CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
1520 West Adams St.
Phoenix, AZ 85007
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

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Arizona Department of Mines and Mineral Resources Mining Collection

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PRINTED: 03/05/2003

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: HERMIT

ALTERNATE NAMES:

MOHAVE COUNTY MILS NUMBER: 747

LOCATION: TOWNSHIP 38 N RANGE 4 W SECTION 17 QUARTER SW
LATITUDE: N 36DEG 41MIN 30SEC LONGITUDE: W 112DEG 45MIN 00SEC
TOPO MAP NAME: HEATON KNOLLS - 15 MIN

CURRENT STATUS: DEVEL DEPOSIT

COMMODITY:
URANIUM

BIBLIOGRAPHY:
ADMMR HERMIT FILE

04/10/87

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: HERMIT

ALTERNATE NAMES:

MOHAVE COUNTY MILS NUMBER: 747

LOCATION: TOWNSHIP 38 N RANGE 4 W SECTION 17 QUARTER SW
LATITUDE: N 36DEG 45MIN SEC LONGITUDE: W 112DEG 45MIN SEC
TOPO MAP NAME: HEATON KNOLLS - 15 MIN

CURRENT STATUS: EXP PROSPECT

COMMODITY:
URANIUM

BIBLIOGRAPHY:
ADMMR HERMIT FILE

HERMIT (F)

COMPLETE AND MAIL TO

STATE MINE INSPECTOR
1616 WEST ADAMS, SUITE 411
PHOENIX, ARIZONA 85007-2627

STATE MINE INSPECTOR

NOV 18 1988

FOR OFFICE USE ONLY
START-UP NUMBER 84375295
STATE NUMBER
DEPUTY NUMBER HAMM
NEW ✓ MOVE

NOTICE TO ARIZONA STATE MINE INSPECTOR

In compliance with the Arizona Revised Statute, we are submitting this written notice to the Arizona State Mine Inspector of our intent to start ✓, stop ____, move ____ an operation.

Please check the appropiate boxes: Contractor ☒, Owner ☐, Operator ☐, Open Pit Mine ☐, Underground Mine ☒, Mill ☐, Quarry ☐, Aggregate Plant ☐, Hot Plant ☐, Batch Plant ☐, Smelter ☐, Leach Plant ☐.

If this is a move, please show last location: ____

If you have not operated a previously in Arizona, please check here: ____ If you want the Education and Training Division to assist with your mine safety training, please check here: ____

If this operation will use Cyanide for leaching, please check here: ____

COMPANY NAME: FAUSETT Diamond Drilling

DIVISION: ____

MINE OR PLANT NAME: Hermit **TELEPHONE:** 643-7321

CHIEF OFFICER: Chuck James

COMPANY ADDRESS: P.O. Box 968

CITY: OSBURN **STATE:** Idaho **ZIP CODE:** 83849

MINE OR PLANT LOCATION: (Include county and nearest town, as well as directions for locating property by vehicle: HERMIT MINE

MT. TRUMBULL Road Mohave County, ARIZONA

TYPE OF OPERATION: DRILLing **PRINCIPAL PRODUCT:** CORE

STARTING DATE: 11/15/88 **CLOSING DATE:** APPROX 4 weeks

PERSON COMPLETING NOTICE: Sam D. Nykolayow **TITLE:** FOREMAN

FORM 101-106 REV. 01/88

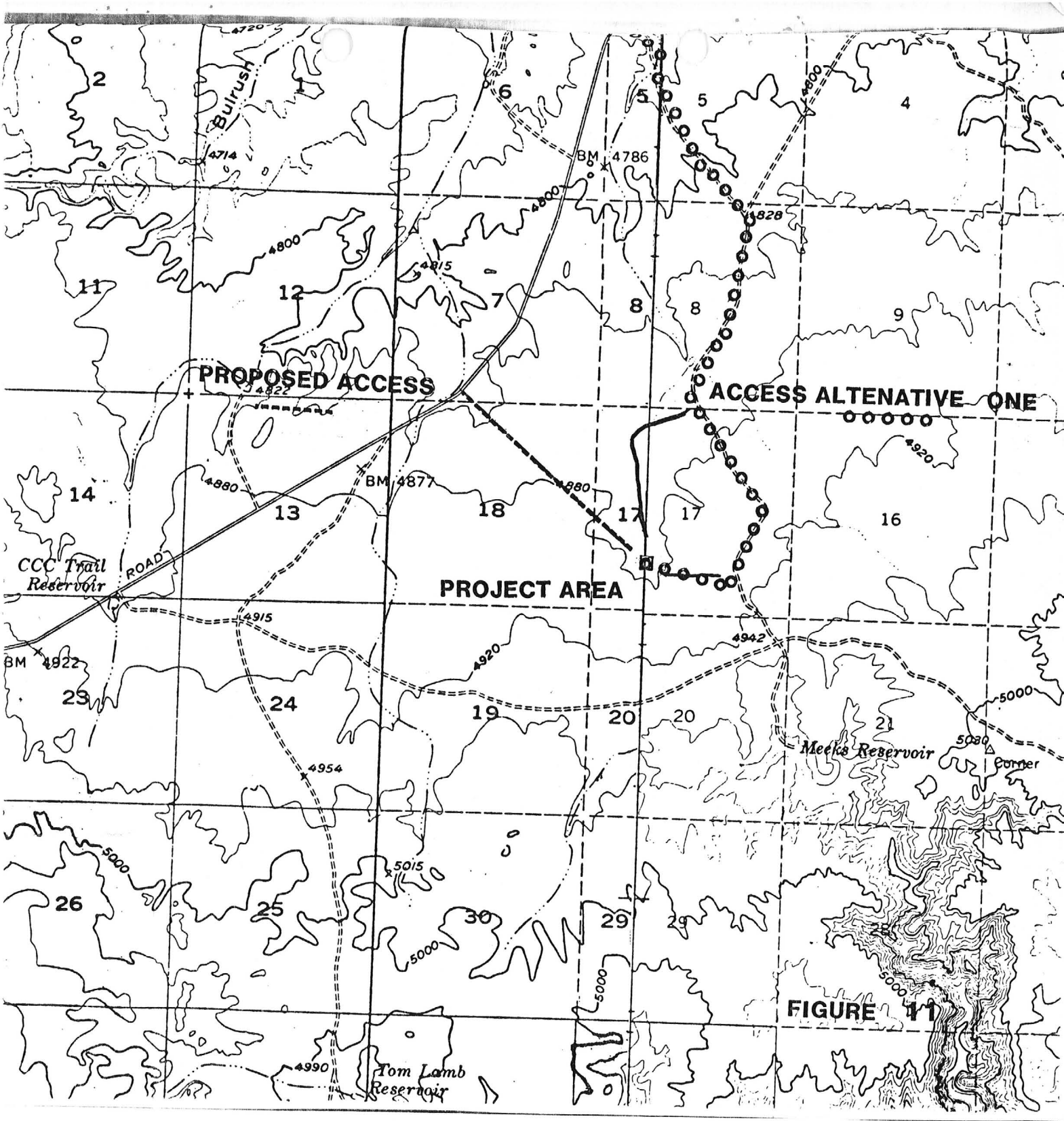


FIGURE 11

HELMIT

T38N R4W Sec 17 SW¼

HEATON KNOLL 15' ⟷ JUMPUP CANYON 15'

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1992

Mohave County

ENERGY FUELS NUCLEAR INC.

P.O. Box 36, Fredonia, AZ 86022 - Phone 643-7321
Manager Mining Operations Roger Smith
Arizona One T36N R5W Sec. 22
Employees: 40 - Located 45 miles southwest of Fredonia -Underground uranium mine - Sinking shaft through March 1992.
Mine Superintendent John Stubblefield
Kanab North T38N R3W Sec. 17
Employees: 35 - Located 25 miles southwest of Fredonia - Underground uranium mine - Developed - On Standby.
Hermit T38N R4W Sec. 17
Located 30 miles southwest of Fredonia - Underground uranium mine - Developed - On standby.
Pine Nut T36N R4W Sec. 21
Located 45 miles southwest of Fredonia - Underground uranium mine - Developed - On standby.
Canyon T29N R3E Sec. 20
Located 45 miles north of Williams - Underground uranium mine - Development awaiting regulatory approval.

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1991

ENERGY FUELS NUCLEAR INC.

P.O. Box 36, Fredonia, AZ 86022 - Phone 643-7321
Manager Mining Operations ..... Roger Smith
Hermit T38N R4W Sec. 17
Located 30 miles southwest of Fredonia - Underground uranium mine - Developed - On standby.

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1990

ENERGY FUELS NUCLEAR INC.

P.O. Box 36, Fredonia, AZ 86022 - Phone 643-7321
Manager Mining Operations ..... Roger Smith
Hermit T38N R4W Sec. 17
Located 30 miles southwest of Fredonia - Underground uranium mine - Developed - On standby.

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1989

ENERGY FUELS NUCLEAR INC.

P.O. Box 36, Fredonia 86022 - Phone 643-7321

Manager Mining Operations ..... Roger Smith

Hermit T38N R4W Sec. 17

Employees 15 - Located 30 miles southwest of Fredonia - Underground uranium mine - Direct shipping ore - Mill in Blanding, Utah - Nearing ore depletion - Reclamation scheduled to begin during 1990.

Mine Superintendent ..... John Stubblefield

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1988

ENERGY FUELS NUCLEAR INC.

P.O. Box 36, Fredonia 86022 - Phone 643-7321

Manager Mining Operations ..... Roger Smith

Pigeon T38N R2W Sec. 5
Employees 40 - Located 20 miles south of Fredonia - Underground uranium mine - Direct shipping ore - Mill in Blanding, Utah.

Mine Superintendent ..... Dave Lipkowitz

Kanab North T38N R3W Sec. 17
Employees 35 - Located 25 miles southwest of Fredonia - Underground uranium mine - Direct shipping ore - Mill in Blanding, Utah.

Mine Superintendent ..... Dan Thebeau

Hermit T38N R4W Sec. 17
Employees 32 - Located 30 miles southwest of Fredonia - Underground uranium mine - Under full time development - Production anticipated 1990.

Mine Superintendent ..... John Stubblefield

Pine Nut T36N R4W Sec. 21
Located 45 miles SW of Fredonia - Underground uranium mine - Developed - On Stand by.

Canyon T29N R3E Sec. 20
Located 45 miles north of Williams - Underground uranium mine - Under full time development.

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

VERBAL INFORMATION SUMMARY

1. Mine file: 1. HERMIT 2. PINE NUT 3. ARIZONA ONE
2. Mine name if different from above:
3. County: Mohave
4. Information from: Don Kilmore

   Company: Energy Fuels Nuclear Inc.

   Address: P.O. Box 36

   Fredonia, AZ 86022

   Phone: 643-7321

5. Summary of information received, comments, etc.:

Low prices for uranium ($14/lb) are causing Energy Fuels to restructure some of their operations. Development of the Hermit mine continues, while the Pine Nut deposit is developed but has been put on standby. No development is occurring at the Arizona One pipe at this time.

Date: October 23, 1988

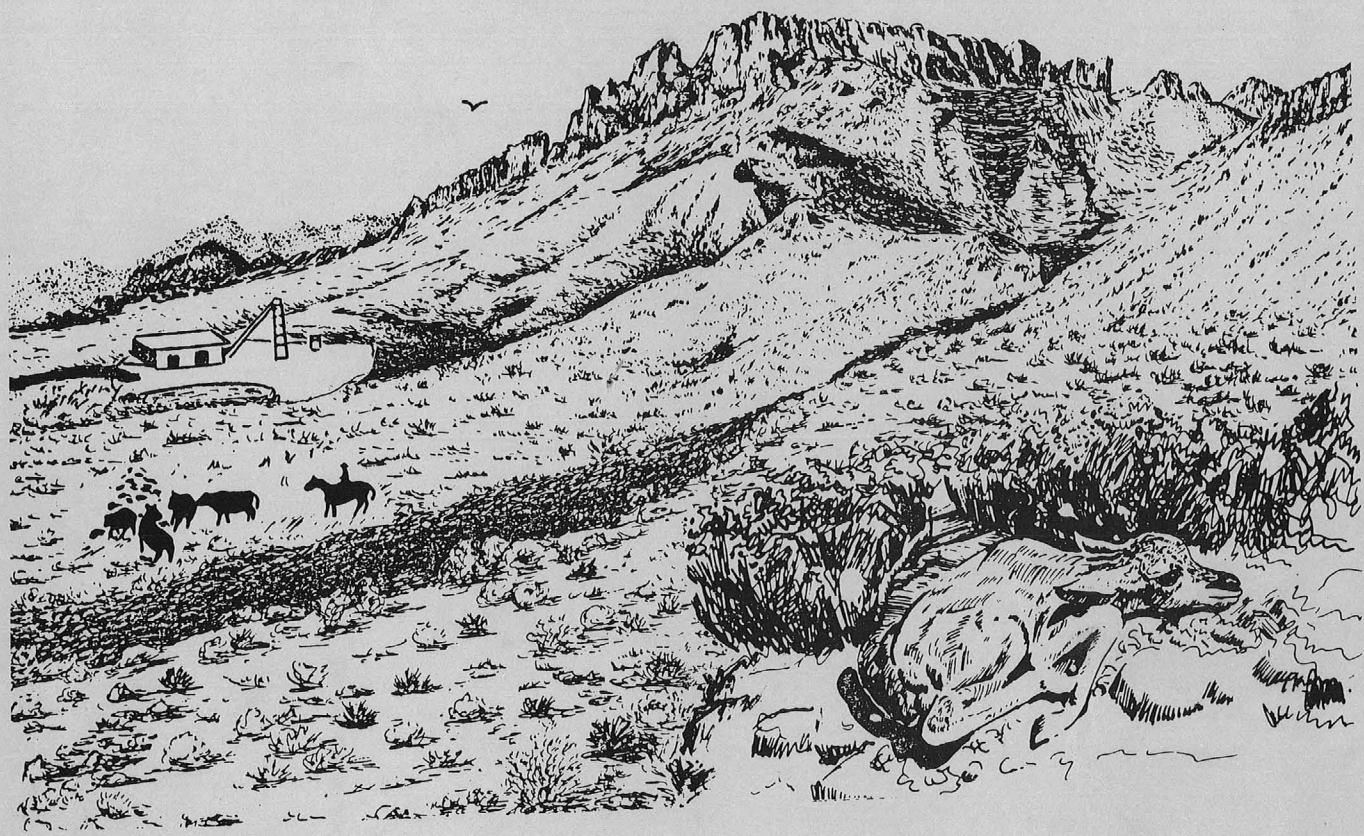
Nyal J. Niemuth, Mining Engineer

HERMIT[redacted] MOHAVE COUNTY

NJN WR 11/27/87: Wayne Seick, Energy Fuels, reported that they are starting to sink the shaft at the Hermit (file) Mohave County.

AB) - P.45, P46

HERMIT (f)



EA No. AZ-010-87-013

THE HERMIT PROJECT
DRAFT ENVIRONMENTAL ASSESSMENT

A Major Modification to the Hunt Project
Plan of Operations for Uranium Ore Extraction

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
March 3

Bureau of Land Management

PUBLIC LANDS ☆USA☆

USE ☆ SHARE ☆ APPRECIATE

AB) - P.45, P46

HERMIT

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March 3,

Bureau of Land Management

PUBLIC LANDS ☆USA☆

USE ☆ SHARE ☆ APPRECIATE

IN REPLY REFER TO:

United States Department of the Interior

3800 (015)

BUREAU OF LAND MANAGEMENT
ARIZONA STRIP DISTRICT OFFICE
196 E. Tabernacle St.
St. George, Utah 84770

APR 7 1987

We are pleased to send you the enclosed DRAFT Environmental Assessment (DEA) for the Hermit Mine Proposal. This DEA was written in response to a Plan-of-Operations submitted by Energy Fuels Nuclear, Inc. (EFN) on March 9, 1987. In addition to the proposal, the DEA evaluates several alternatives that propose various modifications to the Plan, including the No Action Alternative.

In preparing the DEA, outside consultants were used to assess the existing environment and the anticipated environmental impacts to Air Quality, Radiation, Ground Water and Surface Hydrology. While we have attempted to summarize these studies in the DEA, for the readers convenience, these studies are available on a limited basis at the Arizona Strip District Office (phone: (801) 673-3545).

A response, preferrably in writing, on the DEA will be required in order for you to remain on our active minerals mailing list. Comments are due by May 7, 1987 in order for them to be incorporated into the Final Environmental Assessment. The Bureau will target June 7, 1987 for making a decision on the proposal. If you wish to be notified about the decision, please make that request with your submission.

"HERMIT"
Arizona Strip District
Bureau of Land Management
196 East Tabernacle
St. George, UT 84770

Sincerely,

G. William Lamb
District Manager

Enclosure

RECEIVED
APR 10 1987
DEPT. OF MINES &
MINERAL RESOURCES
6/1/87

D R A F T

HERMIT PROJECT

EA No. AZ-010-87-013

A Major Modification to the Hunt Project
Plan of Operations for Uranium Ore Extraction
AS-010-82-24P/Amended, The Hermit Mine

April 7, 1987

HERMIT PROJECT

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Page No.

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*Full reference studies are located in appendix.

EA No. AZ-010-87-013

ENVIRONMENTAL ASSESSMENT

A Major Modification to the Hunt Project Plan of Operations for Uranium Ore Extraction AS-010-82-24P/Amended, The Hermit Mine

I. INTRODUCTION

Energy Fuels Nuclear, Inc. (EFN) has submitted a major modification to the Hunt Properties (Site No. 77), 82-24P(A), an existing Exploration Plan of Operations. The purpose of the modification is to allow EFN to expand the nature and duration of its presently authorized activities to include ore extraction activities pursuant to 43 CFR 3809 regulations and BLM 3809 Manual.

The existing exploration plan was submitted on May 17, 1982 and included a moderately intensive geochemical soil sampling program. The plan was subsequently approved after a review during which the BLM prepared a Decision Record based on an Environmental Analysis to determine site-specific impacts, reasonable alternatives and appropriate mitigation to limit conflicts and prevent undue or unnecessary degradation (June 23, 1982). Three separate minor addendums (7/23/82, 7/29/85 and 8/12/85) were submitted to pursue more strategic drilling.

Until a decision is made on this proposal, all work conducted must be in accord with the approved plan of operations. If the modification is approved, the existing plan of operations will be superceded in all respects.

To date, approximately 40 holes have been drilled, the majority of which are shallow soil samples. Minor road maintenance of the existing road has been allowed. No new permanent access has been constructed. There are approximately 3 acres of disturbance within an approximate 10-acre area.

II. PURPOSE AND SCOPE OF ENVIRONMENTAL ASSESSMENT

Pursuant to the Code of Federal Regulations (CFR), 43, Subpart 3809 (Surface Management), the Federal Land Policy and Management Act (FLPMA) and National Environmental Policy Act (NEPA), the purpose of this Environmental Assessment (EA) is to evalutate if the proposed action can take place in a manner that will prevent unnecessary or undue degradation and provide protection of non-mineral resources on federal lands.

The EA will include within its scope an evaluation of the proposed plan of operations to determine if it will be implemented so as to prevent undue and necessary degradation; while providing for reasonable reclaimation and reasonable protection of the non-mineral resources on Federal lands.

This E.A. is also the vehicle the Bureau will use to determine if there is a potential for significant adverse environment impacts and if so, if an Environmental Impact Statement is warranted.

This EA will also be used to assess the potential environmental impacts of the proposed modification and to identify if feasible or reasonable alternatives exist to reduce those impacts. In addition the EA will be used to assess mitigating measures that could be proposed to further prevent undue and unnecessary degradation pursuant to 43 CFR 3809, FLPMA and BLM 3809 Surface Management Manual.

III. PROPOSED ACTION AND ALTERNATIVES CONSIDERED

A. Proposed Action - General

Operator: Energy Fuels Nuclear, Inc.
One Tabor Center, Suite 2500
1200 Seventeenth Street
Denver, CO 80202

Claimant: Energy Fuels, Ltd.
(Same Address)

Claim Name: Hunt 533-537

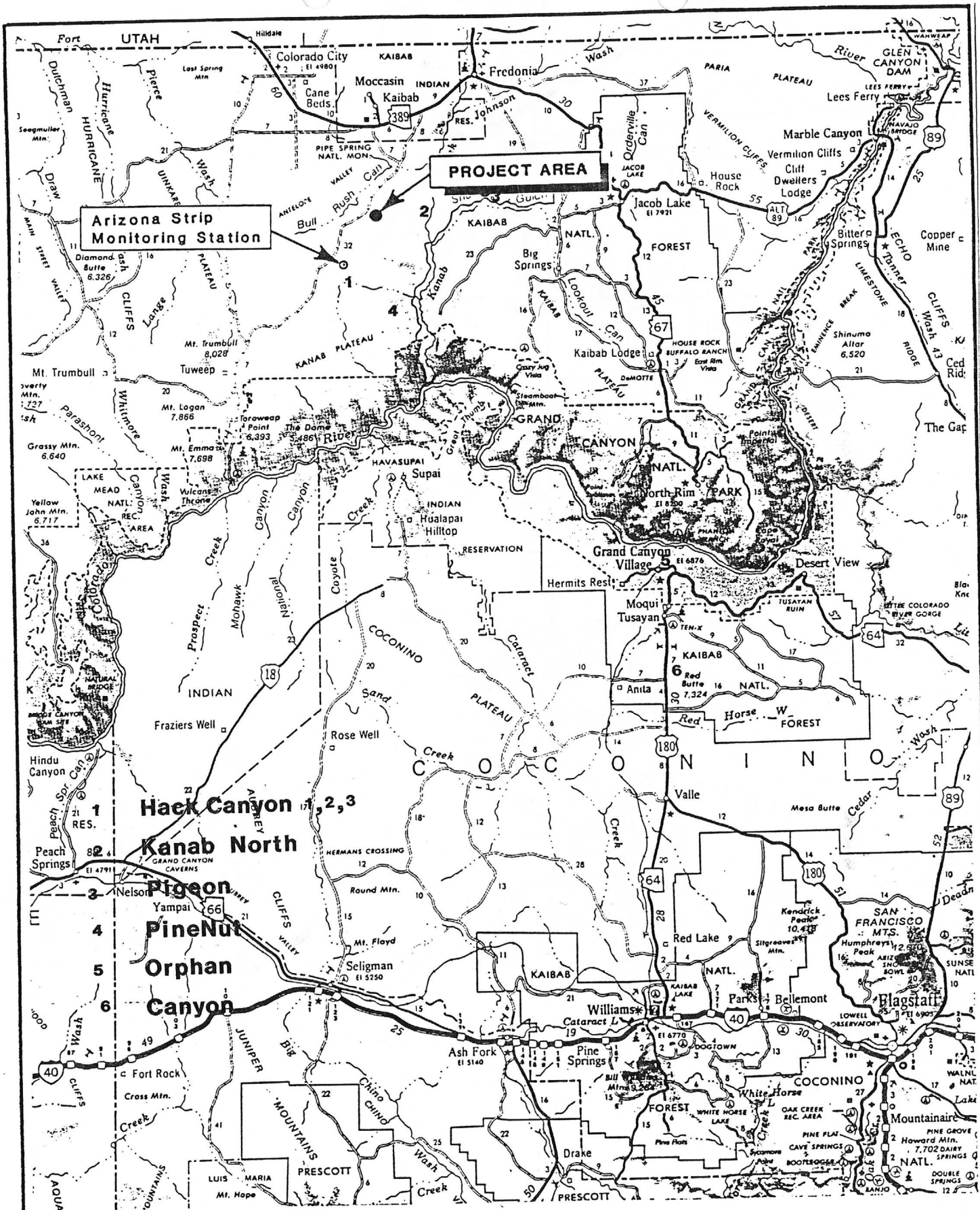
BLM No.: AMC 150856-150861

Local Office: Energy Fuels Nuclear, Inc.
P. O. Box 36
Fredonia, AZ 86022

Location: T38N, R4W, Sec. 17, SW¼, G&SRM (see Figures 1, 1b & 2)

The development and mining of the Hermit deposit will be conducted in two phases. The first phase will involve initial site preparation and shaft sinking activities, followed by underground evaluation, development and production during which ore recovery will occur.

Initial underground evaluations will be conducted by sinking a shaft approximately 1,100 feet below the surface adjacent to the deposit and then extending horizontally into the ore body. Once access to the ore body has been established in Phase I, extensive underground drilling and sampling will be done to more fully define the extent and mining grade of the deposit.



ENECOTECH

PROJECT **Hermit**

Location Map

FIGURE 1

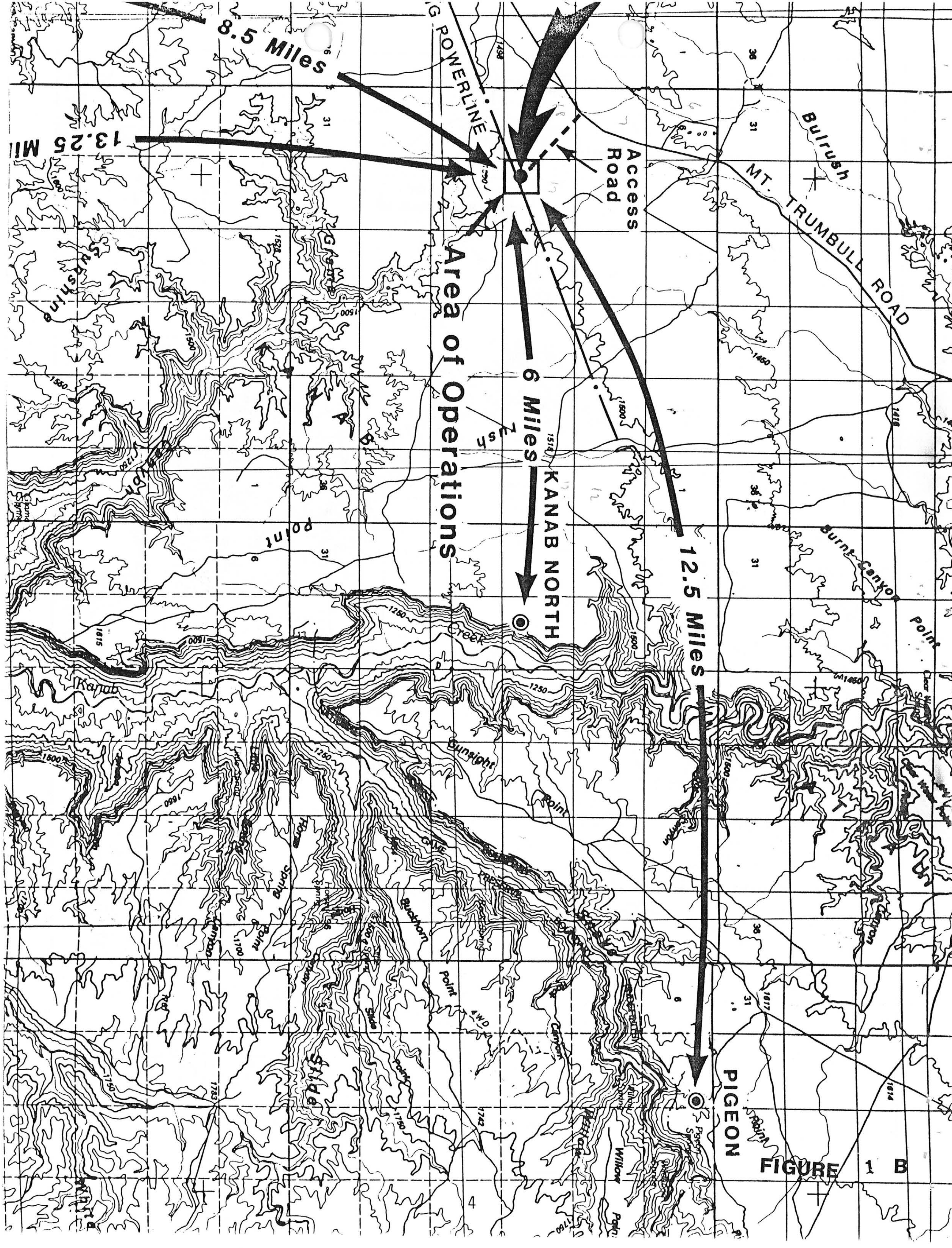
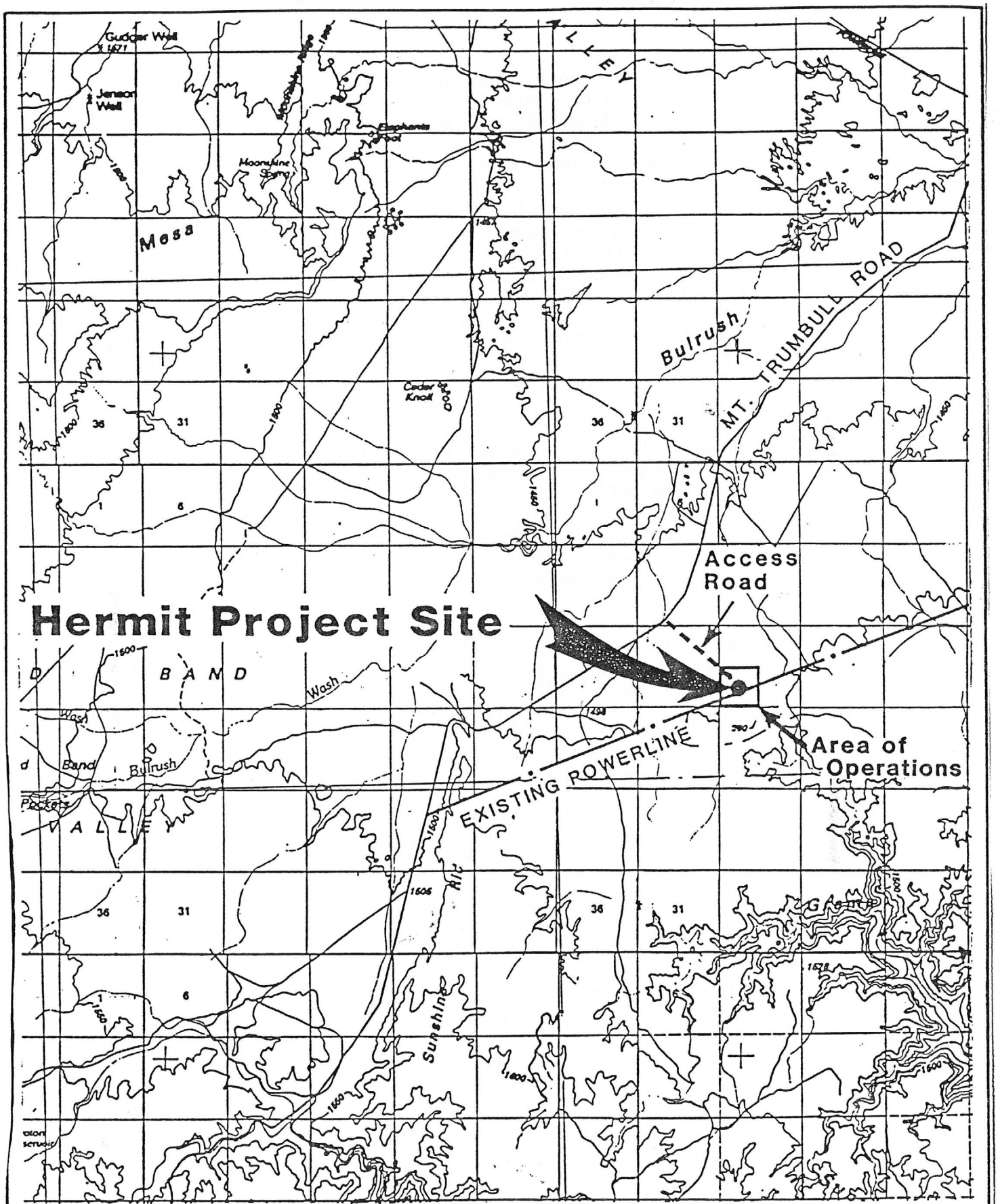

8.5 Miles
13.25 Mi
POWERLINE
Access Road
Area of Operations
6 Miles
12.5 Miles
KANAB NORTH
PIGEON
MT. TRUMBULL ROAD
Bulrush
Burnt Canyon
Kanab
Creek
Gunsight
Point
Sunshine

FIGURE 1 B



ENECOTECH
Denver, Colorado

PROJECT Hermit

LOCAL MINE AREA

FIGURE 2

During the site preparation and shaft sinking phase, surface facilities will be limited to those necessary to facilitate shaft sinking activities. Because of the proximity of the project area to an existing powerline, this phase of activities will be supported by permanent electric power. During initial site preparation and shaft sinking activities, no uranium ore will be encountered. In addition, until completion of the underground evaluation and development activities, it is anticipated that ore production will not exceed a few thousand tons, an amount sufficient for complete bulk sampling of the ore body. Moreover, it is not anticipated that any uranium ore will be encountered until sometime during the second year of activities at the Project Area. Prior to this time, site preparation activities on the surface and shaft sinking activities will not involve the movement or storage of uranium ore on the surface. During the first phase, EFN proposes to add 1.2 miles of new access road.

Once significant ore production activities begin in the second phase of activities, approximately three years after site preparation activities begin, the surface facilities will be expanded as necessary to complete underground development of the ore body and the full mining and extraction of the mineral reserves. During this development and mining phase, further upgrading of the new access road is planned so ore haulage can be safely undertaken.

As a uranium producer, EFN is currently engaged in various phases of site preparation, shaft sinking, underground development, mining or reclamation activities at five mines north of the Grand Canyon. (see Figure 1b). It has recently closed or is in the final stages of mining at the three Hack Canyon Mines (8 miles south of the Hermit Project). Site reclamation activities at the three mines will begin during the second quarter of 1987.

At the Pigeon Mine (12.5 miles northeast of the Hermit Mine), site preparation and shaft sinking began in 1982, with underground drilling, evaluation and development activities continuing until mid-1984 when full mining began. Mining activities at the Pigeon Mine are expected to continue until 1990 (the time when commercial ore production at the Hermit project is expected to commence) when site reclamation will commence.

At the Kanab North Mine (6 miles east of the Hermit Mine) site preparation and shaft sinking activities did not begin until 1985. At the present time, EFN has completed its shaft sinking activities at the Kanab North Mine, and is proceeding with its underground drilling, evaluation and development work. Significant ore production from Kanab North is not expected until 1988 or 1989.

Finally, site preparation and shaft sinking activities at the Pinenut Mine (13.25 miles south of Hermit Mine) began in mid-1986. At present, site preparation for the first phase of activities has been completed and shaft sinking activities have just begun. Significant ore production from the Pinenut Mine is not expected until 1989 or 1990.

It is apparent from the description of the status of activities at other locations where EFN is operating that by the time Hermit Mine is sufficiently developed to enable EFN to produce significant quantities of ore from the project, ore production from the 3 Hacks Canyon Mines and Pigeon Mine will have been completed.

Access to the project area from Fredonia, Arizona is achieved by traveling southwest on State Highway 389 eight miles to Mt. Trumbull Road. After proceeding 11 miles south on Mt. Trumbull Road, a southeast side road is taken 1.2 miles to the project area.

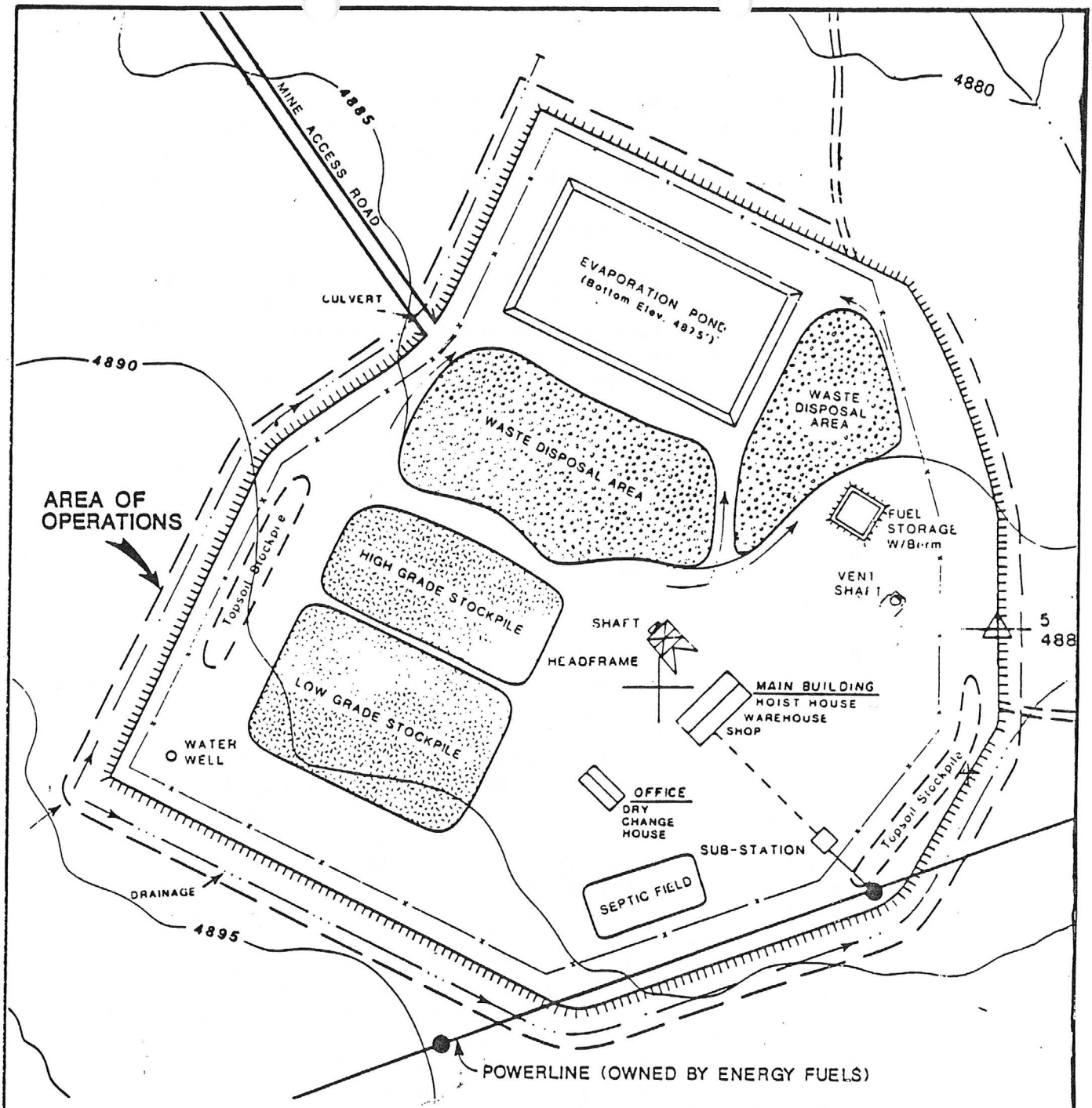
Proposed Action - Specifics

PLANNED OPERATIONS:

During the next several years, EFN plans to develop and mine the uranium deposit located in the project area by underground mining methods in two distinct phases of operations.

Based upon its experience with similar deposits, EFN expects its site preparation, shaft sinking, underground drilling and development, and mining and reclamation activities to be completed in approximately ten (10) years. Access to the deposit will be by a conventional, two and one-half compartment, vertical shaft located immediately southwest of the deposit. The shaft will be excavated to a depth of approximately 1,100 feet below the surface. As the vertical shaft is sunk, horizontal workings will be driven at various levels toward the deposit. Thereafter, two to four underground drilling chambers will be excavated in or near the deposit. From these chambers, underground drilling will be undertaken to further define the full extent of the deposit. Portions of the workings within the deposit and the underground drilling will provide EFN with adequate information to determine the most efficient mining sequence to ensure maximum recovery of the mineral reserve. The proposed shaft location, surface facilities, shaft and waste rock disposal area are identified on Figures 3 & 4.

During site preparation, shaft sinking and underground drilling and evaluation, employment will range from 12 to 22 personnel. Shaft sinking generally is conducted on a three-shift, seven day per week schedule. A two-shift, five day per week schedule is probable during underground drilling and development activities. During this initial phase, a majority of the employees will be skilled shaft

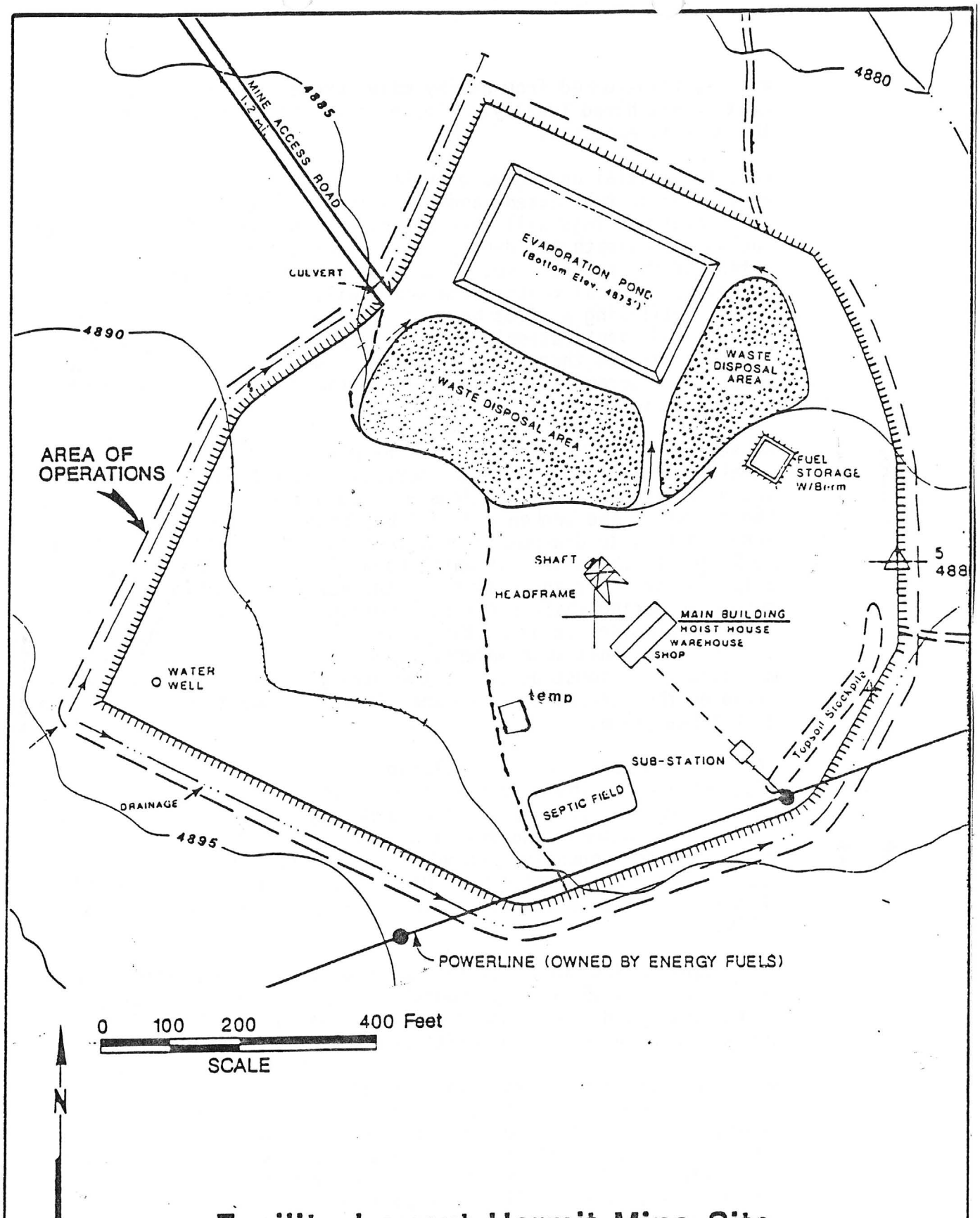


Facility Layout Hermit Mine Site

PHASE ONE

FIGURE 3

Dames & Moore



Facility Layout Hermit Mine Site

PHASE TWO

FIGURE 4

Dames & Moore

miners, transferred from nearby mines presently operated by EFN or contractors hired locally. Little or no influx of new personnel to the area is expected.

Once the initial underground drilling program has satisfactorily confirmed the full extent and dimensions of the ore deposit, horizontal workings will then be driven from the lowest portion of the shaft, beneath the deposit to a point just outside the farthest extent of the ore reserve. From this point, an eight-foot diameter, vertical ventilation shaft will be upreamed to the surface utilizing a pilot hole to intersect the lowest workings. This second (ventilation) shaft will exhaust air, thereby creating adequate airflow through- out the mine workings, and, in addition, providing a second exit or escapeway from the mine in the event of an emergency.

Raise or incline workings within the mine will connect the various levels within or very near the deposit. At various elevations from these levels, sublevel workings will be driven to extract ore from the deposit. The broken ore will be dropped down raises, designed for such use, to drawpoints on the lowest level. The ore will then be hauled to the shaft, at which point it will be transferred to skips in the shaft and hoisted to the surface. Barren waste rock generated during shaft sinking, development and mining will be removed and disposed of on the surface in the waste disposal areas, to the extent that such material cannot be utilized for road maintenance or construction of the mine yard. Ore will be stock-piled on the surface near the shaft until shipment to the Blanding mill takes place.

After development work is completed (approximately three years after start-up), the mine will be operated at an average production rate of 300 tons per day for approximately five years. It is hoped that planned underground drilling will increase the tonnage to be mined and, consequently, extend the operation's life by a few years. However, experience to date at other operations suggests that a production phase significantly longer than five (5) years is unlikely.

Employment during the first few years of underground development will range from 15 to 30 personnel. As production capacity grows, employment could reach approximately 40 personnel at the 300 ton-per-day rate, working two shifts per day.

Most employees are expected to be drawn from existing residents of the area. Moreover, it is hoped that the work force will consist of employees currently working at the Hack Canyon and Pigeon Mines. Since these mines will have ceased operations by the time the production phase of the Hermit Project begins, EFN would plan appropriate transfers, if timing permits. EFN will provide and operate buses to transport employees to and from the Project Area.

Driving of individual vehicles is discouraged. Management and technical staff support will be based at the Fredonia Mine Operations office.

AREAS TO BE DISTURBED:

There are two specific areas that will be temporarily used or disturbed during the project life: (1) the Area of Operations with surface plant and rock disposal area (23.6 acres); and (2) 1.2 miles of access road (5.0 acres). The Area of Operations where all activities will take place, together with planned surface facilities, are shown on Figures 3 & 4. In designing the Plan of Operations, EFN has minimized the size of the Area of Operations as much as practicable to ensure adequate working area while minimizing disturbance. The locations of the shafts, office, hoist house, main building, waste rock storage area and ore stockpiles will all be generally located during each phase as shown on Figures 3 & 4. Of course, further engineering and unexpected problems encountered during construction could cause the actual layout to differ in minor detail from that shown on Figures 3 & 4. In any event, the surface impacts from the proposed operations will be unaffected by any necessary minor relocations within the Area of Operations.

During the first two to three years of the Project or during the underground evaluation phase, only the eastern half or 15-acre portion of the Area of Operations will be utilized. This initial yard is within the larger 23.6-acre Area of Operations to be occupied during the production phase. During the underground evaluation phase, only the shaft and sinking hoist area will be graded to a final yard elevation.

A water source of a few gallons per minute is needed for underground drilling and sanitation during the first phase of activities. Consequently, a water well will be drilled on the southwest edge of the Area of Operations to a depth of 2,000 to 2,500 feet. Tankage to hold water will be located near the site of the water well. In the area shown on Figure 4 at least two house trailers will be located during phase one which will serve as temporary lodging for the mine staff and a security guard as may be needed during phase one. No full-time resident other than a security guard is proposed.

Prior to construction of the mine yard, available topsoil from the initial areas to be disturbed will be removed and stored at the eastern edge of the Area of Operations (see Figure 3).

In addition, during phase two a second topsoil storage area will be created at the western edge of the Area of Operations (see Figure 4). These locations will assure that topsoil will not be disturbed

during mining activities. In addition, after construction of the water diversion facilities discussed below, the topsoil stockpiles will be protected from erosion due to surface runoff. The size and dimensions of the topsoil stockpiles will increase at the beginning of the production phase when additional topsoil is removed and stored prior to construction of the final mine yard.

During phase one, EFN proposes to relocate approximately 1.2 miles of access road as shown on Figure 3 so that access to the Project Area of equipment and personnel can be achieved with safety and minimal environmental impact. In order to avoid the addition of 1.2 miles of new roads to the BLM system, EFN proposes to reclaim fully the existing access road to the Project Area to BLM standards during phase one of activities, provided that such reclamation is acceptable to the BLM. In addition, upon completion of mining activities at the Project Area, the relocated access road would also be fully reclaimed unless the BLM requests that such access road be left intact as part of the BLM system.

During the first phase of activities, a temporary hoist to excavate the shaft will be located approximately 125 feet southeast of the shaft. A building will surround the temporary sinking hoist. The necessary air compressors, semi-trailers for shop, warehousing, office and showers will be located to the southeast of the temporary hoist building. Immediately south of the shaft, a septic field will be located to handle sewage from the showers and trailers located with the Area of Operations.

During initial development activities at the beginning of phase two only minimal ore is expected to be generated incidental to the underground evaluation and development activities. Specifically, EFN estimates that no more than a few thousand tons of ore will be generated during the underground evaluation and development phase of activities. This material will be stored at the location shown on Figure 4 until shipped to the Blanding mill for bulk sampling and amenability testing.

In order to ensure that no surface runoff from outside of the Area of Operations is allowed to enter, EFN will construct water diversion facilities on both the east, south and west perimeters of the Area of Operations as shown on Figures 3 & 4. Prior to the design of these surface water diversion facilities, it was necessary for EFN to analyze the watersheds involved and the potential of the area to experience severe storm events. Consequently, EFN retained the services of Dames & Moore, consulting hydrologists, to evaluate the surface runoff issues and to advise EFN regarding proper design, location and capacities for the diversion facilities. The surface water diversion facilities which EFN will construct will conform with the recommendations of Dames & Moore and will ensure that these facilities are capable of

diverting around the areas of disturbance the surface runoff resulting from at least a 100-year storm event. Importantly, this significant margin of safety will be achieved while making maximum use of the existing natural channels existing in the Project Area. The planned diversion facilities will be constructed during the first phase of activities and will be maintained throughout the life of the Project.

All rainfall which falls within the Area of Operations will be directed to and held in the surface water holding/evaporation pond shown in Figures 3 & 4. This pond will be lined with an artificial impervious material to insure that leakage does not occur. It will be constructed during phase one and will be sized to hold all water which may be encountered during mining activities as well as the surface drainage within the disturbed areas resulting from a 100-year 24-hour event.

After the deposit has been fully evaluated, as part of the next phase of activities the nature and extent of the surface facilities will be expanded as shown on Figure 4. Moreover, during this phase of activities the area of disturbance will be expanded to enable the efficient extraction of the ore reserve--including construction of ore stockpile areas and an additional topsoil stockpile. Finally, as these activities proceed, some additional access road upgrading activities will be necessary to accommodate the ore haulage needs of the mine--estimated to average 12 truck loads per day once full ore production is achieved.

Of course, prior to beginning the surface expansion activities, available topsoil within the additional disturbed areas will be collected and stored for use in final reclamation in the identified topsoil stockpile area.

Barren waste rock from excavation of the underground workings will either be used to build the relocated access roads, mine yard and stockpile areas to the required grade, or any excess will be disposed of in the area shown on Figure 4. This waste disposal area has the capacity to hold the expected barren waste rock to be generated without noticeable change to the original topographic appearance.

The largest and only major building in the surface plant will be the "main building" located as shown on Figure 4. This building will house the permanent hoist, air compressors, standby electric generator, shop warehouse and emergency medical facilities.

South of the main building, various supplies needed during the production phase will be stockpiled. Tankage for storage of gasoline and diesel fuel will be located as shown in Figures 3 & 4 in the area to the northeast of the main building.

Once the surface facilities needed during the production phase of activities have been installed, a six-foot chain link security fence with lockable gates will be erected to enclose the Project Area as noted on Figure 4. The mine-use area will be posted with "No Trespassing" signs. The gates in the security fence will be closed and locked during periods of inactivity at the mine site.

MEASURES TO LIMIT DISTURBANCE:

This Plan of Operations is designed to minimize disturbances to the environment and to provide for complete reclamation of the surface after completion of the mining activities to the standards required by law. The areas proposed to be disturbed are as compact as practicable with surface facilities and stockpile and disposal areas clustered together where feasible.

In the design of this Plan of Operations, EFN recognized that one of the important natural environmental issues at the site is proper handling of surface water runoff from adjacent watersheds. To address this issue, and to insure the integrity of the Area of Operations during activities, flood control measures have been built into the Plan of Operations consistent with the recommendations of an independent surface water hydrologist who evaluated the area. As designed, surface water cannot enter the Area of Operations from any direction. In addition, rainfall within the yard will be retained within the Area of Operations because of its internal drainage. In addition, the designed water holding/evaporation pond will be sized with sufficient capacity to retain the surface runoff which would be expected to fall within the disturbed area as a result of a 100-year, 24-hour storm event as well as any excess water encountered during mining activities which cannot otherwise be utilized in connection with ongoing activities.

Diversion channels to direct surface runoff around the Area of Operations will be constructed as one of the first activities. The small watersheds above the Area of Operations, approximately 200 acres, will flow into the diversion channels rather than into the Area of Operations.

The southwestern portion of the mine yard will be used to stockpile ore prior to shipment to the Blanding mill for processing. Prior to stock- piling ore grade material in the locations shown on Figure 4, EFN will construct an ore pad upon which all ore grade material will be stockpiled pending removal from the Project Area. Each ore pad will be at least one foot thick and shall be constructed utilizing a mixture of limestone and shale produced from the underground excavation at the Project Area. Experience at other facilities has confirmed that ore pads of this type are effective in preventing the movement of any mineral values into the soils below the ore pad during periods of ore storage.

All material containing more than 0.03% U_3O_8 will be temporarily stockpiled at the location shown on Figure 4. Approximately 65,000 tons of such low grade material will be produced during mining activities. If market prices increase, nearly all of this material will be shipped to the Blanding mill for processing before the close of mining activities. If any of this low grade material remains within the Project Area at the close of activities, prior to final reclamation, EFN will haul it from the site or dispose of it underground in the mined-out workings.

EFN will construct and maintain the access road from the Project Area to the Mt. Trumbull Road in conformance with BLM specifications. Ore haulage from the site will be by independent truck contractors using 25-ton capacity trucks which comply with Arizona Highway Department of Transportation requirements. To prevent loss of material from wind erosion and rough roads, each load will be covered with a tarpaulin lapping over the side about a foot and secured every few feet around the truck bed. In the event of a truck accident, EFN will take immediate aggressive action to clean up any spilled material.

MEASURES TO BE TAKEN DURING A PERIOD OF NON-OPERATION:

EFN intends to operate the Hermit Project until all economic ore reserves are exhausted. The federal regulations which require submittal of this Plan of Operations call for a statement of measures to be taken in the event of an "extended period of non-operation before mining is completed." While there is no definitive plan for a shutdown before exhaustion of the mineral reserve, this occurrence must be regarded as a possibility.

Two different types of scenarios would occur depending upon the anticipated length of non-operation. A short shut-down of a few months to a year would require only limited action. In this case, a few employees would be kept at the mine site for repair and maintenance work and a watchman would reside at the mine site. All inventory items that may deteriorate in a year's time, such as explosives, oil, gas and first-aid supplies, would be used or removed from the Project Area. Hardware, such as nuts, nails and pipe fittings, would be secured in place. All equipment would be checked and most of it stored in the shop building or in the mine workings. The limited amount of equipment that could be used at other EFN operations would be removed from the site. All stockpiles above economic grade would be shipped to a mill for processing. There would likely be some stockpile of low grade ore which would be maintained at the mine site during a shutdown. Ventilation fans, electric lines and transformers would be left in place. Steel gates on the mine shaft would be closed and locked.

In the event of non-operation for more than a year, a different procedure would be followed. Nearly all mobile equipment and a portion of the fixed equipment would be removed from the Project Area. Fans would be removed and the ventilation shaft capped with perforated steel plates welded in place to allow natural ventilation but to prevent access to the workings. The buildings, headframe and hoist would be left in place but secured and maintained in the same manner as a short term closure.

MEASURES TO RECLAIM AT THE END OF THE OPERATIONS:

At the conclusion of mining activities, EFN will disassemble and remove the hoist/shop building and bury all concrete footings and concrete slab materials within the mine yard or backfill the material into the shaft. All facilities, materials, supplies and equipment will be removed. Low grade material will be removed from the site or backfilled into the mine shaft. The shaft entrance will be sealed to prevent entry by unauthorized members of the public, and the entire Area of Operations will be fully reclaimed. Specifically, the following reclamation activities will be implemented at the end of mining activities:

(1) After the removal of all equipment, the shaft will be sealed in a manner approved by the appropriate regulatory agencies.

(2) All portions of the Area of Operations not previously reclaimed will be re-contoured and re-topsoiled. All remaining topsoil will be spread over the Area of Operations and contoured.

(3) Sediments accumulated in the holding pond, if any, will be scalped from the pond and either hauled from the Project Area or disposed of underground in the mined out workings.

(4) The Area of Operations will be radiometrically surveyed and any material found which exceeds acceptable radiation standards will be either buried in the mine workings or removed from the site.

(5) The diversion channels built at the start of the Project will be kept in place so as to divert surface runoff around the area of reseeding until revegetation has been adequately established. Thereafter, if requested by the BLM, these channels will be recontoured and seeded.

(6) All ground surface which has been disturbed will be drill seeded using a seed mixture approved by the BLM prior to application.

(7) The potential usefulness of the water well will be evaluated as part of final site reclamation. If there is no other use for the well, it will be sealed and abandoned.

(8) The access road used for site access and haulage will be fully reclaimed unless the BLM requests that it be left in place as part of the regional road system under the jurisdiction of the BLM.

PROPOSED RADIOLOGICAL MONITORING PROGRAM:

The proposed radiological monitoring program involves collection of appropriate data before the mine is operational. Additional measurements will be made as needed during mine operation and in the event of an accidental release of radioactivity to the wash. A final survey will be conducted at the time the mine is closed. Each part of the monitoring program is described below:

(1) **Preoperational Baseline Information:** The preoperational baseline data collection program will last one year and will involve background measurements of direct gamma radiation, radon gas and progeny concentrations, and radioactivity concentrations in air and soil.

Direct gamma radiation measurements are being obtained on a quarterly basis by at least two independent monitoring devices and at a minimum of 4 locations. Passive thermoluminescent dosimeters will provide cumulative dose information. Readings from a pressurized ion chamber and/or two micro-R scintillometers will be recorded whenever the thermoluminescent dosimeters are exchanged. The entire Radiological Assessment of the Hermit project is located in the Appendix of this document.

Quarterly radon concentration measurements are being made at the 4 sites using Terradex alpha track-etch detectors. The first measurements are reported in the Appendix. Passive radon measurements are also being made at the Pinenut, Pigeon, Kanab North and Canyon Mine Sites. Data can be used to determine the local variations in radon concentrations and to monitor for any cumulative impacts from the increased uranium mining activities.

A water sample has been collected from the stock tank located near the proposed mine site. Radionuclide assay for baseline data is in progress.

Water samples from Kanab Creek (DM 85) and the Colorado River (McK 86) have been analyzed and may be used to monitor changes in radioactive material concentrations. However, as a result of variations in water flow rates (dilution factors) and

leaching of ore from the many exposed deposits which are located around the Arizona Strip, Grand Canyon, and the Little Colorado River, no noteworthy manmade increases should be anticipated.

A soil sample has been collected from an area downslope from the site. It will be assayed specifically for Ra-226 and gamma spectrometry performed to determine baseline concentrations of Th-232, Tl-208, K-40, and Cs-137 (from fallout).

Passive dust samples have been collected at the four monitoring sites to obtain background information on the amount of natural radioactivity in the dust around the mine.

(2) Operational Measurements: The quarterly thermoluminescent dosimetry measurements and scintillometer measurements will continue at the four established monitoring sites. Pressurized ion chamber measurements will be performed at least once per year to confirm the thermoluminescent dosimetry and scintillometer readings. Additional sites may be established at the mine and along the haulage route as deemed necessary.

Based on time and need, radon measurements will be performed in and around the mine site. The objective will be to collect sufficient radon information to ensure no noteworthy increase in radon gas occurs downwind from the site and to monitor for any cumulative impacts which might occur as a result of increased mining activities.

Passive dust monitoring will continue and will be used to monitor for significant changes in airborne radioactivity.

Soil samples will be obtained only as needed to delineate possible radionuclide increases from accidental releases or to ensure that ground water, if present, will not be adversely impacted.

Water sampling will continue at any operating on-site wells. The collection program will be integrated with the water sampling programs currently in progress at the other mining operations on the Arizona Strip. It is hoped that the water results and associated information may be used by the Bureau of Land Management, Forest Service and Park Service to assist with ongoing, long- term assessments of water quality in the Grand Canyon area.

Whenever a haulage accident occurs a radiological report will be prepared. The report will contain such information as the amount of material spilled, the extent of area affected, measures taken to provide an adequate cleanup, results of the

final radiological survey, and estimates of any possible non-occupational exposures.

B. Alternatives Considered

1. Alternative 1

No Action. The No Action alternative is a continuation of existing conditions. The details of this are described in the section on "Affected Environment." Under the no action alternative, the Plan of Operations would be denied if it did not meet the criteria of 43 CFR 3809 surface protection regulations to prevent unnecessary or undue degradation. The plan would be returned to Energy Fuels to be resubmitted when it had been upgraded to meet the requirements of the law.

2. Alternative 2

This alternative would involve approval of the plan of operations as submitted.

3. Alternative 3

This alternative involves approval of the Plan of Operations with various additional mitigation or stipulations, including but not limited to the following:

- Alternative access to the project area as depicted on Figures 11 and 12.
- Use of other forms of transportation for employers to access the mine site, i.e. private cars, aircraft.
- Relocation of surface facilities within the mine yard.
- Require reclamation of the two temporary access roads that now lead into the site.
- Require EFN to fully construct holding ponds before uranium ore is stockpiled on the surface; i.e. beginning of Phase I.
- Require dust suppressent on the approved access.

IV. THE AFFECTED ENVIRONMENT

As stated previously in Section III.B. the affected environment is equivalent to that situation that exists currently in the District, prior to EFN submitting their mining proposal. This means all existing mining activities and their environmental impacts are included in the current situation. The proposed action and all alternatives will therefore be evaluated against existing conditions.

A. Land Status

Figure 1 shows the existing land status and boundaries of interest in relationship to this project.

Specifically, this project is located within the unsurveyed Township, T38N, R4W, of SW¼ Sec. 17. Both surface and mineral estates are owned by the federal government and are open to mineral entry under the General Mining Laws of the United States.

B. Non-Living Components

1. Climatology/General

The general area is classified as a semi-arid continental climate. It is typified by cool winters, warm summers and light precipitation. Winter temperatures commonly drop below freezing at night while summer temperatures routinely rise above 90°F in the day.

a. Precipitation

Twenty-three years of data have been summarized at the Fredonia, Arizona weather observation station. A summary of this data shows the average precipitation is 10.1 inches (see Figure 5).

In addition the Bureau has summarized at least 13 years of local rain gauge data in the immediate vicinity of the project area. The results of which are shown in Figure 6.

b. Winds

In 1983, a one-year data set was collected from a meteorological station by independent consultants (Fox Consultants, Inc.) to measure wind patterns of the area.

Prevailing wind directions at the project area is from the south-southwest, with south-southeast through southwest winds clearly dominating the wind patterns of the area (approximately 40% of the time). Easterly component winds are least frequently occurring at the project area, with east-southeast winds occurring less than 1.0 percent of the time.

CLIMATOLOGICAL SUMMARY FOR FREDONIA, ARIZONA[1]

	Temperature (°F)					Precipitation (in.)				Mean No. Days Precipitation[2]
	Mean	Mean Daily	Daily Extremes			Totals	Snowfall			
Month	Monthly	Maximum	Minimum	High	Low	Mean	Maximum	Mean	Maximum[2]	.1"
JAN	32.7	46.0	19.4	66	-18	1.17	3.28	8.1	13.6	4
FEB	36.2	50.6	21.7	71	-15	.89	1.65	4.2	11.0	3
MAR	42.4	58.6	26.2	79	5	1.09	3.56	4.2	14.5	2
APR	50.7	68.7	32.7	86	10	.68	1.87	.7	2.0	1
MAY	58.0	77.0	39.0	94	20	.44	1.33	0	0	2
JUN	66.5	86.7	46.2	104	26	.32	.96	0	0	1
JUL	73.8	92.8	54.7	105	37	.69	1.88	0	0	2
AUG	72.1	90.1	54.1	104	33	1.27	2.68	0	0	4
SEPT	65.1	84.6	45.6	99	26	1.04	2.82	T	T	2
OCT	53.8	72.4	35.4	96	17	.88	3.09	.3	1.5	2
NOV	41.6	58.3	24.9	76	0	.62	1.39	1.2	6.0	3
DEC	34.6	48.5	20.7	70	-15	1.00	2.30	4.6	6.0	2
ANN	52.3	69.5	35.1	105	-18	10.09	3.56	22.3	14.5	28

Source: Climatography of the United States No. 86-2 Arizona.

1. Unless otherwise specified, based upon period of record 1937 - 1960.
2. Period of record 1951 - 1960.

FIGURE 5

SUNSET

YEAR	FALL	WINTER	SPRING	SUMMER	ANN. TOTA	FALL AVE.	WIN. AVE.	SPR. AVE.	SUM. AVE	ANN. AVE.
71-72	1.24	.98	.56	2.66	5.44	1.76	2.14	2.29	3.61	9.80
72-73	3.41	2.39	3.19	1.46	10.45	1.76	2.14	2.29	3.61	9.80
73-74	.23	1.06	.06	1.38	2.73	1.76	2.14	2.29	3.61	9.80
74-75	1.79	2.11	3.89	2.86	10.65	1.76	2.14	2.29	3.61	9.80
75-76	.32	1.60	1.86	5.88	9.66	1.76	2.14	2.29	3.61	9.80
76-77	.13	.40	1.11	1.48	3.12	1.76	2.14	2.29	3.61	9.80
77-78	.80	4.41	3.75	2.01	10.97	1.76	2.14	2.29	3.61	9.80
78-79	3.90	4.36	.89	3.12	12.27	1.76	2.14	2.29	3.61	9.80
79-80	.74	3.69	4.03	3.83	12.29	1.76	2.14	2.29	3.61	9.80
80-81	2.71	1.15	3.58	1.37	8.81	1.76	2.14	2.29	3.61	9.80
81-82	2.29	2.20	2.62	8.07	15.18	1.76	2.14	2.29	3.61	9.80
82-83	2.77	2.23	3.40	7.26	15.66	1.76	2.14	2.29	3.61	9.80
83-84	2.15	1.30	.47	3.25	7.17	1.76	2.14	2.29	3.61	9.80
84-85	.72	3.76	2.31	2.75	9.54	1.76	2.14	2.29	3.61	9.80
85-86	3.18	.42	2.58	6.84	13.02	1.76	2.14	2.29	3.61	9.80

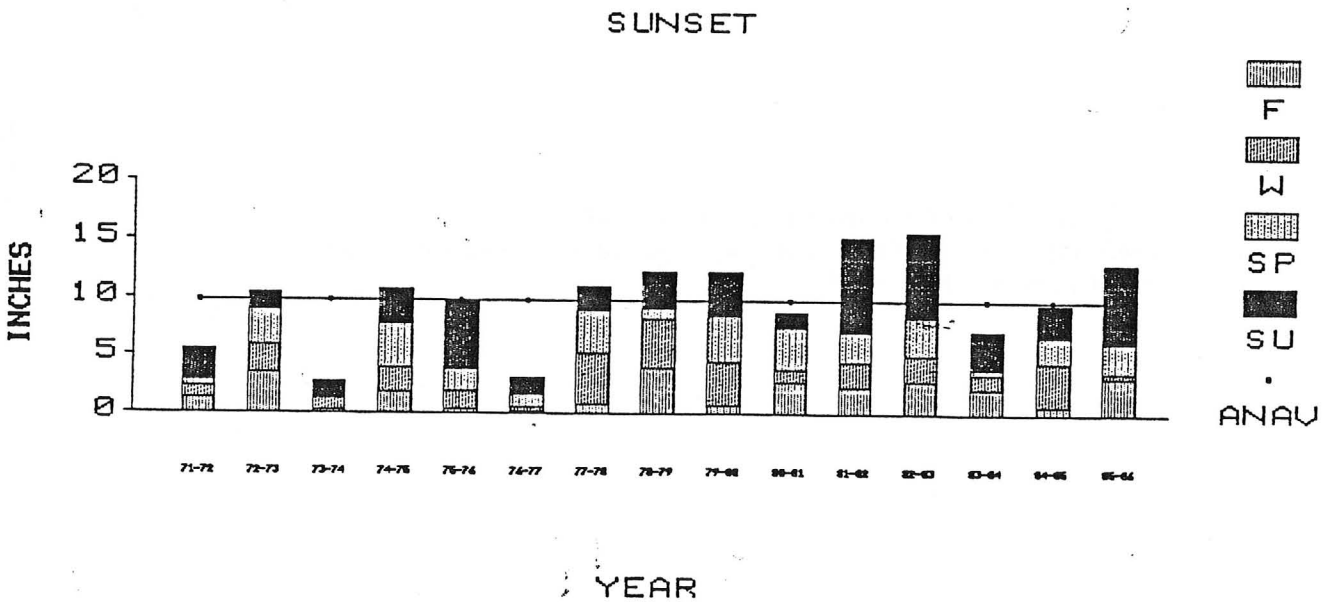


FIGURE 6

Wind speeds averaged 3.4 m/sec (7.6 mph) throughout the one-year monitoring period, with the higher average wind speeds more often associated with the southerly component winds. Higher wind speeds were not as common as wind speeds in excess of 11 m/sec (24.6 mph) occurred only 0.32 percent of the time. (Appendix, Air Quality Impact Analysis of the Hermit Project, Enecotech, 1987).

2. Air Quality

The airshed in this vicinity is designated Class II airshed. Virtually no industrial pollutants exist. Air quality and visibility are good to excellent. The major pollutant is fugitive dust resultant from disturbed areas, roads, stockponds and high livestock use areas.

A Meteorological Monitoring Program was conducted on the Arizona Strip at Sunshine Point to establish the natural background levels of Total Suspended Particulate, (TSP).

All the data collected was in accordance with EPA monitoring and Quality Assurance (QA) guidelines. As part of the QA guidelines the monitoring study program colated samples to assess the precision of the TSP measurements.

This data showed the annual geometric mean to be 13.7 mg/m^3. The highest 24 hour concentration measured in the sampling period was 59 mg/m^3.

Because of the close proximity of the monitoring station to the Project Area, the similarities in climatology and absence of nearby major industrial sources, this data is a good representation of the baseline conditions at the project area.

For brevity, the entire Air Quality Impact Analysis for the Hermit Project is located in the Appendix.

3. Water Resources

Surface water in this area is derived exclusively from precipitation. Storm intensity can be quite severe due to small intense localized summer showers. Surface waters exist in the form of impoundments constructed and designed to capture the intermittent flows from localized and sporadic showers for livestock use. There are two such structures, each approximately 1.0 miles north and south of the project area. A third water source is located at the project site and was minor perched alluvial aquifer that is ephemeral in nature. It is controlled by EFN.

Ground Water

Throughout much of the Colorado Plateau, the regional ground water table is deep and controlled largely by the elevation of the Colorado River and its major tributaries which are deeply incised. In the viscinity of the Hermit Mine, the regional water table is at a depth greater than 2,000 feet and approximately 1,000 feet below the proposed depth of mining.

Perched ground water conditions occur locally within the sedimentary sequence above the regional water table. Perched (alluvial) aquifers, however, are typically discontinous and frequently not capable of being produced on a sustained yield basis due to low rates of natural ground-water recharge and their limited lateral extent.

At the Hermit Mine, perched ground-water conditions have been identified during exploratory drilling within the Coconino sandstone immediately above its contact with the underlying Hermit shale and within the Toroweap limestone. Other perched ground-water zones may also be anticipated to occur at isolated or discontinuous lenses within the Toroweap and Kaibab limestones. These perched zones may yield small quantities of water to mine workings as they are penetrated.

The experience at the Hack Canyon and Pigeon Mines, which are located in the same general area, has been that the rates of ground-water inflow to the mine workings decrease with time and generally cease within a period of several months. Parametric studies have further shown that based on the observed rates of ground water inflow at the Hacks Canyon and Pigeon Mines, the effective radius of influence as a result of drainage into the mine workings will be small and is typically less than a few thousand feet.

The final depth of mining is nearly 1,000 feet above the regional ground-water table within the Redwall-Mauv limestone aquifer. The Red Wall-Mauv aquifer is the upper most aquifer of importance capable of supplying a continuous water supply of a few gallons per minute.

Visual observations within the three Hack Mines and Pigeon Mines have shown the absence of open fractures or joints within the Pipe and that essentially all of the voids within the rubblized collapse zone have been filled with a fine grained matrix comprised of carbonaceous materials. As a result, the breccia pipe and the area immediately surrounding the pipe are effectively impermeable. This has been confirmed by laboratory tests on core samples taken from the same rock formation at the Canyon Mine project. These tests indicate

that the hydrolic conductivities of the rock mass within and adjacent to the pipe is less than 1 X 10^{-8} cm/sec. This is consistent with the observed conditions in operating mines on the North Rim, specifically the Hack Canyon and Pigeon Mines.

In general, the geology in combination with low precipitation and high evaporanspiration losses leads to little water actually infiltrating and percolating downward to the regional water table. Although the exact rates of natural recharge are not known, it is suggested that the rates of natural recharge are probably on the order of several hundredths to a few tenths of an inch per year (Metzer, 1961).

A small potential exists for minor perched ground water conditions to occur above the regional water table wherever a permeability contrast exists, for example, immediately above the contact of the permeable Coconino sandstone with the underlying low permeability Hermit Shale. Perched water may also be anticipated to occur as isolated or discontinuous lenses within the overlying Toroweap and Kaibab limestones. The existance of localized perched ground-water zones above the regional water table is manifested in isolated springs and seeps along the walls of the Grand Canyon and tributary canyons. The discharge from most of these springs is typically less than a few gallons per minute and frequently intermittant.

4. Soils

Soils in this area are alluvial derived from both Kaibab limestone and Moenkopie siltstone. These soils range from cobbly sandy loams to silt loams. Soils vary in depth from shallow on limestone ridges to deep in the Moenkopie swales. All are well drained. Erosion potential is low to moderate due to low relief.

Productivity of these soils are generally moderate, presently supporting mostly grassland/half shrub communities.

Given the subtle topography, low slope factor, there appears to be little potential for significant off site soil loss. For more information see The Soil Conservation Services Order III soil survey completed in 1984.

5. Regional Geology

The Kaibab Plateau, on which the Hermit Mine prospect is located, is underlain by a thick sequence of horizontal to gently dipping Paleozoic rocks (570 to 225 million years before present). The sedimentary sequence, which is exposed in the walls of the Grand Canyon, ranges from about 3,500 to

4,500 feet thick and overlies highly-deformed Precambrian (older than 570 million years before present) sedimentary, metamorphic, and igneous rocks. The Precambrian rocks form the basement complex which for practical purposes constitute the lower limit of ground-water occurrence and movement (National Park Service, 1984). While some ground water undoubtedly occurs within the Precambrian, the quantities and its significance are small compared to those within the overlying sedimentary strata.

Stratigraphy

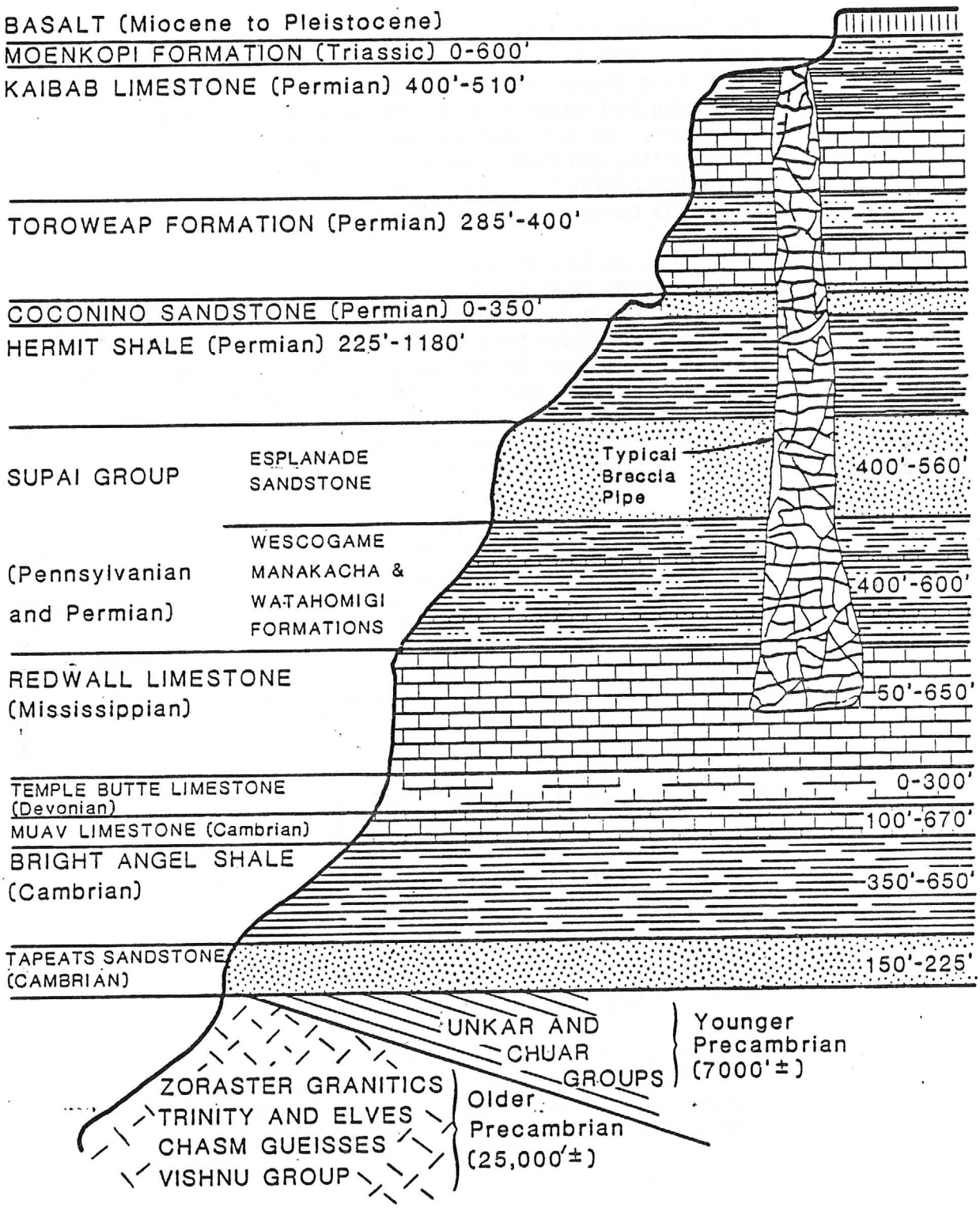
The generalized stratigraphy in the Hermit Mine site area is shown on Figure 7 and discussed below.

In the Hermit Mine site area, the uppermost formation is the Moenkopi of Traissic age. The Moenkopi consists of red siltstone and claystone which outcrop directly at the surface or underlie the surface at a shallow depth. The formation in the mine site area ranges from about 100 to 500 feet in thickness.

The Moenkopi is underlain by the Kaibab and Toroweap limestones. These formations dip gently to the north and are exposed in the walls of the Grand Canyon. In the Hermit Mine area, the aggregate thickness of the Kaibab and Toroweap Formations is 600 to 800 feet. In the vicinity of the Hack canyon and Pigeon Mines, the Toroweap Formation consists of a basal unit of sandstone and shale approximately 30 feet thick (Seligman Member), a 210-foot thick middle unit of fossiliferous grey limestone (Brady Canyon Member), and an upper, slope-forming unit of about 160 feet of gypsiferous shale and siltstone (Woods Ranch Member).

The Kaibab Formation consists of a lower member of fossiliferous, cherty, limestone (Fossil Mountain Member) and an overlying sequence of thinly-bedded limestone, shale and gypsiferous siltstone (Harrisburg Gypsiferous Member).

The Coconino sandstone directly underlies the Toroweap limestone at a depth of 900 to 1,000 feet within the mine area. The Coconino ranges in thickness in the mine area from about 30 to 50 feet. In the canyon rim north of the visitor center at the Grand canyon national Park, the Coconino sandstone is approximately 300 feet thick. The Coconino sandstone is a white, cross-bedded eolian deposit of Permian age.



SOURCES:

- DEPT. OF INTERIOR, 1976, DRAFT ENVIRONMENTAL STATEMENT, GRAND CANYON
- NUEXCO, REPORT 176, APRIL, 1983

Arizona Strip District
Generalized Stratigraphy

Dames & Moore

FIGURE 7

The Coconino sandstone is underlain within the mine area at depths of 930 to 1,050 feet by the Hermit shale. The Hermit shale is a dense, clay-cememted siltstone and behaves as a confining bed under the coarser and more permeable Coconino sandstone. As a result of the permeability contrast between these units, perched ground-water conditions may exist locally above the contact. Also springs and seeps may occur locally along the contact between those units in the canyon walls.

The Hermit shale, in turn, is underlain by the Supai Formation which extends from about 1,050 to 2,300 feet below the surface. The upper few hundred feet of the Supai Formation is the resistant sandstone that resulted in the formation of the inner gorge of the Grand Canyon. The upper Supai Formation and the overlying Hermit shale are the main host rocks for the ore deposit at the Hermit prospect. The lower portion of the Supai grades from a sandstone to a limestone which overlie the older limestones of the Redwall Formation.

The Redwall and underlying Temple Butte and Muav limestones collectively comprise the Redwall-Mauv aquifer of Northern Arizona. The Redwall limestone is a thickly-bedded, fine-grained limestone that typically is a cliff former where exposed along the walls of the Grand Canyon. In the area of interest, the Redwall is approximately 450 feet thick. The upper karstic member of the Redwall limestone is the source of the existing water supply for on-going operations at the Pigeon Mine, Kanab North, Pinenut, and the Canyon Mines. It is also the proposed source of water for the Hermit Mine.

The Temple Butte limestone, which underlies the Redwall, consists of interbedded dolomite, dolomitic sandstone, sandy limestone, siltstone and sandstone. It crops out as thin ledges and occupies small channels cut into the underlying Muav limestone. The Muav limestone consists chiefly of dolomitic limestone and is gradational with the underlying Bright Angel shale.

Structural Geology

Major north-south trending faults provide geologic and topographic boundaries to many of the plateaus. The Kanab Plateau on which the Hermit Mine is located, lies between the Toroweap-Sevier Fault on the west and the West kaibab Fault on the east (Figure 8). Both of these faults trend north-northeast with movement on the order of hundreds of feet. The West Kaibab Fault and the East Kaibab Monocline form the boundaries of the Kaibab upwarp (Kaibab Plateau), topographically the highest of the area. The East Kaibab Monocline and the Vermillion Cliffs intervene between the Kaibab Plateau and the Paria Plateau to the northeast. The Kanab Valley Fault bisects the Kanab Plateau.

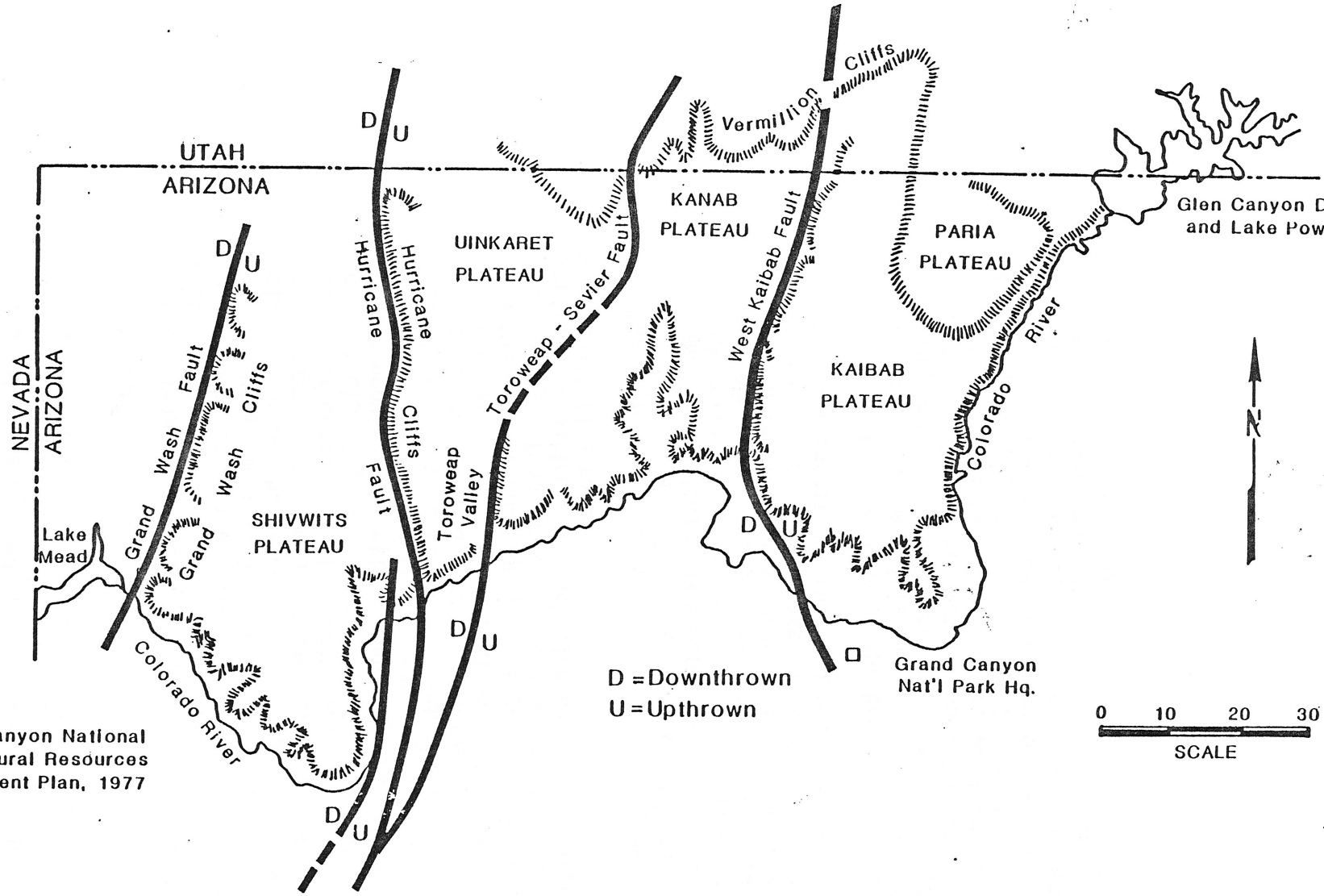
Movements along many of the faults began in the Miocene, but much of the activity peaked during Pliocene time. The faults are thought to be related to underlying Precambrian zones weakness. Numerous smaller faults and folds are also present; these generally trend north, northwest, or northeast.

Breccia Pipes

Roughly cylindrical, pipe-like collapse structures, termed breccia pipes, are common geologic features across the southern portion of the Colorado Plateau. The breccia pipes are relatively small in diameter, generally less than 500 feet, but may be thousands of feet deep. The pipes contain broken, rubbled rock from surrounding formations encircled by a series of concentric ring fractures. The more-permeable annular fault ring and the rock debris within the center of the pipe provided a vertical conduit for ascending and/or descending mineralizing fluids. When mineable ore occurs in a pipe, it typically is located in both the annular fault ring and the central breccia matrix, principally in the Hermit and Supai Formations. Because the pipes are not known to extend below the Redwall limestone, it is generally held that the pipes resulted from successive chimney collapse of the overlying formations into solution caverns developed within the Redwall limestone:

> "Geologists believe that cavities formed millions of years ago by dissolution of portions of the Redwall limestone (which) created space into which the overlying rock collapsed. The collapse zone propagated its way up hundreds, and in some instances, several thousands of feet in the form of a narrow cylinder or cone. This broken rock or pipe created a favorable environment for mineral deposition" (U.S. Forest Service, 1985).

Subsequent to the formation of the breccia pipes and mineralization, the materials within the pipe and in surrounding areas have been recemented and the void spaces filled with a fine-grained matrix consisting mainly of carbonaceous materials. As a result, the breccia pipe and the area around the pipe is effectively impermeable. Laboratory tests, for example, on rock core from the breccia pipe and surrounding areas at the Canyon Mine, (located south of the Grand Canyon), have shown the rock-mass hydraulic conductivities generally to be less than 1×10^{-9} cm/sec.



Source:
Grand Canyon National Park Natural Resources Management Plan, 1977

Arizona Strip District

Major Structural and Physiographic Features Map

Dames & Moore

FIGURE 8

6. Radiological Assessment

The natural radiation environment consists of cosmic radiation and many radioactive elements including Hydrogen - 3, Carbon - 14, Potassium - 40, Rubidium - 87, Uranium -235, Uranium - 238 and Thorium -232. Importantly both Uranium -238 and Thorium -232 are ubiquitious in soil with average concentrations of a few parts per million. Each are parent elements of a radioactive decay series. The thorium decay series is not significant in the Hermit ore body or other uranium deposits in Arizona so it will not be discussed here.

Natural uranium is about 99.3% U-238 so the radiation contribution from the U-235 series is insignificant.

Radioactive materials are naturally present in air, water and soils. Typical concentrations of naturally occuring uranium and Radium-226 in normal soil are on the order of 1 pico-Curie per gram. A pico-Curie (pCi) is equivalent to 2.22 atoms of the radionucliide decaying each minute (an extremely small number). Typical concentrations of Uranium and Ra-226 in surface, ground and domestic water are on the order of 1,3,2 pCi/L. Arizona's uranium concentrations in water have been reported to be between 2.5 and 2.7 pCi/L. These values vary considerably depending on the extent of uranium mineralization in the area.

The units of dose are rem (roentgen equivalent man). Because this unit is so large, it is useful to divide the value by one thousand and discuss radiation dose in terms of 1/1000 rem, or millirem (mrem). Dose rates are described as mrem per hour or per year.

Some typical radiation doses are as follows:

Source	Dose, millirem
Maximum allowable average occupational dose	5,000/yr.
Average dose received by all workers, uranium mines	365/yr.
Average allowable dose to general public	170/yr.
Canyon Mine Project	70-125/yr.
Hermit Project	105/yr.

Hacks Canyon and Kanab North	70/yr.
Average dose from diagnostic X-rays	70/yr.
U.S. average in water and food	25/yr.

Normal environmental outdoor concentrations of radon are generally less than 1 pCi/L. However, in uranium mines, radon concentrations may increase measurably.

Background Radiation

Four monitoring stations which measure background gramma radiation were established around the Hermit Project in September of 1986. The sites are approximately ¼ mile north, south, east and west of the proposed mine.

Other monitoring stations are in place at the Pinenut, Kanab North and Pigeon Mines and an extensive monitoring network has been set up at the Canyon Mine. Since gamma radiation data for all mine sites is being collected using identical detection methods and the entire region has similar radiation characteristics, any changes from existing background will be obvious.

Initial onsite measurements made in September 1986 and January 1987 indicate that the background gamma radiation exposure rates are on the order of 105 mrem/yr.

The entire Radiological Assessment of the Hermit Project is located in the Appendix of this document.

7. Accoustics

Due to the complex nature of accoustical studies conducted previously to evaluate potential impacts, an accoustical guide in the Appendix has been added describing nomenclature, instramentation and methodologies used to gather and analyze data.

Background ambient sound levels within the accoustical environment of the Arizona Strip District vary depending on the proximity of receptors to human activities; particularly highways or local roads, aircraft flight paths and local meteorological conditions. The most common noises resulting from man's activities in the Arizona Strip include off road vehicles such as jeeps, motorcycles and trucks (including lumber, oil and ore trucks) on U.S. Alternate 89, State routes

67 and 389 and other unpaved roads such as Ryan or Mt. Trumbull roads.

The Day-Night Average Sound Levels (Ldn), for open unpopulated areas away from highways is expected to vary from 30-45 dB (decibels). (U.S. Bureau of Reclamation, 1976; National Park Service, 1976) (16). For most detailed information on Acoustics in the Area refer to the Final Pinenut Environmental Assessment.

C. Living Components

1. Wildlife

A diversity of wildlife species has the potential to exist within the general project area.

a. Big Game

Extensive ground and limited aerial surveys were contracted by EFN for this proposed action. These surveys were designed to provide site-specific baseline data and to determine the extent and intensity of wildlife utilization (Spectrum Sciences and Software; Sigler and Associates; 1987). This contracted studies generally supports the data and observations of the Arizona Game & Fish and BLM as described in the Clayhole Habitat Management Plan (HMP).

Mule deer use and occurrence is nominal given the lack of cover around the actual mine site and access roads. Densities of mule deer are estimated to be below 0.5 deer per square mile. However, adverse winter cause deer herds to move from the Kaibab onto winter range areas along the tributaries of Kanab Creek.

Three miles south of this project, the terrain is more variable with substantial amounts of more diverse vegetative cover. Mule deer densities are greater with the better habitat conditions. However, survey data reflects very low numbers. Lack of desirable habitat components (esp. water) in the area precludes any liklihood for large numbers of mule deer.

About 300 pronghorn antelope occur in the Clayhole/ Antelope Valley area. The established herds have not pioneered into this area although it is considered

suitable habitat. However, a few isolated sightings are known in the Sunshine Point area.

About twenty-five desert bighorn sheep are now inhabiting portions of lower Kanab Creek from Grama Canyon south. The sheep are located several miles from the proposed action. Plans exist to manage for sheep throughout Kanab Creek in suitable habitat.

b. **Birds of Prey**

No birds of prey inhabit the local or immediate area due to lack of suitable nesting areas. The closest such habitat is approximately 6.0 miles to the east (Kanab Creek Canyon) or 3.5-4.0 miles south in the lower reaches of Gramma Canyon.

The project area supports a prey base utilized by more common raptor species such as red tail hawk.

c. **Non-Game/Small Game/Passerines**

The immediate habitat, is home to a variety of non-game/small game species.

An indepth species list follows, and cites relative abundance and habitat preferences of each species that has a potential to occur in this area.

o Indicates that the species has a "potential" to occur in the habitat type.

Species	Abundance*	Grassland	Desert Shrub
Great Basin Spadefoot Toad	C	o	o
Red Spotted Toad	C		o
Desert Night Lizard	C		o
Lesser Earless Lizard	N		o
Zebra-tailed Lizard	C		o

Species	Abundance*	Grassland	Desert Shrub
Leopard Lizard	C	o	o
Collard Lizard	C	o	o
Desert Spring Lizard	LC		o
Western Fence Lizard	U		o
Eastern Fence Lizard	C	o	o
Sagebrush Lizard	A	o	o
Side blotched Lizard	A	o	o
Desert Horned Lizard	C	o	o
Plateau Whiptail	C	o	
Tiger Whiptail	C	o	o
Western Blind Snake	U		o
Coachwhip	C		o
Striped Whip Snake	C	o	
Gopher Snake	A	o	o
Glossy Snake	C		o
Common King Snake	C	o	o
Longnose Snake	C		o

*Abundance: A = abundant, C = common, U = uncommon, R = rare
L = Local, S = Spotty, I = isolated, N = no record but may occur.

Species	Abundance*	Grassland	Desert Shrub
Sonora Lyre Snake	R	o	o
Desert Night Snake	C	o	o
Back-tail Rattle Snake	LV		o
Great Basin Rattle Snake	A	o	o
Mojave Rattle Snake	C		o
Desert Sidewinder	C		o

Source: Reptiles and Amphibians of the Arizona Strip
(1978, U.S.G.P.O. - 786-167)

Species	Abundance*	Grassland	Desert Shrub
Desert Shrew	SR	o	
California Myotis	C		o
Yuma Myotis	U	o	o
Western Ripstrelle	A		o
Mexican Big-eared Bat	R	o	o
Silver-harred Bat	R		o
Hoary Bat	U		o
Spotted Bat	LR		o
Brazilian/American Free-tailed Bat	C	o	o
Desert Cottontail	C	o	o

Species	Abundance*	Grassland	Desert Shrub
Jack Rabbit	A	o	o
Cliff Chipmunk	C	o	o
Antelope Ground Squirrel	A	o	o
Roundtailed Ground Squirrel	N		o
Common Pocket Gopher	C	o	
Little Pocket Mouse	C		o
Great Basin Pocket Mouse	C	o	o
Longtail Pocket Mouse	C		o
Desert Pocket Mouse	C		o
Ord's Kangaroo Rat	A	o	
Chisel-toothed Kangaroo Rat	C	o	o
Merriam's Kangaroo Rat	C	o	
Canyon Mouse	C		o
Deer Mouse	A	o	
Brush Mouse	C	o	o
Short-tailed Grasshopper Mouse	U	o	
Desert Woodrat	A	o	o
Coyote	A	o	o
Kit Fox	U		o
Grey Fox	C	o	
Badger	C	o	o
Spotted Skunk	U	o	o
Mt. Lion	U	o	o
Bob Cat	U	o	o
Muledeer	C		o
Pronghorn	LS	o	
Bighorn	LR		o

Source: Mammals of the Arizona Strip
(U.S.G.P.O., 1978 - 786-167)

Species	Abundance*	Grassland	Desert Shrub
Turkey Vulture	C	o	o
Gosnawk	R	o	o
Marsh Hawk	C	o	o
Rough-legged Hawk	C	o	o
Ferruginous Hawk	R	o	o
Red-tail Hawk	C	o	o
Golden Eagle	C	o	o
Prairie Falcon	U	o	o
Peregrine Falcon	R/ Endangered	o	o
Kestrel	C	o	o
Roadrunner	C	o	o
Great Horned Owl	A	o	o
Common Nighthawk	C	o	o

Species	Abundance*	Grassland	Desert Shrub
Lesser Nighthawk	C	o	o
Broad-tailed Hummingbird	U	o	o
Calliope Hummingbird	U	o	o
Anna's Hummingbird	R	o	o
Black-chinned Hummingbird	C	o	o
Costa's Hummingbird	U	o	o
Rufous Hummingbird	U	o	o
Cassin's Kingbird	C	o	o
Wied's Crested Flycatcher	R	o	o
Ash-throated Flycatcher	C	o	o
Olivaceous Flycatcher	R	o	o
Black Phoebe	U	o	o
Horned Lark	A	o	o
Common Raven	C	o	o
Bewick's Wren	C	o	o
Cactus Wren	C		o
Rock Wren	C		o
Canyon Wren	C		o
Mockingbird	C	o	o
Sage Thrasher	R		o
Bendire's Thrasher	U	o	o
Le Conte's Thrasher	U		o
Townsend's Solitaire	U		o
Blue-gray Gnatcatcher	C		o
Black-tailed Gnatcatcher	U		o
Phainopepla	U		o
Northern Shrike	R		o
Loggerhead Shrike	C	o	o
Bell's Vireo	R		o
Orange-crowned Warbler	R		o
Lucy's Warbler	C		o
Yellow Warbler	A		o
Yellowthroat	R		o
Macgillivray's Warbler	U	o	
Wilson's Warbler	R		o
House or English Sparrow	U	o	
Western Meadowlark	C	o	o
Brewer's Blackbird	C	o	o
Brown-headed Cowbird	C	o	o
Scott's Oriole	U	o	o
Western Tanager	C		o
Summer Tanager	R		o
Pyrrhuloxia	R		o
Brown Towhee	R		o
Albert's Towhee	R		o
Savannah Sparrow	U	o	o
Lark Bunting	R		o

Species	Abundance*	Grassland	Desert Shrub
Vesper Sparrow	U	o	o
Lark Sparrow	C	o	o
Black-throated Sparrow	A	o	o
Sage Sparrow	U	o	o
Rufous-crowned Sparrow	U		o
Chipping Sparrow	C	o	o
Brewer's Sparrow	C	o	o
Black-chinned Sparrow	R		o
White-crowned Sparrow	C	o	o
Golden-crowned Sparrow	R	o	o
White-throated Sparrow	R	o	o
Fox Sparrow	U	o	o
Song Sparrow	U	o	o

2. Vegetation

The general area of the mine site as well as the proposed access is located within grassland/desert half shrub type. The area supports 1 AUM per 11.7 acres and is considered in fair to good conditions.

The vegetation composition is basically as follows:

Winterfat	Russian Thistle
Blue gramma	Eriogonum (annuals)
Dropseed	Wolf berry
Big Galleta	Rabbit brush
Indian Rice Grass	Sage
Needle grass	Three-awn
Fourwing	

3. Threatened or Endangered Species

The areas of direct impact were inventoried for all Threatened and Endangered and Category 1 and 2 plant species. None were found.

Specifically, the Hermit Mine site and access was cleared for Pediocactus peeblesianus var. ficheisenii a category 1 species that occurs near the area. None were found. The soil and habitat of the area are not typical for this species. Transects through the area revealed no T&E species nor any other category 1 & 2 species.

Additionally, the area was reviewed for all Threatened and Endangered animal species and none would be directly impacted by this proposed action.

D. Human Values

1. Cultural Resources

A Class III Cultural Resource Inventory was conducted by Abajo Archaeology, at at the location of the proposed mine site and associated ore haulage road. A total of 40 acres encompassing the proposed mine area and 15 acres constituting 1.25 miles of haul road corridor was intensively surveyed.

A total of 5 isolated artifacts were found. No sites, structures or diagnostic features are present. Isolated artifacts include one Elko corner-notched projectile point basal fragment, and the remaining artifacts are non-diagnostic lithic debitage flakes and one core. No paleontological resources are known to occur in the area.

2. Socio-Economics

There are no new published census data since 1980, available for this socio-economic analysis. However, it was assumed that the previous summaries (1970-1980) are still reasonably accurate.

Four counties would be affected by uranium exploration and development at the Hermit Site: Mohave and Coconino Counties, Arizona, Kane and San Juan County, Utah.

a. Population

The Bureau of Census subcounty population data are from units known as census county divisions (CCDs). The primary population areas consist off three CCDs, for which population data are summarized below in Figure 9.

It is reasonable to assume that at least the CCDs containing Kanab, Utah and Fredonia, Arizona have experienced a moderate increase in population, in the period from 1981-1985.

As of 1980, the three CCDs had two incorporated towns, Kanab, Utah and Fredonia, Arizona. Kanab had a 1980 population of 2,148 and Fredonia had a 1980 population of 1,040. The total population in these two towns represent 50.4 percent of the 1980 populations for the three CCD north of the Grand Canyon National Park. The eastern portion of the Mohave North CCD contains most of the Kaibab Indian Reservation population as well as the small communities of Moccasin and Colorado City. These three population units represent an estimated 25 percent of the total population of the three CCDs north Grand Canyon National Park.

FIGURE 9

Census County Division Population Change: 1970-1980

CCD	Population 1970	- 1980	1987	Numerical Change	Percent Change
Mohave North (Co.)	950	1,786		836	88.0
Kaibab (Coconino Co.)	967	1,417		950	46.5
Kanab (Kane Co.)	1,621	3,116*(4800)		2,781	92.2
Total:	3,538	6,319	4,067		78.6

Source: 1970 Census; 1980 Census of Population and Housing Arizona and Utah
***Source:** Kane County Job Service 1987 estimate.

FIGURE 10

Selected Employment Data by County: 1980

Employment Category	Mohave*	Coconino**	Kane***
Manufacturing	1,925	2,150	65
Construction	225	50	15
Transportation/Public Utilities	875	1,025	15
Wholesale/Retail Trade	4,575	7,425	275
Finance/Insurance/Real Estate	675	750	40
Services	2,750	7,675	145
Government	2,625	8,925	275
Agricultural	4,075	1,100	435
Other	-	-	-
Total	18,625	31,275	1,370

*Arizona Statistical Review, Valley National Bank, Phoenix, Arizona 1982.
**Utah, County Economic Facts, 1980, Utah Industrial Development Information System, Salt Lake City, Utah.

As of July 1984, the following unemployment rates existed for the three counties:

	1984	1987 1st Quarter ****
*Mohave *(AZ)	7.3% unemployment	Feb. 10.9%
**Coconino (AZ)	9.0% unemployment	Feb. 10.9%
***Kane (UT).	10.0% unemployment	Feb. 7.2%

*Source: Mohave/Coconino County Job Services (Telephone Conversation)
***Source: Kane County Job Services (Telephone Conversation)
****Source: Arizona Department of Economic Security (Telephone Conversation)

(Both sources were named from quarterly unemployment bulletins.)

b. Employment

Figure 10 shows employment data for Mohave, Coconino and Kane Counties.

In addition to the above data, it is known that operations at the three Hack Canyon Mines (from 1980-1984) has generated at least $2,456,000 of severance, and property taxes for the state of Arizona. This figure will be actually higher when the other mines (Kanab North, Pigeon and Pinenut) are brought into production. EFNs presence in the communities of Kanab and Fredonia provides significant employment and benefits accrued therein.

3. Public Attitudes

Attitudes of the public regarding mineral exploration can be classified as falling into one of three categories: uninterested/uninformed, supportive, and opposed.

a. The Uninterested/Uninformed Category

According to the 1980 Census data, 134,664 people live in the three county region. Figure 9 shows 6,319 residents in the three CCDs closest to the Pinenut Site, representing only 4.7 percent of the total population (three counties). Most residents live in larger cities of Coconino and Mohave Counties, such as Flagstaff, Kingman, Lake Havasu City, Bullhead City, Riviera and Page. Because of uneven population distribution, one can assume that a large portion of its residents are not aware of, informed or interested in uranium exploration at Hermit.

b. The Supportive Category

Support for the proposed action exists on two levels. Generally, most of the three county residents are traditionally supportive of mining. Many feel that mining has been an important part of the economy and mining benefits the economy. Such supporters are sympathetic to the concerns of mining companies and are concerned about Federal and State Legislation/Regulation, which they view as curtailing/hampering mineral development and production.

On a more specific and localized level, past and present experience demonstrates, residents of the CCDs strongly support the proposed action. They perceive the proposed action as a source of potential employment and economic benefit. To many, this action represents the kind of development needed to broaden the economic base of the area beyond ranching, tourism and retirement.

c. The Opposition Category

Two specific groups oppose the proposed action. The main opposition comes from one local group and various individuals associated with specific environmental interests and issues. The second group of opponents consists of outside regional environmental groups. Some of these individuals who are aware of specific mining activities in the area oppose more mining. Others, unfamiliar with the specifics of the proposed action, apprehensive over the preceived potential health hazards of uranium mining and processing (in general the nuclear fuel cycle).

4. Wilderness

This area is approximately 7 miles west of the designated Kanab Creek Wilderness Area (Figure 1).

5. Visual Resources

The proposed project area is located on the Kanab Plateau. Relief is very gently undulating with an elevational difference of approximately 60-80 feet per square mile.

The proposed project area occurs on a portion of one of the important viewsheds on the district i.e. visable from Highway 389 and portions of the Kaibab National Forest. This is a designated Class IV visual designation in which most contrasts attracts attention and will generally dominant the landscape.

More importantly, the area is the foreground view and provides visitors with the open space/remote perceptions that are so important to recreationists seeking open spaces or exceptional sightseeing opportunities.

The Mt. Trumbull Road is the most important Travel Corridor (Travel Influence Zone) within the Resource Area, excluding the state highway system. This is evident by the large number of visitors (6,000 - 7,000) received at the Toroweap Overlook within the Grand Canyon National Park.

6. Other Values

The main value of this area as stated in the Management Framework Plan is the support of ranching, wildlife hunting and mineral interests as well as providing for open space and remote character.

Sightseeing is a common use of this area along the Travel Influence Zone, but camping or other forms of recreation are not known to occur in the area of the new proposed mine.

E. Cumulative Impacts

1. Existing Situation

Uranium exploration and development has been ongoing within the Arizona Strip District since approximately 1980. At present, the number of companies operating within the District has decreased by 50% since 1980.

Those companies still active in uranium operation are as follows:

Company	Comment
Energy Fuels	Presently the only company active in production, with 1 producing mine, 3 mines being reclaimed and two mines gearing up for production
Pathfinder Mines	Active in exploration only, with generally 2 drill rigs active full time. Exploration basically limited to specific claim blocks.
Rocky Mountain	Active in exploration only, with 1 drill rig full time on BLM lands and 1 drill rig full time on state and private lands (mostly in the Shivwits Resource Area).
Uranerz	Active in exploration within Shivwits Resource Area. Activities limited to Savanic, Cunningham and Copper Mountain Mines and a few isolated claim blocks throughout the district.

Cumulative Surface Disturbance Impacts Resulting from Exploration

As of the last Environmental Analysis for a uranium mine (Jan. 1986; Pinenut Environmental Assessment), it was determined that the following amounts of disturbance resulted from exploration in an approximate six year period.

Total Surface Disturbance	Total Reclamation	Total Unreclaimed (Pine Nut EA)
519 acres	447 acres	72 acres -60 acres since reclaimed 12.0

Since that period the following additional activities and disturbance has occurred:

Company	Plans	Notices	Amend	Surface Disturbance	Total Unreclaimed Dist.	Comments
EFN	2	24	10	53.0	20	2 mine plans - Hermit and Pinenut, 10 re-entries
PMI	0	9	24	40.6 ac.	13.1 ac.	27.5 ac. to be submitted
RME	0	14	0	28 ac.	0 ac.	6 of 14 notices were re-entries
U	0	4	0	8.0 ac.	0	reclamation yet to be submitted
TOTAL	2	51	34	129.6	33.1	86.5 acres have been reclaimed

*EFN Figures based on 2.0 acres per Notice and 0.5 acres per amendment. Amendments are re-entries to areas previously disturbed. EFN figures also include state lands. Due to use of common access, figures are unrealistically high.

**PMI Figures based on 0.1 acres per pad area (4000 ft.^{2}) plus actual access disturbance (10 ft. wide) and actual trenching disturbance. PMI currently maintains a significant amount of "common" access that will be reclaimed.

***RME Figures based on 2.0 acres per notice. RME is currently re-contracting reclamation work on all of 1986 notice submissions.

**** Uranerz has reclaimed all notices but plan to re-enter the site.

Reclamation work proceeds immediately after operations cease. However, many drill areas utilize a common access that has been constructed by the companies. Therefore, as the drill site areas are reclaimed the access is left open to continue adjacent exploration.

All companies no longer solvent or active within the District have reclaimed their sites and they have been released by BLM.

One company, Intermountain Exploration still maintains valid claims within the Paria Canyon-Vermilion Cliffs Wilderness Area. Prior to any further surface disturbing activities on these claims a validity exam will be performed to assure complianced with the Wilderness Act.

It is apparent from the above table, that within the last 7 years, exploration activities has resulted in approximately 648.6 acres of disturbance. However of this disturbance, approximately 533.5 acres have been reclaimed.

Even if reclamation were not a requirement, the total percent of surface disturbances compared to that in the resource area or the area of high mineral activities would be very small, generally far less than one tenth of a percent.

HACK CANYON (F)

Cummulative Surface Disturbance Resulting From Uranium Production

Since 1980, the following cumulative surface impacts from mining have resulted.

Hack's 1, 2	Hack's 3	
9.1 acres disturbance	2.55 acres disturbance	=
4.5 miles existing access upgraded	.77 miles additional access	=

Total 11.66 ac + 10 acres buffer zone = 22.0 acres
Total 5.27 miles of access.

- original access was existing but upgraded to accomodate ore haulage
- 48 people are employed.
- EFN busses employees.
- All three mines are in the first phases of reclamation.
- Mt. Trumbull road is maintained by EFN and the county.
- 14.5 miles of powerline on public lands. This powerline will remain because of the Hermit and Pinenut Mine use.

Pigeon

PIGEON MINE (P)

- 40 acres (including 10 acre buffer zone).
- 10 miles of existing access upgraded to accomodate ore haulage plus 1/4 mile new access.
- 38 people are employed.
- EFN busses employees.
- Hauling is approximately 10-15 trips per day on Ryan road.
- Life expectancy is approximately 1990-1991, reclamation is scheduled immediately afterwards.
- 8.0 miles of powerline .

Kanab North (F)

- 28.0 (includes 10 acre buffer zone)
- 6.5 miles of existing access upgraded to accomodate ore haulage,2.0 miles of new access constructed.
- 8.0 miles of powerline
- Ore haulage will not take place until 1988.
- 42 people are employed.
- Life expectancy 1992, reclamation is scheduled immediately afterwards..

Pinenut (F)

- 20.8 acres (for the mine yard)
- 17.0 miles of existing access upgraded (approximately (0.5 miles of new access resulting from realignment).
- Ore haulage not anticipated until 1989.
- Life expectancy approximately 9 years.
- Approximately 38 people employed.
- 8.3 miles of proposed powerlines

Total Disturbance Resultant from Production

Mine Yard Acreage	115.0 acres
Existing Access Upgraded	39.0 miles
New Access Constructed	3.5 miles
Miles of Powerline	30.5 (on Public Lands)

The total impact of mining disturbances is less than 0.0027% of the entire Strip District. Of special importance is that the three Hacks Canyon Mines will begin reclaimation activities during the second quarter of 1987. Therefore, by Mid-1987, there will be no further ore hauling on Mt. Trumbull Road until the Kanab North Mine comences ore production by mid 1988. In 1990, the Pigeon Mine will begin reclamation. The Pinenut Mine will haul on Mt. Trumbull road from mid 1989 through 1994. Thus there soon will be a significant net decrease in the amount of ore hauling in the area that will persist for at least 3 to 5 years, given the staggared rate of production (assuming no additional mines).

By the time the Hermit Mine is producing, the Hack Canyon Mines will be fully reclaimed, the Pigeon Mine will also be under reclamation, the Kanab North mine will be gearing down for reclamation and the Pinenut Mine will still have several years of production left.

The Environmental Impact Statement (EIS) on the Canyon Mine proposal was prepared by the U.S. Forest Service and

it states that the proposed mine would not have any environmental impacts on the Arizona Strip since the impacts from that kind of mine was so localized.

1. **Analysis of Cumulative Impacts from Exploration**

Exploration has resulted in approximately 648 acres of surface disturbance within the Arizona Strip since 1980. Of this, 533.5 acres have been reclaimed. The additional acreages that are at present unreclaimed represent ongoing activities or access that is used in common with several exploration areas.

The following impacts have occurred:

Vegetation

Generally vegetation is trampled by overland type vehicles. Damage is usually not severe where heavy equipment has not been used. Blading will destroy vegetation entirely.

Drill pads are generally not bladed unless on an excessive slope. However revegetation is a requirement on plans, notices, amendments or modifications. It is a renewable resource. The 72 acres yet unreclaimed are considered insignificant. Reclamation is an ongoing activity.

It is a requirement that all areas to be disturbed will be in compliance with the Endangered Species Act. To date all T and E species have been avoided.

Wildlife

Generally, wildlife is affected by the loss of vegetation which provides food, cover and nesting sites. Loss of vegetation is not permanent. Given the total loss plus that which is rehabilitated, impacts are considered insignificant.

The presence of humans/machines and other foreign sites, sounds and smells associated with drilling activities are thought to have had a potentially greater impact on wildlife than the actual temporary loss of vegetation. However the short duration of most exploration operations and the small areas affected do not pose significant impacts. Exploration activities generally are separated by great distances and most last less than 3-4 weeks, depending on drilling results.

Peregrine Falcons are provided strict protection during breeding and fledging periods pursuant to Section 7 (ESA) consultation with U.S. Fish and Wildlife Service. No operations have been approved within 1.0 miles of the Kanab Creek rims in superior habitat from the period from March 1 to August 15th.

Soils

Soils are slightly affected by overland travel and where access or drill pads have been bladed. Significant erosion events are eliminated with proper mitigation and reclamation. Impacts are insignificant.

Fugitive dust resultant from vehicle travel is the largest contributor of dust. Historically there are normally less than four drill rigs operating within the entire district at anyone time. Smaller support vehicles do most of the overland exploration activities (ie, casual use operations). The increase in dust resulting from exploration activities is short lived and local to the immediate area around occasional road blading to the exploration site and therefore is considered insignificant.

Air Quality

Impacts to air quality (Class II) are negligible based on the negligable amount of soils actually disturbed. Fugitive dust resultant from vehicle travel constitutes a line source that could be quantified via computer models but would be insignificant given the amount of vehicle use, temporary duration on each site and the amount of disturbance during operations.

Water Quality

No impacts to surface water have been observed on the Strip District as a result of any mineral action.

Ground water is protected and regulated by Arizona State Law which requires immediate plugging of drill holes in a manner that will preclude cross contamination between aquifers or from the surface.

In any event, the probability of finding mineralization in any single hole is extremely low. (The vast majority of holes are found to be barren).

No quantifiable impacts to the Kanab Creek Drainage has ever been observed. Sixty water/sediment parameters are measured regularly and there has never been a quantifiable change in the results obtained which has been attributed to mining activities.

Remoteness

The remote and isolated nature of the district can be said to have been affected to some degree by the increase in exploration activities over the last 5 years. However, the level of frequency of the activities within the district has not been of a magnitude to alter the fundamentably remote character of the district. In order for this fundamental character to be changed, activities would have to expand tremendously. The affect of exploration activities are considered insignificant for the following reasons:

1. The probability of being in the vicinity of a drill rig during operations is extremely low given the great distances that usually separate these activities and the short duration of time (less than 3-4 weeks) that exploration activities persist on any single site.

2. There are less than 4 drill operations occurring simultaneously on the Arizona Strip's 8.5 million acre. Visual impacts are usually screened by topography and vegetation.

3. No permanent adverse impacts are allowed from any operation pursuant to requirements that provide for mandatory reclamation.

Social/Economic Structure

Economic impacts from exploration activities are positive from the standpoint of employment of locals and support needs for exploration and mining equipment. These operations provide economic revenues to local and state agencies. Additional benefits are added by support of other local services that are not directly associated with exploration activity. Most people hired for exploration and mining are "locals" thus the influx of "outsiders" is very limited. It should be noted however that these activities can have negative impacts on those members of the public, that oppose this type of operation.

b. **Analysis of Impact from Production**

Impacts to soils and vegetation are directly related to the actual surface disturbance that occurs when mine areas, roads or powerlines are constructed. The total amount surface disturbance associated with mining in the District is insignificant when compared to the total amount of land within the District. All operations are temporary and full reclamation is a mandatory requirement.

Visual Impacts

Visual impacts do occur as a result of mining, but such impacts are temporary and usually confined to local on site concerns. Examples: the three Hack Canyon Mine complex can be observed only when one is at the mine site due to twisting canyon turns or at specific places on the rims atop the canyon. The Pigeon Mine is generally not observable from any portion of the access except for the evaporation pond and the yard enclosure atop the canyon. Pigeon Mine is observable from Forest Service lands across the Canyon but not directly visible from the bottom of the Canyon.

The Kanab North Mine is located on the rim of Kanab Creek. It is not visible on the West side of the creek except at an approximate distance of .5 miles when the head frame first becomes visible. Kanab North is visible from a wide area on the east side of Kanab Creek approximately 2.0 miles away, but it is not visible from within the canyon.

Wildlife

Wildlife is potentially affected by ongoing mining operations. Impacts occur due to vehicle use of roads and human activities. The extent of impacts are limited to those impacts that occur within a close proximity to the mine yard or haul route. Impacts are considered insignificant due to the small amount of habitat that is temporarily lost and of short duration of activities and the vast acreages of similar habitat available in the district. Impacts generally are also site specific.

No adverse impacts to resident deer pronghorn or bighorn sheep have been observed as a result of mining activities. There have been no documented cases of mortality to deer, pronghorn or sheep from any hauling operation.

Monitoring for falcons and eagles has occurred. To date there is known evidence that either species has been adversely affected.

Air Quality

Analysis of cumulative impacts on the air quality within the district from mining activities has showed no significant adverse impacts. The small impact areas resulting from mines like the Pigeon Mine and Kanab North Mine and the relatively large distances between operations, make any cumulative impacts highly unlikely. Utilization of haul roads by the operations similarly are not likely to generate levels of TSP which approach the air quality standard of 260 Mg/m. Morever, if such a level were to be approached, mitigation measures are available to reduced the impact. For additional analysis see the proposed action and the Air Quality Impact Analysis for the Hermit Project.

Water Quality

No surface waters have ever been affected as a result of mining operations, including Kanab Creek.

Kanab Creek and several springs are regularly monitored. There has never been an increase above background fluxuation of any mineralized material in the surface water.

V. ANTICIPATED IMPACTS OF THE PROPOSED ACTION

A. Land Status

EFN has not applied for a mineral patient. Therefore, this proposal would have no affect on land status.

B. Non-Living Environment

1. Airshed

A thorough discussion of the computer dispersion models, methods, and significance of anticipated impacts and several worst case analysis are located in the appendix (see Air Quality Impact Analysis of the Hermit Project).

As stated in this report the proposed action would not have a significant adverse environmental impact on the immediate airshed classifications (Class II) nor the Class I airshed of the Grand Canyon National Park.

2. Climatology

The proposed action would have no effect on local or regional climatological patterns.

a. Precipitation

The proposed action would not affect local or regional precipitation.

b. Winds

The proposed action would not affect local or regional wind patterns.

3. Air Quality

To determine the potential impacts of the proposed action on air quality, extensive computer modeling was undertaken using actual meteorological data, emission inventories and emission rates. These studies were conducted to determine actual impacts as well as projected "worst case" impacts under extremely conservative assumptions.

These studies show that the proposed action including mine yard and haul road activities would not create impacts that would approach or exceed any substantial air quality standards or mandates. The Air Quality Impact Analysis is located in the appendix.

4. Surface Hydrologic Impacts

Flooding Potential

With the diversion ditches designed to pass the 100-year flood peaks and additional freeboard provided in the channel design and that available due to the proposed dike, no flood damage is expected to any facility at the mine site. Because of available freeboard, the mine site facilities are flood proof for much more severe floods than the 100-year event. Some overland and overbank flooding may occur, during the 500-year storm event on the channel flank farther from the site boundary. However, this overbank flooding is not expected to be more severe than that expected under the existing conditions. At present, the entire storm runoff from sub-watersheds A and B runs through natural depressions or rills or as overland flow. The construction of the proposed ditches will channelize flood flows and minimize overland flow and the associated soil erosion. Any overbank flows spilling over the channel banks would be much less than the overland flows without the ditches (i.e., under existing conditions).

The on-site retention pond has a capacity to store more than the volume of the 500-year 24-hour storm runoff from the Project Area. Therefore, the flooding potential downstream of the mine site would be somewhat attenuated and the streamflows would be somewhat reduced. However, the area of subwatershed C, from which the surface runoff would be contained is only 8.3 percent of the total area of the watershed contributing runoff to the point immediately downstream of the Project Area. Therefore, the overall impact at this location would be minimal and would become insignificant at points further downstream.

Erosion Potential

With the riprap and or vegetation proposed along the inner banks of the diversion ditches, the potential for bank erosion would be minimized. Some erosion may be expected on the outer (unprotected) banks of these diversion ditches. However, the channel velocities for the most extreme flood events are in the range of 4.5 to 5.0 ft/sec as compared to the reported non-scouring velocities of 2 to 3.5 ft/sec for channels excavated in alluvial silts (Chow, 1959). Therefore, the erosion potention during most flood events is expected to be minimal.

Any flood induced erosion within the Project boundary would be contained and therefore the impact of this erosion on the surrounding surface water environment would be insignificant.

Accidental Release of Contaminants

As described in the previous sections, with the proposed design criteria, the probability of any eroded or accidentally released contaminant getting out of the site area is extremely remote. To analyze a hypothetical scenario, it is postulated that some amount of contaminated liquid gets released into the surrounding surface water environment, during an unexpectedly severe event, e.g., in excess of the design standard. This volume of contaminated liquid would first be diluted by the estimated 2.95 acre-ft of runoff volume generated within the Project Area. Further dilution would be provided by an additional total runoff volume of 30.18 acre-ft from subwatersheds A and B by the time the contaminant reaches the downstream end of the mine site area. This would provide an additional dilution factor of about 11.2. Further dilution will be available when the contaminant reached Bulrush Canyon and a dilution factor of about 2700 would be available in Kanab Creek giving a total dilution factor of about 24,000 between the concentrations in the water getting out of the

mine site area and that flowing down Kanab Creek. It may be noted that the drainage area of Kanab Creek near Fredonia is 1,085 sq. miles compared to a total drainage area of 0.388 sq. mile for the subwatersheds upstream of the outlet point of the mine site area (USGS, 1979). Therefore, it is expected that the available dilution factors in Kanab Creek under other flow conditions would also be of the same order of magnitude as for the storm exceeding the 500-year event.

5. Groundwater Impacts

Experience to date has shown that the rates of ground-water inflow to the existing mines in the Kanab Plateau decrease with time and are small, that is less than 5 gallons per The proposed depth of mining within the mineralized portion of the breccia pipe at the Hermit site would be approximately 1,000 feet above the regional ground-water table within the Redwall-Mauv aquifer. Laboratory tests on rock core from within the breccia pipe but below the depth of uranium mineralization have shown the rock mass to be effectively impermeable. Measured hydraulic conductivities for the non-mineralized portions of the breccia pipe below the depth of mining were less than 1×10^{-8} cm/sec. This compares measured hydraulic conductivities of less than 1×10^{-9} cm/sec for the altered sandstone and siltstone units adjacent to, but outside of the breccia pipe and measured values of 2.0×10^{-7} to 1.4×10^{-6} cm/sec for non-mineralized portions of the pipe within the zone of mining.

Recementation of the collapse breccia within the pipe and the alternation and recementation of the sedimentary units immediately around the pipe have resulted in a very low permeability environment. Because of the very low permeabilities and the physical separation, the potential for any direct impact on water quality or quantity within the Redwall-Mauv limestone aquifer is negligible.

In addition to these physical factors which limit the potential for water quality or quantity impacts with the Redwall-Mauv aquifer, absorption of heavy metals and radioactive constituents on the surfaces of clays as well as chemical reactions with the rock strata would tend to minimize or eliminate any short-term or long-term potential water-quality impacts. Thick sequences of agrillaceous mudstones and limestones with high absorptive capacities physically separate the uppermost aquifer within the Redwall-Mauv limestones and the proposed depth of mining.

It can be expected that mine development may locally dewater perched ground-water systems which exist within the thick unsaturated zone above the regional water table. Any effect on these perched systems, however, would be limited to the immediate mine area. (See the Ground Water Impact, Assessment, Appendix),

6. Soils

Soil disturbance at the mine yard would consist of minor recontouring to internally drain the area towards the holding pond and the channelizing of the watershed around the mine yard. Top soil would be stockpiled causing and adverse changes in the microbial community. Once the area is reclaimed it is believed that due to the small size (less then 23 acres) of disturbance that the microbial population will restore itself rather quickly.

Soil erosion rates would increase during construction but considering the drainage plan proposed, soil loss from the surrounding area is anticipated to be insignificant. If soil erosion rates or soil loss from the site becomes a problem EFN would be required to correct it immediately.

On haul routes, soils would be compacted by the use of heavy equipment and other vehicle activities. Runoff from the road may increase soil erosion rates during periods of intense storm activities. The use of culverts and fill material should greatly reduce this risk and therefore the anticipated adverse impacts should be minimal, as well as temporary.

7. Geology/Topography

During Phase I and II, there would be some change in relief (23 acres) of the project area. To accommodate full internal drainage of the mine yard, minor grading of the mine yard itself is necessary.

Upon cessation of operations, only minor changes in the pre-mining contours would occur. As revegetation proceeds, these changes should be unnoticeable to the average visitor.

Additionally, given the stable nature of the local stratigraphy, there is virtually no probability of a "collapse" that might manifest itself on the areas surface topography.

8. Radiological Impacts

Based on the evaluations of direct radiation, radon, dust emissions and ore hauling within the Radiological Assessment of the Hermit Project (Appendix) and the commitment of EFN to not allow any liquid releases from the mine yard, there is not expected to be any significant adverse radiological impacts to the surrounding area, to visitors, local inhabitants or the mine workers.

During mine operation, the impact from ore piles and releases to the air from vent shaft would not be measurable at distances greater than a few hundred meters from the mine yard. Nor would it be possible to distinguish between mine induced radiation from natural background radiation in the environment. The complete Radiological Assessment of the Hermit Project is located in the appendix document.

9. Acoustical Impacts

Based on similar studies at other mines in the District (Pinenut and Hack Canyon), significant audio-impacts are not anticipated. Those impacts that are anticipated are within applicable limits set for safety standards.

Nor is it anticipated that accoustical effects would have significant negative impacts on recreation due to extremely low use of the area and the fact that higher recreation values are found elsewhere. For comparative purpose see the Pinenut Environmental Assess Acoustical Impacts section.

Based on similar operations and experiences of the U.S. Forest Service at the Canyon Mine, noise from hauling is not expected to have significant adverse impacts on wildlife species.

C. Living Environment

1. Wildlife

a. Big Game

It is anticipated that the proposed action would have only a very minor negative impact on mule deer and antelope for the duration of this project. The combination of low densities of mule deer and antelope, lack of water and cover in the immediate area and the

small amount of surface disturbance associated with the mine yard and haul road does not lend itself to significant adverse impacts.

The increased sights, sounds and smells of human activities are not expected to significantly interrupt daily movements and use of the immediate area by big game due to such low densities of these species.

Impacts are expected to increase slightly in magnitude during Phase II. These impacts would be associated with the construction of the new haul road and actual hauling activities.

The probability of direct mortality to deer or antelope as a result of a vehicle collision is extremely remote and considered insignificant.

No impacts to recent or future transplants of bighorn sheep in Hacks Canyon or Kanab Creek are anticipated.

b. **Birds of Prey**

This project is expected to have no significant adverse impacts on golden eagle (protected) or peregrine falcon (endangered), as this area contains no suitable nesting areas.

Minor insignificant adverse impacts may occur to other raptor species due to the loss of 23 acres (+) of habitat/prey base.

The chance for future adverse impacts is also considered extremely remote. The actual mine yard and hauling areas are far enough removed from known habitat or sightings as to have a negligible impact on any species.

Impacts to the prey base and consequently the effects on other raptors should also be insignificant, given the small amount of area affected, other remaining existing habitat, and the temporary nature of operations.

c. **Non-Game**

Loss of 23 acres and 1.2 miles of access would destroy approximately 23 acres of habitat, including food, cover, burrowing and nesting sites of small animals as well as direct mortality. Impacts may be adverse, but are considered insignificant due to the small amount of habitat actually disturbed. In addition, when

reclamation is accomplished, it is expected, the area would support at least the original populations that existed in the predisturbed conditions.

Increased vehicle traffic and human/wildlife encounters along the aligned road could result in shifts in wildlife use patterns and avoidance of the road area.

2. Vegetation

Negative impacts would result when the mine yard is cleared and graded to insure internal drainage. This impact would involve approximately 23 acres of vegetation in the mine yard plus an additional 5 acres due to the construction of 1.2 miles of access. Although the direct impact to the area of disturbance is severe the overall impact is insignificant due to the abundance of identical habitat.

3. Threatened & Endangered Species

There would be no direct impact to any Threatened or Endangered or Candidate Categories (1,2) plant species as a result of this project. Additionally, no Threatened or Endangered wildlife species would be impacted.

D. Human Values

1. Cultural Resources

As stated in the existing environment, no significant cultural resources or sites were identified during the Class III inventories conducted around the mine yard or the proposed access road.

As a courtesy, the State Office Historical Preservation Officer has been sent a copies of the inventory report for their records.

Due to the absence of cultural resources in the area, there is no known potential for indirect impacts to any known cultural property.

2. Socio-Economics Impacts

This proposal should have no direct effect on the actual population of the local communities. EFN will utilize employees from the soon to be reclaimed Hack Canyon Mine. Some of the employees have already been hired to the Pinenut project.

Positive benefits would accrue, when additional people are hired from the unemployed workforce during Phase II. In addition, increased employment translates into continued support of local services not associated with mining (i.e., manufacturing, construction, public utilities and wholesale/retail trades and local tax base also).

Further benefits would be gained by the State of Arizona and local counties through an increased tax base.

3. Public Attitudes

Implementing the proposed action would create no significant changes in public attitudes. However the intensity and extent to which each side is voicing their opinions is expected to increase.

There has been and still is strong local support in Kanab, Fredonia, Colorado City, Blanding, Monticello and Bluff for the proposal due to the benefits derived from employment and the increased tax base. This is supported by in excess of 200 plus unsolicited letters from people, businesses and local government groups expressing support for the Hermit Mine and EFN. In addition approximately 10 unsolicited letters have been received requesting BLM to prepare an EIS on mining. BLM has responded individually to this last group of people. Interestingly, the letters requesting the Regional EIS were from residences of Washington, Oregon and New Mexico states.

4. Wilderness

The proposed action is not expected to have any direct effects on the Kanab Creek Wilderness Areas. Mining activities should not be visible or audible from the wilderness area.

5. Visual Resources

The mine yard would not be visible from the Travel Influence Zone on Mt. Trumbull Road.

However, this activity would represent the first action that could be seen from great distances. It is suspected that the upper portion of the head frame may be visible from Mt. Trumbull Road, but should constitute only an insignificant adverse impact because it should not dominant the land form or appear on the skyline. The mine yard may be visible from a small portion of State Highway 389 some 12 miles to the North. It is doubtful the visual impacts would be recognized as a mining activity but only as a disturbance or group of structures. The visual impact at these distances would be minimial.

Hauling activities and fugitive dust from the mine yard should not create a significant adverse impacts to visibility in the area (see Air Quality Impact Analysis in the appendix). The increase in 12 trucks per day plus support activities should be for below that which was achieved during the production at the three Hack Canyon Mines.

6. Other Values

Ranching

It is anticipated this action would have only a minimial effect on local ranching operations. If approved, EFN would remove their temporary water well and remove the existing tank to an area inside the mine yard to provide storage capacity for the new water well. Additionally, the windmill (permittee properties) would be removed to another location. EFN has offered the use of additional water from the new well via a trough outside of the mine yard which should provide the ranchers with a more reliable water supply than previously existed.

Some ranchers may perceive a new road to the site as a negative impact because it opens up the area to potential vandalism of livestock improvements.

Recreation

The proposed action would have a negative effect on recreationists who have traditionally perceived the Mt. Trumbull Road as a scenic corridor and gateway to the Grand Canyon National Park.

Generally however, this action would have no direct effect on the majority of recreational opportunities on the District.

Furthermore, the very thought of new construction on the Arizona Strip is preceived as a major adverse impact to many back country users.

E. Cumulative Impacts

With the addition of Hermit Mine, the total cumulative surface disturbance resulting from mining operations would be increased by 23.6 acres. Approximately 1.2 miles of road would be upgraded.

Total mining disturbance would equal the following:

Mine yard access:	138.0 acres
Miles of powerline:	38.8 miles
New access constructed:	4.22 miles
Access upgraded:	38.0 miles

Based on the above, total cumulative disturbance from mining

operation results in approximately 0.005% of the entire Arizona Strip. It is not anticipated that the Hermit Mine would cause any form of cumulative impacts that would correlate with any other Uranium mines based on the data provided in this Environmental Assessment.

For example, fugitive dust and radiological impacts are limited in extent to a certain periphery of the surrounding mine yard and haul routes. Thus those impacts do not translate into area wide impacts regarding air quality.

Hauling would cause a short term impact on the Mt. Trumbull road for the duration that the Hermit Mine is in development or production. This amount of hauling would be less than that which occurred when the three Hack Canyon Mines were in production.

No environmental threshold or standards should be exceeded under normal operations.

VI. IMPACTS RESULTING FROM PROPOSED ALTERNATIVES

A. The No Action Alternative is a continuation of existing conditions. The impacts would be those resultant from the original exploration plan of operation and none of the impacts described in Section V (Anticipated Impacts) would take place.

The environmental impacts would be those resulting from the previously approved plan of operation and the existing exploration activities. Rehabilitation requirements would be those described in the original environmental assessment.

B. Alternative 2. The Proposed Action would be approved as submitted. The resulting impacts would be those described in Section V above.

C. Alternative 3. The proposed action would be approved subject to additional modifications, mitigation or stipulations, including but not limited to the following.

1. Require use of one of two alternate access to the site (See Figures 11, and 12).

The first access alternative (No. 1) would deny use of the proposed access and require that EFN use the existing access to the site. This would necessitate approximately 3.5 additional miles of upgraded road as well as a greater visual impact due to the accute angle of the intersection at Mt. Trumbull Rd. Several areas on this existing access would have to be ripped or blasted because of minor rock formations and ledges. This would be adverse to local wildlife populations because of the intensity of sound levels. Additionally,

slightly more fugitive dust would be dispersed into the airshed as a result of hauling the longer distance. Several large curves would also have to be straightened to fascilitate safety of hauling and others using the road. A greater amounts of culvert work would also be necessary due to crossing more nature drainages.

Even though part of this access was originally constructed for exploration, it would not seem to be the minimum necessary (in terms of environmental impacts) to achieve access to the site for the purposes operating the mine.

The 2nd alternative access would require upgrading of 3.5 miles of existing road. Since the access enters south of the project area, additional hauling distances on Trumbull Road would occur, which would result in more fugitive dust.

Each access alternative (1 and 2) would result in 3.5 and 4.5 miles of additional disturbance (upgrading) respectively than would the proposed access (1.2 miles).

Either alternative access could result in a potential increase in public use to other areas beyond the mine (i.e., Sunshine Point and Gramma Canyon, etc). While additional visitation to these scenic areas are not necessarily a negative impact, there would be a potential for increased vandalism to cultural sites or livestock improvements.

The following impacts would occur on any alternative chosen. However the magnitude of the impact is also a function of the distance travelled.

Blading would destroy vegetation completely. Heavy equipment would compact surface areas and consequently runoff and erosion would increase. The effects of which could be mitigated to insignificance via proper road design and standards.

Access alternatives 1 and 2 would also result in greater negative impacts to small burrowing or nesting animals.

2. This Alternative would require alternate forms of transportation of employees to the project area.

a. Deny bussing of employees and require use of private vehicles.

This alternative could result in 128 vehicle trips per day during Phase I and slightly less than that during Phase II. Additionally a parking lot would be required that would add

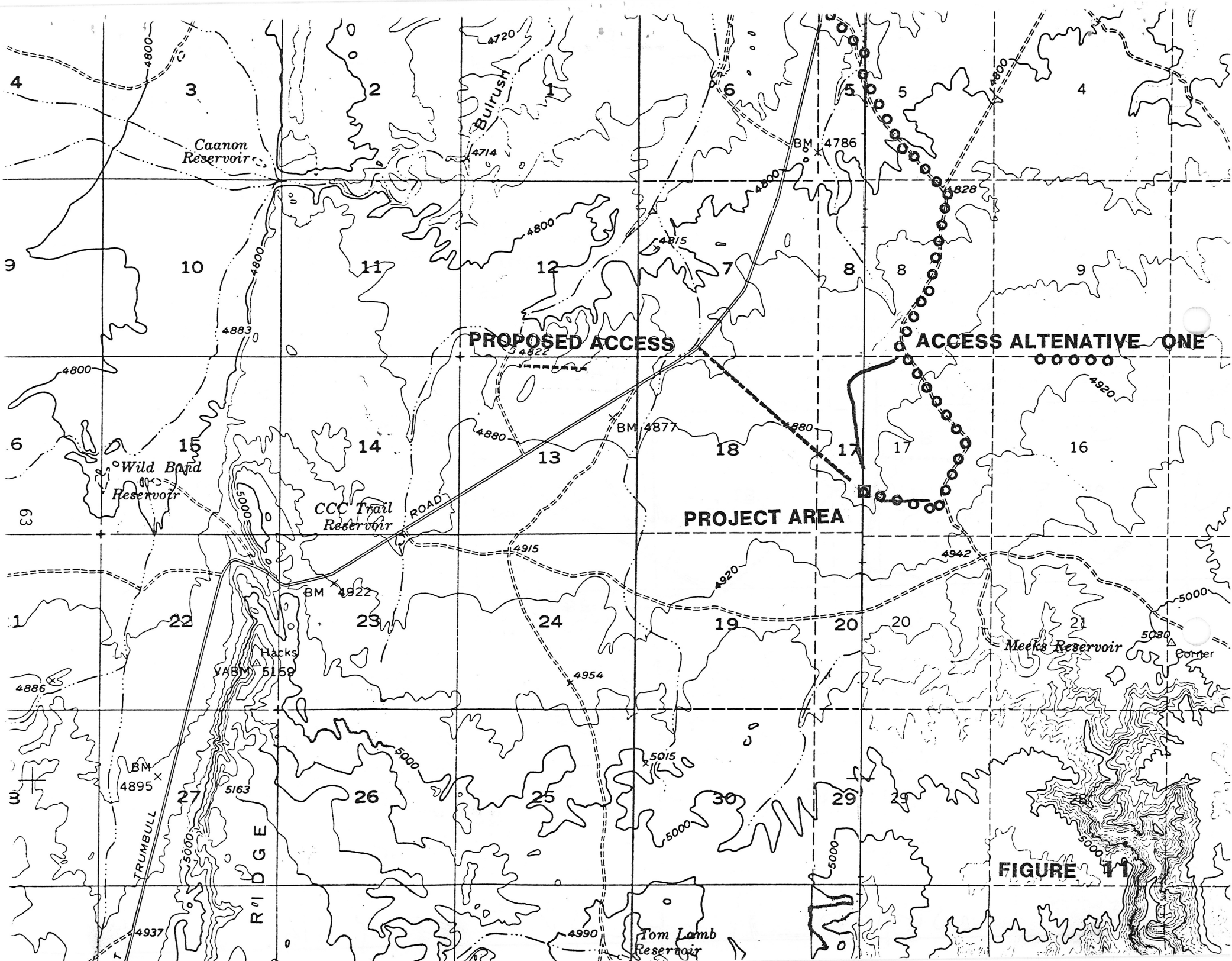

PROPOSED ACCESS
ACCESS ALTENATIVE ONE
PROJECT AREA
Caanon Reservoir
Bulrush
Wild Bond Reservoir
CCC Trail Reservoir
ROAD
Hacks
VABM 5159
BM 4895
TRUMBULL
RIDGE
BM 4786
BM 4877
BM 4922
Meeks Reservoir
Corner
Tom Lamb Reservoir
4720
4714
4800
4883
4822
4815
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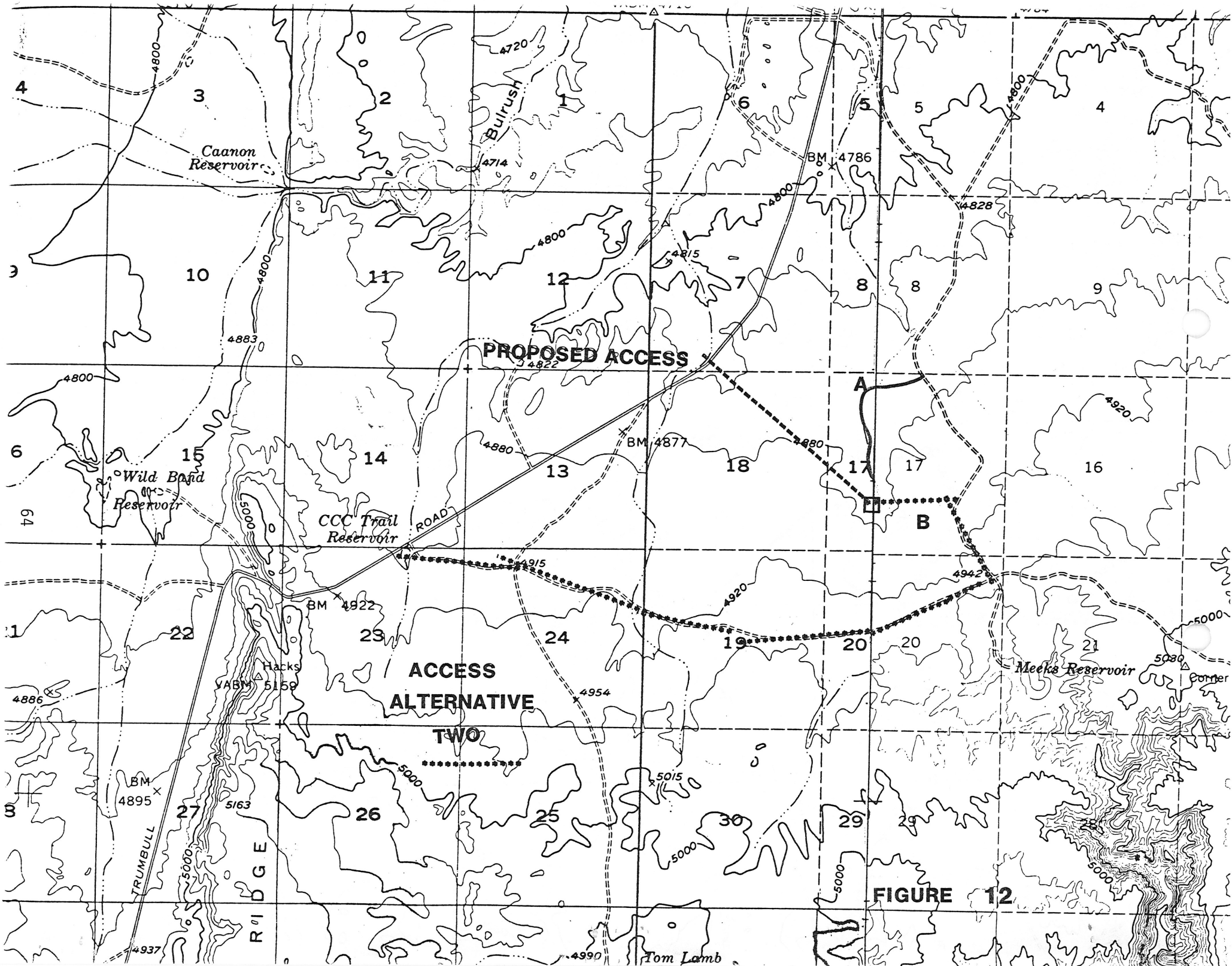
FIGURE 11


PROPOSED ACCESS
A
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ALTERNATIVE
TWO
Caanon Reservoir
Bullrush
Wild Boar Reservoir
CCC Trail Reservoir
ROAD
Hacks
VABM 5159
BM 4786
BM 4877
BM 4922
BM 4895
Meeks Reservoir
Corner
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5030
5163
4886
4937
4990

FIGURE 12

additional surface disturbance and associated impacts to visual resources, vegetation removal, compaction/runoff, and erosion, wildlife and air fugitive dust quality.

In effect this is alternative defeats the objects of reducing traffic volumes and eliminating surface disturbance and air quality impacts.

b. Require personel to be transported by aircraft.

This alternative would result in the need for additional surface disturbance to accomodate an air strip. The use of aircraft would adversely effect recreation user, Peregrine falcon re-establishment, livestock, safety and wildlife. It is also doubtful that this alternative could be required as it would mostly likely violate the "reasonable access" provisions of the General Mining Laws. (Maley).

3. <u>This Alternative would require relocation of surface facilities within the mine yard</u>.

Because the ore body is stationary there are not many viable alternatives to evaluate regarding the mine yard. However some options were analyzed within the scope of this alternative.

a. Require ore piles to be located at the northern part of the mine yard. This alternative would result in ore storage at the lowest part of the mine yard. The area would be subject to runoff from within the yard and would preclude placement of the evaporation/holding pond where it would be most effectiving in gathering surface runoff. The potential for slightly more contamination of holding pond water would increase. In effort, this alternative would defeat the objective of keeping the ore piles in a topographically high part of the yard.

b. This would preclude proper placement of ore piles and would also possibly effect the placement of barren waste rock. It would affect proper storage of top soils which must be protected through out the duration of operations. Buildings that would not be in the higher areas of the yard would be subject to impacts from run off within the mine yard. This alternative would defeat the objectives of requiring surface facilities to be located in a limited compact area to reduce surface disturbance and would effectively cut down on the useable space in which heavy equipment could operate (ie, ore stock piling, loading areas, turn around areas, etc.).

c. Move the mine yard facilities within the surrounding area to the best suitable locations, (ie, ridge tops, flat area, etc.).

Require surface construction facilities to be placed along the east and/or west perimeters of the mine yard.

This would increase the size of the yard significantly making security and safety much less efficient. The beneficial impacts from reducing cut and fill operations would be off set by the disturbance from normal operations between the selected areas. The resulting impact would be greater in extent to all of the environmental parameters; surface disturbance, water, wildlife, noise, flooding, vegetative, air quality, soils, cultural resources and visual impacts. It would be less cost effective and increase the potential for accidents and environmental contamination through the sheer increase in the size of the mine yard area.

4. Other alternatives to the plan of operations include alterations regarding storage ponds.

   a. This alternative would require the construction of the Phase II evaporation pond during Phase I prior to any ore stockpiling on the surface.

      This action would result in an extra margin of safety that would allow for a hundred year event to be handled safely before any ore is stockpiled in the mine yard during Phase I. This would require greater surface disturbance in the mine yard during Phase I but because of the internal drainage design the impact would be insignificant.

   b. Require a larger or secondary overflow pond at commencement of Phase II.

      This action would eliminate the possibility that a storm larger than a 100 year 24 hour event would breach the storage capacity of the holding pond. It would reduce the possibility of overflow and downwash contamination. If the additional capacity could be obtained in the mine yard the increased disturbance would be insignificant. According to E.O. 11988 the 100 year/24 hour event is the federal government's requirement for this action. Therefore requiring greater capacity storage facilities would be difficult to enforce.

   c. This alternative would require oil/gas and diesel storage areas to be bermed to prevent accidental impacts on and off site.

      This action would provide an additional safety margin to prevent the release of contaminated liquid. Berm material is available on site and would result in no additional adverse environmental impacts.

5. This Alternative would require rehabilitation of the temporary exploration access roads.

This alternative would require the two temporary access presently existing to be rehabilitated. Access B (located on Figure 12) was the original temporary overland access to the exploration area. Access A was created by the permittee in the drainage area as an effort to utilize the temporary water source that EFN discovered during shallow exploration drilling. Additional positive affects would be the reduction of surface disturbance, increased visual enhancement and revegetation as well as a single restricted access to the mine site.

VII. Recommended Mitigating Measures to Enhance Environmental Protection

A. Mine Yard

1. If the protection of topsoil stockpiles becomes warranted in the future, EFN will consider use of a tacktifier/or asphalt emulsion to prevent wind erosion.

2. If protection of the stockpiled topsoil on the eastern edge of the yard becomes warranted because of channel or dike erosion, EFN will consider the use of rip rap on the edge of stockpiles closest to the drainage channels and dikes.

3. EFN should ensure that diversion channels and associated dikes (freeboard) are properly maintained throughout the duration of operations.

4. During reclaimation EFN should ensure that topsoils are equally distributed over the disturbed area to better insure proper reclamation.

5. Should periods of prolonged drought occur, EFN should implement a daytime dust abatement program within the mine yard as approved by the authorized officer.

6. Signs should be installed at the entrance of the mine yard and on Mt. Trumbull Road, to inform visitors and other land users that a uranium operation is in progress, in addition to the "No Trespassing" sign on the mine yard fences.

7. EFN should dispose of all concrete pads by breaking them up and back filling them into the mine shaft.

8. To be successfully rehabilitated, ground cover should be established to at least the prevailing conditions (i.e., 20 - 30% canopy cover) and approved by the authorized officer.

The following seeding mixtures and rates would be recommended:

Fourwing salt bush	2.0 lb./acre
Indian rice grass	2.0 lb./acre
Sand drop seed	0.5 lb./acre
Yellow Sweet Clover	0.5 lb./acre
Pubescent Wheat grass	2.0 lb./acre
Russian Wild Rye	2.0 lb./acre
TOTAL	9.0 lb./acre

This area would be expected to respond favorable to harrowing, seeding and chain dragging to cover seeds. Seedings should be planned to take advantage of optimum seasonal moisture conditions.

9. If the State of Arizona's Water Permit Unit determines that an NPDES permit or groundwater protection permit is necessary, then EFN is bound to the conditions of the permit.

10. EFN should report local sightings of falcon or eagle to BLM. Upon such a sighting, no employee will harass, harm or injure the specie.

11. EFN should ensure that the uranium ore stockpiles will not exceed the size of the ore pads.

12. Fuels and solvent storage area should be bermed to prevent accidental release of contaminated liquids.

13. The evaporation pond, dike, and diversion ditches should be routinely maintained to insure their integrity at all times during the operation of the mine with appropriate modifications during reclamation.

14. The roads and road crossings should be monitored for signs of erosion. If any erosional damage is detected, the same should be repaired by riprap or other erosion control measures.

15. All disturbed areas and channel banks (when required) should be properly vegetated to establish satisfactory vegetation cover.

B. Access

1. All road upgrading or construction must at least conform to BLM standards.

2. Any culverts necessary must be sized according to the expected maximum drainage flow and installed according to at least BLM standards.

3. Doublewide cattleguards will be placed at the fence, intersected by the proposed road, for the duration of operations.

4. The proposed access (if allowed) should be fully rehabilitated subject to the discretion of the Authorized Officer.

5. During road construction or upgrading, no actions will be allowed that would have a potential to impact down wash flow, existing reservoirs, etc.

6. The road that is ultimately selected as the haul route should be appropriately graveled to reduce air quality impacts. If absolutely necessary, EFN will conduct dust abatement on the access to the mine site.

7. Road upgrading on that portion of the access road visible from Mt. Trumbull road should be limited to the minimum necessary to meet safety standards. This will help discourage visitor use of the access road that leads exclusively to the mine yard.

8. The haul road access should intersect Mt. Trumbull road at/or close to 90 degree intersection to enhance safety and reduce visual impacts.

C. Aircraft Use

1. EFN should not utilize Kanab Creek Canyon as a flight path to the Hermit Mine yard.

D. Radiological Impacts

1. All operations at the Hermit Mine shall comply with all pertinent Federal and State laws regarding radiological impacts; including but not limited to:

   - ARS-27-31, Concentration of radon gas shall not exceed such amount as may be set by the mine inspector.

   - ARS-27-372, in all uranium operations the operator shall test regularly for radon daughter concentration and submit test records of testing as may be required by the State Mine Inspector.

   - R11-1-473, smoking is prohibited where uranium is mined.

   - R11-1-472, when radon daughter contrations are above 0.1 WL in active working ares, measurements representative of the workers breathing zone shall be determined. Sample dates, locations and results shall be determined, recorded and retained at the mine office for at least two years.

E. Visual

1. Buildings and head frames should be painted a flat earth tone to be more harmonious with the existing environment.

2. Impacts of noticeable "night lights" should be "hooded and directed" to throw light within the area of operations.

F. Accidental Release

1. In the remote event that any liquid from within the mine yard is released off site, EFN will take immediate actions for cleanup, including a final radiological assessment of the impacted area that will be submitted to BLM.

   If additional reports are required by the State of Arizona (i.e., Best management Practices Plan or Best Available Technology Plan), they should be forwarded to BLM.

2. In the remote event that ore is spilled, EFN will immediately contact BLM and provide them with applicable reports on the incident, as soon as possible.

G. Other

1. EFN is responsible for any damages to livestock operations caused by their operations.

VIII. Residual Impacts

Until reclamation efforts prove successful, the following residual impacts are expected.

Mine yard: A nominal amount of soil loss is expected until revegetation efforts become established.

Access: Minor or insignificant amounts of erosion are expected until revegetation is successful. Visual impacts of the access are mostly limited to the road area itself or when passing the access on Trumbull road.

Visual Resources: Results of human activity will be noticeable for several years, until reclamation is successful.

IX. Relationship Between Short Term Use and Long Term Productivity

The short duration of this project is not expected to have any adverse impact on the long term productivity of the area as reclamation efforts are designed to return the area to approximately the prevailing conditions.

X. Irreversible and Irretrievable Commitments

As a result of this project, uranium ore will be extracted and processed thus constituting an irretrievable commitment.

XI. Agencies and People Consulted

A. Mailing List Soliciting Comments

Approximately 480 individuals, groups, organizations and agencies were solicited to provide comments on this EA, including individual and environmental interests as well as local, state and Federal interests. Out of 480 solicitations, approximately 180 people/organizations, have requested the E.A. for comment.

B. Agencies/Groups Consulted

On March 17, 1987, BLM and EFN presented the Hermit mine plan-of-operations, on site, to the following list of agencies and interested parties. BLM solicited concerns from the group after the presentation. As of that time there were no agency concerns over those presented by BLM.

BLM - Arizona

District Staff

Cloyd Swapp - District Geologist
Ken Moore - Environmental coordinator
Julian Anderson - Assist., D.M., Resources
Bob Smith - Hydrologist
Ron Ray - Computer/Landscape Architect
Lee Hughes - Supervisory Range Con/T&E Specialist
Rob Roudabush - Area Manager
Mike Small - Wildlife management Biologist
Ilene Anderson - Lands and Realty
Tom Folks - Recreation/Wilderness
Bob Sandberg - Lead Range Conservationist
Jennifer Jack - Area Archeologist
Timothy Duck - Wildlife Management Biologist
Jack Johnson - Natural Resource Specialist
Scott Spooner - Geologist

State Office Staff

Keith Pearson - Environmental Coordinator
Dan McGlothlin - Hydrology/Soils
Alan Rabinoff - Minerals
Gary Stumpf - Archeologist

Other Federal Agencies

Grand Canyon National Park, John Ray - Resource Manager
Grand Canyon National Park, Mike Ebersol - Tuweep Ranger/Pilot
U.S. Fish and Wildlife Service, Don Metz - Assist. Field Supervisor
U.S. Forest Service (N.K.R.D.), Steve Martinet - Recreation and and Lands Staff

Kaibab Paiutes

Vivian Jake - Tribal Cultural Consultant Representative
Troy Jake - Tribal Manager

State Agencies

Arizona Game and Fish Dept.

Don Randall - Wildlife Manager

Arizona Department of Health Services

Gary Ullinsky - Environmental Health Specialist
Miguel A. Santiago - Environmental Health Specialist

Air Quality Dept.

Water Quality Bureau (Northern Regional Office)

Water Permits Unit

Arizona State Historical Preservation Officer

Mining Company's

Pathfinders, Dieter Krewedl
Rocky Mtn. Energy, W. Cary Voss
Energy Fuels Nuclear, Brad Doores

Grazing Permittee

Fred Heaton

BLM will utilize the Arizona State Clearing House to ensure the review of this document by all appropriate Arizona State Agencies and Regional Council's of Government pursuant to Executive Order 12372.

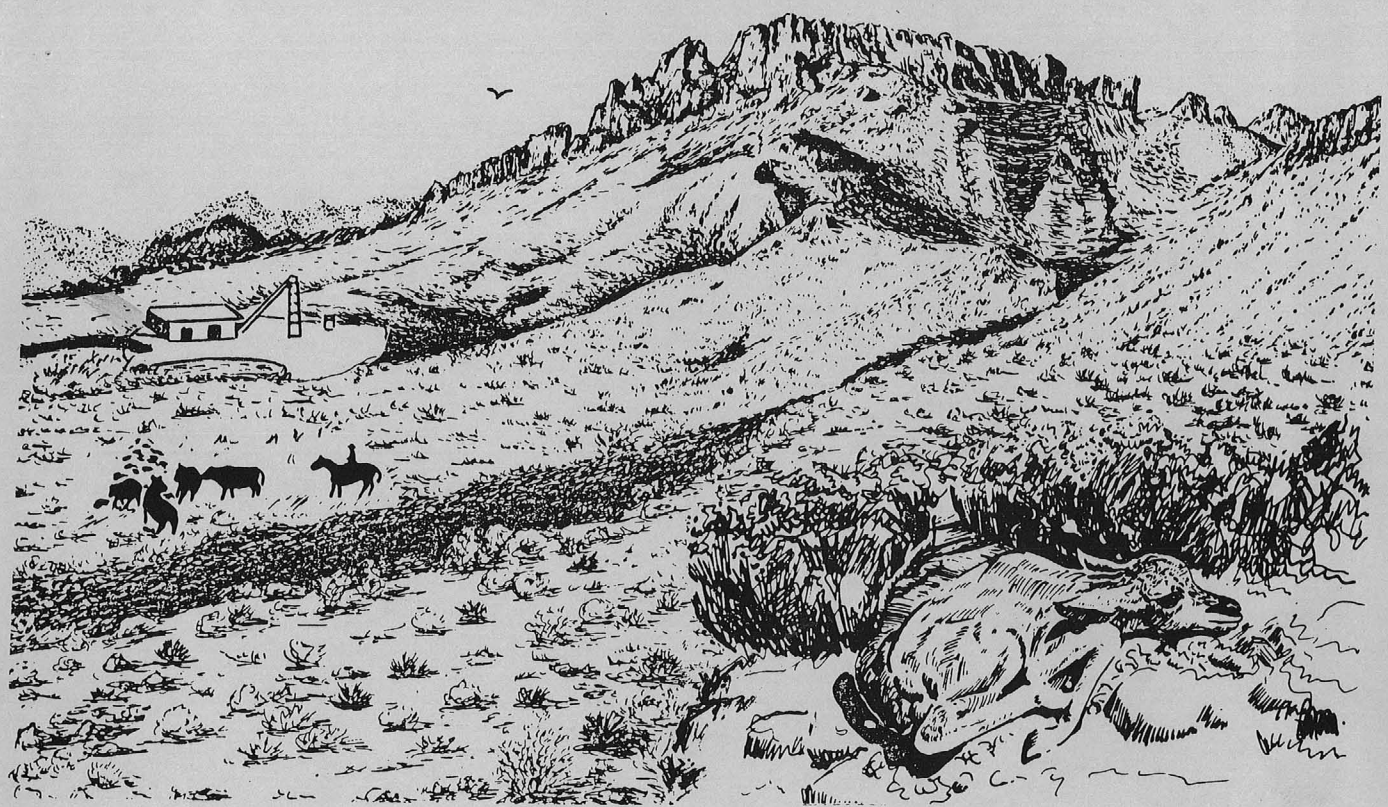
XII. Source Materials

1. Plan of Operations for the Hermit Project (EFNI, Feb. 1987).
2. Air Quality Impact Analysis of the Hermit Project (EnecoTech Inc., Feb. 1987)

3. Radiological Assessment of the Hermit Project (McKlveen, 1987)
4. Hydrologic Evaluations For the Proposed Hermit Uranium Mine In Mohave County, Arizona (Dames and Moore, Feb. 1987; Job No. 09973-033-030).
5. Hermit Mine Ground-Water Conditions (Dames and Moore; March 1987).
6. Wildlife Inventory and Analysis; (Sigler Associates, Feb. 1987).
7. Code of Federal Regulations, 43 CFR; 3809
8. Code of Federal Regulations, 40 CFR; 116 "Designation of Hazardous Substances"
9. Code of Federal Regulations, 40 CFR, 122 "National Pollutant Discharge Elimination System"
10. Arizona Environmental Quality Act - An Overview Section B. Groundwater Quality Provisions and Water Quality Standards. by: David S. Baron
11. House Bill 2518, An Act; State of Arizona House of Representatives, Thirty-seventh legislature, Second Regular Session, 1986.
12. Impacts of Uranium Mining and Milling Upon the Fish and Wildlife Resources of the New Mexico San Juan Basin. (Biological Services Program; Fish and Wildlife Service; FWS-80/56; September 1980).
13. An Environmental Guide to Western Surface Mining, Part Two: Impacts, Mitigation and Monitoring (Biological Services Program; Fish and Wildlife Service; FWS/OBS-78/04; December 1977).
14. Birds of the Arizona Strip, U.S.D.O.I., Bureau of Land Management (U.S.G.P.O. 1978-786-167).
15. Reptiles and Amphibians of the Arizona Strip, U.S.D.O.I., Bureau of Land Management (U.S.G.P.O. 1978-786-167).
16. Mammals of the Arizona Strip, U.S.D.O.I., Bureau of Land Management (U.S.G.P.O. 1978-788-167).
17. Clayhole Habitat Management Plan
18. Pinenut Final Environmental Assessment (May 1986).
19. District Management Framework Plan
20. Glossary of Surface Mining and Reclamation Technology, National Coal Association for the Coal and Environment Conference and Exposition; Louisville, Kentucky; October 22-24, 1974.
21. Anatomy of a Mine from Prospect to Production; U.S.D.A. Forest Service, General Technical Report, INT-35, Revised July 1983.
22. Hacks Canyon Allotment Management Plan, for Meeks Reservoir Pasture.
23. Revegetating Lands Disturbed by Mining in the Southwest. (U.S.D.A. - Soil Conservation Service -- Portland, OR. 1977).
24. Vegetative Rehabilitation and Equipment Work Shop, 39th Annual Report; December 1985.
25. Manual of Revegetation Techniques; (U.S.D.A. - Forest Service, May 1984 - 7100; Engineering; 8471 - 2600.
26. Reclaiming Disturbed Lands; (U.S.D.A. - Forest Service, November 1984;2200; Range 8422-2805)

27. Hydrologic Risk and Return Period Selection for Water Related Projects; (Bruce P. Van Haueven; U.S.D.O.I., BLM September 1979).
28. BLM Manual 8431 - Visual Resource Contrast Rating).
29. User Guide to Vegetation; U.S.D.A. - Forest Service General Technical Report INT-64
30. User Guide to Hydrology; U.S.D.A. - Forest Service General Technical Report INT-74
31. Reclaiming Disturbed Lands; U.S.D.A. - Forest Service November 1984; 2200-Range;8422 2805
32. Upper Guide to Soils; U.S.D.A. - Forest Service General Technical Report INT-68
33. User Guide for Mining and Reclamation; Wildlife; U.S.D.A. - Forest Services General Technical Report INT-126
34. User Guide to Engineering; U.S.D.A. - Forest Service General Technical Report INT-70
35. Proceedings of the Uranium Mining and Milling Workshop, Biological Services Program; FWS/OBS-80-57 August 1980
36. Opportunities for U.S. Fish and Wildlife Initiatives Relating to Uranium Mining and Milling in The Western United States (by: Gerald C. Horak et al.; Enviro Control, Inc., Fort Collins, Colorado).
37. Canyon Mine EIS; U.S.D.A. - Forest Service
38. Jackpile-Paguate-Uranium Mine Reclamation Project EIS - 1985 (U.S.D.O.I. - BLM February 1985).

HERMIT (+)



EA No. AZ-010-87-013

THE HERMIT PROJECT
Appendix Document

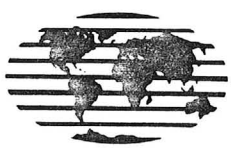
A Major Modification to the Hunt Project
Plan of Operations for Uranium Ore Extraction

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
March 3

Bureau of Land Management
PUBLIC LANDS ☆USA☆
USE ☆ SHARE ☆ APPRECIATE

REPORT
HYDROLOGIC EVALUATIONS
FOR THE
PROPOSED HERMIT URANIUM MINE
IN MOHAVE COUNTY, ARIZONA
FOR
ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

Dames & Moore



1626 Cole Blvd.
Golden, CO 80401
(303) 232-6262
Job No. 09973-033-030
February 1987

Dames & Moore

1626 Cole Boulevard
Golden, Colorado 80401
(303) 232-6262
TELEX: 3720401 Cable Address: DAMEMORE

February 2, 1987
Our Ref: 09973-033-030

Mr. Stephen P. Antony
Energy Fuels Nuclear, Inc.
One Tabor Center
Suite 2500
Denver, CO 80202

Re: Hydrologic Evaluations for
The Proposed Hermit Uranium Mine
in Mohave County, Arizona

Dear Mr. Antony:

This letter transmits, herewith, ten (10) copies of the final report for the above referenced project.

We have enjoyed performing this work for you. If you have any questions regarding this report or require additional information, please contact us.

Very truly yours,

DAMES & MOORE

Anand Prakash/aec

Anand Prakash
Associate

Richard L. Harlan

Richard L. Harlan
Associate

AP:RLH:sj

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1.0 INTRODUCTION

1.1 SCOPE OF STUDY

Energy Fuels Nuclear, Inc. (Energy Fuels) plans to develop an underground uranium mine at the Hermit site in Section 17, Township 39 North, Range 4 West, Gila and Salt River Meridian, Mohave County, approximately 22 miles south-southwest of Fredonia, Arizona. This document describes the hydrologic and hydraulic analyses performed to evaluate the potential impacts of the proposed mining activities on the surrounding surface water environment.

The scope of this study included the following main tasks:

- Assessment of the climatic and hydrologic conditions in the vicinity of the Hermit Mine.
- Determination of the hydrologic characteristics of watersheds near the mine site.
- Estimation of peak flows of different recurrence intervals from subwatersheds in the vicinity of the mine site.
- Development of a drainage control plan based on the 100-year flood.
- Evaluation of potential project-related and cumulative downstream hydrologic impacts.

1.2 PROJECT OVERVIEW

The Hermit Project will involve sinking a vertical shaft approximately 1,100 feet below the surface. The surface facilities will consist of a headframe, main building and a new one-and-a-half mile access road. The areas proposed to be temporarily used or disturbed during the life of the project include about 20.4 acres for the surface facilities and rock disposal and about 5 acres for a new access road to the site.

The Project Area is located on the Kanab Plateau within the Grand Canyon section of the Colorado Plateau physiographic province in the watershed of Bulrush Canyon which is a minor tributary of Kanab Creek.

After development activities are completed (approximately three years after start-up), the project will operate at an average production rate of 300 tons per day for about five years. The barren waste rock generated during shaft sinking and mining will be disposed of in designated waste disposal areas. Prior to the construction of the mine yard, topsoil from the areas to be disturbed will be removed and stored on site. Uranium ore excavated from mine workings will be stockpiled on ore pads. The ore pads will be at least one-foot thick and will be constructed of shale and limestone material.

To minimize hydrologic impacts related to the project, surface runoff from the adjoining watersheds will be diverted around the mine area and the runoff and sediment generated within the mine area will be contained within the project boundary. A description of the proposed flood diversion and retention facilities is provided in the subsequent sections.

2.0 HYDROLOGIC EVALUATIONS

2.1 REGIONAL CLIMATE AND HYDROLOGY

The proposed Hermit Mine is located in the Grand Canyon region of the Colorado River basin in a semi-arid continental climate. The ground elevations in the region vary from above 5200 feet (MSL) in the uplands to lower than 3000 feet (MSL) in the valleys. The region is characterized by cool winters with some snow and below freezing night temperatures to warm summers with high temperatures rising above 90°F. The average annual precipitation in the region varies from about 11 to 15 inches. The annual precipitation for the driest and wettest years at Grand Canyon National Park for the period of record, 1931-1982, have been 7.14 inches in 1976 and 25.51 inches in 1982, respectively. The average annual precipitation at the station is 14.42 inches. Approximately one-half of the annual precipitation in the uplands occurs as snow. A typical distribution of the annual precipitation into monthly increments at Tuweep, Arizona is shown in Table 2.1 (NOAA, 1973).

TABLE 2.1 TYPICAL DISTRIBUTION OF INCREMENTAL MONTHLY PRECIPITATION AT TUWEEP, ARIZONA

Month	Precipitation (inches)	Month	Precipitation (inches)
January	1.10	July	1.28
February	0.90	August	1.97
March	1.25	September	0.79
April	0.73	October	0.80
May	0.40	November	0.77
June	0.40	December	1.31
		TOTAL ANNUAL	11.70

The area is subject to both localized convective storms (thunderstorms) and general frontal-type storms covering relatively large areas (i.e., larger than 10 sq. miles). The thunderstorms generally occur as single cells of intense vertical convection resulting from an invasion of marine air from the Gulf of Mexico or Gulf of California and are prevalent in the summer months of July to mid-September. In the winter (from Novem-

ber to March), frontal type systems are more prevalent with usually light but wide-spread and long lasting rains mixed with snow moving from the west to east. These storm systems derive their moisture from the Pacific Ocean.

2.2 LOCAL HYDROLOGY

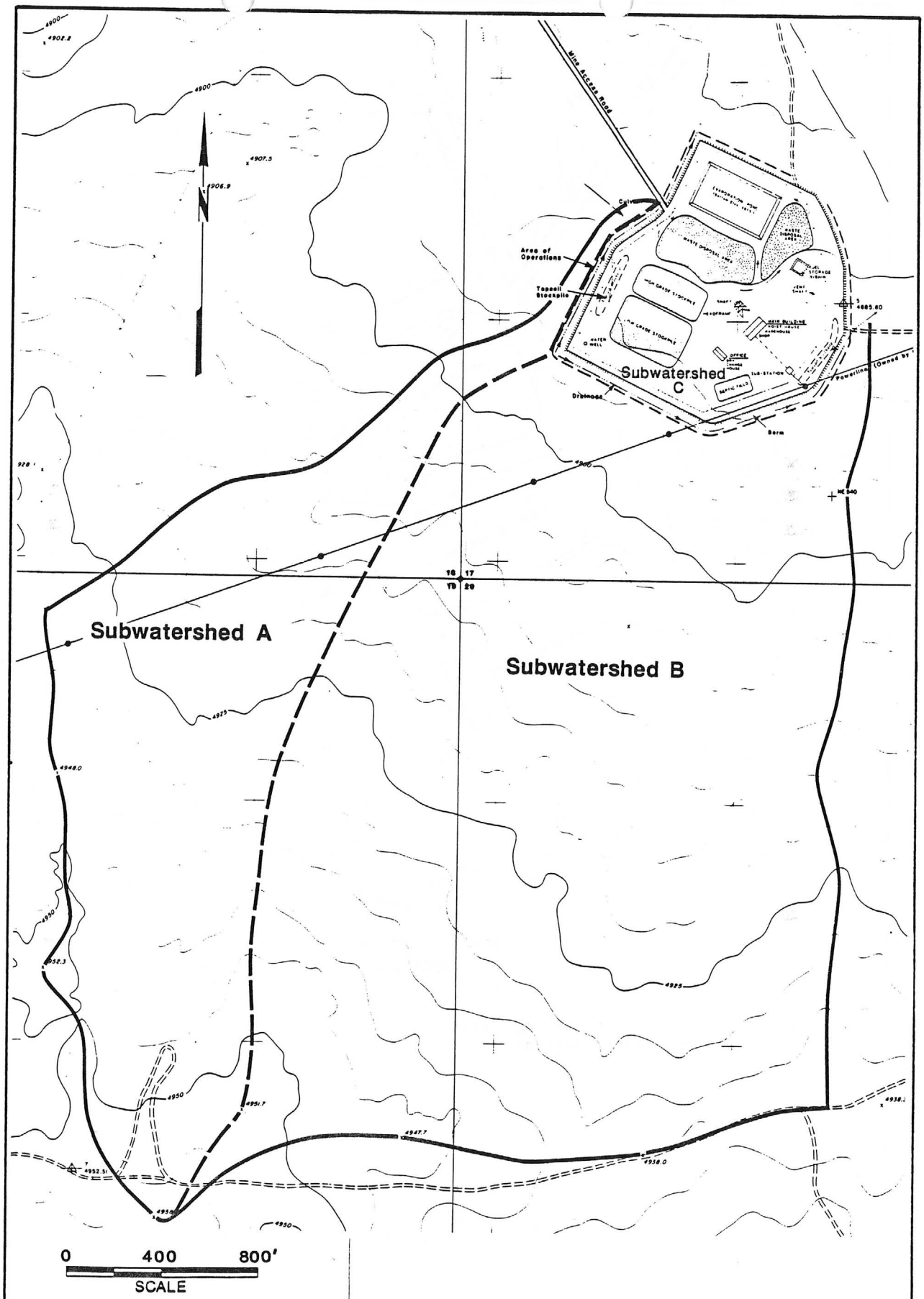
2.2.1 Watershed Characteristics

To perform a hydrologic evaluation of the Project Area, the basin around the mine site was divided into three different subwatersheds as shown in Figure 1. Subwatershed A includes the area upstream of the Project Area on the southwest; subwatershed B includes the area to the south of the Project Area; and subwatershed C includes the area within the Project boundary. A map of subwatershed C along with the proposed surface facilities is shown in Figure 2. The areal extents, hydraulic lengths, topographic relief, and times of concentrations for these subwatersheds are shown in Table 2.2.

TABLE 2.2 HYDRAULIC CHARACTERISTICS OF SUBWATERSHEDS

Subwatershed	Area (sq mi)	Hydraulic Length (feet)	Topographic Relief (feet)	Time of Concentration (hour)
A	0.105	4,448	64	0.429
B	0.251	4,268	66	0.404
C	0.032	800	10	0.121

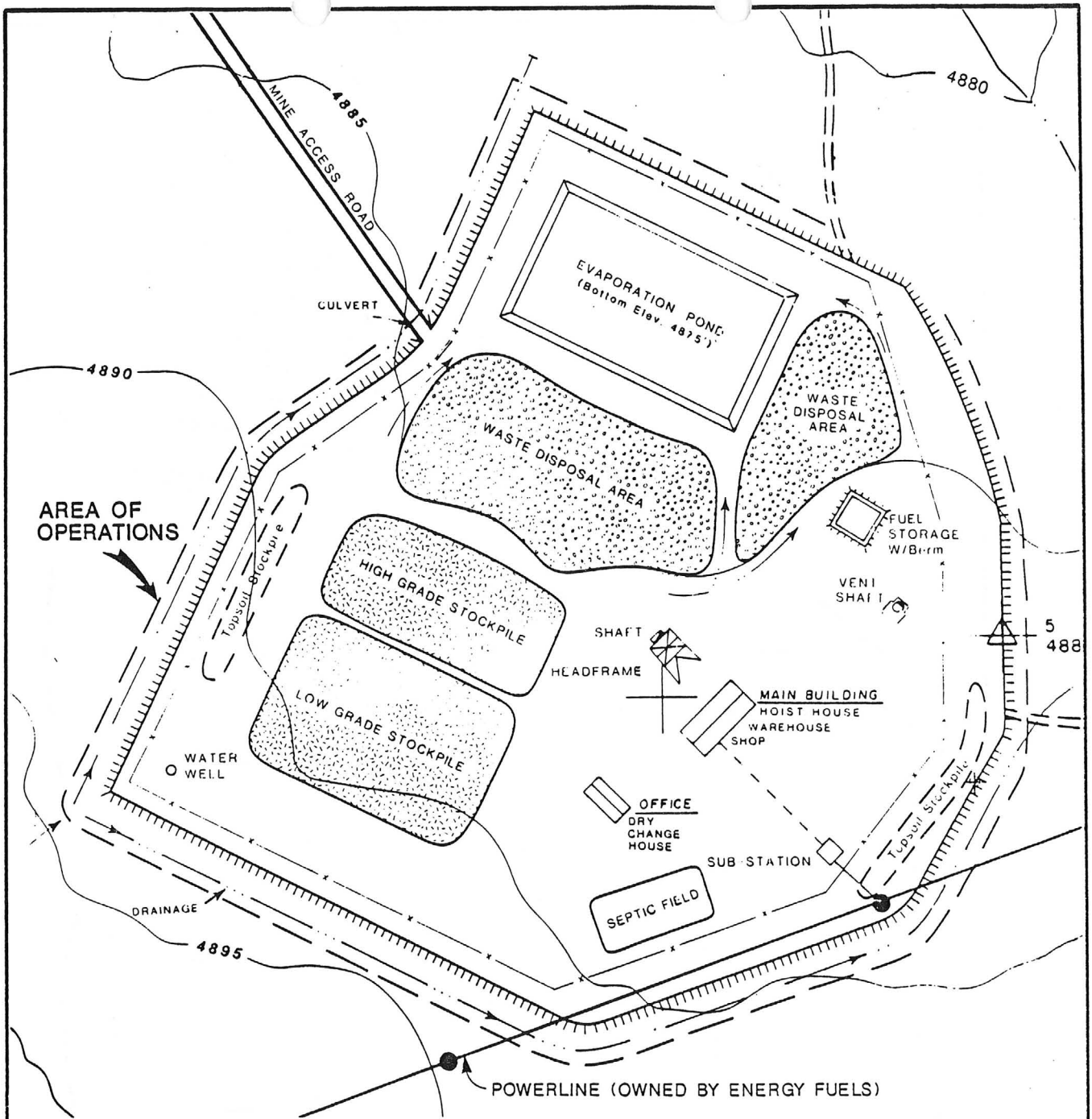
The time of concentration is defined as the time a drop of water takes to travel from the farthest point in the watershed to the point where the surface runoff hydrograph is to be computed. The equation used to estimate the time of concentration is (USBR, 1977):



Subwatersheds in the Vicinity of the Hermit Project

Dames & Moore

Figure 1



Map of Mine Area

Dames & Moore

Figure 2

$$t_c = \left(\frac{11.9\ L^3}{H}\right)^{0.385} \qquad (2.1)$$

where, t_c = time of concentration in hours,

L = hydraulic length of the longest water course in the basin in miles,

H = topographic relief of the subwatershed in feet, i.e., difference in elevation between the furthest point in the watershed and the location where the runoff hydrograph is to be computed

The general vegetative cover in the Project Area consists of grasses and sagebrush with bare rock and soil exposed over about 50 percent of the area. Vegetation and plants exceeding three feet in height are almost non-existent. The three subwatersheds mentioned previously are comprised of moderately undulating plateaus and mesas with average ground slopes of about 1.0 to 1.5 percent. The surface soils consist of residuum and alluvium weathered from limestones and siltstones. For the natural subwatersheds A and B, a Soil Conservation Service curve number (CN) of 72 is adopted assuming AMC-II type of antecedent moisture conditions.

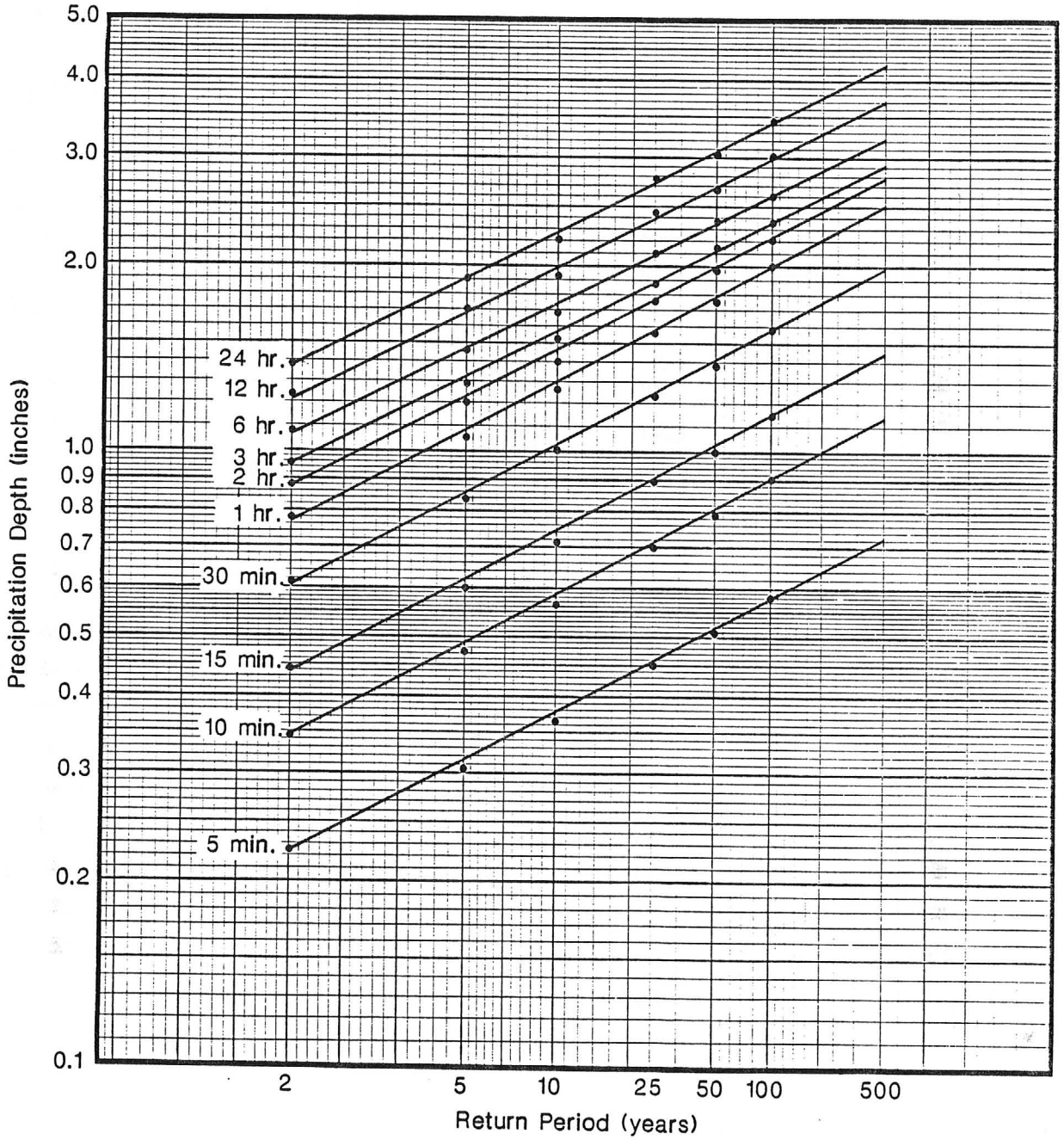
The curve number (CN) is an index used to estimate the surface runoff potential of a watershed for a given depth of precipitation. It depends on the hydrologic soil group of the surface soils, type and condition of land-use or surface cover, hydrologic condition of the watershed for infiltration, and antecedent moisture condition of the soils at the time of the occurrence of the storm (SCS, 1972). The silty and sandy soils in the Project Area are judged to belong to hydrologic soil groups B to C. The small portions of the subwatersheds having rock outcrops belong to hydrologic soil group D. Hydrologic soil groups B, C, and D refer to soils with moderate, slow, and very slow rates of water transmission or moderately fine to moderately coarse, moderately fine to fine, and clay like textures,

respectively. The land use or vegetal cover for these areas is judged to be similar to pastures or ranges with moderate cover of sagebrush and poor to fair conditions for infiltration. The AMC-II type of antecendent moisture condition implies average moisture conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (USBR, 1977).

Before the operation of the mine, subwatershed C will be significantly altered from its natural condition. Some of the features to be installed in this subwatershed are shown in Figure 2. Some of the portions of this subwatershed will be covered with buildings or compacted. For this reason, a higher curve number (CN) of 74 is adopted for AMC-II conditions for this subwatershed.

2.2.2 Hydrologic Analyses

To develop the surface runoff hydrographs for the three subwatersheds listed in Table 2.2 for storm events of different recurrence intervals, the HEC-1 computer program of the U.S. Army Corps of Engineers (USACE, 1981) was used. The approximate location of the subwatersheds is near longitude 112°45' and latitude 36°41'30". The 5-min., 10-min., 15-min., 30-min., 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, and 24-hour precipitation depths for recurrence intervals of 2 to 100 years used as input to this model were computed using the Precipitation-Frequency Atlas for the Western United States, Volume VIII, Arizona (NOAA, 1973). To estimate the precipitation depths for a recurrence interval of 500 years, the aforementioned values were plotted on a lognormal probability paper. The 500-year precipitation depths were then estimated by linear extrapolation. The lognormal probability plots of precipitation depths are shown in Figure 3 and the cumulative precipitation depths for all the durations and recurrence intervals are shown in Table 2.3.



Lognormal Probability Plots of Precipitation Depths of Different Durations

Dames & Moore

Figure 3

TABLE 2.3 CUMULATIVE PRECIPITATION DEPTHS NEAR HERMIT PROJECT (inches)

Recurrence Interval/ Duration	2-yr.	5-yr.	10-yr.	25-yr.	50-yr.	100-yr.	500 yr.
5 min.	0.225	0.305	0.363	0.450	0.508	0.580	0.72
10 min.	0.349	0.473	0.563	0.698	0.788	0.900	1.13
15 min.	0.442	0.599	0.713	0.884	0.998	1.140	1.44
30 min.	0.613	0.830	0.988	1.225	1.383	1.580	1.99
1 hr.	0.776	1.05	1.25	1.55	1.75	2.00	2.50
2 hr.	0.88	1.2	1.40	1.75	1.98	2.2	2.78
3 hr.	0.95	1.29	1.50	1.87	2.13	2.35	2.90
6 hr.	1.07	1.47	1.68	2.1	2.38	2.6	3.2
12 hr.	1.24	1.70	1.92	2.44	2.69	3.0	3.70
24 hr.	1.37	1.9	2.2	2.77	3.0	3.4	4.20

The lag time for each subwatershed is assumed to be 60 percent of the respective times of concentration shown in Table 2.2. The lag time for a subwatershed is defined as the time from the center of mass of the rainfall excess to the time of occurrence of the peak rate of runoff (SCS, 1972).

In addition to the cumulative precipitation depths shown in Table 2.3, the areal extent of each subwatershed (Table 2.2), the lag time, and the curve numbers (CN) described previously are provided as input to the HEC-1 computer program (USACE, 1981). The resulting peak flows, runoff coefficients for the 24-hour storms, and volumes of surface runoff for each subwatershed are presented in Tables 2.4 (a), 2.4 (b), and 2.4 (c).

TABLE 2.4 (a) ESTIMATED PEAK FLOWS AND RUNOFF VOLUMES, SUBWATERSHED A
(Area = 0.105 sq. mi.)

RESULTS OF HEC-1 COMPUTER PROGRAM
Curve Number (CN) = 72
AMC-II

Return Period (years)	Runoff Coefficient	Peak Flow (cfs)	Runoff Volume (acre-ft)
2	0.058	5	0.45
5	0.132	22	1.40
10	0.173	36	2.13
25	0.243	68	3.75
50	0.268	88	4.48
100	0.310	116	5.88
500	0.380	184	8.90

TABLE 2.4 (b) ESTIMATED PEAK FLOWS AND RUNOFF VOLUMES, SUBWATERSHED B
(Area = 0.251 sq. mi.)

RESULTS OF HEC-1 COMPUTER PROGRAM
Curve Number (CN) = 72
AMC-II

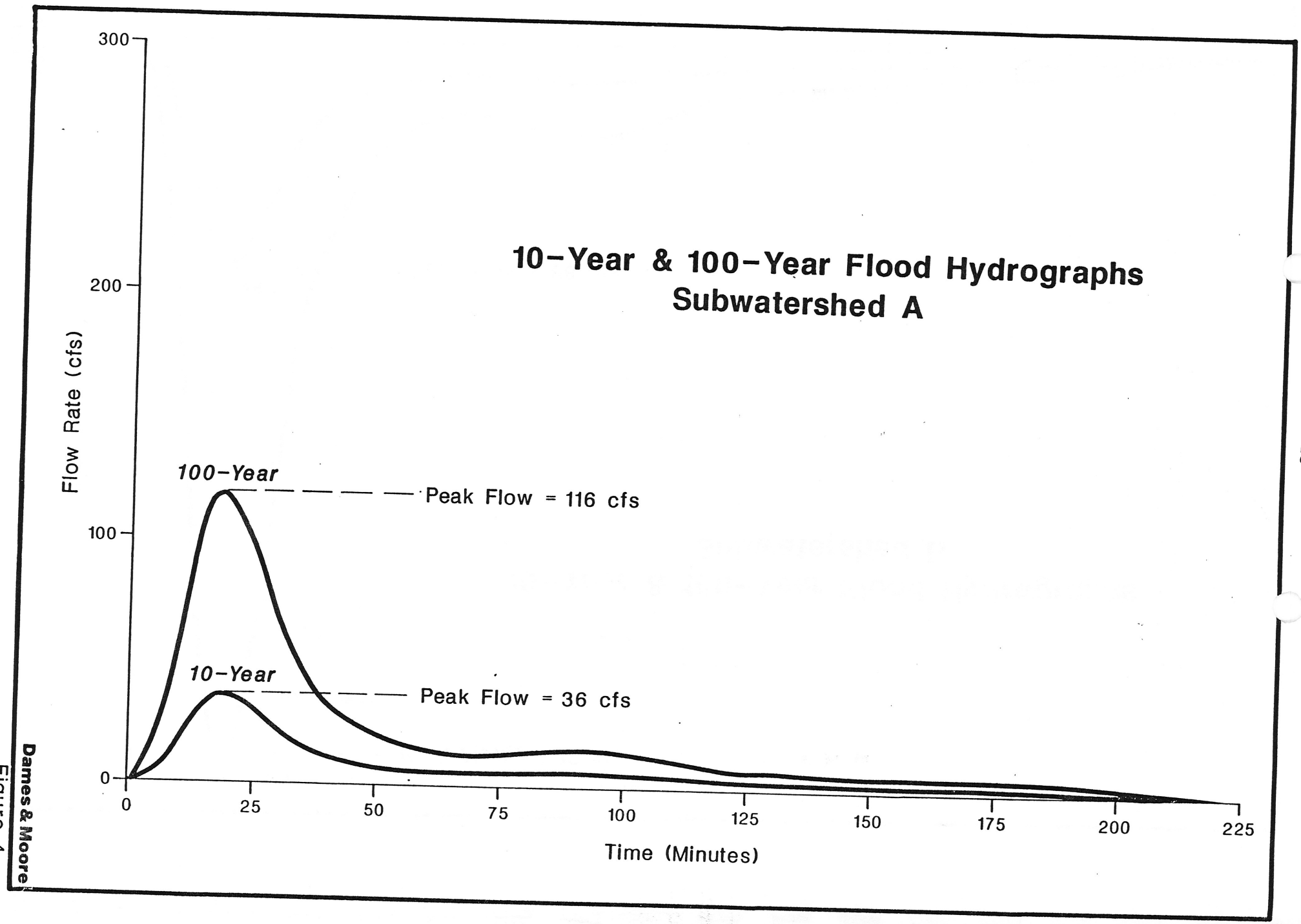
Return Period (years)	Runoff Coefficient	Peak Flow (cfs)	Runoff Volume (acre-ft)
2	0.058	12	1.07
5	0.132	53	3.35
10	0.173	88	5.09
25	0.243	167	8.97
50	0.268	215	10.71
100	0.310	282	14.06
500	0.380	450	21.28

TABLE 2.4 (c) ESTIMATED PEAK FLOWS AND RUNOFF VOLUMES, SUBWATERSHED C
(Area = 0.032 sq. mi.)

RESULTS OF HEC-1 COMPUTER PROGRAM
Curve Number (CN) = 74
AMC-II

Return Period (years)	Runoff Coefficient	Peak Flow (cfs)	Runoff Volume (acre-ft)
2	0.080	4	0.19
5	0.158	16	0.51
10	0.205	26	0.77
25	0.275	49	1.30
50	0.301	62	1.54
100	0.342	82	1.98
500	0.414	128	2.95

The values in Tables 2.4 (a), 2.4 (b), and 2.4 (c) are judged to represent reasonable design bases for hydraulic structures. The 10-year and 100-year flood hydrographs for AMC-II conditions for subwatersheds A and B are shown in Figures 4 and 5, respectively.



Dames & Moore

Figure 4

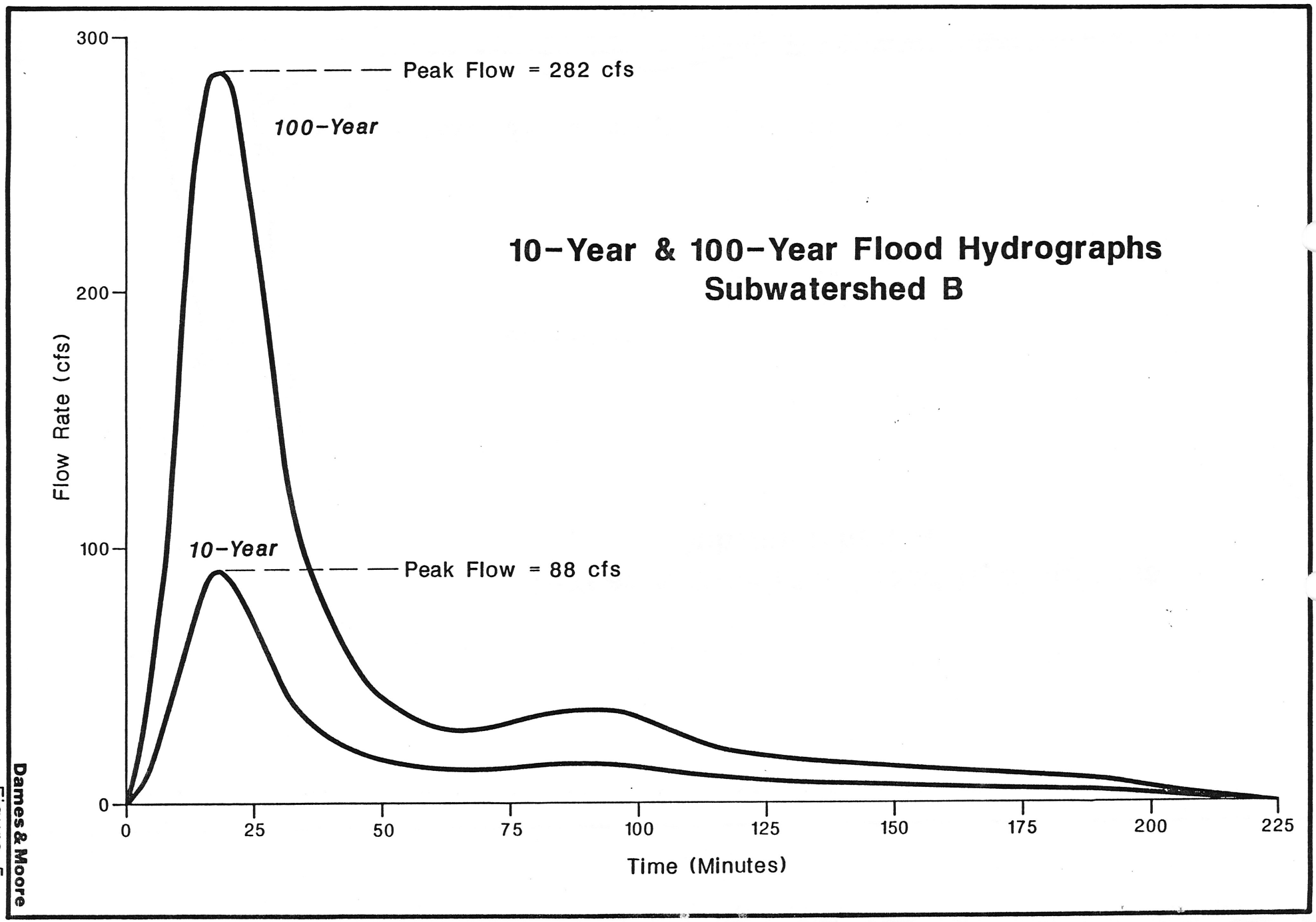

10-Year & 100-Year Flood Hydrographs
Subwatershed B
Peak Flow = 282 cfs
100-Year
10-Year
Peak Flow = 88 cfs
Flow Rate (cfs)
Time (Minutes)
300
200
100
0
0
25
50
75
100
125
150
175
200
225
Dames & Moore

Figure 5

3.0 SURFACE DRAINAGE CONTROL PLANS

3.1 OBJECTIVES OF SURFACE RUNOFF CONTROL

Current regulations and environmental considerations require that the surface runoff control system for the proposed Hermit Project meet the following objectives:

- Surface runoff diversion facilities for subwatersheds upstream of the Project Area should, as a minimum, be designed to control runoff from a 10-year 24-hour storm event.

- The release of radioactive materials into the surface and ground water environment due to erosion from uranium ore stockpiles or otherwise should be prevented even during extreme events up to the 500-year 24-hour storm. To meet this objective, the on-site retention structures should be designed to store surface runoff from the 500-year 24-hour storm with appropriate allowance for sedimentation and disposal/storage of all mine-related water.

- The ground surface and facilities within the Project Area should be graded as to ensure that the surface runoff and eroded material reach the on-site retention structures without spilling over the site boundary.

- The flood diversion system should be designed to cause minimal impacts/changes in the existing drainage patterns of the area.

3.2 PROPOSED DRAINAGE CONTROL PLANS

The proposed surface runoff control plan includes two diversion ditches along the northwestern and southern boundaries of the site area. These diversion ditches would convey surface runoff from subwatersheds A and B, respectively. These ditches would be designed to pass the 100-year 24-hour flood peak from their respective drainage areas with sufficient freeboard to handle the 500-year, 24-hour flood peak without undue damage. This will

ensure that surface runoff from subwatersheds upstream of the Project Area does not enter the site boundary. As an additional measure to prevent run-on to the Project Area, a peripheral dike will be constructed around the Property boundary.

To eliminate the potential for the release of surface runoff and sediments out of the Project Area, an evaporation pond will be constructed on site to store the 500-year, 24-hour storm runoff volume from the area within the site boundary, sediment yield from the area for a period of about five years, carry over runoff from a wet period assumed to be equivalent to a 2-year 24-hour storm runoff volume, and any additional mine-related water. The evaporation pond will be cleaned of deposited sediment as and when required to maintain the aforementioned storage capacity at all times during the operation of the mine.

3.3 SEDIMENTATION ANALYSIS

For a preliminary estimate of the sediment yield of the area within the site boundary, e.g., subwatershed C, the Universal Soil Loss Equation is used with the following parameters (SCS, 1976):

$$A = RKLSCP \qquad (3.1)$$

where, A = estimated sediment yield in tons/acre/year

R = rainfall factor which is estimated to have a value of 40 for the site area

K = soil erodibility factor assumed to be 0.2 for the compacted and partially armored surfaces in the site area after development

LS = slope factor assumed to be 0.55 for about 1.25 percent slope over a length of about 4000 feet in subwatershed C upstream of the proposed retention pond

C = crop management factor taken to be 0.45 for almost no ground cover and no appreciable canopy on the surface

P = erosion control factor, conservatively assumed to be 1.0

Substitution of these values in the Universal Soil Loss Equation results in a sediment yield of 1.98 tons/acre/year or 40.39 tons/year for the total area of 20.4 acres for subwatershed C. Assuming the unit weight

of sediment to be 100 lbs/cft, the annual sediment yield is estimated to be 808 cft requiring a capacity of 0.10 acre-ft. to store the sediment load generated in five years.

3.4 DESIGN SPECIFICATIONS

3.4.1 Diversion Ditches

For nearly maintenance free operation, the diversion ditches will be excavated with bed slopes approximately equal to the existing ground slope. Also assuming that the ditches will develop some vegetation along their banks over time, a Manning's n value of 0.04 is conservatively assumed. The hydraulic design parameters for a trapezoidal ditch along the northwestern edge of the Project Area are:

100-year peak flow (subwatershed A) = 116 cfs
Bed slope: S = 0.010 ft/ft
Bed width = 12 ft, side slopes = 2H:1V
Water depth = 1.7 ft, Area = A = 26.18 sq ft
Wetted perimeter = 19.60
Hydraulic mean depth= R = 1.33 ft

$$\text{Velocity} = \frac{1.486}{n} R^{2/3} S^{1/2} \qquad (3.2)$$

= 4.5 ft/sec (Chow, 1959)

Total depth of excavation with a freeboard of 0.3 ft = 2.0 ft
Height of peripheral dike above ground on the northwestern edge = 2 ft
d_{50} of riprap along the channel bank toward the site boundary = 1.5 in.

This size of riprap will provide an adequate factor of safety against the boundary shear produced by the estimated maximum velocities in the channel (USACE, 1970; 1971). This nominal riprap will be provided only on the bank toward the Project Area. The outer bank will be protected by vegetation cover. The permissible non-scouring velocity for vegetated channels excavated in easily erodible soils with 0 to 5 percent bed slopes varies from about 2.5 to 5 ft/sec (Barfield, Warner, and Haan, 1981). The computations for riprap size are abstracted below:

Local boundary shear in lbs per sq ft = $T_o = \frac{w V^2}{\left[32.6 \text{ Log } \frac{12.2y}{d_{50}}\right]^2}$ (3.3)

Design resisting shear = $T = 0.040 (w_s - w) d_{50}$ (3.4)

Design shear corrected for riprap placed on channel slopes =

$$T^1 = T\left[1 - \frac{\text{Sin}^2 a}{\text{Sin}^2 b}\right]^{0.5} \quad (3.5)$$

Factor of safety = T^1/T_o

where w = unit weight of water = 62.4 lbs/cft

w_s = unit weight of stone = 165 lbs/cft

y = water depth in channel in ft

d_{50} = average stone diameter in ft

a = angle of channel bank slope with the horizontal = 26.57°

b = angle of repose of riprap = 42° (Barfield, Warner, and Haan, 1981)

Thus, T_o = 0.2413 lbs/sq ft; T = 0.513 lbs/sq ft; T^1 = 0.3815 lbs/sq ft, and factor of safety = 1.58

Thickness of riprap = 2.25 inches

Hydraulic design parameters for the trapezoidal ditch along the southern edge of the site boundary are:

100-year peak flow (subwatershed B) = 282 cfs

Bedslope = S = 0.0064 ft/ft

Bed width = 12 ft, side slopes = 2H:1V

Water depth = 3.1 ft, Area = A = 56.42 sq ft

Wetted perimeter = 25.863 ft

Hydraulic mean depth = R = 2.18 ft

Velocity = $\frac{1.486}{n} R^{2/3} S^{1/2}$

= 5.0 ft/sec (Chow, 1959)

Total depth of excavation with a freeboard of 0.4 ft = 3.5 ft

Height of peripheral dike above ground on the southern edge of the site boundary providing an additional freeboard = 2 ft

d_{50} of riprap along the channel bank toward the site boundary = 1.5 inches

Using equations 3.3, 3.4, and 3.5 for the velocity and water depth in the channel, T_o = 0.2385 lbs/sq ft; T = 0.513 lbs/sq ft; T^1 = 0.3815 lbs/sq ft; and factor of safety = 1.6
Thickness of riprap = 2.25 inches

Since the channel velocities during extreme flood events are in the range of 4.5 to 5.0 ft/sec, riprap protection will be provided only along the channel bank towards the Property boundary. The outer bank will be protected by vegetation. As stated previously, the permissible channel velocity for vegetated channels excavated in easily erodible soils with 0 to 5 percent bed slopes varies from about 2.5 to 5 ft/sec (Barfield, Warner, and Haan, 1981).

3.4.2 Evaporation Pond

The storage capacity of the evaporation pond is estimated to be as follows:

o 500-year 24-hour storm runoff volume (AMC-II)	2.95 acre-ft
o Capacity for carry over runoff from a wet period (assumed to be equal to the 2-year 24-hour storm runoff volume (AMC-II))	0.19 acre-ft
o Volume of sedimentation for five years	0.10 acre-ft
Subtotal	3.24 acre-ft
o Capacity for mine water assumed to be 10 percent of the above capacity	0.33 acre-ft
Total Capacity	3.57 acre-ft
say	4.0 acre-ft

3.4.3 Drainage Crossing

As shown in Figure 2, a drainage crossing (culvert) will be installed at the indicated location on the northwestern diversion ditch. This culvert will be designed to pass the design discharge of 116 cfs without overtopping.

An appropriate size for this drainage crossing has been selected using the methods given in Hydraulic Engineering Circular No. 5 of the Bureau of Public Roads (BPR, 1965) and Handbook of Steel Drainage and Highway Construction Products (AISI, 1971). Inlet control conditions have been assumed. In addition, the following general criteria have been followed:

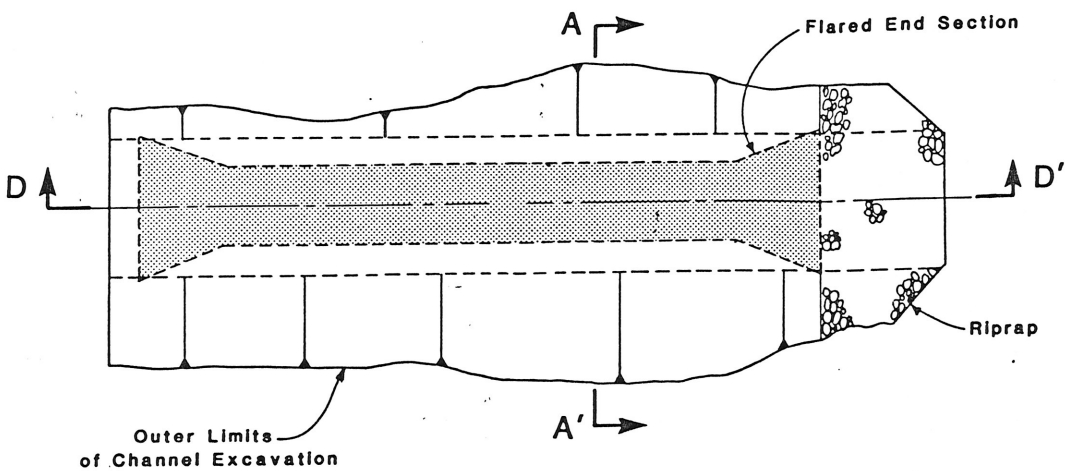
- As far as possible, the culvert invert is laid at the natural grade of the stream in the vicinity of the crossing.
- To minimize maintenance and chances of blockage due to debris accumulation, a minimum culvert opening equivalent to a 24-inch diameter pipe has been adopted.
- The maximum permissible design headwater elevation is taken to be less than or equal to the least of the following:

  (a) 1.5 x depth of opening above the invert for inlet control
  (b) 1.5 ft below the crest of the embankment

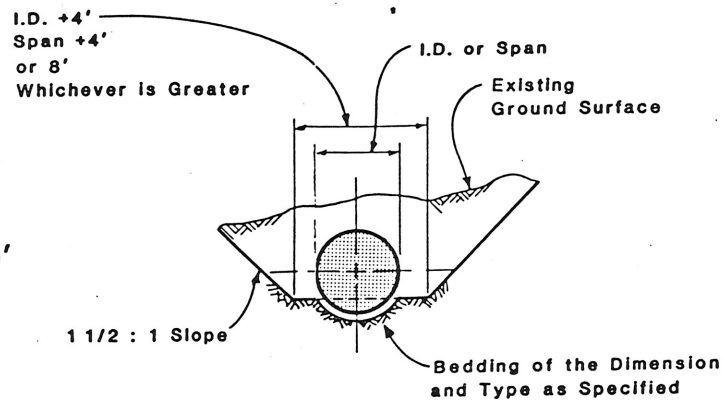
The suggested type and size of drainage crossing is shown in Table 3.1. The plan and section of a typical pipe culvert are shown in Figure 6.

TABLE 3.1 DESIGN DISCHARGE AND SIZE OF CULVERT

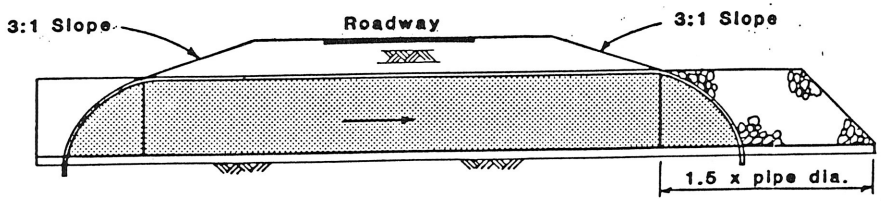
Description	Design Discharge (cfs)	Type and Size of Crossing
Culvert on northwestern ditch	116	Two 50 in x 31 in corrugated steel pipe arches or equivalent



Plan



Section A–A'



Section D–D'

Dames & Moore	NUMBER
Plan and Sections of Typical Pipe Culvert	DESIGNED DRAWN DATE PLATE OF

Figure 6

4.0 HYDROLOGIC IMPACTS

4.1 FLOODING POTENTIAL

With the diversion ditches designed to pass the 100-year flood peaks and additional freeboard provided in the channel design and that available due to the proposed dike, no flood damage is expected to any facility at the mine site. Because of available freeboard, the mine site facilities are flood proof for much more severe floods than the 100-year event. Some overland and overbank flooding may occur, during the 500-year storm event on the channel flank farther from the site boundary. However, this overbank flooding is not expected to be more severe than that expected under the existing conditions. At present, the entire storm runoff from subwatersheds A and B runs through natural depressions or rills or as overland flow. The construction of the proposed ditches will channelize flood flows and minimize overland flow and the associated soil erosion. Any overbank flows spilling over the channel banks would be much less than the overland flows without the ditches (i.e., under existing conditions).

The on-site retention pond has a capacity to store more than the volume of the 500-year 24-hour storm runoff from the Project Area. Therefore, the flooding potential downstream of the mine site will be somewhat attenuated and the streamflows will be somewhat reduced. However, the area of subwatershed C, from which the surface runoff will be contained is only 8.3 percent of the total area of the watershed contributing runoff to the point immediately downstream of the Project Area. Therefore, the overall impact at this location will be minimal and will become insignificant at points further downstream.

4.2 EROSION POTENTIAL

With the riprap and/or vegetation proposed along the inner banks of the diversion ditches, the potential for bank erosion will be minimized. Some erosion may be expected on the outer (unprotected) banks of these diversion ditches. However, the channel velocities for the most extreme flood events are in the range of 4.5 to 5.0 ft/sec as compared to the reported non-scouring velocities of 2 to 3.5 ft/sec for channels excavated

in alluvial silts (Chow, 1959). Therefore, the erosion potential during most flood events is expected to be minimal.

Any flood induced erosion within the Project boundary will be contained and therefore the impact of this erosion on the surrounding surface water environment will be insignificant.

4.3 ACCIDENTAL RELEASE OF CONTAMINANTS

As described in the previous sections, with the proposed design criteria, the probability of any eroded or accidently released contaminant getting out of the site area is extremely remote. To analyze a hypothetical scenario, it is postulated that some amount of contaminated liquid gets released into the surrounding surface water environment, during an unexpectedly severe event, e.g., in excess of a 500-year storm. This volume of contaminated liquid will first be diluted by the estimated 2.95 acre-ft of runoff volume generated within the Project Area (see Table 2.4 (c)). Further dilution will be provided by an additional total runoff volume of 30.18 acre-ft from subwatersheds A and B by the time the contaminant reaches the downstream end of the mine site area (see Tables 2.4 (a) and 2.4 (b). This will provide an additional dilution factor of about 11.2. Further dilution will be available when the contaminant reaches Bulrush Canyon and a dilution factor of about 2700 will be available in Kanab Creek giving a total dilution factor of about 24,000 between the concentrations in the water getting out of the mine site area and that flowing down Kanab Creek. It may be noted that the drainage area of Kanab Creek near Fredonia is 1,085 sq miles compared to a total drainage area of 0.388 sq mile for the subwatersheds upstream of the outlet point of the mine site area (USGS, 1979). Therefore, it is expected that the available dilution factors in Kanab Creek under other flow conditions will also be of the same order of magnitude as for the storm exceeding the 500-year event.

5.0 CONCLUSIONS

The hydrologic impacts associated with the proposed Hermit Mine can be minimized by the construction of the peripheral dike, diversion ditches, and evaporation pond as described in Section 3.0. The following general guidelines are recommended for continued mitigation of hydrologic impacts on the mine facility and the surface water environment surrounding the site:

- The evaporation pond, dike, and diversion ditches should be routinely maintained to insure their integrity at all times during the operation of the mine with appropriate modifications during reclamation.

- The roads and road crossings should be monitored for signs of erosion. If any erosional damage is detected, the same should be repaired by riprap or other erosion control measures.

- All disturbed areas and channel banks (when required) should be properly vegetated to establish satisfactory vegetation cover.

6.0 REFERENCES

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