PROPOSED URANIUM MILL TAILINGS LEACHING OPERATION at NATURITA, COLORADO

RANCHERS EXPLORATION AND DEVELOPMENT

ENVIRONMENTAL REPORT

January 1977

Prepared By
FOUR CORNERS ENVIRONMENTAL RESEARCH
Durango, Colorado

With major contributions from:

Coe and Van Loo Consulting Engineers, Inc., Phoenix, Arizona
(soils testing and facilities engineering)

Four Corners Environmental Research Institute Inc., Durango, Colorado
(environmental assessments)

Hazen Research, Inc., Golden, Colorado
(metallurgical and chemical research)

Science and Engineering Resources, Inc., Socorro, New Mexico
(hydrology and water monitoring programs)

PROPOSED URANIUM MILL TAILINGS LEACHING OPERATION at NATURITA, COLORADO

RANCHERS EXPLORATION AND DEVELOPMENT CORPORATION

ENVIRONMENTAL REPORT

January 1977

Prepared By
FOUR CORNERS ENVIRONMENTAL RESEARCH INSTITUTE
Durango, Colorado

With major contributions from:

Coe and Van Loo Consulting Engineers, Inc.,
Phoenix, Arizona
(soils testing and facilities engineering)

Four Corners Environmental Research Institute
Inc., Durango, Colorado
(environmental assessments)

Hazen Research, Inc., Golden, Colorado
(metallurgical and chemical research)

Science and Engineering Resources, Inc.,
Socorro, New Mexico
(hydrology and water monitoring programs)

Proposed Uranium Mill Tailings Leaching Operation
at Naturita, Colorado

Ranchers Exploration and Development Corporation

TABLE OF CONTENTS

			Page
I.	Proposed Activities:		1
	A.	Leaching Site Preparation and Physical Plant Construction	1
	B.	Materials Moving	2
	C.	Leaching and Extraction	3
		1. Tailings receipt, drying and reclaiming	3
		2. Leach tank loading	4
		3. Leaching	4
		4. Recovery plant	4
	D.	Site Reclamation	5
II.	Obvious Environmental Improvements Offered by the Proposed Operation:		5
	A.	Relief of a Long-Term Hazard on Colorado River System	5
	B.	Reduction of Human Exposure to Radiation	9
	C.	Opening of a Section of the San Miguel Valley to Future Development	11
III.	Qualifications of Ranchers Exploration and Development Corporation to Accomplish the Proposed Work:		11
	A.	Corporate Organization	11
	B.	Personnel Qualifications	13
	C.	Radiation Safety Policy and Program	13
	D.	Security	14
	E.	Utilities and Services	14
IV.	The Proposed Leaching Site:		15
	A.	Site Location and Layout	15
	B.	Regional Demography and Land Use	15
	C.	Regional Historic, Scenic, Cultural and Natural Landmarks	16
	D.	Geology	17
	E.	Seismology	17
	F.	Soils	17
	G.	Hydrology	18
		1. Surface water	19
		2. Groundwater	20
		3. Surface water quality	22
		4. Groundwater quality	24
	H.	Meteorology	24
	I.	Ecology	27
	J.	Background Radiological Characteristics	27
	K.	Other Environmental Features	28
		1. Isolation	28
		2. Proximity to existing tailings pile	29

		Page
V.	Facility Design and Construction:	29
	A. Layout and Design of Tanks, Ponds, Embankments and Dikes	29
	B. Inspection and Assurance of Quality of Constructed Facility	29
	1. Materials testing	29
	2. Specifications for soil liners and embankments	30
	3. In-place inspection and testing	33
	C. Facilities for Control of Wastes and Effluents	33
	1. Dust	33
	2. Radon gas	34
	3. Liquid effluents	34
	4. Sanitary wastes	34
	5. Trash	35
VI.	Environmental Effects of Present Tailings Removal:	35
	A. Radon Gas Release	35
	B. Dust	36
	C. Noise	36
	D. Impact on Historic and Cultural Values	37
	E. Long-Term Radiological Impact	37
	F. Impact on Water Quality	37
	1. Short-term	37
	2. Long-term	37
VII.	Environmental Effects of Site Preparation, Construction, Leaching Operation, and Residue Maintenance:	37
	A. Construction Land Disturbance; Dusting; Noise	37
	B. Changes in Land Use	38
	C. Impact on Historic and Other Cultural Values	38
	D. Water Diversion, Consumption, and Quality Alteration	38
	E. Effect on Wildlife	38
	F. Radiological Impact on Man and Other Biota	39
	1. Radon	39
	2. Gamma radiation	40
	3. Dispersed radioactive solids	40
	G. Process Effluents	40
VIII.	Economic and Social Effects of Construction and Operation:	41
	A. Benefits	41
	B. Costs	42
IX.	Effluent and Environmental Monitoring Programs:	42
	A. Surface Water Monitoring	42
	B. Groundwater Monitoring	43
	C. Air Monitoring	47
	D. Radiological Surveys	47
X.	Environmental Effects of Accidents:	47
	A. Transportation Accidents	48
	1. Tailings spillage	48
	2. Processed uranium and vanadium	48
	3. Sulphuric acid	48

		Page
	B. Leach Site Accidents	49
	1. High precipitation risks	49
	2. Containment violations	49
	C. Fire	50
XI.	Reclamation and Restoration:	50
XII.	Adverse Environmental Impacts Which Cannot be Avoided:	50
XIII.	Relationship Between Short-Term Uses of Resources and Long-Term Productivity:	50
XIV:	Irreversible and Irretrievable Commitment of Resources:	51
XV:	Alternatives to the Proposed Action:	51
	A. Alternate Leaching Site	51
	B. Alternate Processing	51
	C. Do Nothing	52
References		53

LIST OF TABLES

Table 1:	Well Data	21
2:	Water Quality of Dry Creek	26
3:	Boring Location, Depth and Initial Water Level Measurements	45-46

LIST OF FIGURES

(all Figures at end of report)

Figure 1 Vicinity and Index Map
2 Plant Site, Leach Tanks, Ponds
3 Land Ownership and Management
4 Stratigraphic Description and Symbols
5 Regional Geology
6 Stratigraphic Sections
7 Leaching Site Regional Structural Geology
8 Boring Log of Monitor Well #1
9 Diagram of Monitoring Well Casing Installation
10 Process Flowsheet

I. Proposed Activities:

Ranchers Exploration and Development Corporation proposes to move the uranium mill tailings which have been left at the abandoned mill site near Naturita, Colorado to a suitable location away from the San Miguel River and process those tailings for uranium and vanadium recovery. The entire removal operation would be completed in about 18 months.

Environmentally, the proposed operation would be a major step in removing the undesirable presence of tailings on the floodplain of the San Miguel River. The San Miguel is part of the Colorado River System, the water quality of which is currently of national and international concern. Removal of the tailings from the San Miguel Valley also would reduce any existing radon exposures to valley residents and open the possibility of normal long-term development of that section of the valley.

Ranchers has purchased the Naturita tailings from the Foote Minerals Company. The tailings will be moved by truck along State Highways 141 and 90 to a site in the Paradox Valley, where they will be blended and agglomerated, deposited in impermeable earthen tanks, and processed by leaching, ion exchange and/or solvent extraction to remove uranium, and solvent extraction to remove vanadium. The former tailings site and the leaching site will then be reclaimed in accordance with Colorado Radiation Control Regulation #2 and the recommendations of the Colorado Board of Health.

The operation can be broken down into four distinct segments: Leaching Site Preparation and Construction, Material Moving, Leaching and Extraction, and Site Reclamation.

A. Leaching Site Preparation and Physical Plant Construction

The proposed leaching site is located approximately three miles south of the present tailings location, as shown on the Vicinity Map, Figure 1. It is a 160-acre parcel, owned by Ranchers, described as the S½ NE¼ and N½ SE¼, Section 34, T.46N., R.16W.

A new access road to the northeast portion of the site will lead from the existing dirt road going southeast from Highway 90. The dirt roads will be widened to 30 to 40 feet and covered with a minimum of six inches of gravel. Concrete aprons and culverts will be installed through creek bottoms and dry washes as necessary. Required easements and permits for road construction will be obtained by Ranchers.

The facilities to be constructed on the site are shown in Figure 2. A dry wash through the center of the site will be kept open to accommodate run-off waters from the higher slopes to the south. Other natural drainages that cross the property will be diverted around the property or into the central drainage to keep run-off water from impinging on the banks of leach tanks or other facilities.

The recovery plant and material processing sites will be leveled and graveled.

Three leach tanks and two series of evaporation ponds will be constructed, sized approximately as shown on Figure 2. They will be lined with a one-foot thick liner of compacted shale to prevent liquid losses. Their berms will be constructed as detailed on Figure 2.

The floor of the leach tanks will have a one-half percent slope to facilitate drainage of leach liquors.

Evaporation ponds, which will accommodate the bleed stream from the processing plants, will be four feet deep.

Three solution collection ponds also will be constructed as shown on Figure 2. They will be 7½ feet deep, lined with 20 to 30 mil PVC liner material.

The initial one to two feet of excavation material will be stockpiled for later use as cover. Excavation below this level will be designed to balance the cut and fill quantities.

The initial earthwork for the project will consist of all the items shown on Figure 2 with the exception of two leach tanks and corresponding evaporation ponds. These latter facilities will be constructed as required during operations.

B. Materials Moving

The Naturita tailings are located adjacent to the San Miguel River approximately 2½ miles west of Naturita, Colorado, in Sections 14 and 15 of Township 46 North, Range 16 West.

Loading of the tailings will be accomplished, utilizing a 5 cu. yd. loader and a D-6 tractor/bulldozer, at a rate of 2,100 tons per day, five days per week. Two ten-hour operating shifts per day will be the normal schedule. Haulage of the tailings from their existing location to the plant site will be done using 25 to 30 ton capacity bottom dump haulage trucks. Haulage will be over Colorado Highways 141 and 90, for a total of about three miles, plus about one mile of graveled road to the plant site. Ranchers personnel will perform the loading and hauling operations.

C. Leaching and Extraction

1. Tailings receipt, drying and reclaiming

Tailings delivered to the site area will be dumped into a 50 to 100-ton storage bin. A drive-over dump will be constructed to facilitate unloading the bottom dump trucks into the storage bin. A pan feeder will remove tailings from the bin and transfer them to a conveyor that will feet a diesel fuel fired rotary dryer equipped with dust collectors. The material will be dryed from about 16% moisture to 10 to 12% moisture. An additional conveyor will be installed to by-pass the dryer if materials coming into the plant are sufficiently dry. From the dryer, or by-pass conveyor, the material will go into a hammer mill to break up any large clay particles that may be present. It is presently estimated that the size of the hammer mill will be 24 inches by 24 inches. Discharge from the hammer mill will be conveyed to a 24-inch by 100-foot radial stacker that will discharge the material into one of two 10,500-ton radial stockpiles for blending.

The blended material will be transported, using a Cat 988 front-end loader, to a 15 to 20-ton bin and feeder, onto a short conveyor belt and weightometer and into a 12-foot diameter by 33 to 40 feet long agglomerating drum where H_2SO_4 will be mixed in. Discharge will be conveyed into a 50-ton storage bin that will be used for loading 25-ton dump trucks.

2. Leach tank loading

Processed tailings will be transported from the agglomerate storage bin to the leach tanks and dumped along the berm edge and will then be pushed into the tanks, using a D-6 wide-track dozer.

3. Leaching

During construction of the leach tanks, four-inch PVC or Orangeburg pipe will be placed through the berms on the low side of the tanks. Upon completion of the clay liner installation, four-inch perforated PVC or Orangeburg underflow pipes will be laid on the compacted clay liner bottom and covered with approximately 9 to 12 inches of washed gravel. These lines will be on 25-foot centers.

The underflow lines, as they protrude from the outside edge of the berm, will be fitted with plastic butterfly valves and then flexibly connected to one of three collection launders. The launders will be buried or covered and will be routed to the solution holding ponds.

Pumps installed at the recycle 1 and recycle 2 solution ponds will pump solutions back to the leach tanks for recycle through buried or covered 6-inch and 4-inch PVC lines. Solution distribution on top of the tailings will utilize 2-inch PVC lines on 8⅓-foot centers with plastic needle valves every four feet along their length.

4. Recovery plant

The recovery plant will perform the operations indicated in the process flowsheet (Figure 10) by Hazen Research, Inc., of Golden, Colorado. The plant will be designed in detail and, to the extent possible, will be shop fabricated to facilitate expedient field installation. The design will be such as to permit moving to Durango upon completion of the Naturita operation and should be sufficiently winterized to permit year-around operation. The anticipated flow rate to the plant is 120 gallons per minute.

Underflow solutions from the leach tanks will be treated by ion-exchange or solvent extraction for uranium recovery and solvent extraction for vanadium recovery. The final products will be "yellowcake" (U_3O_8) in the form of a moist filter cake and a filter cake of ammonium metavanadate.

D. Site Reclamation

Upon completion of the leaching, the leach tanks, solution ponds and evaporation ponds will be covered with two feet of previously stockpiled top-soil and revegetated. Watering will continue as long as necessary to establish the vegetation.

Fencing around the plant site areas will be installed during plant construction. The area will be suitably posted with signs.

As loading nears an end at the tailings site, top-soil will be hauled from the plant site, or closer location if available, and a two-foot cover placed over the area occupied by the tailings. (Excavation of about two feet beneath the tailings to recover uranium values is anticipated.) Vegetation will be established and watered as required. Fencing will be maintained around the entire area.

II. Obvious Environmental Improvements Offered by the Proposed Operation:

A. Relief of a Long-Term Hazard on the Colorado River System

The Naturita tailings pile is presently located on the southwest bank of the San Miguel River, which flows into the Dolores River and, in turn, into the Colorado. The Dolores River, particularly that section below its confluence with the San Miguel, is currently under study for possible Wild River designation. The Colorado River is one of the nation's major river systems, its waters serving as the life-stream of much of the arid West. Maintenance of the water quality in this river system is a matter of national and international concern.

Historically, the presence of uranium milling activities and abandoned accumulations of mill tailings along the Colorado River drainage system have resulted in radiological pollution and degradation of the aquatic environment. Active mills discharged toxic chemicals, as well as some radioactive wastes, into river waters. Studies of the effects of such waste discharges on the aquatic biota of the Animas, Dolores, and San Miguel Rivers were conducted during 1958-63. Prior to the installation of waste treatment processes, essentially all of the bottom-dwelling aquatic insects were eliminated immediately below the uranium mills, and their numbers were greatly reduced 35 to 40 miles downstream.[1] Radioactivity in the Animas River below the then-active mill at Durango was 500 times background and eight times Radiation Protection Guide limits.[2]

Data collected from water quality surveillance stations in the Colorado RiverBasin showed that elevated radium and uranium concentrations persist from the headwaters of the Colorado River system through Arizona.[3] Combined measurements at Lake Powell, Lake Mead, Lake Havasu, and the Northerly International Boundary (Mexico) showed radium-226 mean concentrations of 0.23 picocuries per liter and total uranium at 7.3 micrograms per liter. Both values are about three times the average background concentrations found in the headwaters of the Colorado River system. A 1962 Public Health Service report (Technical Report W62-12) indicated that examination of Lake Mead mud sediments and calculations regarding the amount of radium-226 added to that impoundment by uranium milling operations over the preceding 20 years yielded an estimate that 2500 curies of radium-226 had accumulated in the sediments of Lake Mead since 1940.

Although waste control systems put into operation at uranium mills have stopped routine discharges into river waters, the presence of abandoned accumulations of tailings in river valleys constitutes a perpetual threat to downstream aquatic populations and a potential hazard to humans. A sudden flood, such as the 1976 Big Thompson Canyon event, could flush most of a given pile of tailings into the river system. In the Naturita case, such an event would add residual toxic chemicals, non-radioactive mineral burden, an estimated 490 curies of radium-226, and other radioactive materials to the river waters.

In the absence of such a catastrophic event, the presence of tailings accumulations on river banks is still highly undesirable. A 1974 Colorado Health Department report on the conditions of uranium millsite and tailings near Naturita (#082174) reports the present status in this manner:

> "The uranium mill tailings accumulation at Naturita occupies a sizable portion of the San Miguel River floodplain which is reduced from a normal width of about 400 feet to approximately 100 feet in the reach containing the tailings. As a result, flow velocities in the reach will be two to four times greater during peak run-off conditions that in adjacent, natural sections. Increased erosion under such conditions is assured.
>
> Flooding at Naturita, whether it is the intermediate regional flood (IRF) or the standard project flood will inundate the tailings. Fluctuations of the San Miguel River as a result of peak run-off conditions in the spring will result in partial saturation of the tailings when the river water seeps into the banks and leaching when the river subsides. Peak flows may physically remove the tailings and disperse them downstream. There is evidence of some erosion of tailings in the past."

Although the Naturita tailings have since been stabilized by dirt cover and revegetation, the AEC-EPA Phase I Study of Inactive Mill Sites (October 1976) points out that no stabilization of existing tailings sites is regarded as completely successful. Experience at Naturita has shown erosion from sudden heavy rains. Periodic washing of tailings into the river can be expected as long as the tailings remain in the river floodplain.

Furthermore, since the tailings are piled on porous soil, their presence at the current location constitutes a perpetual leaching source of pollution of the river and possibly of underground water supplies. A Federal Water Pollution Control Administration report[4] points out that:

1. Once they become a part of the stream environment, tailings constitute a long-term source of dissolved radium-226.

2. Where the soil at the base of a tailings pile is saturated continuously or intermittently, groundwater can be contaminated, even in semi-arid environments. Contamination of underground water can provide a source of pollution for both surface waters and individual and community domestic water supply wells.

3. Since groundwater usually travels at an extremely slow rate, areas that now appear normal may become contaminated later, and once contamination is accomplished, many years would be required to correct the situation.

4. Although contamination may not be currently apparent, future contamination of underground waters may occur some distance from a pile when the groundwater aquifer is recharged by a stream that has been affected by tailings, such as the San Miguel River in Colorado.

5. Data from the San Miguel River collected in 1955 showed dissolved radium concentrations as high as 88 picograms per liter. The bulk of the 88 pg/liter undoubtedly resulted from leaching of extensive river bed tailings deposits.

6. River sediment sampling on either side of the tailings pile at Naturita has shown an increase in the levels of lead-210 downstream of the pile to about twice the levels found upstream, and increases in thorium-230 levels by a factor of six to eight. While the resulting concentrations are still well below MPC values and create no concern as regards immediate hazards, as with radium, the long-term hazard is not so readily ignored.

The same report had previously pointed out that the primary concern regards long-term hazard, rather than immediate danger:

"It should be emphasized at the outset that insofar as radioactive surface water quality is involved, we are concerned primarily with long-term rather than immediate hazards. Data obtained from the Radioactivity Monitoring Network operated by the Project demonstrates that the water pollution control measures practiced by the industry at operating mills have been very effective and there is currently no significant immediate hazard associated with uranium milling activities anywhere in the Colorado River Basin. However, much of the radioactivity contained in the mill tailings is very long-lived -- for instance radium-226 has a half-life of 1620 years, and thorium-230 has a half-life of 80,000 years, to mention two of the more important potential contaminants in the tailings. It is known that the radium-226 contained in the tailings is leached and becomes dissolved in flowing water. Although similar studies have not been made for the other isotopes involved, the present state of knowledge indicates that radium-226 is probably the isotope of most concern.

It is the very long-lived nature of the radioactivity that makes necessary a cautious attitude toward the problem of ultimate disposition of mill tailings."

It is obvious, of course, that the radioactivity contained in uranium tailings will far outlast any quantity of "stabilization" dirt cover subjected to normal erosion forces. While "stabilization" is the approach currently depended upon to minimize degradation of Colorado River System waters by the presence of the Naturita pile, removal of that pile away from the river has not been favored heretofore simply because it was considered too expensive. The proposed operation offers the opportunity to get this tailings accumulation, once and for all, away from the Colorado River drainage - and to do this economically.

8. Reduction of Human Exposure to Radiation

The "Environmental Analysis of the Uranium Fuel Cycle, Part I - Fuel Supply," published by the Environmental Protection Agency in 1973, contains the following comments:

1. Tailings piles will have a radiological impact on the environment through the air pathway by continuous discharge of radon-222 gas (a daughter of radium-226), through gamma rays given off by radon-222 and daughters which undergo radioactive decay, and finally through air and water pathways as radium-226 and thorium-230 are blown off the pile by wind and leached from the pile into surface waters.

2. The radon-222 decay product of radium-226 emanates from these piles at an average rate of about 600 pCi/m^2-s, representing a total release of radon gas of more than 150,000 Ci/year from tailings accumulated as of 1970. (The natural background release of radon from the ground is about 1 pCi/m^2-s in most of the country; it may be 100 times greater over uranium deposits.)

3. Because of the presence in the tailings of thorium-230, which by its decay maintains the radium inventory, the radioactivity in the tailings will remain almost constant for thousands of years.

4. The piles at Grand Junction and Salt Lake City have been stabilized by the addition of an earth cover. While such a cover would tend to eliminate the loss of radium and thorium from the piles by the wind erosion and water leaching, it would not be expected to reduce the amount of radon-222 emanating by more than 25%.

5. Both theoretical predictions and experimental evidence indicates that individuals in the general population may be receiving very high levels of radiation exposure to the lung caused by the release of radon from uranium mill tailings piles.

6. A 20-foot covering of earth would be required to reduce radon emissions from a dry tailings pile by 90% compared to an uncovered dry pile.

Although the full accuracy of some of these statements has been challenged, and there is wide disagreement at this time regarding the significance to human health of radon in the environment, [1,5,6] claims that its emission from tailings piles constitutes a significant human hazard are now appearing in the literature. A report from the Health Physics Division of Oak Ridge National Laboratory[7] suggests that radon-222 may account for more than 99% of the radiation dose to individuals residing in areas adjacent to a tailings pile. David D. Comey argues[5] that, when projected over a long period of time, the number of human deaths from lung cancer caused by radon and its daughters from this source is indeed significant.

The AEC-EPA report of the Phase I Study of Inactive Uranium Mill Sites points out that no tailings piles are stabilized to prevent radon emanation and presently no reasonably economic method is known for such stabilization. (Techniques for controlling radon emission by such means as asphalt cover are under study, with some indication of potential success.)

Radon levels at distances greater than a half-mile from tailings piles are frequently indistinguishable from natural background. (Cohen claims [6] that this is generally true; some individual measurements given in the 1973 EPA report quoted above do not support that claim, but the effect of distance in reducing radon concentrations from a given source cannot be denied.) While the full physiological significance of human exposure to radon gas appears very uncertain at this time, the removal of the Naturita tailings from their present location in the settled valley of the San Miguel River to an essentially uninhabited area may significantly reduce long-term hazards to the health of local residents.

C. Opening of a Section of the San Miguel Valley to Future Development

River valleys in the semi-arid West are the most attractive areas for settlement and development. That section of the San Miguel River Valley now occupied by the Naturita tailings could, with appropriate decontamination of the site and of neighboring regions after completion of the proposed operation, be returned to its normal development potential. If these tailings are not removed, they may impose restrictions on area use essentially forever.

III. Qualifications of Ranchers Exploration and Development Corporation to Accomplish the Proposed Work:

A. Corporation Organization

Ranchers Exploration and Development Corporation was formed in 1954 by New Mexico ranchers who pooled their acreage in potential uranium-producing areas and exchanged mineral rights for stock in the company. Uranium was found on portions of this acreage in northwest New Mexico. These properties were leased to Kerr McGee Corporation and United Nuclear Corporation, and the company began receiving royalties in 1957; royalties to date have totaled about $15 million, and presently exceed $1.5 million annually.

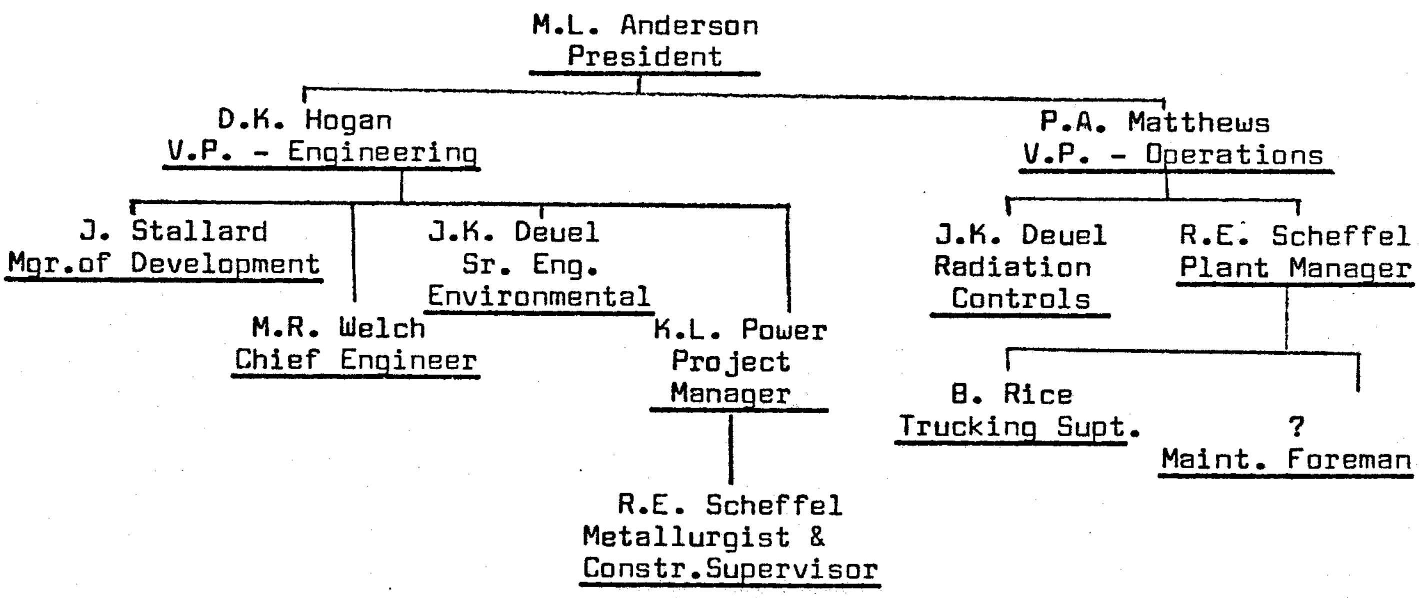
Ranchers became an operating mining company in 1964, when it purchased the Bluebird copper mine near Miami, Arizona. This mine, the first to produce cathode copper by solvent extraction-electrowinning, has an annual output of about 16 million pounds of cathodes. The Company also operates a small cement copper producer -- the Big Mike Mine -- near Winnemucca, Nevada, and has another small copper mine, the Old Reliable, on standby near Mammoth, Arizona.

Ranchers presently has two uranium mines in production, and will have a third producer in operation early in 1977. The largest of these properties is the Johnny M Mine, located in the Ambrosia Lake area in northwest New Mexico. This property will reach maximum output in mid-1977. Also located in northwest New Mexico is the Hope Mine, a smaller uranium producer which will begin production in early 1977. The third mine, the Small Fry, is located near Moab, Utah, and is now in full production.

Ranchers has maintained an active uranium exploration program since 1968, when a joint venture was formed with Combustion Engineering and Houston Natural Gas to explore in New Mexico. This venture led to discovery of the Johnny M deposit late in 1968. Subsequent ventures have been formed with Frontier Mining Corporation and Occidental Minerals, Urangesellschaft, and Texas Utilities.

Ranchers, which is listed on the American Stock Exchange, has corporate headquarters in Albuquerque, New Mexico, and maintains branch offices in Miami, Arizona, and Winnemucca, Nevada.

The organizational chart for the proposed project will be:



B. Experience of Key Supervisors in Handling Radioactive Materials

a. J. K. Deuel, Senior Engineer, a retired Navy Commander, has ten years of graduate level training that includes:

(1) Principles and practices of radiation protection;
(2) Radioactivity measurement standardization and monitoring techniques and instruments;
(3) Mathematics and calculations basic to the use and measurement of radioactivity;
(4) Biological effects of radiation.

This training consisted of six months at the Advanced Nuclear Power School, New London, Connecticut; six months at the National Reactor Testing Station, Idaho Falls, Idaho; and nine years of operations aboard four nuclear submarines.

The principal isotopes involved in Mr. Deuel's experience were N^{16}, Sr^{90}, I^{131} and Cs^{137}, in microcurie quantities. His specific experience involved personnel radiation health monitoring programs and primary plant (radioactive) water chemistry control.

b. Mr. Scheffel, Project Superintendent, has recently completed a formal, two-week Radiation Safety course at the University of New Mexico. All of the theoretical considerations mentioned in Mr. Deuel's background (1 through 4) were included in the course but there was no practical experience provided.

c. Mr. Power, Project Manager, is a graduate metallurgist. He has had no previous radiation training but he is a mature, highly qualified engineer with many years of experience in the mining industry.

C. Radiation Safety Policy and Program

It is the policy of Ranchers to work closely with the State Department of Health and other agencies to establish operational conditions and procedures, as well as monitoring programs, to assure that neither human exposure to radiation nor spread of radioactive materials exceeds standards which are accepted as safe. The company will conduct routine monitoring programs as indicated in Section IX below. Film badging of employees will be used if and where tests indicate exposure to exceed 25% of maximum permissible concentrations.

D. Security

The tailings site is within Foote Minerals' security fence. Access will be controlled during off-hours, when operating personnel are not on the site, by locking the gate.

Operational personnel will be on the leaching site 24 hours per day, seven days per week, and will prevent entry by unauthorized persons.

Product yellow cake will be stored in a locked shed, inventoried and shipped in accordance with Department of Transportation regulations.

E. Utilities and Service

Electric power will be obtained from the San Miguel Power Association or will be generated on site. If purchased, construction of a five-mile transmission line will be necessary. San Miguel has assured Ranchers that adequate power is available.

Water for the process will come from wells located on the site if tests show this to be feasible. Otherwise, water will come either from Dry Creek impoundment or from the San Miguel River through a three-mile pipeline connecting the site with a pumping station on the river.

Ranchers holds water rights, assigned by Foote Minerals, allowing pumping of 110 gallons per minute from the San Miguel River. Plant start-up will require an initial flow of 225 gpm. The possibility of acquiring additional water rights and water from other sources is now being investigated.

Industrial water will be stored on the leaching site in a 30,000 gallon head tank located on top of the flat knoll.

Domestic and reagent water, which will be required at a rate of 10 to 15 gpm, will be obtained from wells or trucked to the site and stored in a 10,000 gallon head tank.

IV. The Proposed Leaching Site:

A. Site Location and Layout

The leaching site location and layout will be as shown on Figures 1 and 2.

B. Regional Demography and Land Use

1975 population estimates published by the Montrose County Planner give the West End (the area in the county west of the federally owned Uncompahgre Plateau) 3,577 out of the total county population of 20,859. The towns near the project are Naturita, estimated at 741, and Nucla, five miles north, at 858. The population in the area is not large enough to support developed recreational facilities or hospitals; these services are obtained at Montrose and Grand Junction, 85 and 105 miles away, respectively. The area is served by roadway transportation and a 6200-foot paved and lighted airstrip.

Local schools are operating below pupil capacity. The elementary and high schools are located in Nucla, and have current enrollments of 290 and 235 pupils. The junior high is in Naturita, with 255 pupils. The superintendent estimates that a 15% increase in enrollments could be absorbed by the system, although if many children in the 12 to 14 age group are added to the community, the junior high would need more staff and classroom space. The RE-2 District had 850 pupils in 1976, down from the 1963 high of 1350. Small elementary schools at Uravan and Paradox enroll 90 and 41 pupils, respectively.

The non-township population in the area tends to be around Nucla, as indicated by the voter registration figures (1976). Paradox has 113 registered voters; Uravan has 233; Naturita has 355; and Nucla has 703.

There are fewer than a dozen self-sufficient farming or ranching businesses in the area; uranium mining is the major industry, both as original employer and as supplemental employer for many with small businesses or farms. Colorado Ute Electric Association operates a 39 MW generating plant near Nucla, employing 26 people.

The land immediately surrounding the proposed leaching site is practically uninhabited; one dwelling unit, which was not regularly occupied in 1976, is located a mile northwest of the site. As shown on Figure 3, most of the surrounding land is public domain, administered by the Bureau of Land Management.

Other nuclear fuel cycle facilities within 50 miles of Naturita are the General Electric/nuclear uranium ore storage station at the Foote Mineral site adjacent to the property purchased by Ranchers; the Rio Algom mill at La Sal, Utah; the Union Carbide/nuclear mill at Uravan; and numerous small uranium mines predominantly located within a circle beginning at Naturita going north to Gateway, southwest to La Sal, southeast to Slickrock and back to Naturita.

C. Regional Historic, Scenic, Cultural and Natural Landmarks

The nearest place which appears in the National Registry of Historic Places is Lowry Ruin, approximately 40 air miles south-southwest of the proposed leaching site. There are no registered landmarks within a 40-mile radius of the site.

A search for surface evidence of Native American habitation of the site (arrow points, chips or pot shards) revealed no such evidence. If evidence of early habitation or other archaeological values should be encountered during excavation, those values will be salvaged by qualified personnel before construction proceeds at that location. The Colorado State Preservation Officer has been contacted to notify him of this proposed project and to request information regarding historic or cultural resources which should receive special concern and protection.

D. Geology

Figures 6 and 7 show the stratigraphy and structural geology of the region. Figure 5 identifies the location of stratigraphic sections shown on Figure 6, which intersect on the site, perpendicular to each other. Symbols used are identified and described on Figure 4.

The site is on Mancos shale, near the center of an underlying syncline.

E. Seismology

The Paradox Valley is in Zone 1 of Seismic Risk Map of Alger Missen.[8] Structures in this zone built to withstand fundamental periods greater than 1.0 seconds can be expected to suffer no more than minor damage from large distant earthquakes. Simon confirms[9] that the Paradox Valley is aseismic. She places the nearest earthquake epicenter more than 50 miles away near Montrose.

While the proposed facilities could withstand modest seismic activity without significant effect, available evidence indicates that such activity is not likely to occur.

F. Soils

Coe and Van Loo Consulting Engineers, Inc., of Phoenix, Arizona, investigated the soils and subsurface characteristics of the proposed leaching site. In this study they completed 21 auger borings, 7 monitoring wells, and 8 backhoe test pits. In addition to auger borings, approximately 27 feet of NX size core was recovered from the monitoring wells which are 130 and 148 feet deep. The boring log of well #1 is shown on Figure 8. Complete boring logs and lithologic data are available in the Coe and Van Loo report, a copy of which has been sent to Mr. David Shelton of the Colorado Geological Survey. Locations of auger holes, monitoring wells and test pits are shown on Figure 2.

The following description of soils at the leaching site is taken from the Coe and Van Loo report. Chemical analyses and results of physical tests on soil samples are discussed below in Section V-B.

"The bulk of the soil at the site consists of gravelly, sandy silty clay (CL) which is normally brown to red brown to olive in color and is very stiff to hard, in situ. This soil is generally moderately plastic and normally contains 20 to 35% clay sizes and 10 to 35% sand with the remaining being silt size. It is very nearly impervious when compacted to within 95% of ASTM D-1557 with the coefficient of permeability ranging between 10^{-6} and 10^{-8} cm/sec. However, it also exhibits a fair amount of swell when water is added to the remolded sample, the swell approaching 8%. The carbonate content is generally high for a semi-arid environment, with values approaching 2%.

The other major soil group consists of cobbly, gravelly, silty sand-sandy silt (SM-ML) which varies in color from light brown to dark gray. It is very dense in situ and generally has an appreciable amount of fines (up to 50% passing #200 seive) and as such would be considered 'dirty' silt or sand. Permeability of this material apparently ranges between 10^{-6} to 10^{-7} cm/sec. when remolded to 95% of ASTM D-1557, which implies that this soil is nearly impervious when compacted. Its carbonate content is fairly high, with test values approaching 3.5%.

The last general materials group consists of weathered silty mudstone-siltstone (Mst) which is generally light gray to black in outcrop. This material is very hard within a foot or so of the surface but can probably be easily ripped and worked with standard excavating equipment. It tends to become a moderately plastic silty clay (CL) when broken down by the addition of water. When remolded to within 95% of ASTM D-1557 it is very nearly impervious with permabilities on the order of 10^{-7} cm/sec. However, once remolded, it tends to swell up to 10% with the addition of water. The carbonate content is approximately 2.5% and the gypsum content is not quite 1/2%."

G. Hydrology

The hydrology of the proposed site has been studied, under contract with Ranchers, by Science and Engineering Resources, Inc. (SER) of Socorro, New Mexico, hydrology consultants. The following information is excerpted from their report. The full report is available upon request from the Four Corners Environmental Research Institute.

1. Surface Hydrology

a. Site drainage

The site is drained by three unnamed arroyos which enter the site from the south and drain northward. These arroyos are ephemeral, carrying water only during precipitation events. The three arroyos drain to Dry Creek, which flows northward and passes west of the site. (See topographic maps, Figures 1 and 2.) Dry Creek flows into the San Miguel River about two miles northwest of the town of Naturita, Colorado.

Site plans contemplate diversion of the eastern and western arroyos upstream of the operations site so that run-off would flow at the boundaries of the site and through the center arroyo. The center arroyo will be left open through the site.

b. Dry Creek

Dry Creek is a small stream which does not flow continually but does flow most days of the year. Its drainage area is 85.9 square miles.

The U. S. Geological Survey has gaging station records for a gage located 1.2 miles downstream from Dead Horse Creek, five miles northwest of Basin, and 14 miles south of Naturita. The available period of record is July 1966 through September 1975. Water is diverted for irrigation above the station and also is imported above the station from Naturita Creek.

The mean daily flow of Dry Creek by month, averaged over the period of record, in cubic feet per second is:

Jan.	0.1	May	7.1	Sept.	7.5
Feb.	0.6	June	1.5	Oct.	2.5
March	2.4	July	2.3	Nov.	0.4
April	3.1	Aug.	3.9	Dec.	0.3

The high average flows in May and September are affected by exceptional single month values and the short period of record. The highest monthly mean flow, 55.4 cfs, occurred in September 1970. By contrast, the flow was zero for September 1968 and 1973. The effect of short-term thunderstorm activity on flow in Dry Creek is shown by the maximum 24-hour difference in daily flow, which displayed a spread of .07-1030 cfs in September 1970, with the peak discharge recorded at 5660 cfs.

For the period of record, Dry Creek's annual volume of flow averaged 1866 acre-feet, varying from a minimum of 727 acre-feet in 1968 to 4870 in 1970.

c. San Miguel River

The U. S. Geological Survey maintains a gaging station at Naturita. The flow is affected by storage reservoirs and irrigation diversion.

The maximum daily discharge occurs during April, May and June. The response to thunderstorm activities shown by Dry Creek is masked by larger flow, larger drainage area, irrigation diversions and, more clearly, by snow-melt run-off.

Comparison of annual flow volumes of the San Miguel River and Dry Creek shows an average dilution factor of 145 for Dry Creek waters entering the San Miguel. This factor varied from 55 in 1970 to 251 in 1968.

2. Groundwater Hydrology

Very few data are available of direct import to the Naturita site concerning groundwater hydrology.

Data from the Colorado State Engineer's Office are shown in Table 1, which concerns wells located in adjacent townships or ranges. No information was available on the township and range in which the site is located. From Table 1, it appears that yields are in the range of 10 gpm except for higher producing wells in the valley of the San Miguel River. Unfortunately, no information is available from the State Engineer's data to indicate aquifer name, zone of perforation, nor maximum yield under proper well completion.

The U. S. Geological Survey has not published any hydrology reports from any area near the site. Neither the Colorado State Engineer's Office nor the Colorado Water Conservation Board have published reports on the area.

Soils borings and materials pits have been completed on the site by Ranchers (see paragraph F of this section). The results from these borings indicate that the site is underlain by shale and siltstone of the Mancos shale formation.

TABLE 1: WELL DATA

TOWNSHIP	RANGE	SECTION	WELL YIELD (in gpm)	WELL DEPTH (in feet)	WATER LEVEL (in feet)
46N	15W	4	7	125	2
46N	15W	5	5	116	10
46N	15W	6	5	235	42
46N	15W	8	50	348	UNK
46N	15W	11	20	265	235
46N	15W	16	15	80	UNK
46N	15W	17	38	335	150
46N	15W	29	15	355	60
46N	16W	1	10	220	192
46N	16W	12	8	240	218
46N	16W	14	8	36	20
46N	16W	24	200	50	10
46N	16W	24	200	50	10
46N	16W	24	200	15	3
46N	16W	27	30	250	UNK

The Mancos shale is relatively impermeable although small amounts of water may be enclosed in the lensing sandstones. Those boreholes located near the arroyos may, at times, contain some water. This water results from shallow recharge during run-off periods to the upper few feet of weathered shales and should not be considered available groundwater nor should such groundwater be considered to extend throughout the site.

The next lower formation below the Mancos shale is the Dakota sandstone. The Dakota sandstone is a viable aquifer although yields in the site are likely to be small. The Dakota is protected at the site by 100 to 250 feet of Mancos shale.

The surface of the site slopes toward the north. This means that shallow groundwater occuring as a recharge in weathered shale near arroyos also flows toward the north.

The site lies in a small syncline plunging slightly toward the south. A recharge area for the Dakota sandstone lies north of the site. Water in the Dakota sandstone should flow towards the south. The low yields evidenced in Table 9 probably indicate that water in the Dakota sandstone flows very slowly.

3. Surface Water Quality

The U. S. Geological Survey informed SER that it has no water quality data for the San Miguel River at its gaging station at Naturita nor for Dry Creek.

The Colorado Department of Health has commissioned analyses of spot samplings of the San Miguel River as part of broader studies of the Colorado River drainage. The most recent of these analyses were done by the Four Corners Environmental Research Institute in 1975, and reported to the Department of Health in 1976 as part of the report "Biological and Chemical Studies of Selected Reaches and Tributaries of the Colorado River in the State of Colorado." Two sampling points used in that study are of particular interest to this project, for they have been selected, as discussed below, as appropriate points to monitor San Miguel River waters during the proposed operations. These points are designated SM-32 and SM-34, and are, respectively, at the bridge crossing of Highway 97 in Naturita and at the bridge less than a mile downstream from the present Naturita tailings pile location. (Dry Creek flows into the San Miguel River between these sample points.) Chemical analyses from the 1976 report for these two sample points are, in mg/l:

	SM-32	SM-34
Total Iron	.10	.15
Total Chromium	< .055	< .055
Manganese	< .024	< .050
Zinc	.030	.030
Copper	< .040	< .040
Molybdenum	< .33	< .33
Lead	< .11	< .11
Dissolved Oxygen (ppm)	10.2	9.8
Temperature (°F)	51	49
pH (no units)	8.4	8.4
Total Alkalinity (mg $CaCO_3$/l)	120	29
Turbidity (JTU)	2	2
TSS	2	5
Total Phosphate	.010	.018
Total Nitrate	< 1	< 1

Dates these samples were taken, as well as analyses of similar spot samples taken several years earlier, can be obtained from the original report at the Colorado Department of Health.

Some radium-226, uranium, and other radiological data for the San Miguel River are available in the July 1973 EPA report of analyses of samples from water quality surveillance stations in the Colorado River Basin.[3]

One older analysis of Dry Creek, made in October 1960, has been located in the Department of the Interior's 1973 Catalogue of Data. It is given in Table 2, along with data from a sample taken of Dry Creek by Ranchers in November 1976. Dry Creek reflects the soluble sulfate minerals occurring in the Mancos shale.

4. Groundwater Quality

No published analyses exist for wells near the site. The U. S. Geological Survey is sending unpublished data concerning wells at substantial distance from the site for SER review. However, it is unlikely they will be pertinent because of distance.

Analyses of water found in test drill holes on the site will be made in the immediate future for information regarding background conditions existing prior to commencement of the leaching project.

Additional background data on both surface and groundwater quality will be obtained from available samples at all established monitoring points prior to startup of the proposed operation.

H. Meteorology

Climatic data for Naturita, Uravan, Paradox and other sites in Colorado have been obtained by Ranchers from the U. S. Department of Commerce's National Climatic Center in Asheville, North Carolina. Information on mean temperatures, temperature extremes, and precipitation for the years 1931-1975 have been reviewed.

Data for the period 1961 to 1975 for Uravan, ten miles north of the proposed leaching site at an elevation of 5010 feet, show a mean annual temperature of 52.1°F, temperature extremes of 104° and -23°, and the mean of extreme yearly lows at -6.8°. Similar data for Paradox, 15 miles northeast of the site in the lower end of the Paradox Valley at an elevation of 5280 feet, show the mean at 49.7°, range 104° to -21°, and mean yearly low at -11.5°.

Mean annual precipitation for the same period at Paradox was 12.6 inches and at Uravan 12.2 inches. Annual extremes were 21.42 and 21.96 inches, respectively, in the year 1965. But for that anomalous year, there was little variation around the mean.

Excluding 1965, annual total precipitation ranged from 10.05 to 15.26 inches at Paradox and from 7.85 to 13.79 inches at Uravan. Snowfall begins at Paradox in November and generally is over by April. Sketchy records for the period 1951 to 1960 show a mean annual snowfall total of 27.5 inches.

Flow of the San Miguel River at Naturita averages 339 cubic feet per second, according to U.S.G.S. Water Resources data gathered from 1917 to 1929 and from 1940 to the present. The maximum discharge recorded was 7,100 cfs on April 15, 1952, at which time the Naturita gage height was 9.80 feet.

Meteorologic data most directly relevant to the proposed operation are evaporation rate measurements made in 1975 by the U. S. Bureau of Reclamation. The Bureau, which is building solar evaporation ponds at Paradox for desalinization purposes, installed evaporation pans at Paradox and at Dry Creek, next to the proposed leaching site. The 1975 measurements were corrected by a 0.7 pan factor and correlated to 32 years evaporation experience to arrive at an annual expected average evaporation at Dry Creek. The Bureau of Reclamation figures are as follows:

1975 Evaporation Actual		Correlated and Corrected Expected Evaporation	
April	5.94"	5.72"	
May	7.55"	7.68"	
June	11.23"	9.27"	Zero evaporation
July	10.44"	9.19"	November - March
August	10.60"	7.56"	
September	6.49"	5.81"	
October	5.41"	3.70"	
		48.93"	

In summary, about 12 inches of precipitation annually falls on the leaching site, which experiences temperature extremes from 104° to -20°F. Evaporation of about 49 inches of water annually can be expected.

TABLE 2: WATER QUALITY OF DRY CREEK
(in mg/l)

Date	SiO_2	Al	Fe	Mn	Ca	Mg	Na	K	HCO_3	SO_4
Oct. 1960	15	1.0	0.06	0.00	420	535	452	15	322	3670
Nov. 1976	--	<0.1	0.05	0.09	---	---	---	--	230	2360

	Cl	F	NO_3	PO_4	TDS	pH	pCi/l Beta-Gamma	pCi/l Ra	µg/l U	As
Oct. 1960	158	1.2	0.0	0.08	5040	7.1	50	0.1	12	0.00
Nov. 1976	78	0.5	<0.1	--	6010	7.8	--	---	37.4	0.04

	Se	Ba	Cd	Cu	Zn	V	Mo	TOC	Total Hg	Pb
Oct. 1960	0.06	--	--	--	--	--	--	---	--	--
Nov. 1976	<0.01	0.166	<0.001	0.005	0.021	0.012	<0.001	33.4	0.0022	<0.001

	Ag	Co	Ni	pCi/l Ra-226	pCi/l Ra-228
Oct. 1960	--	--	--	--	--
Nov. 1976	<0.001	0.001	<0.01	2.3±1.1	4.8±4.0

I. Ecology

James G. Erickson, Ph.D., biologist and consultant for the Four Corners Environmental Research Institute, visited the site on November 24, 1976 during the middle of the day for the purpose of evaluating the flora and fauna which might be affected by the proposed operation. Field observations were made on the site and in areas immediately adjacent to the site. The following three paragraphs are from his report.

> "The climax vegetation consists almost entirely of sagebrush with small patches of bunch grass. Other plants within the area of the proposed leaching operation include prickly pear cactus, pinon pine, juniper, and yucca. The land near the site in the vicinity of the stream includes greasewood, rabbit brush, four-wing saltbush, tamarisk, willow, and cottonwood in addition to sagebrush and grass. There is some economical value to this vegetation: the grass represents food for some wild and domestic animals, and the sagebrush has some value as deer food. Neither would seem to be significant. The hills to the south are characterized by pinon and juniper and are good habitat for mule deer.
>
> Animals seen or inferred include a wide variety of birds (although only two ravens were seen), mule deer, miscellaneous small rodents, and rabbits. Two specimens of the whitetail antelope squirrel were seen on the site. This animal ranges over the four corners area and a considerable portion of the arid regions of the west and southwest. The stream adjacent to the area has a good population of algae and a small population of insects. The presence of caddis fly larvae indicates that the stream flows with clean water.
>
> As defined in section 2.8 of the 1973 AEC Regulatory Guide 3.8, the only "important" animals on the area are mule deer. Since these animals range rather widely, they cannot be considered as residents within the proposed leaching area."

The Colorado Division of Wildlife has been informed of the proposed project and asked for comment regarding big game migration routes through the area.

J. Background Radiological Characteristics

A scintillation scan of the leaching site and its surroundings, made with a Mount Sopris SC-131A scintillometer, shows relatively constant background radiation levels. Within the site boundaries, minimum readings were 1.65 cps on top of the dominant knoll and maximum were 2.50 cps in a small gulley at the south base of the knoll. These readings correspond to about 7 and 11 μR/hr., respectively, both within the background range found in the neighboring San Miguel Valley by Ford, Bacon and Davis Utah.[10] Off site, readings were within the same range except along Highway 90, the edges of which frequently showed readings 2 to 3 times as high. These higher readings, if mill tailings were not used as highway fill, indicate some spillage or dusting from uranium ore trucks during the decades of ore transport on this highway.

Uranium and radium values in a 1960 spot analysis of water from Dry Creek are included in Table 2. Significant background data on uranium, radium, and thorium content of surface and groundwater near and at the site will be obtained from analyses of initial samples taken at monitoring stations (described in Section IX below) and wells before operations commence.

K. Other Environmental Features

1. Isolation

As mentioned in Section B above, there is only one residence in the general vicinity of the proposed leaching site. It is approximately a mile distant and currently is not inhabited most of the time. All other residences are two air miles or more from the site. A high ridge also separates the site from Naturita and other habitations in the San Miguel Valley.

Because the surrounding area is mostly public domain, as shown on Figure 3, this site is additionally isolated from future residential development pressure. The surrounding public lands, which are under BLM control, can be so managed that residual radioactive tailings, stabilized and left at the proposed leaching site, can remain relatively isolated from the human environment indefinitely. This isolation potential is a very advantageous feature of the proposed leaching (and storage) site.

2. Proximity to the existing tailings pile

Although it is appealingly isolated, the proposed leaching site requires only a four-mile haulage from the existing tailings pile. At this distance, moving of the tailings to the proposed site by Ranchers is economically feasible. Tailings moving costs can be paid from sales revenues of recovered uranium and vanadium, and the removal of the tailings from the San Miguel floodplain can be achieved without cost to the taxpayer.

V. Facility Design and Construction:

A. Layout and Design of Tanks, Ponds, Embankments and Dikes

The layout and designs are detailed on Figure 2.

B. Inspection and Assurance of Quality of Constructed Facility

1. Materials testing

Coe and Van Loo Consulting Engineers, Inc., of Phoenix, Arizona, conducted tests to determine the overall suitability of materials found at the site for construction purposes and the general overall spacial continuity of those materials. Their field investigation consisted of auger boring, rotary and core drilling, test pitting with a backhoe, some surface sampling and some outcrop mapping in the various stream channels.

Locations of the 21 auger holes, 7 monitoring wells, and 8 backhoe test pits are shown on Figure 2.

Bulk samples and some small "bag" samples totaling approximately 1800 pounds were acquired for materials property testing, the bulk samples being taken predominantly from the backhoe pits. Approximately 27 feet of NX size core also was recovered from the two deep monitoring wells installed at the site.

Coe and Van Loo had laboratory tests conducted to determine the physical nature of the materials at the site and to develop design parameters for embankment and liner construction. Tests performed included determination of Atterburg limits and grain size distribution; remolded unconfined compressive and shear strength parameters; remolded consolidation and swell characteristics; remolded permeabilities; optimum moisture-density relationship; and chemical baseline data.

All standard testing was conducted by competent soils laboratories according to current guidelines published by the American Society for Testing of Materials. Physical properties testing was conducted by Engineering Testing Laboratories of Phoenix, and Sergent, Hauskins, and Beckwith of Albuquerque, New Mexico. The former also determined gypsum content, carbonate and sulfate content, and the pH of soil samples. Test results are appended to the full Coe and Van Loo report to Ranchers, copies of which are available on request. (A copy of the complete report has been sent to Mr. David Shelton of the Colorado Geological Survey.)

As a result of the materials testing program, Coe and Van Loo concluded that:

(a) The soil and rock materials encountered at the proposed plant site appear to display physical characteristics which make them suitable for embankment fill and as a liner for fluid retention.

(b) Soil liners should be adequate if compacted according to recommendations and to a thickness of at least one foot.

(c) Compacted fluid retention and leach heap embankments should be stable when constructed according to the recommended geometry constraints and compaction specifications.

(d) Sufficient borrow soils and mudstones are apparently available at the site to construct the proposed leach heaps, evaporation pond embankments and soil liners.

2. Specifications for soil liners and embankments

The Coe and Van Loo assessment of materials suitability for construction is as follows:

> "The soils and mudstones-siltstones encountered at the site appear to be adequate for embankment and soil liner construction. The materials are adequate from a strength or structural point of view and they have a definite advantage in that they are relatively impervious as indicated by the various permeability tests. The display of impermeability implies that the silty clays and remolded or compacted mudstones and siltstones should provide a very good embankment and liner material from the standpoint of fluid retention.

Generally embankments and soil liners will be placed on similar material used in construction of the embankments and soil liners. By compacting this base material to design specifications an additional thickness of relatively impervious membrane will be added to the minimum design recommendations. Also, the impervious nature of the underlying silty clays and mudstones should retard any seepage.

The silty clays and remolded mudstones should have a moderately inherent resistance to piping and are expected to resist saturation of downstream slopes during the useful life of the embankment. Although it is possible that embankment failure could result from erosion due to small concentrated leaks or by progressive sloughing, this possibility can be substantially eliminated by designing with moderately safe slopes and maintaining design specifications during construction. It should be noted that if large leaks are allowed to develop piping will cause embankment failure within a short time.

Embankment and liner erosion due to wave action is not expected to develop because of the short 'fetch' length expected at the evaporation ponds.

As previously mentioned, the silty clays and mudstones are adequate materials from a construction standpoint. Similar materials are utilized for forming impervious cores on large earth dams and have performed well as small dams without any type of reinforcement.

The site materials also exhibit a fair degree of swell potential. This swell potential can produce increased porosity in the post construction phase and upon drying may produce cracking of the embankment and soil liners. However, this tendency is normally mitigated within acceptable standards by constructing the embankments and soil liners on the wet side of optimum within the allowable bounds of the design specifications and consistent with maintaining the soil strength.

a. Soil liners

Prior to placing the soil liner all loose topsoil and organics should be removed. The remaining surface should then be scarified and compacted to within 95% of ASTM D-1557 for the material upon which the liner is to be placed. Molding water should be added as necessary to achieve the required moisture/density relationship. The moisture content should not vary below -1% nor over +3%. All rock fragments greater than one foot in any dimension should be removed prior to compacting the liner base.

The soil liner should be not less than one foot in compacted thickness.

The soil liner should consist of material which is predominantly fine-grained and is moderately plastic in nature. Liner materials should have at least 50% of the material passing the #200 U. S. Standard seive and should achieve a plasticity index of at least 9. All fragments in excess of six inches in one dimension should be removed prior to compaction.

The liner material should be free of all organic materials such as roots, etc., prior to placement.

The liner material should be compacted to within 95% of ASTM D-1557. Molding water should be added as necessary to achieve the required moisture/density relationship. The moisture content should not vary below -1% nor over +3%.

Liner materials should be placed such that the maximum compacted lift thickness does not exceed six inches.

b. Embankments

Prior to placing embankment materials all loose top soil and organics should be removed. The remaining surface should be scarified and compacted to within 95% of ASTM D-1557 for the material upon which the embankment is to be placed. Molding water should be added as necessary to achieve the required moisture/density relationship. The moisture content should not vary below -1% nor over +3%. All rock fragments greater than one foot in any dimension should be removed prior to compacting the embankment base.

The embankment material should consist of homogeneous earth fill which is moderately plastic in nature. Embankment material should have at least 40% of the material passing the #200 U. S. Standard seive and the fine fraction should achieve a plasticity index of at least 9. All fragments in excess of one foot along one dimension should be removed prior to completion.

c. Compaction and moisture control

The recommended method of compaction is with a heavy sheepsfoot roller. However, a rubber-tired roller can be utilized but it will be necessary to scarify or disk each lift surface prior to placing the next vertical lift of material. This is necessary to insure that proper adhesion is obtained between succeeding lifts.

If the borrow material is found to be too wet, in situ, it is recommended that the material be disked, ripped or scarified and/or possibly windrowed and allowed to air dry until proper moisture content is achieved. Because of the fine-grained nature of the materials at the site, it is felt that mixing or blending of wet and dry material would result in spotty or non-uniform moisture content when placed and compacted.

The preferred method of moisture control is to add water at the borrow site. However, adequate results can be achieved on the fill by water trucks equipped with spray bars. This technique does, normally, require more testing to insure uniform distribution of the moisture in the soil.

3. In-place inspection and testing

A competent soil engineer or soil technician will be present on the site during all phases of embankment and soil liner construction. This person will inspect, test and verify that the appropriate specifications for the various materials are accomplished.

Testing of embankment and soil liner will be carried out by approved methods such as those established by ASTM. The test sequence will include at least one test for every 2000 cubic yards of embankment placed, at least one test for every 1000 cubic yards of soil liner placed, at least one test for every 350 cubic yards of trench backfill, and at least one test wherever there is suspicion as to the quality of moisture control or effectiveness of compaction. Supplementary compaction tests also will be conducted at a ratio of one for every ten field moisture-density determinations.

C. Facilities for Control of Wastes and Effluents

1. Dust

Fugitive dust from truck travel over haul roads will be controlled by wetting as needed to comply with Colorado Air Pollution Control Regulation No. 1, Part II D 2. A sprinkler truck will be maintained as needed for fugitive dust control.

Low-level radioactive dust from the tailings, which could be generated either by wind action or by the mechanical processes of loading and unloading, also will be controlled by wetting. The addition of acid solutions during agglomeration and heap sprinkling will prevent dusting after the material enters the agglomerator until leaching ends. Thereafter, reclamation procedures will prevent radioactive dust emissions.

The rotary dryer will be equipped with dust collectors.

2. Radon gas

The undisturbed part of the tailings pile will be kept wet both to control windblown dust and to reduce the amount of radon escaping the heap.

Entrapped radon will be released as the heap is moved. Since this is an open-air operation, however, it is expected that radon concentrations in the air away from the tailings piles will be maintained at acceptable levels. The time any individual spends in the loading area will be monitored and may have to be limited if concentration levels increase from the anticipated radon gas release.

The wetness of the leaching heap will minimize radon emission from it.

3. Liquid effluents

Removal of the tailings will be planned and carried out in such a manner that the neighboring San Miguel River is protected from pollution due to spillage or flooding. The present dike will be left in place until the remainder of the pile is removed and a major part of the site reclamation is accomplished.

All liquid effluents from the leaching operation will be recycled or caught and stored in evaporation ponds. No discharge to either surface or subsurface waters is anticipated because of the relative impermeability of the system.

Evaporation ponds will be built in series, such that dike seepage or liquids released through dike rupture, if that should occur, will be caught and retained in the next lower pond. Pumps will be provided for use, if needed, in returning liquids to the higher ponds.

4. Sanitary wastes at the leaching site will flow into the evaporation ponds, which will serve as sanitation lagoons.

5. Non-contaminated trash and garbage will be collected by the local private contractor and disposed of, along with similar materials collected throughout the region, in the nearby county-owned land fill. This land fill is at a surface-mined site near the present mining operations of the Peabody Coal Company.

VI. Environmental Effects of Present Tailings Removal:

A. Radon Gas Release

The tailings pile contains an estimated 490 curies of radon, in equilibrium with its parent, radium-226. Although radon has a half-life of less than four days, its constant generation from radium-226 keeps the quantity which is present relatively constant.

Althouth the 1973 EPA report discussed in Section II-B indicated that most of the radon would escape through a thin earth cover, and although radon is being emitted constantly from the present pile, the major portion of this 490 curies of radon would remain trapped in the undisturbed pile. Entrapment is increased by dampness maintained in the pile and by pile depth. Trapped radon will be released to the atmosphere upon removing the tailings from the pile and loading them on trucks. This release will temporarily increase the radon burden in the surrounding air. Movement of the tailings at the anticipated rate should release about a curie of previously entrapped radon per day, over and above the normal emission from the pile.

Measurements of radon concentrations reported by Ford, Bacon and Davis Utah[10] show average radon concentrations above the undisturbed Naturita pile to be greater than 200 pCi/l. The authors of that report, noting that radon concentrations in the neighboring valley generally increased during the night but reverted to background values during the day, attributed increased night values to thermal inversion and reduced wind velocities.

The maximum permissible concentration for radon-222 recommended by the International Commission for Radiation Protection is 10 pCi/l for non-occupational exposure. The Colorado State standard is 3 pCi/l. Acceptable occupational radiation exposure is generally ten times as great as non-occupational standards.

Radon concentrations in the immediate vicinity of the pile appear already to be above recommended occupational exposure standards. Freeing of entrapped radon could raise local concentrations to values such that working times of operators of loading equipment may have to be limited. Because of the short duration of the moving operation, any temporary environmental detriment due to increased radon concentrations in the neighboring valley during this project should be highly preferable to the perpetual release of radon from the pile in its present location.

There currently is marked uncertainty regarding the correlation of radon exposure with health effects and in measurements of radon concentrations. Ranchers will attempt to develop a cooperative program with ERDA for radon monitoring and control during the proposed operation.

B. Dust

EPA and ERDA gamma surveys have shown that windblown tailings are present in the valley for several miles downwind from the Naturita pile.[10] At 0.8 mile downriver from the pile, gamma radiation was measured at double the average background. Most of this spread of windblown dust is assumed to have occurred prior to tailings pile stabilization.

Radioactive dust from the disturbed pile, as well as non-radioactive dust from access roads, will be controlled and minimized by water spraying.

C. Noise

The noises of truck and loader operation will be present during this program. The only neighboring activity is one of a similar nature, the trucking in and unloading of uranium ore at the General Electric buying station, located on the abandoned site of the Naturita mill which created the tailings pile. Noises from these activities are usually of a reasonably low level, and expected by operating personnel. Since there are no residences nearby, these noises should not have significant impact on the environment.

D. Impact on Historic and Cultural Values

Although the tailings pile itself may be considered by some to be of historic interest, general environmental improvement achieved by its removal would greatly outweigh any historic loss. Such historic value, if it exists, can be transferred to the new location. Cultural values will be enhanced by removal of a long-term hazard from a settled valley.

E. Long-Term Radiological Impact

As discussed in Section II above, removal of the tailings will reduce radon and radioactive dust exposure to valley residents and reduce radioactive contamination of the Colorado River System.

F. Impact on Water Quality

1. Short-term

Disturbance of the stabilized pile may increase the amount of radioactive material blowing or washing into the San Miguel River during the moving operation. The conditions which might cause such increase will be temporary. Any increase should be slight because of the mitigating measures discussed above.

2. Long-term

Removal of the pile will eliminate a perpetual source of radioactive material for washing or blowing, on occasion, into the San Miguel River. It also will remove this source from porous soil in the river valley, into which leaching could contaminate both surface and underground waters. This contamination also could continue indefinitely into the future.

VII. <u>Environmental Effects of Site Preparation, Construction Leaching Operation, and Residue Maintenance</u>:

A. Construction Land Disturbance; Dusting; Noise

The isolation of this site will make ordinary construction noise and minor dust emission insignificant. A spray truck will be available to reduce dust if that reduction should be necessary in order to stay within the standards of Colorado Air Pollution Control Regulation No. 1, Part II-D-2.

B. Changes in Land Use

The 160-acre site will be removed from minor grazing use and assigned to perpetual storage of stabilized and covered radioactive wastes.

C. Impact on Historic and Other Cultural Values

There are no identified historic or cultural sites near enough to this site to be impacted.

D. Water Diversion, Consumption, and Quality Alteration

There will be diversion of water for the temporary period of the leaching operation. The water will come from wells on the site, an impoundment of Dry Creek, or from the San Miguel River. It will be evaporated and not returned to underground or surface stream systems.

Ranchers will need 225 gallons of water per minute the first two months of operation. Rights to 110 gpm from the San Miguel River were acquired from Foote Minerals with purchase of the tailings. If sufficient well water cannot be developed at the site, water may be piped to the site from the San Miguel River. Availability of well water is under investigation.

Specifications for leach tank and evaporation pond liner and embankment construction are designed to assure that valuable leach solutions are not lost from the system and that there is no significant contamination of groundwaters from seepage through tank and pond liner or of surface waters from seepage through embankments. Because evaporation ponds will be in series, any surface seepage through the embankment of one will be caught and retained by the next pond. The radioactive material content of any seepage that might occur through tank liners will be reduced as the solution passes through the underlying strata by adsorption and soil ion-exchange. Groundwaters will be monitored, as discussed below (Section IX) to assure that groundwaters are not significantly altered as a result of this operation.

The quantities of water diverted to this operation and evaporated are not great enough to alter the quality of water in remaining streams.

Run-off waters will be diverted around the operational facilities. Rain or snow falling on the leach heaps or evaporation ponds will be retained by them until evaporated. Essentially no alteration of surface water quality should result from the proposed operation.

E. Effect on Wildlife

During the operation, small animals and deer will be displaced from the site. Deer will shy away from the area of human activity. Since the site is surrounded by wide expanses of open public lands, this displacement can be accommodated with ease.

After the operation is completed and the residual tailings covered and stabilized, wildlife activity in the area should revert essentially to that of the present, even though the area will remain fenced. Slight radiological effects on local wildlife might occur, as discussed below.

F. Radiological Impact on Man and Other Biota

1. Radon

Radon levels should not exceed background more than a half-mile from the stabilized tailings. Since there is only one human habitation less than two miles from the site and no major foci of human activity nearby, the effect of radon emitted from this site will be considerably lower than from the present location.

Rodents and other animals which take up residence on the stabilized tailings may be affected by emitted radon. Functional impairment of a few small animals, if it should occur, will not significantly alter the normal proliferation of wildlife in the area.

2. Gamma radiation

Recent gamma measurements on the present pile ranged between 66 and 976 μR/hr.[10] Figures in this range can be expected also on the reprocessed tailings. Wildlife, if resident on the heaps, could experience some effects from this radiation. As in the case of radon, the effects cannot be determined in advance, but are not expected to be significant.

In the absence of spread of tailings by wind or water, gamma levels will not be above background more than a few meters from the tailings heaps. Gamma rays from the heaps will not affect human beings, since human access to the fenced site will be restricted.

3. Dispersed Radioactive Solids

Dampness of tailings during the operation and stabilization cover afterwards will prevent significant airborne dispersal of tailings material. Precautions described above snould prevent significant dispersal by water. Neither human nor other animal environments should be impacted by windblown nor water-carried radioactive materials from the site.

Radioactive elements could be absorbed by plants growing on the heaps and ingested by insects and rodents in the immediate vicinity. As such animals are eaten by roving predators, the radioactive elements could spread. Although there is some possibility of genetic effect to such animals as hawks, owls, coyotes, and bobcats, the risk of this is little or no greater than it is from the present tailings situation.

G. Process Effluents

There will be two stationary sources of stack emissions to the atmosphere at the leaching site, a 30 million BTU/hr. rotary dryer and a boiler or heater for process liquids. The latter will have an energy input of somewhat less than 10 million BTU/hr. Both units will be fueled with diesel oil. Emissions will comply with Colorado Air Pollution Control Commission Regulation No. 1, Sections II-A and III, covering particulate and sulfur oxide emissions. At these levels, stack emissions should have no discernible impact on the environment.

Other process effluents will be retained on the site and will not affect the surrounding environment. (Emitted radon gas is discussed above.) Liquid effluents will be retained in the evaporation ponds until dried. The dry evaporation residues will be buried and retained in place.

Management of effluents under unexpected conditions is discussed in the accident analysis of Section X.

VIII. Economic and Social Effects of Construction and Operation:

A. Benefits

The value of the uranium which will be recovered from the tailings pile at Naturita can be expressed in terms of the electricity it will generate, estimated to be 5.5 billion KWH.

The employment benefits, for which local public acceptance is high, according to interviews in the area in December 1976, will come in two stages. During the first five months of construction, 35 will be employed. During the 18 months of operation, 51 will be employed. An annual payroll rate of over $800,000 would be generated. Interviews with local businessmen and public officials yielded a consensus that as many as 30 persons could be found in the Nucla/Naturita area for these jobs, particularly those of an earth moving/construction type. Some special skills may need to be sought in Grand Junction or Montrose. Three management positions will be filled from the Company's home office.

$2,500,000 for plant and equipment will be added to the area's tax base during the project.

Improvements to the area's environment include the elimination of the hazards to air and water quality from the present location of the tailings pile in the river floodplain. A desirable settlement area in the river valley will be more available to human occupancy. The present tailings site is visible from the highway; the area will be cleaned up, and the leaching site is not visible from the highway, although it will be covered and replanted so as to meld back into the terrain.

B. Costs

The internal costs of the project include the $2.5 million investment in plant and equipment (some of which is designed to be used again at other sites), and the $1.2 million operating payroll.

Temporary external costs are very few and of short duration. City officials agree that municipal services will not be strained by this project; water and sewer system capacities are adequate; heating fuel is available; fire and police protection are well organized and efficient. The school system will not be strained. Rental housing, however, is potentially a problem. Current mining activity in the area has absorbed the rental housing supply in Naturita and Nucla. New construction currently brings less than half a dozen homes onto the market each year, and these are not in the price range suitable for short-term workers. The low-cost rental units at the Vancoram townsite five miles west are currently full, but turnover rates are high and some units should be available during the course of the project. Adequate trailer court sites are not yet developed. The Lou Development Corporation, of Lafayette, Colorado, is currently evaluating a multi-unit rental housing project in the Naturita area.

There will be no long-term external costs of impairment of recreational, scenic or historical values, nor any lost income or decreases in real estate values.

IX. Effluent and Environmental Monitoring Programs:

To assure that environmental contaminants are not dispersed as a result of the proposed operation, surface water, groundwater, land and air monitoring programs will be conducted. Frequencies of sampling will be adjusted as the operation proceeds and initial results indicate more or less frequent sampling to be necessary or useful.

A. Surface Water Monitoring

The San Miguel River will be monitored at two sample points, at the bridge crossing of Highway 97 in Naturita and at the bridge downstream from the tailings site. The same points have been used in past Colorado Department of Health samplings of the San Miguel River, and some background water quality data are therefore available for these points. The points are selected primarily, however, because they bracket both the site of the proposed tailings removal and the point of entry of Dry Creek, which would carry any surface water pollutants from the leaching site if there were such.

Dry Creek also will be sampled at two points, upstream and downstream of the confluences of arròyos which drain the leaching site.

Surface water monitoring at the leaching site itself will be achieved through four samplers emplaced underground in the bed of the east, central, and west arroyos downstream of the operations and in the central arroyo upstream of the operation. The samplers will be attached to a permanent stake. The buried sample bottles will contain an above-surface air vent and sample tube. When run-off occurs, the water and suspended sediment enter the bottle. As soon as possible after the run-off event, the sampler is replaced and the sample prepared and sent for analysis.

Initial sampling frequency: monthly for streams; at times of run-off events, but not more than monthly, for arroyos.

Materials and conditions checked:
TSS, COD, TDS, SO_4, pH;
Dissolved As, Se, V, Mo, and Ra;
Total As, Cd, Zn, Ra, Th, and U

B. Groundwater Monitoring

Seven wells, located on the leaching site and at its periphery by SER, Inc., consulting hydrologists, (locations shown on Figure 2) will serve as stations for groundwater monitoring.

SER's rationale for selection of these monitoring points is as follows:

If seepage occurs, it could move as shallow subsurface flow following topography and trending toward the arroyos. If it were to breach the surface of the arroyo, it will be seen and also monitored by the surface monitors described above. If it flowed downstream as subsurface baseflow in the arroyos, it would be monitored by the groundwater monitor holes placed near the arroyos for this purpose. The data of Table 3 show that the monitor holes are in contact with such baseflow at the present time. That shallow groundwater in the area is restricted to zones near arroyos and is not present throughout the site is evidenced by the large number of dry borings shown in Table 3.

An example of construction of groundwater monitor sites is given on Figure 9. The holes are purposely left open from surface to total depth in order that all water zones may be sampled. If contamination becomes evident, the more expensive procedure of isolating individual zones can be initiated. The clay packing at the surface is to eliminate surface inflow.

The possibility of seepage reaching the Dakota sandstone is extremely remote due to the brief time period of site operation and the thick section of relatively impermeable Mancos shale between the ponds and the Dakota. Two deep holes were drilled (MW-1 and MW-2, Figure 2) to demonstrate the thick Mancos shale section and to test for any potential aquifers in the Mancos. Borehole MW-1 was drilled to 130 feet without reaching the Dakota and intersected one 13-foot thick fine-grained sandstone. Borehole MW-2 was drilled to 148 feet without reaching the Dakota and intersected no clearly defined sandstones of any reasonable potential as an aquifer. The sandstone at 105 feet depth in MW-1 had lensed out before reaching the site of MW-2. This lack of widespread sandstones is to be expected in the Mancos and decreases the potential for seepage transmission.

Borehole data for the shallow groundwater monitor sites are detailed in the Coe and Van Loo report. The important point is that the section is clay-rich, thus featuring low permeability and high adsorption capacity. Secondarily, one should note the absence of any sandstones capable of being developed as an aquifer.

Table 3: Boring Location, Depth & Initial Water Level Measurements

Boring Designation	Explanation	Coordinate	Surface Elevation	Depth	Depth To Water	Date Measured
R-1	Auger Hole	12,370N-9,900E	5,534	40	Trace @ 38'	11-5-76
R-2	Auger Hole	11,610N-9,950E	5,562	40	Dry	11-5-76
R-3	Auger Hole	10,720N-10,065E	5,595	40	Dry	11-5-76
R-4	Auger Hole	10,835N-11,380E	5,591	40	19'	11-5-76
R-5	Auger Hole	10,580N-11,880E	5,605	40	34'	11-5-76
R-6	Auger Hole	11,418N-12,140E	5,575	40	See MW #6	
R-7	Auger Hole	12,480N-12,223E	5,543	40	Dry	11-5-76
R-8	Auger Hole	12,517N-11,618E	5,538	40	38'	11-5-76
AH-9	Auger Hole	10,618N-10,680E	5,597	42	24'	11-11-76
AH-10	Auger Hole	11,252N-10,591E	5,585	26'	Dry	11-11-76
AH-11	Auger Hole	11,725N-10,505E	5,555	50'	Dry	11-11-76
AH-12	Auger Hole	12,460N-10,841E	5,539	47'	45'	11-11-76
AH-13	Auger Hole	12,035N-12,252E	5,555	50'	Dry	11-11-76
AH-14	Auger Hole	10,470N-10,144E	5,608	31.5'	Dry	11-11-76
AH-15	Auger Hole	11,241N-11,205E	5,579	49'	Dry	11-11-76
AH-16	Auger Hole	10,855N-11,775E	5,595	50'	Dry	11-11-76
BHP-1	Back Hoe Pit	12,618N-10,520E	5,536	5.5'	-	-
BHP-2	Back Hoe Pit	12,460N-11,445E	5,539	8'	-	-
BHP-3	Back Hoe Pit	12,460N-12,288E	5,543	6'	-	-
BHP-5	Back Hoe Pit	10,990N-10,162E	5,585	5'	-	-
BHP-6	Back Hoe Pit	10,915N-11,406E	5,589	8.5'	-	-
BHP-7	Back Hoe Pit	11,150N-11,820E	5,585	5'	-	-
BHP-9	Back Hoe Pit	10,420N-11,425E	5,607	10'	-	-
BHP-10	Back Hoe Pit	10,465N-12,160E	5,610	12'	-	-
MW-1	Monitoring Well	11,585N-10,735E	5,564	130'	*22.5	11-14-76
MW-2	Monitoring Well	12,852N-11,088E	5,528	148'	*12.5	11-16-76
MW-3	Monitoring Well	11,810N-9,928E	5,547	47.5'	28'	11-14-76
MW-4	Monitoring Well	12,810N-10,122E	5,523	50'	20.7'	11-14-76

*Water used for rotary and core advance may not have stabilized at time of measurement.

TABLE 3 (continued)

Boring Designation	Explanation	Coordinate	Surface Elevation	Depth	Depth To Water	Date Measured
MW-5	Monitoring Well	10,360N-11,320E	5,609	48.5'	13.1'	11-14-76
MW-6	Monitoring Well	11,418N-12,140E	5,575	50'	47'	11-14-76
MW-7	Monitoring Well	12,875N-12,340E	5,531	47.5'	**45.5'	11-14-76
SP-1	Surface Sample	11,410N-11,345E To 11,465N-11,345E	5,580-5,586	2-3'	-	-
SP-2	Surface Sample	11,665N-11,218E To 11,690N-11,270E	5,590-5,604	2-3'	-	-
SP-3	Surface Sample	11,820N-11,052E To 11,905N-10,970E	5,552-5,560	2-3'	-	-

**May be water introduced to boring to cool auger bit.

NOTE:
Coordinate location 50'±; Elevations from topography map provided for the site.

Initial sampling frequency: monthly

Materials and conditions checked:
Dissolved As, Cd, Mo, Se, V, Zn, Ra, Th, and U;
pH, SO_4, TDS and water level.

C. Air monitoring

As previously mentioned, an effort will be made to establish a cooperative program with ERDA for radon monitoring in the environs of the present tailings pile during the moving operation.

Air samplers will detect wind-blown spread of radioactive dust from either site. Locations and frequency of sampling are yet to be determined. Air sample filters will be checked for Ra, U, and Th.

D. Radiological Surveys

On-site surveys of radiation levels will be made to assure that exposure of workers does not exceed recommended safe limits. Instruments available for survey use are:

a. Eberline SAC-1 Pulse Rate Meter for alpha detection: 26,300 ± 500 alpha particles/min; 51,800 ± 1,100 dpm

b. Eberline Model E510 Geiger Counter for gamma (as well as alpha and beta) detection; 0.02-200 mr/hr.

c. Mount Sopris Model SC-131A Scintillation Counter; 1 cps full scale in .02 divisions, X 1 to 100.

Surveys outside the controlled area also will be made to supplement air sample information. The frequency of surveys will be adjusted as experience indicates them to be useful. Non-scheduled checks will be made after any unusual event of a nature which could disperse radioactive materials from the controlled areas.

X. Environmental Effects of Accidents:

Conditions which will minimize adverse environmental effects from the proposed operation also reduce potential hazards due to accidents. These conditions may be listed as: a) relatively short duration of the operation; b) isolation of the operation from human habitations; c) siting on impervious geologic shales; and d) previous long experience of the operators with acidic leach minerals recovery. However, accidents may happen and although all are assessed to be of low probability, the following are conceivable.

A. Transportation Accidents

1. Tailings spillage

The haulage trucks are planned to be purchased new, thereby minimizing the prospects for any mechanical breakdowns. The hauled tailings will all be quite moist (10% or more moisture), so any accidental spills will be confined to the accident area and can be readily recovered.

The tailings transportation accident hazards are lower than those associated with the numerous uranium ore carriers that currently are authorized to operate in the area.

2. Processed uranium and vanadium

The output of the treatment process will be moist (40-60%) filter cakes of U_3O_8 and ammonium metavanadate. These products will be shipped in sturdy, industry approved 55-gallon drums. This individual packaging will reduce the probability of releasing any of the product in an accident situation, and the high moisture content will minimize spreading any that does leave the contaminant barrier. Clean-up of damp yellow cake is not difficult. The material would be recovered if it were accidentally released.

3. Sulphuric acid

Approximately two or three times a day standard sulphuric acid trucks will deliver leachant to the site. Although there is a risk of accident to these vehicles, it is the same as accepted all over the country by other users of sulphuric acid. Ranchers' experience with these vehicles over a 12-year period in Arizona is that the probability of an accident is very, very low. Department of Transportation regulations will be followed.

B. Leach Site Accidents

1. High precipitation risks

The meteorological data for the area of the selected site supports the statement that this is not a high water risk area. However, the once-in-a-lifetime precipitation event has been considered in the engineering design layout for the site. Two principal design considerations were adopted: a) locate the operating areas on high ground; and b) provide adequate drainage around these areas to maintain the integrity of the elevation.

There is a natural main drainage virtually through the center of the site (see Figure 2). It will be retained and cleaned out to define it more positively. The operating areas will be treated as two separate elevated sites, with smaller diversion ditches provided for each. Possibilities of washout of embankments by local thunderstorms is minimized by this design.

2. Containment violations

The likelihood of accidental breakage of tank or pond embankments will be minimized by the mass of the embankments, designed with a safety factor of 150% or greater. The shallowness of the tanks, minimizing hydraulic head, also reduces embankment failure probability.

Accidental breach of tank or pond liner is difficult to conceive. If it did happen, the fact that the facilities are underlain with impermeable Mancos shale should confine any solution leakage to the local area.

Since containment vessels have been gravity sequenced, material accidentally freed from one vessel generally would be caught in the next. The leach tanks and evaporation ponds have been located to utilize the natural contours of the area, so leakage from one will flow into the next in sequence.

Acid leaks, if they should occur, will be controlled by a containment berm around the acid storage area.

C. Fire

Solvent extraction agents are kerosene solutions (96 to 97% kerosene). Fire could occur in the kerosene, kerosene solutions, or in diesel fuel, which will be used to fire the dryer and process liquid heater.

Solvent extraction settlers will be covered. Berms will be built around fuel and chemical storage areas. If fire should occur, it will be confined to a local area and extinguished.

XI. Reclamation and Restoration:

The excavated tailings site will be contoured, covered with top-soil, and revegetated. This area might subsequently be onened for public use.

The heaps of re-processed tailings will be contoured, covered with soil, and revegetated in compliance with Colorado Department of Health Radiation Regulation No. 2. The site will be fenced, posted, and access controlled.

XII. Adverse Environmental Impacts Which Cannot Be Avoided:

A major part of the leaching site, 160 acres of non-cultivated sage brush lands, will be fenced and kept under restricted access for an undefined period into the future. At this site, quantities of radon gas will be emitted which are greater than those now emitted from the unencumbered site. Radon concentration above background levels may be expected within a half-mile of this site. As noted above, long-term adverse impacts in the isolated leaching area are greatly overshadowed by relief of similar impacts in the San Miguel Valley.

During facility construction and haulage of tailings, there will be some noise and modest amounts of construction and road dust, as well as increased traffic on Highway 141 and 90.

XIII. Relationship Between Short-Term Uses of Resources and Long-Term Productivity:

The proposed operation salvages residual uranium and vanadium resources which otherwise would be wasted. It offers the possibility of opening the present tailings site area to productive future use, while transferring the land allocation for long-term tailings storage to an area with much lower future production potential.

Resources assigned to short-term use, such as gasoline or diesel fuel for trucks and equipment, will be consumed in order to recover resources of greater value.

XIV. Irreversible and Irretrievable Commitment of Resources:

Resources committed to this operation are the lands used for leaching and storage of residual tailings and the human energy, chemicals, gasoline, and other fossil resources consumed in the operation, such as diesel oil or coal for the electric power used. Commitment of the land is theoretically retrievable, but not fully so in present intent. Fuels and chemicals consumed during the operation are not retrievable.

XV. Alternatives to the Proposed Action:

A. Alternate Leaching Site

For reasons detailed above, the chosen site seems well suited for the proposed use. There appear to be no alternate sites within economic hauling distance from the present tailings location with as many obvious environmental advantages as the proposed site.

B. Alternate Processing

The long-term tailings storage concern could be alleviated if thorium-230 and its daughter, radium-226, also were extracted and removed, stripping the residues of their long-term radioactivity. Removal of these materials is not economic. If, however, government agencies and the public should decide that this should be done in the future, the new location of the tailings on impermeable and compacted soil beds may make such removal possible and practical.

Processing techniques other than heap leaching are not economically practical for uranium-vanadium recovery from tailings because of the low concentrations of uranium and vanadium contained therein.

C. Do Nothing

The alternative of not carrying out the proposed operation would leave the tailings in a most undesirable location of a river floodplain, where they recurrently contribute pollutants to Colorado River System waters, prevent normal use and development of a section of the river valley, and emit radon into a settled valley area. While the U. S. ERDA Phase III proposals involve moving some tailings piles from undesirable locations at taxpayer expense, current plans are for stabilization of the Naturita tailings in place. Not carrying out the proposed operation would amount to missing a public opportunity (which may not recur) to get these tailings moved to a more suitable location at other than public expense.

REFERENCES

1. "State-of-the-Art, Uranium Mining, Milling, and Refining Industry," Robert S. Kerr Environmental Research Laboratory, Office of Water Resources Research, PB-235 557, June 1974, distributed by U. S. Department of Commerce (NTIS); pp. 89; 68.

2. "Radiation Hazards Associated with Uranium Mill Operations," T. C. Hollocher and J. J. MacKenzie, p. 47, "The Nuclear Fuel Cycle," Union of Concerned Scientists, MIT Press, 1975.

3. BSA/TIB-24, "Radium-226, Uranium, and Other Radiological Data Collected from Water Quality Surveillance Stations Located in the Colorado River Basin of Colorado, Utah, New Mexico and Arizona, January 1961 through June 1972," U. S. Environmental Protection Agency, Region VIII, July 1973.

4. "Disposition and Control of Uranium Mill Tailings Piles in the Colorado River Basin," Federal Water Pollution Control Administration, Region VIII, Denver, Colorado, March 1966.

5. "The Legacy of Uranium Tailings," David D. Comey, Bulletin of the Atomic Scientists, September 1975.

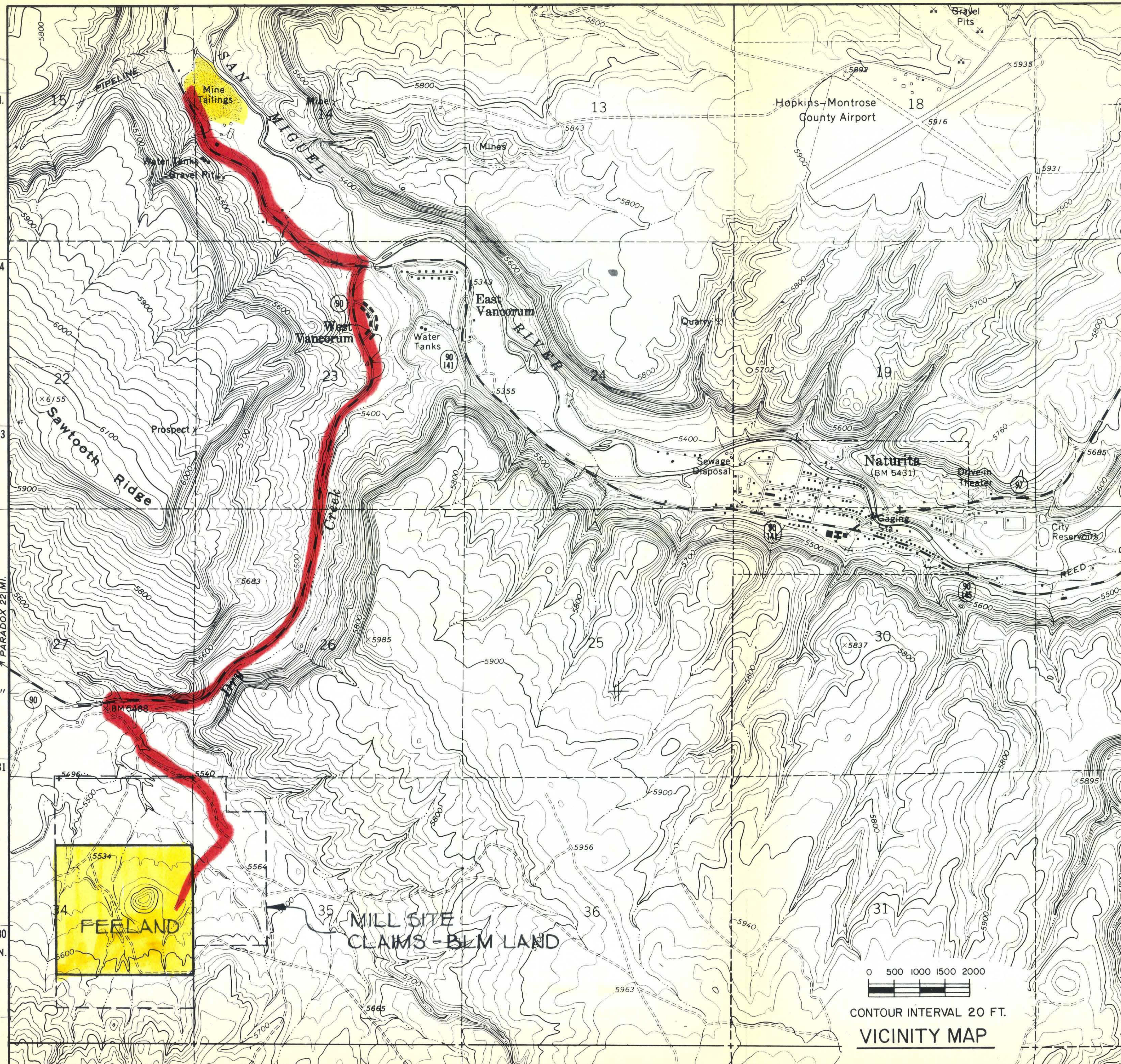
6. "Environmental Impacts of Nuclear Power Due to Radon Emissions," Bernard L. Cohen, Bulletin of the Atomic Scientists, February 1976.

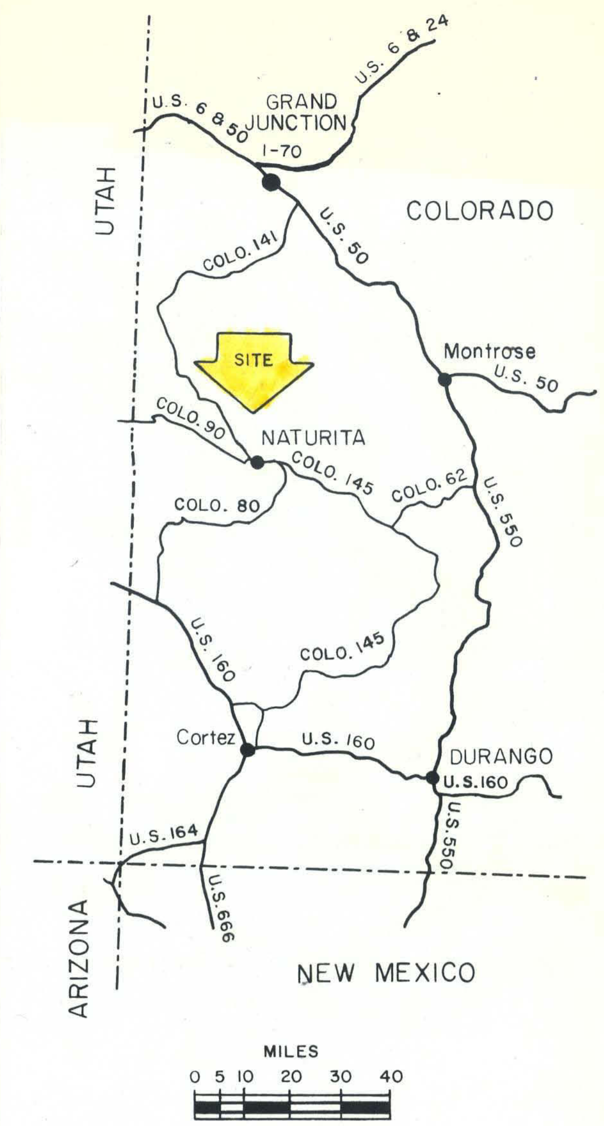
7. "Guidelines for Cleanup of Uranium Tailings from Inactive Mills," W. A. Goldsmith, et al, Health Physics Division, Oak Ridge National Laboratory.

8. Alger Missen, S. T., "Seismic Risk Studies in the U. S.," Fourth World Conference on Earthquake Engineering, Santiago, Chile, Reprint N.O.S., U. S. Department of Commerce, Rockville, Maryland.

9. Simon, R. B., "Seismisity of Colorado - Consistency of Recent Earthquakes with Those of Historical Record," Science, Vol. 165, 1969.

10. "Phase II Title 1 Engineering Assessment of Inactive Uranium Mill Tailings, Naturita, Colorado," by Ford, Bacon and Davis Utah, under ERDA contract, Draft, December 1976. (Report to be released in 1977.)



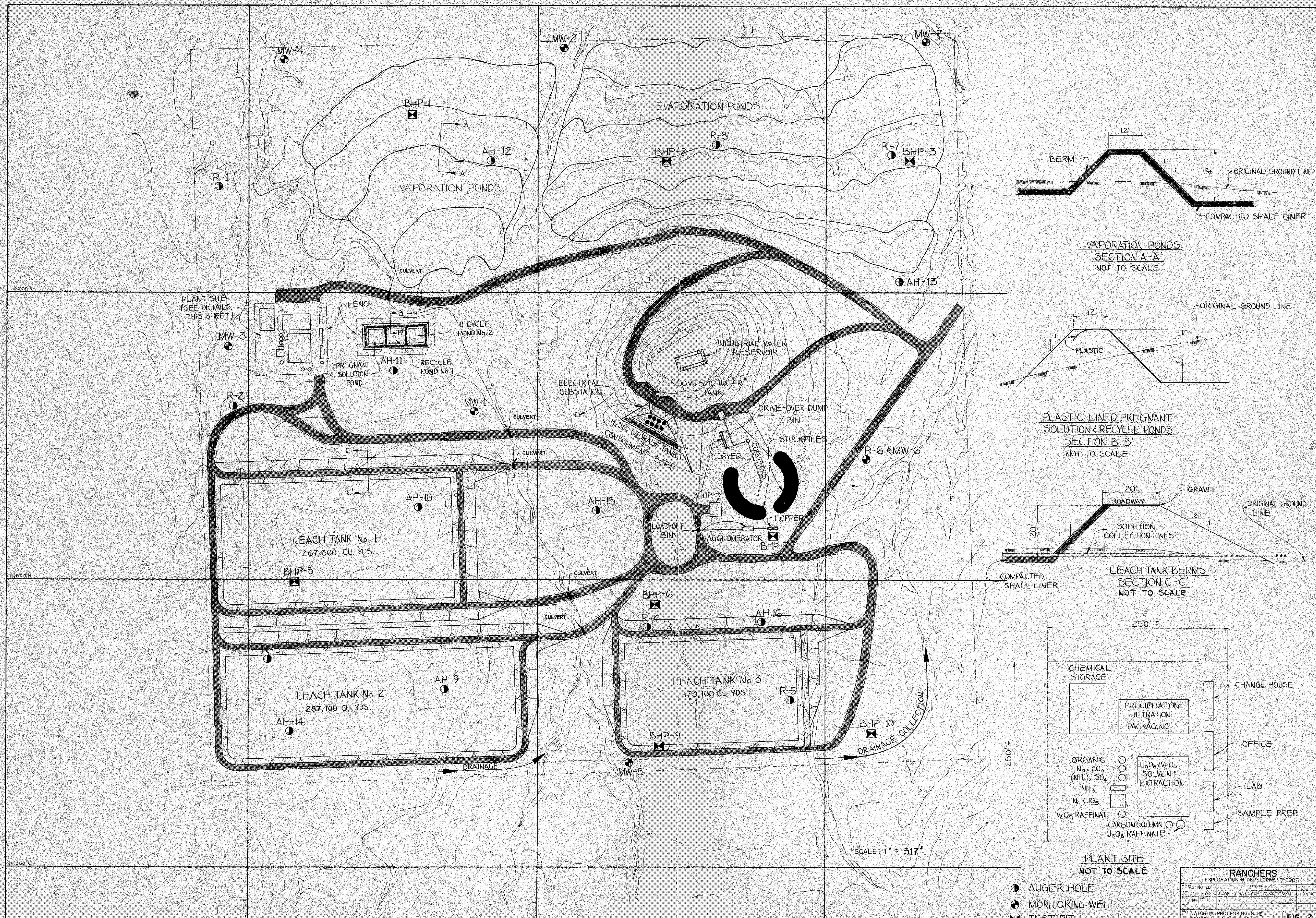


INDEX MAP

RANCHERS
EXPLORATION & DEVELOPMENT CORP.

SCALE AS SHOWN	REVISIONS	BY	DATE
DATE 11-24-76			
DR'N L.H. CKD.			
AP'VD			

TITLE	NO.
VICINITY AND INDEX MAP WESTERN COLORADO PROJECT	FIG. I


MW-4
MW-2
MW-7
BHP-1
EVAPORATION PONDS
EVAPORATION PONDS
AH-12
BHP-2
R-8
R-7
BHP-3
R-1
CULVERT
AH-13
PLANT SITE (SEE DETAILS, THIS SHEET)
FENCE
RECYCLE POND No. 2
MW-3
PREGNANT SOLUTION POND
AH-11
RECYCLE POND No. 1
INDUSTRIAL WATER RESERVOIR
DOMESTIC WATER TANK
ELECTRICAL SUBSTATION
MW-1
R-2
DRIVE-OVER DUMP BIN
H_2SO_4 STORAGE TANKS
CONTAINMENT BERM
DRYER
CONVEYORS
STOCKPILES
R-6 & MW-6
AH-10
AH-15
SHOP
HOPPER
LOAD-OUT BIN
AGGLOMERATOR
LEACH TANK No. 1
267,300 CU. YDS.
BHP-5
BHP-6
R-4
AH-16
R-3
LEACH TANK No. 2
287,100 CU. YDS.
AH-9
AH-14
LEACH TANK No. 3
173,100 CU. YDS.
R-5
BHP-9
BHP-10
DRAINAGE
DRAINAGE COLLECTION
MW-5
SCALE: 1" = 317'
12'
BERM
ORIGINAL GROUND LINE
COMPACTED SHALE LINER
EVAPORATION PONDS
SECTION A-A'
NOT TO SCALE
12'
ORIGINAL GROUND LINE
PLASTIC
PLASTIC LINED PREGNANT
SOLUTION & RECYCLE PONDS
SECTION B-B'
NOT TO SCALE
20'
GRAVEL
ROADWAY
ORIGINAL GROUND LINE
SOLUTION COLLECTION LINES
COMPACTED SHALE LINER
LEACH TANK BERMS
SECTION C-C'
NOT TO SCALE
250' ±
CHEMICAL STORAGE
PRECIPITATION FILTRATION PACKAGING
CHANGE HOUSE
OFFICE
ORGANIC
Na_2CO_3
$(NH_4)_2SO_4$
NH_3
$NaClO_3$
V_2O_5 RAFFINATE
U_3O_8/V_2O_5 SOLVENT EXTRACTION
LAB
SAMPLE PREP.
CARBON COLUMN
U_3O_8 RAFFINATE
PLANT SITE
NOT TO SCALE
AUGER HOLE
MONITORING WELL
TEST PIT
RANCHERS
EXPLORATION & DEVELOPMENT CORP.
AS NOTED
12-11-76
PLANT SITE, LEACH TANKS, PONDS
NATURITA PROCESSING SITE
GENERAL LAYOUT & SECTIONS
FIG. 2

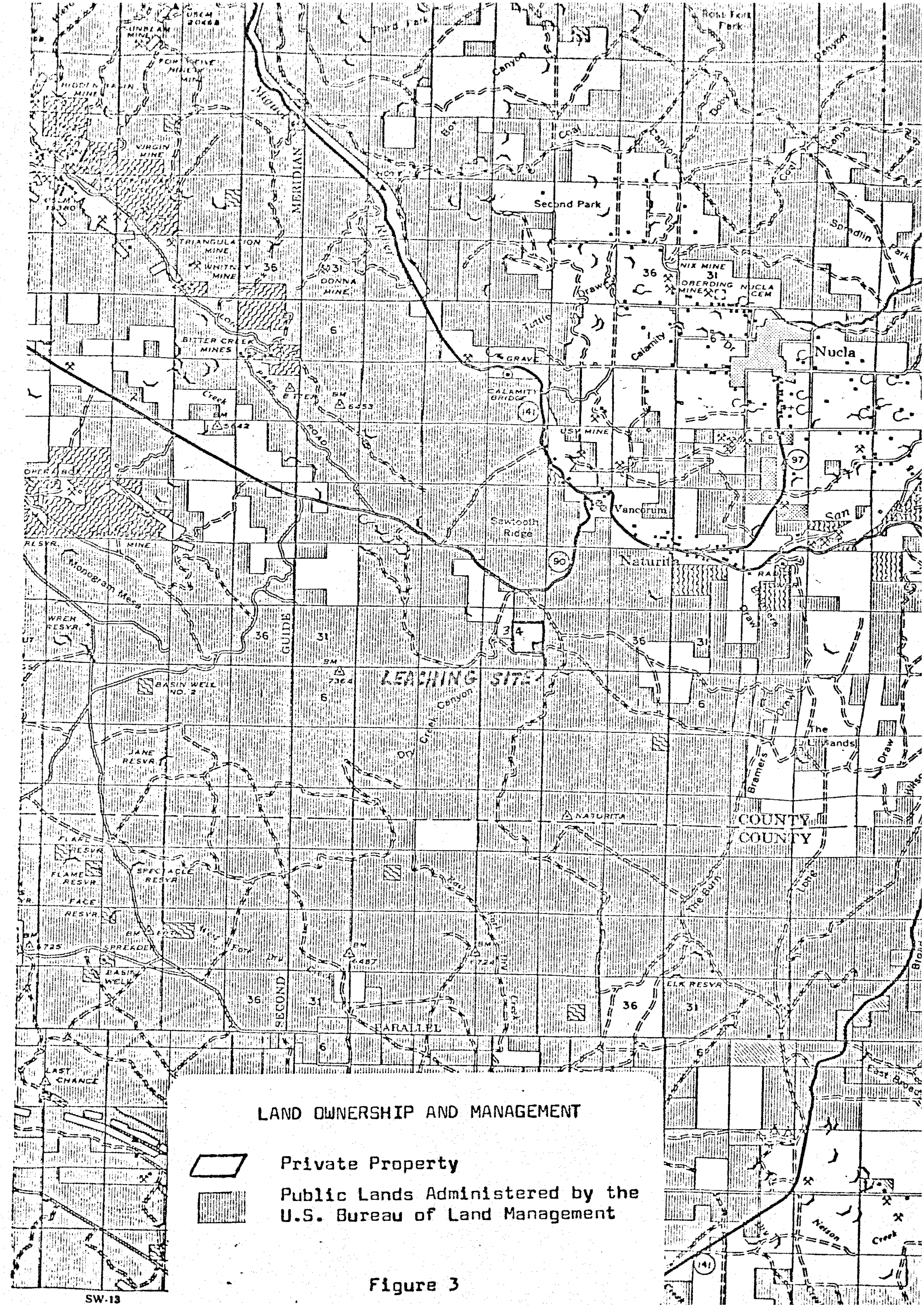

LAND OWNERSHIP AND MANAGEMENT
Private Property
Public Lands Administered by the U.S. Bureau of Land Management
Second Park
Nucla
Vancorum
Naturita
Sawtooth Ridge
LEACHING SITE
NIX MINE
NUCLA CEM
CALAMITY BRIDGE
BITTER CREEK MINES
TRIANGULATION MINE
WHITNEY MINE
DONNA MINE
VIRGIN MINE
MERIDIAN
GUIDE
SECOND
PARALLEL
Monogram Mesa
BASIN WELL NO. 2
JANE RESVR.
SPECTACLE RESVR.
FLAME RESVR.
ELK RESVR.
LAST CHANCE
COUNTY
COUNTY
SW-13

Figure 3

STRATIGRAPHIC DESCRIPTION & SYMBOLS

Age	Lithologic Symbol	Formation	Local Max. Thickness	Lithologic Characteristic
Quaternary	Qal	Alluvium	±45'	Unconsolidated silt, sand & gravel
	---unconformity---			
Quaternary (?)	Qfg	Fanglomerate	140'	Indurated sand, gravel & boulders
	---unconformity---			
Cretaceous	Km	Mancos	+148'	Dark-gray fissile shale
Cretaceous	Kd	Dakota	195'	Sandstone & conglomerate with carbonaceous shale & coal
	---unconformity---			
Cretaceous	Kbc	Burro Canyon	250'	Sandstone & conglomerate with green & purple shale
Jurassic	Jmb & Jms	Morrison	820'	Shale (Jmb) at top with sandstone (Jms) at base
Jurassic	Js	Summerville	105'	Sandy shale and mudstone
Jurassic	Jec	Entrada & Carmel	110'	Sandstone (Entrada) at top and mudstone (Carmel) at base
	---unconformity---			
Jurassic (?)	Jk	Kayenta	220'	Sandstone, siltstone, shale & conglomerate
Jurassic (?)	Jw	Wingate	240'	Sandstone that is poorly cemented
Triassic	TRc	Chinle	520'	Siltstone, with interbedded sandstone, shale & conglomerate
	---unconformity---			
Triassic	TRm	Moenkopi	90'	Mudstone with sandstone & arkosic conglomeratic sandstone
Permian (?)	Pc	Cutler	190'	Conglomerate, arkose, arkosic sandstone with thin mudstone beds
Pennsylvanian	Ꝑhl & Ꝑhp	Hermosa	+13,000'	Limestone with thin shale beds at top (Ꝑhl) and gypsum with salt, sandstone, shale, in Paradox member (Ꝑhp) at the base

SYMBOLS USED ON FIGURE - 5

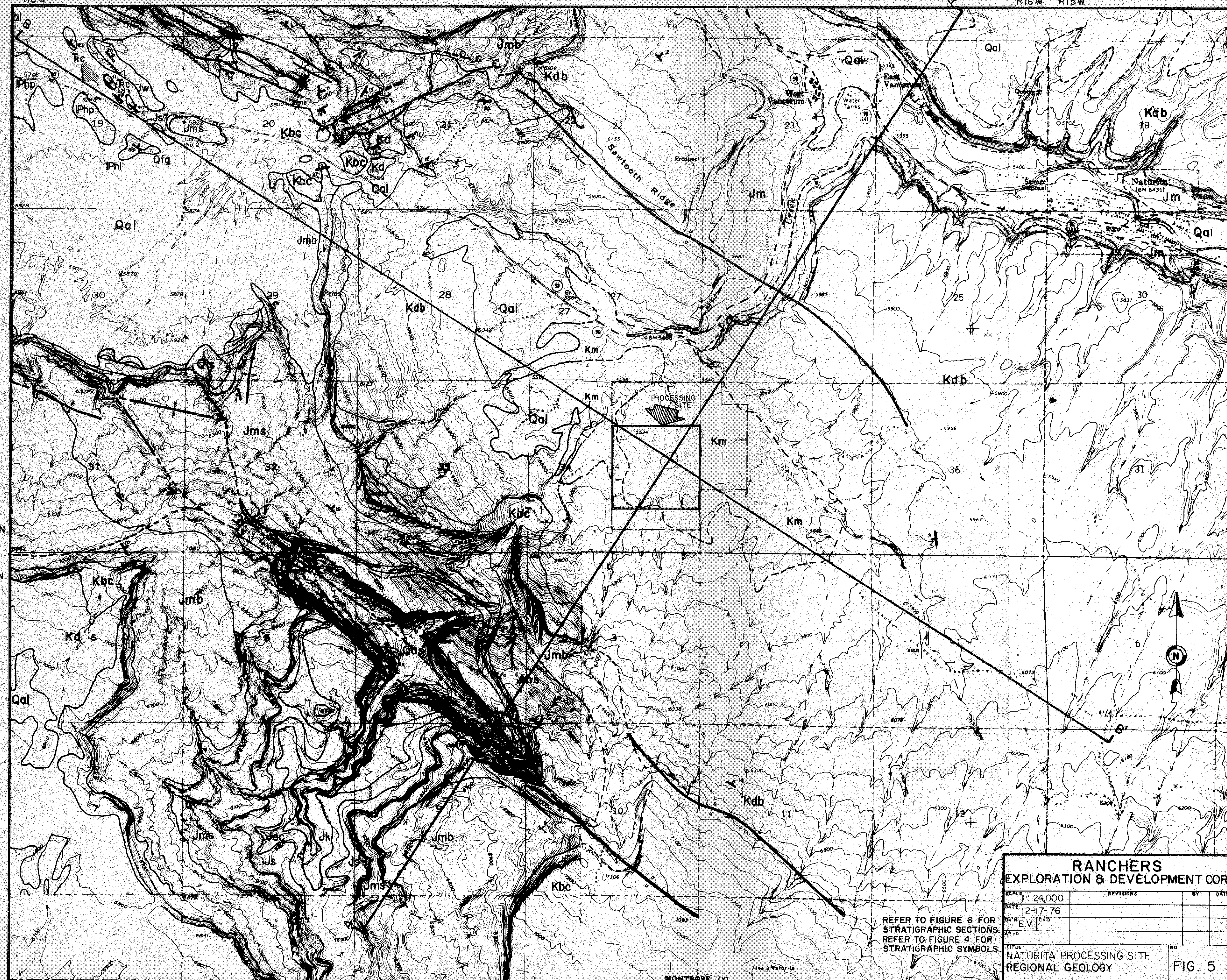
- Geologic Contact (after Cater,Jr,1955, Naturita NW Quad)
- Geologic contact (after Williams,1964, Map I-360)
- Syncline
- Anticline
- U / D Fault
- 9 Strike and dip of beds
- A — A' Line of cross section

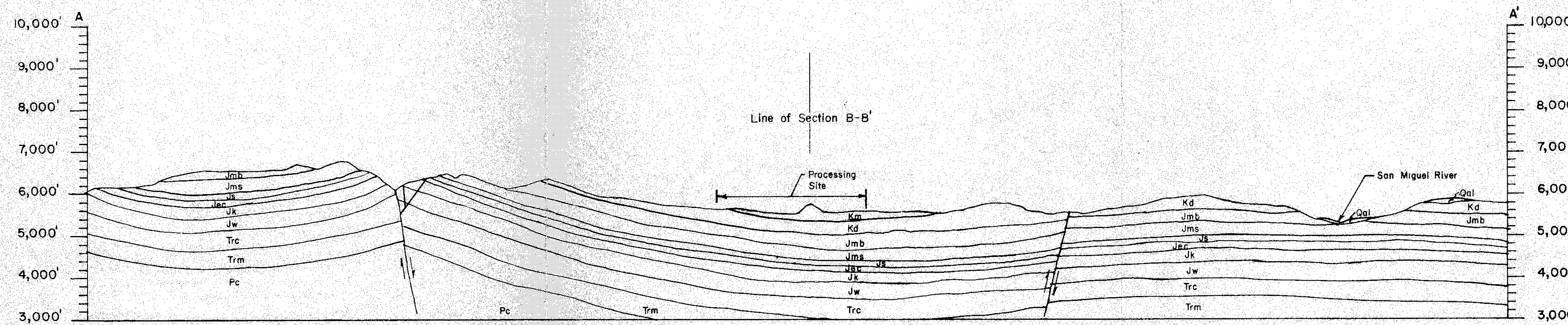
RANCHERS
EXPLORATION & DEVELOPMENT CORP.

12-14-76

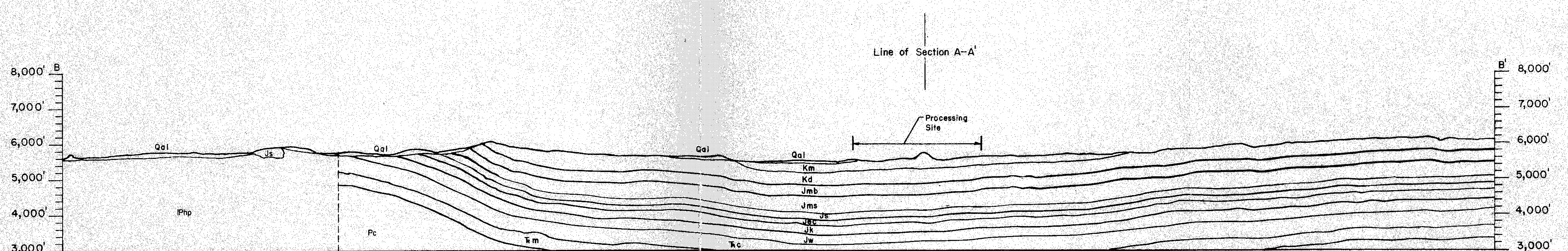
NATURITA PROCESSING PROJECT
Stratigraphic Description & Symbols

NO. Fig.-4


R16W
R16W R15W
T46N
T45N
Qal
Jmb
Kdb
Kbc
Kd
Jms
Qfg
Jm
Km
Sawtooth Ridge
West Vancorum
East Vancorum
Water Tanks
Prospect
Sewage Disposal
Naturita (BM 5431)
PROCESSING SITE
MONTROSE CO
RANCHERS
EXPLORATION & DEVELOPMENT CORP.
SCALE 1 : 24,000
DATE 12-17-76
DR'N E.V.
REVISIONS
REFER TO FIGURE 6 FOR STRATIGRAPHIC SECTIONS.
REFER TO FIGURE 4 FOR STRATIGRAPHIC SYMBOLS.
NATURITA PROCESSING SITE
REGIONAL GEOLOGY
FIG. 5



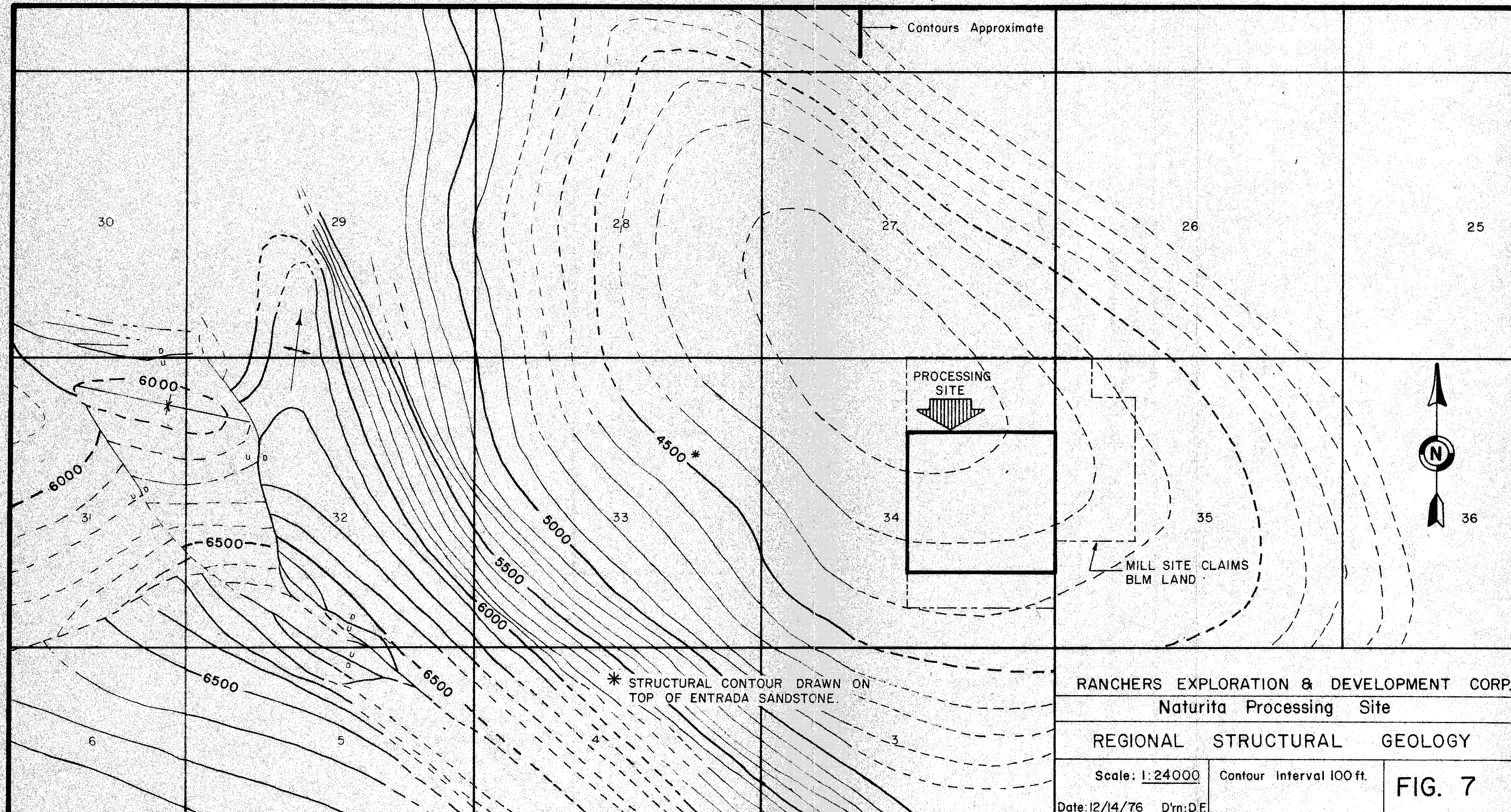
SECTION ALONG LINE A-A'



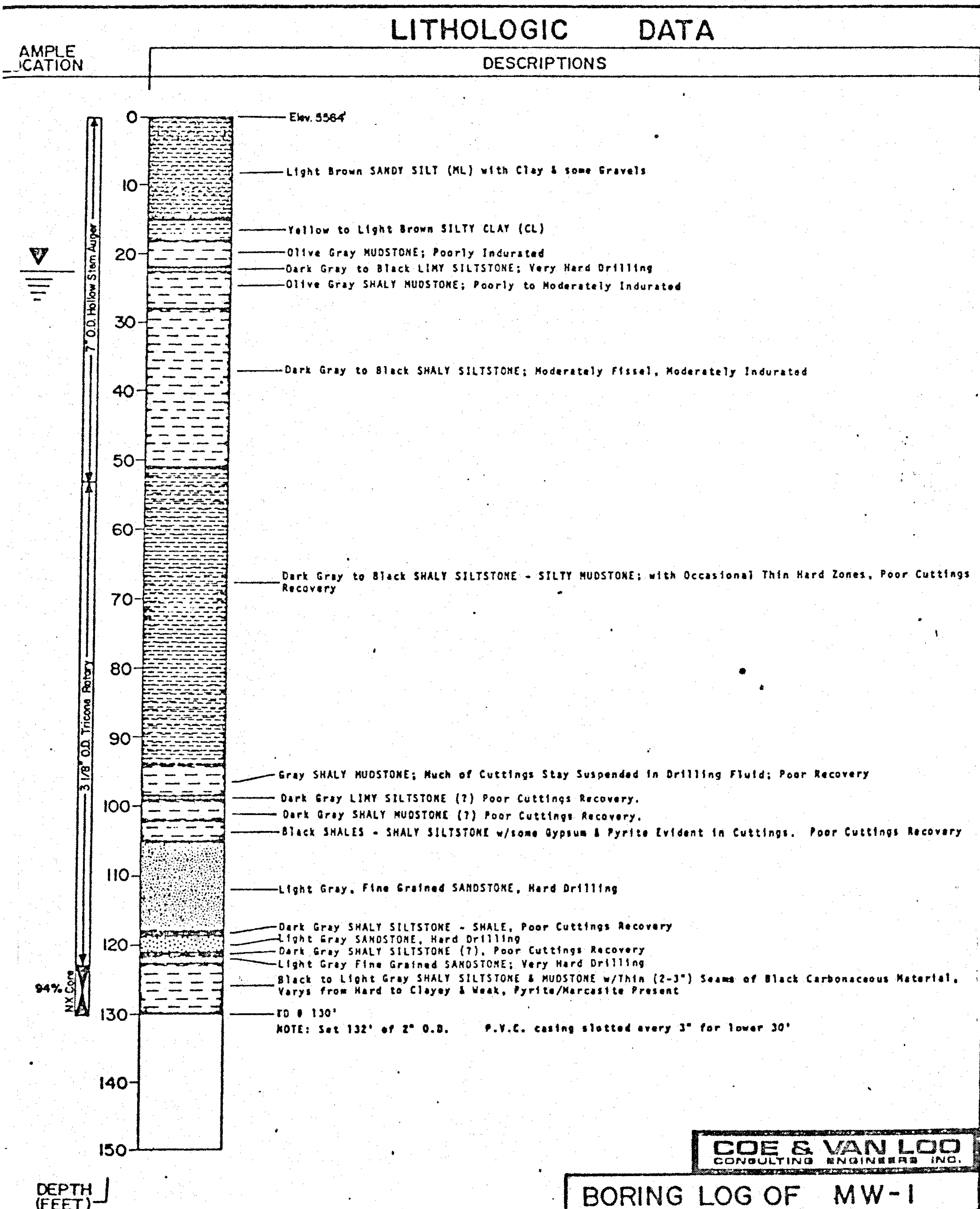
SECTION ALONG LINE B-B'

REFER TO FIGURE 5 FOR REGIONAL GEOLOGY.
REFER TO FIGURE 4 FOR STRATIGRAPHIC SYMBOLS.

RANCHERS EXPLORATION & DEVELOPMENT CORPORATION
12-16-76
DR'N: E.V.
SCALE: 1: 24,000
TITLE: NATURITA PROCESSING SITE STRATIGRAPHIC SECTIONS
NO. FIG. 6



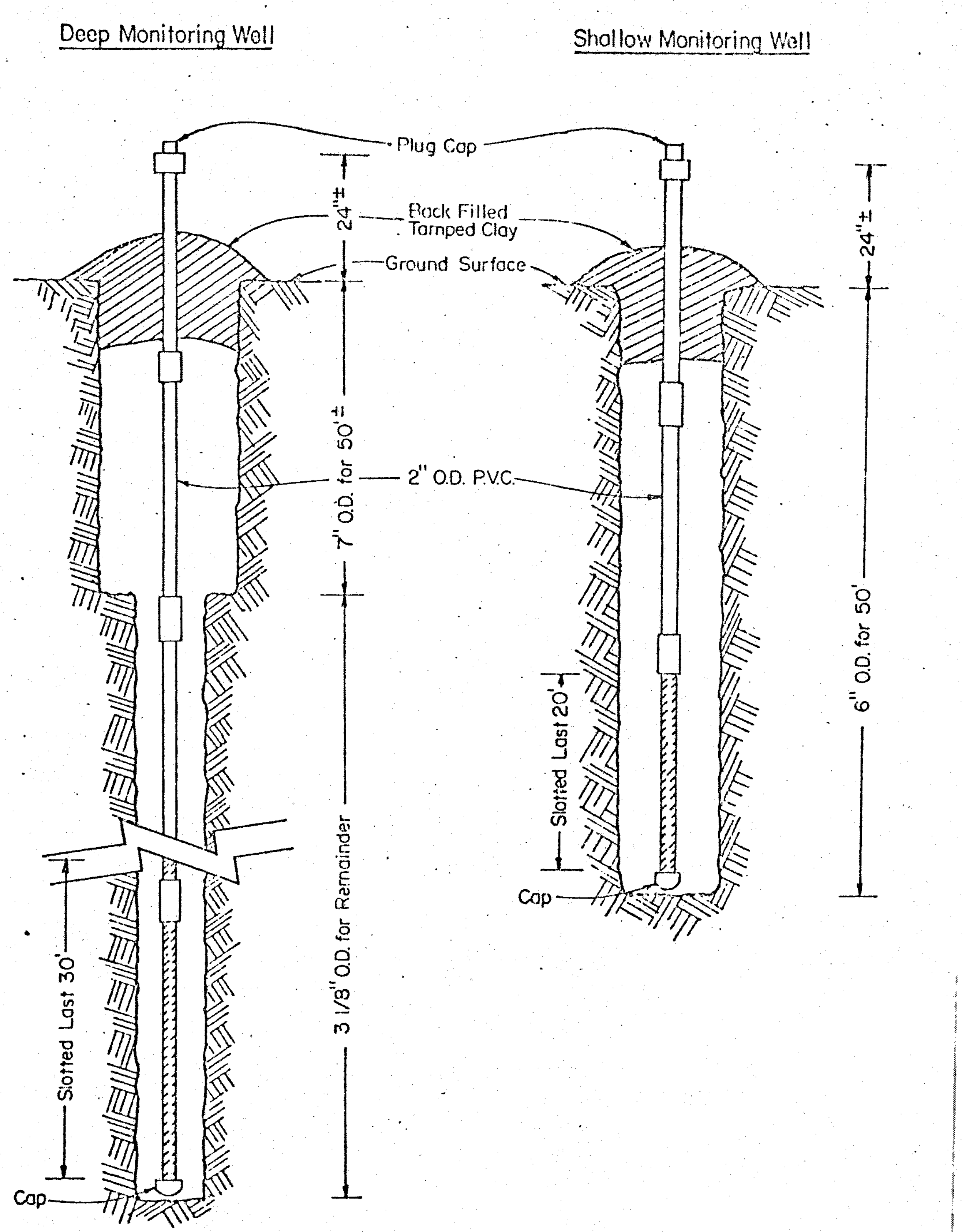
Section 34 in T 45N - R. 16W



LITHOLOGIC DATA
SAMPLE LOCATION
DESCRIPTIONS
Elev. 5564'
Light Brown SANDY SILT (ML) with Clay & some Gravels
Yellow to Light Brown SILTY CLAY (CL)
Olive Gray MUDSTONE; Poorly Indurated
Dark Gray to Black LIMY SILTSTONE; Very Hard Drilling
Olive Gray SHALY MUDSTONE; Poorly to Moderately Indurated
Dark Gray to Black SHALY SILTSTONE; Moderately Fissel, Moderately Indurated
Dark Gray to Black SHALY SILTSTONE - SILTY MUDSTONE; with Occasional Thin Hard Zones, Poor Cuttings Recovery
Gray SHALY MUDSTONE; Much of Cuttings Stay Suspended in Drilling Fluid; Poor Recovery
Dark Gray LIMY SILTSTONE (?) Poor Cuttings Recovery.
Dark Gray SHALY MUDSTONE (?) Poor Cuttings Recovery.
Black SHALES - SHALY SILTSTONE w/some Gypsum & Pyrite Evident in Cuttings. Poor Cuttings Recovery
Light Gray, Fine Grained SANDSTONE, Hard Drilling
Dark Gray SHALY SILTSTONE - SHALE, Poor Cuttings Recovery
Light Gray SANDSTONE, Hard Drilling
Dark Gray SHALY SILTSTONE (?), Poor Cuttings Recovery
Light Gray Fine Grained SANDSTONE; Very Hard Drilling
Black to Light Gray SHALY SILTSTONE & MUDSTONE w/Thin (2-3") Seams of Black Carbonaceous Material, Varys from Hard to Clayey & Weak, Pyrite/Marcasite Present
TD @ 130'
NOTE: Set 132' of 2" O.D. P.V.C. casing slotted every 3" for lower 30'
7" O.D. Hollow Stem Auger
3 1/8" O.D. Tricone Rotary
94% NX Core
DEPTH (FEET)
COE & VAN LOO CONSULTING ENGINEERS INC.
BORING LOG OF MW-1

Fig. 8

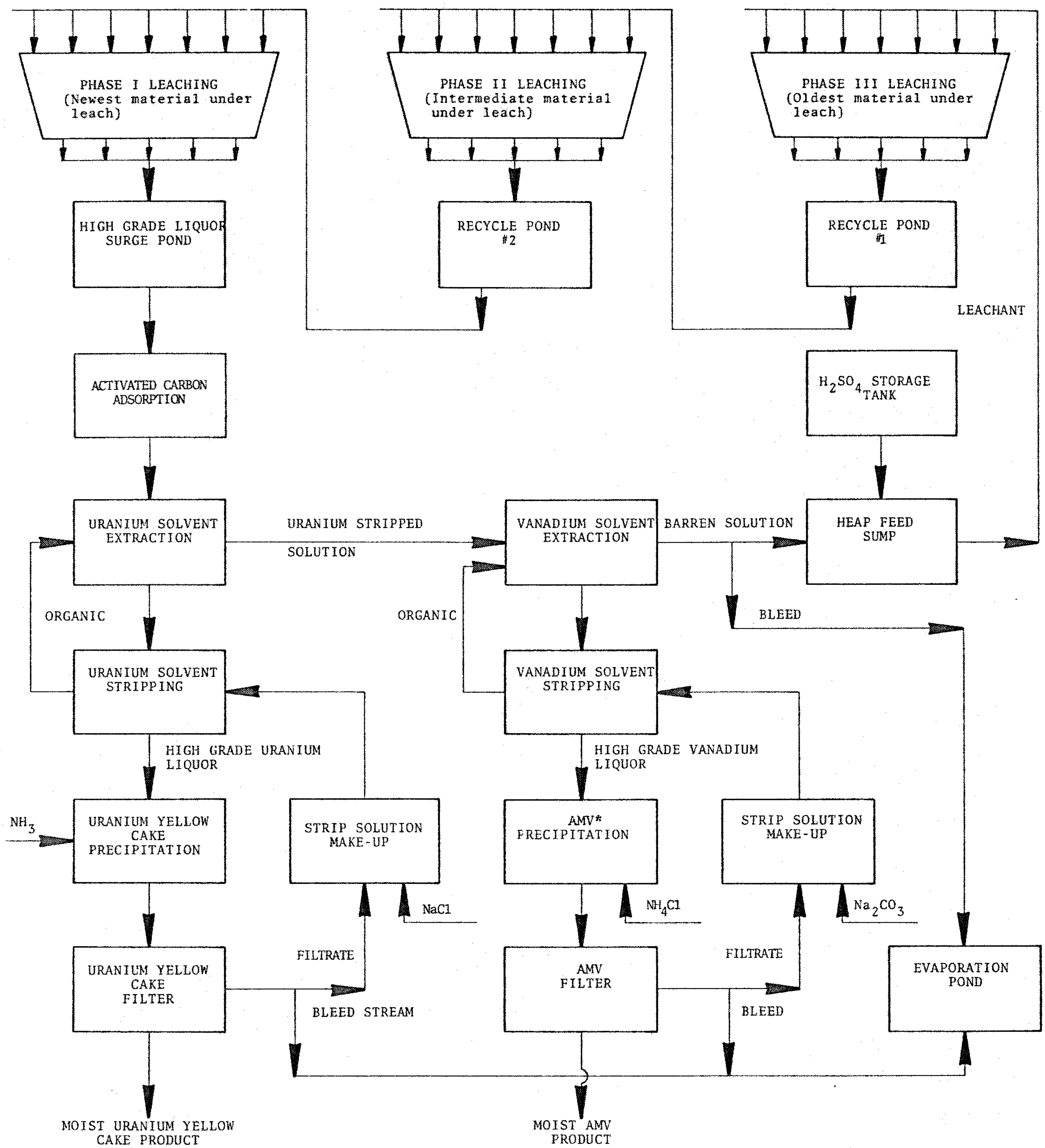
Diagram of Monitoring Well Casing Installation



No Scale

LOOS & VAN LOO
CONSULTING ENGINEERS INC.

FIGURE 9



*AMV: Ammonium Metavanadate

RANCHERS
EXPLORATION & DEVELOPMENT CORP.

SCALE None	REVISIONS	BY	DATE
DATE 11-24-76	Carbon Adsorption, chemicals	RES	1-3-77
DR'N LH / CK'D RES			
AP'VD MRW			

TITLE Flow Diagram - Uranium SX Circuit Western Colorado Project

NO Fig. 10