Rio Blanco Oil Shale Company

Tract C-a

ANNUAL PROGRESS REPORT

January 1982 — December 1982

Gulf Oil Corporation / Standard Oil Company (Indiana)
A General Partnership
2851 South Parker Road, Aurora, Colorado 80014

INDEX

RBOSC PROGRESS REPORT

JANUARY 1982 THROUGH DECEMBER 1982

SECTION I

INTRODUCTION AND SUMMARY

SECTION II

MINING

SECTION III

PROCESSING

SECTION IV

ORE STORAGE

SECTION V

SUPPORT FACILITIES

SECTION VI

ENVIRONMENTAL PROTECTION, HEALTH AND SAFETY

SECTION VII

SUMMARY - ENVIRONMENTAL ASSESSMENT AND MONITORING

SECTION 1

INTRODUCTION & SUMMARY

CHAPTER I

INTRODUCTION

1.1 ANNUAL PROGRESS REPORT REQUIREMENT

The requirement to submit an Annual Progress Report (APR) on each anniversary date of the lease following approval of a development plan is contained in Section 1(c) (4) of the Environmental Stipulations to the Federal Oil Shale Lease (Serial No. C-20046) under which the Rio Blanco Oil Shale Company (RBOSC) is operating. Gulf Oil Corporation and Standard Oil Company (Indiana) formed RBOSC as a general partnership to develop Tract C-a with the intention of engaging in the commercial production of oil shale. The legal description of Tract C-a, as defined in the Lease is:

<u>TIS., R.99W., 6th P.M.</u>
Sec. 32: E1/2, E1/2W1/2
Sec. 33: All
Sec. 34: W1/2, SE1/4, W1/2NE1/4, SE1/4NE1/4

<u>T.2S.,R.99W., 6th P.M.</u>
Sec. 3: All
Sec. 4: All
Sec. 5: E1/2, E1/2W1/2 (incl. Lots 1, 2 and 3)
Sec. 8: E1/2
Sec. 9: All
Sec. 10: All
situated in the County of Rio Blanco, State of Colorado containing 5,089.70 acres, more or less.

This APR describes the operational programs on Federal Tract C-a from January 1, 1982 through December 31, 1982. An environmental monitoring report is being submitted separately for the calendar year for air quality, meteorology, biological, and hydrologic data. Since this APR is defined to include a report of the monitoring programs, Section VII of this report contains a concise summary of the environmental programs for 1982.

Approval to develop Tract C-a was received by RBOSC on September 22, 1977. The reports which described operations from that date through the end of 1978, 1979, 1980, and 1981 were submitted to the Deputy Conservation Manager - Oil Shale (DCM-OS) in Grand Junction, Colorado in April of 1979, 1980, 1981 and 1982 respectively. They also contained a summary of environmental assessment and monitoring for the periods covered (originally, seasonal years were covered; these were later changed to calendar years).

The information and background material contained in the previous reports are not included in this report. The previous reports were distributed by the Oil Shale Office (OSO) to many Federal, State, and local agencies, libraries and private industry. It is on open file in many public places for reference and should be referred to for operational and monitoring information prior to 1982.

1.2 ANNUAL PROGRESS REPORT ORGANIZATION AND USE

RBOSC's APR is written and organized to closely follow the organization of the first APR which in turn corresponded to the organization of the Detailed Developed Plan (DDP) of May 1977. All major section titles of the APR are the same as the DDP except Section 7 which combines Section 7 and 8 of the DDP. By referencing the section number and title, the reader can refer to the previous APR or the DDP for additional information on the subject being addressed. Chapter titles have been utilized only as they pertain to the work being done during the report year, so they may vary from the previous APR or DDP.

A three-digit page numbering system is used throughout the APR. Page numbers are keyed to the chapters within the section; page 5-3-4, for example, refers to Section 5, Chapter 3, page 4. A similar system is used for figure and table numbers.

CHAPTER 2

EXECUTIVE SUMMARY AND PROJECT OVERVIEW

2.1 PROJECT BACKGROUND

The Department of the Interior (DOI), early in the process of developing the prototype program and evaluating lease tracts, identified the potential for open pit mining and attendant high resource recovery for Tract C-a along with the need for off-tract disposal. The Draft Environmental Statement for the program published in September 1972, and the Final Environmental Statement for the program, published in August 1973 discussed these subjects. The "Notice of Sale" for competitive bidding for lease of six tracts under the program, published in the Federal Register on November 30, 1973, further recognized the need for off-tract lands for disposal. It withdrew from all forms of appropriation certain lands in the vicinity of the lease tracts, and cited authority under section 101 of the Public Land Administration Act to provide off-tract lands in connection with disposal of spent shale.

Therefore, at the time of sale of Tract C-a in February 1974, all parties were on notice that the Department favored open pit development of Tract C-a for the high resource recovery possible. It was recognized that off-tract lands were needed for disposal and that the DOI had represented it would make off-tract lands available under statutes other than the Mineral Leasing Act, particularly the Public Land Administration Act.

Following the lease sale in February 1974, RBOSC commenced an environmental program and engineering design work in accordance with the terms of the lease. After its engineering studies confirmed the need for off-tract land for disposal and other non-mining needs, the lessees applied to BLM for off-tract lands in December 1974 and January 1975. In March 1976, in accordance with lease terms, the lessees submitted a Detailed Development

Plan which set out the details of open pit mining of Tract C-a and identified a specific parcel of land for off-tract disposal of waste.

The Department of the Interior, prior to the lease sale, had represented that it could and would make lands available for off-tract disposal. In February 1975 following a review of its authority to grant off-tract leases, the Department stated that it had no authority to grant rights to dispose of spent oil shale on Federal land other than that subject to an oil shale lease. Bills to authorize the issuance of off-tract leases for disposal of waste were introduced in both Houses of Congress in 1975 and several times since. None of those bills had been enacted into law through mid-1982.

In September 1976, RBOSC was granted a one-year suspension of operations in part because of the Department's lack of authority to lease lands for off-tract disposal. During the suspension, RBOSC was faced with three choices: (1) relinquishing the lease; (2) indefinitely delaying development by open pit methods until off-tract authority could be obtained, thereby risking loss of incentives and incurring bonus and royalty costs without any attendant development progress; or (3) submitting a development plan which did not require off-tract land. In May 1977, a revised Detailed Development Plan to demonstrate a Modified In Situ (MIS) method for developing Tract C-a was submitted. The method was theoretically able to recover more shale oil from the tract than conventional underground room-and-pillar methods. Modified In Situ, like underground room-and-pillar methods, did not require off-tract lands.

The plan was approved and the suspension terminated in September of 1977. Since that time, RBOSC spent almost five years testing the MIS methods on the thick oil shale beds of the tract. Although technically successful, the tests indicate that only one-third as much oil would be recovered from the tract by MIS as by open pit mining and surface retorting with off-tract waste disposal. Earlier studies had shown that only one-fifth as much oil can be recovered from the tract by room-and-pillar mining and surface retorting compared to open pit mining with surface retorting.

2.2 1982 TRACT C-a LEASE SUSPENSION

On June 16, 1982, RBOSC applied for a Suspension of Operations and Production, continued suspension of minimum royalty payments for five years after termination of the Suspension of Operations and Production, a modification of the due diligence requirements during any suspension of minimum royalty payments, and an extension of the primary term of the Oil Shale Lease to 25 years. The request was granted in July, 1982 and became effective on August 1, 1982. The Suspension of Operations and Production will remain in effect until RBOSC secures a Federal surface lease for off-tract disposal of spent shale and plant siting needed to develop Tract C-a or until July 31, 1987, whichever occurs first.

The Mineral Leasing Act of 1920 and Sections 1(d) and 22 of the Oil Shale Lease established the authority for the Department of the Interior to grant RBOSC's request. The basis for the request was, among other things, the lack of authority in the Department of the Interior to issue off-tract leases for placement of overburden and spent shale. It was also based on the fact that off-tract disposal of spent shale would allow the greatest ultimate recovery of the oil shale resource at Tract C-a, and thereby conserve natural resources.

To August 1, 1982, RBOSC had spent a total of $330 million for lease acquisition and development. Of this amount, $126 million was paid to the Government for the first three bonus bid installments, and $204 million was spent on lease development. Of the $204 million spent on development, approximately $84 million was used as an offset against the last two bonus payments. Some of the remaining $120 million was and will be used as an offset against minimum royalty payments due in the sixth through the tenth lease years. The MIS component of leasehold development had cost about $132 million to August 1, 1982.

In December, 1982 U.S. Senator Armstrong (R-Colo) offered an amendment to the Mineral Leasing Act authorizing the Secretary of the Interior to lease 6400 acres to RBOSC for plant siting and spent shale disposal, all of which are necessary to support open pit mining of Tract C-a. This leasing provision was attached to the Interior Department Fiscal 1983 Appropriation Bill and survived a joint conference of the Senate and House during the lame duck session of Congress. The bill, PL 97-394, was signed by the President on December 30, 1982. However, RBOSC's Suspension of Operations and Production remains in effect until it secures the off-tract lease.

2.3 DESCRIPTION AND SCHEDULE OF PROJECT

A. Amendment to the DDP - Prior to obtaining the Tract C-a lease suspension, RBOSC submitted to the Oil Shale Office in May 1982 an Amendment to the Detailed Development Plan. This amendment, approved in June, covered RBOSC's plans for mining and maintenance at Tract C-a and its Commercial Development Program consistent with lease requirements for efforts leading to orderly development of the oil shale resources.

The mining and maintenance section discussed the wind-down of the MIS demonstration program which was completed by RBOSC in December, 1981. The Commercial Development Program described the planning for an open pit operation on Tract C-a with surface retorting and off-tract disposal. Major activities within the Commercial Development Program are directed to identify and reduce areas of technological, environmental, operational and economic risk. Some of the activities in the Commercial Development Program are occurring at various locations other than Tract C-a. These activities are being carried out under RBOSC direction and control, and as such, remain exclusively an RBOSC activity.

B. Commercial Development Program - During 1982 and continuing into 1983, RBOSC's commercial development engineering program consisted of conceptual studies based on existing data. However, there are technical, economic and off-tract land questions that must be resolved before RBOSC can proceed to final design and a commercial decision. To answer technical uncertainties, RBOSC established a data acquisition program composed of the following:

- o a research and development program,
- o construction and operation of a Process Development Unit (PDU) based on Lurgi retorting technology,
- o evaluation of the need for planning and performing larger scale retort testing.

RBOSC began preparing a reference conceptual design to preliminarily define the project. As data are developed from the R&D program, pilot plant operation, and any larger scale testing, they will be incorporated in the conceptual design.

1. Research and Development Program - RBOSC's ongoing R&D program is designed to support the development engineering program and detailed design of a first commercial increment at Tract C-a. The major areas under study are retorting, upgrading, process support, and environmental research. Retorting research includes projects applicable to the Lurgi as well as other retorts. The objective of the upgrading R&D is to determine the most effective methods of producing a refinery-acceptable syncrude from raw shale oil. Shale oil from various sources will be used for testing until Lurgi shale oil becomes available from the PDU. Process support includes studies on toxicology, water, and solid waste. Environmental research focuses on reclamation and wildlife habitat restoration and enhancement.

2. Lurgi Process Development Unit (PDU) - RBOSC is constructing a Lurgi PDU at the Gulf Research Center in Harmarville, Pennsylvania. The overall objective of the PDU is to provide key process information and to confirm a design basis prior to detailed design and construction of a demonstration plant and/or first commercial increment of production. This

project is intended to reduce risks and improve the eventual profitability of a shale oil commercialization effort. Construction of the PDU began in the fall of 1981 and operations are scheduled to begin in mid-1983. RBOSC acquired the feed shale supply from Tract C-a during 1982.

3. Larger Scale Retort Testing - RBOSC is investigating the necessity of demonstrating basic process operability and equipment workability on a larger scale than the PDU in Harmarville. As part of this investigation, RBOSC is evaluating alternatives ranging from the construction or use of smaller size demonstration units at other locations, to constructing a demonstration unit on Tract C-a which can eventually be incorporated into the first commercial increment of operation.

C. Conceptual Engineering - 1982-1983 - During 1982 and continuing into 1983, RBOSC's development engineering program must be based on existing data. As new data are obtained from research, the PDU runs, vendor tests, and larger scale demo runs (if planned), the data will be incorporated into the conceptual design.

In 1982, RBOSC established a reference case design and order-of-magnitude cost estimate to preliminarily define the project in the areas of processing, mining, and water-related issues. Specific engineering tasks will subsequently be performed to reduce technical uncertainties in all major areas. However, conceptual design in the mining area can proceed only to a certain point at which time the need to have a lease for off-tract land in-hand becomes imperative.

D. RBOSC Development Schedule - Figures 1-2-1, 1-2-2, and 1-2-3 represent RBOSC's development schedule for Tract C-a operations, commercial engineering program data acquisition, and commercial engineering program engineering design. The latter schedule (Figure 1-2-3) shows a break of activity timelines; the commencement and completion dates of these

RBOSC TRACT C-a OPERATIONS, DECEMBER 1982

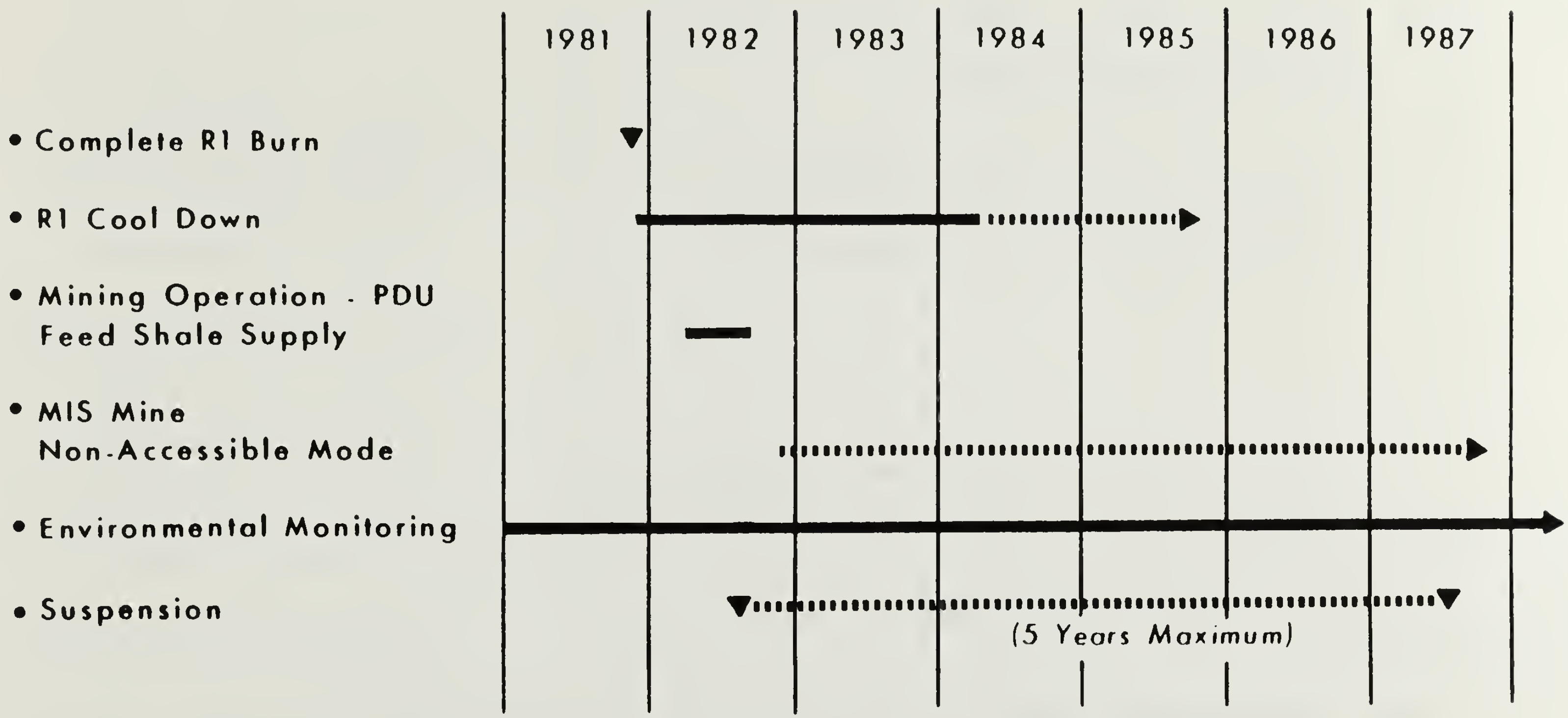

Figure 1-2-1

RBOSC COMMERCIAL ENGINEERING DATA ACQUISITION PROGRAM, DECEMBER 1982

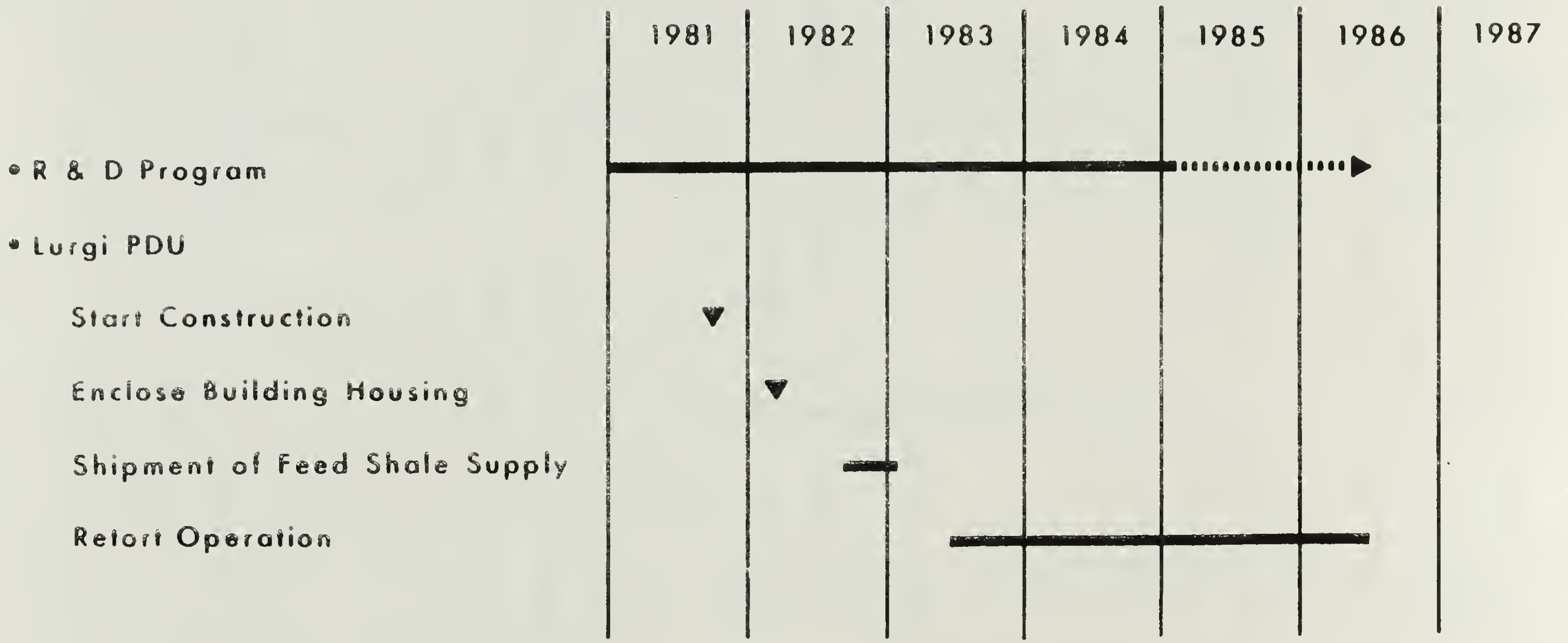

Figure 1-2-2

RBOSC COMMERCIAL ENGINEERING DESIGN PROGRAM, DECEMBER 1982

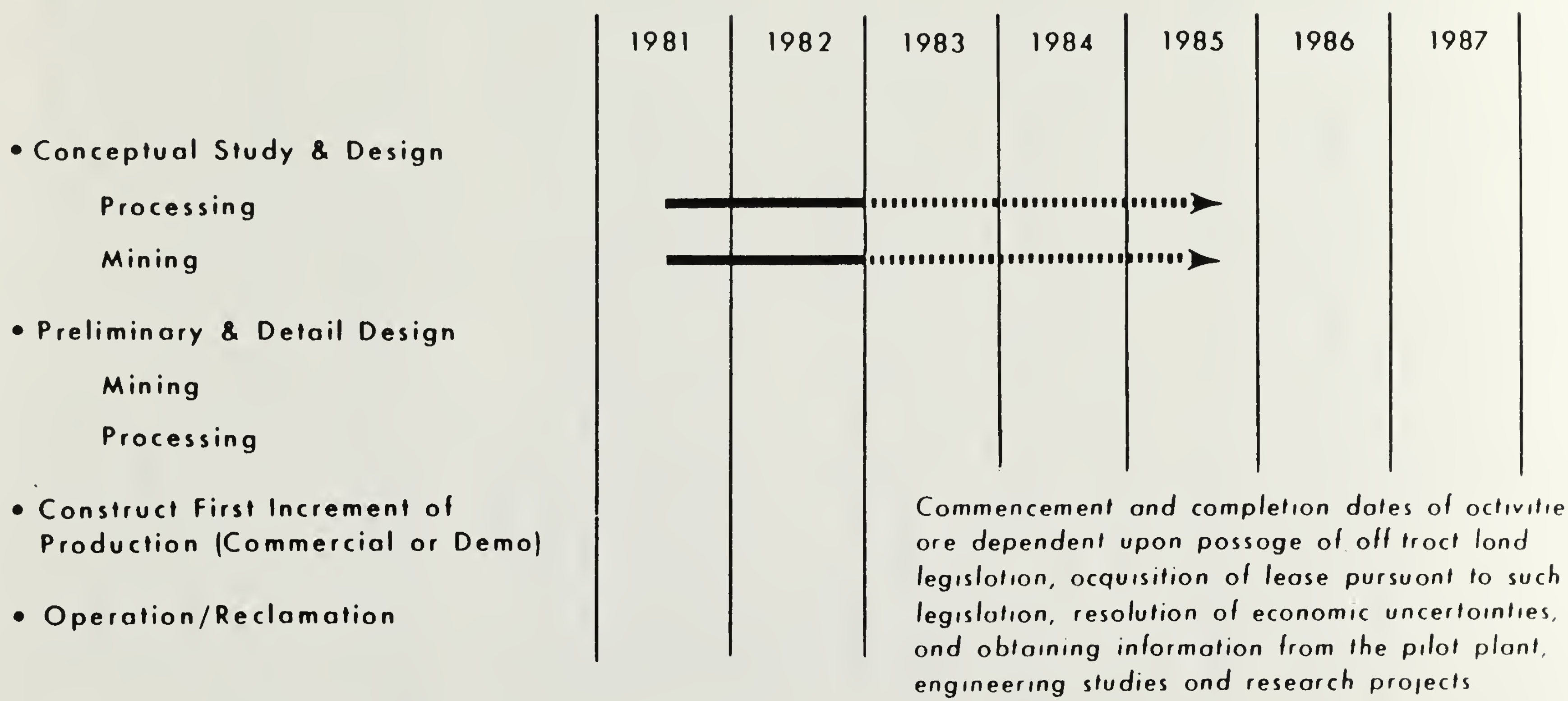

Figure 1-2-3

activities are dependent upon acquisition of an off-tract lease, obtaining information from the pilot plant, engineering studies and research projects, and resolution of economic uncertainties.

2.4 TRACT ACTIVITIES SUMMARY -- JANUARY 1982 THROUGH DECEMBER 1982

After completion of the MIS demonstration program in December 1981, RBOSC's 1982 activities focused on reducing operations and staff prior to obtaining a lease suspension. The general areas of operations included:

- Processing
  - Retort cooldown
  - Decommissioning of surface processing facilities
  - Sale of MIS oil
- Mining
  - Maintenance mode
  - PDU sample mining
  - Removal of mine equipment to the surface
  - Non-accessible standby mode
  - Mine dewatering
  - Sale of equipment
- Support Facilities
  - Consolidation and Decomissioning

In the processing area, the cooling of Retort 1 proceeded throughout 1982. Towards the end of the year, several pump failures in the mine dewatering system caused partial flooding of the retort, resulting in total quenching of the lower part of the retort. The processing equipment located on the surface was inspected during the early part of the year and decomissioned. In addition, approximately 19,000 barrels of MIS oil which were stored in two large storage tanks on-tract, were sold.

In the mining area, the mine was put in a maintenance mode for several months at the beginning of 1982 when no mining operations were occurring. During that time, preparation was begun for mining a bulk sample of feed shale for the Lurgi PDU being being built in Harmarville, PA. Approximately 5000 tons were mined from "C" Level to get samples of specific grades of ore (Figure 1-2-4). The material was crushed at the tract, bagged, and a portion of it was shipped to the PDU.

After mining was completed, the mobile mining equipment, pumps, electrical switchgear, monitoring devices and supplies were removed to the surface and the mine placed in a non-accessible standby mode. In this mode, the service-production shaft collar doors were closed, the main fan was shut off, and a small fan was installed to provide minimal circulation to prevent methane build-up.

To accomplish mine drainage during the non-accessible mode, the underground pumps were removed and replaced with a large capacity submersible pump in late August. After two months of operations, several successive pump failures caused partial mine flooding. The single large submersible pump was replaced with three smaller submersible pumps which have worked satisfactorily since then.

Environmental monitoring continued throughout the year in accordance with the approved Scope of Work. The scope was reduced during the year commensurate with reduced activities at the tract and the lease suspension. In general, the following studies were done:

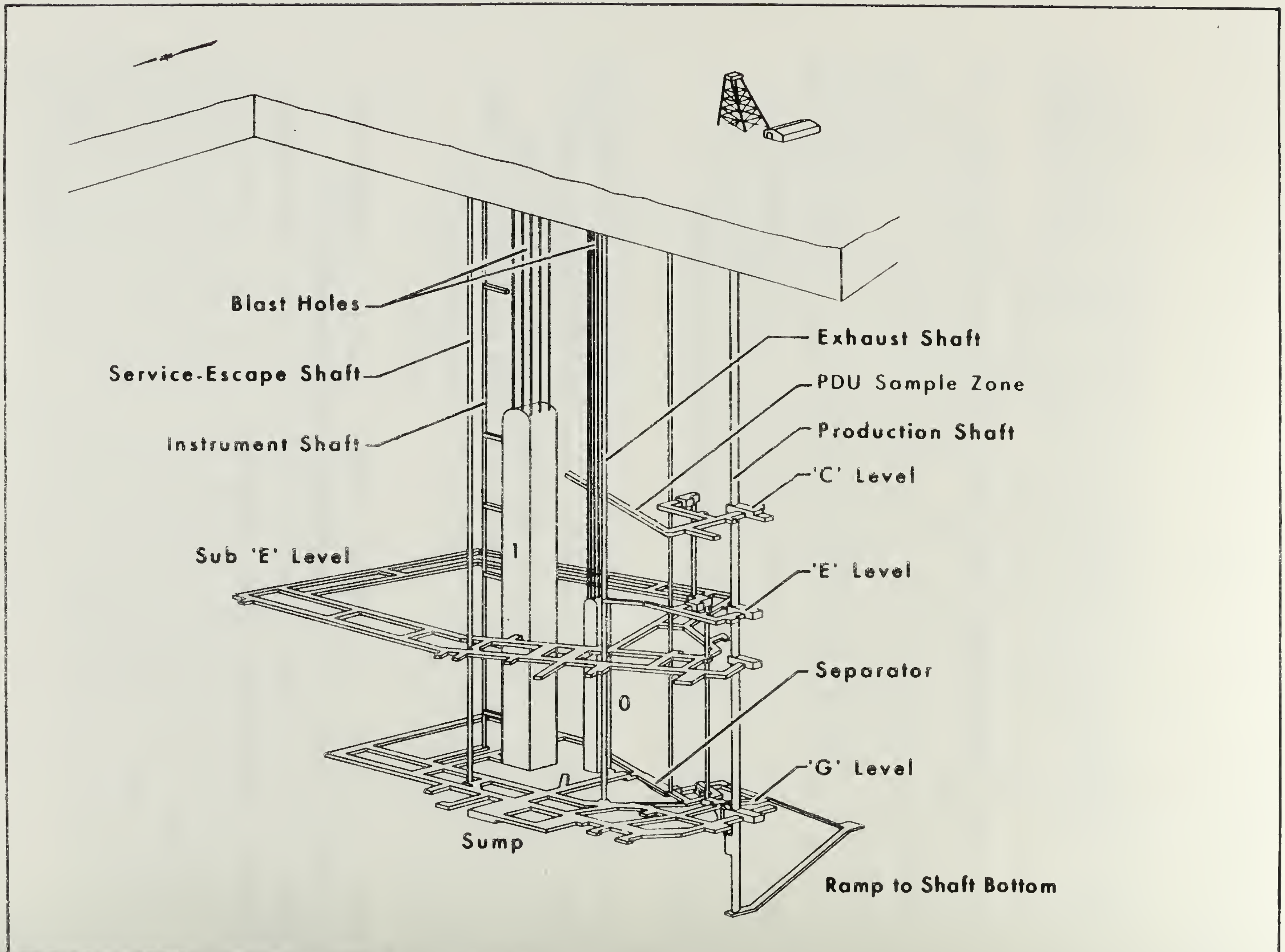

Figure 1-2-4. Mine and Retort Development Plan and PDU Sample Zone.

- Air Studies - meteorology, air quality, visibility

- Terrestrial Ecology - mule deer abundance, feral horse abundance, mule deer road kills, vegetation mapping/stress, range productivity and utilization, browse condition and utilization, reclamation success

- Aquatic Ecology - flow, water quality, benthic organisms, periphyton

- Hydrology - surface water flow and water quality, groundwater levels and water quality, operations monitoring (ponds, reinjection system, etc.), erosion monitoring

As tract activities decreased, the number of personnel was accordingly decreased. In early 1982, RBOSC personnel assumed the project administration functions from Morrison-Knudsen, Tract C-a managing contractor. Eventually, most records were transferred to RBOSC's home office in Aurora, Colorado. At the start of the year, RBOSC had 22 employees at the Tract for management, planning, environmental monitoring, and process supervision. By year end, the RBOSC staff had been reduced to four employees: one Tract Supervisor and three in the environmental area. The Morrison-Knudsen function was reduced from 22 to 0. Mine, Shaft & Tunnel, which provided mine supervision and labor, was reduced from 22 employees in January to 0 when the mine was placed in a non-accessible mode. During the mining of the PDU ore in the spring and summer, 12 employees were required. The Industrial Company (TIC) provided process craft labor, services, and surface construction during 1982. Their employment was reduced from 60 at the beginning of the year to 14 at year end. These 14 workers are responsible for maintenance, housekeeping and health and safety operations at the tract during the suspension.

During 1982, all remaining hazardous waste on-tract was removed.

The following figures show the configuration at the tract at the start of the year:

- o Figure 1-2-5 — Tract C-a Plot Plan
- o Figure 1-2-6 — MIS Construction Area, January 1982
- o Figure 1-2-7 — MIS Processing Facility Plot Plan

No additional construction occurred during 1982 so at year end, Figure 1-2-5 remained unchanged.

Referring to Figure 1-2-6, MIS Construction Area, the only active areas at year end were as follows:

- o Mine Rescue Building - this building has replaced the Administration Building for housing the 18 people at the tract.
- o West Retention Pond - used to hold dewatering water prior to reinjection.
- o Firewater Pump House and Water Treatment Building - used to support water reinjection.
- o ROM Storage Area - the bagged, crushed shale mined for the Lurgi PDU, that has not been shipped yet, is stored in this area.
- o Scrubber Blowdown Ponds - the sour water still being produced by water seepage into the retort area is pumped to these ponds for evaporation.

The dewatering wells, shown as D-1 through D-7 were not in use anytime in 1982; other wells served the purpose.

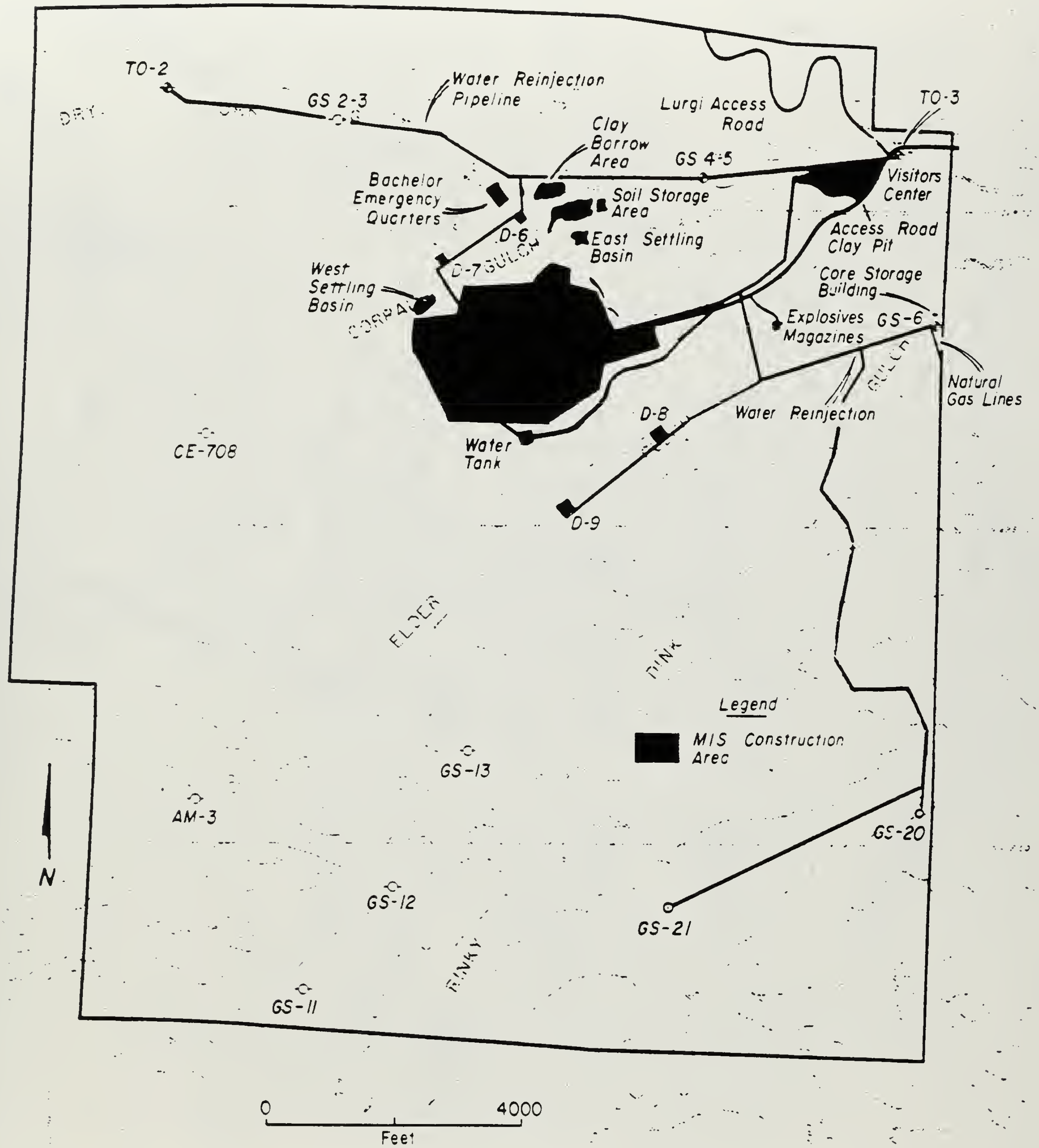

Figure 1-2-5. Tract C-a Plot Plan

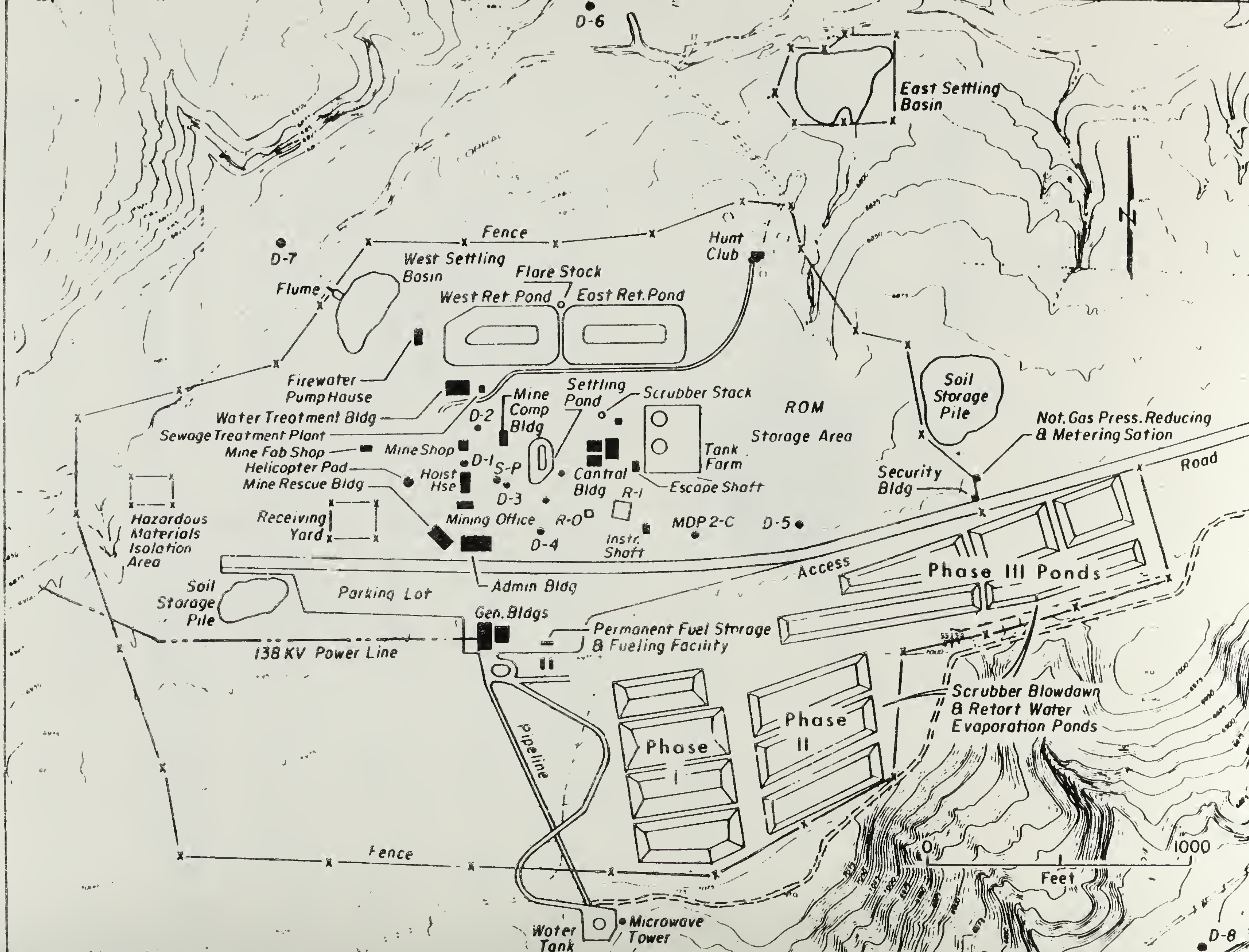

Figure 1-2-6. MIS Construction Area, January 1982

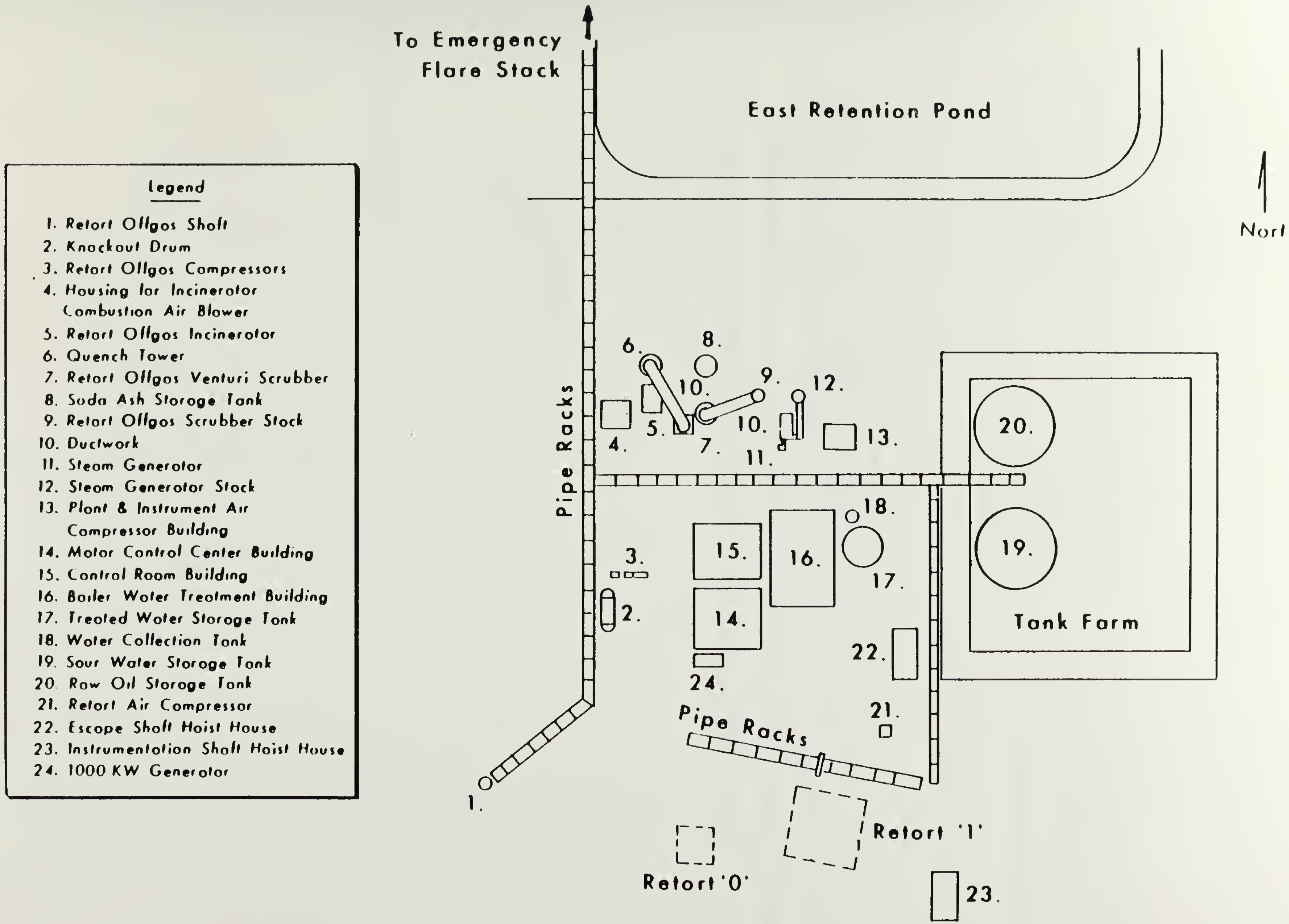

Figure 1-2-7. MIS Processing Plot Plan

In the processing facility, shown on Figure 1-2-7, the only area still being used at the end of the year is a shop that is located near the Plant and Instrument Air Compressor Building (No. 13). All other facilities have been decommissioned.

2.5 SOCIOECONOMIC ACTIVITIES

The community relations office in Meeker was closed after the suspension was granted. As the employee count dropped during the year, the bus to Rifle was terminated and the use of vans initiated. Rio Blanco County has roughed out the road to Rangely, but the road has not been graveled or paved. Funds for this construction were provided from the Oil Shale Trust Fund.

2.6 FINANCIAL INFORMATION

The 1982 summary of expenditures by RBOSC on Tract C-a are as follows:

SUMMARY OF COST 1982
($000)

MIS Development (January, 1982)	632
TRACT MAINTENANCE (FEBRUARY - DECEMBER, 1982)	
General Administrative	731
Mine Operations	491
Process Operations	104
Service Operations	798
Electric Power	639
Fuel Gas	108
Environmental	251
Mine Abandonment	236
Pump Operations	260
Other	47
Total Tract Maintenance	3,665
TOTAL C-a PROJECT	$4,297

SECTION II

MINING

INTRODUCTION

In 1982, the MDP mine produced about 5000 tons of oil shale for the Lurgi Process Development Unit at Harmarville, PA before being placed on inaccessible standby status. All mobile equipment, monitoring devices, electrical switchgear, supplies and pumps were removed from the mine. Deepwell submersible pumps were installed in the mine and retort areas to control the respective water levels.

2.1 MINE ACTIVITIES SUMMARY

Following completion of the MIS retort burns in December 1981, the level of mining activity dropped significantly. A major sample mining program was instituted on C level to provide feed for the Lurgi PDU. Upon completion of the sample mining program, the mine was placed on inaccessible standby status after all equipment was removed to the surface. Separate deepwell submersible pumps were in the mine and retort systems to control the respective water levels. Frequent failures of the mine water pump resulted in severe mine flooding before the pump problems were resolved by replacing the large pump with three smaller pumps. At the end of 1982, the mine water level was at 6200-foot elevation which is 122 feet above the G level station. The water level in the retort was 6195-foot elevation. Under these conditions, any leakage between the mine and the retorts will be from the mine into the retorts, thereby preserving the mine water quality.

The mining group worked the entire year, 24,969 manhours, without a lost time accident. In October the mine was officially shut down and four of the mine crew became part of the 14-person multicraft caretaker force.

Table 2-2-1 is a summary of the 1982 mining milestones. A summary of material mined for the entire MIS program is shown in Table 2-2-2.

Table 2-2-1

1982 MINING MILESTONES

	Start	Completion
PDU Sample Mining	March, 1982	August, 1982
Underground Equipment Removal	June, 1982	September, 1982
Submersible Pump Installation	July, 1982	August, 1982
Submersible Pump Problems	September, 1982	November, 1982
Surplus Equipment Disposal	October, 1982	Ongoing

Table 2-2-2

Material Mined- Total Project

	1978	1979	1980	1981	1982	Total
Shafts & Ore Passes	11400	7250	8350	-	-	27,000
C Level	8040	-	-	-	-	8,040
E Level	4330	1700	220	-	-	6,250
Sub E Level	-	-	38440	-	-	38,440
G Level		13100	42600	-	-	55,700
Retort 0 Rubble	-		1860	-	-	1,860
Retort 1 Rubble	-	-	30060	-	-	30,060
Instrument Station	-	-	3520	-	-	3,520
Samples	-	-	425	350	5,000	5,775
Total	23770	22050	125475	350	5,000	176,645

A. PDU Sample Mining - A small mining program was completed on C level to provide oil shale for the Lurgi PDU at Harmarville, PA.

1. Sample Mining - An inclined drift 426 feet long was driven at 15 percent slope from C level up through the Mahogany marker to obtain a bulk sample for feed to the PDU. Two short crosscuts, 17 and 100 feet long, were also driven to get larger samples of specific grades of ore. Approximately 5000 tons were mined during this program.

2. Sample Preparation - Each blast round was kept separate so that the ore grade could be maintained. All of the material was crushed to minus 6 inch size using a feeder breaker. Eight hundred ninty-seven 1.5-ton polypropylene bags were filled with crushed shale for future shipment to the PDU. One hundred seventy eight bags were shipped during the year.

B. Support Operations

1. Ventilation - The mine ventilation system was maintained in its normal configuration until all equipment had been removed from the mine. At that time the Service Production (S/P) shaft collar doors were closed, the main fan was shut off and a 20-hp fan was installed to blow air down the S/P shaft and provide minimal circulation through the mine. The vent shaft and the Service Escape (S/E) shafts are both exhausting at this time. All underground workings were left in a manner that would allow air flow to and from all areas. The current drift and ventilation layouts for G, Sub E, E and C Levels are shown in Figures 2-2-1, 2-2-2, 2-2-3, and 2-2-4 respectively (also refer to Figure 1-2-4).

The mine was operated in accordance with MSHA gassy mine regulations until it was placed in an inaccessible standby status. All required checks for CH_4, H_2S and CO were made each working shift in the working places. No problems were encountered during the year. The exhaust air at the S/E shaft was checked on a weekly basis for CH_4 and H_2S.

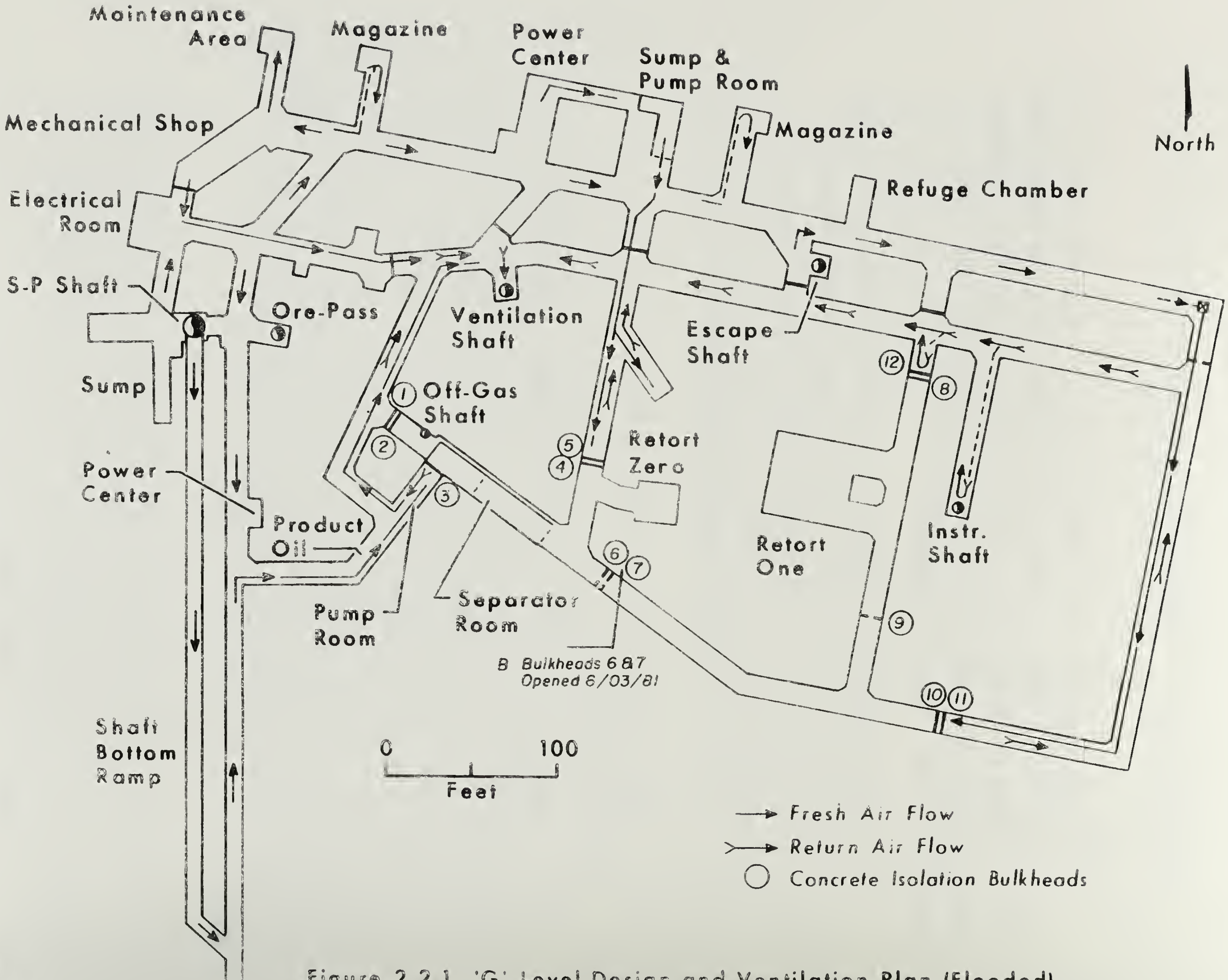

Figure 2-2-1. 'G' Level Design and Ventilation Plan (Flooded)

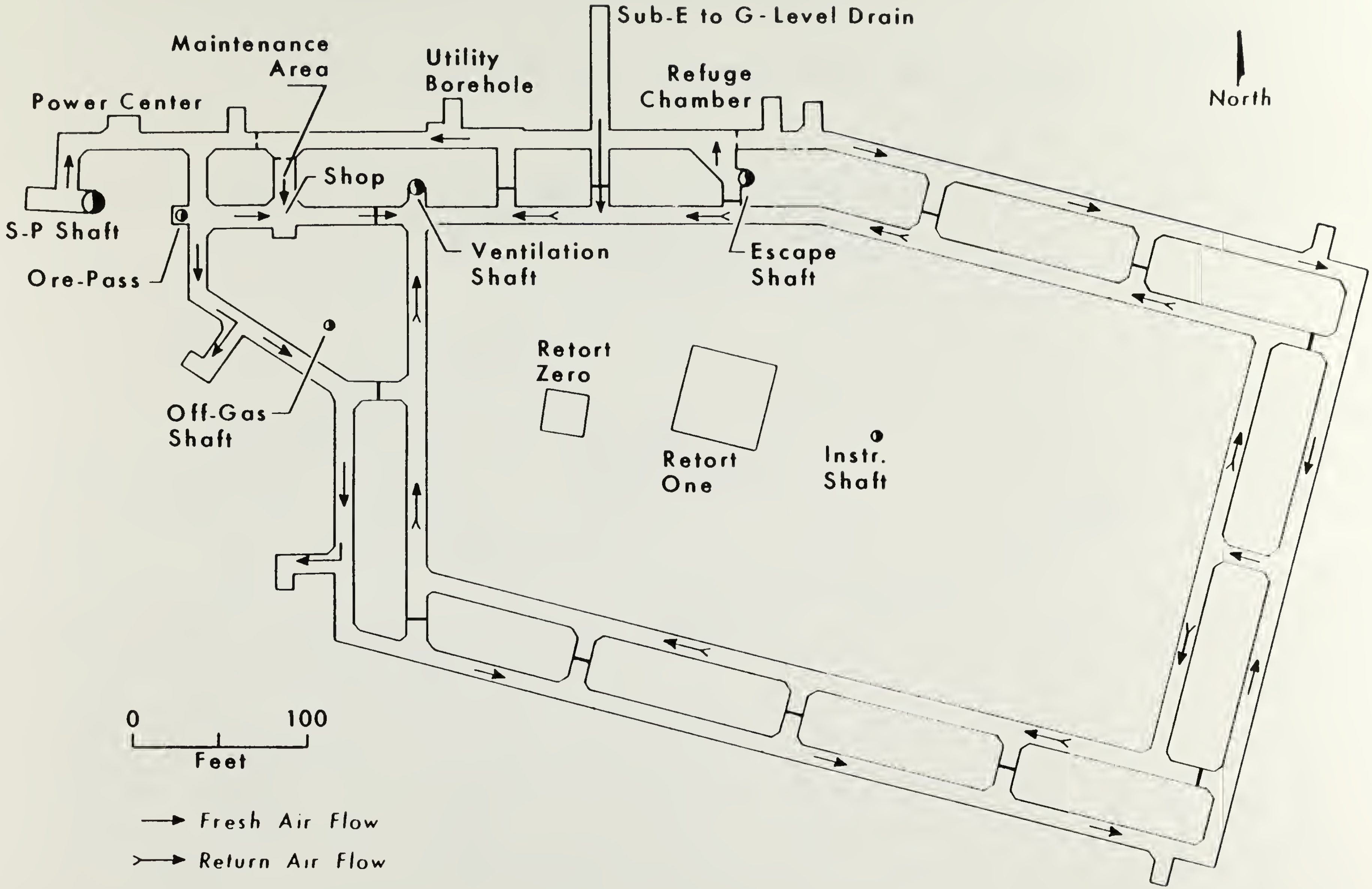

Figure 2-2-2. Sub 'E' Level Design and Ventilation Plan (Inactive)

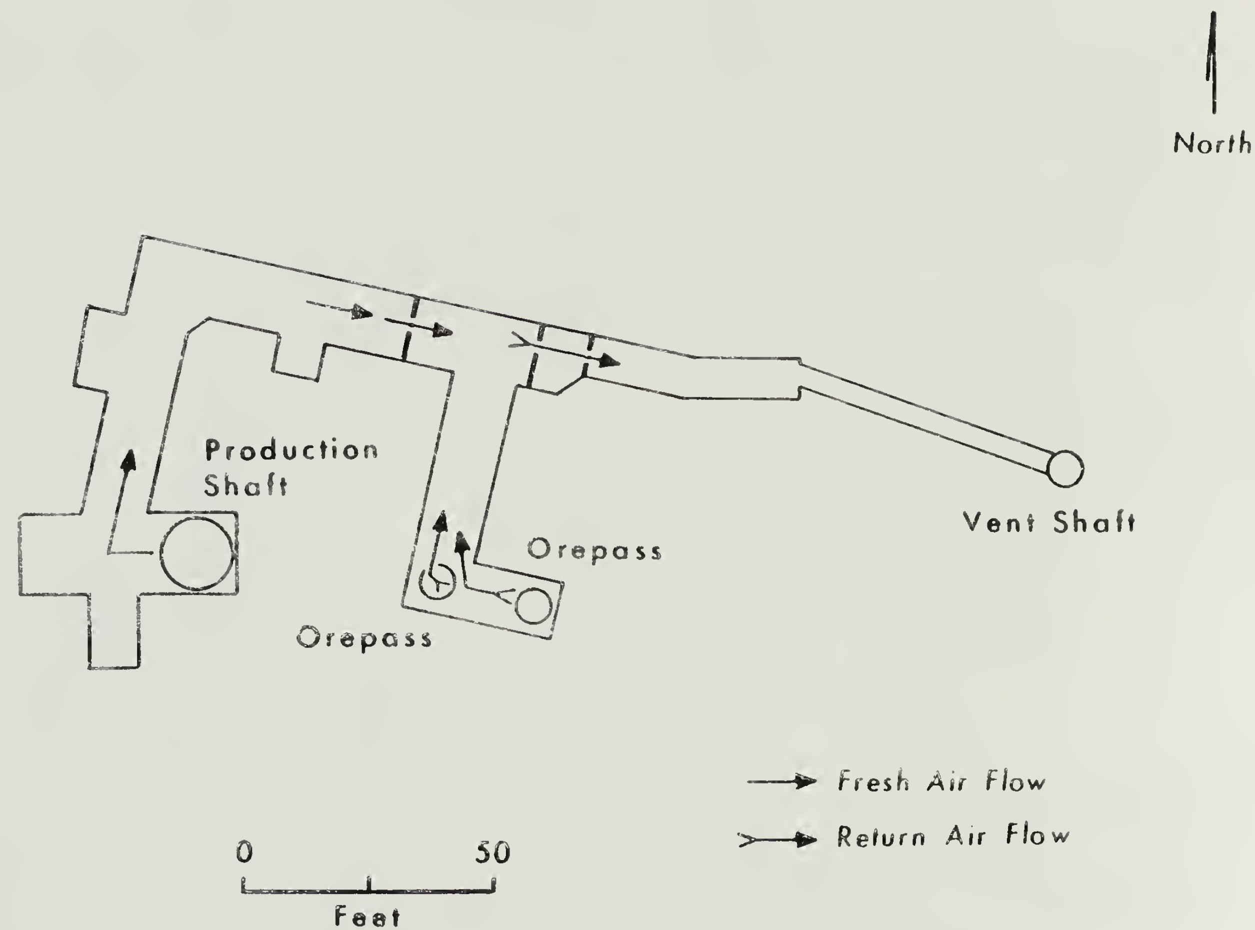

Figure 2-2-3. 'E' Level Design and Ventilation Plan (Inactive)

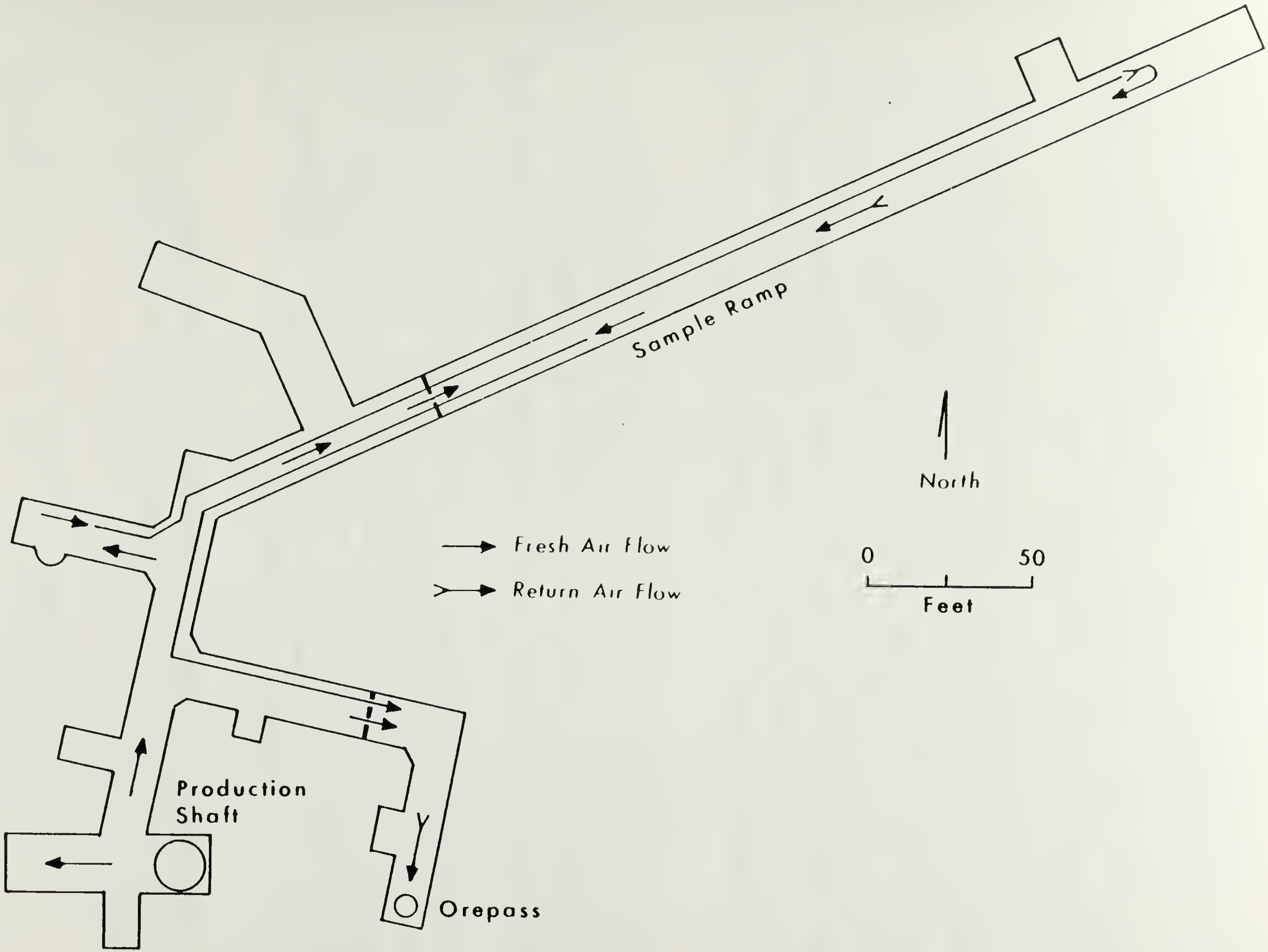

Figure 2-2-4. 'C' Level Design and Ventilation Plan (Inactive)

2. Ground Control - Split set bolts and mats were used for the C Level sample mining program. Some roof problems were encountered in the lower crosscut where the crosscut alignment corresponded to the strike of the locally closely spaced joints in the roof and ribs. The problem was overcome by changing the direction of the drift.

3. Mine Drainage - Mine water inflow fluctuated from 1100 gpm in January to 1200 gpm during March and April before stabilizing at 1040 gpm during July and August. In late August, a 1250-gpm deep well submersible pump was installed in the S/P shaft and the underground pumps were removed. The mine was then allowed to flood to an elevation of 6070 feet which is about 8 feet below G Level. Inflow decreased to about 900 gpm by the end of the year. Severe pump problems in September and October resulted in additional mine flooding. This is discussed in part D.1 of this chapter.

4. Mine Power - All electrical switchgear and power centers were removed from the mine. A bank of three 4160v/2300v transformers was installed at the S/P shaft to provde power for the mine dewatering pump. A similar installation was made at the S/E shaft for the mine dewatering pumps in that area. Both of the surface standby generators are operational.

C. Mine Equipment Withdrawal - All mining equipment, pumps, electrical gear, fans and supplies were removed from the mine. All power lines and piping were left in place. All of the larger equipment was hoisted up the vent shaft using a 200-ton crane. The S/E headframe was removed to accomodate one of the submersible mine dewatering pumps. The S/P hoist, headframe and conveyances are still operable.

D. Mine Dewatering Program - A system to control water levels in the mine and retort systems during the inaccessible standby mode of operations was installed in August.

1. Mine Dewatering System - The initial system for mine dewatering included a 14-inch diameter well casing in the S/P shaft that extended from the shaft collar to within 10 feet of the shaft bottom. A 1250-gpm Reda

400-hp submersible pump was installed inside the 14-inch well casing. The intent was to maintain a mine water elevation of 6070 which is 8 feet below the G Level station by continuous pump operation in a throttled mode. In two months of operation, 4 motor failures and 2 pump/protectors failures resulted in the mine being flooded to an elevation of 6361 feet which was 283 feet above G Level. The single large pump was replaced in November with three 500-gpm Centrilift 180-hp submersible pumps. One of the small pumps was placed in the 14-inch casing in the S/P shaft. Another was set in the 8 5/8-inch cased borehole into the mine refuge chambers. The third pump was shrouded and hung in the S/E shaft. Since the latter two pumps are just above G Level, it is not possible to maintain the original water level. The water level at the end of the year was being held at 6200 foot elevation, which is 122 feet above G Level. The daily average pumping rate was fluctuating around 900 gpm at year's end. Once the water level stabilized, one of the 180-hp pumps was shut down and is being used as a spare. The mine water level is monitored by electrical sensors.

2. Retort Water Pumping - Initially, a single 60-gpm Reda 35-hp pump was placed in a 6-inch wellcasing installed in the S/P shaft. The 6-inch well casing was connected to a 6-inch line that extends from the bottom of the S/P shaft up the shaft bottom ramp, through the product pump room and through bulkhead #3 into the retort separator room. Since the retort inflow rate is about 10 gpm, the level was allowed to rise to within 2 feet of the mine water level and then the pump was operated until the level dropped about four feet. By maintaining the mine water level slightly higher than the retort, it is possible to minimize leakage between the two systems and also to assure that any leakage would be from the mine into the retort. In this manner, the mine water quality is maintained.

The failure of the mine dewatering pump and subsequent flooding also caused the water level in the retort to rise to an elevation of 6262 feet which is 184 feet above G Level. Insufficient evaporation pond capacity prevented pumping to keep the retort water at its original level. During this time another 35-hp Reda pump was installed for backup in a 6 1/2-inch cased borehole which intersects the retort product collection drift.

At the end of the year the retort water level was being held between 6190 and 6195 foot elevation. Pumping is done using either or both pumps on an as-needed basis.

E. Surplus Underground Mining Equipment Disposal - A program to dispose of underground mining equipment deemed to be surplus was implemented in October, 1982. Sales were based on an as the opportunity presents itself basis, rather than by immediate liquidation by auction.

SECTION III

PROCESSING

1.1 INTRODUCTION

Retort 1 operation was terminated in late December, 1981. Processing activities in 1982 consisted of completing the shutdown and mothballing of the process facilities, monitoring underground temperatures, pumping sour water to the evaporation ponds and sale of the MIS oil.

1.2 SHUTDOWN AND MOTHBALLING OF MIS FACILITIES

Retort 1 was placed under natural gas blanket to maintain positive pressure to the retort. About 20 SCFM of natural gas was injected using automatic instrumentation control to maintain the retort pressure slightly higher than in the mine. Without natural gas injection, a chimney effect would have existed and air would have been drawn into the product drift, possibly creating an explosive mixture. The natural gas injection provided a reliable and economical means to keep the retort under positive pressure.

Following shutdown of the retort on December 23, 1981, the remaining process equipment, such as the steam plant, water treatment plant, incinerator and soda ash scrubbing system, was all shut down, cleaned up and decommissioned by the end of February.

1.3 MONITORING UNDERGROUND TEMPERATURES

The rubble and wall temperatures were determined from the few live thermocouples remaining after the burn. Cooling rates were slow since heat moved by conduction out into the surrounding rock. Considerable heat was removed from the retort in the form of vented steam when mine flooding occurred (see Section III -Mining) and allowed water to invade the bottom portion of the retort.

1.4 SOUR WATER PUMPING

Following shutdown of Retort 1, sour water continued to be produced due to a small leakage of aquifer water into the retort at about 5-10 gpm. Two sour water pumps were installed (one as a backup) to be operated from the surface after the mine was decommissioned. These 60-gpm pumps were operated periodically to remove accumulated sour water originally from the separator room, then later (after the retort was flooded) to maintain the water level in the retort between set limits. (See Section II, Chapter 2, Part D.2-Retort Water Pumping).

1.5 SALE OF MIS OIL

During September and October, a small portable steam boiler was used to heat the MIS oil in tanks 101 and 102 prior to shipment. Tanker trucks were then brought in to load the oil and transport it to a rail siding at Rifle, Colorado, where it was loaded into tank cars for delivery to a fuel oil terminal in Oklahoma. About 19,000 barrels were sold before losing suction on the tanks. The MIS oil was blended with other residual fuels, apparently with very satisfactory results.

2.1 CONSTRUCTION

In the fall of 1981, RBOSC began construction of the PDU at the Gulf Research Center in Harmarville, PA. During the early part of 1982, the building housing the PDU was enclosed. By the end of the year, construction of the PDU was 90% complete. Mechanical completion was achieved in February 1983 and operations will start in mid-1983, following calibration and other startup procedures. Mining of 5000 tons of feed shale was completed in the summer of 1982 and a portion was shipped to Harmarville.

SECTION IV

ORE STORAGE

CHAPTER 1

ORE STORAGE

4.1 RUN OF MINE ORE STORAGE

No additions were made to the run-of-mine ore storage pile during 1982. The approximate quantity stored is 171,000 tons.

The localized area of heating detected in late 1980 was monitored with all thermocouples indicating no additional heating. Temperatures have returned to near ambient in all cases.

4.2 PDU SAMPLE STORAGE

About 5000 tons of oil shale were mined for the Lurgi PDU. This material was segregated by blast round on the surface of the run-of-mine stockpile. All but 4 of the 97 rounds was crushed to minus 6 inches. Eight hundred ninty seven 1.5-ton polypropylene bags were filled with crushed shale in preparation for shipment to the PDU in Harmarville, PA. Seven hundred nineteen bags remain to be shipped.

4.3 LYSIMETER TESTS

The run-of-mine lysimeter test program continued through 1982. Water samples were collected for analysis by Colorado State University which is under contract to the EPA.

SECTION V

SUPPORT FACILITIES

At the beginning of 1982, RBOSC was providing two buses and five vans for mass transportation of employees from Rifle, Meeker, and Rangely. As a result of the reduced number of personnel at the tract, the bus service was terminated and only vans are used for transporting Rifle residents. Special transportation arrangements are made for employees who now reside in Rangely or Meeker.

The use of the 84 Mesa landing strip was eventually limited to special cases by prior arrangement. Runway cracks were sealed to prevent potential damage to aircraft.

Eighteen tract vehicles were eliminated from tract services.

POWER SUPPLY AND DISTRIBUTION

2.1 ELECTRICAL

No significant changes were made to the electric power distribution system during the year.

Electrical power consumption decreased from 29.7 million kwh in 1981 to 10.1 million kwh in 1982. The decrease resulted from completion of the MIS program and eventual reduction of tract activities to a standby maintenance level by the end of 1982. Average monthly power consumption during 1982 amounted to approximately 843,000 kwh.

2.2 NATURAL GAS

No significant changes were made to the gas distribution system during the year.

The average monthly natural gas consumption during 1982 was 3,780 MCF, down from approximately 34,500 MCF in 1981. With the reduced activities at tract C-a, the only uses of natural gas was for heating of three buildings, including the Mine Rescue Building which now serves as an all purpose building, and for blanketing the retort. (See Section III, Chapter 1, Part 1.2).

3.1 INTRODUCTION

Only one major problem marred an otherwise satisfactory operation of the water management facilities. As discussed below, the switch from in-mine pumping to deepwell pumping in September created problems as the initial submersible pumps failed to operate properly. The water treatment plant, sewage treatment plant and sour water evaporation ponds performed satisfactorily.

3.2 STATUS

A. Potable Water - The potable water plant was utilized during 1982 to provide water on-tract. Water production dropped to an average of 3,500 gallons per day (gpd) for the year, reflecting the cutback in personnel and activity on-tract. Spring #08 in Box Elder Creek continued to be used as a raw water source for the potable water treatment plant through September 25, 1982. Bottled water was hauled in for drinking water throughout most of the year.

B. Sewage Treatment - The sewage treatment plant was operated in 1982 on a limited basis. Discharge of treated sewage effluent continued to be to Corral Gulch where it immediately evaporated or seeped into the alluvium. There were no major upsets or plant difficulties during the year.

The aerated digested sludge was disposed by Valley Disposal Company of Meeker. Approximately 1500 gallons were disposed in this fashion.

C. Dewatering and Reinjection - The major water management operation continued to be the dewatering and reinjection system for the mine shaft. The water production in the mine increased slightly from January to the end of April, reflecting the discontinuance of dewatering wells D-6 and D-8 in late November 1981. Production peaked at about 1200 gpm but dropped off to about 1000 gpm by late August. In late August, the mine pumps were shut off and removed to convert to deepwell pumping in preparation of converting the mine shaft to a non-accessible mode. See Section 2, Chapter 2 for additional discussion of mine dewatering operations in 1982.

Total water handled continued to drop in 1982 with approximately 1710 acre feet of water pumped as mine seepage, as compared to 2620 acre feet pumped in 1981. Of the total dewatering production, 1580 acre feet, or approximately 92.6 percent, was reinjected. On two different occasions, due to line breaks or pump difficulties, a small amount of water was discharged to surface streams. This amount was about 5 acre feet or less than one half of one percent of the water produced. The balance of 7.4 percent was used to operate the tract facilities and for dust suppression. This included a little over 10 acre feet provided to others for oil and gas drilling in the area.

Total dewatering production from 1978 through 1982 was 13,136 acre feet. Total reinjection through 1982 was 7791 acre feet. Tables 5-3-1 and 5-3-2 summarize tract water handling for 1982 and since initiation of major water pumping.

TABLE 5-3-1

TRACT C-a WATER MANAGEMENT - 1982

Month	Total Production (MMGal)	Total Reinjection (MMGal)
January	50	47
February	47	42
March	54	46
April	52	45
May	53	47
June	49	45
July	47	45
August	44	44
September	42	37
October	35	35
November	44	40
December	40	43
TOTAL (MMGal)	557	516
TOTAL Acre Feet	1710	1584

TABLE 5-3-2

TRACT C-a WATER MANAGEMENT - CUMULATIVE

YEAR	PRODUCTION AF	REINJECTED AF	REINJECTED %
1978	3080	1080	35.1
1979	2870	791	27.6
1980	2857	2191	76.7
1981	2619	2145	81.9
1982	1710	1584	92.6
TOTAL	13,136	7791	59.3

D. Pond Operation - The sour water (water draining from the retorts and other process water that could be contaminated) is piped to the evaporation ponds for disposal by evaporation. With the switchover to surface pumping, a special pipeline and six-inch cased pump were installed in the mine shaft to withdraw sour water directly from the retorts. A back-up casing and pump were later installed. These sour water pumps operate on an intermittent basis. Production was on the order of seven gallons per minute but did increase significantly during the September-November period when water levels rose in the mine and retorts. By the end of the year, the water inflow rate had stabilized at 11 gpm. Although the sour water pumps could have pumped all of the water draining through the retorts, it was desirable to maintain retort water levels roughly equivalent to the mine water levels to reduce pressures on the bulkheads separating the two areas. Operation during the upset time as well as during normal conditions was designed to keep the retort water levels below the mine water levels so that seepage flow would be toward the retorts rather than from the retorts.

The evaporation ponds have performed satisfactorily during the year with no major seepage problems. The evaporation ponds are designed to handle up to 17 gpm of sour water for an indefinite period. Pond use at the end of the year was 17.3 million gallons of the 23.7 million gallons of capacity, or 73 percent of capacity.

The evaporation enhancement experiment by spraying was continued in the summer of 1982.

During 1982, a ten-key phone system was installed to eliminate the PBX. The existing pair of lines to Meeker were retained. An FX line was installed by Mountain Bell to Grand Junction eliminating long distance charges to this city. Mountain Bell also installed a Silt FX line to eliminate long distances to the Rifle area; however, Mountain Bell has not been able to make this line operative.

Mine paging telephones were installed in all the work areas on-tract giving RBOSC the capability of contacting any area quickly.

CHAPTER 5
BUILDINGS

The large administration building was vacated and all remaining personnel moved into the Mine Rescue Building. All buildings not being used were shut-down and mothballed as a conservation measure.

SECTION VI

ENVIRONMENTAL PROTECTION, HEALTH & SAFETY

CHAPTER 1
INTRODUCTION

This section contains discussions on the following areas: Health and Safety; Fire Prevention and Control; Air Quality Control; Hazardous Waste Control; Land Rehabilitation and Erosion Control; and Fish and Wildlife Management Plan. Water quality control was discussed in Section 5, Chapter 3, and will not be repeated in this section. Detailed information of the experimental revegetation section is included in MDP Monitoring Report 11 submitted to the OSO under separate cover in April 1983.

2.1 TRAINING

During the year, required MSHA compliance training was given in the following areas: Accident Prevention; Hazard Awareness; Respiratory Devices; H_2S; Oxygen Analyzer; Health; Explosive Hazards; Electrical Hazard; Communications; Transporation; First Aid; Cardio Pulmonary Resuscitation.

2.2 EMERGENCY PREPAREDNESS

Two Emergency Medical Technicians (EMTs) were selected to remain with the caretaker crew to give at least part time coverage. Prior to this, EMTs were provided on all shifts and received continuing monthly training from St. Mary's Hospital in Grand Junction.

By the end of the year, the number of ambulances at the tract was reduced from two to one.

2.3 SAFETY

A. Mine Safety and Health - The emphasis on safety and health did not diminish as the size of the mine operation decreased. When the mine was shut down at the end of September, a total of 24,969 manhours had been worked during the year with no lost-time accidents. In fact, the mine had operated for 20 months and 130,493 manhours with no lost-time accidents. The continued excellent safety performance was attributable to a small experienced crew, good supervision, improved safety awareness, high quality training, and frequent safety meetings.

Mine rescue training and proficiency was maintained until the mine was shut down.

All mine and equipment inspections were made as required. No significant problems were detected by mine or MSHA personnel.

B. Other Safety - The total TIC (support services) contractor man hours worked were 53,526 hours, but one lost-time accident occurred after 42,152 hours. The total RBOSC hours worked without a lost-time accident was 18,488 hours.

3.1 FIRE BRIGADE

Two fire brigades, each with a six-worker crew, were available while major activities were ongoing during the year. These crews maintained familiarity with the operation of the pumper truck, water hydraulics, foam application, and use of dry chemical fire extinguisher. Movies were shown to tract personnel on fire prevention and fire fighting.

3.2 MINE RESCUE

During the period of the year when mine operations were ongoing, the miners received four hours of MSHA required training in Mine Rescue each month. This included at least two hours working under oxygen breathing apparatus.

4.1 SUSPENDED PARTICULATES

Tract C-a continued its dust control measures during 1982, using water sprinkling trucks for applying water as required in the construction and unpaved road areas. The amount of water used on haul roads and heavy traffic areas is listed below:

TRACT C-a 1982 WATER APPLICATION

Month	Water (Gallons)
April	15,000
May	70,000
June	329,500
July	322,500
August	161,000
Total	898,000

There was no burning of slash or other materials during 1982.

A notification of Hazardous Waste Activity for Tract C-a was filed on August 1, 1980 and a Part A RCRA application for Interim Status was filed with the EPA on November 18, 1980. This Part A application was revised on September 23, 1981.

Four types of hazardous waste facilities on Tract C-a were designated in the Part A application.

Facility	Process Code	Capacity
Surface Impoundments (Evaporation Ponds)	T02	23,000 GPD
Tank (Retort Water Storage Tank)	S02	840,000 Gal
Incinerator	T03	2,400 gal/hr
Container (Oil, Hazardous Materials and Hazardous Waste Storage Area)	S01	76,000 Gal

The surface impoundments, the incinerator and the retort water storage tank were included in the application because of the potential that the waste products stored therein might be hazardous.

In July 1982, RBOSC requested that the surface impoundments, incinerator, and retort water storage tank be removed from its Part A RCRA interim status Permit. This request was granted by EPA in August 1982.

After this modification, the following hazardous wastes remained and were stored in the on-site storage facility:

Description of Waste	EPA Hazardous Waste No.	Amount of Waste(Pounds)
API Separator Sludge	K051	300
Air Pollution Control Incinerator Residue	D007	4800
Waste Solvents Process Lab	F003, F005	3900
Phosphoric Acid Anhydride Lab Waste	D003	4

The waste solvents contained acetone, toluene, shale oil, water and alcohol.

In November, 1982, the first three items listed above were transported to Envirosafe Services, Idaho for disposal. The EPA manifest system was used to track this transportation and disposal activity. After discussions with EPA personnel, the phosphoric anhyride was reacted and neutralized on-site. At one time, an indication was made that some waste carbon disulfide ampules from RBOSC's laboratories were held in our hazardous waste storage area. Subsequent examination of the ampules has shown them to be samples of shale oil light ends and are thus not hazardous wastes.

Since operations have been suspended on Tract C-a, no hazardous waste generation is anticipated in the near future.

An annual report describing these activities was submitted to EPA. A closure plan for the hazardous waste storage area will be developed in 1983.

6.1 GENERAL

Activities related to land rehabilitation and erosion control are performed in compliance with OSO and lease requirements, as well as stipulations contained in RBOSC's Regular Permit (No. 77-497) from the Colorado Mined Land Reclamation (CMLR) Division. Technical revisions to the CMLR Board are presented in Table 6-6-1. Due to reporting constraints for the CMLR permit, data reported in this chapter cover activities on Tract C-a from February 1, 1982 through January 31, 1983. However, because of limited activity during winter months, these data correspond closely with the January-December reporting period for the Tract C-a Annual Progress Report.

6.2 AREAS DISTURBED AND/OR SEEDED DURING REPORTING PERIOD (1982)

Although 10 acres of disturbance had been projected for this report year, no new disturbance occurred during 1982 nor is any projected for calendar year 1983 (Table 6-6-2). It should be noted that total acres disturbed, seeded and/or reseeded do not necessarily equate to the total acres disturbed, as listed on Table 6-6-2, because several areas have been disturbed and seeded more than once. An example is the Access Road Sand Pit where total disturbance equals 9.5 acres but 14.0 acres have been seeded over the years. Approximately 11.7 acres were seeded during the reporting period (Table 6-6-2). Areas seeded included fill slopes on the access road to Dead Horse Ridge, a portion of the booster pump station on the water reinjection system within Box Elder Gulch, disturbed areas at Spring 8, redisturbed areas of the Access Road Sand Pit, the active portion of the Hunting Road Clay Pit, and the simulated disposal bench. Seeding on all areas except the access road fill slopes was accomplished during May and early June 1982. The fill slopes were seeded during November 1982 and the clay borrow pit was reseeded at the same time. Reseeding the clay borrow pit was necessitated because drill seeding in the spring was

TABLE 6-6-1

TECHNICAL REVISIONS REQUESTED AND/OR APPROVED DURING THE REPORTING PERIOD, FEBRUARY 1982 THROUGH JANUARY 1983

Date Requested	Subject of Revision	Resolution of Request
September 9, 1982	Tract C-a development and reclamation schedule	Approval confirmed in CMLRB letter of November 1, 1982

TABLE 6-6-2

ESTIMATES OF MDP ACREAGES DISTURBED AND ACREAGES REVEGETATED [1/]

Disturbed Area	Disturbance Magnitude	Acreages Disturbed					Acreages Revegetated					
		1977	1978	1979 [2/]	1980 [3/]	1981 [4/]	1978	1979 [5/]	1979 [6/]	1980 [7/]	1981 [8/]	1982
Mine Service Area,	Major	48.2	3.2									
Ponds & Plant Site												
Retention Ponds							8.0					
Plant Side Slopes							12.0				0.2	
Area Near Hunting Club							2.0	1.0				
Area Between Water Tank & Plant Site							5.0					
Diversion System			4.2				3.0	3.0				
Settling Basins			3.4				1.0	1.0	0.1			
Equipment Yard							3.0					
Area Near Substation								1.0				
Access/Service Roads	Moderate	10.0	3.0	0.4	17.0		6.5	6.5	0.5	0.8	1.5	2.0
ROM Disposal Area	Major		12.3				10.0					
Soil Storage (1,2,3,4) Storage A, B, C, D	Moderate	4.0	3.0		1.4	0.5	3.0		1.3	1.4	1.8	
Powder Magazine	Moderate	0.9			0.2							
Water Reinjection System	Moderate		12.2	13.8	4.0		7.0			10.3	12.7	0.1
Spring #8	Moderate					0.1						0.1
Transmission Line	Moderate		0.5		0.7						0.1	
Natural Gas Pipeline	Moderate			0.8								
Reservoirs & Soil Pits	Major											
Access Road Sand Pit			9.5					5.0		4.5		4.5
Hunting Road Clay Pit			4.0	0.9			2.0					4.0
Monitoring Facilities	Moderate		0.2		3.5					2.6	3.0	
Simulated Disposal Bench	Moderate					1.0						1.0
Trailer Parking Facility					0.5					0.2		
Run-Off Diversion Ditches	Moderate					0.2					0.9	
Evaporation Field	Major		7.0									
Scrubber Blowdown Ponds	Major			8.9	8.0	7.2				1.8	2.4	
Scrubber Blowdown Pond Pipeline	Moderate			0.05								
Airplane Ridge Road Relocation	Moderate			1.9								
Shale Grouting Trench Test	Moderate					0.5					0.5	
Old Airplane Ridge Road Segment								8.5		0.8	0.8	
TOTALS		63.2	62.5	26.8	35.3	9.5	62.5	26.0	1.9	22.4	23.9	11.7

1/ Acreages revised from 1979 Annual Report based on "as built" survey data
2/ Includes acreages disturbed between February 16, 1979 and February 29, 1980
3/ Includes acreages disturbed between February 29, 1980 and January 31, 1981
4/ Includes acreages disturbed between February 1, 1981 and January 31, 1982
5/ Areas seeded May 1979
6/ Area redisturbed during 1979 and reseeded in November 1979
7/ Area seeded October and November 1980
8/ Area seeded October and November 1981

apparently unsuccessful, perhaps due to seeding depth in the loose soils. Fall seeding was accomplished via broadcasting followed by harrowing.

Seeding techniques, seed mixtures, and mulch types utilized for areas seeded in 1982 are indicated on Tables 6-6-3 and 6-6-4. Because of previous success in seeding the Sand Borrow Pit without the use of mulch, a number of areas with gentle slopes were not mulched during 1982. These included the clay pit, pump station, and Spring #8. No mulch was used on the access road to Dead Horse Ridge due to the large percentage of rocks on the fill slopes. Seeding success on these slopes will be dependent on seed working its way into the soil between the rocks. Direct application of mulch to these interstices would be nearly impossible. No fertilizer was used during the reporting period.

Revegetation success was assessed quantitatively during August by estimating cover within 1 m^2 sampling frames placed at five meter intervals along permanently established transects within seeded areas. An assessment of seeding success on two transects seeded during May 1982 is presented even though these areas were in their first growing season.

Cover for all planted and invaded species encountered on two transects located in the Access Road Sand Borrow pit averaged 21.8 percent (Table 6-6-5). Invaded forbs, primarily Chenopodium species, accounted for approximately 45 percent of total cover. Nevertheless, both planted forbs and grasses were doing well (6.0 and 4.6 percent, respectively) and are expected to out-compete the invaded species over the next several years.

6.3 WATER BARS AND DIVERSION DITCHES

Diversion ditches above and below the simulated mine/disposal pile bench were constructed during the reporting period. The ditch upslope from the test site diverts runoff around the study area, while the ditch below the site collects any runoff and/or erosion from the study area.

No new water bars were required during the reporting period. However, exsisting water bars were maintained as required.

TABLE 6-6-3

SEEDING AND MULCH REGIMES USED ON TRACT C-a[1/]

Disturbed Area	Seed Mixture	Mulch Type	Seeding Method[2/]	Seeding Rate (lbs./A)
Access/Service Roads	1/2	None	H	37.50/32.0
Access Road Sand Pit	1	Hay/None	D	18.75
Hunting Road Clay Pit	1	None	D/B	18.75/37.50
Water Reinjection Pump Station	1	None	D	18.75
Spring 8	1	None	D	18.75
Simulated Disposal Bench	1	Hydro	H	37.50

1/ Seed Mixture - See Table 6-6-4

2/ D = Drill, H = Hydroseed, B = Broadcast

TABLE 6-6-4

THREE SEED MIXTURES USED FOR RBOSC REVEGETATION ACTIVITIES[1/]

	Plant Species	Seeding Rate[2/] (lbs PLS/acre)
Seed Mixture 1	Luna Pubescent Wheatgrass	2.5
	Western Wheatgrass	3.5
	Sodar Streambank Wheatgrass	2.0
	Indian Ricegrass	1.5
	Green Needlegrass	1.5
	Manchar Brome	1.5
	Cicer Milkvetch	1.5
	Madrid Yellow Sweetclover	0.75
	Lewis Flax	1.0
	Winterfat	1.0
	Fourwing Saltbush	1.0
	Bitterbrush	1.0
	TOTAL	18.75
Seed Mixture 2	Yellow Sweetclover	1.0
	Barley	1.0
	Western Wheatgrass	6.0
	Luna Pubescent Wheatgrass	8.0
	TOTAL	16.0
Seed Mixture 3	Yellow Sweetclover	4.0
	Crested Wheatgrass	8.0
	Barley	8.0
	Luna Pubescent Wheatgrass	5.0
	TOTAL	25.0

1/ Seed Mixture 1 intended for permanent revegetation efforts, Mixture 2 for soil storage piles and other areas requiring short term, temporary stabilization, and Mixture 3 for erosion control on slopes within the Mine Service Area.

2/ Based on drilling rate; rate for broadcasting and/or hydroseeding is doubled.

TABLE 6-6-5

1982 ASSESSMENT OF AREA SEEDED IN 1982

AREA SEEDED= SOIL BORROW PITS
NUMBER OF TRANSECTS= 2

GROWTH FORM	PLANTED OR INVADED		PERCENT COVER
FORB	PLANTED		6.0
FORB	INVADED		9.9
GRASS	PLANTED		4.6
GRASS	INVADED		1.1
SHRUB	PLANTED		0.1
		TOTAL=	21.8

6.4 STATUS OF ACREAGE SEEDED DURING 1981

Cover ranged from an average of 11.3 percent within the slurry trench test site to 49.1 percent on one transect in the mine service area (Table 6-6-6). Invaded forbs predominated within two areas sampled; however, based on past experience, planted species are expected to out-compete the invaders after several years. The high cover attributed to invaded forb species on soil storage piles results primarily from Russian thistle on Soil Storage B. Russian thistle also was common along the transect located in the Access Road Sand Pit. It should be noted that Soil Storage B and Soil Pile #4 were both fenced during the reporting period to limit grazing by cattle. High cover of planted forbs on the mine service area results from an abundance of yellow sweetclover which is expected to decline as grasses and other forbs become better established.

6.5 STATUS OF ACREAGE SEEDED DURING 1980

The six transects representing areas seeded during 1980 fall within three general categories as shown on Table 6-6-7. Cover ranged from 36.4 to 49.8 percent. Cover in all three categories increased relative to 1981. There was a marked increase in cover of planted forbs within the mine service areas, which resulted primarily from yellow sweetclover. It is possible that the clover set seed during its second year of growth and reseeded itself during 1982. The increased cover of invaded forb species, primarily Chenopodium species and Russian thistle, within the water reinjection system transects may be due in part to the inclusion of transect 80-05 in the analyses. Although areas adjacent to this transect were seeded in 1980, they were redisturbed and reseeded during 1981. Planted grasses and forbs on this site have not yet provided sufficient competition to reduce the cover of such invaders as Chenopodium species and Russian thistle.

6.6 STATUS OF ACREAGE SEEDED DURING 1979

The nine transects seeded during 1979 fall within the four categories listed on Table 6-6-8. Cover ranged from 29.1 percent on access road sites to 46.3 percent on the topsoil stockpile location. Cover within each

TABLE 6-6-6

1982 ASSESSMENT OF AREA SEEDED IN 1981

GROWTH FORM	PLANTED OR INVADED		PERCENT COVER
AREA SEEDED= MINE SERVICE AREA			
NUMBER OF TRANSECTS= 1			
FORB	PLANTED		44.7
FORB	INVADED		1.6
GRASS	PLANTED		2.8
		TOTAL=	49.1
AREA SEEDED= SOIL STORAGE PILE			
NUMBER OF TRANSECTS= 2			
FORB	PLANTED		0.4
FORB	INVADED		20.9
GRASS	PLANTED		18.7
		TOTAL=	40.1
AREA SEEDED= SOIL BORROW PITS			
NUMBER OF TRANSECTS= 1			
FORB	PLANTED		0.4
FORB	INVADED		33.2
GRASS	PLANTED		3.0
GRASS	INVADED		1.4
		TOTAL=	38.0
AREA SEEDED= SPECIAL STUDIES			
NUMBER OF TRANSECTS= 1			
FORB	PLANTED		0.6
FORB	INVADED		1.3
GRASS	PLANTED		7.2
GRASS	INVADED		1.8
SHRUB	INVADED		0.4
		TOTAL=	11.3

TABLE 6-6-7

1982 ASSESSMENT OF AREA SEEDED IN 1980

GROWTH FORM	PLANTED OR INVADED	PERCENT COVER

AREA SEEDED= MINE SERVICE AREA
NUMBER OF TRANSECTS= 1

FORB	PLANTED	47.3
GRASS	PLANTED	2.5
	TOTAL=	49.8

AREA SEEDED= WATER REINJECTION SYSTEM
NUMBER OF TRANSECTS= 4

FORB	PLANTED	3.6
FORB	INVADED	15.6
GRASS	PLANTED	8.9
GRASS	INVADED	6.5
SHRUB	PLANTED	1.0
SHRUB	INVADED	0.8
	TOTAL=	36.4

AREA SEEDED= SOIL STORAGE PILE
NUMBER OF TRANSECTS= 1

FORB	PLANTED	12.7
FORB	INVADED	0.1
GRASS	PLANTED	35.8
GRASS	INVADED	0.2
	TOTAL=	48.8

TABLE 6-6-8

1982 ASSESSMENT OF AREA SEEDED IN 1979

GROWTH FORM	PLANTED OR INVADED		PERCENT COVER
AREA SEEDED= MINE SERVICE AREA			
NUMBER OF TRANSECTS= 2			
FORB	PLANTED		8.4
FORB	INVADED		0.2
GRASS	PLANTED		28.2
SHRUB	PLANTED		3.4
SHRUB	INVADED		0.6
		TOTAL=	40.9
AREA SEEDED= SOIL STORAGE PILE			
NUMBER OF TRANSECTS= 1			
GRASS	PLANTED		46.3
		TOTAL=	46.3
AREA SEEDED= DIVERSION DITCHES			
NUMBER OF TRANSECTS= 2			
FORB	PLANTED		7.9
FORB	INVADED		0.8
GRASS	PLANTED		25.4
GRASS	INVADED		0.1
SHRUB	PLANTED		0.0
SHRUB	INVADED		0.2
		TOTAL=	34.5
AREA SEEDED= ACCESS ROADS			
NUMBER OF TRANSECTS= 4			
FORB	PLANTED		12.5
FORB	INVADED		0.1
GRASS	PLANTED		14.9
SHRUB	PLANTED		1.5
SHRUB	INVADED		0.1
		TOTAL=	29.1

category increased relative to 1981. In nearly all instances the increases were related to planted forbs and grasses. Furthermore, there were marked decreases in cover of invaded forb species within all four categories.

6.7 STATUS OF ACREAGE SEEDED DURING 1978

Eleven transects, grouped into three categories, were sampled within areas seeded during 1978 (Table 6-6-9). Cover within each category increased as compared to 1981. The most pronounced increase was noted on the water reinjection system where both planted grasses and forbs increased substantially. Planted shrub species on these same sites decreased in cover; however, this corresponded to an increase of invaded shrub species so that overall cover of shrubs actually increased from 1981 to 1982.

TABLE 6-6-9

1982 ASSESSMENT OF AREA SEEDED IN 1978

GROWTH FORM	PLANTED OR INVADED		PERCENT COVER

AREA SEEDED= MINE SERVICE AREA
NUMBER OF TRANSECTS= 7

FORB	PLANTED		10.5
FORB	INVADED		0.4
GRASS	PLANTED		17.3
GRASS	INVADED		0.1
SHRUB	PLANTED		0.5
SHRUB	INVADED		3.7
		TOTAL=	32.4

AREA SEEDED= WATER REINJECTION SYSTEM
NUMBER OF TRANSECTS= 3

FORB	PLANTED		21.2
FORB	INVADED		1.4
GRASS	PLANTED		19.8
SHRUB	PLANTED		0.5
SHRUB	INVADED		3.0
		TOTAL=	45.9

AREA SEEDED= SOIL STORAGE PILE
NUMBER OF TRANSECTS= 1

GRASS	PLANTED		31.7
		TOTAL=	31.7

The Tract C-a lease environmental stipulations require RBOSC to avoid, minimize, and/or mitigate damage to fish and wildlife habitat. Section Four of the environmental stipulations requires that RBOSC submit:

> "a detailed fish and wildlife management plan which shall include the steps which the Lessee shall take to: 1) avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies; 2) restore such habitat in the event it is unavoidably destroyed or damaged; 3) provide alternate habitats; and 4) provide controlled access to the public for the enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedule, performance standards, proposed accomplishments, and ways and means of avoiding or minimizing environmental impacts on fish and wildlife" (p.A-17).

The Fish and Wildlife Management Plan presented in this chapter summarizes RBOSC's efforts to meet this requirement. RBOSC is committed to avoiding and to mitigating, to as great an extent as possible, the potential adverse impacts on fish and wildlife resulting from project activities.

It should be pointed out, however, that the absence of any sizable water body near Tract C-a precludes direct impact on a fisheries resource. Any future off-tract activities will be designed to avoid or minimize impacts on fisheries resources.

To satisfy the above lease stipulations, RBOSC, with the cooperation of Federal and State officials, is presently concentrating on development of methods for maintaining and for potentially increasing local populations of mule deer, the principal wildlife species in the area. Benefits to livestock and other wildlife will probably result, but the program is directed specifically to benefit mule deer. The developmental program is divided into three efforts: 1) mule deer habitat modification; 2) habitat restoration; and 3) human disturbance control. A detailed description of these efforts was presented in the January 1981 - December 1981 "Tract C-a Annual Progress Report".

The habitat modification test program is designed to augment food supplies for mule deer in the winter and during the early spring. Winter food supplies must be available to deer during periods of deep snow to be of significant value. The RBOSC deer winter habitat modification program allows access to areas where forage is increased through treatments of selective sagebrush removal, vegetation plantings and fertilizing.

Mule deer generally enter the spring months in a poor body condition due to the drain on their physical reserves caused by inadequate nutrition during the winter. The period termed "spring green-up" when grasses and forbs begin to grow is frequently critical to mule deer because of the important protein value of green vegetation. Modifying a small area near Tract C-a to provide quality forage during this critical period is also part of RBOSC's attempt to increase mule deer populations in the area.

Restoring some disturbed habitats to a condition more suitable for deer winter range than presently exists is one of the goals of the RBOSC reclamation program. Monitoring of various reclamation experiments and efforts should provide techniques for achieving this goal.

Educating and informing Tract C-a personnel on the proper use of Colorado's natural resources is part of the RBOSC employee training program. Sound recreation behavior by Tract C-a employees should help reduce potential wildlife impacts in areas distant from the tract. Wildlife impacts due to employee and visitor actions on the tract are reduced through a combination of education efforts and regulations.

SECTION VII

ENVIRONMENTAL ASSESSMENT & MONITORING

1.1 AIR STUDIES

Both air quality and meteorological data were collected at sites near Tract C-a during 1982. No violation of any National Ambient Air Quality Standard (NAAQS) was detected. Considering the very low activity level on and around the tract, this result is not surprising. With the exception of ozone and total suspended particulates (TSP), concentrations of all air quality parameters were found to be near or below the threshold of detection of the state-of-the-art instruments used in the monitoring program.

The range of ozone concentrations recorded during 1982 was 0.016 to 0.078 ppm. This range of concentrations is very similar to that found in previous years, and appeared to be uninfluenced by the decrease in site activity. This lends support to the hypothesis advanced in earlier reports that the source of the ozone concentrations is located elsewhere (e.g., ozone is brought in by long range transport or stratospheric injection).

Although peak summertime concentrations of TSP in 1982 are similar to concentrations in 1981 and 1980 (approximately one-half of the secondary NAAQS for TSP), the annual geometric mean concentrations have dropped substantially. This drop in TSP concentrations has been greatest at Site 3, which was probably impacted in earlier years by activity on and around the tract. At present, all three TSP sites appear to be measuring primarily background concentrations, with little impact due to localized activity. Correlations of the TSP data sets on an annual basis among the three sites were very high, averaging 0.92.

The meteorological data from 1982 showed that the year was slightly cooler and wetter than previous years. The annual temperature range of 56 C included the coldest temperature (-26.2C) recorded at Site 1 during the monitoring program. Precipitation at the tract totalled approximately 16 inches during 1982, compared to a mean of 14 1/2 inches over the past five years.

The mean annual visual range in 1982 was 93 miles, which is a slight increase from 86 miles in 1981, 85 miles in 1980, and 79 miles during the baseline. A mean daily visual range of 174 miles measured during the spring was the highest daily average found during the entire monitoring program. The most unusual finding in the 1982 visibility study was the higher average visual range in the spring compared to the fall, when all previous years found that fall had higher visual ranges. However, it is very likely that this situation was simply caused by the ten sampling days in the spring falling during periods when meteorological conditions were abnormally good for visibility.

Four noise surveys were taken during 1982. The measured sound levels generally ranged from less than 30 dBA (the threshold of the instrument) to 45 dBA, except near the main construction area (adjacent to the headframe), which averaged 60 dBA. If the measurements taken near the main construction area are excluded, these sound levels are comparable to data taken during the baseline period.

2.1 TERRESTRIAL STUDIES

The components of the Terrestrial Monitoring Program examined during the 1982 reporting period include browse condition and utilization, phytosociology, range production and utilization, mule deer abundance, feral horse abundance and mule deer road kills.

Browse condition and utilization studies indicated that the weighted average utilization ranged from 6 percent in the Mixed Brush to 16 percent in the Pinyon-Juniper vegetation type. Utilization during 1982 remained the same for the Mixed Brush type but increased substantially in both the Pinyon-Juniper and Sagebrush types relative to 1981. Sagebrush (*Artemisia tridentata*) was the most heavily browsed species in the Mixed Brush and Sagebrush vegetation types, 11 and 12 percent respectively. Although utilization of sagebrush also was substantial in the Pinyon-Juniper type (19 percent), bitterbrush (*Purshia tridentata*) and mountain mahogany (*Cercocarpus montanus*) exhibited approximately twice the utilization of sagebrush, 47 and 38 percent respectively. Higher levels of browse utilization may indicate that the size of the mule deer herd is increasing from the lower numbers present after the harsh 1978-79 winter. Low utilization within the Mixed Brush vegetation type probably results from limited winter access to the north-facing slopes where the Mixed Brush type is typically found.

Only minor variations were noted between 1982 and 1981 data for the distribution of shrub species by form, age and hedging classification. Range condition ratings based on hedging classification were generally better than those based on age classification. Aside from bitterbrush, mountain mahogany and serviceberry which were rated as being in "poor" condition in the Pinyon-Juniper vegetation type, all species were either in "good" or "excellent" condition, as based on the percentage of individuals which were severely hedged.

Seven years of data concerning browse condition and utilization of seven shrub and/or tree species within three vegetation types have documented the relative abundance of the species, variations in use of different species, variations in use patterns, the distribution of the species among age classifications, and the varying degrees of hedging which the species display in the Tract C-a vicinity. These data will be of use as a baseline for comparison of browse condition and utilization during future activities in the vicinity of Tract C-a and serve to indicate which browse species might be most beneficial for use in revegetation efforts.

In general, results indicate that the Pinyon-Juniper type was used more heavily than either the Mixed Brush or Sagebrush types. Heavier use of the Pinyon-Juniper type was expected because this habitat type is typically found on southerly exposures, or on ridgetops adjacent to southerly exposures, where winter snow depths allow for movement of the deer and access to low lying shrub species. Because of the heavier use of Pinyon-Juniper relative to the other two vegetation types sampled, average utilization of most species within that type tends to be heavier than for the corresponding species in other vegetation types. Concomitant with heavier leader utilization, a greater percentage of species in the Pinyon-Juniper type exhibited severe hedging. This is particularly the case for bitterbrush, mountain mahogany, and sagebrush, the three species which received the heaviest leader use in the Pinyon-Juniper as well as in the other vegetation types.

Variations in mule deer use patterns based on the browse utilization data are difficult to ascertain. However, data seem to indicate that, providing all other factors are equal, deer are not inhibited from using sites adjacent to MDP activities on Tract C-a. Because the deer seem to require some sort of protective cover relatively close to browsing sites, some of the variability in use patterns evidenced by these utilization data may be related to positioning of individual transects within a given vegetation type. For example, a transect within the Sagebrush type which happens to be adjacent to a Pinyon-Juniper stand, which provides readily accessible cover, may receive more use than another sagebrush transect in the middle of a large opening. Considerations of this sort should be taken into account in designing future monitoring programs.

These browse data offer a unique opportunity to study intraspecific variations in sagebrush as they relate to mule deer preference. Because the same individuals were, for the most part, sampled every year, these data can be used to identify those individuals which are consistently heavily browsed. By testing these individuals relative to other less heavily browsed sagebrush individuals along the same transects, intra-specific differences could be documented. Results of these studies would be beneficial to reclamation as well as mitigatory planning for future Tract C-a operations.

Baseline phytosociological data were collected from Area 6 (control) and from Areas 5 and 7 (treatments) during 1982. Percent cover of herbaceous species in the Pinyon-Juniper vegetation type ranged from 11.3 in Area 6 to 15.2 in Area 7. Although fewer species of grasses than forbs were encountered, the grasses accounted for the largest proportion of the total cover. No significant differences in cover of grasses or forbs were noted between sample periods, among transects within an area, or among areas for the Pinyon-Juniper vegetation type.

Cover of herbaceous species in the Sagebrush vegetation type exceeded that encountered in the Pinyon-Juniper type, with a range of from 30.8 in Area 7 to 41.0 percent in Area 6. As with the Pinyon-Juniper type, cover of grasses generally exceeded that of forbs; however, the disparity between growth forms was not as pronounced. The cover of forbs differed significantly among areas, but cover of forbs within a given area or between sample years did not vary significantly. Such differences, which result from natural variations, must be taken into account when these data are used to assess potential impacts of Tract C-a operations.

The phytosociological studies which began in 1979 have served to document plant community composition and structure within Sagebrush and Pinyon-Juniper vegetation types. Phytosociological data will be useful for comparison against which potential impacts can be assessed. Thus far, data from the "control" and "treatment" areas show few significant differences between areas, among transects within a given area, or between sample periods for a given vegetation type. Consequently, the data base should be useful as a baseline for indirect comparisons provided that future potential impacts are in the general vicinity of Tract C-a. Phytosociological data are also useful as references of species composition and/or diversity against which reclamation success can be assessed.

Range productivity and utilization studies indicated that production ranged from 118.8 kg/ha in the Pinyon-Juniper type to 415.6 kg/ha in the Mixed Brush vegetation type. Production within caged (protected) sample locations increased during 1982 relative to 1981 within the Pinyon-Juniper type, but decreased for both Mixed Brush and Sagebrush types. Utilization of herbaceous vegetation, as based on a comparison of standing crop within caged and uncaged plots, appeared to have increased somewhat within the Pinyon-Juniper type and decreased within both the Mixed Brush and Sagebrush types relative to 1981 data.

Statistical comparisons of range production among transects sampled in 1982 within three vegetation types indicated significant differences for grass production within both caged and uncaged plots in the Sagebrush type, and for forbs encountered in uncaged plots of the Pinyon-Juniper type. Variations among years (1978 through 1982) were also evident. Significant differences in grass production were noted within uncaged plots for all three vegetation types. Variations in forb production in uncaged plots were significant for the Sagebrush type. Production in caged plots, which were not available to grazing, also varied significantly for grasses in the Pinyon-Juniper type, and for both grasses and forbs in the Sagebrush type. Differences in production within uncaged plots may be related to variations in grazing pressure while those evidenced for caged plots may represent natural variations related to site conditions.

Range production and utilization data collected within three vegetation types over a five year period serve to document the production (standing crop) and utilization (comparison of standing crop within protected vs unprotected sample locations). Production within protected plots serves to identify natural variations in growth that result from climatic differences over years. These data largely reflect differences which are not related to development of Tract C-a (eg. climatic variability and variable use of BLM-regulated livestock grazing allotments). However, some tract-related activities may actually have promoted livestock and wildlife use of the area. Discharge of water into areas otherwise occupied by ephemeral streams and revegetating disturbed areas have been observed to attract both livestock and wildlife. Range production data will serve as criteria against which revegetation success can be judged during future reclamation activities.

Production of grasses and forbs within the Mixed Brush type averaged 320 kg/ha over five years of study, as compared to 255 kg/ha in the Sagebrush and 79 kg/ha in the Pinyon-Juniper types. Utilization between years within a given vegetation was variable, but the Sagebrush and Mixed Brush types generally were used more heavily than the Pinyon-Juniper type. Data have provided some indication of use patterns (primarily those of livestock) in the vicinity of Tract C-a. There have appeared to be no adverse effects relative to tract development. The variations in production among years are thought to be related primarily to climatic conditions, whereas differences in utilization over time probably reflect variability in the use of BLM grazing allotments in the vicinity of Tract C-a.

Winter density of mule deer estimated from pellet group counts around Tract C-a, has apparently increased since the 1978-79 winter die off. The winter density of deer per square mile in the RBOSC study area has ranged from a high of 51 in 1977-78 through a low of 28 in 1979-80 and 80-81 back up to 32 in 1981-82. The average number of deer per square mile for the five winters of study is 36. Distribution of pellet groups across habitat types, slopes, aspects and elevation ranges indicate that deer may be found in almost all ecotypes in the RBOSC study area at various times throughout the winter, depending upon the severity of the winter.

Only one deer road kill was observed along Rio Blanco County Road 24 during the reporting period. This reduction in road kills from previous years is probably a function of reduced traffic and limited snow depth which allowed the deer to roam in areas away from the road.

Four bands of horses totalling 24 individuals were observed in the January 1982 feral horse count on the Tract C-a study area. This is the fewest horses counted since the study began in 1978; probably a result of the success of the BLM feral horse round-ups conducted in the Piceance Basin in 1980 and 1981.

The Tract C-a and surrounding area do not provide critical habitat for any state or federally designated threatened or endangered species. The Bald Eagle is occasionally seen in the winter months foraging in the area. Golden Eagles and other raptors protected in Colorado are year long residents and may nest in the area.

3.1 AQUATIC STUDIES

Physical parameters examined at each of the aquatic sampling stations indicate seasonal as well as annual variability. A trend of increased downstream conductivity measurements was identified.

Selected water quality measurements made in 1982 and throughout the MDP program indicate a trend in increasing concentration with distance downstream from Tract C-a. Sodium, bicarbonate, total dissolved solids and alkalinity each were demonstrated, statistically, to be good indicators of water quality differences among the stations sampled.

Year to year variations in seasonal periphyton densities occur and are directly related to such highly variable environmental parameters as current velocity, temperature, light, spring runoff, turbidity and substrate type. The 1982 density estimates at station CG-1 were higher than other MDP values for this station, and changes in species composition indicate a slightly higher organic load. The density changes may be due in fact to changes in methodology. Changes in species dominance over time at this site are probably naturally induced since such changes are not uncommon in aquatic habitats like Corral Gulch.

Station YC-3 on Yellow Creek has spring and fall periphyton communities which appear to be inated by a group of diatoms whose relative abundance varies annually. There has been an increasing summer trend of green algal density at station YC-3 during the MDP monitoring studies from 1979 through 1982.

The benthic macroinvertebrate fauna at station CG-1 are characteristic of the fluctuating conditions common to small streams in semiarid regions. Station CG-1 is located in an area characterized by variable flow and turbidity. As might be expected under such conditions, minor seasonal changes in benthic macroinvertebrate densities occurred at this station in 1982.

Yellow Creek is a small ephemeral creek also affected by natural fluctuations in hydraulic and water quality parameters. The upper Yellow Creek station, YC-1, showed similarities to station CG-1 in seasonal changes in macroinvertebrate densities. Stations YC-2 and YC-3 on lower Yellow Creek have similar macroinvertebrate communities characterized by organisms tolerant of relatively high conductivities.

4.1 INTRODUCTION

The hydrology monitoring program collects information for several needs:

- Stipulations of the lease and conditions of approval from the OSO
- Engineering design input for mine and water handling systems
- Evaluation of the need for environmental mitigative measures
- Permit requirements

The program includes monitoring at numerous installations, including stream gaging stations, springs and seeps, alluvial and deep aquifer wells, surface impoundments, surface discharges, and reinjection system. The natural hydrologic and hydrogeologic environment as well as facilities associated with tract development have been monitored.

During 1982, the hydrology monitoring program was modified to focus on two major development activities at Tract C-a:

- Dewatering/Reinjection/Discharge Program
- MIS Modular Development Area

Hydrology monitoring stations have been classified as follows:

- Type I - control stations not expected to be influenced by a given set of development activities
- Type II - expected to exhibit direct, short-term impacts, should impacts result from development; such stations are located generally downgradient in near-field area relative to development

- Type III - expected to exhibit indirect or long-term impacts should impacts result from development; such stations are located downgradient from development in far-field areas.

Grouping stations allows for spatial as well as temporal comparison of water quality and physical parameters. Thus "pre and post" development levels and the "control vs potentially affected" areas can be compared.

4.2 DEWATERING/REINJECTION/DISCHARGE PROGRAM

During 1982, the dewatering operation was accomplished using mine sumps; dewatering wells were not operated. This resulted in only minor modification of the cone of depression. The 1982 cone of depression exhibited a diminishing of the -200 foot contour relative to 1981, while the -100 foot contour was essentially unchanged. The area of the -60 and -20 foot contours also decreased somewhat during 1982.

Dewatering flows were all reinjected or consumed during 1982 except in March and September when reinjection line breaks necessitated the rerouting of mine water to the discharge flume. Flows up to 144 gallons per minute were released in March and up to 404 gallons per minute were released in September. Total surface discharge was less than 2 acre-feet in March and less than 3 acre-feet in September.

As would be expected, water quality in the Jeffrey Pond, which receives mine water, and that observed in the composite reinjection water were similar during 1982. The conductivity of composite reinjection water as measured in lab analyses was in the 1300 to 1600 micromhos per cm range during 1982 with a slight minimum in July, due mostly to small changes in magnesium and bicarbonate concentrations. Of the eighteen trace elements sampled in October, only Br (0.96 mg/l), Li (0.09 mg/l), Mn (0.01 mg/l) and Sr (7.5 mg/l) were above the detection limits of analysis. Overall, the water quality of mine water was stable thoughout 1982 and comparable to observations of previous years.

Water quality observations in upper aquifer control wells during 1982 were generally similar to 1981 values. Observations included increases in mean and maximum observations for some constituents between 1981 and 1982 (e.g. conductivity, calcium, bicarbonate, sulfate). However, these changes are not great and there were decreases for some constituents.

Water quality observed at upper aquifer near-field wells in 1982 showed somewhat elevated conductivity relative to 1981. However, the concentrations of major ions in near-field wells in 1982 were not appreciably greater than observed in 1981. Mean concentrations of calcium, bicarbonate and fluoride at far-field upper aquifer wells in 1982 were slightly greater than 1981 means. However, the overall water quality at the far-field wells was comparable between the two years.

Most of the trace elements monitored in the upper aquifer were below detection limits during 1982. Typically, of the eighteen trace metals sampled, only Br, Li, Mn, and Sr were measureable.

The Multivariate Analysis of Variance (MANOVA) for selected upper aquifer water quality parameters indicated significant variability for most constituents (at the .05 significance level) for all parameters except pH, fluoride, chloride, and marginally for bicarbonate) for the area main effect. Significant variability for the year main effect was noted only for pH, magnesium, sodium, and chloride. The interaction term (area x year) was nonsignificant for all of the constituents examined. This indicates a lack of change in the relative water quality at control, near-field, and far-field wells over time, although the variability among station types and years is highly significant for some constituents when just these main effects are considered. This analysis result (including these specific constituents) was also observed for the 1981 analysis.

The MANOVA analyses, and the Duncan's Multiple Range Test results indicate that, although certain constituents vary significantly in time and space, the general pattern of water quality has not changed appreciably over time. Impact-related changes were not apparent from these analyses.
The water levels have been very uniform over the last three years of record

for the lower aquifer, indicating an absence of influence from the continuing reinjection operations.

4.3 MIS MODULAR DEVELOPMENT AREA

Monitoring of the MIS Modular Development Area includes sampling of various process ponds, alluvial aquifers and deep aquifers. The focus of this sampling is on water quality.

In the East Pond, the mean values of several parameters (pH, conductivity, sodium, bicarbonate, carbonate, sulfate, fluoride and DOC) increased in 1982 relative to 1981. However, the maximum values observed during the two years were comparable or the 1982 maxima were lower.

Piezometers 1, 2 and 4 were observed to contain water during 1982. However, the water exhibited conductivities in the 1000 to 1100 micromhos per cm range and pH in the 7.7 to 7.8 range, much different than East Pond water. Thus, no leakage is indicated. Similar water has been observed in these piezometers since 1979 and 1980.

During 1982, the mine sump system for collecting mine water and pumping it to the surface was replaced by submersible pumps, and the mine was placed in a "no-access" mode. Water collected at the bottom of MIS Retort 1 is pumped to the surface using a system separate from the mine-water system.

In September-November, a series of mine-water pump failures resulted in partial flooding of the mine and retort. Water quality data collected during this period show that mine water quality was not appreciably impacted by the incident. The mine and retort water pumping systems were again operational (with additional backup capacity) in November. Water levels are being maintained such that the level in the mine is always above that in the retort.

Observations at stream stations were comparable to spatial and temporal patterns observed in earlier years. The 1982 water quality observed at YBOXFL and YMET3 was very similar and the 1982 data were similar to 1981 observations at these sites. The concentrations of most major inorganic constituents increased appreciably between YMET3 and YSEOFL, located downstream. Most of the increase in dissolved solids is due to sodium and sulfate concentrations, with calcium, magnesium, bicarbonate, and chloride concentrations contributing to a lesser extent. Most of the increased dissolved solids load is probably due to spring discharges just upstream from YSEOFL.

MANOVA techniques were used to evaluate the temporal variability (comparison of 1981 and 1982) at these flume stations. The results showed few differences for any of the stations.

A general water balance for Tract C-a was developed using USGS gage station data. As observed in previous years, the tract area is a net producer of water (i.e. more water leaves than flows onto the tract).

The general water quality (TDS, alkalinity, and DOC) at alluvial control wells has been fairly stable since the baseline period (1976). The 1982 water quality was comparable to 1981 observations. The concentrations for most major inorganic constituents in the MIS alluvial wells increase in the downstream direction. Typically maximum concentrations in MIS alluvial wells in 1982 were observed at far-field stations. Potassium, ammonia, boron and DOC concentrations, however, were generally somewhat higher at near-field than at either far-field or control alluvial wells. This increasing trend in the downstream direction is typical for natural systems. No development related effects were indicated.

The results of the alluvial aquifer MANOVA for selected water quality constituents indicate, for most major inorganic constituents, significant variability (at the 0.05 level) for the main effects of monitoring area or station type (control, near-field, far-field) and year. The interaction term (area x year) was significant for TDS, pH, and sulfate. Thus, for most constituents, the spatial pattern of water quality variability has not changed significantly over time.

The Duncan's Multiple Range Test results show that in general, the 1982 means are not inconsistent with earlier alluvial aquifer observations, particularly recent years. Most of the observed changes over time, though significant statistically, do not appear to be of great magnitude nor indicative of development-induced impacts on water quality of the alluvial system.

Mean and maximum levels of most water quality parameters for upper aquifer control wells in 1982 were somewhat lower than 1981 means. The general chemical composition of upper aquifer control stations has not changed appreciably since the baseline period. The mean concentrations of major inorganic ions in 1982 in near-field upper aquifer wells were similar to the means observed in 1981, although observed levels for some constituents were somewhat greater in 1982 than in 1981.

The mean concentrations of major ions in far-field upper aquifer wells in 1982 were generally similar to those observed in 1981. Although the 1982 mean and maximum conductivity levels were appreciably greater than in 1981, this change was not reflected in the concentrations of major inorganic ions.

In the upper aquifer wells monitored in 1982 for the MIS Area hydrology monitoring program, the mean salinity (TDS) generally decreased in the downgradient direction (from control to near-field to far-field). This trend was mostly attributable to decreases in calcium and bicarbonate concentrations. Sodium, potassium, sulfate and chloride concentrations were generally greater in the far-field than near-field during 1982. No impact-related trends, such as increased concentrations in the near-field wells are apparent from these observations.

The results of the MANOVA for selected water quality constituents for the upper aquifer indicate that, for most major inorganic constituents, significant variability was observed for the main effects, area (station type) and year. Significant variability over the MIS upper aquifer monitoring areas was observed for all tested constituents except conductivity, alkalinity and sodium. Significant temporal variability (year main effect) was noted for all constituents except TDS, conductivity, and calcium. All constituents tested showed a significant interaction term (area x year).

All three monitoring areas (station types -- control, near-field, far-field) were significantly different for pH, calcium, and sulfate. Control and far-field station groups were not significantly different for magnesium and fluoride. The data indicate that the mean concentrations for control stations are generally greater than, or comparable to, those for near-field and far-field wells. Exceptions to this generalization are pH and chloride concentrations which generally increase in the downgradient direction.

The upper aquifer data also show an increasing trend in pH over time in the upper aquifer, and general decreases in alkalinity and sodium concentrations since the baseline period. Observations of mean concentrations in recent years have been fairly stable and development-related impacts are not evident.

5.1 REVEGETATION

A. Experimental Revegetation on Surface Disturbed Sites - Experimental revegetation Plot R-1, located on a northwestern exposure at 2164 M (7100 ft), had an average vegetative cover of 49.5 percent over the sixteen treatment combinations tested. Planted grasses accounted for 43 percent of this average. Although wheatgrass (*Agropyron*) species continued to be the most abundant planted grass species, green needlegrass (*Stipa viridula*) and Indian ricegrass (*Oryzopsis hymenoides*) were encountered frequently. There were no significant differences in the cover of planted or invaded grasses based on either mulch or fertilizer treatments during 1982. However, there were significant differences among years. Cover of planted grass species during 1982 was significantly higher than that of all other sample periods except 1981.

Cover of planted forb species averaged 15.9 percent during 1982, or approximately 32 percent of the total cover averaged over all treatments. The most prevalent planted forb species continued to be Lewis flax (*Linum lewisii*), yellow sweetclover (*Melilotus officinalis*) and cicer milkvetch (*Astragalus cicer*). Invaded forb species accounted for an average of 3.3 percent cover, resultant in large part from scarlet gilia (*Ipomopsis aggregata*), Douglas chaenactis (*Chaenactis douglasii*), *Cryptantha sericea* and *Machaeranthera* species. Significant differences were noted among blocks for planted forbs and among mulch treatments for invaded forbs during 1982. When data for all years were compared, it appeared that forbs were favored by hydromulch more so than by either of the straw mulch treatments. Comparisons among sampling periods indicated that cover of planted forbs during 1982 was significantly higher than for any other sample period. In addition, there appeared to be a proportional, inverse relationship between planted and invaded forb cover.

Shrub cover on newly established quadrats during the 1982 growing season averaged 4.4 percent for planted species and 0.4 percent for invaded shrubs. Total shrub cover accounted for 9.7 percent of total cover on Plot R-1. Big sagebrush (Artemisia tridentata), winterfat (Ceratoides lanata) and rubber rabbitbrush (Chrysothamnus nauseosus) were the most common planted species, whereas broom snakeweed (Gutierrezia sarothrae) was the only invaded shrub encountered. No significant differences in cover of planted shrubs were noted for 1982; however, comparisons among years showed that cover for 1982 was significantly higher than that for all other years except 1980.

Cover for all species over all treatment combinations on Plot R-2 averaged 38.6 percent, which was slightly lower than that recorded at Plot R-1. Although the two study sites are located at approximately the same elevation, reduced effective precipitation at Plot R-2 relative to R-1 may result from its southeasterly exposure. Mean cover for 1982 was 8.5 percent higher than that for 1981, which may have been due, in part, to the use of newly established sample quadrats.

Planted grasses accounted for 36 percent of the total cover on Plot R-2. This was a slightly lower percentage than that noted in either 1981 or 1980. Invaded grasses accounted for approximately 10 percent of total grass cover. Wheatgrass species and Indian ricegrass were the most common planted grass species while squirreltail (Sitanion hystrix) and needle-and-thread (Stipa comata) were the common invaded grasses. No significant differences in cover of planted or invaded grasses were noted among treatment combinations based on 1982 data. However, comparisons among years indicated that cover of invaded grasses was significantly higher in 1976 than any other sample period. Cover of planted grass species for 1980 and 1982 was similar, with the remaining four years of data having significantly lower cover of planted grasses.

Cover of planted forbs averaged 9.8 percent on Plot R-2 during 1982, or approximately 25 percent of the total mean cover. This represented a slight increase from cover recorded during 1981 and 1980. The most prevalent planted forb species were Lewis flax and cicer milkvetch.

Douglas chaenactis, Cryptantha, Machaeranthera and lobeleaf groundsel (Senecio multilobatus) were common invaded forb species which contributed to an average cover of 1.9 percent. No significant differences in forb cover among treatment combinations were noted for 1982. Comparisons of cover among sample periods showed that cover of planted species for 1982 was significantly higher than for any of the previous years. Conversely, cover of invaded forb species was at a six year low during the 1982 season.

Shrub cover for planted species averaged 10.5 percent during 1982. Combined with an average of 0.8 percent cover for invaded species, total shrub cover accounted for 29 percent of the total mean cover for all species. This represented a substantial increase in shrub cover relative to 1981, which may have been related to the use of newly established sample quadrats during 1982. Rabbitbrush species were the most common planted shrubs encountered whereas broom snakeweed was the only invaded shrub recorded. No significant differences in cover of planted shrub species were noted for 1982 data, as based on the 16 treatment combinations tested. However, cover for the three year period 1980-1982 was significantly higher than either 1976, 1977 or 1978. Although earlier data indicated no mulch and/or hydromulch treatments had favored planted shrub species more so than straw mulch treatments, this effect was not evident in either the sixth or seventh years of growth.

Species richness on Plots R-1 and R-2 is lower than that recorded in the surrounding Sagebrush and Pinyon-Juniper vegetation types; however, as is the case in these relatively undisturbed plant communities, the majority of herbaceous cover on Plots R-1 and R-2 results from three or four grass species, and two or three forb species. Cover of woody species on the two sites is well below that recorded in undisturbed communities. With time, species richness may increase as species from the surrounding communities disperse and become established within the study areas. As this occurs and as the existing individual shrubs on the two study areas reproduce, cover of woody species can be expected to increase. But, plantings of containerized shrub and/or tree species will probably be required in order to meet cover/density requirements for woody species during future reclamation efforts. Data on the seeding mixture used for Plots R-1 and R-2 will be useful for future planning and permitting activities. However, consideration should also be given to species which have been demonstrated as being successful in other research efforts.

The analyses of 1982 data show that, after seven years, few significant differences exist among the 16 mulch and fertilizer treatments tested on Plots R-1 and R-2. During the first several years of growth, however, cultural amendments were of importance. Mulch is of particular importance on steep areas both to reduce erosion and to maintain soil moisture for seedlings. Moisture retention is of particular importance on southerly exposures, as demonstrated during the first several years of growth on Plot R-2. Erosion control is, of course, important on all sites where slope angles promote rill and/or gully erosion. In terms of promoting cover of planted species and inhibiting competition from invading species during the period of establishment (the first several years after planting), data from Plots R-1 and R-2 indicate that hydromulch is preferable to either straw mulch treatment tested. From an operational standpoint, application of hydromulch from benches on disturbed sites would be preferable to operating straw mulching/crimping equipment on steep slopes.

Inconclusive results were obtained from Plots R-1 and R-2 regarding the application of fertilizer. Nevertheless, the use of fertilizer during future planning and reclamation efforts should not be ruled out. Other researchers in the Piceance Basin have noted that biomass of seeded grasses increases in response to fertilization (Redente and Cook 1981). Native shrub species also were shown to benefit from fertilization in the aforementioned study. The type, time of application and quantity of fertilizer utilized will be dependent on site specific conditions.

Data obtained from Plots R-1 and R-2 after seven years of growth indicate that an effective vegetative cover capable of self-regeneration appears to have been established on disturbed sites in the vicinity of Tract C-a. This has been accomplished by seeding topsoiled sites with a diverse mixture of grasses, forbs and shrubs. Such sites may require fertilization and should be mulched in order to control erosion and to assure the greatest chance for successful seedling establishment. The resultant vegetative cover and/or biomass of herbaceous species has been equivalent to that in surrounding sagebrush or pinyon-juniper communities. Therefore, revegetated sites are expected to provide forage equivalent to that present prior to disturbance.

B. Experimental Revegetation on a Simulated Processed Shale Disposal Site

Cover for all species averaged 43.5 percent on the control (no processed shale) portion of R-3 and 43.8 percent on the treatment (underlain by processed shale) portion. The cover of herbaceous species recorded during 1982 was higher on both the control and treatment portions of the study area than that recorded during either 1979, 1980 or 1981.

Planted grasses accounted for 42.1 and 38.1 percent of the total mean cover on control and treatment portions of R-3, respectively. Invaded forb species accounted for 10.3 and 8.4 percent of the total mean cover on control and treatment portions of the study area, respectively. Wheatgrass species and Indian ricegrass continued to be the most prominent planted species while the most prominent invaded grasses included cheatgrass (*Bromus tectorum*) and crested wheatgrass (*Agropyron cristatum*). Aside from the significantly higher cover of invaded grasses on hay mulch relative to no mulch treatments, no differences were noted among the various treatment combinations if species were lumped by growth form. When considered on an individual species basis, some significant differences were evident. Furthermore, comparisons among years showed that cover of planted grasses was significantly higher in 1979 than during any other sample period.

Cover of planted forb species on Plot R-3 accounted for 15.9 percent of total mean cover on the control and 14.6 percent on the treatment side. Invaded forbs, on the other hand, accounted for only 1.8 and 1.6 percent of the total mean cover for control and treatment portions. Cicer milkvetch contributed the largest proportion of planted forb cover while *Machaeranthera*, *Cryptantha*, and twinpod (*Physaria floribunda*) were the more common invaded forbs. No significant differences in cover of planted forbs were evident among treatment combinations during 1982. However, forb cover for 1982 was lower, though not significantly different from that recorded during 1981.

Shrub cover averaged 11.6 on the control and 15.6 percent on the treatment portion of R-3, accounting for 26.7 and 35.6 percent of the total mean cover respectively. Winterfat and fourwing saltbush (Atriplex canescens) were the most prominent planted species, and broom snakeweed was the primary invaded shrub species encountered. Species lumped by the shrub growth form showed no significant differences in cover among treatment combinations. Data partitioned by individual species showed that rabbitbrush was apparently favored by hydromulch, low seeding rates and/or the processed shale substrate. Comparisons among years showed that shrub cover for 1979 and 1982 was significantly higher than for the four remaining sample periods.

Biomass for herbaceous species during 1982 averaged 84.9 and 79.1 gm/m^2 on control and treatment portions of Plot R-3, respectively. Planted grasses accounted for 77 and 80.7 percent of the mean standing crop of herbaceous species on control and treatment portions of the site, respectively. Grasses as a whole showed no significant differences in aboveground biomass as based on substrate, seeding or mulch treatments. However, some differences among treatments were noted when individual species were considered.

The standing crop for planted forb species averaged 10.9 gm/m^2 on the control portion and 9.2 gm/m^2 on the treatment side, or approximately 12 percent of the standing crop of all herbaceous species. No significant differences in forb biomass were noted among the various treatment combinations based on the 1982 data. However, the mean biomass for 1982 (10.0 gm/m^2) was significantly higher than the 3.5 gm/m^2 recorded during 1979.

Precipitation at Plot R-3 totalled 10.64 inches for the April-October 1982 period. The highest monthly total occurred during September when 3.73 inches was recorded. The seven month precipitation total for 1982 was the highest recorded since R-3 was established in 1976.

Results of soil analyses for 1982 indicated that there were no significant differences in soil conductivity between control and treatment portions of Plot R-3. Analyses were also made on tissues of five plant species (three replicates per species for each substrate) to determine the content of arsenic, boron, fluoride, molybdenum and selenium. The only significant difference noted between the shale and no shale substrates was for boron in rubber rabbitbrush. In this instance, the content of boron was significantly higher on the control (no shale) portion. When determinations for trace elements within plant materials were compared with values from R-3 soil samples, it appeared that all of the trace elements tested were being accumulated to some extent by the five plant species, regardless of substrate type.

After six years of growth on a reconstructed soil profile overlying processed shale, an effective vegetation community capable of self-regeneration appears to have been established on Plot R-3. As noted with similar study areas on surface disturbed sites, the majority of herbaceous cover results from three or four grass species, and two or three forb species. From this respect, the vegetative cover is similar to that of the surrounding undisturbed communities; however, species richness on the revegetated site is lower than natural communities, as is the case for cover of woody species. Use of containerized shrubs and trees will help achieve greater cover and density of woody species during future reclamation efforts.

At present, few significant differences in cover and biomass exist between the seeding rate, mulch and substrate treatments tested. Results thus far indicate that seeding rates for mixtures of grasses, forbs and shrubs should be 22 to 28 kg/ha. The use of hydromulch (1.7 MT/ha) is beneficial from both biological and operational standpoints; however, the favorable effects are important during the first several years of growth and are generally not evident in subsequent data. The results of mulch treatments on Plot R-3 inidicate that, if a "natural" mulch is required, the use of native hay mulch is preferable to straw (as tested on Plots R-1 and R-2) because fewer undesirable species are introduced with the native hay mulch.

Continued study of Plot R-3 can be expected to better delineate changes in species richness, cover and biomass as succession continues on the study area. Furthermore, studies of soil moisture and root penetration into (or perhaps through) the reconstructed soil profile will provide useful information on the long term adequacy of this type of barrier for segregating processed shale from surface growth media. Because the active rooting zone on Plot R-3 is well into the rubblized overburden, it is important that the materials derived from this overburden barrier are amenable to plant growth. This appears to be the case for Uinta Sandstone underlying Plot R-3.

5.2 MULE DEER HABITAT MODIFICATION STUDY

Cover and density of shrub species, as well as cover of herbaceous species, was assessed along transects established within two study areas, one in which rotochopped areas were aligned parallel and the other perpendicular to the prevailing winds. No significant differences were noted among chopping, seeding or fertilization treatments on the study area aligned perpendicular to the wind. However, cover of shrubs and/or herbaceous species appeared to be related to both fertilization and rotochopping on the parallel orientation. Cover was significantly higher on fertilized portions as well as those which were not rotochopped. In spite of the aforementioned differences, very few of the planted species appeared to be doing well. Therefore, the differences between treatments resulted from sprouting of sagebrush or invasion of other non-planted shrubs and/or forbs. Deer use of the modified sagebrush habitat was minimal during 1982; consequently, too few pellet groups were found along any of the transects to determine differential deer use among treatment combinations.

5.3 SHRUB GROWTH ENHANCEMENT ON A SIMULATED MINE SITE AND/OR DISPOSAL PILE BENCH

A simulated mine site/disposal pile bench was constructed on Tract C-a in early 1982. The simulated bench is designed principally to evaluate the effects of water harvesting techniques on shrub growth. In addition, the effects of topsoil depth and deer browsing are to be evaluated. The bench is designed to concentrate available moisture in certain areas using water bars and variations in slope. Various combinations of fencing and topsoil applications will also be tested. Shrubs were planted in each of the resulting treatment areas in the spring of 1982. Shrub growth will be evaluated on a yearly basis beginning in 1983 to identify any effects of the various treatments on shrub growth. The success of the water harvesting techniques will be evaluated by periodic measurements of soil moisture content at fixed locations. The results of these evaluations will be included in subsequent MDP Environmental Monitoring Reports.

5.4 STUDY TO ALTER NATURAL SUCCESSION AFTER FIRE FOR ENHANCED DEER-LIVESTOCK FORAGE

After the natural occurrence of a fire in Yellow Creek bottom in September 1981, a program was established to study methods which might improve the forage for deer and livestock in a burned area. The study includes two seeding rates of a seed mixture containing 12 species of valuable forage plants and various grazing/browsing exclosures. The effects of fire, livestock grazing pressure, deer browsing pressure, and seeding rates on plant species percent cover will be estimated in 1983.

5.5 RUN-OF-MINE LYSIMETER

A lysimeter was set up in the field to collect leachate from a raw shale pile at 5, 10, and 15 feet. Data have now been collected and analyzed for two years. The conductivity of leachate in the 5-foot collector has been fairly stable at approximately 20 millimhos per cm, whereas the conductivity of leachate in the 15-foot collector increased slightly from 30 millimhos per cm in 1981 to 35 millimhos per cm in 1982. There was less precipitation and leachate in 1982 than in 1981. The primary differences between leachate from the 5-foot and 15-foot collector are the much higher concentrations of magnesium and sulfate ions from the deeper collector. Magnesium sulfate dominates the inorganic ion composition in samples from both leachate collectors.

5.6 SPECIAL METEOROLOGICAL INVESTIGATIONS

Two field projects were undertaken: a tracer study of fugitive emissions, and an upper air meteorological study. The tracer study was conducted during the summer of 1981, and the upper air study was conducted during the summer of 1982.

The tracer study was designed to simulate emissions near the surface (e.g., fugitive dust from hauling, crushing, dumping and storage facilities) from an oil shale production facility, under worst case meteorological conditions. Sulfur hexafluoride was used as the tracer, and was released at 1.7 meters at a potential plant site during early morning hours, under conditions of light drainage winds and stable atmospheric conditions. Measuring the resulting tracer gas concentrations in the ambient air downwind of the release point revealed that there was very little mixing before sunrise in the air draining down the shallow gulches. After sunrise, mixing within the lowest surface boundary layer rapidly increased until the tracer gas was diluted below detection limits. The experimental results showed that mixing near the surface is very limited until sunrise, and is probably the worst case for low level emissions. This data set can be used in the future to validate air quality models applied to this situation.

The upper air meteorological study was conducted as a cooperative effort between Rio Blanco and NOAA's Atmospheric Turbulence and Diffusion Laboratory. An instrument package consisting of a tethersonde and airsonde was used to collect meteorological data from the surface to several kilometers above the ground at three locations near Tract C-a. All of the data has not yet been reduced and analyzed, so only preliminary results are available at this time.

The most unusual condition noted to date in this study occurred at night under light winds and clear skies. A mid-level easterly wind extending from 50 meters to 1000 meters above the ground surface was found, sandwiched between a surface westerly drainage wind and the upper level westerlies of the general atmospheric circulation. Although unexpected, this phenomenon has been measured before near Tract C-a. Additional investigation is needed to better characterize this easterly wind, particularly since it may alter the location and the extent of the air quality impacts from an oil shale facility.

5.7 COMPARISON STUDY OF INHALABLE AND TOTAL SUSPENDED PARTICULATES

Two PM_{10} monitors (which have a 50 percent particle cutpoint of 10 μm) were installed colocated with standard Hi-Vols (measuring Total Suspended Particulates (TSP - particles up to 30-50 μm) in late August, 1982, to measure the ratio of PM_{10} to TSP near Tract C-a. This comparison is particularly appropriate with the current deliberations over a size specific particulate standard. The data collected to date show a PM_{10}/TSP ratio averaging 0.6, but this is based upon a small data set collected after the peak concentrations of particulate matter had occurred in early and mid-summer. A more representative data set will be available at the end of the 1983 monitoring period.

5.8 YELLOW CREEK STREAM CLASSIFICATION SURVEY

The Colorado Department of Health, Water Quality Control Commission proposed a set of stream use classifications and water quality numeric standards for segments 12 and 13 of the White River drainage system. A two season survey was conducted in April (spring runoff) and August (dry season) to evaluate the aquatic habitat for segment 13, Yellow Creek and tributaries. Data collected in this survey provided information that was used to present RBOSC's position in the public hearings held in October 1982 for the lower Colorado, Yampa, Green and White River systems. Intermittent flow was found to be the limiting factor for aquatic biota for most of the Yellow Creek drainage system. Permanent flow conditions were found only in the lower portions of Yellow Creek and near the head waters of the drainage system east of Cathedral Bluffs. The majority of the middle portion of Yellow Creek, lower Big Duck Creek, Little Duck Creek, and Dry Fork Gulch, were found to exhibit dry stream conditions in both survey seasons. Flow was variable in both seasons in the lower Yellow Creek segments and in Corral Gulch, where permanent flow conditions exist.

Stream conductivity and habitat characterization data were also collected. These data indicated that the lower Yellow Creek segments exhibited higher stream conductivity and contained a wider variety of aquatic habitat conditions than the spring fed head water segments of the Yellow Creek drainage.

As a result of these data and other testimony, Segment 13 was classified for agriculture use only. No water quality standards were placed on the Yellow Creek drainage system.

5.9 TOXICOLOGY

In 1981, a toxicology program to develop data on MIS and Lurgi process materials was initiated. Test results to date indicate that none of the shale oil, process water, raw or spent shale produce significant toxicity when administered as single doses either orally or by skin contact. Oils were minimally irritating to the eye. Spent shale (Lurgi) was also mildly irritating, probably due to mechanical irritation. Shale oils and process water are mildly irritating to the skin, however the oils also stain the skin precluding the use of conventional criteria for evaluating dermal irritation. Light Lurgi oil vapor is esssentially non-toxic in acute inhalation exposure.

Shale oil samples showed mutagenic response in several of the cell assay tests. No such response was observed for process waters, raw or spent shale. Cytogenetic studies showed some response but produced no indication of increased tendency toward aberrant chromosomes.
Preliminary dose-ranging studies with pregnant and non-pregnant test animals showed reduced body weight but no indication of interference with pregnancy or with survival of off-spring.

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