UNITED STATES NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL ASSESSMENT

BY THE

URANIUM RECOVERY FIELD OFFICE

IN CONSIDERATION OF AN APPLICATION FOR A

SOURCE MATERIAL LICENSE

FOR

FERRET EXPLORATION COMPANY OF NEBRASKA

CROW BUTTE COMMERCIAL IN SITU LEACH OPERATION

DAWES COUNTY, NEBRASKA

DOCKET NO. 40-8943

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INTRODUCTION

1.0 INTRODUCTION

1.1 Background

By letter dated October 7, 1987, Ferret Exploration Company of Nebraska (Ferret) submitted an application for a Source Material License to commercially operate the Crow Butte in situ leach facility.

Source Material License SUA-1441 was issued January 4, 1985, for the Crow Butte research and development (R&D) scale operation. The commercial operation will be an expansion of the R&D operation and will incorporate the existing facilities of the R&D. An Environmental Assessment (dated September 1984) was prepared in the consideration of the issuance of Source Material License SUA-1441 for the R&D scale operation. The R&D operation commenced in July 1986, and continues until the present.

The R&D facility is in Section 19 of Township 31 North, Range 51 West, in Dawes County, Nebraska. The location of the proposed commercial operation will include all or portions of Sections 11, 12 and 13 of Township 31N, Range 52W, as well as all or portions of Sections 18, 19, 20, 29 and 30 of Township 31N, Range 51W. The location is approximately 5 miles southeast of the town of Crawford, Nebraska, and covers approximately 2560 acres. Figure 1.1.01 is a regional location map. Figure 1.1.02 is a map of the proposed project area.

Land ownership is approximately 85 percent private while 15 percent is owned by Ferret. Ferret maintains leased mineral rights from the private owners.

Ferret proposes to in situ leach uranium contained from the Basal Chadron Sandstone, at depths ranging from 400 to 800 feet. The overall width of the mineralized area varies from 1000 to 5000 feet. The ore body ranges in grade from less than 0.05 to greater than 0.5 percent U_3O_8, with an average grade estimated at 0.26 percent equivalent U_3O_8 and 0.31 percent chemical U_3O_8.

During the uranium extraction process, gaseous oxygen or hydrogen peroxide will be combined with sodium bicarbonate. This solution, or lixiviant, will be injected into the mineralized zone where it will dissolve uranium from the formation. The uranium-bearing solution will then be recovered along with native ground water and the uranium extracted in the process plant. The well-field design will consist of injection and production wells in a five or seven spot configuration. The spacing between injection wells will range from 40 to 100 feet depending upon topography, ore grade and ground water mechanics. Each well field will be divided into mining units averaging approximately 22.5 acres. Scheduling for mining and restoration will be accomplished upon a mining unit basis.

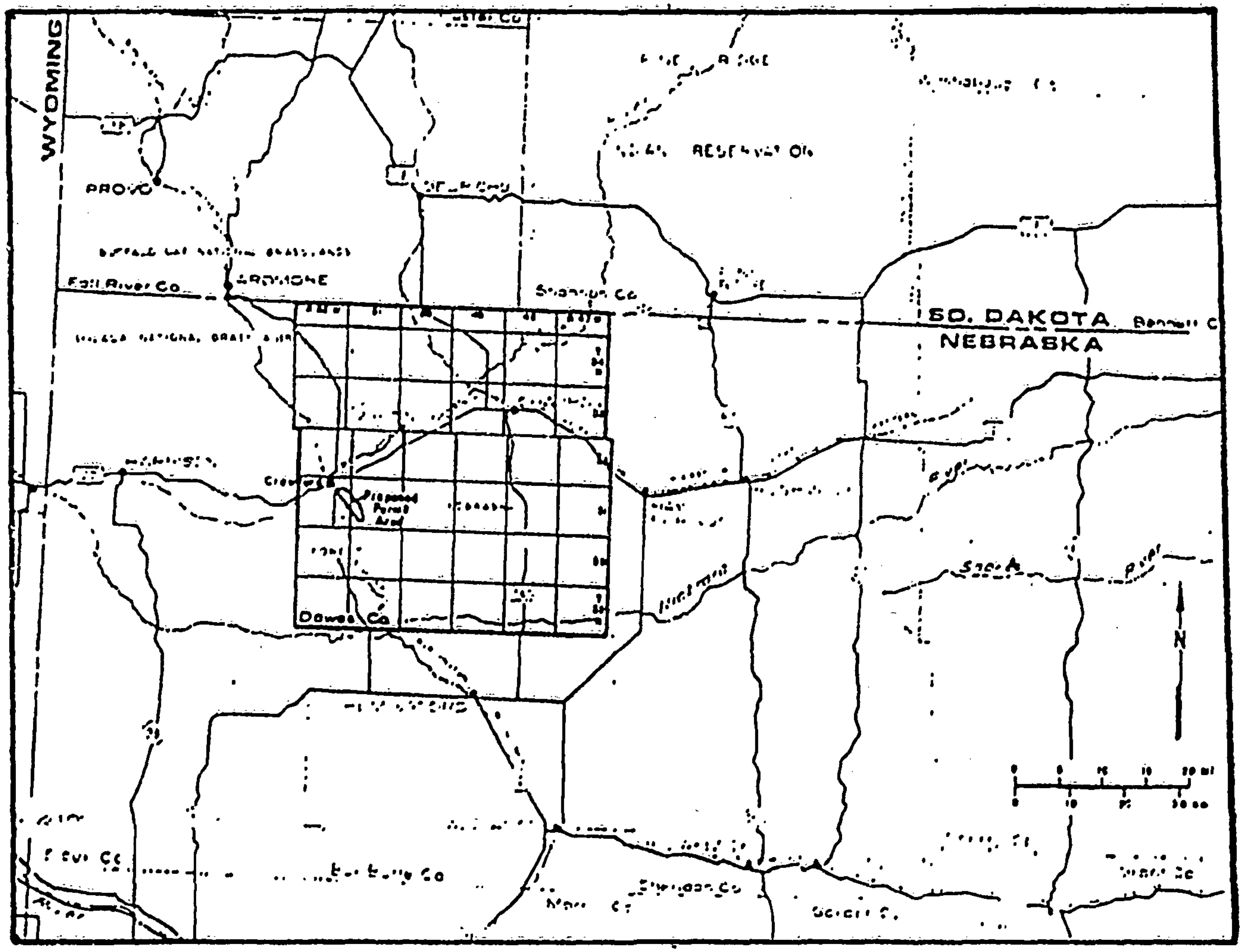
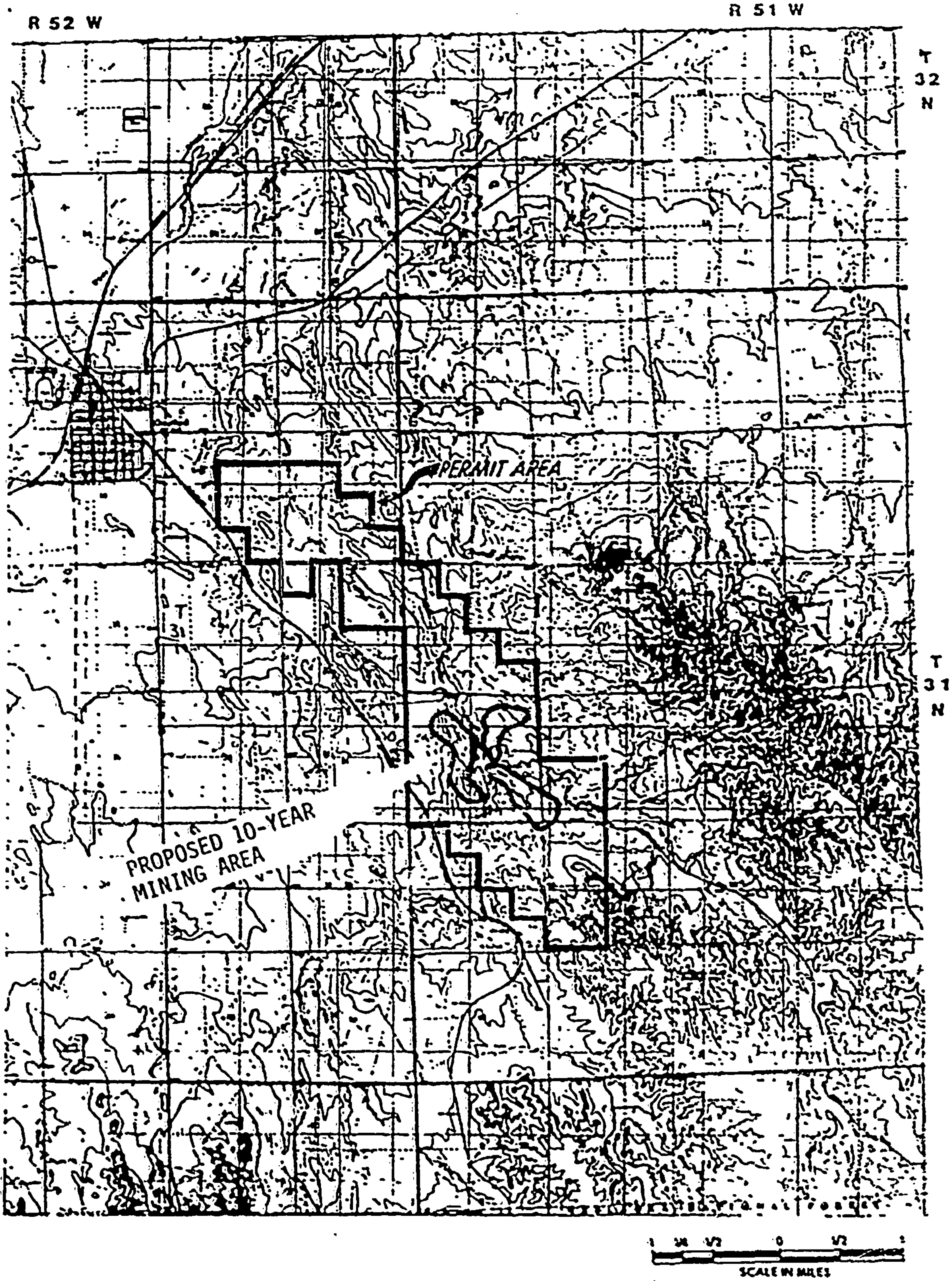


Figure 1.1.01

Regional Location of the Proposed Facility



- PERMIT AREA

Figure 1.1.02

Proposed Project Area

Extracted fluids will be pumped to the central processing plant at an average rate of 2500 gallons per minute (gpm), where the uranium will be recovered by an ion exchange resin. The fully loaded resins will subsequently be stripped, resulting in a wet uranium product. The yellowcake will then either be shipped to another facility for drying and further processing or dried onsite by a vacuum dryer.

Following the uranium recovery operation, in an individual mining unit, the ground water will be restored. The restoration method will involve ground-water sweep, reverse osmosis with permeate injection, use of a reductant and well-field recirculation. The primary goal of restoration activities is to return the ground water chemistry to baseline concentrations.

1.2 Proposed Action

By Form NRC-2, dated October 7, 1987, Ferret applied for a source material license for their Crow Butte ISL facility to allow commercial scale operations. Ferret submitted revised sections to their application dated December 14, 1987; January 22, 1988; May 17, 1988; April 27, 1988 and July 27, 1988.

This EA discusses the environmental aspects of the commercial project and summarizes the environmental effects associated with its operation. Additional information concerning the safety aspects of the proposed action is contained in the accompanying Safety Evaluation Report (SER).

1.3 Review Scope

1.3.1 Federal and State Authorities

Under Part 40 of Title 10 of the Code of Federal Regulations (CFR), (Domestic Licensing of Source Material), a NRC license is required in order to "...receive, possess, use, transfer...any source material..." In addition, the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) requires persons who conduct uranium source material operations to obtain a byproduct material license to own, use, or possess tailings and wastes generated by the operation which includes aboveground wastes from in situ operations.

In accordance with 10 CFR Part 41, this EA serves to (a) briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact, (b) fulfill the NRC's compliance with the National Environmental Policy Act when no environmental impact statement is necessary, and (c) facilitate preparation of an environmental impact statement when one is necessary. Should the NRC issue a finding of no significant impact, no environmental impact statement would be prepared and the commercial source material license would be granted subject to operating conditions contained in the source and byproduct material license.

The State of Nebraska, Department of Environmental Control (NDEC), administers and implements the State's rules and regulations. Ferret has applied for, and will be required to receive, a permit from the State of Nebraska prior to commencing operation of the proposed commercial scale operation.

Additionally, the Environmental Protection Agency maintains a review role in the aquifer exemption portion of the Underground Injection Control program (40 CFR Part 146.4). Ferret must apply for and receive an exemption to allow injection of lixiviant into the mineralized zone. This will also result in a revision to NDEC's Underground Injection Control program.

1.3.2 Basis for NRC Review

The NRC is preparing this EA in review of the proposed licensing action, in accordance with Title 10, CFR, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.

In conducting this assessment, the staff considered the following:

- Environmental information submitted by the applicant dated October 7, 1987; December 14, 1987; January 22, 1988; April 27, 1988; May 17, 1988; and July 27, 1988; to support their application for a commercial license.

- Operational history of the research and development operations, including inspection reports, quarterly environmental monitoring reports, radiological safety audits and well-field restoration information.

- Information supplied in discussions with the State of Nebraska, Department of Environmental Control and the Environmental Protection Agency, relating to the State permitting actions and aquifer exemption procedures, respectively.

- Information derived from professional papers, journals and textbooks; NRC regulations and regulatory guides as well as independent consultants.

2.0 SITE DESCRIPTION

2.1 Location and Land Use

The proposed facility and associated well fields are located in west-central Dawes County, Nebraska, just north of the Pine Ridge area. Figures 1.1.01 and 1.1.02 show the general location of the proposed commercial project site. The proposed project site is approximately 5 miles southeast of the city of Crawford via Squaw Creek Road. The predominant land use in Dawes County, as well as the proposed project area, is livestock grazing and associated feed production. The cultivated lands adjacent to the permit area are primarily used for production of winter wheat, alfalfa and oats. The native grasslands are grazed or harvested for hay. Ferret has claims or lease-hold interests for the surface and use rights along with uranium mineral rights within all of the areas proposed to be mined. After mining, the land will be reclaimed and returned to its original use of livestock grazing land.

The environmental assessment of the project is based upon a license application. The application is valid only for the described activities. To assure that other environmental disturbance is not created without sufficient assessment, Ferret will be .equired by license condition to environmentally evaluate future activities prior to their implementation. Following the evaluation, Ferret will be required to seek a license amendment.

The total surface area of the project site is approximately 2560 acres. Of this total surface area, it is estimated that approximately 500 acres will be disturbed during the life o, the project. Site activities will be limited by license condition to the geographical area described in the license application.

2.2 Geology and Hydrogeology of the Ore Body

2.2.1 Hydrogeologic Setting

The project area topography consists of low rolling hills of the Missouri Plateau dominated by a north-facing scarp, locally known as the Pine Ridge. This ridge skirts the south and west sides of the project area. The Pine Ridge serves to divide the Great Plains into two subdivisions, the High Plains south of the ridge and the unglaciated Missouri Plateau north of the ridge. Two major water sheds, Hat Creek and the White River, drain the area north of the Pine Ridge. The proposed commercial project lies within the White River watershed. Two tributaries of the White River, Squaw Creek and English Creek, drain the project area. Figure 2.2.1 01 shows these drainages and their relationship to the project.

The major structural feature of the area is the Chadron Dome which is surficially expressed in northeastern Dawes County. This anticlinal feature strikes northwest-southeast along the northeastern boundary of Dawes County. Over much of the area, the feature is buried by rather flat-lying Miocene aged rock. Two northeast trending faults are present in Dawes County. These faults are down thrown to the north. The closest fault to the project area is the White River Fault. This fault was discovered during the exploration drilling phase of the project and follows the White River north of Crawford, approximately 2 miles from the northern portion of the proposed project area. Total vertical displacement is 200 to 400 feet with no strike-slip movement.

Sedimentary strata within the Crawford Basin range in age from late Cretaceous (Pierre Shale) through the Tertiary (Eocene, Oligocene and Miocene). Figure 2.2.1.02 is the stratigraphic column representing the project area. The ore zone is the Basal member of the Chadron Formation, an arkosic sandstone underlain by the Pierre Shale, a very extensive and thick marine sediment. Above the Basal Chadron is the middle member of

Figure 2.2.1.01

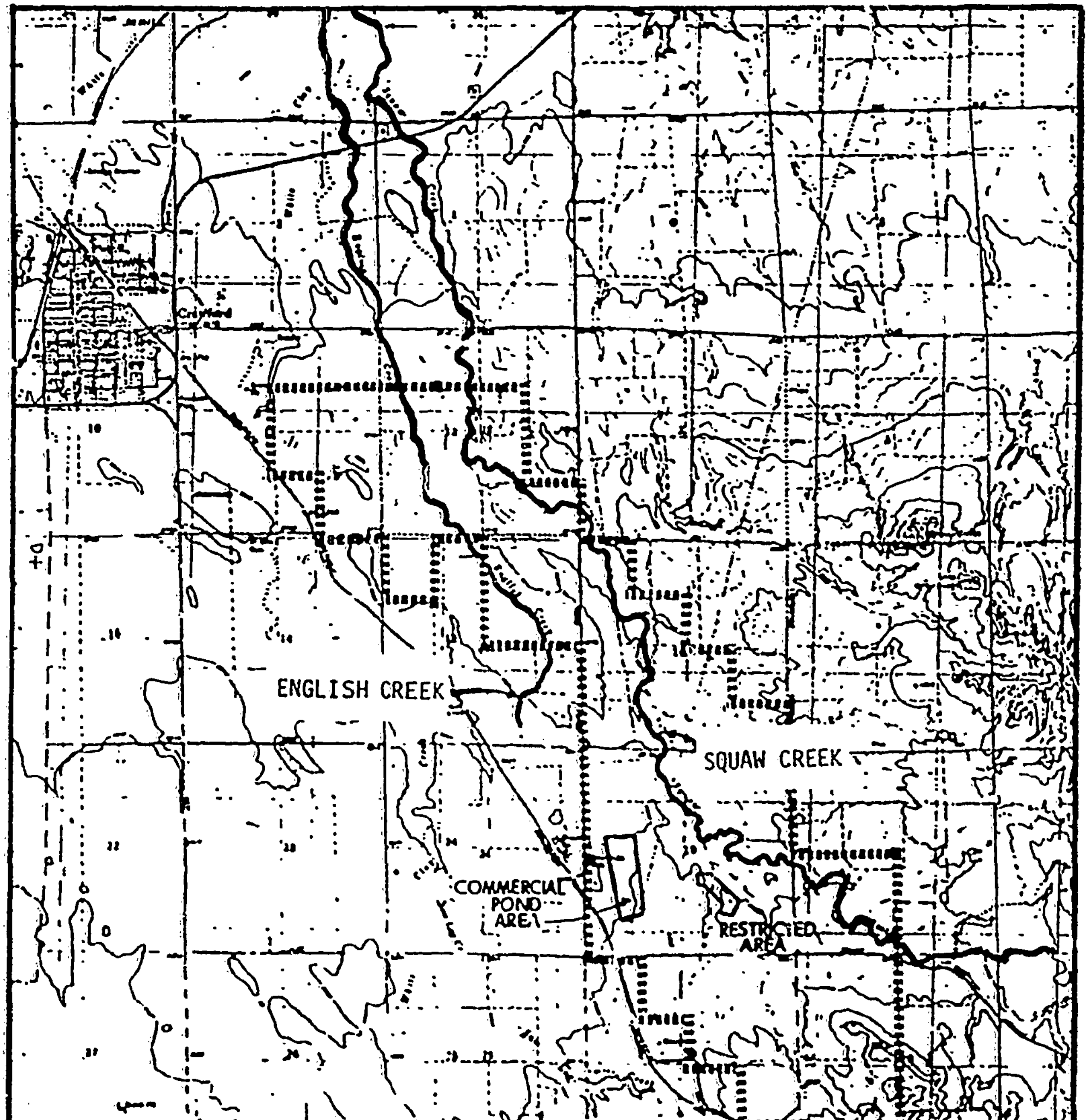


Figure 2.2.1.01

English Creek and Squaw Creek Drainages

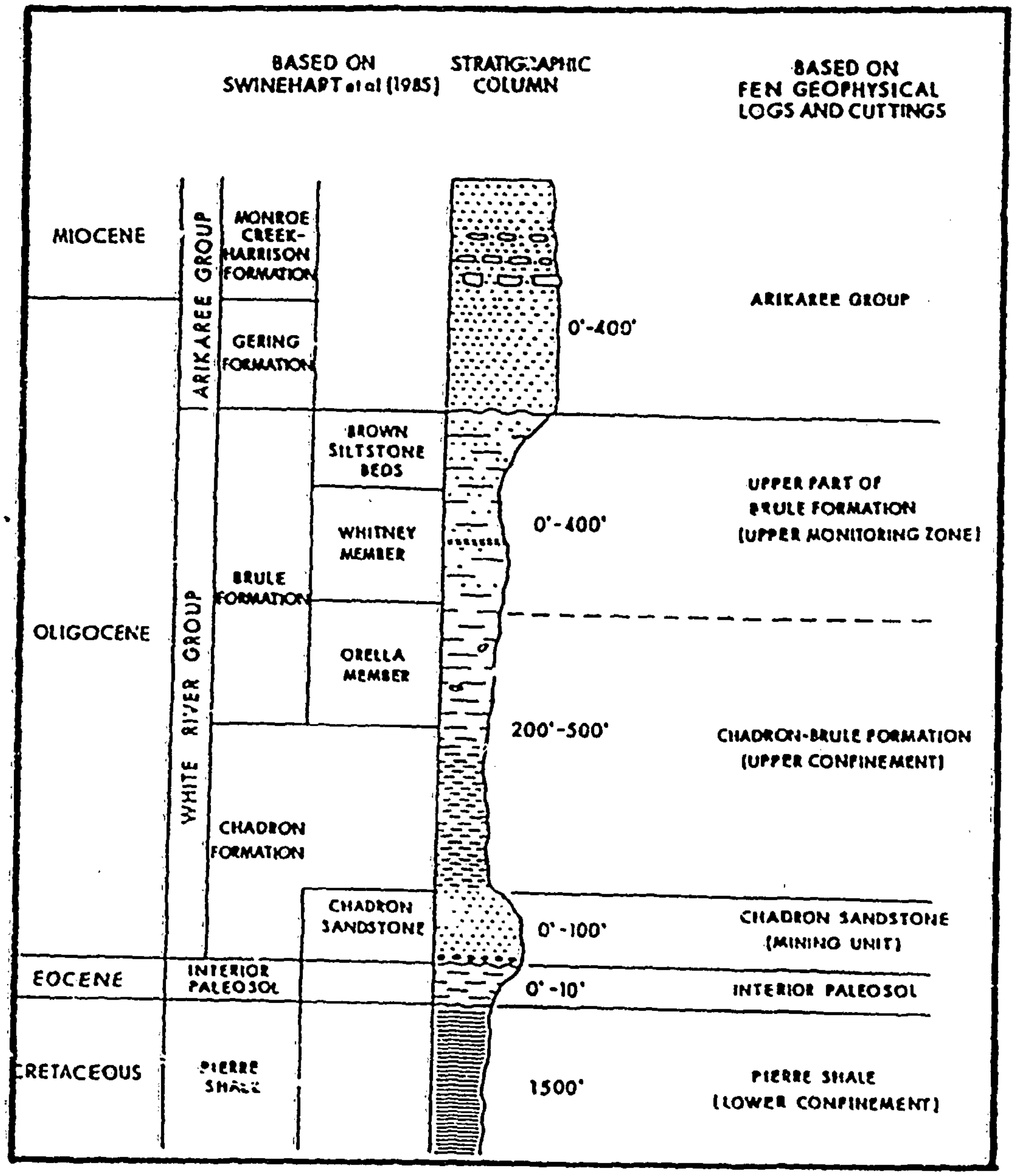


Figure 2.2.1.02

Project Area
Stratagraphic Column

the Chadron, consisting of bentonite clay and sandy claystone. At the project site, the Basal Chadron is approximately 500 to 600 feet below the ground surface. Over the area the Basal Chadron ranges from 400 to 800 feet below the ground surface, due to topographic changes.

The Pierre shale is a widespread unit of dark gray to black marine shale. Throughout its upper thickness, numerous bentonitic seams and stringers are present. In the project area, the Pierre shale underlies the Basal Chadron with a thickness of approximately 1200 to 1500 feet. The top of the Pierre is an erosional unconformity with a well developed paleosol as a result of exposure to atmospheric weathering. In the project area, this paleosol was eroded prior to deposition of the Basal Chadron. The Pierre outcrops north of the White River Fault and northeast of Crawford. The Pierre is essentially impermeable; although moist, it does not contain aquifers of any significance. As a result of its nonpermeable nature, it serves as an excellent formation to prevent downward migration of mining solutions.

The White River Group is Oligocene in age and consists of the Chadron and Brule Formations. The Chadron is the oldest Tertiary formation of record in northwest Nebraska. Its contact with the Pierre Shale is an erosional unconformity. The Chadron Formation is comprised of three distinct members. The Basal Chadron Sandstone is the depositional product of a large, vigorous braided stream system which occurred during early Oligocene. Regionally, the Basal Chadron Sandstone thickness ranges from 0 to 350 feet. In the vicinity of the proposed commercial area, the Basal Chadron is generally 30 to 45 feet thick. However, in some locations, the sandstone is over 80 feet thick as shown in Figure 2.2.1.08 . Figure 2.2.1.03 is an isopach map of the Basal Chadron. The Basal Chadron is a coarse grained arkosic sandstone with frequent interbedded clay stringers and silt lenses. The clay and silt lenses generally represent flood plain or low velocity deposits which normally occur during fluvial sedimentation. The Basal Chadron through x-ray diffraction indicates that kaolinite, illite, smectite and expandable mixed illite-smectite clay minerals are numerous. The Basal Chadron sandstone is the only water bearing strata in the Chadron Formation that can be considered an aquifer. The Basal Chadron aquifer is artesian and locally some free flowing wells are present. The direction of ground-water migration in the area is north toward the White River fault.

The Middle Chadron Member represents a distinct and rapid facies change from the underlying basal sandstone. The lower portion of the Middle Chadron is characterized by a brick red clay, which grades upward into light to medium green clay containing numerous fine sand grains. The brick red clay is frequently interbedded with gray-white bentonitic clay. The Middle Chadron Member has been observed in virtually all drill holes along the mineral trend but is less likely to occur in drill holes outside the Basal Sandstone channels. Thickness of the Middle Chadron averages 60 feet throughout the site area.

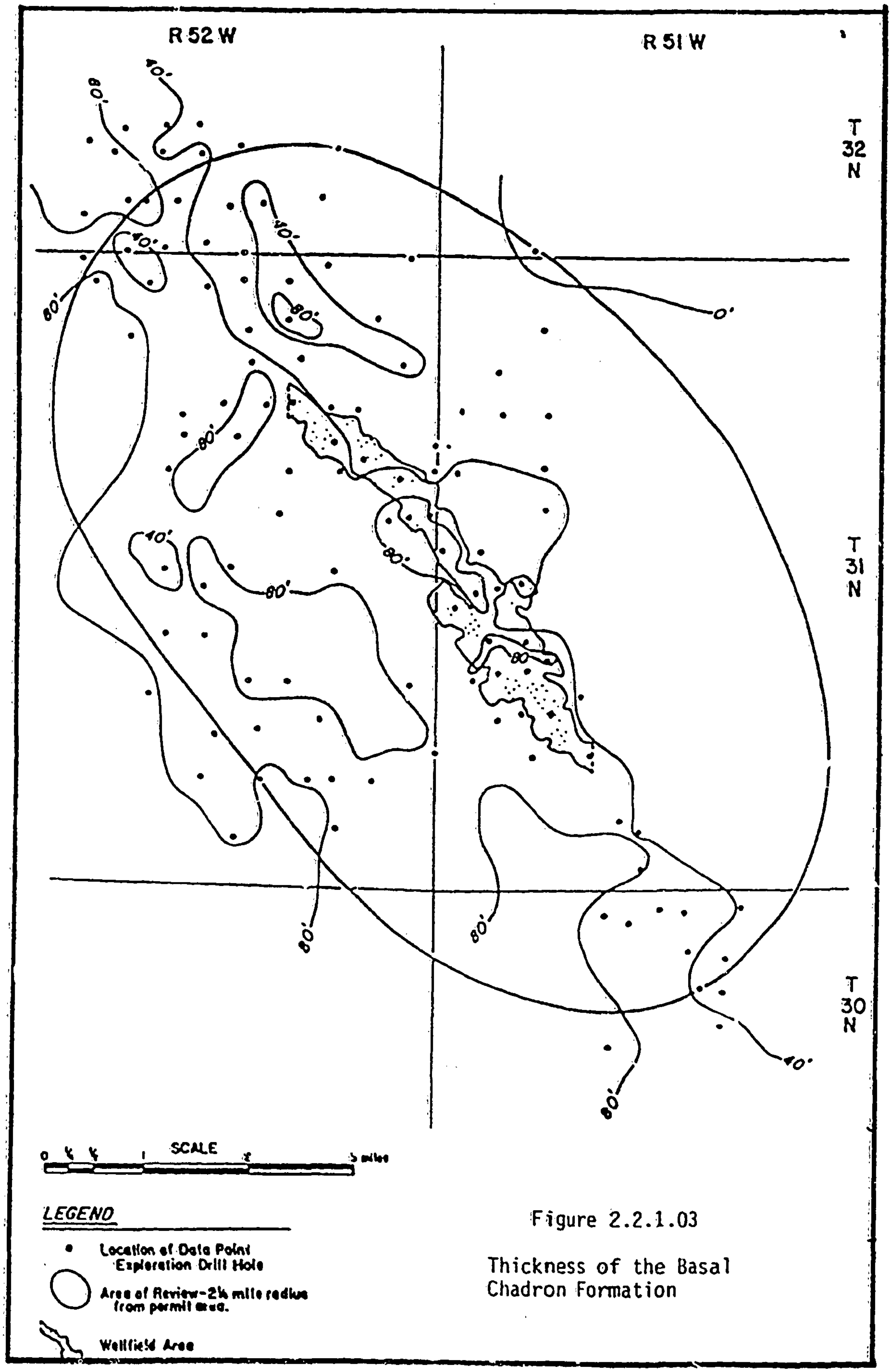


Figure 2.2.1.03

Thickness of the Basal Chadron Formation

The Upper Chadron consists of massive claystones and siltstones. These range in color from a dark blue-green to greenish-brown. The sequence of green siltstones and mudstones is generally considered fluvial channel and flood plain deposits with limited lacustrine and eolian material present. Sand channels are rarely encountered in test holes and where found, have very limited lateral extent. The Upper Chadron averages 150 feet thick within the site area.

The Brule Formation lies conformably on top of the Chadron Formation and with the Chadron, comprises the White River Group. The Brule has been subdivided into the Orella and the Whitney Members. The Orella lies directly on the Chadron Formation. An approximate Brule-Chadron contact can be detected in drill hole cuttings, but not usually in geophysical logs. The Orella is composed of buff to brown siltstones, with persistent spotty green nodules as it grades into the green clays of the Chadron. The Whitney Member of the Brule is comprised of fairly massive buff to brown siltstones, which are probably eolian in origin. Several volcanic ash horizons have been reported in outcrops. The Whitney Member frequently becomes coarser grained upward near the Miocene contact. Some moderate to well defined channel sands can be observed in both drill holes and in outcrops. These Upper Brule channels are limited in lateral extent and continuity, but may be occasionally saturated with water in the otherwise generally impermeable Brule. Within the project area, these sand units are encountered in the upper 250 feet of the drill holes.

Regionally and locally, the Brule is an important aquifer, producing sufficient quantities of water with low total dissolved solids, which are suitable for domestic and agricultural purposes. Locally, the direction of flow in the Chadron and Brule aquifers is to the north-northwest. Figures 2.2.1.04 and 2.2.1.05 show the water levels measured in the Chadron and Brule Formations. Hydrologic cross-sections of the project site are shown on Figures 2.2.1.06, 2.2.1.07 and 2.2.1.08.

The uranium deposit at the Crow Butte site is a roll-front deposit, similar to those in the Wyoming basins. The uranium was precipitated in the host rock in several long, sinuous roll fronts that are found within the lower subunits of the Basal Chadron Sandstone. Precipitation of the uranium resulted when the oxidized water containing the uranium entered reducing conditions. These reducing conditions are probably the result of hydrogen sulfide, and to a lesser degree, organic material and pyrite that were present in the aquifer. The Basal Chadron Sandstone is locally divided into subunits by thin clay beds that confine the uranium-bearing waters into several distinct hydrologic subunits. These clay beds are laterally continuous for hundreds of feet, and control the precipitation of the uranium over even greater distances. As a result, the mineralized zone of the Basal Chadron is essentially restricted to the lower 40 feet of the Basal Chadron.

The Crow Butte project area is within seismic risk Zone 1, where only minor damage is expected from earthquakes which occur within this area.

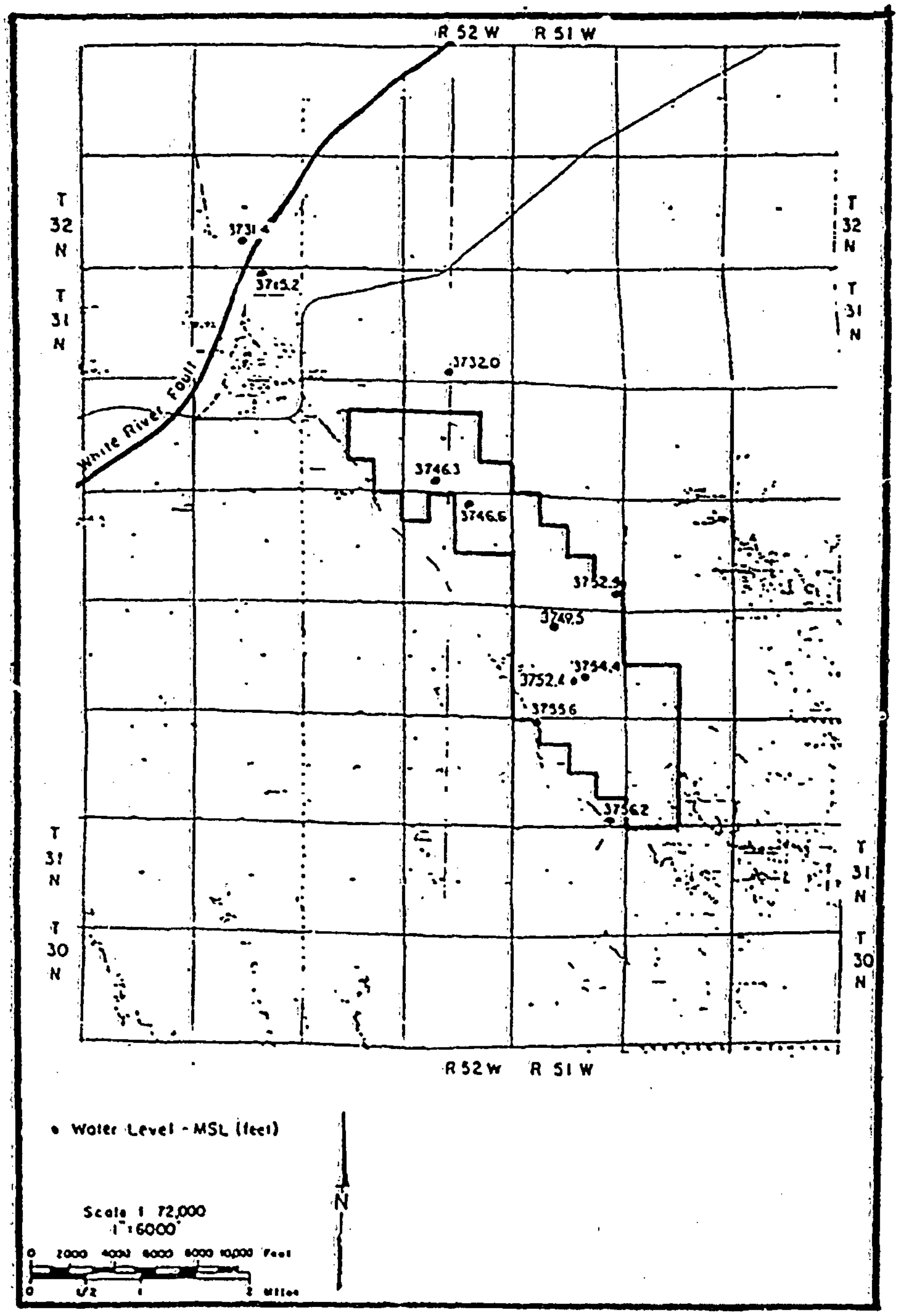


Figure 2.2.1.04

Baseline Water Levels in the Chadron Formation

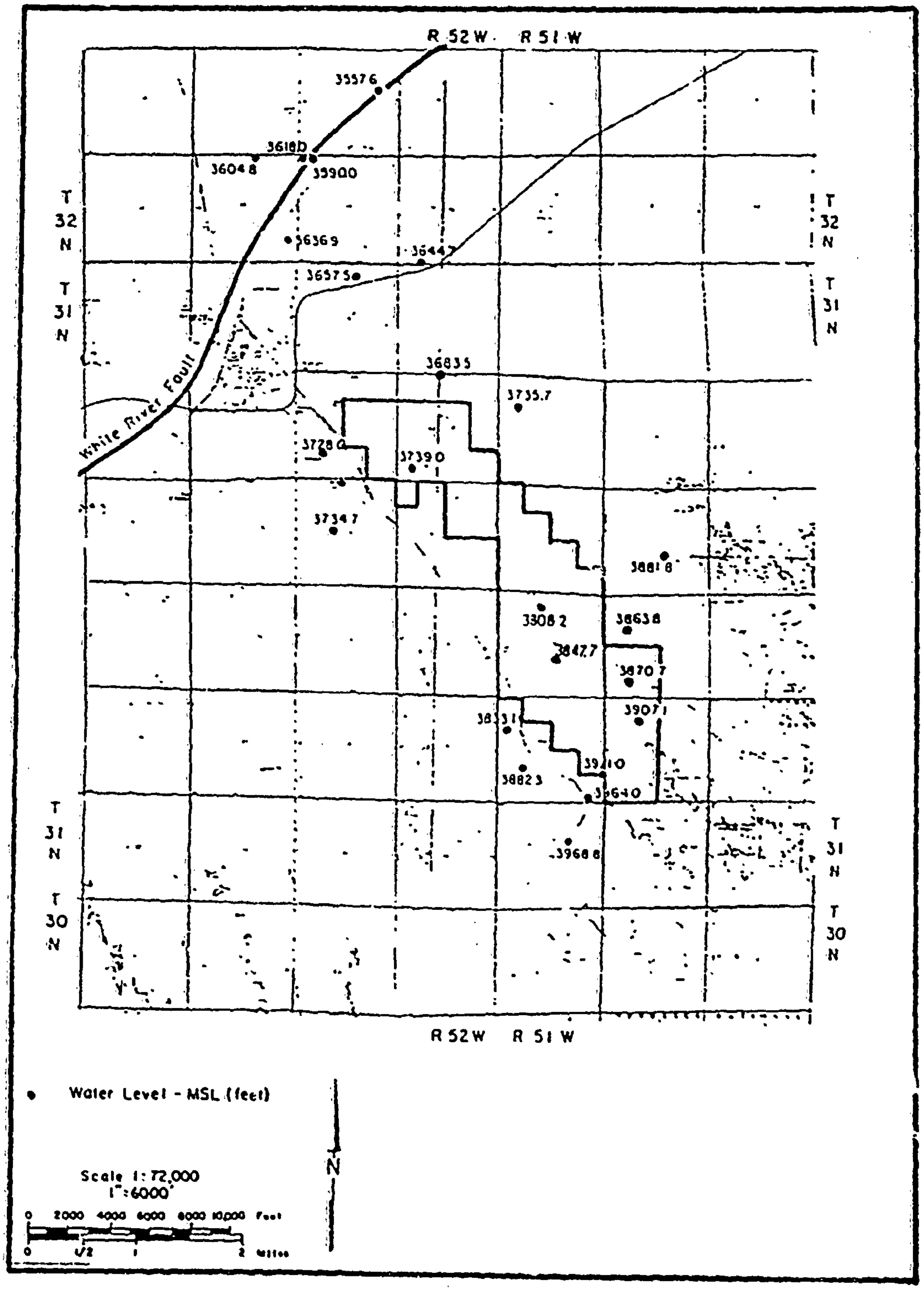


Figure 2.2.1.05

Baseline Water Levels in the Brule Formation

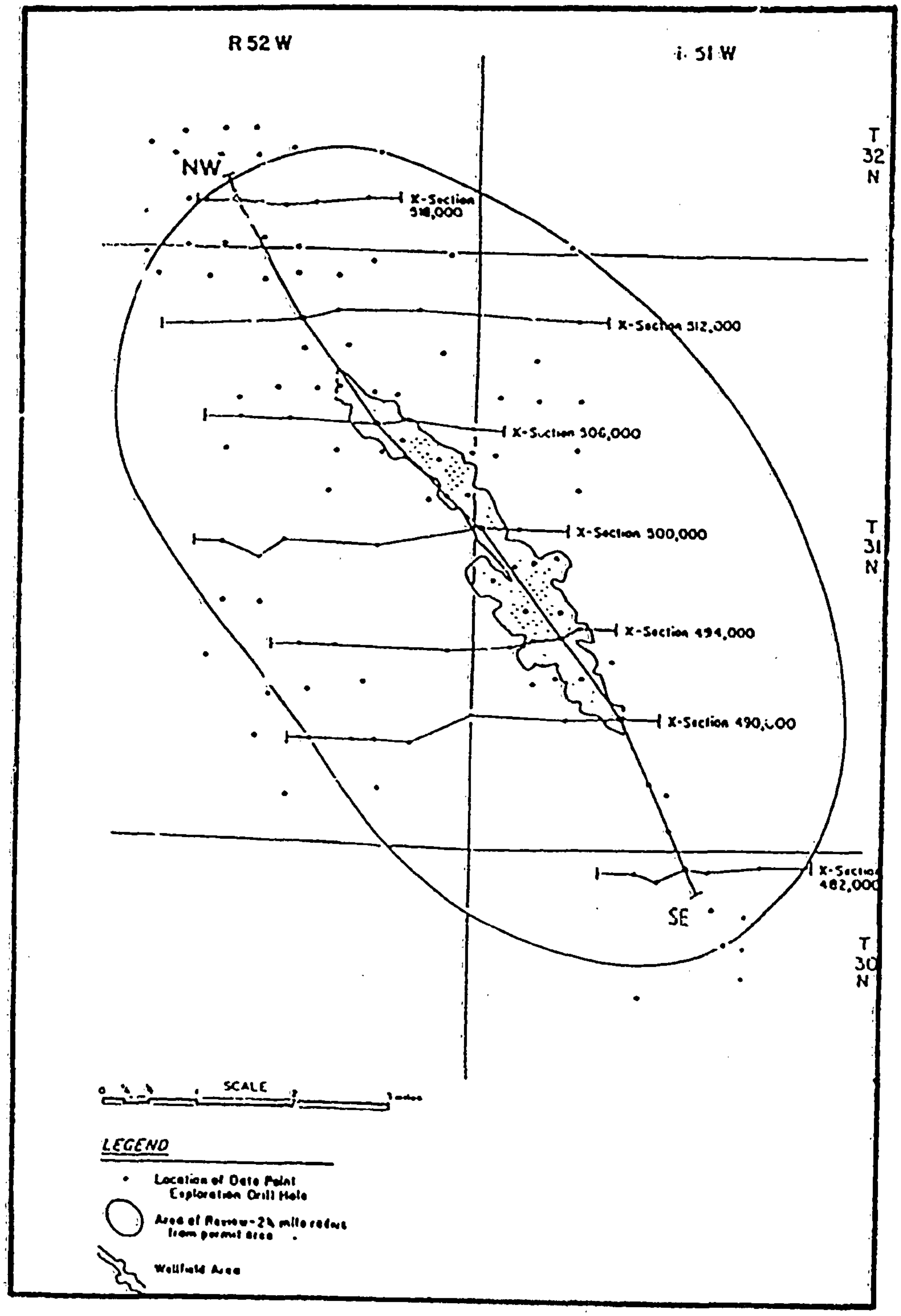


Figure 2.2.1.06

Location of Hydrostratigraphic Cross-Sections through the Project Area

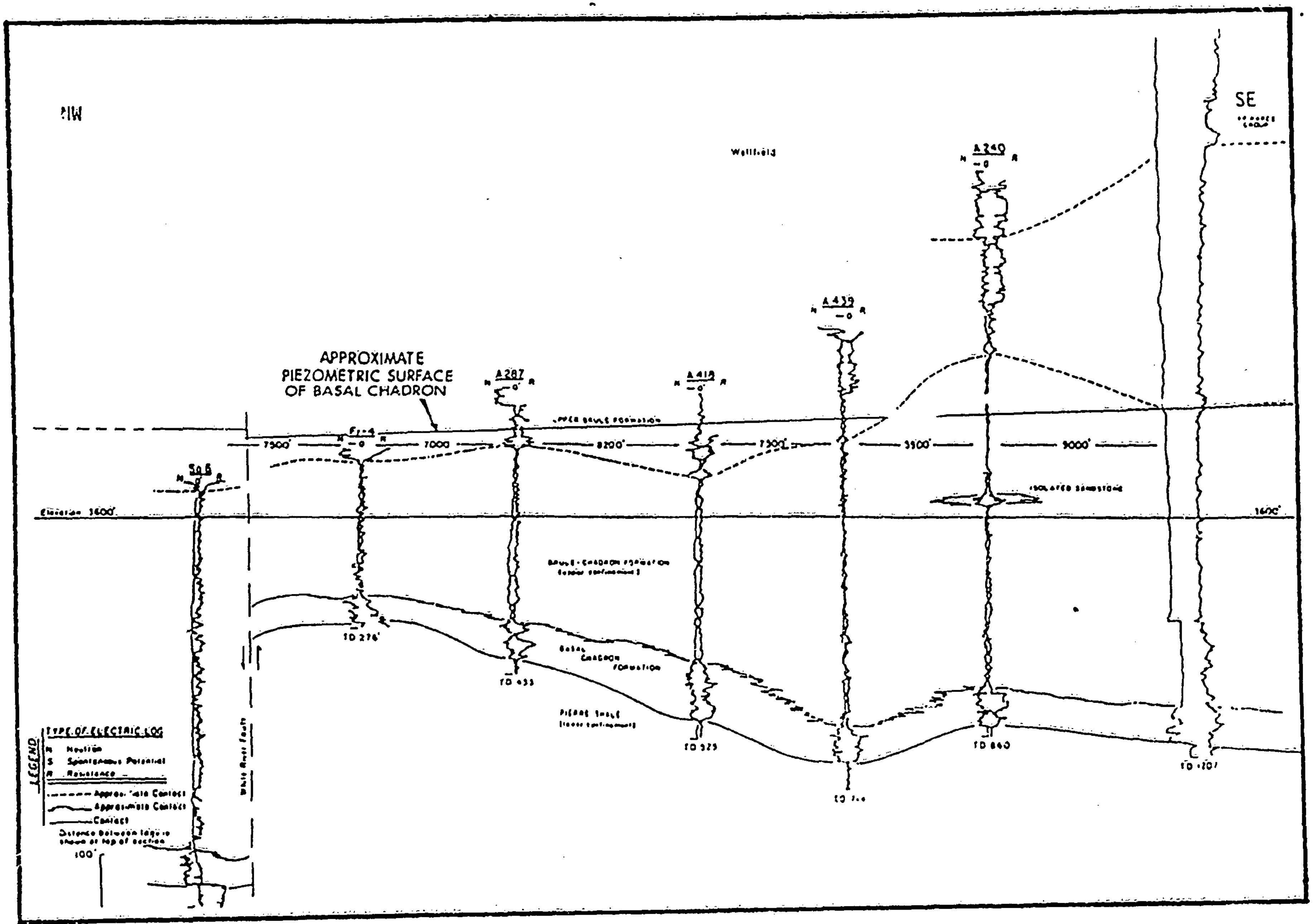


Figure 2.2.1.07

Typical NW-SE Hydrostratigraphic Cross-Section

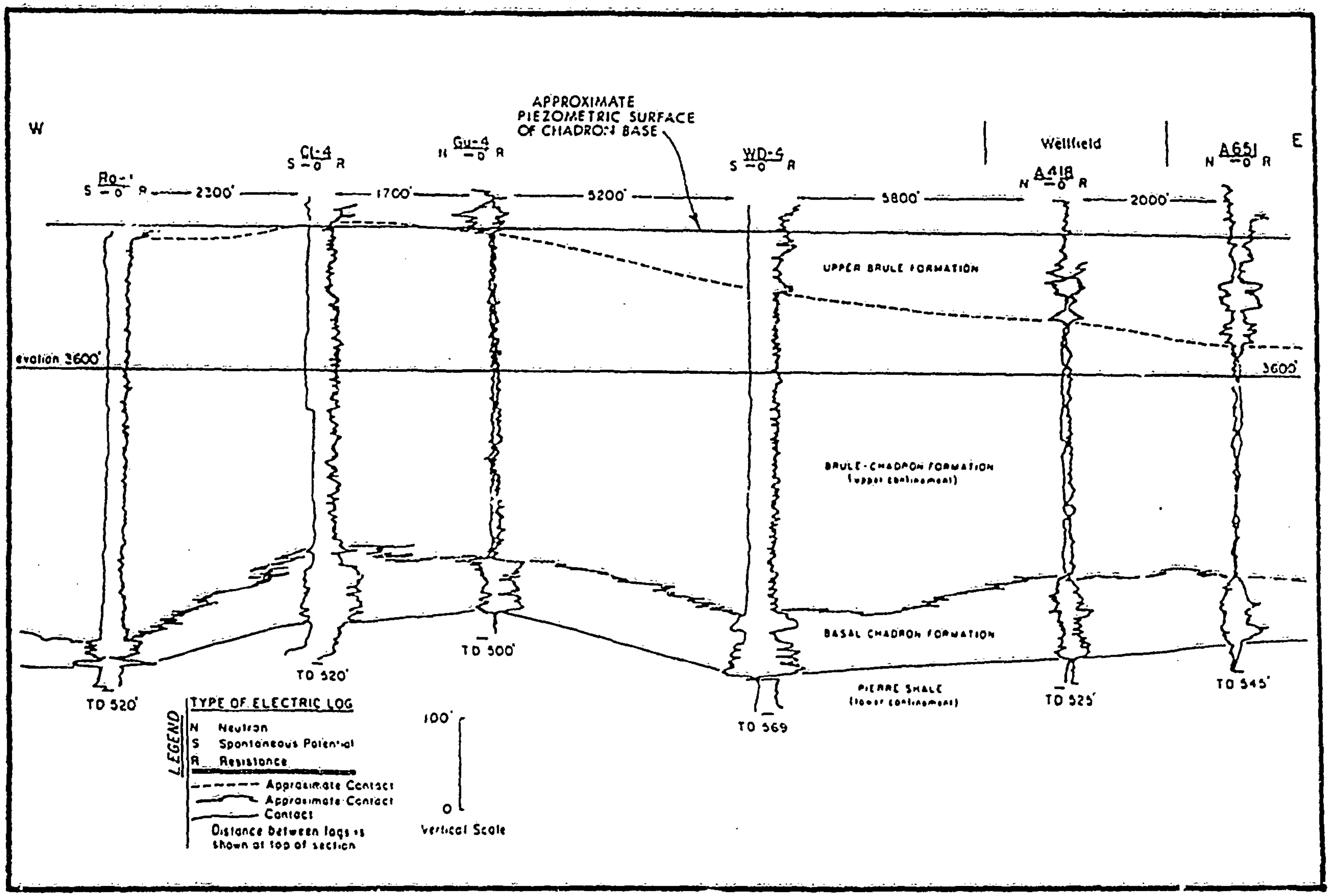


Figure 2.2.1.08

Typical E-W Hydrostratigraphic Cross-Section

The nearest area to the project area of higher seismic risk is in the southeastern part of Nebraska, within the eastern part of the central Nebraska Basin, about 300 miles from the project. Although the project is within an area of low seismic risk, occasional earthquakes have been reported. The strongest earthquakes in northwest Nebraska occurred near Chadron on July 30, 1934, with an intensity of VI (Modified Mercalli Intensity Scale). This earthquake resulted in damaged chimneys, cracked plaster and to a lesser extent, falling china. Another earthquake occurred near Chadron on March 9, 1963. This earthquake had an intensity of II-III and was not accompanied by any damage or noise. Although the risk associated with major earthquakes in the project area is slight, some low to moderate tectonic activity is occurring. This activity is, however, not expected to affect the mining operations.

2.2.2 Water Quality

Ferret submitted a compilation of water quality data for selected wells within the area of the proposed commercial project. Seven wells are completed in the Chadron Sandstone and four in the overlying Brule. Figure 2.2.2.01 shows the locations of the monitoring wells utilized to characterize ground-water quality over the proposed project area.

The water quality data indicates that the Basal Chadron aquifer is generally of good quality and has been defined by the NDEC as an underground source of drinking water. However, in the vicinity of the mineralized zone, uranium and radium concentrations are elevated. In the wells that were utilized to determine regional baseline water qualityradium-226 values ranged from 0.1 to 619 pCi/l, with a mean of 53 pCi/l. Similarly, within the R&D well field, radium-226 concentrations had a baseline mean of 859 pCi/l. These values are well above the 5 pCi/l EPA primary drinking water standard. Due to this, the Basal Chadron Sandstone water would not be recommended for human consumption. Furthermore, in several areas, the radium-226 concentrations would make it totally unsuitable for human consumption. Table 2.2.2.01 summarizes the water quality of the Basal Chadron Sandstone from the baseline monitoring in the wells. Water in the Basal Chadron aquifer is a sodium-sulfate type of water as illustrated in the stiff diagram in Figure 2.2.2.02.

Ferret has determined baseline water quality primarily on a regional scale. However, prior to mining, Ferret will be required to establish baseline water quality within the mining zone, at the mining zone perimeter as well as in the first aquifer overlying the mining zone. These water quality data will be utilized to determine monitoring requirements, restoration success and the extent of their impacts. Additionally, these data will be utilized to calculate upper control limits to determine if excursions are taking place. Should an excursion take place, Ferret will be required, by license condition, to implement corrective actions as well as submit a report on their efforts.

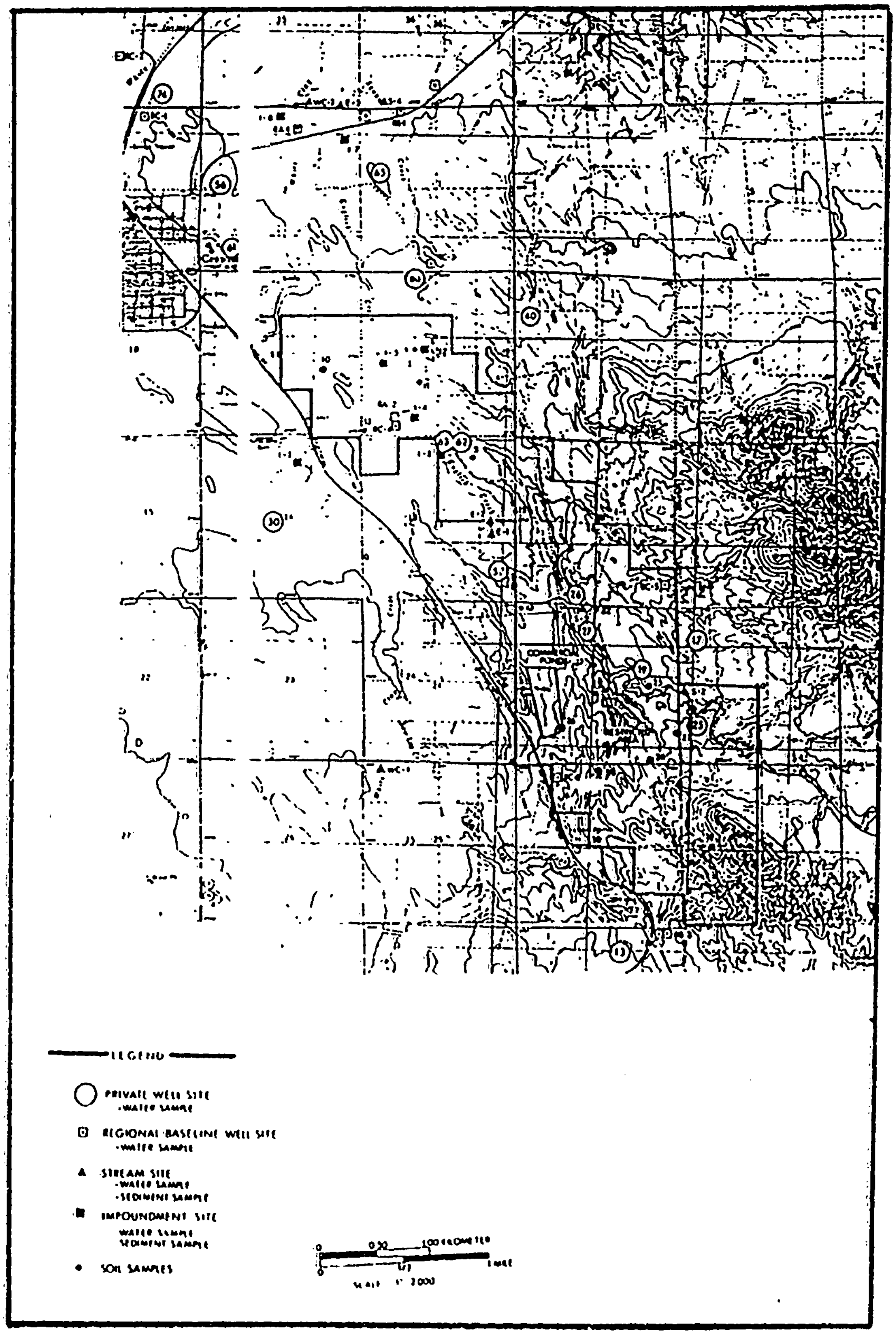


Figure 2.2.2.01

Non-Radiological Sampling Locations

Table 2.2.2.01

Basal Chadron Aquifer Water Quality Summary*

	MIN	MAX	MEAN
MAJOR CONSTITUENTS			
All values in mg/l unless noted			
Calcium	11	41	20
Magnesium	0.8	7.2	3.2
Sodium	340	540	410
Potassium	7.0	19.8	12
Carbonate	<1	14	2.5
Bicarbonate	308	411	368
Sulfate	254	620	407
Chloride	134	250	176
Ammonia as N	0.03	0.65	0.36
Nitrite as N	<0.001	0.03	0.01
Nitrate as N	<0.01	0.2	0.05
Fluoride	0.5	1.54	0.78
Silica (as SiO2)	6.8	16	12
TDS	958	1534	1215
Conductivity (μmhos)	1500	2500	1900
Alkalinity (as $CaCO_3$)	250	337	307
pH (standard units)	7.6	8.7	8.2
MINOR CONSTITUENTS			
All values in mg/l unless noted			
Aluminum	0.01	0.2	0.094
Arsenic	<0.001	0.013	0.004
Barium	<0.1	0.1	0.1
Boron	0.67	1.67	1.02
Cadmium	<0.001	0.016	0.002
Chromium	<0.001	0.0085	0.003
Cobalt	<0.0002	<0.050	0.004
Copper	<0.001	<0.1	0.007
Iron	<0.01	0.08	0.050
Lead	<0.005	0.015	0.007
Manganese	<0.002	<0.1	0.038
Mercury	<0.00005	0.0003	0.0002
Molybdenum	0.0008	0.033	0.011
Nickel	<0.001	0.020	0.007
Selenium	<0.001	0.063	0 008
Vanadium	<0.01	<0.1	0.009
Zinc	<0.02	0.157	0.021
Uranium (as U)	<0.01	2.4	0.092
Radium-226 (pCi/l)	0.1	619	53

* - Summary of average values for baseline wells drilled by FEN listed in Table 2.9-3 of the October 7, 1987 submittal.

Figure 2.2.2.02

Basal Chadron Water Quality

STIFF GRAPH
===========

```
 (epm) 15        10        5         0         5        10        15   (epm)
---------|---------|---------|---------|---------|---------|---------|---------
                                       :
Na+K ***********************************
                                       |********** Cl
                                       :
                               Ca **|************ HCO3
                                       :
                                 Mg *|***************** SO4
                                       :
                                   Fe : CO3
```

CATIONS:
========

	PPM	EPM	%EPM
Na	410.00	17.83	91.90
K	12.00	0.31	1.58
Ca	20.00	1.00	5.14
Mg	3.20	0.26	1.36
Fe	0.05	0.00	0.01
Mn	0.04	0.00	0.01

ANIONS:
=======

Cl	176.00	4.96	25.39
HCO3	368.00	6.03	30.85
SO4	407.00	8.47	43.34
CO3	2.50	0.03	0.43
NO3	0.00	0.00	0.00

TOTAL DISSOLVED SOLIDS (TDS) : 1399
ERROR IN CATION/ANION BALANCE : -0.38%
TOTAL HARDNESS (as CaCO3) : 63
SODIUM ADSORBTION RATIO (SAR) : 120.38

Table 2.2.2.02

Original Baseline Wells

Well No.	Formation	Screen Interval (ft)	Depth (ft.) to Bottom of Screen Assembly
RA-1	Brule	7 - 27	32
RA-2	Brule	7 - 27	32
RB-1	Brule	100 - 110	115
RB-3	Brule	95 - 115	120
RC-1	Chadron	330 - 350	355
RC-2	Chadron	572 - 592	597
RC-3	Chadron	260 - 270	275
RC-4	Chadron	340 - 360	365
RC-5	Chadron	672 - 692	697
RC-6	Chadron	713 - 733	738
RC-7	Chadron	708 - 718	723

2.2.3 Aquifer Testing and Ore Zone Containment

The aquifer testing program consisted of two aquifer tests. The first test was conducted in support of the R&D operations, in November 1982. The second test was conducted in June 1987, at a site located approximately 2800 feet north of the initial aquifer test site. The initial aquifer test indicated that vertical movement of mining solutions was highly unlikely. This theoretical interpreta on of the test data was verified by the R&D mining which is currently tak ace. To date no mining solutions have vertically migrated from the min alized zone. This is primarily due to the mineralized zone having a permeability which allows mining solutions to be controlled by pumping rates. The two tests have zones of influence which slightly overlap, due to this, they adequately define the hydraulic conditions over the project area. Based upon the mapped stratagraphic cross sections, there is a high degree of confidence that the locations of the two aquifer tests are representative of the entire proposed commercial project area. However, to assure that mining solutions can be controlled, additional testing in the northern section of the proposed area will be required prior to mining that area, to verify the existence to similar geologic units.

The first aquifer analysis was discussed in the October 1984 EA for the R&D license. Based upon the results of the analysis in the R&D EA, it was concluded that the Basal Chadron Sandstone (the ore zone) is adequately confined and that effects of leakage from the upper aquitard are minimal. The results of the second aquifer analysis were similar to the results of the first.

In summary, the results of the aquifer analysis indicate that the Basal Chadron Sandstone is a nonleaky, confined, slightly anisotrophic aquifer. The effective transmissivity is 364 ft^2/day (2726 gpd/ft). The average thickness in the vicinity of the project area is 40 feet with a range of 30 to 40 feet. Therefore, the average hydraulic conductivity is approximately 3.2E-3 cm/s (68 gpd/ft^2). The vertical hydraulic conductivity of the confining layers, the 15 to 25 feet of red clay above and middle Chadron above and the 1200 feet of Pierre Shale below, are approximately 1.4E-10 cm/s and 3.5E-11 cm/s, respectively. This hydraulic conductivity is almost identical to that in the ore zone mined during the research and development operations. Furthermore, the hydraulic conductivity of the ore zone contrasts sharply with that of the overlying and underlying confining layers. Based upon the measured hydraulic conductivities, the average thickness of the aquitards and the assumption that they have a porosity of 22 percent under a gradient of one, it would require approximately 12,000 years for water to move through t overlying aquitard and over 100 times this long for water to penetrat the underlying aquitard. The properties of the Basal Chadron and the confining strata are summarized in Figure 2.2.3.01.

It is known from the laboratory testing of the overlying confining layers that they exhibit a minor amount of leakage. However, during the aquifer testing, no loss of pressure occurred that would indicate that leakage was

Figure 2.2.3.01

Summary of Hydrogeologic Properties

Middle Chadron	Overlying confirming layer = 315-325' thick
Red Clay Bed 10-25'	Vertical hydraulic conductivity = 2.5E-10 cm/s Vertical hydraulic conductivity = 3.5E-11 cm/s > 1.4E-10 cm/s
Basal Chadron 30-44'	Transmissivity = 480 ft^2/day (3591 gdf) Hydraulic conductivity = 3.3 E-3 cm/s Storativity = 7E-5
	$\text{Transmissivity}_{pump}$ = 359-374 ft^2/d (2682-2795 gpd/f) Storativity 8.4E-5 to 1.3E-4 $\text{Transmissivity}_{recover}$ = 348-355 ft^2/d (2604-2659 gpd/f)
Pierre Shale 1200'	Vertical hydraulic conductivity = 3.4E-11 cm/s Vertical hydraulic conductivity = 3.6E-11 cm/s
First Test	
	(2°) Transmissivity = 401 ft^2/d (3000 gpd/f)
	(92°) Transmissivity = 290 ft^2/d (2169 gpd/f)
Second Test	
	(51°) Transmissivity = 369 ft^2/d (3760 gpd/ft)
	(141°) Transmissivity = 360 ft^2/d (2692 gpd/ft)

occurring. Similarly, the underlying confining layer response attributable to the aquifer testing showed no leakage.

The upper confinement is composed of the Chadron Formation above the Basal Chadron Sandstone and that portion of the Brule Formation which underlies the intermittent Brule Sandstones. This part of the Chadron Formation is an impermeable clay grading upward into several hundred feet of Brule Formation siltstones and claystones. These units isolate the Basal Chadron Sandstone with several hundred feet of clay and siltstones. The Chadron Formation clays also have a large lateral extent and have been observed in all holes within the project area. These clays contain about 44 percent montmorillinitic clay minerals.

Lower confinement is provided by over 1000 feet of Pierre Shale. The Pierre is a homogeneous black shale of low permeability that is one of the most laterally extensive formations in northwest Nebraska. The Pierre contains approximately 47 percent montmorillinite and mica-illite clay minerals.

The aquifer testing theoretically indicates that ground-water flow would be contained by the confining strata and concentrated within the production zone. The confining characteristics, associated hydraulic conductivities and the continuous extent of the confining beds assure vertical control of the mining solutions. Further evidence of the confining characteristics associated with the strata bounding the production zone has been demonstrated by the lack of vertical migration during operation of the R&D project.

Uranium production and restoration efforts took place within the production zone of Well Field No. 2 for a period of 24 months. These efforts continually stressed the confining characteristics of overlying and underlying strata without a detected excursion. The operational data from the R&D maintained an approximately 1.5 percent overproduction rate which continually drew injected mining solutions as well as natural ground water into the mining zone. This practice was sufficient to assure control of the mining solutions. A similar overproduction is proposed to be maintained during the commercial operation.

As discussed above, the geology is rather uniform over the area proposed to be mined. Due to this the production zone and confining strata are also continuous over the proposed commercial area. The lithologic properties vary slightly, but for the most part, the geologic data as well as the aquifer testing data indicate that similar ground-water responses can be expected over the entire area proposed to be mined.

3.0 PROCESS DESCRIPTION

3.1 In Situ Leaching Process

The in situ leach method of uranium recovery was first applied in south Texas in 1975. Since that time, numerous other facilities have been developed on both the research and development scale as well as the commercial scale. For the most part, these ventures have shown that uranium can be economically recovered and the ground-water quality restored to baseline or premining class of use standards.

There are many environmental advantages to in situ leaching of uranium over conventional mining methods such as open pit mining or underground mining. Conventional extraction methods can produce a significant impact on the environment due to open pits, mine dewatering, spoil piles, etc. The greatest impact of the in situ leach extraction method is a temporary impact to the ore zone ground-water quality. This impact is termed temporary because, in most instances, the ground water can be restored to its baseline quality, premining use, or potential use category. In situ leaching permits economic recovery of deep, low-grade sandstone uranium deposits currently economically unrecoverable by conventional mining methods. The extent to which in situ leaching can be conducted is limited in that the ore zone conditions must be suitable for containing and controlling lixiviant during the leaching process.

The mechanics of in situ leaching are relatively simple in theory. An oxidant-charged lixiviant is injected into the production zone aquifer through injection wells. With slight pH adjustments, the reduced uranium is oxidized and solubilized when contacted by the lixiviant. Following this, the uranium-rich solution is drawn to the recovery wells where it is pumped to the surface and transferred to the processing facility.

During production, there is a constant movement of mining solution through the aquifer from the outlying injection wells to the internal recovery wells. The injection and recovery wells can be arranged in any of a number of geometric patterns depending on ore body configuration, aquifer permeability and operator preference; however, most often, they are in a five or seven spot pattern. Monitor wells surround the well-field pattern area, both vertically and horizontally, and are screened in appropriate stratigraphic horizons to detect any lixiviant that may migrate out of the production zone. Due to confining layers above and below the mining zone and the continual movement of lixiviant to centrally located recovery wells, excursions of mining solutions are rare.

Once the uranium-rich solution reaches the processing facility, it is pumped through a bed of ion exchange resin where the uranium is absorbed onto the resin. The barren solution from the ion exchange vessel is cycled back to the injection circuit for chemical reconstitution and reinjection into the well field for further uranium recovery.

When the resin bed becomes saturated with uranium, the resin is eluted or stripped by passing a strong chloride solution through the resin bed. The resultant concentrated uranium solution is transferred to tanks where the uranium is precipitated out of solution by the addition of hydrochloric acid, sodium hydroxide and hydrogen peroxide. The resulting product is a uranium slurry that is approximately one-half water. This product may either be shipped as a slurry, processed slightly more to a wet cake, or dried.

3.2 The Orebody

The production zone at the Crow Butte project consists of the Basal Chadron Sandstone. In this formation, the uranium is in the form of several long, sinuous, roll-front type deposits. The origin of the uranium is believed to be from within the host rock itself, either from the feldspar or volcanic ash content, or from the Middle Chadron claystone. During formation, the precipitation of the uranium resulted when the oxidized ground water which contained the uranium, entered areas of reducing conditions. These reducing ground water conditions were probably the result of hydrogen sulfide and to a lesser degree, organic material and pyrite that are present in the formation, as well as other dissolved materials. When the uranium enriched ground water encountered these conditions, it became insoluble and precipitated as mineral coatings on sand grains and within pore spaces.

The individual roll fronts are developed within subunits of the Basal Chadron Sandstone. This coarse-grained arkosic sandstone is locally divided into subunits by clay beds that confined the uranium-bearing waters to several distinct hydrologic subunits of the sandstone. The confining clay beds are laterally continuous for hundreds of feet and control the uranium deposition over even greater distances.

The ore body ranges in grade from 0.05 to greater than 0.5 percent U_3O_8, with an average grade of 0.26 percent equivalent U_3O_8 and 0.31 percent chemical U_3O_8.

The physical shape of the ore deposit is dependent on the local permeability of the sandstone matrix, its continuity and distribution in the geologic unit as well as the oxidation/reduction front in the paleo aquifer. The recoverable ore is located in a portion of the Basal Chadron Formation, which ranges from 1000 to 1500 feet wide. Figure 2.2.1.03 shows the sinious nature of the well field. A currently planned well field construction will consist of the mineralized zone and a 400-foot buffer area. The buffer area will be utilized for placement of perimeter monitoring wells.

For in situ leaching to be successful, the ore deposit must (1) be located in a saturated zone, (2) be bounded above and below by suitable confining layers, (3) have adequate permeability, and (4) be amenable to chemical leaching. As described above, the proposed mining area has favorable hydrogeological and structural characteristics to allow in situ leaching of uranium. The hydrogeology and aquifer characteristics indicate that mining solutions will be contained within the production zone. Further evidence of this is demonstrated by the operational history of the R&D project.

3.3 Well Field Design and Operation

The proposed mining project is divided into five phases. Each of these phases is designed to have about the same amount of reserves. Due to the possibilities of the orebody boundaries being changed as a result of future ore reserve information, the actual configuration of the various well fields, as well as the ultimate final boundaries of the mining units will be determined

Table 3.3.01

Ferret Project Mine Schedule

Years No.	Mining Flow (GPM)	Restoration Flow (GPM)	Average Area Being Mined (Acres)	Average Area Being Restored (Acres)	Average Area Being Reclaimed (Acres)
1	1250	0	11.25	0	0
2	1250	0	11.25	0	0
3	2500	0	22.5	22.5	0
4	2500	400	22.5	22.5	0
5	2500	400	22.5	22.5	22.5
6	2500	400	22.5	22.5	22.5
7	2500	400	22.5	22.5	22.5
8	2500	400	22.5	22.5	22.5
9	2500	400	22.5	22.5	22.5
10	2500	400	22.5	22.5	22.5
11-20+	2500	400	22.5	22.5	22.5
+1 yr.	0	400	0	22.5	22.5
+2 yrs.	0	400	0	22.5	22.5
+3 yrs.	0	0	0	0	22.5 Site Decommissioning

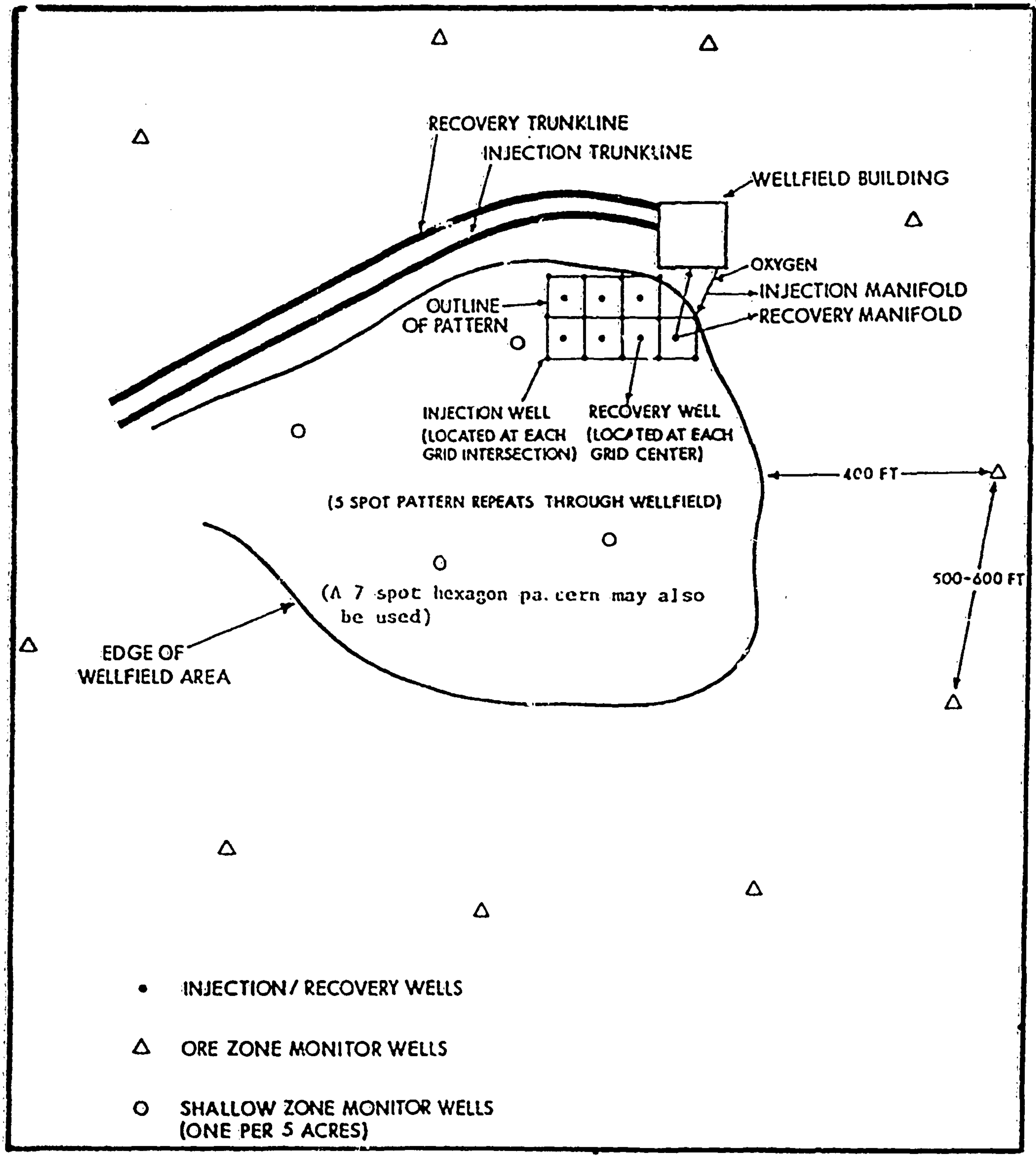


Figure 3.3.01

Typical Well Field Pattern

when the production and injection wells are installed. The ore body will be mined through the use of a series of five or seven-spot patterns installed over the mineralized section of the formation. A single five-spot pattern is roughly rectangular and consists of four injection wells surrounding a single central recovery well. Spacing between the wells in any five-spot will range from 40 to 100 feet, depending on the topography and ore characteristics. Figure 3.3.01 shows a typical well field pattern for the project. Table 3.3.01 shows the proposed mining schedule. The proposed mining schedule is a best estimate, however, the flow rate of 2500 gpm actually determines the amount of effluent the facility will produce. Due to this, the process will be limited, by license condition, to a maximum flow rate of 2500 gpm. Figure 3.3.01 also shows the proposed spacing of the ore zone perimeter monitoring wells. These wells are proposed by Ferret to be located approximately 400 feet from the injection wells. However, the staff considers 300-foot spacing is more appropriate considering the hydrogeology of the ore body. Due to this, perimeter monitor wells will be located 300 feet from the well field on 400-foot centers.

Typical well construction will consist of two methods. The first method will involve drilling the hole, geophysically logging the hole to define the mineralized zone and reaming the hole as necessary to the desired depth and diameter. The casing/screen string will be lowered and held in place utilizing a cement basket. The annulus is cemented by injecting cement from the inside of the casing with flow to the outside via "weep holes" in the casing just above the cement basket. The cement passes out through weep holes in the casing and is directed by the basket back to the surface through the annulus. After the cement has cured sufficiently, the plug at the bottom of the blank casing will be drilled out and the well developed by air lifting or pumping. The second method is similar to the first in that the hole is drilled and geophysically logged to determine the mineralized zone. However, the hole is reamed only to the desired screen interval. The blank casing is then cemented in place as in the first method. After the cement has cured, the remainder of the hole is reamed. The screen is then telescoped through the casing and set in the desired location. The screen is set at the bottom of the casing by a packer and/or shale traps. Well development will then be accomplished by air lifting or pumping. These well completion methods are illustrated in Figures 3.3.02 and 3.3.03.

Ferret proposes that all injection wells will be tested for integrity after completion. It is common practice to require integrity testing for both production and injection. The license will require both injection and production wells to be tested. The integrity test will utilize a packer just above the screen and a packer at the well head. These packers will segregate the nonperforated section of the well casing. The integrity test consists of pressurizing the segregated portion of the casing to a level which simulates the maximum anticipated operation pressure plus an engineering safety factor. If more than a 10 percent pressure loss occurs during 20 minutes, the well will fail the integrity test. Wells not passing the integrity tests are commonly reworked and tested again. Repeated failure of the integrity testing will result in the well being plugged. The integrity testing program will ensure

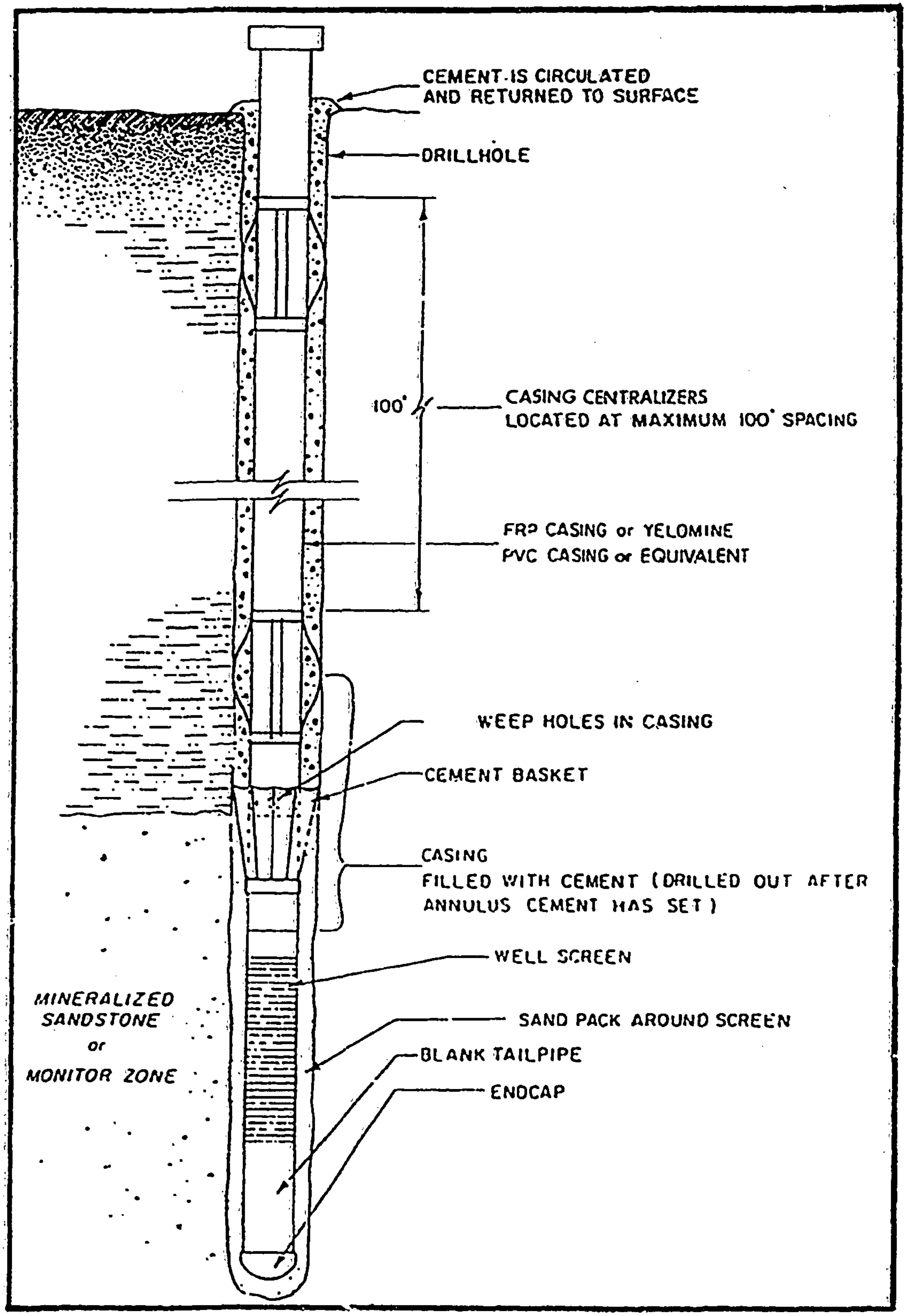


Figure 3.3.02

Typical Cement Basket Method of Well Completion

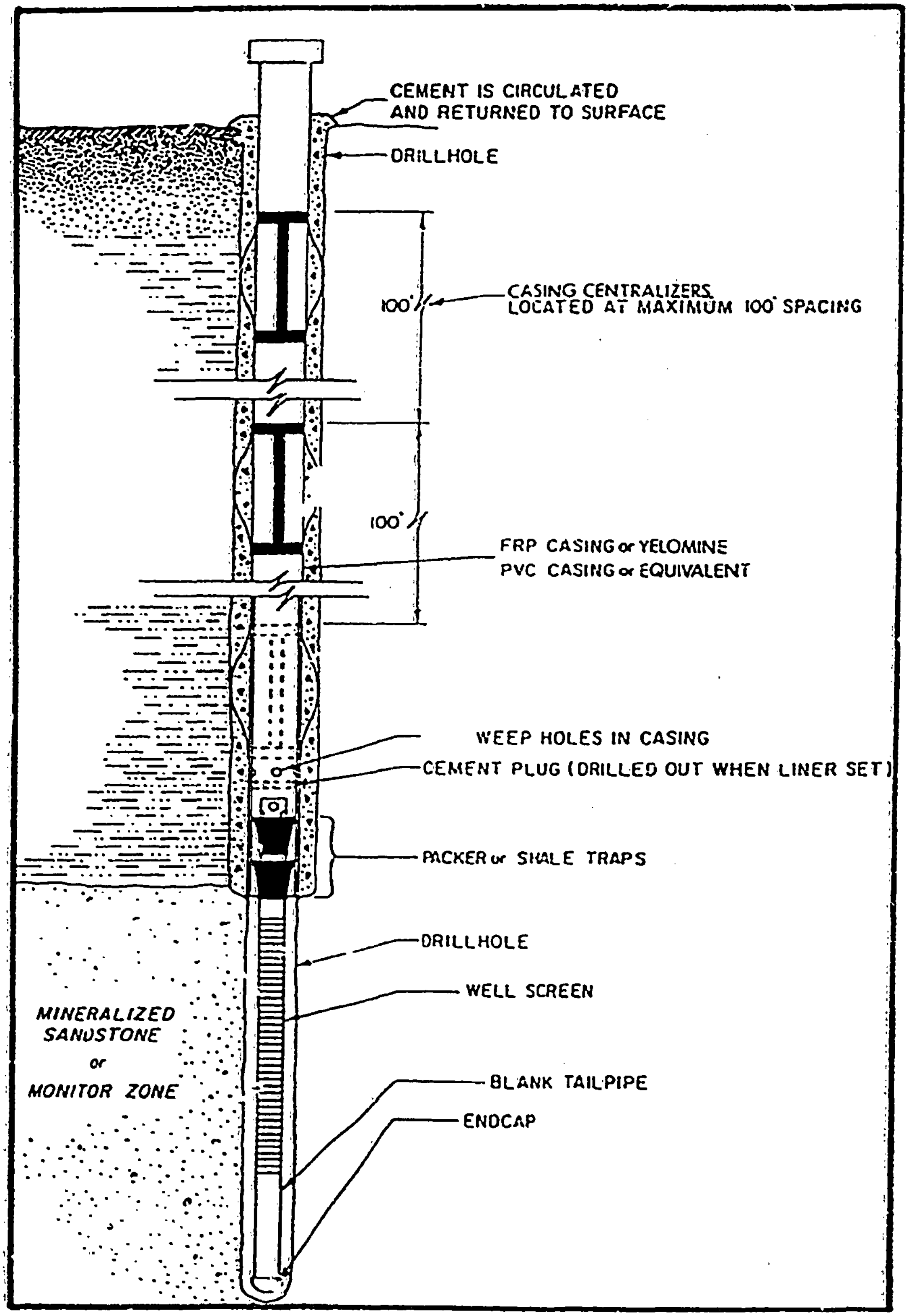


Figure 3.3.03

Typical Shale Trap Method of Well Completion

Table 3.4.01

Typical Lixiviant Concentration and Composition

Species	Range Low	Range High
Na	≦ 400	6000
Ca	≦ 20	500
Mg	≦ 3	100
K	≦ 15	300
CO_3	≦ 0.5	2500
HCO_3	≦ 400	5000
Cl	≦ 200	5000
SO_4	≦ 400	5000
U_3O_8	≦ 0.01	500
V_2O_5	≦ 0.01	100
TDS	≦1650	12000
pH	≦ 6.5	10.5

*All values in mg/l except pH, which is in standard units.

NOTE: The above values represent the concentration ranges that could be found in barren lixiviant or pregnant lixiviant and would include the concentration normally found in "injection fluid."

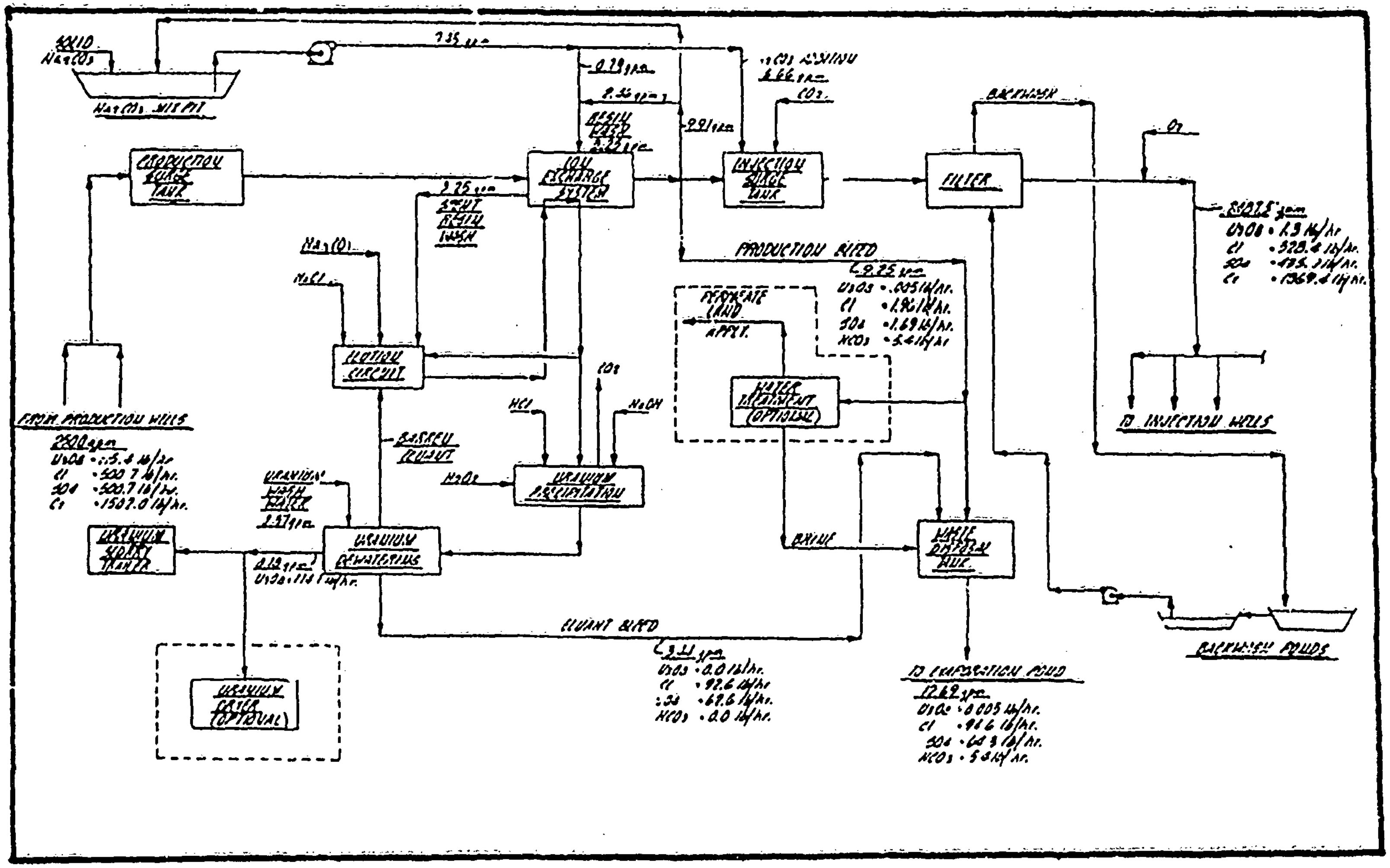


Figure 3.5.01

Operational Water and Material Balanc

that fluids injected and recovered during mining are not lost from the well due to failure in the casing.

In addition to initial integrity testing, the license will require that wells be retested for integrity after undergoing physical alteration from any workover operation, that could cause casing damage. Repeated integrity testing will also be required for operating wells on a schedule of once every 5 years.

3.4 Lixiviant Chemistry

The proposed chemicals to be mixed with the recirculated ground water will consist of sodium and carbonate species along with oxygen or hydrogen peroxide. The expected lixiviant concentration and composition is shown in Table 3.4.01. No other form of lixiviant will be permitted at the site without first seeking a regulatory modification in the form of a license amendment.

3.5 Uranium Recovery Process

The uranium will be mined from the host rock at a flow rate not to exceed the maximum plant capacity of 2500 gallons per minute (gpm). Uranium recovered during the mining operation will be processed as shown in Figure 3.5.01. The environmental analysis is based, in part, on this process diagram. Due to this, any significant changes to the process will require an amendment to the license. During mining, the well field waters will be enriched with uranium as well as several other metals associated with the formation. Data from the R&D project indicate that trace metals such as arsenic, selenium, vanadium, iron and manganese are liberated during the leaching process and are mobilized with the uranium. Consequently, the metal-enriched ground-water solution is pumped to the surface and transferred from the well field by utilizing buried pipelines. These fluids enter a surge tank where it is pumped into a series of ion exchange (IX) columns. It is here that the uranium and to a lesser extent other metals are absorbed onto the resin beads. Those metals which are not absorbed on the resins are placed in a continual loop and recirculated back into the well field. The solution exiting the IX columns is depleted in uranium and has had its lixiviant strength diminished, therefore additional oxidizing and complexing agents are added to the stream prior to reinjection.

Once the majority of the ion exchange sites on the IX column resin are filled with uranium, the column is taken off stream. The loaded column is then stripped (eluted) of uranium through an elution process. In the elution process, the uranium is stripped from the resin beads with a concentrated solution of sodium carbonate and sodium chloride. The product of elution is a pregnant eluant that is discharged into a holding tank.

When a sufficient volume of pregnant eluant is held in storage, it is acidified to destroy the uranyl carbonate complex ion that has been created. Hydrogen peroxide is then added to the solution to precipitate the uranium. The precipitated uranyl peroxide slurry (yellowcake) is pH-adjusted and allowed to settle. Following this the clear solution is decanted and either recirculated back to the barren eluant storage tank or treated as a waste and sent to the solution evaporation ponds. The yellowcake is further dewatered and washed using a vacuum belt filter or equivalent. The resultant uranium slurry will be shipped as a wet cake or dried. The Crow Butte facility expects to recover approximately 1,000,000 pounds of yellowcake per year.

3.6 Description of Process Plant, Ponds and Wastes

3.6.1 The Process Plant

The process plant is proposed to be housed in a building approximately 300 feet long by 120 feet wide. In addition to processing equipment, the building will house an office and laboratory space. A diagram of the proposed plant is shown in Figure 3.6.1.01. The plant will house the following process operations: lixiviant recovery, ion exchange, filtration, lixiviant injection, elution/precipitation, and dewatering/drying.

The lixiviant recovery system will consist of two recovery surge tanks. The surge tanks will be utilized for temporary storage of the recovered lixiviant prior to being pumped to the ion exchange system. The ion exchange system will consist of two sets of four columns. The depleted lixiviant is filtered to remove any formation particulates or pipe scale and then pumped to the lixiviant injection system. The injection system consists of two injection surge tanks and associated injection pumps. The elution/precipitation circuit will consist of the barren eluant tanks and the acidizer/precipitator tanks. The eluant will be pumped from the barren eluant tanks to the ion exchange columns and the pregnant eluant will be transferred to the acidizer/precipitor where the uranium is precipitated. The precipitated uranium will be dewatered and washed using a vacuum bed filter or equivalent. The yellowcake will be shipped as a slurry or dried on site by a vacuum dryer.

3.6.2 Solar Evaporation Ponds

Up to five solar evaporation ponds will be built to contain the anticipated liquid waste associated with processing and restoration. Initially, two ponds will be constructed. They will be sufficient to store wastes for the first 3 years of production. The remaining ponds will be constructed and operational by the 4th year of operations, when inflows are expected to increase due to restoration activities. The ponds will be located to the west of the process facility as shown in Figure 3.6.2.01. The ponds will have two basis geometries. Ponds 1, 2 and 5 will have bottom dimensions of 850 feet by 200 feet, while ponds 3 and 4 are slightly wider and shorter with bottom dimensions of 700 feet by 250 feet. Each pond will have a uniform depth of 15 feet. At maximum capacity, there will be over 372 acre feet of waste water storage. However, normal operating levels will result in approximately 243 acre feet of storage.

Under normal operating conditions, a freeboard of 5 feet will be maintained. This freeboard is designed to accommodate a 25-inch precipitation event as well as a 60-mile per hour wind generated wave with

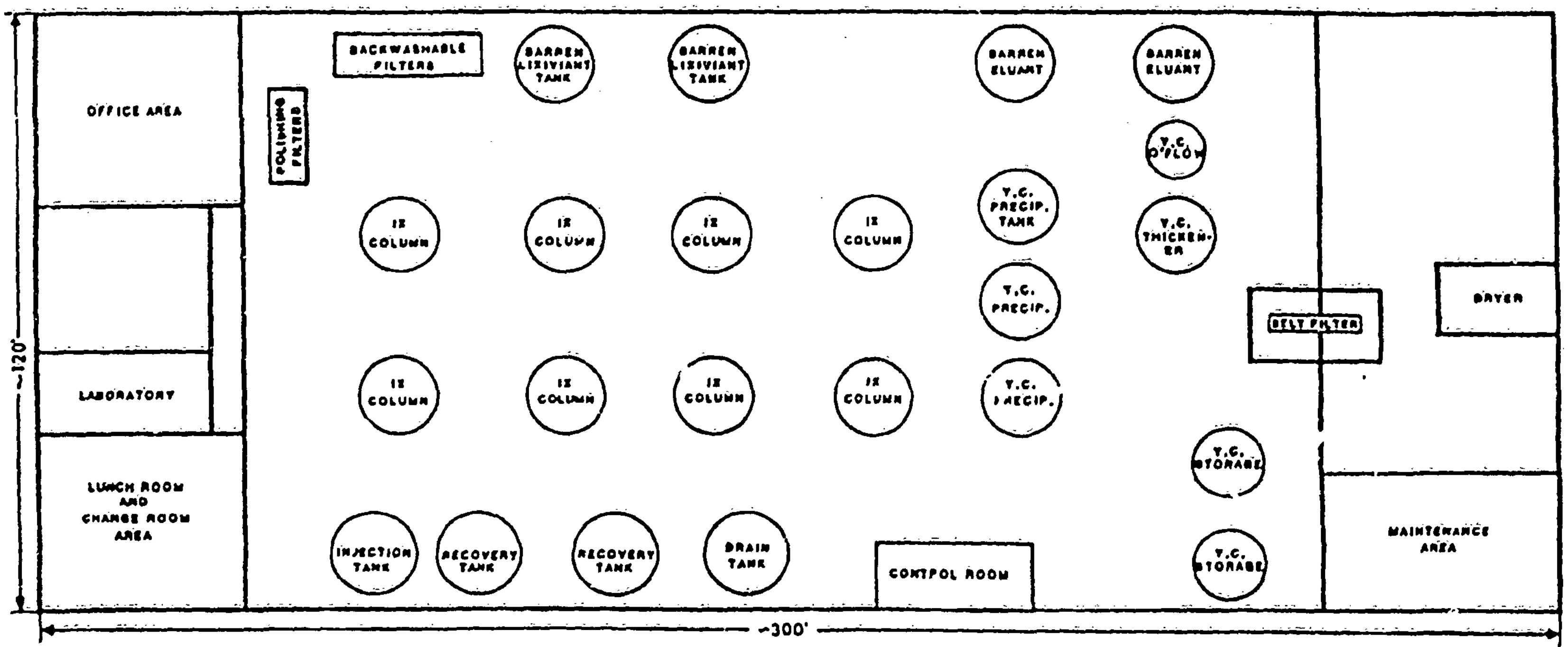


Figure 3.6.1.01

Processing Facility Design

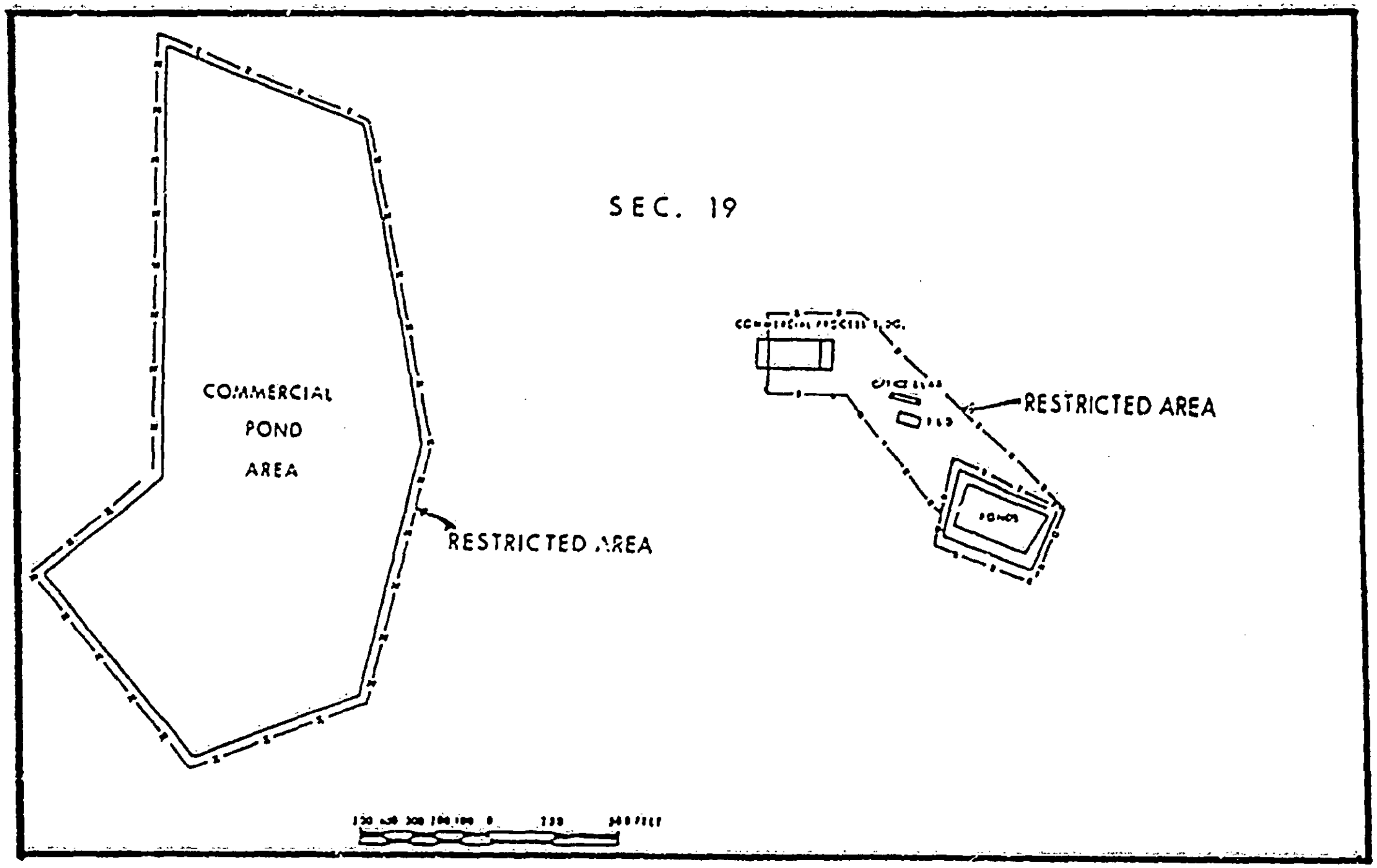


Figure 3.6.2.01

Commercial Facility Layout

an engineering safety factor of 1.8 feet. Additionally, the freeboard capacity of each pond is adequate to contain at least one-half the capacity of any other pond. This storage may be utilized if pond repairs are necessary.

Ferret has submitted a detailed design for the evaporation ponds and will be required by license condition to construct them in accordance with this design. The design meets the requirements of NRC Regulatory Guide 3.11, Staff Position Paper No. WM-8101 and the NDEC requirements specified in Title 123.

3.6.3 Wastes

Liquid and solid wastes will be generated at the Crow Butte facility. Operation of the process plant will result in two primary sources of liquid waste: the eluant bleed and the production bleed. These wastes will be routed to water treatment facilities or the evaporation ponds at an average flow of 12.5 gpm (6.6 million gallons per year). Approximately 32.3 million gallons of restoration fluids will be generated each year that restoration operat are active. However, not all of this solution will go to the evapora . ponds. Recovered fluids will be run through a reverse osmosis unit and the permeate will either be used in restoration or land applied.

To assure that all liquid wastes are accounted for, Ferret will be required by license condition to return all liquid effluents to the process circuit or to the appropriate disposal system. By maintaining the liquid wastes in these locations, the environmental assumptions utilized in this assessment remain valid. Optional disposal methods will require an amendment proposal and environmental assessment.

Land application rates based upon a 2500 gpm flow rate will not exceed 2 inches per week for 13 to 14 weeks per year. The solution will be applied to approximately 60 acres in the northeast quarter of Section 13, utilizing a center pivot system or a gridwork of perforated plastic pipe to spray irrigate.

Land application of reverse osmosis permeate took place twice during research and development operations. An analysis of the treated permeate is shown in Table 3.6.3.01. The treatment option as proposed by Ferret should result in similar water quality. Also as shown in Table 3.6.3.01, Ferret proposes to treat the water to maximum constituent standards. If these standards cannot be met, land application will not take place.

Sanitary wastes from the restrooms and lunchroom will be disposed of in a septic system. The size, design and installation will be as specified by the State of Nebraska. Solid wastes generated at the site will consist of spent resin, empty reagent containers, miscellaneous pipe and fittings, and domestic trash. These wastes will be classified as contaminated or noncontaminated waste, according to their radiological survey results.

Contaminated solid waste will be separated into two categories. The first category will be waste which has some salvage value and can be decontaminated to unrestricted release limits of noncontaminated waste. This type of waste

Table 3.6.3.01

R&D Land Applied R.O. Permeate Water Quality Concentration

Parameter	Concentration (mg/l)	Proposed Waste Water Irrigation Constituent levels
Calcium	1.5	No level
Magnesium	0.14	No level
Sodium	89.3	No level
Carbonate	24.4	No level
Bicarbonate	14.3	No level
Sulfate	4.7	250
Chloride	129	250
Ammonia - N	0.17	No level
Nitrate - N	0.17	10.0
Fluoride	0.1	4.0
Conductivity (μmho/cm)	519	No level
pH	7 96	6.5 to 8.5
Trace Metals		
Arsenic	<0.001	0.05
Barium	0.20	1.0
Boron	0.96	No level
Cadmium	<0.001	0.010
Chromium	<0.005	0.05
Copper	<0.01	1.0
Iron	<0.03	0.3
Lead	<0.005	0.05
Manganese	<0 005	0.05
Mercury	<0.0002	0.002
Selenium	<0.001	0.01
Silver	<0.05	0.05
Vanadium	<0.1	No level
Zinc	0.04	5.0
Uranium	<0.1	3.0
Ra 226/228	5 pCi/l	30 pCi/l
Gross Alpha (including radium-226 but excluding radon and uranium)	8 pCi/l	No level
Gross Beta	16.6 pCi/l	No level

may include piping, valves, instrumentation, equipment and any other item which can be decontaminated. Decontaminated materials will have radiation levels lower than those specified in NRC Branch Technical Position "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material". All decontaminated wastes will be inspected and surveyed by the radiation safety officer or health physics technician prior to their release from the site to assure that appropriate decontamination procedures have been observed.

The second category of waste will include items which have no salvage value and have been contaminated during uranium recovery operations. The most common type of this material is radium contaminated filters. These materials will be stored in a secure area until such time as they can be shipped to a licensed waste disposal site or licensed mill tailings facility for disposal.

Ferret has contracted with a private disposal organization, licensed by the State of Utah, to receive contaminated wastes. The State of Utah, however, does not have authority under their agreement with NRC to authorize disposal of byproduct material. Although Utah has applied to NRC to modify the agreement to include authority to license disposal of certain kinds of nuclear waste, the modification does not currently include disposal of byproduct material. This same disposal firm has recently applied directly to the NRC for a license to dispose of byproduct material. The review of that application is just being initiated.

Accordingly, Ferret does not currently have an acceptable location for disposal of their waste. However, there appear to be several options open to them in the near future including amendment to the Utah agreement, licensing by NRC of the disposal operation in Utah, amendment of low-level waste licenses in South Carolina, Washington and Nevada to allow disposal of byproduct material, disposal in a uranium mill tailings impoundment, disposal in a byproduct material disposal site at another in-situ leach mine, and onsite disposal by Ferret at the Crow Butte site. Therefore, the NRC has determined that there are sufficient options available to issue a license to Ferret that will enable them to proceed with construction of the facility. However, Ferret will be prohibited by license condition from beginning operation and generating any waste until such time as an approved disposal site is in place.

Noncontaminated solid waste will be collected at the site on a regular basis and disposed of in the nearest sanitary landfill. The waste is surveyed as per "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" to assure that no contaminated waste is released from the site.

3.7 Ground-Water Restoration, Reclamation and Decommissioning

3.7.1 Ground-Water Restoration

Ground-water restoration is achieved when the quality of all ground water affected by the injection or recovery fluids is returned to baseline quality, or quality of use consistent with the uses for which the water was suitable prior to the operation. The primary purpose of the restoration process is to reduce to acceptable levels the concentration of contaminants remaining in the ground water after uranium recovery has stopped. Ferret proposes to return water quality of the affected ground waters to the premining quality of use. This is not entirely consistent with the above defined restoration criteria of returning the water to baseline. Therefore, Ferret will be required by license condition to have as its target, returning the water in the affected aquifer to baseline conditions. As was evidenced in the R&D restoration demonstration, baseline levels for all ground-water parameters cannot always be met. Therefore, a secondary ground-water restoration goal of returning the water to a quality consistent with its premining use will be established. To assure that the staff has a reasonable amount of time to review all restoration plans, the license will stipulate that at least 3 months prior to termination of a mining unit, a ground-water restoration plan be submitted for NRC review and approval.

Ferret proposes that the restoration criteria be established on a mine unit average basis. This is entirely consistent with the current practices. An average mine unit will be approximately 22.5 acres. Within the mining unit, one well per acre will be designated for establishing restoration criterion. Each of these wells will be sampled three times at two week intervals and analyzed for the parameters in Table 3.7.1.01. Laboratory results for each of the parameters will be averaged to arrive at a mine unit average value for each constituent. These numerical values will be the primary restoration goals, recognizing spatial and temporal variations.

Ferret proposes to use essentially the same restoration methodology in the commercial operation as was used at the R&D project. Ground-water restoration conducted at the R&D operation utilized halo recovery, permeate injection/reductant and aquifer recirculation.

The halo recovery stage of restoration draws well field waters as well as natural ground water in toward the center of the mining unit. This procedure is generally done without any well field injection. Due to this, a cone of depression is established causing waters to flow into the mining unit. During the R&D operation, this stage was continued until the majority of the injected solution was recovered from the area surrounding the well field. Samples from the injection wells and comparative volume calculations are utilized to determine when this phase is complete. During the R&D operation, this stage required 15 days, and utilized approximately 707,800 gallons of water. The water recovered during the halo recovery stage was processed by a reverse osmosis (RO) unit in order to minimize waste volumes in the evaporation ponds. The clean water (permeate) produced by the RO was sent to the east pond and the brine was sent to the west pond. The clean water was further treated by the RO units to reduce contaminant levels to standards specified by the NDEC for land application of water. Following this, the water was land applied. A similar process is proposed to be utilized at the commercial facility.

After halo recovery has been completed, the permeate injection/reductant stage will be initiated. In the permeate injection/reductant stage, the

Table 3.7.1.01

Parameter	Baseline Minimum	Baseline Maximum	Baseline Mean	Target Restoration Value	Stabilization Mean
As	<0.001	0.003	0.001	0.05	0.001
B	0.87	0.95	0.93	1.1414	0.84
Ba	<0.1	<0.1	0.1	1	0.1
Ca	10.4	16.4	14.1	143.2	10.5
Cd	<0.001	<0.001	0.001	0.01	0.001
Cl	176	301	202 6	261	169
Cr	<0.005	<0.005	0.005	0.05	0.005
Cu	<0.01	<0.01	0.01	1	0.01
F	0.62	0.74	0.68	2.4	0.55
Fe	<0.03	0.05	0.03	1	0.03
Hg	<0.0002	<0.0002	0.0002	0.002	0.0002
K	10.2	15.4	12.0	117.2	8.7
Mg	2.45	4.2	3.351	37	2.41
Mn	<0.005	0.013	0.0065	0.2	0.023
Mo	0.02	0.02	0.02	1	0.04
Na	387	470	404	500	333
NH_4 as N	0.17	0.40	0.29	0.5	0.62
Ni	<0.01	<0.01	0.01	0.2	0.01
NO_2 as N	<0.001	<0.001	0.001	1	0.014
NO_3 as N	<0.01	0.21	0.05	10	0.03
Pb	<0.005	<0.005	0.005	0.05	0.006
pH s.u.	8.30	8.64	8.39	6.5-8.7	7.91
Ra-226 pCi/l	32.8	1541.0	858.7	953.4	236.7
Se	<0.001	<0.001	0.001	0.01	0.001
SO_4	316	356	343	600	275
TDS	1106	1270	1153	1187	972
Tot.Carb.	347.6	374.9	362.8	594	306.1
U	0.053	0.245	0.111	5	1.316
V	<0.01	<0.01	0.01	0.01	0.03
Zn	<0.01	0.02	0.01	5	0.02

* All units are mg/l unless otherwise noted.

water recovered from the well field is processed in a water treatment system using the reverse osmosis unit and the permeate (clean water) will be injected into the well field. The brine solution will be routed to an evaporation pond for loss to the atmosphere. If required, a reductant will be added to the permeate injection stream to re-establish reducing conditions in the aquifer. During the R&D operation, the well field was recirculated a number of times during this stage to allow the reductant to contact as much of the host rock as possible. Approximately 1,276,000 gallons of water were treated by reverse osmosis during this stage. Approximately 90 percent of this volume was reinjected with the remaining 10 percent being sent to the evaporation ponds.

Reductant was periodically added during the recirculation stage in an effort to re-establish premining solubility of uranium and several other metals. As an aid in reducing radium concentrations in the well-field waters, the recirculated solutions were periodically passed through a radium selective complexer to remove radium. Approximately 4,467,000 gallons of water (14.9 pore volumes) were recirculated during the R&D restoration program.

The number of times that the total volume of the R&D well field is recirculated is larger than that expected for the commercial restoration. As was noted earlier, the primary purpose of the recirculation was to reduce the uranium levels and the secondary purpose was to reduce the radium levels. The uranium levels during restoration at the commercial facility will be lower than the levels encountered during R&D restoration. This is primarily due to more thorough mining in the commercial operations. Additionally, during the R&D restoration, a significant amount of uranium remained in the mineralized zones immediately adjacent to the well field. This causes the uranium to be mobilized during the restoration program. During restoration at the commercial facility, the uranium will be mined more completely and mobilization will be minimized during restoration; therefore theoretically less reductant will be required to reduce the uranium concentration to the background value.

The total number of pore volumes produced during the R&D restoration was approximately 19, with approximately 16.4 pore volumes being reinjected.

The NRC reviewed the restoration results of Well Field No. 2 and on April 12, 1988, amended the R&D license to confirm successful restoration of the well field. It should be noted that the R&D restoration criterion was based upon returning the ground water to a category of use standard rather than to the mean of the baseline value.

Table 3.7.1.01 shows the ground-water quality data for 30 well field parameters. Of these parameters, 21 were restored to equal or less than the baseline minimum value. There are, however, nine parameters which were not returned to the baseline minimum value. These parameters are: ammonia, manganese, molybdenum, two forms of nitrogen, lead, radium-226, uranium, vanadium and zinc. Comparisons of premining and restoration values are shown in Figures 3.7.1.01 and 3.7.1.02.

As can be seen from these figures; ammonia, manganese, molybdenum, nitrate, lead and vanadium are elevated above baseline maximum values. Nitrate, radium-226 and zinc, are not, however, elevated above their respective baseline maximum value.

The elevation of the ground-water parameters above baseline maximum values indicates that some of the naturally occurring constituents in the host rock were brought into solution due to oxidizing conditions being established. However, as shown on Figures 3.7.1.01 and 3.7.1.02, the degree of elevation in the worst case for ammonia is approximately two-tenths of a mg/l. Similarly, the other elevated constituents are in Table 3.7.1.01, either hundredths or thousandths of a mg/l. These rises in constituent levels are so minute that the water has undergone little or no change.

Because the overall change in water chemistry is very small, the water is suitable for any premining use. Accordingly, the restoration effort is considered fully successful and similar results are expected during the commercial operations.

3.7.2 Reclamation and Decommissioning

Ferret expects to not have more than three mining units in mining, restoration or reclamation at any one time. A certain amount of reclamation activities will therefore take place while new mining units are being developed. Reclamation activities in individual mining units will involve returning disturbed lands to their premining use.

This reclamation and limited decommissioning will represent interim steps that are necessary prior to the final decommissioning of the site. To assure that final decommissioning is adequate to return the site to an unrestricted use, a plan will be required by license condition. The decommissioning plan will be submitted at least 12 months prior to site termination, for NRC review and approval.

All injection, production and monitor wells will be plugged and abandoned prior to final closure of the site and after the restoration has been successfully completed. Well plugging will utilize an approved abandonment mud which will be mixed in a cement unit and pumped down a hose, which is lowered to the bottom of the well casing using a reel. When the hose is removed, the casing is topped off and a cement plug placed on top. A hole is then dug around the well and, at a minimum, the top 3 feet of casing is removed. The hole is backfilled and the surface revegetated.

Reclamation will consist of several operations. Within the well field, disturbance will be minimal. Soil may be compacted in areas from the drilling and maintenance traffic. Closure of the wells will also require some surface disturbance immediately surrounding each well. the non-vegetated or disturbed areas including roads will be either plowed or disced to aerate the soil. A grass seed mixture and fertilizer will then be spread. Assistance will be obtained from the U.S. Soil Conservation Service to determine the proper seed mix and rate of application.

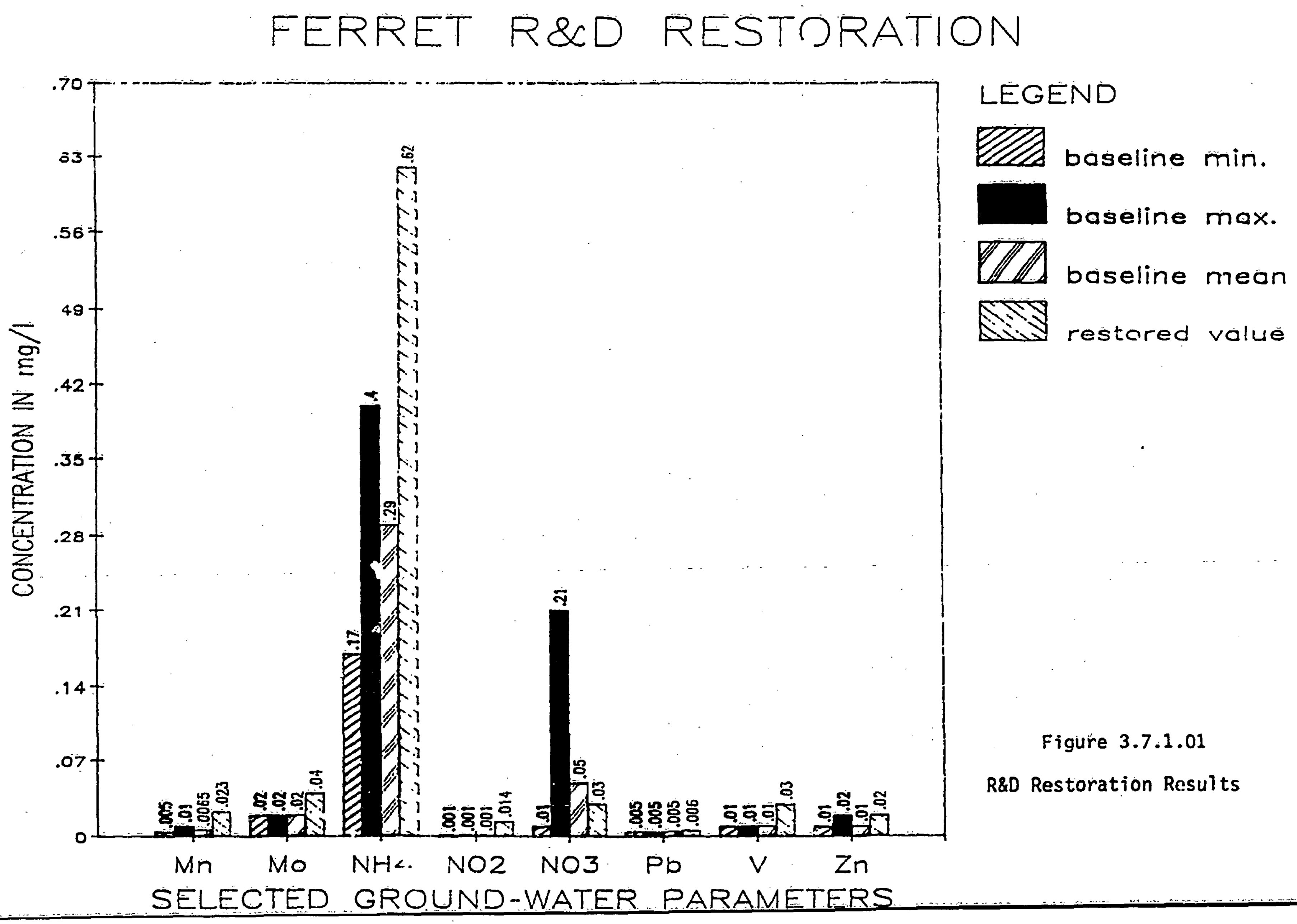


Figure 3.7.1.01

R&D Restoration Results

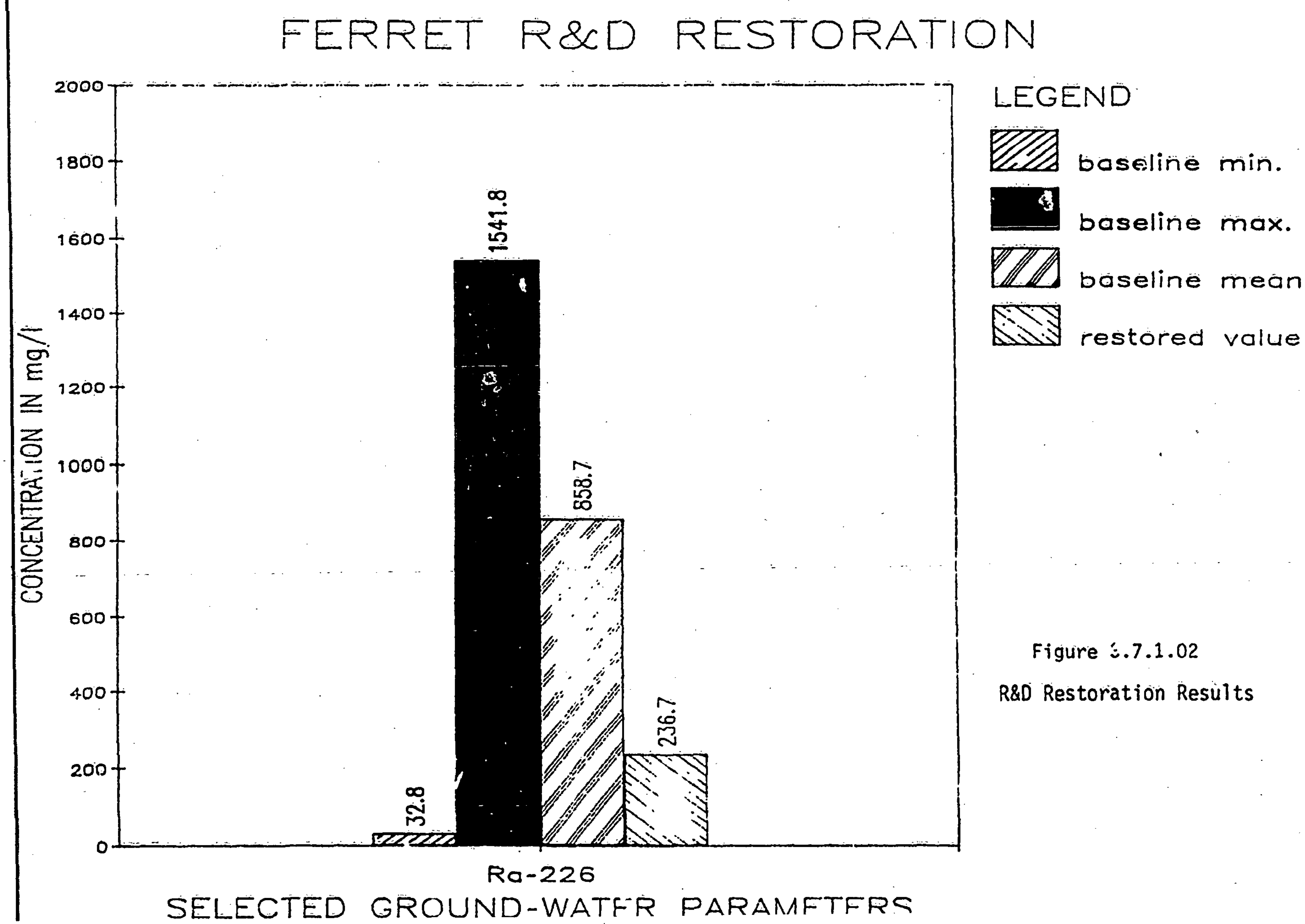


Figure 3.7.1.02

R&D Restoration Results

The plant site and solar evaporation pond areas will experience more disturbance than the well field areas. The plant and pond areas will be reclaimed in a similar fashion as the well field areas. Excess soil from the built-up plant base and pond embankments will be returned to the ponds as fill. Following this, land surface contours will be re-established. Finally, topsoil will be replaced on all plant and pond disturbed areas. Reseeding and fertilizing will follow U.S. Soil Conservation Service recommendations.

A period of 1 to 2 years will be required to establish a suitable grass cover. During this time, fences will be maintained to keep livestock off the area and away from new vegetation. After that time, the land may be returned to grazing use.

Prior to release from the site for unrestricted use, all equipment, buildings and other items will be surveyed for radioactive contamination. Records wil. be maintained of equipment and corresponding contamination levels for all items released from the site. Any item having contamination levels which exceed regulatory limits will be disposed of at a site approved to receive byproduct materials, as discussed in Section 3.6.3 of this assessment.

An alternative method of disposing of contaminated materials may be to sell the equipment and building to a holder of a source material license. This method would involve minimal contamination removal from equipment and associated structures prior to shipping. Although final radiation levels may be higher than for unrestricted release, all equipment will be shipped according to D.O.T. requirements.

Dismantling of the facility and pond closure will take place after ground-water restoration has been successfully completed. Reusable equipment will be segregated from wornout or scrap items. Both categories of materials will be cleaned and temporarily stored onsite prior to final disposal. Cleaned refuse may be disposed of in sanitary landfills, while contaminated materials will be disposed of at an NRC approved facility.

Pond closure will include the transfer of any remaining liquids to vessels for shipment to an approved disposal site. Bottom sludge can then be loaded into a tank truck or placed in drums for disposal. The pond liners will than be cleaned to the degree possible. If after cleaning they meet the limitations for surface contamination, the liners will be cut into smaller pieces, placed in the pond bottoms and covered with soil to final contours. If contamination limits are exceeded, the liners will be disposed of in an approved disposal site. Cement from storage pads and the building floor will be decontaminated if necessary, broken up and placed in the pond bottom. Road bed materials and the parking surface area will also go into the pond.

After the equipment, building, piping and associated support facilities have been removed from the well field area, a gamma survey will be conducted over the same well field grid as was surveyed prior to operation. It will be a requirement that all buried piping be removed from the well fields. The gamma survey results will be compared with those detected initially. Soil samples will then be obtained from locations which display elevated gamma readings. These soil samples will be analyzed for natural uranium and radium-226 content. Based upon the results, contaminated soil will be removed and shipped to a disposal site. The gamma survey and soil sampling results will create a data base to assure that the site is radiologically safe for unrestricted use. All survey results will be verified by the NRC.

The plant area will be comprised of compacted earth, some surface covering material, a cement foundation and the building. Once the building and cement pads have been removed, a gamma survey will be made of the compacted area. Any areas with elevated gamma readings will be sampled for radium and natural uranium to determine if contaminated soils need to be removed. The compacted area will then be recontoured with excess soil placed in the pond pits and the topsoil replaced. A final gamma survey will be performed and the results compared with the preoperational survey.

4.0 EVALUATION OF ENVIRONMENTAL IMPACTS

4.1 Ground-Water Impacts

4.1.1 Excursions

An excursion occurs when lixiviant fortified ground water moves beyond the expected confines of a mining unit and s detected in a monitor well. It is common practice to dramatically degrade the water quality within the mineralized zone during mining. The unexpected migration of these mining solutions could occur based upon a variety of circumstances. Most causes of excursions are from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity or hydrofracturing of the ore zone or surrounding units. The likelihood of these situations occurring due to the hydrologic and geologic conditions which occur at the site are extremely remote. Based upon the differential hydraulic conductivities which exist at the site, it is improbable that a vertical excursion would occur. It is much more likely that a horizontal excursion may occur. Horizontal excursions are primarily controlled by well-field overproduction, should overproduction fail, lixiviant fortified waters could move to a monitor well. Should such an event take place, it is easily reversed by increasing the overproduction rate and thereby drawing the lixiviant back into the mining zone. Based on the information previously discussed and operational controls to be implemented, none of the above are expected to be a problem. Furthermore, the operational history of the R&D site indicates that no excursion events took place.

4.1.2 Evaporation Pond Seepage and Spills

Accidental leaks from the evaporation ponds could, if uncontrolled, contaminate shallow aquifers and locally degrade ground-water quality. The proposed installation of a synthetic bottom liner in the solar evaporation ponds at the Ferret site makes such an occurrence a highly unlikely event. Furthermore, if a pond leak developed, the monitoring program described in Section 5.1.2 would allow for early detection and repair of the damaged cell, thereby minimizing the quantity of leakage. Based on the use of a synthetic pond liner as well as the leak monitoring and repair program, the staff concludes that the impact of pond leaks on ground-water quality will be minimal or nonexistent.

Spills from the evaporation ponds resulting from dike failure could result in unacceptable contamination of surface and ground waters. Because the pond embankments and the minimum acceptable freeboard from the top of the berms to the ponds' free water surfaces have been designed based on Nuclear Regulatory Commission design standards, spills from the evaporation ponds or embankment failures are extremely unlikely.

4.1.3 Ground-Water Restoration

Ground-water restoration will include halo recovery, permeate injection/reductant and aquifer recirculation. Each of these stages of restoration modifies the water quality of the mining zone. As was previously discussed, the R&D operation was successful in restoring the ground-water quality to below baseline concentrations for the majority of the constituents as well as to baseline concentrations for several other constituents. There are also a minimal number of constituents which had their concentrations raised slightly during the mining/restoration effort; however, no premining uses of the water were precluded.

Restoration of the mining zone will result in varying water quality within the aquifer. This is in part due to the complete mixing that will take place as well as due to the change in oxidation state that will result from the injection of mining solutions. The commercial license will require Ferret to restore the aquifer to a use that is consistent with the premining use. Based on the R&D demonstration as well as restoration efforts at in-situ mining operations in other parts of the country, no impacts on the aquifer are expected.

4.2 Radiological Impacts

4.2.1 Introduction

The primary sources of radiological impact to the environment in the vicinity of the proposed project are naturally occurring radiation and radon-222. The average annual total-body dose rate from natural background radiation to the population in the site vicinity is estimated to be about 153 millirems. Diagnostic medical procedures result in an average annual dose of 75 millirems.

This section describes project-contributed incremental radiological effects on the environment in the vicinity of the proposed project. Exposure pathways are discussed as are the estimated radiological impacts resulting from emissions associated with the facility. The impacts to nearby individuals are estimated as are potential radiation exposures of project employees and biota other than man.

Because the proposed operations at the Ferret facility do not involve displacement of ore from the orebody, there will be no radionuclide particulate associated with ore. Similarly, Ferret has proposed to utilize a vacuum dryer for final yellowcake processing. The vacuum dryer operates on the principal that dust and gases generated with drying of the product are collected in a liquid condenser. Due to this, the effluent collection system is 100 percent efficient and no particulates are released to the environment. This conclusion played a major role in predicting the radiological effluents that would be released to the environment. To assure that the assumptions regarding efficiency remain in effect, Ferret will be required by license condition to maintain the effluent control systems to the manufacturer's specifications. A drawing of a typical vacuum dryer is shown in Figure 4.2.1.01. Based upon the utilization of a vacuum dryer, the exposure pathway that will be discussed is gaseous radon-222 release to the atmosphere.

Because there is expected to be no particulate release and radon-222 should be the only gaseous radionuclide to be released from the proposed operation, the environmental exposure pathways of primary concern are the inhalation of radioactive materials (radon and its daughters) in the air and the external exposure to radon daughter radionuclides in the air and on the ground. The ingestion of food products such as meat, milk and vegetables, which may be affected by radon-222 releases are much less significant contributors to dose.

4.2.2 Offsite Impacts

Radioactive emissions of radon-222 will be vented to the atmosphere by way of a manifold system connected to numerous production surge tanks. Such a release may result in three exposure pathways: inhalation, ingestion and external exposure. Because this manifold is designed to collect all the radon-222 from the plant surge tanks, it is considered the primary conduit for radiological release. It will therefore be utilized as the origin of radiological releases to determine compliance with regulatory limits for radionuclides in air.

The estimated radiation dose at a reference point depends on the distance and direction of the point with respect to each of the sources, as well as the wind directional frequency toward the receptor from each of the sources. Doses are generally higher at locations downwind from the radiological source. As radon is transported by wind, its daughters grow, which potentially results in higher dose commitments farther from the plant until the radon is further diluted by dispersion.

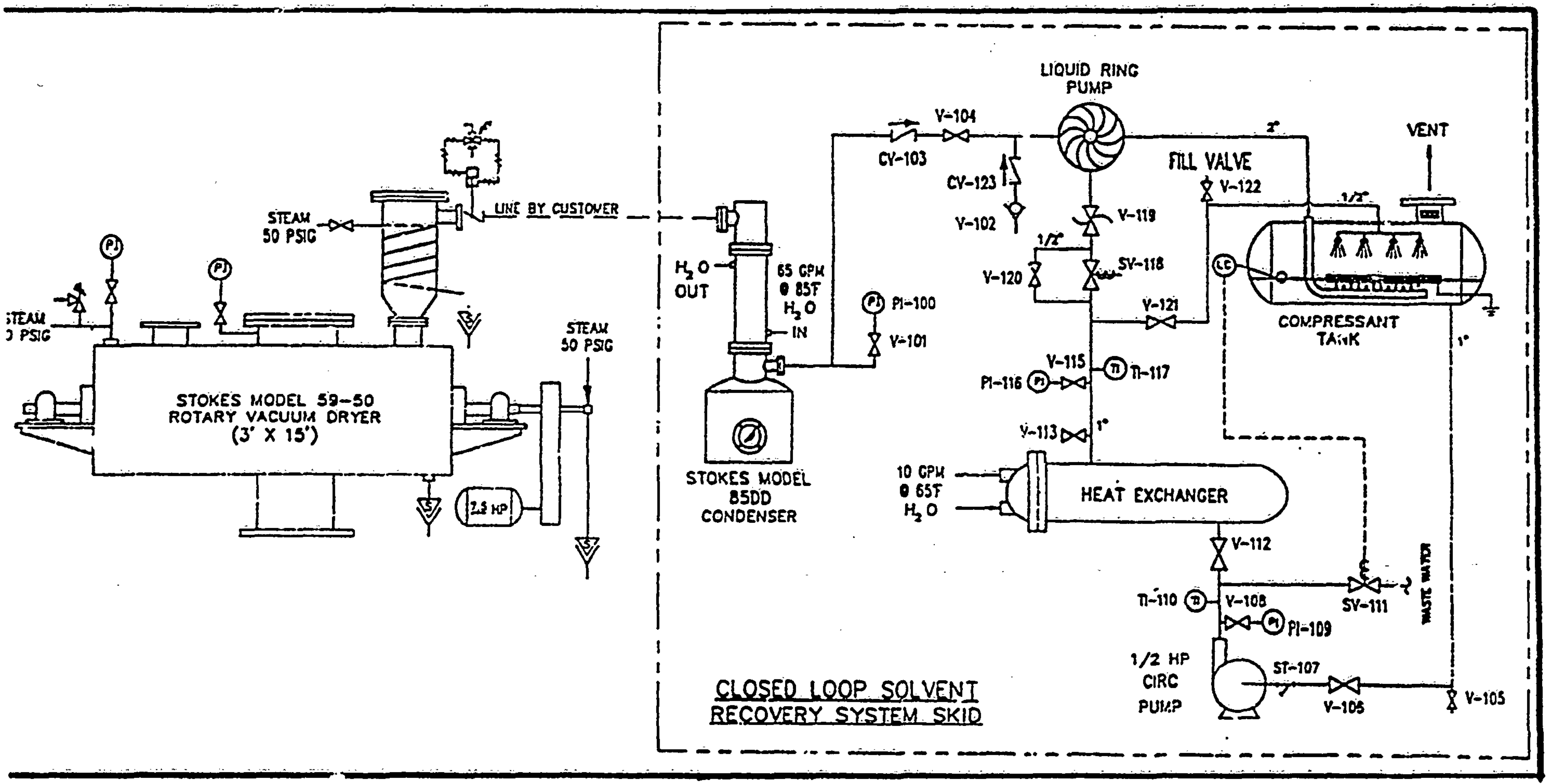


Figure 4.2.1.01

Typical Vacuum Dryer

10 CFR Part 20, "Standards for Protection Against Radiation," lists acceptable levels of radionuclides in air for restricted areas and unrestricted areas. A restricted area represents an area where access is controlled by the licensee for purposes of protection from radiation and radioactive materials. Therefore, only employees, contractors, and others under the direct control of the licensee are allowed into restricted areas and their exposure is monitored. Unrestricted areas represent locations where protection from radiation is not required because radionuclides are less than maximum permissible concentrations (MPC). To determine the impacts associated with venting radon-222 to the atmosphere, the percentage of MPC at various locations around the proposed processing site was determined.

Ten receptors were modeled for these radon-222 concentrations due to the operation of the proposed facility. Table 4.2.2.01 shows the pertinent data for these locations. As is shown in the table, the percentage of MPC, based upon an unrestricted air concentration of 3.0E-9 μCi/ml, ranges from a high of 53 percent to a low of 0.06 percent.

The nearest resident to the proposed vent location is approximately 700 meters east. At this location, it is estimated that the radon-222 would be 3.6 percent of MPC. Additionally, the town of Crawford is approximately 7500 meters northwest of the plant, where the concentration of radon-222 would be less than 1 percent of MPC.

For these calculated dose estimates, it was conservatively assumed that vegetables, milk and meat consumed by the residents were produced locally.

As indicated in Table 4.2.2.01, projected radioactivity concentrations near the project site fall well below NRC limits. To ensure that offsite concentrations are maintained below permissible limits, the staff will require the applicant to monitor radon concentrations at and near the site boundary.

4.2.3 In-Plant Safety

As was previously discussed, MPC limits exist for restricted and unrestricted areas. Although both are continually verified based upon air monitoring, only the restricted area concentrations are routinely utilized to determine individual exposures. The NRC will require Ferret to implement an in-plant radiation safety program that contains the basic elements required for, and found to be effective at, other uranium in-situ leach operations to assure that exposures are kept as low as reasonably achievable (ALARA). The scope of the program has been sized to account for the nature of the commercial project In general, the program will include the following:

- Airborne and surface contamination sampling and monitoring·

Table 4.2.2.01

Modeled Receptors

Receptor No.	Distance from Source (Meters)	Direction	RN-222 Concentration (Ci/m^3)	% MPC
1	100	N	1.60E-09	53.0
2	100	E	5.04E-10	16.8
3	100	W	2.89E-10	9.6
4	100	S	1.03E-09	34.2
5 (AM-1)	792	E	1.08E-10	3.6
6 (AM-8)	1036	NE	3.25E-10	10.8
7 (AM-2)	1280	NNW	1.50E-10	5.0
8	3292	NW	2.49E-11	0.83
9	1890	NW	3.02E-11	1.0
10	10,000	W	1.76E-12	0.06

- Personnel exposure monitoring;
- Qualified management of the safety program and training of personnel;
- Written radiation protection procedures; and
- Periodic audits by highly qualified outside parties and frequent inspections to assure the program is being conducted in a manner consistent with the ALARA philosophy.

The staff considers the program of in-plant safety sufficient to protect in-plant personnel by keeping radiation doses as low as reasonably achievable.

4.3 Waste Disposal

The NRC has taken the position in regulations on uranium milling (10 CFR 40, Appendix A, Criterion 2) that byproduct material from uranium in-situ leach operations should preferably be disposed of at existing tailings disposal sites or other licensed radioactive burial grounds to avoid proliferation of waste sites. Therefore, the NRC shall require that solid wastes generated at the Ferret project be disposed of at an existing licensed radioactive waste disposal site (see Section 3.6.3 for further discussion on the disposal of byproduct material). To assure that all contaminated wastes remain under control of Ferret, the license will stipulate that an area within the restricted area be maintained for temporary storage of contaminated materials.

5.0 MONITORING

5.1 Ground Water

Ground-water monitoring will be done prior, during and after the proposed operation. Prior to well-field installation, ground-water data is collected to determine ground-water quality and define aquifer properties. This regional data is built upon during well-field development when data is collected to establish upper control limits and restoration criteria. During and following mining and restoration, additional ground-water monitoring is performed to verify the affect, if any, on the aquifer.

5.1.1 Water-Quality Monitoring

Numerous water quality monitoring wells will be located in and around the various well fields as well as at the solar evaporation pond locations. All monitor wells will be sampled on a routine basis during extraction operations to determine if mining solutions are being contained within the mining zone. Monitoring for vertical excursions will take place in the first saturated aquifer overlying the mineralized zone. Due to the thickness and hydraulic properties of the underlying Pierre Shale, no excursion monitoring will take place below the mineralized zone. Monitoring for horizontal excursions will encircle the various mining units with wells completed in the mineralized formations at a distance not to exceed 300 f... from the production area and spaced not more than 400 feet apa

Excursion indicators will include chloride, sulfate, sodium, conductivity and alkalinity. Biweekly samples for these parameters will be collected from monitor wells associated with well fields during mining and restoration.

An excursion will be assumed if any two excursion indicators in any monitor well exceed their respective upper control limits (UCLs) or a single excursion indicator exceeds its UCL by 20 percent. The UCLs for each excursion indicator will be defined as the maximum baseline water quality value plus 20 percent.

If two UCL values are exceeded in a well or if a single UCL value is exceeded by 20 percent, a verification sample will be taken within 24 hours after results of the first analyses are received. If the second sample does not indicate exceedance of the UCLs, a third sample will be taken 48 hours after the first sample. If neither the second or third sample indicate exceedance of the UCLs, the first sample shall be considered in error. If the second or third sample indicates elevated levels of excursion indicators, the well will be placed on excursion status.

Should a well be confirmed to be on excursion status, a corrective action program will be required to return the water quality to baseline concentrations. During and following such an event, the sample frequency will be increased to weekly for the excursion indicators until the excursion is concluded.

If corrective actions have not been effective within 60 days since the first excursion verification, injection of lixiviant within the well field on excursion shall be terminated until such time as the problem is solved and aquifer clean-up is complete. Since ground-water travel times are relatively slow in these formations, the amount of lixiviant involved in the excursion is generally small, and it usually takes several weeks for water quality to begin to improve, the 60-day time limit is considered reasonable.

Quality Assurance (QA) proc... s will be maintained by the Radiation Safety Officer. All QA programs ... be conducted according to the Regulatory Guide 4.15 "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment." Standard QA procedures will be maintained throughout the project life.

5.1.2 Evaporation Reservoir Leak Detection Monitoring

Ferret has proposed to inspect the leak detection system sumps on a daily basis during operations. If a specified level of water is detected in the inspection sump, chemical assays will be used to confirm the source of the water. The chemical assay will be for conductivity, chloride. alkalinity, sodium and sulfate. The detection of a specified amount of liquid within the leak detection system will be reported to the NRC within 48 hours. All assay results will be reported in writing as soon as they are available. If a leak is confirmed, the damaged pond will be emptied immediately by transferring the solution to the other pond so that remedial actions can be made. Additionally, solution evaporation ponds will have a designed freeboard to reduce the risk of spillage from precipitation events and wave activity.

5.2 Environmental Monitoring

Ferret has had a surface radiological monitoring program for the R&D site. The program consists of a number of monitoring sites which sample surface water, soils, sediments, vegetation, direct radiation, air particulates, radon and ground water. The proposed radiological monitoring program for commercial operation is shown in Table 5.2.01. This program is basically an extension of the monitoring program that was utilized during the R&D operation. Ferret will be required by license condition to monitor the various environs and report the results on a semiannual frequency. Additionally, they will be required by license condition to maintain all monitoring records for a minimum of 5 years. These records will, among other things, include a log of all significant solution spills that have taken place at the site.

The environmental monitoring program is outlined in Table 5.2.01. It is designed to determine if the environmental assessment of the project accurately represents the impact on the environment. To assure that a high quality sampling and analytical program is maintained, Ferret will be required to license condition to prepare, review and update standard operating procedures for all environmental monitoring required for the operation. These standard operating procedures will be reviewed by the Radiation Safety Officer to determine if proper radiation measurements are being applied.

6.0 ALTERNATIVES

6.1 Introduction

The action that the Commission is considering is the issuance of a source material license pursuant to Title 10, Code of Federal Regulations, Part 40. The alternatives available to the Commission are:

- Issue the license.
- Deny the application and not issue the license.

The selection of either alternative is based on a consideration of a number of factors related to protection of health, safety and the environment. Section 40.32 of 10 CFR 40 states that an application for a specific license will be approved if, among other things:

- The application is for a purpose authorized by the Atomic Energy Act;
- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property;

Table 5.2.01

Radiological Monitoring Program

Type of Sample	Sample Collection: Number	Location	Method	Frequency	Sample Analysis: Frequency	Type of Analysis
AIR						
Particulates						
	Six	Nearest residences and in the prevalent wind direction	Continuous air sampler with glass fiber filter	Two week per month (maximum)	Quarterly composite of filters according to location	Natural Uranium Thorium-230, Ra-226 Pb-210
	One	Control location near the Town of Crawford	same	same	same	same
Radon						
	Seven	Same as air particulates	Continuous	Monthly	Each sample	Rn-222
WATER						
Ground Water	One from each water well	Within 1 km of area well field	Grab	Quarterly	Each sample	Natural Uranium, Ra-226
Surface Water	Two from Squaw Creek	One upstream, one downstream of restricted area	Grab	Quarterly	Each sample	Natural Uranium, Ra-226

Table 5.2.01 (Cont'd)

Type of Sample	Sample Collection: Number	Location	Method	Frequency	Sample Analysis: Frequency	Type of Analysis
SOIL	One each	Air sampling stations	Grab (top 5 cm)	Once	Once	Natural Uranium, Ra-226, Pb-210
SEDIMENT	Two from Squaw Creek	One upstream, one downstream of restricted area	Grab	Annually	Annually	Natural Uranium, Ra-226, Th-230, Pb-210
VEGETATION	One	Animal grazing area in direction of prevailing wind	Composite of dominant vegetation present	Three times during grazing season	Each sample	Ra-226 and Pb-210
DIRECT RADIATION	One each	Plant site, well field, evaporation ponds, air sampling stations	Dosimeter	Quarterly	Quarterly	Gamma exposure rate μR/hr using a continuous integrating device

- The applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and

- The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

In determining if these stipulations will be met, pursuant to 10 CFR, Part 51, an environmental assessment is performed to determine if an environmental impact statement is require or if a finding of no significant impact can be determined. If the stipulations discussed above are met and either a finding of no significant impact is made or the environmental impact statement finds that the impact is acceptable after weighing the environmental, economic, technical and other benefits against environmental costs, and considering available alternatives, then the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values.

6.2 No License Alternative

If any of the stipulations are not met, including the environmental considerations discussed above, the action called for would therefore be denial of the proposed license.

7.0 SUMMARY AND ENVIRONMENTAL FINDINGS

Based upon the staff evaluation of the Ferret application for commercial operation, the operational history of the R&D site and the comments received on the draft environmental assessment, the NRC has decided to issue a final finding of no significant impact in the Federal Register. Documents used in preparing the assessment included operational data from the research and development in-situ leach operation and the licensee's application. Based on the review of the operational data as well as the incremental increase associated with the commercial operation as detailed in the licensee's application materials, the Commission has determined that no significant impact will result from the proposed action.

The following statements support the final finding of no significant impact and summarize the conclusions resulting from the environmental assessment.

A. The ground-water monitoring program proposed by Ferret is sufficient to monitor the operations and will provide a warning system that will minimize any impact on ground water. Furthermore, aquifer testing indicates that the production zone is adequately confined, thereby assuring hydrologic control of mining solutions.

B. Radiological effluents from the proposed operation of the well field and processing plant will be only small percentages of regulatory limits and will be continuously monitored.

C. The environmental monitoring program is comprehensive and will detect radiological releases resulting from the operation.

D. Radioactive wastes will be minimal and will be disposed of at an approved site in accordance with applicable Federal and State regulations.

E. Ground water, based upon previous testing, can be restored to baseline concentrations or applicable class of use standards.

In accordance with 10 CFR Part 51.35(a), the Director of the Uranium Recovery Field Office, made the determination to issue a final finding of no significant impact. Concurrent with this finding, the Uranium Recovery Field Office will issue a commercial source material license authorizing the operation of the Crow Butte in-situ leach facility, subject to the following license conditions:

- The authorized place of use shall be the licensee's Crow Butte facility in Dawes County, Nebraska.

- For use in accordance with statements, descriptions and representations contained in Sections 3.0, 4.0, 5.0 and 6.0 of the licensee's application submitted by cover letter dated October 7, 1988, as revised by submittals dated December 14, 1987; January 22, 1988; May 17, 1988; April 27, 1988 and July 27, 1988.

  Notwithstanding the above, the following conditions shall override any conflicting statements contained in the licensee's application and supplements.

- The licensee is prohibited from commencing lixiviant injection or generating any byproduct materials until such time as written NRC concurrence is received on their proposed waste disposal facility.

- The annual throughput shall not exceed a flow rate of 2500 gallons per minute, exclusive of restoration flow.

- Any significant changes in the process circuit as shown in Figure 3.1-9 of the application, shall require NRC approval in the form of a license amendment.

- Release of equipment or packages from the restricted area shall be in accordance with the attachment to this license entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

- The results of effluent and environmental monitoring described in Table 5.7-5 of the license application shall be reported in accordance with 10 CFR Part 40, Section 40.65, to the NRC, Uranium Recovery Field Office. The report shall also include injection rates, recovery rates and injection manifold pressures.

- Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.

- The results of the sampling, analyses, surveys and monitoring, the results of calibration of equipment, reports on audits and inspections, all meetings and training courses required by this license and any subsequent reviews, investigations and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least five (5) years.

- Standard operating procedures (SOPs) shall be established for all operational process activities involving radioactive materials that are handled, processed or stored. Standard operating procedures for operational activities shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for nonoperational activities to include in-plant and environmental monitoring, bioassay analyses and instrument calibrations. An approved, current copy of each written procedure shall be kept in the process area to which it applies.

- All written procedures for both operation and nonoperational activities shall be reviewed and approved in writing by the Radiation Safety Officer (RSO) before implementation, whenever a change in a procedure is proposed and at least annually, to ensure that proper radiation protection principles are being applied.

- The licensee shall maintain effluent control systems as specified in Section 4.1 of the license application with the following additions:

  A. Yellowcake drying operations shall be immediately suspended if any of the emission control equipment for the yellowcake drying or packaging areas is not operating within specifications for design performance.

  B. The licensee shall, during all periods of yellowcake drying operations, assure that the manufacturer recommended pressure is maintained in the heating chamber. This shall be accomplished by either (1) performing and documenting checks of air pressure differential approximately every four (4) hours during operation, or (2) installing instrumentation which will signal an audible alarm if air pressure differential falls below the manufacturer s recommended levels. If an audible alarm is used, its operation shall be checked and documented daily.

  C. Air pressure differential gauges for other emission control equipment shall be read and the readings documented at least once per shift during operations.

- The licensee shall submit a detailed decommissioning plan to the USNRC at least twelve (12) months prior to planned final shutdown of mining operations.

- All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the solution evaporation ponds, or land-disposed in accordance with the July 1988, wastewater irrigation proposal.

- The licensee shall submit baseline water quality data for all production units from wells established in the mining zone, the mining zone perimeter and the upper aquifer. All baseline data shall be submitted to the NRC, Uranium Recovery Field Office, for review and approval two (2) months prior to mining. The data shall, at a minimum, consist of the sample analyses shown in Appendix 2.9(a) of the license application.

- Prior to mining, baseline water quality data for each production unit shall be established at the following minimal density: all mining zone perimeter monitor wells, two (2) upper aquifer monitor wells per production unit, and one(1) production/injection well per acre.

- The licensee shall, two (2) months prior to lixiviant injection, propose in the form of a license amendment, upper control limits (UCLs) for all monitoring wells from each production unit.

  If two UCLs are exceeded in a well or if a single UCL value is exceeded by twenty (20) percent, the licensee shall take a confirmation water sample within forty-eight (48) hours and analyze it for chloride, conductivity and total alkalinity. If the second sample does not indicate exceedance, a third sample shall be taken within forty-eight (48) hours. If neither the second or third indicate exceedance, the first sample shall be considered in error.

  If the second or third sample indicates an exceedance, the well in question shall be placed on excursion status and the NRC shall be notified by telephone within twenty-four (24) hours and within seven (7) days in writing from the time the confirmation sample was taken. Upon confirmation of an excursion, the licensee shall implement a corrective action and increase the sampling frequency for the excursion indicators to once every seven (7) days. An excursion is considered concluded when the concentrations of excursion indicators are below the concentration levels defining an excursion for three (3) consecutive 1-week samples.

- A written report shall be submitted to the NRC, Uranium Recovery Field Office, within two (2) months of excursion confirmation. The report shall describe the excursion event, corrective actions taken and results obtained. If the wells are still on excursion at the time the report is submitted, injection of lixiviant within the well field on excursion shall be terminated until such time that aquifer cleanup is complete.

- The licensee shall perform well integrity tests on each injection and production well before the wells are utilized and on wells that have been serviced. The integrity test shall pressurize the well to 125 percent of the maximum operating pressure and shall maintain 90 percent of this pressure for twenty (20) minutes to pass the test. At the licensee's option, a single point resistance test may be utilized. If any well casing failing the integrity test cannot be repaired, the well shall be plugged and abandoned.

Additionally, flow rates on each injection and recovery well and manifold pressures on the entire system shall be measured and recorded daily. During well-field operations, injection pressures shall not exceed the integrity test pressure at the injection well heads.

- The licensee shall utilize sodium carbonate/bicarbonate as the lixiviant with an oxygen or hydrogen peroxide oxidant. Any variation from this combination shall require a license amendment.

- The solution evaporation ponds shall have five (5) feet of freeboard.

  Additionally, the licensee shall, at all times, maintain sufficient reserve capacity in the evaporation pond system to enable the transfer of the contents of a pond to other ponds. In the event of a leak and subsequent transfer of liquid, the freeboard requirements shall be suspended during the repair period.

- The licensee shall perform and document weekly visual inspections of the evaporation pond embankments, fences and liners, as well as measurements of pond freeboard and checks of the leak detection system. Any time six (6) inches or more of fluid is in the leak detection system standpipes, it shall be analyzed for conductivity, chloride, alkalinity, sodium and sulfate. Should analyses indicate that the pond is leaking, the NRC, Uranium Recovery Field Office, shall be notified by telephone within forty-eight (48) hours of verification and the pond level lowered by transferring its contents into an alternate cell. Standpipe water quality samples shall be analyzed for the above parameters once every seven (7) days during the leak period and once every seven (7) days for at least two (2) weeks following repairs.

  A written report shall be filed with the NRC, Uranium Recovery Field Office, within thirty (30) days of first notifying the NRC that a leak exists. This report shall include analytical data and describe the mitigative action and the results of that action.

- The licensee shall maintain a log of all significant solution spills and notify the NRC, Uranium Recovery Field Office, by telephone within forty-eight (48) hours of any failure which may have a radiological impact on the environment. Such notification shall be followed, within seven (7) days, by submittal of a written report detailing the conditions leading to the failure or potential failure, correct ve actions taken and results achieved. This requirement is in addition to the requirements of 10 CFR Part 20.

- The licensee shall maintain an area within the restricted area boundary for storage of contaminated materials prior to their disposal. All contaminated wastes and evaporation pond residues shall be disposed at a licensed radioactive waste disposal site.

- At least three (3) months prior to termination of uranium recovery in a mining unit, the licensee shall submit to the NRC, Uranium Recovery Field Office, in the form of a license amendment, a plan for ground-water restoration and post-restoration monitoring. The goal of restoration shall be to return the ground-water quality, on a production unit average, to baseline concentrations.

- The licensee shall maintain with the State of Nebraska, a surety bond sufficient to cover all costs of restoration, decommissioning and reclamation. The bond shall be updated annually and a copy of the update submitted to the USNRC, Uranium Recovery Field Office, for review and approval.

Gary R. Konwinski
Project Manager

Approved by:
Ramon E. Hall
Director

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