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Memorandum

To: State Director, Wyoming State Office

From: Director, Denver Service Center

Subject: FY 1977 EMRIA Water Resources Work Plan

Enclosed are copies of the FY 77 Water Resource Investigation Work Plan for the SO, DO and detached Area offices involved in the EMRIA program.

If you have questions or need additional copies, contact Bob Delk, D-307, 234-2333.

Enclosure

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TOTAL	<u>\$83,500</u>	

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TOTAL	<u>\$189,245</u>	

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Stream Gage - White River at Ouray	\$11,000	66
TOTAL	<u>\$133,000</u>	

WYOMING

Powder River	\$100,810	67
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TOTAL	<u>\$216,572</u>	

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Water Data Analysis of the Upper Colorado River Basin	\$27,000	73
TOTAL	<u>\$154,590</u>	

INTRODUCTION

Fiscal year 1977 is the third year of the joint US Geological Survey (Water Resources Division)/Bureau of Land Management (EMRIA) water resources investigation. The program has doubled in size since fiscal year 1975. The original program had activities in North Dakota, Montana, Wyoming, Colorado, Utah and New Mexico. Alabama and Oklahoma were added to the above in fiscal year 1976.

Emphasis in the program has changed from basic data collection and monitoring specific sites to developing and testing hydrologic models to assist BLM land managers predict impacts from surface mining. The program must be flexible to meet the needs of the eight states which involve eight district offices, six sub-districts, two regional offices, and two central labs of the Water Resources Division; plus six state offices, nine district offices, three detached area offices and two project offices of the Bureau of Land Management. For that reason, the work plan is only specific enough to insure some accountability; but, hopefully, flexible enough to allow project people to adapt to specific problems.

ANNUAL WORK ORDER

USGS Water Resources Division and BLM (EMRIA) Fiscal Year 1977

AUTHORITY

The General Agreement between the Bureau of Land Management (BLM) and the Geological Survey (GS), dated August 15, 1974, is considered an integral part of the Work Plan.

PURPOSE

The purpose of this work order is to specify the nature and amount of assistance to be provided by GS to BLM under the EMRIA program during FY 77.

SCOPE

This work order includes all services to be provided by the GS under the EMRIA program to BLM in fiscal year 1977 in the state of Alabama, Colorado, Montana, New Mexico, North Dakota, Oklahoma, Utah and Wyoming.

The GS will provide the services, including personnel, equipment, supplies, and facilities to conduct water resources investigations in areas designated by the BLM. Services will include installation, operation and maintenance of surface water gages, ground water wells and climate stations as well as water quality collection and analysis. Detailed descriptions of all studies in the eight states are presented in "Annual Work Plan for the BLM (EMRIA)/GS Water Resources Investigation - FY 77" which is considered an integral part of this work order.

PROCEDURE

Fiscal year 1977 is the third year of this cooperative effort. Some work begun in fiscal years 1975 and 1976 will be continued in fiscal year 1977, while some projects may be dropped. New studies will begin in fiscal year 1977, some of which will carry into fiscal year 78 and beyond. These decisions will be made in joint meetings among the GS district and state offices and the Denver Service Center. The annual work plan is developed by D-307 after negotiations with BLM field offices to determine needs and GS field offices to determine capabilities.

Field investigative procedures will be standard GS water resource investigation techniques.

REPORTS

Reporting will generally be standard GS report procedures with some derivations that are detailed in the Annual Work Plan.

FUNDING

BLM will reimburse GS for actual expenses incurred in providing the services covered in this work order, not to exceed \$1,599,382 upon receipt of SF 1081. Details of cost items for each study in each state are presented in the Annual Work Plan. A summary of costs by state is presented below.

SUMMARY OF COST ESTIMATES BY STATE

<u>State or Office</u>	<u>FY 77 Cost</u>
Alabama	122,800
Colorado	314,180
Montana	361,065
New Mexico	83,500
North Dakota	189,245
Oklahoma	48,730
Utah	133,000
Wyoming	216,590
Public Lands Hydrology	127,590
Central Region	2,700
Total	<u>\$1,599,382</u>

APPROVED

U.S. Geological Survey

Bureau of Land Management

Date

Date

HYDROLOGIC SURVEILLANCE OF POTENTIAL MINING AREAS

IN WARRIOR COAL FIELD, ALABAMA

- A. Location of study: The Warrior Coal Field is the principal area of study which includes parts of Walker, Fayette, Tuscaloosa, and Jefferson Counties, an area of about 3,900 square miles (fig. 1).
- B. Objectives: The data collection and interpretation of these data are designed to aid the Bureau of Land Management in its responsibility for preparation of environmental impact statements and in its planning and management of coal reserves. As described in last year's plan, 1976, the interpretation of data collected is divided into three phases to determine the following:
- (1) Definition of baseline hydrologic conditions.
 - (2) Effect coal mining will have on the hydrology.
 - (3) Assess the reclamation practices by reviewing literature and personnel contacts on the various reclamation practices presently performed in Alabama and the evaluation of data currently being collected as a part of AL 75-034.

The data currently being collected to meet the objectives include:

- (1) Surface water.--Discharge, chemical quality, biologic, and sediment.
 - (2) Ground water.--Information on wells, aquifer yield, water use, water levels, chemical quality, water availability, occurrence, and movement.
 - (3) Rainfall.--Distribution and chemical character.
- C. Procedures: The reconnaissance planned for the transition quarter to determine the basins and specific sites to be monitored was completed. The monitoring sites in these basins will be used to determine seasonal

C--Continued

changes prior to mining operations and will be continued during mining operations to assess the reliability of predictions of the effect that mining has on the hydrologic system. As a result of the reconnaissance, four basins were selected for monitoring: they are Upper Blue, Bear, Turkey, and Yellow Creeks. The parameters used in selecting the basins to be monitored included percentage of area for which BLM has mineral management responsibility, the extent of mining and the surface geology (table 1). Figure 2 shows the locations of the water-resources data collection sites.

Seven sites have been selected for water-resources monitoring. Data collection at these sites will be used to determine seasonal changes prior to mining operations and will be continued during mining operations to assess the reliability of the predictions of the effect that mining has on the hydrologic system (fig. 2).

- (1) Bear, Upper Blue, Turkey, and Yellow Creek basins have been selected for monitoring. Bear and Upper Blue Creek basins are in an area where the surface geology is predominantly weathered sandstone and shale that occurs above the coal seams in the Pottsville Formation. Turkey and Yellow Creek basins are in an area in which there is a high percentage of unconsolidated sand of Cretaceous age overlying the coal seams in the Pottsville Formation (see table 1). Mining may start in these areas in 1 or 2 years, and data obtained from these basins will have transfer value to similar areas within the Warrior Coal Field.

C--Continued

- (2) Two continuous-record stations equipped with surface water-level recorders, rain gages, automatic sediment samplers, and water-quality monitors, measuring temperature and specific conductance, are in operation (see stations 02463900 and 02462990, fig. 2).
- (3) A continuous temperature and specific conductance unit has been installed at the automated streamflow and sediment station on Crooked Creek in Jefferson County that is being maintained as a part of the Federally financed project, AL 75-034. This additional data will be integrated into the BLM work, because it was collected to assure maximum transferability.
- (4) A network of observation wells, utilizing existing wells, is being planned for completion by March 1, 1977. The results of the reconnaissance study of the four basins selected indicate a scarcity of water wells that could be used as observation points. Test drilling may be required to adequately design an observation-well network. Test drilling is not provided for in the present plans and funds may be required; however, the Conservation Division of the Geological Survey is planning an extensive drilling program in the State in connection with their commitments to BLM in determining coal reserves, and coordination of this effort with the need for observation wells may be possible.
- (5) The first round of water-level measurements and water-quality sampling is planned to start on March 1, 1977. (See table 2 for the parameters and frequency of sampling.)
- (6) Tabulate and interpret on a current basis all water-quality, sediment, biologic, geologic, and meteorologic data pertaining

C--Continued

(6)--Continued

to baseline conditions prior to mining and to assess any changes resulting from mining as it develops.

- (7) Contract work with Southern Resources Mapping Corporation for aerial photography of the four basins, a total of 120 square miles, will be completed in February 1977 for use in the preparation of 1:24,000 base maps. The photographs will aid in determining the percentage of areas in the basin that are mined, the land use, the location of timber trails, etc.

- (8) Coordination with other agencies to avoid duplication of data collection and to inform other agencies of the objectives of the project and the data being collected. Meetings or discussions have been held with the following agencies or firms: Water Improvement Commission, Geological Survey of Alabama, West Alabama Planning and Development Council (responsibility for 208 project, Tuscaloosa County), Bureau of Mines, and University of Alabama, Gulf States Paper Corporation, Burgess Mining Company, Warrior River Coal Company, Odell Mining Company, Brilliant Mining Company, Soil Conservation Service, Environmental Protection Agency, U.S. Forest Service, MESA, Cullman Times, Sumiton News, Drummond Coal Company, Alabama Development Office. U.S. Geological Survey personnel assigned to the BLM project will move to a new office space at Wood Square in Tuscaloosa January 15, 1977. BLM personnel will open an office adjacent to this space on March 1, 1977. This arrangement will hopefully foster close working relations between the two offices.

C--Continued

(8)--Continued

During the first week of March an orientation conference is planned by the U.S. Geological Survey for BLM personnel for the purpose of reviewing project activities and the availability of data that will be required in preparation of EIS statements.

(9) Five partial-record stations have been established. Periodic streamflow measurement and the collection of samples for water-quality determination has been started. All sites have been reviewed by biologic consultants from the Central Lab and determined to be acceptable for biological sampling (see tables 3 and 4 for the parameters and frequency of sampling). The parameters and the frequency of sampling given in tables 3 and 4 may change with time, as the data received from these sites will be evaluated on a timely basis, and changes may be made during the course of the project depending on the significance of the results. A tentative work plan for the operation of the stations follows.

Seven sites have been selected where data collection for the project will be done monthly and as dictated by weather conditions. One additional site in an actively mined area will be added to this network in the near future. Since part of the data collection must be done during inclement weather, and all data must be collected simultaneously, several work groups and sets of equipment must be used. Data collection must begin as soon as possible, if the project is to be completed as scheduled. As a means of expediting this phase of the project, the following summary, giving basic data needs, procedures, and manpower needs for data collection follows.

Regular Monthly Data Collection and Procedures

Regular monthly data collection will be done at all sites (table 3).

The data needs and procedures are as follows:

a. Stream discharge.--Measure each site during each visit until the stage-discharge relationship throughout the flow regimen has been established. Fletcher Sedberry will determine, with the concurrence of the project chief, when a station is rated.

b. Sediment.--Collect sample during each visit to determine suspended sediment concentration. Additional sediment samples for particle size will be collected at predetermined intermittent intervals. Standard procedures outlined in TWRI Book 3, Chap. 2C will be used in sample collection.

c. Chemical quality.--The following quality water work will be done during each visit:

1. Collect 250 ml sample (RU)
2. Collect 250 ml sample (FU)
3. Field determinations of pH, specific conductance, bicarbonate, and temperature will be made during each visit.

NOTE: RU - raw and unacidified

FU - filtered and unacidified

FA - filtered and acidified with one ampoule of HNO_3

The regular monthly data collection program as stated above shall apply to the following sites:

<u>Station No.</u>	<u>Station Name</u>
(1) 02462600	Blue Creek near Oakman, Ala.
(2) 02462980	Yellow Creek above Northport, Ala.
(3) 02462985	Unnamed tributary to Yellow Creek near Northport, Ala.
(4) 02462990	Yellow Creek near Northport, Ala.

C--Continued

<u>Station No.</u>	<u>Station Name</u>
(5) 02463890	Dry Branch near Samantha, Ala.
(6) 02463900	Bear Creek near Samantha, Ala.
(7) 02464145	Turkey Creek near Tuscaloosa, Ala.
(8)	Site to be selected

All sample bottles containing samples for chemical analyses and for sediment determinations must be clearly marked giving the station number, station name, date, time, stage, location in stream where sample was collected, such as sounding station number at left, middle, or right one-third of stream, and the abbreviation for the type of sample (for example, FA, FU, RU). Sediment samples should be collected in a minimum of ten verticals using the ETR method.

Data Collection and Procedures for Flood Events

Data collection and procedures will be the same for all sites (see stations listed in preceding section) and are as follows:

a. Stream discharge.--Make as many measurements as possible in order to rate the gaging station site throughout the entire flow regimen.

b. Sediment.--Samples should be manually collected once before the rise and during the rise, peak, and recession of the peak. During the rise, peak, and recession, sampling should be done at least once each hour and in some cases as often as possible, depending on the individual rise characteristics. For stations with installed automatic sediment samplers, two samples 12 hours apart are normally collected per day; during a flood event, the samplers are to be set to collect samples at 15-minute intervals during the entire flood event when stage is 2 feet above base-flow conditions. Samples should be collected manually at

C--Continued

b--Continued

different stages until the relationship between sediment discharge obtained sampling manually and by the automatic sediment sampler can be determined. Samples should be collected in a minimum of ten verticals using the ETR method. Use standard procedures as outlined in TWRI Book 3, Chap. 2C.

c. Chemical quality.--Depth integrated samples for chemical quality will be collected at a point where the maximum depth and velocity occurs. Two liters of water must be collected. For each sample, determine and record the specific conductance, pH, and temperature. If a 20 percent change in conductance is noted between current and previous sample or a rise of 1 foot occurs, the following is done:

Collect 250 ml sample (RU)

Filter water and divide into:

- (1) 250 ml sample (FU)
- (2) $\frac{1}{2}$ liter sample (FA)
- (3) 1 liter sample (FU)

All sample bottles must be clearly marked giving the station number, station name, date, time, stage, location in stream where sample was collected (example: sounding station number at left, middle, or right one-third of stream), and whether sample was acidified, unacidified, filtered, raw (example: FA, FU, or RU). A field determination of bicarbonate will be done before the rise, if time permits; otherwise, bicarbonate will be determined as part of the laboratory analysis.

C--Continued

Work Teams and Equipment

Personnel from the Tuscaloosa Subdistrict office and, on occasion, the District office, will be utilized for data collection during flood events at all project AL 76-041 data collection sites. Teams of three men will be assembled in order to collect data simultaneously and in the most efficient way possible. Teams will be formed just prior to flood events and will be selected from available personnel at the time of the event. It is anticipated that two teams will be formed for a flood event with a third team being formed at a later time (approximately 12 hours) in order to provide relief for the first two teams. Data collection will be directed and concentrated at the automated sites of the two basins under study, alternating basins as individual flood events occur or as directed by the project chief. Initially, Yellow Creek basin will have first priority in the flood event data collection effort. The available manpower and duty capabilities are listed as follows:

<u>Stream gaging</u>	<u>Chemical quality</u>	<u>Sediment</u>
J. W. Tucker	*J. G. Newton	*I. A. Giles
F. C. Sedberry	N. A. Armingeon	*C. Puente
N. A. Armingeon	*I. A. Giles	J. R. Avrett
*I. A. Giles	*J. T. Allen	E. F. Hubbard
*C. Puente	J. R. Avrett	*J. T. Allen
J. R. Harkins	*C. Puente	T. N. Russo
E. F. Hubbard	T. N. Russo	*J. G. Newton
*J. T. Allen	T. Whitbeck	T. Whitbeck
H. H. Jeffcoat	R. H. Bingham	

*Core team member. This member will serve as team leader.

Personnel with assigned vehicles are given below. The vehicles and equipment will be available and ready for any event as it occurs.

C--Continued

Jimmy Tucker.....stream gaging truck
Neil Armingeon.....stream gaging truck
Fletcher Sedberry.....4-wheel drive utility truck
Ira Giles.....gray QW van, blue QW van
John T. Allen.....station wagon
Celso Puente.....Dodge utility truck

Site collection assignments will be made at the same time that data collection teams are formed and will be based on particular data needs and available personnel. Office and field folders will be kept for all data collection sites and should be kept current at all times. These folders will contain information concerning stream discharge, date, stage, time, change of stage per unit of time, QW and sediment samples taken.

Station locations are shown on figure 1 and station numbers, station names, and latitude and longitude are given in table 5.

D. Report products: All data collected as a part of the project will be placed in computer storage on an ongoing basis. All baseline data will be published in annual reports of the U.S. Geological Survey. A final report outlining baseline conditions and the effect of mining coal on the hydrology of the area will be prepared at the termination of the project. During the course of the study, interpretations of the data obtained from the project will be incorporated into papers presented to professional organizations that deal with coal mining. A review of progress of other State and Federal agencies' activities in coal mining projects will be made on a periodic basis to keep abreast of the activities so that phases of this investigation will not duplicate ongoing projects. Those agencies that are currently involved in this type of activity include the Geological Survey of Alabama, the University of Alabama Research Department, and NASA.

E. Distribution of funds: Funds in the amount of \$53,700 to supplement BLM funding for this project for fiscal year 1977 have been approved by WRD for construction of gage houses (\$16,800) and biologic studies (\$36,900). A breakdown of expenditures of funds planned for 1977 fiscal year and the allocation of money from BLM follows.

<u>Item</u>	<u>1977 FY</u>	<u>Cost estimate</u>
Salaries.....		\$77,700
Travel.....		1,000
Aerial photography.....		1,200
Data processing.....		2,500
Laboratory services.....		19,900
Equipment and supplies.....		4,000
WOTSC.....		<u>16,500</u>
	Total	\$122,800 ^{1/}

1/ Does not include \$53,700 WRD.

Table 1.--Parameters used in selecting basins to be monitored in the Warrior Coal Field, Alabama

Area (mi ²)	Bureau of land management responsibility		Mining (mi ²)	Cretaceous or Quaternary		Pottsville outcrop or weathered Pottsville		
	Mineral rights (mi ²)	Mineral rights (percent)		Mining (percent)	(mi ²)		(percent)	
6.0	0.63	10	0	0	2.75	46	3.25	54
					TURKEY CREEK			
					YELLOW CREEK			
8.4	.97	12	0	0	6.0	71	2.4	29
					BLUE CREEK (UPPER)			
12.9	2.41	19	0	0	.38	<3	12.52	>97
					BLUE CREEK (LOWER)			
23.9	11.5	48	1.0±	4	2.63	11	21.27	89
					BLUE CREEK (ALL)			
36.8	13.91	38	1±	<3	2.01	8	34.79	92
					BEAR CREEK			
14.9	2.9	19	0	0	.63	4	14.27	96
					TYRO CREEK			
21±	4.5+	21+	.8(?)	.4(?)	Unknown	Unknown	Unknown	Unknown

Table 2.--Ground water quality sampling program

Constituents to be determined at beginning of project and at any time a large change in chemical characteristics occur.

Silica	Hardness, noncarbonate
Iron	Acidity
Manganese	Sodium absorption ratio
Calcium	Specific conductance
Magnesium	pH
Sodium	Temperature
Potassium	Color
Bicarbonate	Arsenic
Carbonate	Cadmium
Sulfide	Chromium
Sulfate	Cobalt
Chloride	Copper
Fluoride	Lead
Nitrogen, nitrate, total	Lithium
Nitrogen, total Kjeldahl	Mercury
Phosphorus, total	Selenium
Dissolved solids	Strontium
Hardness, calcium-magnesium	Zinc

Constituents to be determined semiannually

Iron	Hardness
Bicarbonate	Specific conductance
Carbonate	pH
Sulfate	Temperature

Table 3.--Surface-water chemical quality sampling program

<u>Constituent or description</u>	<u>Semiannual</u>	<u>Quarterly</u>	<u>Monthly</u>
Discharge, ft ³ /s			x
Silica		x	
Iron		x	
Manganese	x		
Calcium		x	
Magnesium		x	
Sodium		x	
Potassium		x	
Bicarbonate			x
Carbonate			x
Sulfide		x	
Sulfate			x
Chloride		x	
Fluoride		x	
Nitrogen, nitrate, total		x	
Nitrogen, nitrite, total		x	
Nitrogen, total Kjeldahl		x	
Phosphorus, total		x	
Phosphorus, orthophosphate		x	
Dissolved solids		x	
Hardness, calcium-magnesium		x	
Hardness, noncarbonate		x	
Acidity		x	
Sodium absorption ratio		x	
Specific conductance			x
pH			x
Temperature			x
Color		x	
Dissolved oxygen		x	
Specific conductance/sulfate			x
Aluminum		x	
Organic carbon, total	x		
Carbon, total	x		
Phenols	x		
Arsenic	x		
Boron	x		
Cadmium	x		
Chromium	x		
Cobalt	x		
Copper	x		
Lead	x		
Lithium	x		
Mercury	x		
Selenium	x		
Strontium	x		
Zinc	x		
Gross Alpha, Beta radionuclides	x		
Radium 226	x		
Uranium	x		

Table 4.--Surface-water biological quality sampling program

<u>Description</u>	<u>Quarterly</u>	<u>Monthly</u>
Periphyton		
Algal identification		x
Chlorophyll		x
Biomass		x
Benthic invertebrates		
Type II	x	
Algal growth potential		x
Phytoplankton		
Chlorophyll		x
Identification		x
Adenosine triphosphate		x

Table 5.--Regular data collection sites, project AL 76-041

1. 02463890 Dry Branch near Samantha, Ala.
Lat: $33^{\circ}32'33''$ Long: $87^{\circ}32'22''$
2. 02463900 Bear Creek near Samantha, Ala.
Lat: $33^{\circ}32'33''$ Long: $87^{\circ}33'43''$
3. 02464145 Turkey Creek near Tuscaloosa, Ala.
Lat. $33^{\circ}24'32''$ Long: $87^{\circ}30'45''$
4. 02462990 Yellow Creek near Northport, Ala.
Lat: $33^{\circ}22'23''$ Long: $87^{\circ}28'26''$
5. 02462985 Unnamed tributary to Yellow Creek near Northport, Ala.
Lat: $33^{\circ}23'18''$ Long: $87^{\circ}27'51''$
6. 02462980 Yellow Creek above Northport, Ala.
Lat: $33^{\circ}23'26''$ Long: $87^{\circ}28'30''$
7. 02462600 Blue Creek near Oakman
Lat: $33^{\circ}31'17''$ Long: $87^{\circ}29'07''$

Sediment yield of streams draining the Piceance Creek basin, northwestern Colorado

A. Location of study

Garfield, Rio Blanco, and Moffat Counties, Colorado

B. Objectives and procedures

The objective of this program is to define the sediment yield of streams draining the Piceance basin and the prototype oil-shale lease tracts. Twenty-seven automatic suspended-sediment samplers are operated at selected sites throughout the basin. In addition, annual surveys of previously established stream-channel cross sections and profiles on hillslope erosion transects are performed. These data will be used to estimate rates of erosion and aggradation so that sediment yield can be estimated and compared to those measured by the automatic equipment.

C. Report products

The sediment data collected during the study will be published annually in "Water Resources Data for Colorado, Volume 2". An interpretive report evaluating the impact of oil-shale development on the sediment yield of streams is planned for 1981. A report, "An evaluation of hillslope and channel erosion related to oil-shale development in the Piceance basin, northwestern Colorado," by D. G. Frickel, L. M. Shown, and P. C. Patton, was published. The report is based on data from 52 channel cross sections and 35 hillslope erosion transects.

On an interim basis, the sediment data will keep BLM informed as to natural sediment production and changes, by area and in time, that may result from mining operations. The final interpretive report will relate sediment yield and characteristics to mining and spent-shale disposal activities, changes in land use patterns, and provide the basis for remedial measures if sediment yields are excessive.

D. Distribution of funds

Salaries	\$29,326
Travel	1,480
Laboratory support	7,500
Data Processing	3,050
WOTSC	<u>6,454</u>
Total	\$47,810

Ground-water level monitoring, Iles and Williams Fork Formations
northwestern Colorado

A. Location of study

Moffat County, Colorado

B. Objectives and procedures

The objective of this program is to define seasonal and annual water-level fluctuations in the Mesaverde Formation and the alluvium in the Grace tract, and the Iles and Williams Fork Formations throughout the northwestern Colorado coal region. These data are essential for mapping the potentiometric surface and for evaluating the ground-water hydrology and potential impacts of surface mining. Samples will be collected annually for comprehensive chemical analyses.

C. Report products

A potentiometric surface map, with explanatory narrative that relates to mine dewatering and lowering of the potentiometric surface to changes in the hydrologic system that are or may be of concern to BLM, will be prepared.

D. Distribution of funds

Salaries, professional and technical assistance	\$ 5,180
Travel, including transportation	2,000
Laboratory costs	6,500
Data processing	500
WOTSC	1,910
	<hr/>
Total	\$16,090

Potentiometric surface mapping -- Piceance Creek basin, north-
western Colorado

A. Location of study

Garfield, Rio Blanco, and Moffat Counties, Colorado

B. Objectives and procedures

The objective of the study is to provide an observation-well network that can be used to define existing water-level altitudes (potentiometric surface) in the principal aquifers and changes in water levels resulting from oil-shale development. To accomplish this objective 22 observation wells have been drilled in the Piceance basin. These wells, in conjunction with previously existing wells, provide the observation-well network. Water temperature and specific-conductance data, water samples for chemical analysis, and discharge-rate

measurements will continue to be obtained from each well. Continuous water-level recorders are operated at selected wells and the rest will be monitored twice each year. Additional water quality data will be obtained. Data collection should continue prior to, during, and following oil-shale development. The data are used to construct potentiometric maps of the upper and lower aquifers. The maps will be used to improve the calibration of the ground-water model and provide baseline data on hydraulic head from which the effects of mine dewatering on the ground-water system can be evaluated.

Ground-water data, collected during the construction of the wells, and potentiometric maps will be published in basic-data reports as appropriate. An interpretive report on the impact of dewatering for oil-shale mining on the ground-water system will be prepared when adequate data have been collected during development to fully calibrate the ground-water digital model.

C. Report products

All water-level information will be included in the soon to be published report "Water Level Records for Colorado 1972 - 76."

A report on the completion of 22 observation wells, including potentiometric maps, will be prepared in 1977.

D. Distribution of funds

Salaries	\$22,391
Travel	3,950
Data processing	2,636
WOTSC	4,523
	<hr/>
Total	\$33,500

Monitoring program in Priority Area 1 -- Foidel and Middle Creek basin, northwestern Colorado

A. Location of study

Routt County, Colorado

B. Objectives and procedures

The objective of this program is to define the hydrologic system of the basin, interrelating surface-water flow, ground-water movement, precipitation, and climate. The availability and quality of surface and ground water will be defined. This information will be related to present and future mining operations to assess the affects of mining on basin hydrology. This program will provide data for the total assessment of the impacts of mining.

For FY77 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality, ground-water quality and potentiometric surface levels, and area climate will be collected. A Convertible Data Collection Platform (CDCP) will be installed at the climate station to facilitate more rapid and complete data collection and reduction. New observation wells from governmental and private drilling programs will be obtained if available for completing the area observation well network.

Three surface-water gaging stations are operated. Discharge, water temperature, and specific conductance are continuously monitored at each station. Monthly water samples are collected at each station to be analyzed for major chemical constituents. Water samples are collected quarterly at each station and analyzed for trace metals. Monthly sediment samples are collected at the upper Foidel Creek and the Middle Creek stations. Sediment samples at the lower Foidel Creek station are collected by an automatic suspended sediment sampler.

A climatological station is operated on Middle Creek. Precipitation, air temperature, relative soil temperature, wind, and solar radiation are measured at this site. A second precipitation gage is operated on the rehabilitation study area and a third precipitation gage is installed at the mouth of Foidel Creek.

Three deep wells (about 400 feet deep) and five shallow alluvial wells (about 50 feet deep) were drilled in the study area. Two shallow wells were abandoned and six wells were completed as observation wells. Five wells drilled by the Bureau of Reclamation on the Bureau's reclamation study site are completed as observation wells. Water levels are measured in each observation well.

C. Interim results are to be published in an interagency, interdisciplinary report immediately after the end of the current fiscal year. Final results will be published at the conclusion of the study, three to five years hence.

D. Distribution of funds

Salaries, professional and technical assistance	\$23,630
Travel, including transportation	3,200
Equipment	1,500
Laboratory analyses	14,100
Data processing	2,500
WOTSC	6,090
Total	<u>\$51,020</u>

Monitoring program in Priority Area 2 -- Taylor, Wilson, and Jubb Creek basin, northwestern Colorado

A. Location of study

Rio Blanco and Moffat Counties, Colorado

B. Objective and procedures

The objective of this program is to define the hydrologic system of the basin, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface and ground water will be defined. This information will be related to present and future mining operations to assess the affects of mining on basin hydrology. This program will provide data for the total assessment of the impacts of mining on the environment and the direction of future reclamation of mined lands.

For FY77 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality, ground-water quality and potentiometric surface levels, and area climate will be collected. A Convertible Data Collection Platform (CDCP) will be installed at the climate station to facilitate more rapid and complete data collection and reduction. New observation wells from governmental and private drilling programs will be obtained if available for completing the area observation well network.

Two surface-water gaging stations are installed which, including two existing stations, brings the total number of gaging sites in the area to four. Operation of three gaging stations on Wilson, Taylor, and Jubb Creeks is funded by the Bureau of Land Management. Discharge, water temperature, and specific conductance are continuously monitored at each station. Monthly water samples are collected at each station and analyzed for major chemical constituents. Quarterly water samples are collected at each station and analyzed for major constituents and trace metals. Monthly sediment samples are collected at the Taylor and Jubb Creek stations. An automatic suspended-sediment sampler is installed at the Wilson Creek station.

A climatological station is operated in Wilson Creek basin. Air temperature, relative humidity, precipitation, soil temperature, wind and solar radiation are measured at this site. A second precipitation gage is operated in the headwaters of Wilson Creek and a third precipitation gage is scheduled to be installed on the Taylor-Wilson Creek divide.

One deep well (about 400 feet) was drilled in Wilson Creek drainage. Twelve additional wells drilled to bedrock by W. R. Grace, the Bureau of Reclamation, and the U.S. Geological Survey were completed as observation wells. All wells were tested to determine the hydraulic properties of the alluvial and deeper aquifers. Water levels are measured monthly in each observation well.

C. Interim results are to be published in an interagency, interdisciplinary report immediately after the end of the current fiscal year. Final results will be published at the conclusion of the study, three to five years hence.

D. Distribution of funds

Salaries, professional and technical assistance	\$22,000
Travel, including transportation	3,200
Laboratory analyses	11,600
Data processing	2,500
WOTSC	5,310
Total	\$44,610

Monitoring program in Priority Area 3 -- Hayden Gulch, northwestern Colorado

A. Location of study

Rio Blanco and Moffat Counties, Colorado

B. Objective and procedures

The objective of this program is to define the hydrologic system of the basin, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface and ground water will be defined. This information will be related to present and future mining operations to assess the affects of mining on basin hydrology.

For FY 77 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality, ground-water quality and potentiometric surface levels, and area climate will be collected. New observation wells from governmental and private drilling programs will be obtained if available for completing the area observation well network.

This area has been chosen to complete the hydrologic network for northwestern Colorado. Hayden Gulch lies between the streams described in Item 15 related to Priority Area 1 and Item 16 relating to Priority Area 2.

Hubberson Gulch and Watering Trough Gulch were selected as basins with proposed coal development. A third basin, Stokes Gulch, was selected as being representative for the dryland-farming areas of the region. Stokes Gulch will provide data to compare the hydrologic impacts of coal development with those of agriculture in the Yampa Basin.

A surface-water gaging station is installed on Stokes Gulch and gages are proposed for both Hubberson and Watering Trough Gulches. Discharge, water temperature, and specific conductance will be continuously monitored at each station. Monthly water samples will be collected at each station and analyzed for major chemical constituents. Quarterly water samples will be collected at each station and analyzed for major constituents and trace metals. Monthly sediment samples will be collected at the Hubberson and Watering Trough Gulch stations. Sediment samples at the Stokes Gulch station are collected by an automatic suspended-sediment sampler.

Delay in installing the Hubberson Gulch site is being caused by negotiation problems with the surface rights land owner for these sites. As soon as these problems are resolved the gages will be installed.

A climatological station will be installed in the Hubberson and Watering Trough Gulch area. Precipitation, air temperature, and relative humidity will be measured at this site. A second precipitation gage will be installed in this area and two precipitation gages will be installed in the Stokes Gulch basin.

Coal leases in the Hubberson and Watering Trough Gulch area are owned by Peabody Coal Co. Peabody has three existing observation wells in the basins. These were made available to the U.S. Geological Survey, as will future holes to be drilled for resource inventory. Water levels will be measured periodically in these wells and water samples will be collected annually for analysis of major constituents and trace metals.

- C. Interim results and data will be published in an interagency, interdisciplinary report. Final results will be published at the conclusion of the study, three to five years hence.

D. Distribution of funds

Salaries	\$27,640
Travel	3,200
Laboratory	17,300
Data processing	2,500
WOTSC	6,840

Total \$57,480

Techniques for evaluation of salinity potential of Mancos Shale lands

A. Location of study

Three study sites: (1) observation reservoir 4-A, Prairie Dog Site; (2) observation reservoir No. 12, Middle Basin Site; (3) observation reservoir No. 2-A, West Twin Site; in Badger Wash near Mack, Colorado

B. Objectives and procedures

HYDROLOGY

1. Operate the gages, April 1 - October 31 each year, collect samples, tabulate the streamflow, water quality (Schedule 1 analysis), and rain gage data. The streamflow gages will be operated on a 5-minute punch interval (with peak-stage indicator). The water sampler will be set to collect a sample every 5-minutes during the runoff period. It is estimated that about 10 samples per site be taken after the first runoff event and 3 samples per site for approximately 3 other storms per year will be collected and analyzed.
2. Run topographic survey of each reservoir at the end of each runoff season.
3. Equipment purchased to facilitate this contract shall become the property of BLM at the end of the study.

C. Report products

1. Provide BLM with copies of all tabulated data as it is completed. All discharge and water-quality data will be published in Water Resources Data for Colorado on an annual basis.
2. Summarizations will be compiled of total rainfall, runoff, sediment yield, and quality of water carried into the reservoir for each site and submitted to the BLM.

D. Distribution of funds

Salaries, professional and technical assistance (field, office, and lab)	\$ 4,040
Travel	0
Vehicles	350
Supplies and equipment	200
Data processing (lab costs) and computer costs	3,820
WOTSC	1,845
Administrative	3,415
Total	\$13,670

Hydrology and reclamation potential of coal spoils piles

A. Location of study

Routt County, Colorado

B. Objectives and procedures

The objectives are three-fold. First, the hydrologic characteristics of coal spoils piles will be defined. The quantity, quality, and timing of water movement across and through the spoils will be examined and compared to the same parameters for undisturbed basin areas. The hydrologic data collected will be used to develop a model to predict the impact of coal development on the quantity and quality of water leaving a mined basin. In addition, the model will aid in the assessment of the reclamation potential of disturbed areas by providing a complete annual water balance for those specific areas of a basin.

The second objective will be the assessment of the use of cuttings from holes drilled in undisturbed areas to predict the water-quality changes that will occur after mining of these areas. Water-quality changes in existing spoils piles will be compared to quality changes in water passed through a column of cuttings from areas adjacent to the spoils. This technique would provide a relatively inexpensive method for predicting water-quality changes in areas to be mined. These data would then be used in the hydrologic simulation model to predict the impact of mining on total basin hydrology.

The third objective is to examine the effects of various reclamation procedures on spoils piles hydrology. Different land surface treatment and vegetative covers will be applied and evaluated as to their effectiveness in reclaiming disturbed areas, their specific water requirements, and their impact on water quality. This objective will not be examined until objective one is met.

The hydrology of spoils piles will be examined using a combination of lysimeters and observation wells. Lysimeters will be installed in the upper 7 to 10 feet of the soils profile. Three lysimeters will be installed in a reclaimed spoils area and two lysimeters will be installed in an undisturbed area. A rainfall simulator will be used to obtain surface runoff and deep percolation samples for quality and quantity analyses from two lysimeters in the spoils area and one in the natural area. Because the rainfall simulator produces an above-average water movement through the profile, one lysimeter in each area will be used to monitor hydrologic response under natural conditions. The rainfall simulator will permit determination of the hydrologic characteristics of spoils, the validity of induced versus natural lysimeter response, and the effects of various reclamation treatment on spoils hydrology. Soil-water regimes within the lysimeter and areas adjacent to the lysimeter will be monitored using access tubes and a neutron soil moisture probe.

Three holes will be drilled in an existing spoils pile to total mined depth (about 150 feet) and three holes will be drilled to an equivalent depth in adjacent undisturbed areas. All holes will be completed as observation wells and periodic water samples will be collected for analysis of major chemical constituents and selected trace metals. Water-quality changes within the total depth of spoils will be determined from these samples. Cuttings from each hole will be collected and used to construct laboratory columns which are representative of the holes from which the cuttings came. Water will be passed through the columns at various flow rates and water samples will be collected at predetermined times during the column runs. Analyses of water samples from the column runs will be related to the results of lysimeter runs and the sample analyses for the three observation wells in the spoils. Relationships developed between water-quality changes in the columns and those observed in the field will show the feasibility of a rapid, relatively inexpensive method for predicting water-quality changes in areas to be mined.

Once the hydrology of the lysimeters in the spoils area are defined, various reclamation treatments will be imposed. The rainfall simulator will be used to stress these treatments. The effects of these treatments on water use, runoff, and water quality will be determined.

C. Report products

A U.S. Geological Survey Professional Paper will be published at the completion of this project. All data collected, procedures developed, data analyses, and model development will be reported in this publication.

D. Distribution of funds

Salaries	\$ 6,010
Travel	1,610
Laboratory analysis	15,410
Lysimeter construction	8,890
Observation well drilling	10,330
Data processing	1,000
WOTSC	6,750
	<hr/>
Total	\$50,000

ANNUAL WORK PLAN
MONTANA

The general agreement between the Bureau of Land Management (BLM) and the U. S. Geological Survey (USGS) is considered an integral part of the work plan.

Purpose and Scope of Program

Assistance by the USGS to the BLM during the current fiscal year involves two general types of activities: 1) Maintaining selected water resource assessment sites (surface water and quality of water) installed through previous work agreements in 1974 and 1975, and 2) Continue ground water studies in eastern Montana. Each project or work component under the two general types of activities is described as follows:

I. Maintain water-resource assessment sites previously installed.

1. Location of study

- 1) Fort Union Coal region, eastern Montana

2. Objectives

- 1) To supplement surface-water data being collected under other programs to evaluate the surface-water resources of the area.
- 2) To collect sufficient quality of water data to establish "baseline" conditions.

3. Procedure

- 1) Standard U. S. Geological Survey methods of surface-water data collection will be used to obtain data at the following stations:

C. Procedure (cont.)

- a. Mizpah Creek near Mizpah
- b. Nelson Creek near VanNorman
- c. Prairie Elk Creek near Oswego
- d. Squirrel Creek near Decker
- e. Burns Creek near Savage
- f. East Fork Trail Creek (4 stations)

2) Water samples will be collected and analyzed by Standard

U. S. Geological Survey methods at the following stations:

- a. Sarpy Creek near Hysham
- b. Deer Creek near Decker
- c. Hanging Woman Creek near Birney
- d. Cook Creek near Birney
- e. Bear Creek at Otter
- f. Threemile Creek near Ashland
- g. Otter Creek at Ashland
- h. Liscom Creek near Ashland
- i. Foster Creek near Volberg
- j. Nelson Creek near VanNorman
- k. Prairie Elk Creek near Oswego
- l. Squirrel Creek near Decker
- m. Burns Creek near Savage
- n. Pumpkin Creek near Sonnette
- o. Pumpkin Creek near Loesch
- p. Little Pumpkin Creek near Volberg
- q. Pumpkin Creek near Volberg
- r. Pumpkin Creek near Miles City

C. Procedure (cont.)

- s. Mizpah Creek at Olive
- t. Mizpah Creek near Volberg
- u. Mizpah Creek near Mizpah
- v. East Fork Trail Creek

4. Report Products

Basic records for surface-water and quality-of-water stations will be submitted to the BLM annually or as mutually agreed upon. Basic records for surface water and quality of water will be published by the USGS in an annual basic data report, "Water Resources Data for Montana." Interpretive reports are planned that will utilize these records and hydrologic data from other programs in assessing the effect of coal extraction on the hydrologic system. (see paragraph F, below)

5. Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	36,700
Laboratory Services	26,600
Travel	24,654
Supplies and Equipment	5,000
Data Processing	2,500
WOTSC	<u>18,726</u>
Total	114,180

6. Relationship to other USGS studies

This program will be correlated with a U. S. Geological Survey Energy study of the Fort Union coal area of eastern Montana.

6. Relationship to other USGS studies (cont.)

The energy study will include the interpretation of basic data being collected in the Fort Union coal region and the operation of the following surface-water and/or water-quality sites:

Redwater River at Circle (SW & QW)

Rosebud Creek near Colstrip (SW)

Rosebud Creek at mouth near Rosebud (SW & QW)

Powder River near Broadus (SW & Sed.)

Yellowstone River at Billings (Sed.)

II. Ground-water studies in eastern Montana

A. Continued collection of ground-water data at reclamation study sites and at selected sites south of the Yellowstone River.

1) Location of study--Bear Creek, Otter Creek, East Fork Trail Creek, and observation wells previously installed south of the Yellowstone River.

2) Objectives

To provide a ground-water data base from which an assessment can be made of the resource, future responses to stresses can be predicted, and pollution and supply problems can be detected and defined. The data also are necessary to extend in space and time the results of the reclamation site studies and to relate the results of other ongoing programs to the site studies.

II. Ground-water studies in eastern Montana (cont.)

3) Procedures

- a. Pump and collect water samples from test holes drilled in previous fiscal years.
- b. Analyze water samples for the parameters listed in Table 1.
- c. Make water-level measurements and continue operation of water-level recorders.
- d. Compile and analyze data.

4) Report Products

The data and its interpretation will be used in reports that assess the possible hydrologic effects of coal extractions and predict the hydrologic effects of mining and related activities.

5) Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Laboratory services	12,950
Salaries for field operations	5,500
Travel	2,500
Data processing	750
Data compilation and analyses	11,500
WOTSC	<u>6,800</u>
Total	40,000

6) Relationship to other USGS studies

Data collected under this activity will be used to help define pre-mining conditions at reclamation study sites,

A. Continued collection of ground-water data (cont.)

help calibrate ground-water models to predict the effects of mining, and help transfer data to surrounding areas from intensively studied reclamation sites.

B. Continue collection of ground-water data at selected sites north of the Yellowstone River.

1) Location of study--Fort Union coal area north of the Yellowstone and South of the Missouri Rivers including parts of Garefield, McCone, Richland, and Prairie Counties.

2) Objectives

Many tracts of land between the Missouri and Yellowstone Rivers have been recently nominated for coal leasing. Although the long-term objectives are the same for this activity as for activity II-A, the data base for the area is much smaller and the short-term objectives are directed toward acquiring data that defines the quantity and quality of ground-water throughout the area.

3) Procedures

- a. Case and test holes drilled by other agencies.
- b. Collect water samples and analyze for the parameters listed in Table 1.
- c. Establish an observation well network from existing wells and newly drilled test holes.
- d. Make water-level measurements and operate water-level recorders near streamflow stations.

4) Report Products

The data and its interpretation will be used in reports that assess the ground water resource and the possible hydrologic effects of coal extraction. Data will be stored in WRD automated files before its interpretation and release in the WRI series.

5) Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Laboratory services	7,000
Pump testing, and rig time for installation of casing	5,300
Salaries for field operations	4,500
Travel	3,700
Data processing	1,080
WOTSC	<u>4,420</u>
Total	26,000

6) Relationship to other USGS studies

This activity obtains ground-water data near streamflow stations operated under other parts of the EMRIA program. Also, this activity supplements well inventory programs (now mostly completed) supported by EPA.

C. Complete and install observation wells south of the Yellowstone River.

- 1) Location--Fort Union coal area south of the Yellowstone River including tracts nominated for coal leasing outside the Powder River structural basin.

2) Objectives

To extend the ground-water data base from which an assessment can be made of the resource, response to future stresses can be predicted, and pollution and supply problems can be detected and defined. To provide the ground-water data necessary to extend in space the results of reclamation studies and to relate site studies to regional studies.

3) Procedures

- a. Case, complete, and evaluate test holes drilled for coal exploration by other agencies as observation wells and/or as sites to obtain aquifer transmissivity or storage coefficient.
- b. Collect water samples shortly after drilling and testing.
- c. Analyze water samples for parameters listed in Table 1. If necessary, drill, case, and test pump test holes in critical areas where information is needed to calibrate and test ground-water models.
- d. Enter test holes into existing monitoring program described under Item II-A.
- e. Cooperate with BLM offices to insure data is obtained in critical areas and that data collected by other public and private organizations is checked for quality and included in this activity, and
- f. Coordinate Montana Bureau of Mines and Geology program with BLM and USGS needs.

4) Report Products

Data will be summarized in interpretative reports released in the Hydrologic Atlas and WRI, USGS series. Data will be stored in automated files for release upon request.

5) Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Laboratory services	1,600
Pump testing and rig time for installation of casing	2,500
Purchase of well casing	4,000
Salaries for field operations	3,000
Travel	4,000
Salaries for coordination efforts	1,000
Data processing	500
WOTSC	<u>3,400</u>
Total	20,000

6) Relationship to other studies

Test hole data collected under this activity constitutes a link between site-specific studies and the studies necessary to describe and predict the regional effects of coal extraction on the ground-water resources.

D. Grant to Montana Bureau of Mines and Geology for test drilling and test pumping in areas where coal leasing appears imminent.

1) Location of study--Fort Union coal area south of the Yellowstone River.

2) Objectives

To provide a ground-water data base from which an assessment

2) Objectives (cont.)

can be made of the resource, future response to stress predicted, and pollution and supply problems detected and defined. Also, to provide a test drilling program that can be directed by the USGS and BLM to areas where ground-water information is needed most due to impending leasing or due to critical needs for hydrologic information.

3) Procedures

- a. Drill and log test holes to about 50 feet below the lowest "stripable" coal bed.
- b. Case with 4 inch plastic casing, perforate, and isolate the aquifer being investigated from the rest of the rock section.
- c. Pump test the aquifer and collect water samples for laboratory analysis.
- d. Compile data to submit to USGS.

4) Report Products

Field data will be compiled in a report describing the results of the grant and 20 copies submitted to the USGS, who will send copies to the BLM.

5) Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Grant to Montana Bureau of Mines and Geology	50,000
WOTSC	<u>10,242</u>
Total	60,242

E. Reclamation study sites, Pumpkin Creek and East Fork Trail Creek.

1) Location of studies--Pumpkin Creek site is along the drainage divide between Pumpkin and Mizpah Creeks in R. 49 E., T. 2 and 3 S. East Fork Trail Creek includes the drainage basin, which lies mostly in T. 9 S., R. 43 and 44 E.

2) Objectives

Provide the data and interpretation necessary to predict and suggest alternate solutions to the ground-water problems that may be important during mining or reclamation. Implement a monitoring system to define "baseline" conditions and to document ground-water changes in flow and quality that could be caused by mining or reclamation.

3) Procedures

Pumpkin Creek--Drill about 14 test holes to and through the Sawyer Coal bed; core about 4 holes and supply the core to the Branch of Coal resources; case and make radioactive logs of those holes which penetrate saturated coal; inventory wells in adjacent areas; pump test and sample for chemical analyses selected test holes in the study area; use test hole data in conjunction with geologic data from Geologic Division to prepare an informal report that will be submitted to the Bureau of Reclamation.

East Fork Trail Creek--Test holes through the Anderson and Dietz coal beds, pump tests, and water samples will be obtained by the Montana Bureau of Mines and Geology.

3) Procedures (cont.)

Their data will be submitted to the USGS as a completion report from their grant and will be used in combination with geologic data obtained by Geologic Division to prepare a report describing the ground-water resources and the possible effects of mining. USGS, WRD will install one (1) station to monitor all stages of surface flow on East Fork Trail Creek and three parshall flumes to record "base flows." The streamflow stations and test holes will be used for continuing monitoring. At a later date the area may be instrumented to obtain solar radiation and rainfall data to be used in a rainfall-runoff model

4) Report Products

The Pumpkin Creek data will be compiled in a report describing the ground-water resources, or lack thereof, as related to the reclamation of mined lands by June 1977. This report will be combined by the Bureau of Reclamation with others describing the reclamation problems and reclamation potential of the area. The East Fork Trail Creek data will be compiled and interpreted in a report describing the ground-water resources as related to the reclamation of mined lands. Completion of the report depends on weather conditions that control the test drilling, but assuming normal weather patterns, the

4) Report Products (cont.)

report should be completed by September 1977. It will be submitted to BLM for collation with other reports pertaining to the site.

5) Distribution of Funds for Pumpkin Creek

<u>Item</u>	<u>Cost Estimates</u>
Test drilling and manpower required for supervision	20,000
Laboratory services	4,500
Pump testing	1,500
Salaries for field operations	11,620
Travel	2,800
Data processing	700
Report preparation	8,760
WOTSC	<u>10,216</u>
Total	60,096

Distribution of funds for East Fork Trail Creek

<u>Item</u>	<u>Cost Estimates</u>
Salaries for field operations	5,600
Travel	2,000
Coordination meetings with MBM & G	900
Data processing	500
Report preparation	12,580
Laboratory Services	2,070
WOTSC	<u>4,850</u>
Total	28,500

6) Relationship to other USGS studies

Both reclamation site studies are part of an effort involving Geologic Division, USBR, BLM, and MBM & G.

Results of the site studies are used with other information to evaluate the ground-water resources and problems in the Powder River structural basin.

F. Geothermal studies in KGRA's (Known geothermal resource areas)

- 1) Location--Chico Hot Springs area (T. 5 and 6 S., R. 8 and 9 E.) and Hunter's Hot Springs area (T. 1 S., R. 12 E.)

2) Objectives

Provide the data that the BLM and Forest Service have requested to help evaluate the effects of proposed geothermal exploration and development on the chemical quality of the Yellowstone River near Hunter's and Chico Hot Springs. The major objective is to help define roughly baseline conditions representing periods of moderate to low flow in tributaries crossing the proposed lease application areas and the adjacent reaches of the Yellowstone River before geothermal operations begin.

3) Procedures

Collect water samples and make discharge measurements during a period of low base flow (90% duration) and a period of high base flow (50% duration) probably in the fall of 1976 and the late winter or spring of 1977 on the Yellowstone River and tributaries containing

3) Procedures (cont.)

geothermal waters. Each set of measurements will be completed within two (2) days. All samples will be collected, processed, and analyzed according to procedures accepted by the USGS for describing total streamflow in terms of the parameters listed in Table 2.

4) Report Products

A final report, completed soon after the last set of measurements, will include a compilation of the measurements, results from the chemical analyses, expression of the the water and chemical discharge of tributary inflow as percentages or corresponding values in the adjacent Yellowstone River, an evaluation of unusual chemical occurrences, if any, and recommendation for further study, if warranted.

5) Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Sampling and analyses	5,600
Travel and field salaries	2,900
Data processing	500
Report preparation	1,000
WOTSC	<u>2,047</u>
Total	12,047

6) Relationship to other USGS studies

The data will be of greatest use to agencies concerned with evaluating the environmental effects of geothermal

6) Relationship to other USGS studies (cont.)

exploration and development; however, it will also be useful in the geothermal program the USGS is funding in southwestern Montana. The data will be included in reports planned by the USGS to describe and evaluate geothermal resources.

Table 1.--Parameters for chemical analysis in ground-water.

Common Constituents

Silica, dissolved	Nitrate & nitrate total as N
Iron, dissolved	Dissolved solids
Calcium, dissolved	Sodium absorption ratio (SAR)
Magnesium, dissolved	PH
Sodium, dissolved	Specific conductance
Potassium, dissolved	Alkalinity, total
Bicarbonate	Temperature
Sulfate, dissolved	Color
Chloride, dissolved	
Flouride, dissolved	

Trace elements, nutrients and radiochemical

Aluminum, dissolved	Vanadium, dissolved
Arsenic, dissolved	Zinc, dissolved
Manganese, dissolved	Sulfide, dissolved
Barium, dissolved	Bromide
Cadmium, dissolved	Iodide
Cobalt, dissolved	Nitrogen, ammonia, total
Chromium, dissolved	Nitrogen, total organic
Lead, dissolved	Nitrogen, total Kieldahl
Lithium, dissolved	Nitrogen, total
Molybdenum, dissolved	Nitrogen, total as NO ₃
Nickel, dissolved	
Strontium, dissolved	

Phosphorus, total

Gross alpha and beta dissolved

Carbon, total organic

and suspended

Arsenic, dissolved

Boron, dissolved

Copper, dissolved

Mercury, dissolved

Selenium, dissolved

Table 2 - Parameters for analyses of water samples from Chico and Hunter's areas.

*Alk, Tot (As CaCO3)	MG/L	Molybdenum Dissolved	UG/L
Arsenic Dissolved	UG/L	Nickel Dissolved	UG/L
Beryllium Dissolved	UG/L	*NO2+NO3 AS N Diss	MG/L
*Bicarbonate	MG/L	Oxygen Dissolved	MG/L
Boron Dissolved	UG/L	*pH Field	
Cadmium Dissolved	UG/L	Phosphorus Diss AS P	MG/L
*Calcium Diss	MG/L	*Potassium Diss	MG/L
*Carbonate	MG/L	*Residue Dis Calc Sum	MG/L
*Chloride Diss	MG/L	*Residue Dis Ton/Aft	
Copper Dissolved	UG/L	*SAR	
Chromium Dissolved	UG/L	Selenium Dissolved	UG/L
*Flouride Diss	MG/L	*Silica Dissolved	MG/L
*Hardness Noncarb	MG/L	*Sodium Di-s	MG/L
*Hardness Total	MG/L	*Sodium Percent	
Iron Dissolved	UG/L	*SP. Conductance Fld	UG/L
Lead Dissolved	UG/L	Strontium Dissolved	UG/L
Lithium Dissolved	UG/L	*Sulfate Diss	MG/L
*Magnesium Diss	MG/L	Vanadium Dissolved	UG/L
Manganese Dissolved	UG/L	*Water Temp (DEG C)	
Mercury Dissolved	UG/L	Zinc Dissolved	

WORK ORDER

October 1, 1976 to September 30, 1977

Hydrologic surveillance of coal lease areas near Fruitland and near Bisti Trading Post in Northwestern New Mexico

A. *Location of Study*

The two areas of study are located in San Juan County in northwestern New Mexico. The area near Fruitland, New Mexico is located in and around the San Juan Coal Mine lease (sections 3, 4, 9, 10, 15, 16, 21, 22, 27, 28, 33, 34 or Township 30 North, Range 15 West). The area near Bisti Trading Post is in and around BLM's Bisti West EMRIA reclamation study site (sections 6, 7, 8, 17 of Township 23 North, Range 12 East).

B. *Objectives and Procedure*

This work order proposes to maintain the hydrologic data collection program at selected sites in or around the described areas. The objective of the study is to expand the hydrologic data base for both the surface and ground water resources for more accurate definition of baseline or present conditions and to help determine if any observed changes are natural or manmade. The information gathered should help BLM in the planning and management of coal mining on Federal lands. The information should be helpful in developing environmental statements, assisting BLM prepare lease stipulations, in assisting to evaluate any reclamation plans or efforts, and in determining suitable land use alternatives. Data collection in these areas began in FY 74 with emphasis placed initially in the Fruitland area where mining was already in progress. The arroyos and washes flow unpredictably immediately after intense local rainstorms, and the sampling sites are often inaccessible during and after rainstorms. This work order proposes the following program:

1. *Operation and maintenance of four surface water gaging stations as follows:*

Shumway Arroyo near Fruitland, (inflow to mine area)

Shumway Arroyo near Waterflow, NM (baseline outflow station from mine area)

DeNazin Wash near Bisti Trading Post (baseline outflow station from BLM's Bisti West EMRIA site)

Hunter Wash near Bisti Trading Post, NM (major tributary drainage potential strippable coal areas)

2. Storm event or periodic sampling by field observers or field investigator for comprehensive analyses of chemical quality and suspended sediment on the Shumway Arroyo, Hunter Wash and DeNazin Wash outflow stations.
3. Maintenance and operation of automatic pump sampling installations at the Shumway Arroyo near Waterflow and DeNazin Wash near Bisti for sampling of major flow events for suspended sediment and chemical quality analyses.
4. Maintenance of sets of single stage samplers installed on the Shumway Arroyo, Westwater Arroyo, Hutch Canyon, DeNazin Wash, Coal Creek, Alamo Wash, Hunter Wash, and other miscellaneous tributaries for remote collection of storm runoff for chemical quality and suspended sediment analyses.
5. Continue measurement of water levels and collection of at least one set of water samples from each of 15 wells within and around the study areas. Constituents to be analyzed will be selected from review of previous analyses.
6. Maintain network of nonrecording raingages which have been installed in and around the study areas.
7. Continue survey of reference channel cross sections after the storm season for channel geometry changes. These reference cross sections are on the Shumway Arroyo, Westwater Arroyo, and DeNazin Wash.

C. Report Products

Any preliminary data will be furnished to BLM on a schedule agreed upon or upon request by BLM. Data tables of stream discharges, suspended sediment concentrations, chemical analyses of surface and ground waters, and ground water levels will be published in the annual basic data report of the USGS. BLM will be advised of any changes that should be made to previous reports on the basis of new information.

D. Distribution of Funds

<u>Item</u>	<u>Cost Estimate</u>
Salaries	\$15,400
Travel	3,200
Laboratory Services	10,500
Equipment and Supplies	400
Data Processing	2,000
Administrative Services	9,000
	<hr/>
	\$40,500

LIST OF WATER QUALITY PARAMETERS

June 28, 1976

The water quality parameters that may be measured on water and soil samples collected for this study are listed below. The project investigator shall select the parameters to be measured for a sample and the frequency of measurement at a site. Other parameters may be added to this list if needed. The dissolved and suspended concentrations of many constituents, particularly trace elements, will be determined.

Acidity	Nickel
Alkalinity	Nitrogen, ammonia
Aluminum	Nitrogen, nitrate
Arsenic	Nitrogen, nitrite
Barium	Oxygen, dissolved
Beryllium	pH
Bicarbonate	Phosphorous, as dissolved PO_4
Boron	Phosphorous, total
Cadmium	Potassium
Calcium	Residue at 180 C (dissolved solids)
Carbon, organic	Selenium
Carbonate	Silica
Chemical oxygen demand	Silver
Chloride	Sodium
Chlorophyll	Specific conductance
Chromium	Streptococci bacteria, fecal
Cobalt	Strontium
Coliform bacteria, fecal	Sulfate
Color	Sulfide
Copper	Temperature, water
Cyanide	Turbidity
Fluoride	Zinc
Hardness	Phytoplankton
Hydroxide	Radioactivity, gross alpha
Iron	Radioactivity, gross beta
Lead	Radium
Lithium	Uranium
Magnesium	Suspended sediment
Manganese	Suspended sediment particle size
Mercury	Discharge, streamflow or yield
Molybdenum	

HYDROLOGIC INVESTIGATION OF BLM'S RECLAMATION STUDY
SITE NEAR KIMBETO IN NORTHWESTERN NEW MEXICO

A. Location of Study

The area of proposed study is located in San Juan County in northwestern New Mexico in and around BLM's Kimbeto reclamation study site (sections 6-south half, 7, 17, 18, 19-north half; in township 22 north, range 10 west). Maps showing these locations are attached.

B. Objectives and Procedure

The USGS will collect hydrologic information on both surface and ground water resources within and around the specific study site which will aid BLM in the planning and management of potential strip mining of coal from the Fruitland Formation near Bisti, New Mexico. The information obtained should be applicable to similar strippable coal areas. This study should help in preparing environmental impact statements, in developing coal-lease stipulations, in evaluating reclamation plans and efforts, and in determining suitable land-use alternatives.

This study is part of BLM's EMRIA program. Related studies on soil surveys, coal assay, vegetation, surveys, erosion potential, and revegetation studies are to be conducted by other agencies. This study should provide such information as the natural quantity and quality of the water resources, flow characteristics of the surface runoff, sediment transport of the surface flow, ground water yields and direction of movement, and hydrologic changes which may be induced by strip mining and rehabilitation.

The study area is located in an arid to semi-arid region and presents special problems for studying the sparse surface and ground water supplies. These problems were considered in this proposal.

Work to be accomplished includes:

1. Hydrologic field reconnaissance of the watersheds draining the reclamation study site. This includes sampling of water for chemical analyses from arroyos, ponds, springs, seeps and existing wells; channel geometry study for water and suspended sediment carrying capacities; surveying of ponds for sediment deposition; and photographing of channels and other features for changes caused by erosion.

2. Install, maintain and operate baseline outflow station on Ah-shi-sle-pah Wash. The station will include a surface water gage, an automatic pump sampler, and single stage point samplers. This station will be visited periodically and frequently during the storm season to collect samples for comprehensive chemical quality and suspended sediment analyses.
3. Monitor the quantity and quality of any runoff on the small tributary transversing section 18.
4. Install and maintain single-stage samplers on tributary arroyos within the study site for capturing flow events for suspended sediment and chemical quality analyses.

C. Report Products

Any preliminary data will be furnished to BLM on a schedule agreed upon or when requested by BLM. Basic data tables of stream discharges, suspended sediment concentrations, chemical analyses of surface and ground waters, and ground water levels will be published in the annual basic data reports of the USGS. A report defining the hydrology of the study area and describing anticipated changes from coal mining will be furnished as part of the comprehensive reclamation study report. The report should include tables, graphs, and maps.

D. Distribution of Funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	\$16,000
Travel	3,000
Laboratory Services	8,000
Supplies and Equipment	5,000
Data Processing	2,000
Administrative Support (Div., Dist.)	9,000
	<hr/>
TOTAL	\$43,000

Hydrologic effects of strip mining in the Gascoyne area, Bowman County, North Dakota

A. Location of study

Eastern Bowman County, southwestern North Dakota

B. Objectives and procedure

Lignite has been strip mined in the Gascoyne area for several years. Generally, the production has averaged about 100,000 tons per year. However, production is being increased to about 3,000,000 tons per year in order to supply the fuel needs of an electricity-generating plant in eastern South Dakota. The lignite will be shipped to the plant by rail.

A preliminary reconnaissance study has indicated that the proposed large expansion of strip-mining activities will result in changes in the streamflow and ground-water regimen in the area (Northern Great Plains Resources Program--Water Work Group, 1974). Some changes will be temporary but others may remain even after strip mining has ceased. The purpose of this investigation is to identify, measure, and evaluate the changes.

In order to understand the operation of the existing hydrologic system and to predict the effects of new stresses imposed upon it, it will be necessary to simulate the system by means of a conceptual model or models involving finite element and difference approximations of the complex ground-water and surface-water flow equations. The entire project is scheduled for three years and will be executed in three phases (not necessarily coincident with the years). It is expected that all of Phase I and item 1 under Phase II will be completed in fiscal year 1976.

Phase I (Partially completed in 1976 and transition quarter.)

1. Collation and evaluation of all existing hydrologic and chemical data that will be used as the resource base for preliminary digital models.
2. Selection of suitable models.

3. Output from models will supply information as to the locations of needed test holes, observation wells, and other data acquisition sites.
4. Adjustment of digital model program, as necessary.

Phase II (Partially completed in 1976 and transition quarter.)

1. Collection of new geologic, hydrologic, and chemical data, including test drilling and well construction.
2. Refinement of data for the digital model and evaluation of results. Readjustment and calibration of digital models, as necessary.
3. Selection of additional data collection sites based upon output from models.
4. Valid digital model representing present hydrologic and geochemical systems will be available at the end of Phase II.

Phase III

Based on the conceptual model developed by the end of Phase II, the effects of mining on various phases of the hydrologic system will be forecast. The results of the investigation will be published in a Geological Survey report. An interim report is planned for open-file release prior to the availability of the final report.

C. Relationship to other closely associated non-EMRIA funded activities

The Gascoyne lignite deposit is one of the deposits that will be covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY '75 and is funded by the U.S. Geological Survey. The data collection under ND-070F will be coordinated with the needs of, and will be of value to, the present study. Inasmuch as the ultimate objective of ND-070F is to provide an in-depth appraisal of the hydrologic effects of mining for each of the identified strippable deposits, the Gascoyne study will result in a savings in the eventual overall cost of ND-070F.

D. Report products

Basic records for surface-water and water-quality stations will be published annually by the U.S. Geological Survey in "Water Resources Data for North Dakota, Parts 1 and 2". Basic records for ground-water and water-quality stations will be submitted annually to BLM and other interested parties. An interpretive report on the hydrologic effects of strip mining in the Gascoyne area will be published after the three-year study is completed, probably either as a U.S. Geological Survey Professional Paper or Water Supply Paper with an interim open-file report.

E. Distribution of funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	\$30,740
Travel	7,000
Contractual services	10,000
Supplies and equipment	6,000
Laboratory costs	3,500
Data processing, including computer costs	7,500
Administrative costs (17%)	13,260
	<u>\$78,000</u>

Hydrologic data for effects of lignite extraction, western North Dakota

A. Location of study

Strippable lignite areas in seven western counties of North Dakota

B. Objectives

An intensified system of hydrologic data collection in the coal and oil shale areas of the Rocky Mountain and Northern Plains States, designed to supplement the ongoing data-collection programs of the Geological Survey with special attention to the coal and oil shale leasing, environmental, and land and resource management needs of the BLM. Hydrologic data are to include surface-water discharge, chemical quality of surface and ground water, and ground-water levels. Water quality measurements are to include but are not to be limited to those physical, chemical, and radiological constituents or characteristics agreed to by interchange with other U.S. Geological Survey offices and BLM personnel, with adjustments as appropriate to the surface or subsurface occurrence of the water. The data are to be published by the Geological Survey and are also to provide the basis for special reports in accordance with the objectives and applications of the data program to BLM and other-agency needs.

C. Relationship to other closely associated non-EMRIA funded activities

Water samples from selected streams, lakes, and aquifers in the Fort Union coal region are being collected and analyzed by the U.S. Geological Survey under a cooperative agreement with the Environmental Protection Agency to assess the environmental effects of lignite mining. Data collection under the BLM program is coordinated with that of the Environmental Protection Agency and other ongoing programs.

D. Procedures

1. Computation of daily and peak flows for the following stream gaging stations:

06339560	Brush Creek near Beulah, N. Dak.
06349930	Coal Bank Creek near Havelock, N. Dak.
06355310	Buffalo Creek Tributary near Gascoyne, N. Dak.

2. Estimate sediment yield of these streams through periodic (monthly, high and low flows) sampling.
3. Analyzing chemical and physical properties of the water in the streams through periodic sampling. (See Table 1.)
4. Measure monthly changes in ground-water levels at the following sites:

Well location

131-099-21DDD
 131-099-29BBB
 131-099-34BCA

5. Measure chemical and physical properties of ground water at above sites. (See Table 1.)

E. Report products

The data acquired on the surface streams and ground-water wells will be published in the annual series "Water Resources Data for North Dakota, Parts 1 and 2". In addition, the data will be used with data from other projects to produce interpretive reports, particularly ND75-070F (Hydrologic changes due to lignite mining in North Dakota).

F. Distribution of funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	\$ 9,260
Travel	4,000
Data processing	600
Laboratory costs	7,590
Administrative costs (17%)	4,390
	<hr style="width: 100px; margin-left: auto; margin-right: 0;"/>
	\$25,840

TABLE 1

Suggested Parameter Code List

Energy Stations

<u>Storet Code</u>	<u>Parameter Name</u>	<u>Remarks</u>
<u>Monthly</u>		
<u>Field</u>		
00061	Discharge, ft ³ /s	SW only
00010	Temperature, °C	
00400	pH	
00095	Specific Conductance	
00300	Dissolved Oxygen	SW only
00310	Oxygen, percent saturation (calculation)	
<u>Laboratory</u>		
00410	Alkalinity (tot as CaCO ₃)	
00440	Bicarbonate	
00915	Calcium, Diss	
00940	Chloride, Diss	
70300	Residue, Diss at 180°C	
70301	Residue, Calc Sum	
70303	Residue, Diss Ton/Aft	SW only
70302	Residue, Diss Ton/day	SW only
00950	Fluoride, Diss	
00902	Hardness, Noncarb	
00900	Hardness, Total	
00925	Magnesium, Diss	
00935	Potassium, Diss	
00955	Silica, Diss	
00931	SAR	
00930	Sodium, Diss	
00932	Sodium, Percent	
00945	Sulphate, Diss	
00600	Nitrogen Tot as N	SW only
71887	Nitrogen Tot as NO ₃	SW only
00625	Nitrogen Total KJD as N	SW only
00630	NO ₂ + NO ₃ as N Tot	SW only
00610	Nitrogen, NH ₄ as N Tot	SW only
00607	Nitrogen, Diss Org as N	
00608	Nitrogen, NH ₄ as N Diss	
00623	Nitrogen, Diss KJD	
00631	NO ₂ + NO ₃ as N Diss	
00665	Phosphorous, Tot as P	SW only
00650	Phosphorous, Tot as PO ₄	SW only
00666	Phosphorous Tot Diss as P	
00681	Carbon, Diss Org	
00689	Carbon, Susp Org	SW only
80154	Susp. Sed Conc.	SW only

<u>Storet Code</u>	<u>Parameter Name</u>	<u>Remarks</u>
<u>Quarterly</u>		
Susp. Sed.	Size Analysis	SW only
Bed Matl.	Size Analysis	SW only
00310	BOD, 5-day	SW only
01106	Aluminum	
01000	Arsenic	
01005	Barium	
01020	Boron	
71870	Bromide	(Ground Water only)
01025	Cadmium	
01030	Chromium	
01040	Copper	
01046	Iron	
01049	Lead	
01130	Lithium	
01056	Manganese	
71890	Mercury	
01060	Molybdenum	
01145	Selenium	
01080	Strontium	
01090	Zinc	

Annual Radio Chem
Analysis Schedule 473

80030)	
80050)	Gross Alpha, Beta -- Dissolved
80040)	Gross Alpha, Beta -- Suspended
80060)	Radium 226 by Radon,
80010)	Uranium Fluorometric
09511)	

NOTE: Ground-water samples will be taken annually.

Hydrologic evaluation of mining and reclamation, Beulah Trench area, Mercer County, North Dakota

A. Location of study

Central Mercer County, Mercer County, North Dakota

B. Objectives and procedure

Preliminary data indicate that the proposed expansion of strip-mining activities in the Beulah Trench area, North Dakota, may result in changes in the streamflow, geochemical, and ground-water regimen. Some changes will be temporary but others may remain even after strip mining has ceased. The purpose of this investigation is to (1) determine premining hydrologic and geochemical conditions in a small representative drainage basin, (2) provide historical data with which to compare the magnitude of change with mining, and (3) determine the hydrologic and geochemical effects of mining in nearby areas on the Antelope Creek aquifer.

In order to understand the operation of the existing hydrologic and geochemical systems in the Beulah Trench area and predict the effects of new stresses imposed on it by mining operations, it will be necessary to simulate the systems by means of a digital model or models involving finite element and difference approximations of the ground-water and surface-water flow and mass transport equations. Although either electric analog or digital model could be used, the digital model is preferable because of time, cost, and facility restrictions. A three-phased approach to quantitative hydrology in the study area is planned.

Phase I

1. Collation and evaluation of existing hydrologic and chemical data that will be used as the resource base.
2. Development of conceptual models of the hydrologic and geochemical systems and selection of digital computer models that simulate the conceptual models.

3. Output from the digital models will aid in the selection of locations of needed test holes, observation wells, and other data acquisition sites.
4. Adjustment and refinement of conceptual and digital models, as necessary.

Phase II

1. Collection of new geologic, hydrologic, and chemical data.
2. Refinement of data for the digital models and evaluation of results. Readjustment and calibration of digital models, as necessary.
3. Selection of additional data collection sites based upon output from models.
4. Digital models representing the present hydrologic and geochemical systems will be available at the end of Phase II.

Phase III

Based on the conceptual and digital models developed by the end of Phase II, the effects of mining on various phases of the hydrologic and geochemical systems will be forecast. A final, complete report is planned for April 30, 1979.

C. Relationship to other closely associated non-EMRIA funded activities

The Beulah Trench lignite deposit is one of the deposits that will be covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY '75 and is funded by the U.S. Geological Survey. The data collection under ND-070F will be of value to the present study. Inasmuch as the ultimate objective of ND-070F is to provide an in-depth appraisal of the hydrologic effects of mining for each of the identified strippable deposits, the Beulah Trench study will result in a savings in the eventual overall cost of ND-070F.

Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission, the Environmental Protection Agency, the Corps of Engineers, and with U.S. Geological Survey funds. There will be a mutually beneficial exchange of data between the programs.

D. Report products

Basic records for surface-water quantity and surface-water quality stations will be published in the U.S. Geological Survey annual series "Water Resources Data for North Dakota" or as an appendix to an interpretive report. Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of strip mining and reclamation in the Beulah Trench area is scheduled for review by April 1969 and will probably be published in the Water Resources Investigation series of the U.S. Geological Survey.

E. Distribution of funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	\$42,085
Travel	9,550
Contractual services	5,000
Supplies and equipment	6,250
Laboratory costs	7,000
Data processing, including computer costs	1,000
Administrative costs (17%)	14,520
	<hr style="width: 100px; margin-left: auto; margin-right: 0;"/> \$85,405

OKLAHOMA

Hydrologic monitoring and collection of hydrologic data on coal lease areas in eastern Oklahoma

A. Location of study sites

1. Near Blocker - parts of T.6 and 7N., R.16 and 17E.
2. Near Rock Island - parts of T.8 N., R.26 and 27 E.
3. Near Spiro - parts of T.8 and 9N., R.24 and 25 E.

B. Provide baseline hydrologic data that will be needed to evaluate the effects of strip mining and reclamation on the hydrology of the area.

C. Approach

1. Blocker area

- a. Blue Creek - (1) operate and maintain discharge station; (2) collect water quality and sediment samples.
- b. Blue Creek tributary - (1) make monthly discharge measurement; (2) collect water quality and sediment samples.
- c. Mathuldy Creek - (1) operate and maintain crest-stage gage; (2) make monthly discharge measurement; (3) collect water quality and sediment samples.
- d. Rain gage - operate and maintain recording rain gage.
- e. Ground-water level recorder - Install and maintain water-level recorder in abandoned well near Blocker.
- f. Hydrologic inventory - (1) Inventory selected wells and make field determinations of temperature, pH and conductivity; (2) collect five samples of ground water for laboratory analysis; (3) inventory tributaries of Blue and Mathuldy Creeks to determine discharge, temperature, pH, conductivity and other selected water-quality parameters.

2. Rock Island area

- a. James Fork near Cameron - (1) maintain crest-stage gage; (2) make monthly discharge measurement; (3) collect water-quality and sediment samples.
- b. James Fork near Hackett, Ark. - continue collection of water quality and sediment samples.

- c. Rain gage - install and maintain recording rain gage.
- d. Ground-water level recorder - install and maintain water-level recorder in abandoned well near Rock Island.
- e. Hydrologic inventory - (1) inventory selected wells and make field determinations of temperature, pH, and conductivity; (2) collect five samples of ground water for laboratory analysis; (3) inventory selected tributaries of James Fork to determine discharge, temperature, pH, conductivity, and other selected water-quality samples.

3. Spiro area

- a. Coal Creek - (1) maintain two crest-stage gages; (2) make monthly discharge measurements; (3) collect water-quality and sediment samples.
- b. Ground-water level recorder - install and maintain water-level recorder in Coal Creek basin.
- c. Rain gage - install and maintain recording rain gage in Coal Creek basin.

D. Report products

- 1. Stream discharge, water-quality, sediment, and ground-water level data will be published in annual reports.
- 2. An interpretive report describing the general hydrology is in preparation.

E. Distribution of funds

Salaries	\$13,500
Travel	600
Laboratory services	16,680
Supplies and equipment	4,650
Data processing	5,016
WOTSC + assessments	<u>8,284</u>
 TOTAL	 \$48,730

Hydrology of Alton Reclamation Study Site near Kanab, Utah

- A. Location: A 2,080-acre site in a known coal-leasing area north of Kanab in T.40 S., Sec. 8, 17, 18, R.4½ and 5 W., Sec. 13.
- B. Objective: To collect and interpret hydrologic data for an assessment of the impacts of mining and reclamation on the hydrology of the study area.
- C. Approach: (1) Operate 5 streamflow gaging stations to monitor stream stage at:

- Skutumpah Creek above study site (T.40 S., R.4½ W., Sec. 5)
- Skutumpah Creek below study site (T.40 S., R.4½ W., Sec. 20)
- Thompson Creek above study site (T.40 S., R.5 W., Sec. 13)
- Thompson Creek below study site (T.40 S., R.5 W., Sec. 24)
- Unnamed ephemeral tributary below study site (T.40 S., R.4½ W., Sec. 19)

(2) Determine water-quality characteristics of streams from monthly samples collected at 5 gaging sites in item (1). Analyses will include determination of calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, nitrate, nitrite, orthophosphate, boron, total solids.

(3) Determine sediment discharge characteristics of streams from samples collected at 5 gaging sites listed in item (1). Daily samples will be collected April-June, weekly samples July-September, and bi-monthly samples October-March.

(4) Measure ground-water levels periodically in available wells and test holes.

(5) Collect precipitation data at 5 locations in and near the study area from approximately April to October when the plastic gages will not freeze and break. The work will be done in connection with regular visits to collect other data.

(6) Pull pump on abandoned irrigation well; clean out well; install recorder to establish observation well.

- D. Reports: Current information will be included in annual basic data reports of the Utah District. BLM may request the data directly if needed. A progress report will be prepared annually, and a report on the hydrology of the site will be prepared after conclusion of the investigation (approximately 3 - 5 years).

- E. Budget distribution of funds:

Salaries	\$21,460
Travel and transportation	4,000
Supplies and equipment	2,600
Well reconditioning	1,000
Laboratory support	3,000
Data processing and reporting	2,000
SLUC	1,700
WOTSC	5,580
Total	<u>\$41,340</u>

Hydrologic reconnaissance of Utah coal fields

- A. Location of study: All or parts of known coal fields in southern and eastern Utah; total area about 5,600 square miles.
- B. Objective: During FY 1977, subject to budget, personnel, and time limitations:
- (1) Identify baseline conditions--surface-water availability, distribution in time and place, runoff characteristics and quality; ground-water recharge, movement, storage, discharge, and quality.
 - (2) Make quantitative estimates of water-resources quantity, quality, availability, and potential for development.
 - (3) Make semi-quantitative predictions, if feasible, of potential effects of proposed developments on water resources.
 - (4) Recommend long-term monitoring network and additional detailed studies that may be needed.
- C. Approach: (1) Search literature and files; coordinate with related District projects, compile available data and identify deficiencies.
- (2) Field reconnaissance: Selectively inventory water sources and existing uses; measure channel geometry, streamflow, ground-water levels, water quality; collect and analyze selected water and sediment samples, rock samples; map phreatophytes, geology, and soils as needed. During FY's 1977-78, collect data from on-going drilling programs of Federal agencies and private companies.
 - (3) Compile, analyze, and interpret data; prepare maps and graphs for immediate use.
 - (4) Prepare interpretive report.
- D. Reports: An interpretive report will be completed for the Wasatch-Plateau and Bookcliffs coal field area by September 30, 1977. The report will include estimates of existing hydrologic conditions, potential for additional development of water resources, probable effects on the hydrologic system of specific proposed developments, and recommendations for continued monitoring and detailed studies. Basic hydrologic data will be released separately by the District at the end of the project but will be available by request during project. An additional interpretive report summarizing information gathered from drilling programs of Federal agencies and of private companies, will completed by September 30, 1978.
- E. Distribution of funds (FY 1977):

Salaries	\$54,000
Travel and transportation	4,500
Supplies and equipment	1,120
Laboratory support	6,840
SLUC	3,310
WOTSC	10,890
Total	<u>\$80,660</u>

Hydrologic study in potential oil-shale development area in Uinta Basin, Utah

- A. Location: Southeastern Uinta Basin; about 2,400 square miles.
- B. Objective: To collect streamflow data in 1977 fiscal year and continuing contingent upon annual appropriations.
- C. Approach: (1) Operate streamflow gaging station at 1 site:

<u>Station No.</u>	<u>Description</u>
09306900	White River at mouth near Ouray, Utah, in SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 2, T.9 S., R.20 E., Uintah County, Lat 40°03'54", Long. 109°38'06".

- (2) Collect daily sediment samples at the gaging site shown under item 1 and calculate daily suspended-sediment loads.

- D. Reports: Information will be included in normal Basic-Data reports of the Utah District. BLM may request the data directly if needed.

E. Budget distribution of funds:

Salaries	\$ 3,385
Sediment observer	2,080
Travel and transportation	1,000
Supplies and equipment	100
Laboratory support	2,000
Data processing and reporting	500
SLUC	450
WOTSC	1,485
Total	<u>\$11,000</u>

WYOMING

Hydrologic monitoring in coal resource areas of the Powder River Basin in Wyoming.

A. Location of study:

Powder River basin in northeastern Wyoming.

B. Objectives:

1. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal.
2. Determination of the physical effects of coal mining and land reclamation on surface runoff and ground-water recharge.
3. Determination of the chemical and biologic quality of surface water, in accordance with the attached table 1, and sediment transport in streams.

C. Procedure:

1. Operate eight streamflow and water-quality stations and two streamflow-rainfall stations in areas of present or projected surface mining of coal in the Powder River basin.
2. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.

D. Report products.--The aquifer properties of coal at the White Tail Butte will be analyzed by techniques assuming first a homogeneous aquifer and secondly an inhomogeneous aquifer using a method described by Papadopoulos (1965). Analyses of other tests in coal will depend on the results of this more detailed aquifer test.

The sources, sinks, and gradients of dissolved constituents in the water will be used to help define the flow system and predict the impact of mining on the quality of water.

Surface-water runoff data will be analyzed using the U.S. Geological Survey's rainfall-runoff model (Dawdy, Lichty, Bergmann, 1972) and the long-term synthesis program to develop peak and volume frequencies. Infiltration in the two adjacent basins will be compared to determine difference, if any, in rate of infiltration due to a difference in surface geology.

Surface-water quality samples will be collected for salinity, COD, nutrient, and trace metals. Field determinations will be made for pH, specific conductance, and temperature. Standard methods of collecting sediment data will be followed (Guy and Norman, 1970). Sediment samples will be analyzed for concentration, coal and the silt-sand split.

A report on the hydrologic features of the site, as they relate to rehabilitation will be written for inclusion in the overall rehab report. Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded by the USGS.

E. Distribution of funds

<u>Item</u>	<u>Cost estimates</u>
Salaries	\$ 62,250
Travel	9,490
Supplies and equipment	9,190
Data processing	2,000
Rent, utilities, misc.	3,770
WOTSC	14,110
	<hr/>
Total	\$ 100,810

Hydrologic monitoring in coal and oil shale resource areas of the Green River and Great Divide basins in Wyoming.

A. Location of study:

Green River and Great Divide basins of Wyoming.

B. Objectives:

1. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal and oil shale.
2. Determination of the physical effects of coal mining, land reclamation, and in situ oil shale retorting on surface runoff and ground-water recharge.
3. Determination of the chemical and biologic quality of surface water, in accordance with the attached table 1, and sediment transport in streams.

C. Procedure:

1. Operate nine streamflow and water-quality stations in areas of present or projected surface mining of coal or in situ retorting of oil shale in the Green River or Great Divide basins.
2. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.

- D. Report products.--Data from the Potter Mountain site are being analyzed. A report will be written to show the interactions of streamflow, chemical quality of water, sediment transport and biologic health of streams. The water-bearing properties of aquifer and the chemical quality of ground water will be described. Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded by the USGS.

E. Distribution of funds

<u>Item</u>	<u>Cost estimates</u>
Salaries	\$ 54,490
Travel	8,300
Supplies and equipment	8,040
Data processing	2,000
Rent, utilities, misc.	3,270
WOTSC	12,390
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Total	\$ 88,490

Hydrologic monitoring in coal resource areas of the Hanna Basin in Wyoming.

A. Location of study:

Hanna Basin in south-central Wyoming.

B. Objectives:

1. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal.
2. Determination of the physical effects of coal mining and land reclamation on surface runoff and ground-water recharge.
3. Determination of the chemical and biologic quality of surface and ground water, in accordance with the attached table 1 and sediment transport in streams.

C. Procedure:

1. Operate three streamflow and water-quality stations in areas of present or projected surface mining of coal in the Hanna basin in areas of coal mining in the Hanna basin.
2. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.

- D. Report products.--Analyze data and prepare progress reports as significant data become available. Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded by the USGS.

E. Distribution of funds

<u>Item</u>	<u>Cost Estimates</u>
Salaries	\$ 16,550
Travel	2,500
Supplies and equipment	2,440
Data processing	1,000
Rent, utilities, misc.	964
WOTSC	3,818
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Total	\$ 27,272

PUBLIC LANDS HYDROLOGY

1. Reconnaissance techniques for evaluation of reclamation potential of energy lands
 - A. Names and locations of studies (1) Beulah Trench near Beulah, North Dakota, (2) Hanging Woman Creek near Decker, Montana, (3) ~~White Tail Butte near Recluse, Wyoming~~, (4) Kimbeto Wash near Bloomfield, New Mexico.
 - B. Objectives and procedures

Vegetation and Soils

- 1) Vegetation-soils units within each of the four study areas will be identified and mapped using aerial photographs.
- 2) Native vegetation in each plant community will be identified and measured by the first contact-point method. Ground cover variables that will be measured include vegetation by species, mulch, rock and bare soil. The annual growth of vegetation will be clipped, dried and weighed to determine forage production.
- 3) Soils will be sampled in the fall and spring to coincide as near as possible with maximum wet and maximum dry conditions. These data are used to obtain estimates of water stored and evapotranspired.
- 4) Changes in bulk density of soil with depth and seasonally will be measured in order to compute quantities of moisture stored and subsequently dissipated and the degree of wetting normally achieved in each horizon.
- 5) Moisture retention capacity and the hydrologically-active depth of soils will be determined.
- 6) Salinity, pH, infiltration rate and detachability rate of soils will be determined.

Hydrology

- 1) Estimates of source-area sediment yield will be made using reconnaissance techniques that utilize measurements of drainage basin characteristics, and sediment accumulation in small reservoirs. Estimates of sediment yields from drainage basins will be made by applying a sediment delivery factor to the weighted average source-area sediment yield.
- 2) The Flaxman equation will be tested for its utility as a quantitative method for estimating the sediment yield of

basins that are 0.1 to 50 square miles in size. Use of the Universal Soil Loss Equation will be investigated for estimating soil loss from spoil slopes that are in various states of rehabilitation.

C. Report products

- 1) Vegetation and soils maps with interpretations to show pre-mining conditions and post-mining potential for rehabilitation.
- 2) Detachability and infiltration maps based on soils data and slope measurements for pre-mined conditions.
- 3) Source-area sediment yield maps that represent present conditions.
- 4) Recommendations will be made as to the type and optimum depth of soils and vegetation species for surface-mine rehabilitation as well as any mechanical land treatments that would promote the establishment and production of vegetation and minimize erosion.

D. Distribution of funds

<u>Item</u>	<u>Cost estimates</u>
Salaries, professional and technical assistance (field, office, and laboratory)	\$80,000
Travel	6,000
Vehicles	3,000
Supplies and equipment	1,000
Computer cost and data processing	1,000
Manuscript preparation	<u>4,000</u>
	\$95,000
WOTSC 17%	19,460
Administrative Services 3%	<u>3,000</u>
	\$117,460

E. Inspections of rehabilitation work will be done at the Navajo Mine, New Mexico, Big Horn Mine, Wyoming and the Knife River Mine, North Dakota to determine the effectiveness of the work with respect to revegetation and erosion and sediment control. The feasibility of a mutually beneficial study of vegetation, soil moisture and erosion on rehabilitated spoils will be explored with the personnel of one or two of these mines.

Distribution of funds

<u>Item</u>	<u>Cost estimates</u>
Salaries	\$ 4,450
Travel	1,500
Vehicles	750
Supplies and equipment	500
Data processing and computer costs	500
Manuscript preparation	<u>500</u>
	\$ 8,200
WOTSC 17%	1,680
Administrative Services	
3%	<u>250</u>
	\$10,130
New study areas	\$ 117,460
Studies of on-going reclamation	<u>10,130</u>
Total	\$127,590

WATER DATA ANALYSIS OF THE UPPER COLORADO RIVER BASIN

I. Introduction

The water of the Colorado River has become increasingly saline as water allocated to the states have been developed. This is from increased consumption and salts carried back to the streams through return flows. The specified period of record for analysis will be compared with results of previous studies and used to quantify present salt yields with particular emphasis on national resource lands. The analyzed results will be included in our salinity control feasibility report.

II. Objective

- A. Analyze flow data of stream gaging stations to determine most recent 10 year and 5 year annual average discharge, average monthly discharge and associated standard deviation, and variation or range of flow.
- B. Correlate total dissolved solids data (TDS) with specific conductance (EC) and discharge to determine total salt loading at each station. The flow weighted method will be used for the same period of record as shown above in A. Additional correlations may be required for TDS and discharge to estimate salt loading for water quality stations where daily EC is not recorded.
- C. Evaluate groundwater quality data with respect to geologic formation. Show water quality ranges of the individual formations and identify areas of potential water problems.

III. Procedures

A. Surface Water

The most recent 10 and 5 year periods of record will be analyzed using the USGS computer service programs. The analysis will determine the mean annual, mean monthly discharges and standard deviation. Correlations will be made between TDS, EC and discharge to determine the monthly, mean monthly, annual and mean annual flow weighted salt loadings as well as the associated standard deviation. The output will be presented in a downstream order and arranged by tributary where there is more than one station per tributary.

B. Groundwater

The groundwater analysis will correlate water salinity with the geologic formation which forms the aquifer. The mean, standard deviation and range will be determined from all sample locations

associated with a particular aquifer. Variation between samples from the same well or spring will be presented. The well locations will be plotted by latitude.

IV. Funding

The funds will be provided through 1260-1012-SS00, through the work agreement with the USGS Water Resources Division and BLM consummated with the EMRIA program. The following cost breakdown is provided.

Groundwater	\$ 700.00
Surface Water	<u>2,000.00</u>
Total	\$2,700.00

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