fairbanks, includes an adit in permafrost in which a complete cross section of silt, gravel, and bedrock is exposed underground. The Bureau participates with the University of Alaska and the Department of the Army in the funding for the maintenance of this facility, which makes available to the Bureau a permafrost research site in a state of readiness for use.

15. Investigation of Borehole Mineral Assaying Technology (WO, U.S. Geological Survey, J0134032)

Objective: To investigate and to establish new technologies for improving borehole mineral assaying methods. Emphasis of this research is to design, construct, and evaluate an assaying borehole logging system that uses a neutron accelerator as its source of neutrons. Laboratory investigations will seek to identify optimum operating conditions (pulse rate) and the resultant nuclear reactions needed to improve delineation and determine composition of mineral deposits.

COAL MINING TECHNOLOGY

In-House Projects

1. Geomechanics and Longwall Mining Method for Thick Coal Seams (DRC)

Objective: To improve the recovery of thick and multiple coal seams by solving underground stability problems through basic geomechanical research applicable to western U.S. mining conditions. The study will address geomechanical problems associated with pillar stability in both thick-seam room-and-pillar and longwall mining, stress concentrations (interaction) between multiple-seam workings, and competency of overburden and interburden.

2. Mine Roof Support Studies (PRC)

Objective: To establish fundamental engineering design data to better understand the function of longwall roof support in maintaining the desired ground control and to derive criteria for more effective design and utilization of these systems relative to the geological conditions in which they are used. This project will construct a computer graphics

program for a generic longwall roof support, initiate a study to model a typical longwall roof support system using finite element modeling techniques, determine the actual loads in various members of a longwall shield, drill core holes to be used for geologic observations and assessment of interburden strata behavior, install instrumentation to measure the pressure distribution in the gob, and instrument a longwall panel with stress meters to assess the magnitude and location of the front abutment load zone.

3. Cutting and Boring (PRC)

Objective: To improve the productivity of coal mining machines by investigating the potential benefits of water-jet assisted cutting and boring. The project will identify the optimum water jet location, jet pressure, and transverse rate of movement. Studies will be conducted on a single cutting pick instrumented to measure and record cutting force while cutting with and without water-jet assist.

4. Underground Coal Mining Systems (Completion of Equipment Testing) (PRC)

Objective: To establish system performance requirements for underground coal mining extraction and transport systems. Testing of prototype equipment will continue at the Mining Equipment Test Facility. Equipment under evaluation includes the automated extraction system, umbrella miner, hopper-feeder-bolter, and variable wall miner system. A data base will also be generated for the multiple unit continuous haulage system, flywheel powered shuttle car, monorail bridge conveyor, and the autotrack bridge conveyor train. Performance criteria will be established to compare these technological developments with state-of-the-art transport equipment in underground coal mining.

5. Hydraulic Transport Research Facility (Complete Mothballing) (PRC)

Objective: To place the Hydraulic Transport Research Facility (HTRF) in a standby mode. This project will complete documentation of final data runs of the HTRF and complete technical documentation of program functions. This will complete the current program for the facility.

6. Longwall Automation (PRC)

Objective: To advance the potential for automation in underground mining systems. This investigation will evaluate feedback systems to monitor significant roof and coal parameters and feed the sensory information back to a remote operator of a longwall machine.

7. Investigation of In-Mine Support Functions for Thick and Steeply Pitching Seams (PRC)

Objective: To assess and define the haulage requirements for mining thick and steeply pitching coal seams and any associated human factors problems. The project will include a literature search and data collection on the transport systems as well as an examination of the tasks to be performed.

8. Numerical Analysis Methods--Advancing Longwall-Packwall Interaction Study (SRC)

Objective: To investigate concepts of new mining methods for nonconventional coal reserves located in the western United States. The project will use computer programs to model the mining methods to determine the stress distribution in the rock and coal during each step of the excavation sequence and to evaluate possible modifications to the mining method to reduce the stress loadings.

9. Coal Mining With Backfill (SRC)

Objective: To investigate the technologies required to obtain a greater extraction rate from fossil fuel deposits by using mine waste as backfill. The purpose of using mine waste as backfill is twofold. First, as an environmentally sound means of disposing of such solid waste; and second, as a support medium in underground openings, which permits the extraction of valuable fuels left in

pillars or as support. Such use of mine backfill would increase the recovery of fuel resources in large ore bodies, and would stabilize the underground working once mining operations cease, thereby minimizing the impacts from subsidence. Fundamental investigations will be conducted to improve the understanding of the behavior of backfill structures and to improve their load carrying abilities.

10. Fundamental Hydraulic Coal Fragmentation (TCRC)

Objective: To investigate technologies to provide efficient fragmentation of coal. Research will examine the use of abrasive slurries (water jet) for hydraulic cutting of coal.

Contract Projects

A coal mining technology program was created in the Bureau in 1974, shortly after the oil embargo and the resulting Project Independence. With the formation of the Department of Energy in 1977, the program and its associated funding and staff were transferred to that agency. Appropriations for the program reached a peak of $56.7 million in 1978. In September 1982, in the FY 1982 Supplemental Appropriations Bill (Public Law 97-257), Congress returned the program to the Department of the Interior; a Secretarial order subsequently delegated responsibility to the Bureau of Mines.

All listings in this section are contracts begun in prior fiscal years and transferred from the Department of Energy to the Bureau. A major portion of these contracts are equipment development programs that are nearing completion. The Bureau intends to bring all of the following contracts to an orderly and logical conclusion. If any new contract research efforts are initiated, they will be directed toward the high-risk, long-term aspects of coal mining problems. Major equipment development programs and demonstrations are more appropriate to be undertaken by the private sector.

1. Longwall Mining Steep Seams (DRC, Snowmass Coal Co., J0233923)

Objective: To stimulate the development of underground mining technology by demonstrating a system of mining steeply dipping (25° or more) coalbeds by longwall methods and techniques capable of increasing coal production and resource recovery.

2. Demonstration of Shield Type Longwall Supports (DRC, Kaiser Steel Corp., J0233912)

Objective: To provide operational, safety, and ground control data on the use of shield supports under conditions of deep cover and sandstone roof. Operational, safety, and minimal roof control data are being collected for the Government shields at the 18L longwall panel in the Sunnyside Mine in Utah.

3. In-Mine Trial of Longwall Multilift Mining (DRC, Mid-Continent Resources, Inc., J0233913)

Objective: To further the development of underground mining technology through an in-mine trial of the multilift method of mining thick (approximately 20 ft) western U.S. coalbeds. Feasibility studies indicate the multilift mining method is capable of increasing coal production and resource recovery.

4. Water Jet Assisted Cutterhead for Coal Measure Rocks (PRC, Colorado School of Mines, J0233900)

Objective: To design, test, and evaluate a high efficiency cutterhead for use on a coal mine entry development machine. High efficiency is to be obtained by utilizing drag bits assisted by low-pressure water. Phase I was to design an optimum jet assisted drag bit cutting system and to verify its validity in the laboratory. Phase II is to develop and test a rotary cutting head utilizing the jet assisted drag bit cutting system.

5. Operation of Mine Equipment Test Facility (PRC, Boeing Services, International, J0333956)

Objective: To operate and maintain the Mine Equipment Test Facility. To provide support for R&D programs at the Pittsburgh (PA) Research Center, which will utilize the Mine Equipment Test Facility, taking advantage of its unique capabilities. This will enable advancing production and safety technology for underground coal mining in order to foster improvements in mine productivity and health and safety.

6. Characterization of Subsidence Over Pillar Extraction Panels (PRC, GAI Consultants, J0233920)

Objective: To determine the geometric and chronological relationships between pillar extraction mining, subsidence, mine stress, and overburden deflection at the Kitt Mine in West Virginia. Comprehensive measurements of subsidence, mine stress changes, overburden deflection, and changes in aquifer characteristics are being measured at the Kitt Mine pillar extraction panel. The measurements will improve basic understanding of subsidence mechanisms and provide data for calibration of an analytical model.

7. Characterization of Subsidence Over Longwall Panels (PRC, D'Appolonia Consulting Engineers, J0233918)

Objective: To determine the geometric and chronological relationships between longwall mining and subsidence, mine stress, and overburden deflection at the Kitt Mine in West Virginia. Comprehensive measurements of subsidence, mine level stress changes, and overburden deflection are being made at two longwall panels in the Kitt Mine. The measurements are intended to improve basic understanding of subsidence mechanisms and provide data to calibrate analytical structural models of subsidence.

8. Hopper-Feeder Bolter (PRC, ESD Corp., J0333940)

Objective: To test the capability of a prototype multifunctional machine system as an interface vehicle between a continuous miner and a face haulage system, and a bolter machine placing bolts for permanent roof support alongside a two-pass continuous miner.

9. Automated Bridge Conveyor Train (PRC, Foster-Miller Associates, J0333913)

Objective: To develop and test a prototype continuous face haulage system comprised of alternating mobile bridge carriers and extensible piggyback bridge conveyors that are automatically guided by microprocessor control and sensors in a room-and-pillar underground coal mine plan.

10. Coal Injector for Coarse Slurry Transport (PRC, Foster-Miller Associates, J0333914)

Objective: To conceive, design, fabricate, and test a device for the controlled injection of run-of-mine coal into an operating hydraulic pipeline in an underground coal mine. The device should do this without degradation of the coal, without leakage of water from the pipeline, and without causing plugging of the line. Controlled injection means that the feed rate can be regulated, ranging up to the output capability of continuous mining machinery, for the purpose of controlling slurry concentration. The device shall be adaptable to vertical, sloped, or horizontal pipelines.

11. Variable Wall Miner System (PRC, Southwest Research Institute, J0333951)

Objective: To develop and test a novel coal extraction and transport prototype designed for use on longwall faces or in the second mining of coal pillars.

The variable wall mining system consists of a series of side cutting augers that are connected end to end and distributed across a coal panel. Supplying rotary power at the end of the auger string and anchorage from conventional longwall roof supports, the augers are sequentially thrust into the face and then lifted to the roof to extract the coal in a continuous manner. The augers not only cut but also transport the coal.

12. Minos Mine Monitoring System Site (PRC, Barnes and Tucker Coal Co., J0133921)

Objective: To provide an operating coal mine for the installation of the Minos monitoring and control system. The Bureau has provided Barnes and Tucker with the use of the National Coal Board developed Minos monitoring system, in return Barnes and Tucker will allow access to the data and information arising from this trial.

13. Industry Assessment of Minos Mine Monitoring System (PRC, Bituminous Coal Research, J0133922)

Objective: To provide preliminary engineering and assistance for the site selection, installation, startup, and operation of the Minos system and then provide a 3-yr evaluation of the system. Bituminous Coal Research National Laboratory has provided the necessary engineering and assistance leading to the installation and operation of the Minos system at Barnes and Tucker Mine No. 20. The 3-yr evaluation phase is now in progress.

14. Minos (PRC, National Coal Board, J0133930)

Objective: To develop, install, and test a computer controlled mine monitoring and control system. The National Coal Board has developed and installed a Minos monitoring and control system at Barnes and Tucker Mine No. 20. This trial will allow for the evaluations of the Minos system during operation in a U.S. coal mine.

15. Appraisal of Models in Coal Management (PRC, Columbia University, J0133908)

Objective: To determine the impact of decision technology on policy and decisionmaking within the Federal coal management program, and ascertain the relative importance of behavioral, organizational, and systems-specific factors in determining implementational success. In particular, mathematical-economic models and computer data bases, as a means of support to decisionmaking, will be appraised.

16. Advanced Coal Extraction System (PRC, Jet Propulsion Laboratory, J0134054)

Objective: To define performance and design characteristics of advanced underground coal mining systems.

17. Coal Mine Productivity (PRC, Carnegie-Mellon University, J0133924)

Objective: To examine the relationship between underground coal mining productivity and human resource utilization and managerial practices, in order to determine how they vary over time and across mine characteristics of seam height, size, mining technology, and ownership. Provide initial technological support to companies that wish to develop new policy to enhance mining productivity.

18. Dynamic Coalbed Reservoir Measure (PRC, U.S. Steel Corp., J0233927)

Objective: To develop realistic approach to near-mine degasification in the Warrior Basin. The work will measure coalbed pressure and fluid saturation; drainage rate as a function of pressure and fluid saturation conditions; and ability to predict borehole degasification performance using the information gathered.

19. Methane Gas Mine Inflow Prediction (PRC, U.S. Steel Corp., J0333952)

Objective: To develop and demonstrate mathematical coal-methane modeling capabilities that are required to plan coal mining ventilation and mining operations systems. Make mine inflow rate predictions based on primary controlling factors and use these rates to formulate one or more preliminary methane models. After field testing to determine usefulness as a predictive tool, the model(s) will be adjusted to increase authenticity and presented in a form directly usable by mine planners.

20. Concentration Sensor For Coal-Water Mixture (PRC, Science Applications, Inc., J0333933)

Objective: To design, fabricate, and test four concentration sensors for the accurate measurement of coal-refuse-water concentrations in haulage pipelines. All of these sensors are designated "research sensors," as performance is to be strongly emphasized in their development. A small research sensor, applicable to a 10-in-diameter pipeline, will be designed, fabricated, and tested. Contingent upon the results of the small research sensor tests, a large research sensor, applicable to a 12-in-diameter pipeline, will be developed. The final phase entails reconditioning and delivery of hardware.

21. Flywheel-Powered Shuttle Car (PRC, ESD Corp., J0333911)

Objective: To develop and test a nontethered, flywheel-powered face haulage vehicle for use in underground coal mines.

22. Umbrella Miner (PRC, Fairchild Research and Development, J0133926)

Objective: To develop and test a novel continuous mining machine prototype capable of coal extraction and simultaneous placement of permanent roof support in underground coal mines for seams 48 to 72 in. in height.

23. Monorail Bridge Conveyor (PRC, Goodman Equipment Corp., J0333917)

Objective: To develop and test a unique prototype continuous face haulage system composed of multiple belt bridge conveyors suspended from a special monorail bolted to the mine roof.

24. Hydrotransport Boost Pump Development (PRC, Foster-Miller Associates, J0133934)

Objective: To develop a low-profile pressure increasing pump for hydrotransport in thin-seam underground coal mines, which can tolerate fluctuating flows, varying solids concentration, large solids particles, and entrained air while minimizing wear and solids degradation.

25. Coal Injector (PRC, Ingersoll-Rand Research, Inc., J0333920)

Objective: To conceive, design, fabricate, and test a device for the controlled injection of run-of-mine coal into an operating hydraulic pipeline in an underground coal mine. The device should do this without degradation of the coal, without leakage of water from the pipeline, and without causing plugging of the line. Controlled injection means that the feed rate can be regulated, ranging up to the output capability of continuous mining machinery, for the purpose of controlling slurry concentration. The device shall be adaptable to vertical, sloped, or horizontal pipelines.

26. Returning Coal Waste Underground (PRC, Ketron, Inc., J0133928)

Objective: To assess feasibility of total integrated mining operation at a selected minesite with all disposal and at least part of the coal processing facilities underground. Conduct a trial for verification of costs and benefits of using existing industrial equipment for

disposal of coal mine waste underground in an active coal mine.

27. Jet Boost Pump for Hydraulic Transport (PRC, University of Minnesota, J0333928)

Objective: To conduct tests that will determine preferred dimensions and operating parameters for the combined peripheral jet pump and a centrifugal pump when serving as in-line boost pump for transporting raw coal slurry in horizontal and vertical pipelines. In phase I, model jet pump shall be designed and fabricated to fit a 3-in-diameter pipeline and the model system then will be tested for both horizontal and vertical flows. Evaluation of effectiveness and efficiency shall be done on the total system and on three subsystems: the jet pump, the permeable-wall strainer, and the centrifugal pump. In the first phase, preferred dimensional values of a boost pump for water should be established through experimental studies. Several configurations shall be tested to provide performance curves by which the best configurations may be determined. In the second phase the parts of the "best" pump configuration shall be fabricated and the pump system shall be evaluated with run-of-mine coal slurry for both horizontal and upward vertical flow.

28. Demonstration of Longwall Mining (PRC, Old Ben Coal Co., J0333949)

Objective: To demonstrate that the coalbeds in the Southern Illinois Coal Basin can be mined by longwall methods using shield type roof supports. Work on two longwall panels will include studies on rock mass behavior and surface subsidence.

29. Near Mine Stimulation Techniques (PRC, Dames and Moore, J0333908)

Objective: To gather information pertaining to stimulation, providing a sound basis upon which mine planning decisions can be made. Specific objectives include measurement of results and refinements of designs that yield general improvement to degasification technology. Manage the drilling completion, abandonment, and underground investigation of 12 vertical boreholes, two boreholes each with six separate coal horizons representing a cross section of major coal producing areas.

30. Evaluation of Cross Ridge Mountaintop Mining (PRC, Mathtech, Inc., J0133936)

Objective: To design concepts for a cross-ridge mountaintop removal mining system in which mining progresses in a direction perpendicular to the long axis of the ridge line; to subject the proposed concepts to technical-economic feasibility and environmental impact analyses; and develop a field demonstration program for the most promising concept.

31. Potential Recoverable Anthracite Resources (PRC, Resource Technologies Corp., J0333932)

Objective: To define the physical size and geographic distribution of anthracite coal resources in Pennsylvania that are potentially recoverable using surface and underground mining methods and analyze the potential market value. Study mining methods and coalbed parameters and prepare a final report to identify anthracite resources, classified by relative minability and economic feasibility.

32. Miner-Bolter System (SRC, Ingersoll-Rand Research, Inc., J0133927)

Objective: To fabricate two bolting modules, a right- and a left-hand unit. The first has been designed, built, and tested. The second unit will be built as a second-generation bolter module that can be applied to a variety of mining systems. It will be simplified to improve the maintenance requirements, and reduced in size so that it will be more suitable for application as a component in a miner bolter.

33. Surface Mining Optimization Model (SRC, Montana State University, J0233922)

Objective: To modify and expand a computer-based surface mining and reclamation planning system (SEAMPLAN) to provide a practical planning tool for mine operators that can be used for both short- and long-range mine planning, and that can be readily adapted to mining industry and Bureau minicomputer systems.

34. Continuous Surface Mining Machine Using Impact Breakers (SRC, Foster-Miller Associates, J0233907)

Objective: To determine the feasibility of developing a continuous surface mining machine utilizing impact breakers in its cutting head, which is capable of cutting and loading from 1,000 to 3,000 tons per hour from 10- to 20-ft-thick coal seams and/or rock strata without recourse to blasting.

35. Optimal Multiple Seam Dragline (SRC, Fluor Mining and Metals, Inc., J0233903)

Objective: To develop methods of optimizing dragline operating procedures in multiple seam area surface mines that will typically result in productivity increases exceeding 5 pct. Effort will result in development of two products: (1) design manual containing planning instructions for mine operators' use in designing multiple seam surface mines and (2) report of specific mine designs that emphasize optimized procedures to enhance productivity.

RESOURCE CONSERVATION TECHNOLOGY

CONTROLLING MINE WASTES

In-House Projects

1. Prediction and Control of Acid Drainage at Surface Mines (PRC)

Objective: To provide techniques and strategies to reduce or mitigate acid mine drainage. Empirical procedures for predicting acid drainage in advance of mining will be assessed and expanded. Investigations of the influence of site hydrology and oxygen availability on acid production will identify oxygen levels that limit the rate of pyrite oxidation and determine the patterns and rates of mass transport in spoil and refuse.

2. Reducing Acid Mine Drainage by Inhibition of Bacteria (PRC)

Objective: To investigate procedures to effectively control acid drainage at its source. Research will focus on bactericidal techniques including further development of surfactant treatment in solution and controlled release forms and evaluation of potential bacterial inhibitors suitable for use in underground mines.

3. Generic Modeling of Waste Embankments and Backfill Structures (SRC)

Objective: To define and assess techniques and strategies for structural stability of mine and mill wastes from various extraction operations and to provide control methods that meet environmental and permitting requirements. Analytic models that provide for the design, performance, and maintenance of surface waste embankments and underground backfilling structures will be tested using mathematical analysis, computer codes, and centrifuge testing. The research will provide, through laboratory and field experimentation, a bridge between idealized concepts and practical applications. This research effort is cofunded by the Health and Safety Technology Program.

4. Geotechnical Characteristics of Mine Waste Structures (SRC)

Objective: To improve the performance of mine waste structures by producing a new technique for establishing the engineering parameters of waste materials through computer-aided analysis of soil

properties. Prediction of mine waste behavior will be improved by evaluating the competency, limitations, and adaptations of the cone penetrometer, electrical probe, and impedance analyzer tests for producing more accurate data for standard stability analyses.

5. Investigation of Geophysical Methods for Measuring Hydrologic Variables (TCRC)

Objective: To determine and verify electrical resistivity theories and methods that quantify the water storage and transport capacities of jointed, near-surface formations. Surface geophysical techniques will be evaluated to demonstrate a comprehensive field technique for mining hydrology applications in measuring geologic-hydrologic parameters.

6. Dewatering Strategies for Mines in Fractured Formations (TCRC)

Objective: To improve ground water control strategies for mine development through upgrading of an existing interactive computer model of mine hydrology to include layered aquifers hydraulically linked by vertical fracture conduits. A hydrology model will be produced that will aid in the design of dewatering systems for slopes near flooded mine workings.

7. Controlled Burnout of Coal Waste Banks (PRC)

Objective: To validate new concepts for controlling and extinguishing coal waste bank fires through field and laboratory studies. Construct a burnout control system at a site of a burning coal waste bank, and evaluate the equipment designs and effectiveness of the controlled in situ burning process.

8. Renton No. 1 Mine Fire, Allegheny County, PA (PRC)

Objective: To assist the Office of Surface Mining in applying the Bureau's water injection-fume exhaustion (WIFE) technique to an abandoned mine fire. Establish and implement a WIFE system at the Renton No. 1 Mine and evaluate methodology for monitoring the extinguishment process.

Contract Projects

1. Study of the Hydrology and Water Quality of Watersheds Subjected to Surface Mining (DRC, U.S. Department of Agriculture and Ohio Agriculture Research and Development Center, J0166054)

Objective: To obtain and analyze hydrologic and water quality data from four treatment watersheds, 30 to 60 acres in size, scheduled for mining. Hydrologic and water quality data will also be obtained and analyzed from erosion and treatment plots for 2 to 3 yr and a control watershed for 4 yr. The hydrogeology of the watersheds and the water quality characteristics of the aquifer systems for premining and post-surface-mining conditions will be described, and a ground water model for simulation of the ground water flow conditions and movement of solutes for the premining and post-surface-mining conditions will be produced.

2. Investigation of Mechanics of Acid Mine Formation in Underground Coal Mine Drainage (PRC, Ultrasystems, Inc., J0333937)

Objective: To determine the mechanics of acid production by laboratory and field investigations. Samples obtained from eight coal seams were analyzed for pyrite and carbonate content and subjected to laboratory weathering tests. Results of the research will be used to develop a method for estimating in-mine acid production.

3. Treatment of Mine Drainage From Abandoned Mines by Biological Iron Oxidation and Limestone Neutralization (PRC, Peer Consultants, Inc., J0113033)

Objective: To determine if the natural iron removal capacity of sphagnum

moss bogs can be used in conjunction with neutralization by limestone rubble as a low-maintenance treatment for acid mine drainage. Includes determining changes in water quality as acidic drainage passes through the system, viability of the transplanted moss, and conditional requirements for successful treatment.

4. Premine Prediction of Acid Drainage Potential (PRC, Engineers International, J0328037)

Objective: To predict postmining drainage characteristics from a minesite based on the physical and chemical characteristics of the site prior to mining. Data will be obtained from at least 30 surface mines including permit information, background surface and ground water quality, and hydrologic characteristics. Data collected will be compared and correlated with representative water quality samples from each site and measurable parameters identified that most effectively predict discharge quality. A minimum of three predictive schemes will be evaluated.

5. Effects of Coal Mine Subsidence on Ground Water Aquifer in Northern Appalachia (PRC, Science Management Engineering, J0199063)

Objective: To provide a comprehensive hydrogeologic record of the changes in the ground water systems above and adjacent to an active longwall section as subsidence occurs.

6. Impact of Mining on Ground Water in the Globe-Miami Copper Mining District (SRC, Central Arizona Association of Governments, J0205039)

Objective: To gather and evaluate ground water data in the Globe-Miami copper mining district using existing data and further field tests, and to develop a base for a reasonable water management program in the district. This contract is a small part of a multiagency-industry program effort.

7. Evaluation of Best Management Practices for Solid Mining Waste Disposal (SRC, Pedco Environmental, H0222003)

Objective: To determine the best management practices for disposal of mine waste generated during the production of various ores (copper, iron, lead, nickel, molybdenum, zinc, phosphate, and uranium) by utilizing results from an extensive monitoring program for ground and surface water and air quality. EPA is the lead agency for this study with the Bureau as a cooperator.

8. Monitoring of Ground Water in the Tucson Copper Mining District (SRC, Pima Association of Governments, J0215006)

Objective: To monitor and analyze ground water data in the Tucson copper mining district and develop a further basis for water management decisions. Parameters monitored will include water quality, quantity, and direction of flow.

9. Developing a Slurry Fill for Modified In Situ Oil Shale Mining (SRC, Rio Blanco Oil Shale Co., J0295046)

Objective: To develop an underground slurry filling system to minimize surface and underground environmental disturbance, and to render in situ shale rubble virtually impermeable and minimize contamination of the ground water. Methods will be evaluated to bind the spent shale into a coherent mass sufficiently strong to resist surface subsidence. A maximum amount of the retorted shale material will be used as the major constituent of the fill, thereby minimizing or eliminating disposal of spent shale on the surface.

10. Mine Waste Location by Satellite Imagery (SRC, Science Systems Applications, Inc., J0208030)

Objective: To establish the potential for using satellite (Landsat) data

for detecting active coal and metal-nonmetal waste and tailings disposal site and updating data contained in waste embankment inventories.

11. Investigations of the Flow Characteristics of Mine Tailings (SRC, University of California, J0285039)

Objective: To determine the flow characteristics of mine tailings, and the probable extent of travel when a mass of mine tailings liquifies and flows. Case studies of mass flow failures of mine waste embankments will be back-analyzed.

12. Investigation of the Geochemical and Hydrological Transformation in Backfilled Uranium Mines (SRC, University of New Mexico, J0225002)

Objective: To investigate cementation processes, contamination transformation, and ground water movement in underground uranium mines for application in (1) maximizing the percentage of tailings that can be disposed of underground, (2) isolating potential contaminants from the ground water system, and (3) providing acceptable mine working conditions.

13. Instrumentation for Remotely Detecting the Placement of Injected Backfill (TCRC, Earth Tech Research Corp., J0295061)

Objective: To improve monitoring capability for detecting the placement of backfill in underground voids in connection with blind backfilling operations. Recommendations shall be made for the design, development, and demonstration of the most practical and technically feasible monitoring system.

14. Cone Piezometer Field Test (TCRC, Geotechnical Engineering and Mining, S0221076)

Objective: To obtain data on hydrologic flow patterns and physical property measurements for water-saturated, loosely consolidated tailings materials. The results of the investigation will be analyzed to design realistic models that may be used for underdrain systems.

15. Removing Heavy Metal Pollutants From Runoff Water Draining Lean Copper-Nickel Ore Stockpiles (TCRC, Minnesota Department of Natural Resources, J0205047)

Objective: To evaluate low-cost, low-labor (passive) techniques for removing specific heavy metal irons from runoff draining ore stockpiles, waste rock piles, and adits to underground operations. Laboratory tests utilizing various materials such as sawdust, peat, tailings, etc., will be conducted to determine the best collecting agent.

16. Demonstration of Aquifer Dewatering Coordinated With Planning and Development of a New Underground Coal Mine (TCRC, Moody Associates, J0225014)

Objective: To design and implement a mine dewatering operation that (1) takes advantage of naturally occuring high permeability fracture zones, (2) is coordinated with plans for mine development, and (3) results in a cost effective means of controlling mine water and reducing mine drainage.

17. Development of a Dewatering System for Controlling Fracture Dominated Inflow for Acid Mine Drainage Abatement (TCRC, Skelly and Loy, H0202002)

Objective: To design and field-test a pilot-scale fracture dewatering system for acid mine drainage. Construction of dewatering wells at the Sunshine Mine test site is completed. Typical off-fracture wells in the project area have a 24-h substainable yield of 10 to 25 gpm, whereas wells located in the fracture zones produce at an average rate of 300 gpm. The enhanced yields of dewatering wells drilled in major fracture zones have clearly been demonstrated.

18. Development of Environmentally Attractive Leachants (TCRC, University of of Texas, H0282016)

Objective: To determine the optimum constituents from several candidates for leachants to be used in extracting uranium from sandstone uranium ores. It is anticipated that the new leachant will facilitate the restoration of the ground water quality after leaching.

19. Tug Valley Flood Study (WO, U.S. Geological Survey, J0100052)

Objective: To assess the relative effect of land use on the surface water hydrology of the Big Sandy River Basin in West Virginia, Kentucky, and Virginia with emphasis on the Tug Fork.

20. Water Purification With Cyanobacteria (WO, Morehouse College, J0134023)

Objective: To investigate the potential of certain blue-green algae strains to remove heavy metals from surface drainage contaminated by mining operations. The research will focus on the determination of the rate of uptake of specific heavy metals by the algae strains cultured in enriched media. The long-range goal of this investigation is to provide information basic to the development of a low-cost technology system of water purification of specific metal contaminants related to mineral operations.

CONSERVING LAND RESOURCES

In-House Projects

1. Characterization of Surface Subsidence Over Underground Mines (DRC)

Objective: To provide technology for preserving the quality of surface land areas overlying active and inactive underground coal mining operations and maintain a subsidence information data base. Measure and characterize surface effects of subsidence over single and multiple coal seam longwall panels in Utah and at steeply pitching longwall operations in Colorado. Compare results of mathematical modeling with actual subsidence measurements to assist in determining geological mining parameters that may be responsible for subsidence variations in different coal mines in the major U.S. coal mining regions.

2. Subsidence Reference Guide (DRC)

Objective: To compile an annotated bibliography of coal mine subsidence references for use by coal mine operators in complying with regulations of the Office of Surface Mining (OSM). This work will be done in cooperation with OSM and will be published as a Bureau of Mines Information Circular.

3. Subsidence Prediction Techniques for Underground Coal Mines (PRC)

Objective: To provide technology for preserving of the quality of surface land areas overlying abandoned and active underground coal mining operations. Through application of experience and standard methodology, develop techniques for determining the size and shape of surface land movements associated with longwall and room-and-pillar coal mining operations.

4. Tri-State Demonstration Project Management (RORC)

Objective: To complete a demonstration project to close or seal open mine shafts in the Tri-State lead-zinc mining areas using precast or site-cast concrete slabs, cones, pyramids, or other shaped closure devices. Following placement of the closure devices, worksites will be periodically monitored, and a summary report on the near-term stability of the sites will be prepared.

5. Revegatation Reference Guide (TCRC)

Objective: To provide an annotated bibliography on reclamation-revegetation of coal mine spoil for the Office of Surface Mining and the coal mining industry.

Information and data will be compiled on the reclamation and revegetation of coal mined lands. A reference manual on revegetation for disturbed coal mine lands will be developed in close coordination with OSM and will be published as a Bureau of Mines Information Circular.

Contract Projects

1. Surveying and Monitoring of Mine Subsidence at the Shoemaker Mine (PRC, Edkins Surveying, S0328018)

Objective: To provide a subsidence data base by obtaining profiles of the surface over the Shoemaker Mine. To date this is one of the most complete data bases for the United States.

2. Development of an Integrated System of Monitoring for the Detection of Imminent Subsidence (PRC, Engineers International, J0134022)

Objective: To investigate the state-of-the art methodology and equipment for detection of imminent subsidence. The selected study area will be northeastern Pennsylvania.

3. Surface Coal Mine Spoil Stability Study, Eastern Coal Province (PRC, Law Engineering and Testing, J0395011)

Objective: To quantify and assess the slope instability problems associated with coal surface mining in the eastern province and to recommend spoil placement techniques that provide slope stability.

4. Development of Preliminary Predictive Model for Room-and-Pillar Subsidence (PRC, MRM Engineers, J0100073)

Objective: To develop a preliminary predictive model for the process of surface subsidence over underground coal mine room-and-pillar workings. The model should have application for mining situations using first mining only and situations using both first and second mining.

5. Enhancing Short- and Long-Range Availability of Nitrogen and Phosphorus on Topsoil-Deficient Mine Spoil (PRC, Virginia Polytechnic Institute and State University, J0100071)

Objective: To conduct a series of experiments and technology transfer activities designed to improve short- and long-range availability of nitrogen and phosphorus in topsoil-deficient spoils, and to deliver research findings to mine operators, regulatory officials, and other interested individuals through demonstration plots and written materials. This project will be targeted to steep slope spoils in Appalachia where topsoil is in short supply.

6. Breeding of Improved Grasses for Mined-Land Reclamation (SLRC, U.S. Department of Agriculture, J0205024)

Objective: To make available to the Bureau the improved plant stock being developed by selective breeding for metal tolerance. Bureau personnel will test these plants, in a greenhouse, on lead-zinc tailings and on a coal site. The work is in cooperation with the Agricultural Crops Research Laboratory located in Logan, UT.

7. Development of Systems for Leveling and Contouring Abandoned Spoil Banks (SRC, Golder Associates, Inc., J0295048)

Objective: To investigate and evaluate the economic and engineering feasibility of innovative systems for leveling and recontouring abandoned spoil banks. The work will determine the applicability of present reclamation systems and large material-handling equipment for recontouring applications in abandoned coal lands. It will also develop innovative machine and/or system concepts to meet deficiencies related to recontouring abandoned coal lands.

8. Computer Simulation Model for Surface Mine Reclamation Planning (SRC, Pennsylvania State University, J0295005)

Objective: To extend the capabilities of the existing open pit material handling simulator (OPMHS) to provide the logic necessary to simulate techniques for spoil leveling, highwall reduction, topsoil handling, and rock removal. The expansion of the OPMHS will provide the Bureau with the capability to test research findings from the mining system program in order to assess the feasibility of programs and to determine the need for further research in this area.

9. Demonstration of Modular Irrigation Systems for Reclaimed Strip Mined Lands (SRC, Sherman & Kinkead, H0222004)

Objective: To establish design criteria and specifications for supplemental irrigation systems, and based on this criteria, develop and test operating systems at surface coal mines. Each irrigation system shall be evaluated according to its technical and economic feasibility. An irrigation system technology will be developed for application in surface coal mine land reclamation to supplement natural precipitation in arid and semi-arid regions.

10. Production, Engineering, Development, and Demonstration of the Draft Power Sensor (SRC, Southwest Research Institute, H0292016)

Objective: To demonstrate and transfer to the mining industry an improved version of a draft power sensor to be attached to the dozers used in regrading spoil during mining. Previous research developed and tested a prototype sensor. The results indicated potential regrading cost savings and productivity increases. This project seeks to show the mining industry the merits of the system to increase dozer production and to reduce fuel consumption in mined-land recontouring work.

11. Reclamation of Tailings Basins Resulting From Copper-Nickel Milling (TCRC, Barr Engineering, J0205050)

Objective: To evaluate vegetation for stabilizing tailing material from copper-nickel milling operations and reducing liberation of toxic elements from the tailings.

12. Study of the Effects of Subsidence From Multiple Seam Coal Mining (TCRC, University of Missouri, J0225021)

Objective: To investigate the effects of subsidence in the Rend Lake area. The site includes multiple seam mining and is close to a large earthen dam.

13. Impact of Surface Mining on Soil Compaction in the Midwestern U.S.A. (TCRC, Hittman, H0208016)

Objective: To assess the nature and extent of soil compaction problems in coal mining areas of the Midwest from both premining and postmining perspectives, and recommend ways in which the problems might be eliminated or abated.

14. Determine Effectiveness of Dust Controls for Unpaved Mine Roads (TCRC, Pedco Environmental, J0218021)

Objective: To determine the cost-effectiveness of dust controls used on unpaved haul and access roads in surface mines.

15. Fatigue Tests in Full-Scale Block Walls (TCRC, U.S. Department of Commerce, National Bureau of Standards, J0123061)

Objective: To test full-scale block walls as part of the earthquake seismic

research program at the National Bureau of Standards (NBS). The NBS has completed construction of a large tri-directional vibration test facility that will accommodate the proposed Bureau block wall tests. NBS will test several block wall configurations to determine fatigue effects, minor damage vibration levels, and serviceability of block walls.

16. Florida Phosphate Mine Reclamation (TURC, U.S. Fish and Wildlife Service, J0123057)

Objective: To cooperate with the Fish and Wildlife Service in the effective consideration of fish and wildlife resources related to the proposed mining and subsequent reclamation of a natural wetland at the Big Four Mine.

17. Monitoring of Phosphate Mining Area in Central Florida Using Landsat Satellite Imagery (TURC, University of New Mexico, J0113099)

Objective: To monitor the central Florida phosphate area by satellite in an attempt to determine the effect of mining on wetlands.

18. Technology for Control of Environmental Noise From Off Road Haul Trucks (TCRC, Woodward Associates, Inc., J0218020)

Objective: To develop cost-effective techniques for reducing the noise from large haulage trucks without significantly reducing the efficiency of the vehicles. Prototype noise reduction techniques would be applied to trucks and demonstrated under operating conditions.

19. Influence of Rock Mass Discontinuities on Coal Mine Subsidence (TCRC, Woodward-Clyde, J0100087)

Objective: To determine the effects of rock mass discontinuities, both regional and site-specific, on coal mine longwall subsidence. Using two-dimensional finite element analysis supported by comprehensive surface panel monitoring data and geomechanical laboratory and in-mine instrumentation data, the rock mass response to mining operations shall be modeled and the general applicability of the finite element technique shall be assessed as a subsidence prediction tool.