Mobil Oil Corporation

P.O. BOX 5444
DENVER, COLORADO 80217

URANIUM/MINERALS DIVISION

October 22, 1981

Ms. Maxine Goad
Program Manager, Ground Water Section
Water Pollution Control Bureau
Environmental Improvement Division
P. O. Box 968
Santa Fe, New Mexico 87503

Attention: Mr. David Boyer

AMENDMENT TO APPLICATION
SOUTH TREND DEVELOPMENT AREA
DISCHARGE PLAN APPLICATION

Dear Ms. Goad:

With this letter, Mobil Oil Corporation is submitting an amendment to our Discharge Plan Application for the South Trend Development Area which was submitted on November 10, 1980. The amendment effectively replaces Section 2.0 - Proposed Operations and makes a few very minor changes and/or corrections in Sections 1.0, 3.0, 4.0, 5.0, and 7.0. No changes were made in the remaining sections of the application.

If you have any questions, please contact Mr. W. A. Steingraber at (303) 572-5764. Thank you for your cooperation in and attention to this matter.

Sincerely yours,

G. A. Cresswell
Manager - Hydrological &
Environmental Affairs

WASteingraber:dp
Enclosure
cc: D. B. Cooper, Nufuels, w/o
W. L. Luthy, Nufuels, w/o
P.F. 1.A.2.4.3

SOUTH TREND DEVELOPMENT AREA APPLICATION
IN SITU PROJECT
McKINLEY COUNTY, NEW MEXICO

Errata/Minor Changes

1. All references to "evaporation pond(s)" or "evaporation (waste) pond(s)" should read "operating and evaporation pond(s)."

2. P. B-102 Figure B 1.5.5-1
   The names of the soil associations "Hagerman-Travessilla" and "Lohmiller-San Mateo" should be reversed to match the map and text.

3. P. B-137 Last line on the page
   Radon-227 should be changed to Radon-222

4. P. B-195 Section 3.5.1. Vegetation - (the following section will replace the section in the report).

   Vegetation will not be cleared from the area of the first well field and the surrounding monitor wells. This is planned so that the vegetation can hold down the soil, and prevent erosion during the drilling, leaching, and restoration operations.

   Only the plant and operating pond site will be stripped of vegetation. The total area of disturbance for this will be in the west half of the SE¼, Section 16. Disturbance, i.e., due to drilling the first well field, will occur in the east half of the SE¼ of Section 16 and the west half of the SW¼ of Section 15. As the facility is increased in size and the number of well fields is increased, the seven remaining quarter sections will be used. All the planned well fields will not be operating at the same time.

   Reclamation and reseeding of all disturbed land will occur after each well field has been restored and after the project has ceased operation. The undisturbed land surrounding the disturbed areas will serve as additional sources of seed for recolonization.

   After the plant is operating, it may be necessary to install additional small evaporation ponds. If so, the area for these ponds (Figure B 2.1.-2b) will be stripped. All land on which the ponds are located will be reclaimed.

   The total areas for proposed and future operations are on lands that contain a large variety of vegetation types. They are widely distributed throughout the region surrounding the site. Alteration of 200 or so acres at any one time during the life of the operation, therefore, should not constitute a significant adverse impact.

5. P. B-218 Section 4.2.2. Failures of Well Casing

First paragraph, line one "epoxy-sand..." should be replaced with "rough surface..."; and

First paragraph, line seven "one monitor well..." should be replaced with "two monitor wells...."

6... P. B-233 Section 5.2.2.1. Well Field Monitoring - (The following paragraph will replace the second complete paragraph on P. B-233.

The configuration of the initial well field has been previously described in Section 2.2. The well field will be surrounded by monitoring wells. The initial well field will have 18 monitoring wells (Westwater Canyon Member) located on the perimeter of the pattern. All perimeter monitoring wells will be perforated in the ore-bearing zone(s) in a manner similar to the injection and production wells. In addition to the perimeter monitor wells, two (2) monitor wells will be located in the aquifer (Dakota Sandstone) overlying the ore-bearing aquifer or leach zone.

7. P. B-246 and P. B-247 Table B 7.2.-1. List of Project Permits
This table should be replaced with the new table B 7.2-1 attached.

8. Appendix A Excursion Correction Program

Modify Part "A" of the Excursion Correction Plan to read as follows: "Notify the New Mexico Environmental Improvement Division and the U. S. Geological Survey - Conservation Division by telephone of the affected monitor well and the nature of the significant increase within 48 hours of detection."

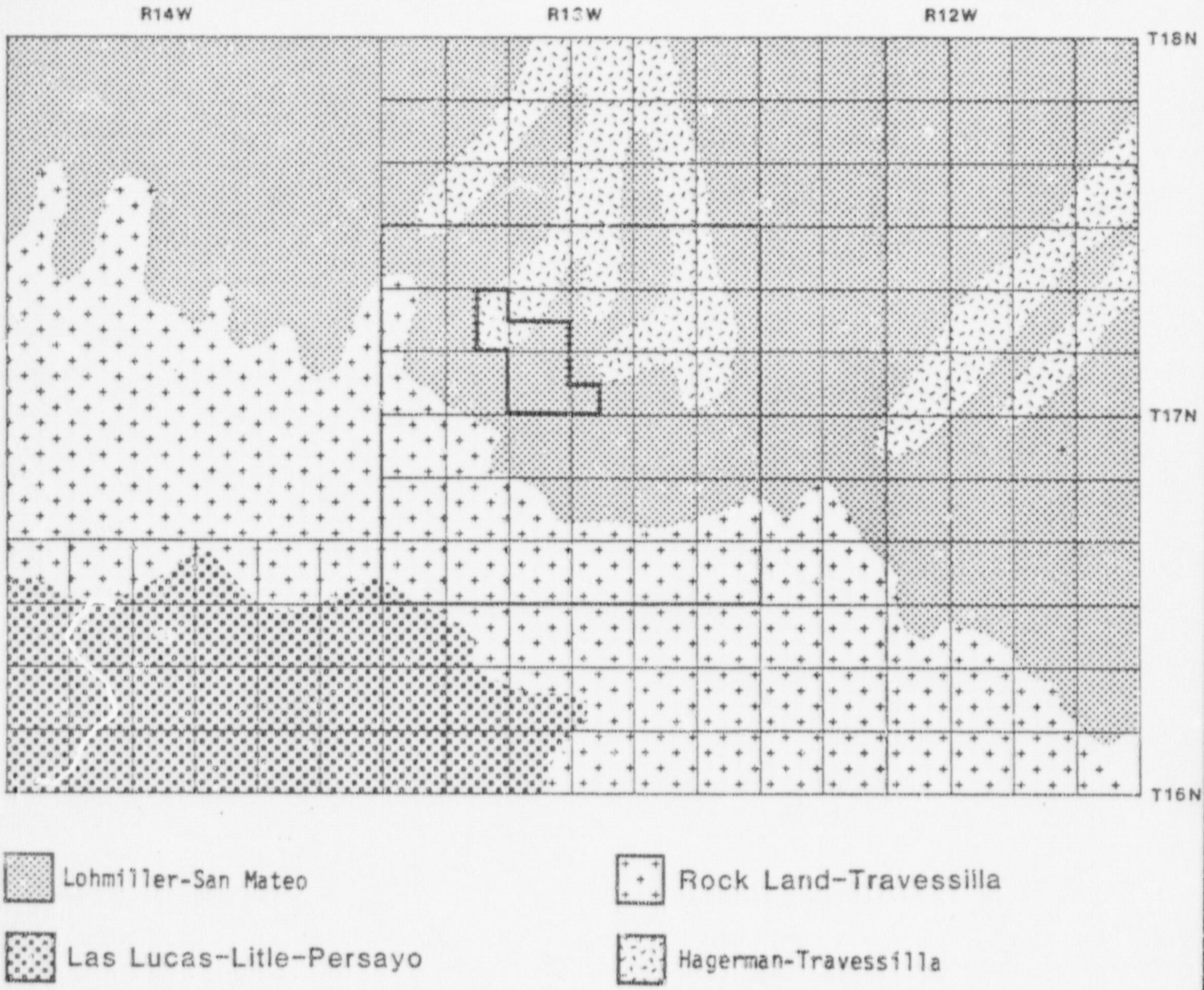

Figure B 1.5.5-1 REGIONAL SOIL MAP for the SOUTH TREND DEVELOPMENT AREA (from MAKER et al, 1974)

The available preoperational radiological monitoring program included analysis of air, soil, groundwater, flora, and fauna in the vicinity of the in-situ leach plant of the South Trend Development Area (Section 16, T17N, R13W). The preoperational data base included information from the following: Crownpoint In-Situ Pilot Test (Section 9, T17N, R13W) and a one-year program at Section 12, T17N, R13W. In addition, operational data from the Crownpoint in-situ pilot test at Section 9, T17N, R13W, has been included. This data is within the appropriate standards and thus is not contributing significantly to the preoperational values at the South Trend Development Area. The results of these programs are discussed in the following sections.

Mobil will be collecting preoperational data at the South Trend Development Area and will be submitting the results of the data when it becomes available. Also included will be a map of the preoperational and operational data-gathering sites.

1.7.1 Surface

The surface radiological studies in the project vicinity include air monitoring, soil, flora, and fauna. Results are reported from the Crownpoint In-Situ Test Pilot project in Section 9 and studies in Section 12.

1.7.1.1 Air Monitoring

Gamma radiation, gaseous radon-222, and radioactive constituents of suspended particulate matter were monitored to establish background airborne radiation contamination levels. These results are shown in Tables B 1.7.1-1 to B 1.7.1-4.

Gamma radioactivity level increased by approximately a factor of three when the in-situ pilot facility was operational as compared to preoperational levels (Table B 1.7.1-1). The levels in both cases were very low. Thermoluminescent dosimeters at ten locations during the preoperational in-situ program indicated an average annual dose of 136 mrem (Table B 1.7.1-2). For comparison, the estimated radiation dose levels over the United States averaged about 102 mrem/yr. Radon-222 in air may show a slight increase during events of this magnitude, is very small. (See Section 1.5.4 for further discussion.)

3.5 BIOLOGY

3.5.1 Terrestrial Ecology

3.5.1.1 Vegetation

Vegetation will not be cleared from the area of the first well field and the surrounding monitor wells. This is planned so that the vegetation can hold down the soil, and prevent erosion during the drilling, leaching, and restoration operations.

Only the plant and operating pond site will be stripped of vegetation. The total area of disturbance for this will be in the west half of the SE¼, Section 16. Disturbance, i.e., due to drilling the first well field, will occur in the east half of the SE¼ of Section 16 and the west half of the SW¼ of Section 15. As the facility is increased in size and the number of well fields is increased, the seven remaining quarter sections will be used. All the planned well fields will not be operating at the same time.

Reclamation and reseeding of all disturbed land will occur after each well field has been restored and after the project has ceased operation. The undisturbed land surrounding the disturbed areas will serve as additional sources of seed for recolonization.

After the plant is operating, it may be necessary to install additional small evaporation ponds. If so, the area for these ponds (Figure B 2.1.-2b) will be stripped. All land on which the ponds are located will be reclaimed.

The total areas for proposed and future operations are on lands that contain a large variety of vegetation types. They are widely distributed throughout the region surrounding the site. Alteration of 200 or so acres at any one time during the life of the operation, therefore, should not constitute a significant adverse impact.

On the basis of the Crownpoint Project Area mineralogy and geology, reservoir modeling, injection and production rate characteristics, and past experience with pilot in-situ leach projects, successful confinement of the leachate in solution mining is possible. Nevertheless, a small possibility exists for subsurface lixiviant excursions from the production/injection wells into the monitoring wells. The causal factors and principles of leachate excursion control are discussed below.

The configuration of a five-spot leach pattern is characterized by injection wells located at each of four corners surrounding a production well. The producing (or pumped) well draws down the hydrostatic pressure in the formation surrounding the completed interval (well casing perforations) by lowering the water column in the well casing. The producing well then becomes both a pressure and fluid sink in the formation.

The leachate flows radially from an injection well, due to the low pressure condition created in the vicinity of the production well. As an overall process, leachate from the injection wells migrates toward the centrally positioned production well in a manner that is dependent on system fluid flow dynamics.

Should an excursion be detected, the Excursion Correction Program (Appendix A) will immediately be initiated.

4.2.2 Failures of Well Casing

Failure of a well casing, although unlikely, could result in an excursion. The possibility of such a failure is minimized by the use of continuous ~~epoxy sand~~ rough surface coating on the exterior of the fiberglass pipe, good pipe centralization, displacement of the cement slurry in turbulent flow, and circulation of the cement from total depth to surface to ensure successful borehole cementation. The monitoring schedule calls for sampling all monitor wells every two weeks and analyzing these samples for specified parameters. ~~One~~ Two monitor well in each well field will be located in the leach pattern and completed in the Dakota Sandstone, the next overlying aquifer. The monitoring of these wells will allow for early detection of any potential horizontal or vertical leachate excursions.

reevaluated based upon additional baseline data and may be changed prior to or during the operational phase of a specific production well field area to reflect actual known variations in a regional groundwater.

Conductivity: a 25 percent increase above the highest baseline value measured for all the monitor wells.

Uranium: a 5 mg/l increase above the highest baseline value measured for all the monitor wells.

Sulfate: a 25 percent increase above the highest baseline value measured for all the monitor wells.

Molybdenum: a 5 mg/l increase above the highest baseline value measured for all the monitor wells.

Monitor well sample concentrations above these values will constitute an excursion and the Excursion Control Plan (described in Appendix A) will be implemented. However, localized variations in groundwater chemical concentrations may account for the increase and may not indicate the presence of leachate.

Errata/prior change

The configuration of the initial well field has been previously described in Section 2.2. The well field will be surrounded by monitoring wells. The initial well field will have 18 monitoring wells (Westwater Canyon Member) located on the perimeter of the pattern. All perimeter monitoring wells will be perforated in the ore-bearing zone(s) in a manner similar to the injection and production wells. In addition to the perimeter monitor wells, two (2) monitor wells will be located in the aquifer (Dakota Sandstone) overlying the ore-bearing aquifer or leach zone.

The excursion monitoring program will consist of sampling all monitoring wells every two weeks and analyzing the water samples for conductivity, uranium, sulfate, and molybdenum. The samples for this excursion monitoring program will be analyzed for conductivity and then filtered prior to further analysis at the Mobil field laboratory.

Water level measurement will be made for all monitor wells. These data will be collected prior to pumping the monitor wells for excursion monitoring and will be reported with the excursion monitoring data.

APPENDIX A
EXCURSION CORRECTION PROGRAM

Excuse/Minor Change

Once an excursion has been verified an excursion correction program will be initiated. This program will entail the following corrective actions:

Modify Part "A" of the Excursion Correction Plan to read as follows: "Notify the New Mexico Environmental Improvement Division and the U. S. Geological Survey - Conservation Division by telephone of the affected monitor well and the nature of the significant increase within 48 hours of detection."

B. Initiate increased unbalanced production (production exceeding injection) in the vicinity of the affected monitor well to ensure groundwater flow from the affected well to the production area.

C. Initiate twice per week sample analysis of the affected well for excursion parameters (conductivity, uranium, sulfates, and molybdenum) beginning with the next day after the excursion is confirmed.

D. Mobil will use any method judged necessary and prudent to define the extent of the leaching solutions and to effect clean-up in an expeditous and practical manner. This may include the installation of a secondary well beyond the affected well.

E. The secondary well will be completed in the same sand as the affected well and in a direction away from the production area.

F. Obtain a water sample from the secondary well and analyze for excursion parameters after the well has been completed.

G. If values obtained above indicate no leachates have reached the secondary well, continue corrective action in the affected well until it is returned to values below excursion levels for three consecutive sampling days.

Table B 7.2-1 List of Project Permits

Permit	Description/Applicability	Statutory/Regulatory Authority	Status
Partial Plan for Well Drilling Completion and Hydrologic Testing	Submit records of location and conditions encountered. Show intent for proper completion.	USGS 30 CFR 1.1, Part 231 in concurrence with BIA 25 CFR 1.2 Part 177 National Park Service.	Approved
Permit to Explore the Underground Water of the State of New Mexico	Submit records of location and testing to be done.	New Mexico State Engineer Office	Approved
Groundwater Appropriation	The appropriation must be obtained for the total amount of water to be diverted and for the net consumption.	New Mexico State Engineer Office	Submitted
Discharge Plan	A description of methods and conditions, including any monitoring and sampling requirements for the discharge of effluent of leachate which may move directly or indirectly into ground water.	NMEID Water Quality Control Commission Regulations Part 3-104	Submitted
Radioactive Materials License	No person may receive title to receive, possess, use, or transfer source material after removal from its place of deposit in nature without this license.	NMEID Radiation Protection Regulations (1980)	Submitted
Mining and Reclamation Plan for In Situ Uranium Leaching	A description of all proposed pilot test mining activities, environmental setting, impacts, and restoration procedures.	USGS 30 CFR1.1 Part 231 in concurrance with BIA 25 CFR 1.2 part 177	Submitted

Table B 7.2-1 List of Project Permits

Permit	Description	Authority	Status
State Air Quality Permit (#702)	Detailed description of operation, estimated fugitive dust, particulate emission, regional climatology, meteorology and air quality to satisfy state requirements.	New Mexico Air Quality Bureau	To be submitted

2.0 PROPOSED OPERATIONS

2.1 INTRODUCTION

Mobil proposes to construct and develop an in-situ leach plant and well fields with a capacity for producing in the range of one million pounds of yellowcake annually. The operational life of the project will be approximately 27 years and it is anticipated that injection/production rate of the 3,000-gpm well field will meet the yellowcake production estimate. The proposed project will be located on the South Trend Development Area and will include all of Section 16, the SW 1/4 of Section 15, the S 1/2 of Section 9, and the E 1/2 of Section 8, T17N, R13W (Figures B 2.1-1 and B 2.1-2).

The planned production and well-field development will occur in incremental phases. Initially, the in-situ leach plant will be operated at 600 gpm with development planned on the SE 1/4 of Section 16 and the SW 1/4 of Section 15, T17N, R13W (Figure B 2.1-2). The second phase will increase production to 2,100 gpm and include a yellowcake drying and packaging unit. This incremental increase will occur when market conditions permit. A third phase will increase leachate injection/production to the licensed rate of 3,000 gpm.

The in-situ leaching process offers several potential advantages when compared with conventional underground mining. While these aspects are discussed more fully elsewhere in the document, they are summarized below. In-situ leaching: 1) can effect higher recovery of the resource, 2) requires substantially less net water withdrawal than conventional mining, 3) avoids possible environmental damage encountered in surface processing of ore; (e.g. mill tailings disposal), 4) results in less radiation exposure to operations personnel, 5) requires fewer, less-skilled personnel and hence lower socioeconomic impact, and 6) requires a net transfer to the surface of an insignificant amount of extraneous waste material compared to underground mining.

Preliminary feasibility studies, including bench-scale laboratory tests, pilot plant operations, field hydrologic tests, and engineering designs have demonstrated that the in-situ uranium leach technology can be employed in the

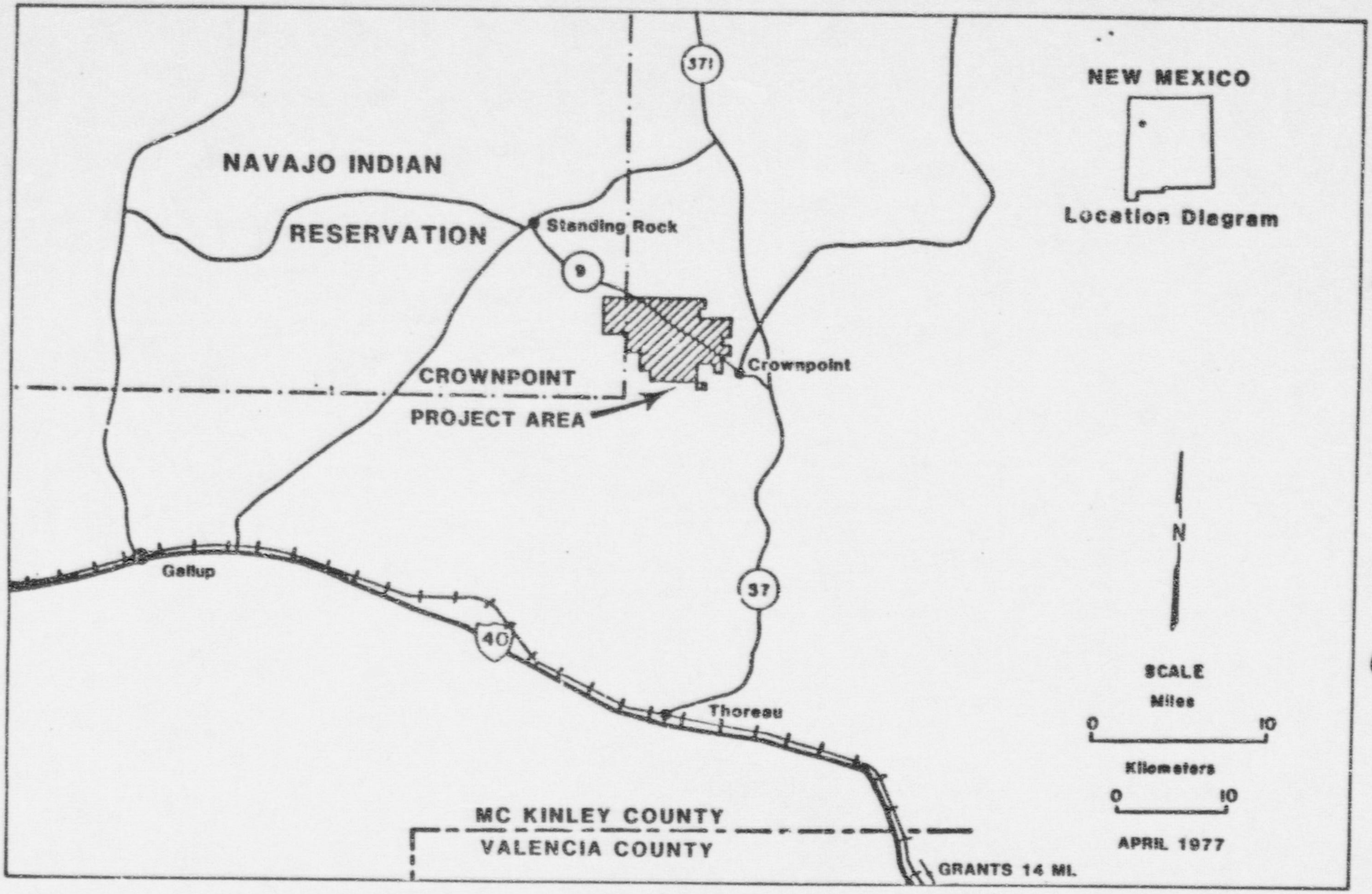

Figure B 2.1-1 CROWNPOINT PROJECT AREA LOCATION MAP

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South Trend Development Area (Mobil 1978 and 1980). Experience learned in the Pilot In-situ leach operation at Section 9, T17N, R13W, has shown technical feasibility of in-situ leaching is dependent on a number of factors. These include the leachability of the ore body, the fluid flow rates and uranium recovery that is obtained as a function of the well spacings, and the manner of completing the wells.

Pilot test data were also used for final selection of the type of oxidant, the appropriate pH at which to run the leaching process, the concentrations of injection chemicals, and other similar process considerations. Other considerations being tested in the Section 9 pilot plant operations are the environmental impacts arising from the leaching process. The following factors are being demonstrated/determined: (1) the leachate can be controlled underground, (2) the amount of water consumed with solution mining and restoration (this is substantially less than that used by conventional underground mining), (3) volumes and concentrations of any liquids and solids that are discharged from the process plant, and (4) safe waste disposal.

The determination of the degree of resource recovery and its associated economics is a key element in progressing from pilot tests to commercial leach operations. The recovery efficiency of in-situ leaching is being measured in the pilot tests. This information can be used to determine the overall recovery of U_3O_8 reserves and by optimizing process design, capital costs for the commercial in-situ leach operation can be estimated.

Initially, the commercial operation at the South Trend Development Area will consist of one well field, a 600-gpm skid-mounted modular in-situ leach plant, a change room, a lunchroom, service building, tanks for chemical storage and an operating pond. A distribution and gathering pipeline system will interconnect the well field and leach plant. The processing plant and the number of well fields will be enlarged when market conditions permit, to operate at 2,100 and later to 3,000 gpm for a total maximum capacity of one million pounds of yellowcake per year.

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MINE PLAN

SOUTH TREND DEVELOPMENT AREA

Operational Area	Leach Start	Leach Stop	Restoration Start	Restoration Stop
1	9/1/82	12/31/88	1/1/89	12/31/91
2	1/1/84	12/31/94	1/1/95	12/31/97
3	1/1/89	12/31/95	1/1/96	12/31/98
4	1/1/89	12/31/95	1/1/96	12/31/98
5	1/1/91	12/31/98	1/1/99	12/31/01
6	1/1/93	12/31/99	1/1/00	12/31/02
7	1/1/95	12/31/01	1/1/02	12/31/04
8	1/1/96	12/31/03	1/1/04	12/31/06
9	1/1/98	12/31/04	1/1/05	12/31/07
10	1/1/99	12/31/06	1/1/07	12/31/09

Table B 2.1.2-1

2.1.1 Location

The commercial in-situ leach facility and well fields will be located on nine quarter sections of Sections, 8, 9, 15 and 16, T17N, R13W. This is designated as the South Trend Development Area of the Mobil Crownpoint Project. The Crownpoint Project Area is located in McKinley County in northwestern New Mexico, just northwest of the town of Crownpoint (Figure B 2.1-1). Access is gained via Interstate Highway 40 to Thoreau, then north approximately 50 km (30 mi) on State Highway 57 to Crownpoint and west approximately 10 km (6 mi) on Navajo Route 9 to the plant site on the SE 1/4 of Section 16 (Figure B 2.1-2 a and b). The initial well field will straddle the SE 1/4 of Section 16 and the SW 1/4 of Section 15 (Figure B 2.1-2 a and b). Later well field development will encompass all nine quarter sections of the South Trend Development Area (Figure B 2.1.1-1). The Mobil Crownpoint Project Area includes both Indian-allotted lands and mining claims, totaling some 12,470 acres (Figure B 1.2.1-2). The South Trend Development Area consists of nine quarter sections (1,530 acres) of Indian-allotted land within the Crownpoint Project Area.

2.1.2 Mine Plan

A mine plan has been developed for mining the nine quarter section area within the South Trend Development Area. Figure B 2.1.1-1 shows the location and size of each operational area. Table B 2.1.2-1 details the respective leach and restoration periods for each operational area.

Prior to the initiation of leaching in one of the defined operational areas Mobil will submit site specific data on the well field area, i.e., size and shape, number and placement of injection and production wells, leach zone(s), number and placement of monitor wells, monitoring program, stratigraphy, hydrologic testing (aquifer pump tests), and water quality. Upon review and approval of this supporting data leaching operations would commence in the new operational area. Such operations would be subject to all of the stipulations/obligations set forth in the original permit, mining and reclamation plan or license. This procedure does not entail the issuance of a new permit, mining and reclamation plan or license, but rather the implementation of the company's mine plan via the submission of applicable data before the initiation of leaching in a new operational area.

After each area is leached, restoration will begin immediately. Any area that is being leached will be separated from a restoration area by a tuffer zone. This will ensure that no intermixing of ground waters will occur during each operational period.

The mine plan as proposed (Figure B 2.1.1-1 and Table B 2.1.2-1) schedules the area in which the Crownpoint Section 9 Pilot In Situ Leach Test is located to be leached/mined as part of the second operational area to be developed. Initiation of leaching operations in this area (Development Area #2) is scheduled for January 1, 1984. It is proposed that the applicable permit, mining and reclamation plan or license covering the Crownpoint Section 9 Pilot Test Project remain in force until such time as approval is received by Mobil for the South Trend Development Area Project containing the mine plan which provides for the leaching and restoration of the Section 9 Pilot Test Site as part of Development Area #2. Thus the applicable permit, mining and reclamation plan, or license covering the Section 9 Pilot Project would be superceded and replaced by the applicable authorization issued for the South Trend Development Area.

2.2 LEACH OPERATIONS

2.2.1 Introduction

Uranium in the Crownpoint, New Mexico region was depositied from ground water containing low concentrations of uranium. When the uranium-bearing water emcounters strong reducing agents, such as hydrogen sulfide or organic material, the uranium precipitates.It has been found to be water soluble in an oxidizing environment containing bicarbonate.

When the precipitated uranium is sufficiently concentrated in an area for economical production, the zone of mineralization is termed an ore body. Insitu leaching dissolves the uranium in an oxidizing solution for pumping to the surface for processing and recovery.

2.2.2 General-Mineralogy and Geochemistry

The uranium reserves in the Crownpoint Project Area occur at depths of up to 700 m (2,200 ft). The reserves are in permeable sands about 22 m (72 ft) thick in a sandstone formation (Westwater Canyon) of up to 78 m (250 ft). The sandstone formation is isolated from other aquifers by highly impermeable overlying and underlying shale strata. Uranium ore is not uniformly distributed in the sands of the Westwater Canyon. The uranium minerals occur predominantly as uraninite and coffinite. In addition to the host rock (sandstone) of the uranium deposit, there are clays and calcium carbonate present in varying amounts. Calcium carbonate averages three percent (by volume) and the clay constitutes less than 10 percent (by volume) of Westwater Canyon. Trace amounts of pyrite, magnetite, apatite, zircon, sphene, organic carbon, and volcanic glass are present.

2.2.3 Leachate

Westwater Canyon Formation water will be used to make up the leachate. It will be buffered to a pH of about 7 using sodium bicarbonate. During this operation the bicarbonate concentration will be raised from approximately 220 (ppm) parts per million in the original formation water to about 2,000 ppm in the leachate. Leach fluid containing bicarbonate will be injected into the ore body formation and pumping will begin simultaneously in the production wells to maintain an overall injection/production fluid imbalance (i.e., more fluid is extracted than injected). If any uranium exists in an oxidized state, it will be complexed and solubilized as it is contacted by the bicarbonate. (During this initial operation, monitor wells will be sampled on the normal monitoring schedule to detect any potential excursion from the pattern). As soon as steady-state conditions with the alkaline leachate is established, the oxidant (oxygen gas) will be introduced into the leachate to oxidize the uranium in the ore body.

All injection wells will have corrosion-resistant casing which meets the requirements of the State Engineer. Oxygen gas will be injected down hole at a regulated rate through corrosion-resistant tubing.

Figure B 2.2.3-1 summarizes the chemical reactions for the leach solution. Other minerals such as molybdenite and to a lesser extent pyrite will also be oxidized under these conditions (Figure 2.2.3-1). Data obtained from the pilot operation on Section 9, T17N, R13W indicate uranium will be the major valuable element in solution. Laboratory analyses were conducted to determine the concentration of dissolved uranium and to identify trace minerals which may be present in the pregnant leachate or lixiviant. The uranium concentration in the produced leachate is expected to range from 20 to perhaps 200 or 300 ppm.

Uranium and possibly other elements (e.g., molybdenum) will be removed from the lixiviant during surface processing. Some of the trace substances have a tendency for adsorption on the ion exchange resin and could be removed from the leachate during the ion exchange step. The concentration of these substances in the recirculated barren leachate in any event is expected to be small. Before reinjection, the barren leachate will be readjusted for pH and bicarbonate content at the surface.

2.2.4 Amenability-to-Solution-Mining

The solution mining process, in comparison to underground mining, can expand potential uranium reserves and conserve natural resources. These benefits can be achieved since uranium from lower grade ore can be recovered by in-situ leaching and because there are fewer restrictions on horizontal ore continuity and extent for in-situ leaching than there is in underground mining.

In-situ leaching has a lower consumptive demand for water than does underground shaft mining since most of the water used in the leaching process is recirculated. For example, an in-situ operation producing one million pounds of yellowcake (U_3O_8) per year would use water at a net consumptive rate of 100 - 150 gpm. By comparison, a typical underground mine with the same one million pound yellowcake production would require 1,500 - 3,000 gpm of water be pumped from the aquifer to depressure, or dewater, the formation. The majority of this water is disposed as a surface discharge. Water also is required for the milling of the ore from the conventional mining.

Restore Lixiviant Leach Chemicals

Barren Lixiviant + CO_2 + NaOH + O_2

↓

Injection Wells

↓

Ore Body Reactions

Uranium: $2UO_2 + O_2 + 2H_2O \rightarrow 2UO_2^{+2} + 4OH^-$

$UO_2^{+2} + 3HCO_3^- + 3OH^- \rightarrow [UO_2(CO_3)_3]^{-4} + 3H_2O$

Pyrites: $4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3\downarrow + 16H^+ + 8SO_4^{-2}$

Molybdenite: $2MoS_2 + 9O_2 + 6\ H_2O \rightarrow 2MoO_4^{-2} + 12H^+ + 4SO_4^{-2}$

Calcite: $CaCO_3 + CO_2 + H_2O \rightarrow Ca^{+2} + 2HCO_3^-$

Clays: $CaClay + 2\ Na^+ \rightarrow Na_2Clay + Ca^{+2}$

↓

Production Wells

↓

Process Plant Reactions

Anion IX

Load: $[UO_2(CO_3)_3]^{-4} + 4\ Resin\ Cl \rightarrow (Resin)_4[UO_2(CO_3)_3] + 4Cl^-$

Elute: $(Resin)_4[UO_2(CO_3)_3] + 4Cl^- \rightarrow [UO_2(CO_3)_3]^{-4} + 4Resin\ Cl$

Precipitation

Acidize: $[UO_2(CO_3)_3]^{-4} + 6HCL \rightarrow [UO_2^{+2}] + 3H_2O + 2Cl + 3CO_2\uparrow$

Oxidize: $UO_2^{+2} + H_2O_2 \rightarrow UO_4\downarrow + 2H^+$

Neutralize: $NaOH + H^+ - Na^+ + H_2O$

Figure B 2.2.3-1 CHEMISTRY of IN SITU LEACHING and PROCESSING URANIUM

Solution mining avoids possible environmental damage which might be associated with underground mining by eliminating the mill tailing pond, thus reducing the radioactive wastes, and greatly minimizing regional hydrologic disturbance.

In-situ leaching also involves fewer operational hazards than underground mining since the miners/operators are not required to be underground where they can be exposed to higher levels of radiation.

Solution mining has less socioeconomic impact than underground mining. For an in-situ leach plant operating at one million pounds of U_3O_8 per year, up to 80 personnel would be required for well field and plant operations. By comparison, a conventional mining and milling operation producing the same amount of yellowcake would require about 315 persons. Furthermore, the skills required for an in-situ leaching operation are more readily available from the local labor force. If appropriate skills are unavailable, the in-situ leach process is simple and the available workforce can acquire the necessary skills with on-the-job training.

In ore mining (conventional mining) the weight of "rock" brought to the surface may average 500 - 1,000 times the weight of yellowcake produced. In solution mining extraneous materials brought to the surface (dissolved and suspended) are no more than one to three times the weight of yellowcake produced.

2.2.5 Well-Field

The following section provides the details associated with the well field development and operation.

2.2.5.1 Description and Location

The production pattern will consist of five-spot or other appropriate patterns. Patterns used will depend on specifics of ore body configuration and characteristics. Initial development will be with 200-ft well spacing with the initial well field illustrated in Figure B 2.1-2. A schematic of a series of interconnected five-spot patterns is shown in Figure B 2.2.5.1-1. The initial well field will have a total of 89 wells. It will be comprised of 42 injection wells, 27 production wells, and 20 monitor wells (18 Westwater and 2 Dakota). This well field will produce sufficient capacity to operate the 600-gpm facility. The number of wells needed to supply the 3,000-gpm facility will be about 144 production and 200 injection.

Level pads will be prepared for the individual well sites for drilling operations. These pads will be maintained during leach and restoration activities for the servicing of the wells. The area of Section 16 on which the plant and accessory buildings are to be located will also be leveled. Dikes and ditches will be constructed, if necessary, to divert runoff from the site and to prevent erosion. Concrete pads will be constructed for the plant and/or chemical storage tanks.

2.2.5.2 Well Completion

All production, injection, and monitor wells will be completed in accordance with procedures approved by the U. S. Geological Survey and the New Mexico State Engineer.

The injection and production wells will be drilled and cased in the following manner. If necessary, a 31.12 cm (12.45 in.) conductor hole will be drilled from ground surface to 12.2 m (40 ft). Steel casing (24.5 cm [9.625 to 10.75 in.] O.D.) will then be inserted and cemented in place. Once the cement has hardened, a 22.25 cm (8.75 in. to 9.625 in.) hole will be drilled through the Westwater Canyon Forma tion to a depth of approximately 675 m (2,200 ft). Necessary electric logs, e.g., SP, resistivity, gamma, and drift, will be run. The hole will be cased with a 17.95 cm (7.06 in.) O. D. fiberglass casing and cemented in place. The fiberglass casing will be perforated across from the zone of interest in the Westwater Canyon. Pumps will then be placed on 6.03 cm (2.375 in.) fiberglass tubing and set at approximately 185 m (600 ft).

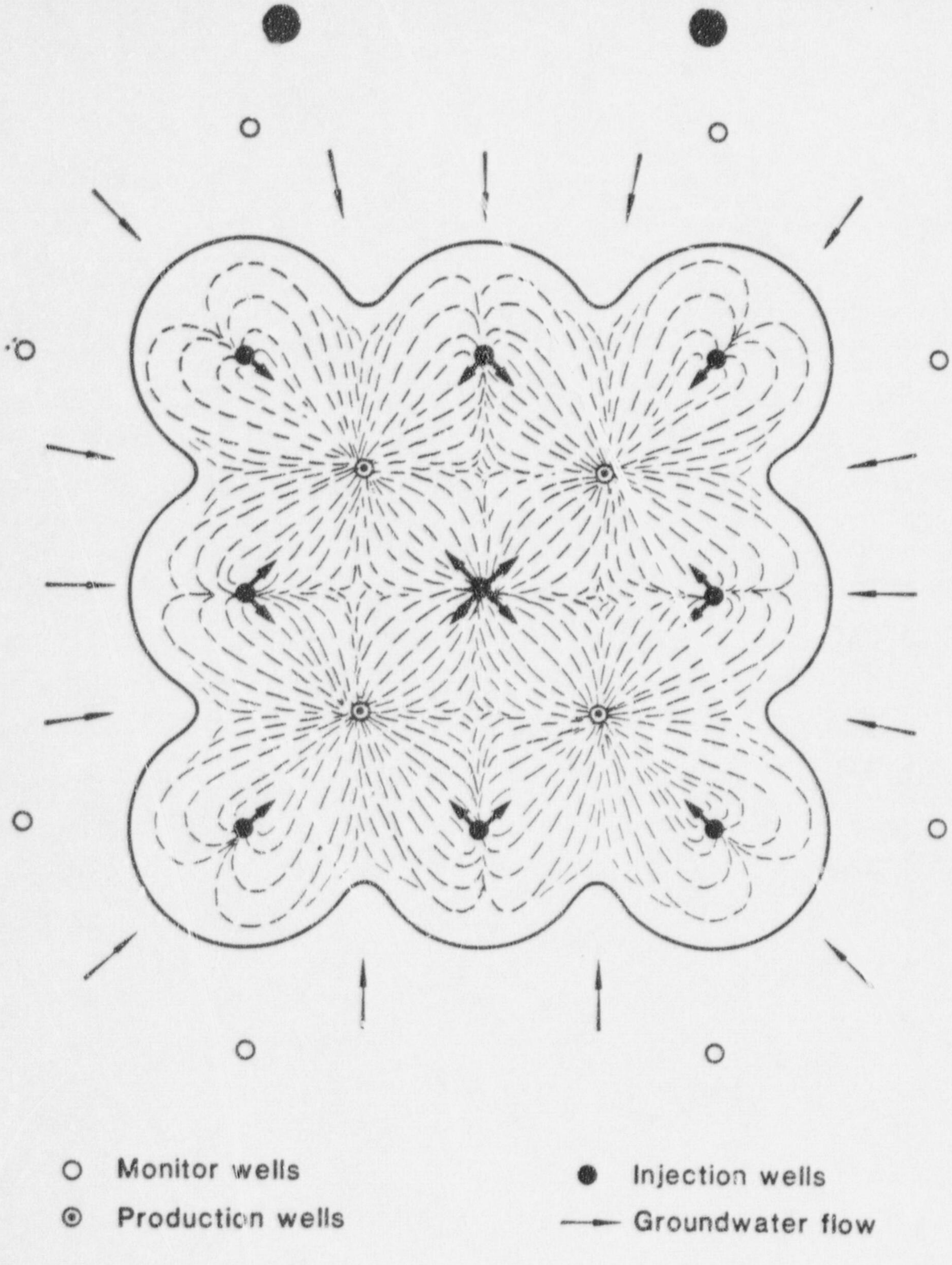


Figure B 2.2.5-1 SCHEMATIC OF A FOUR 5-SPOT INJECTION/PRODUCTION WELL FIELD

Two types of monitor wells will be installed. One type of monitor well will be installed using the procedure discussed for production and injection wells. Monitor wells of this type will be located in areas where future well fields will be placed. By doing so, the well can then be used as a production and/or injection well in the future. The other type of monitor well, to be known as a "non-ore" monitor well will be installed in areas where no ore exists, where the monitor well is within 500 feet of a lease boundary, or i' used as a Dakota monitor.

In a non-ore monitor well, the procedure outlined above will be followed except that a 17.15 cm (6.75 in.) hole will be drilled and a 11.7 cm (4.6 in.) O. D. fiberglass casing will be installed and cemented. For Dakota non-ore monitor wells, the hole will be drilled through the Dakota Sandstone to a depth of approximately 500 m (1,630 ft).

For all production, injection, and monitor wells, excluding the non-ore monitor wells, a centralizer will be installed on every collar from the total depth (T. D.) to 30.5 m (100 ft) above the sand containing the ore. Thereafter, centralizers will be installed on every third collar to the surface. For non-ore monitors, a centralizer will be installed from T. D. 30.5 m (100 ft) above the monitor zone. A centralizer will be installed on every third collar above this section to the surface.

All casing strings will be cemented from total depth to the surface to preclude vertical migration of natural and injected fluids. The rough exterior surface of the fiberglass casing ensures good pipe cementation and displacement of cement slurry (in turbulent flow). The casing will be run with a float collar to prevent the cement from flowing back after being pumped into the the annulus.

During cementing, the casing will be preflushed with water. Cement will then be pumped into the casing at a constant rate and followed by a small amount of water. The casing will be reciprocated during this period. Then either a prepared weighted completion fluid or weighted mud and a bump plug will follow the cement to help force the cement into the annulus as pressure is added. Cement returns to the surface will be observed. All displaced drilling mud will be pumped to a holding tank and/or awaiting tank/pit.

The cement slurry will be a 65-35 posmix cement. The cement consists of 35 percent posmix, 65 percent Class "B" cement and 6 percent gel. The cement slurry has a 24-hr compressive strength of 583 psi.

After the cement hardens, small diameter working tubing will then be run into the casing until bottom is tagged. Weighted completion fluid or weighted mud will be replaced by water through reverse circulation. Completion fluid will be pumped to storage tanks for reuse. Necessary cased hole electric logs will be run at this point in time.

Following selection of perforating zone, the casing will be perforated with four shots per foot with a steel hollow carrier-shaped charge perforating gun with 90^{o} phasing under negative head conditions. Cleanup of the well will follow by pumping the well until conductivity and pH stabilizes.

All perforations will be performed at least six feet away from the clay-and-mudstone barriers in the Westwater Canyon Formation which isolate the ore-bearing zone from the remainder of the Westwater. These barriers along with the overlying Brushy Basin and underlying Recapture formations serve as confining barriers to vertical leachate movement.

2.2.6 Underground-Flow Patterns and-Confinement-of-Leachate

Underground leachate control is important from two aspects, resource recovery and environmental considerations. Figure B 2.2.5.1-1 is a plan view of underground leachate flow for a series of five-spot leach patterns in a uniform medium. An injection well is located on each corner with a production well in the center of each pattern. The producing (or pumped) well creates a drawdown around the well by pumping one to five percent more liqid than injected and thus creating an artificial flow toward this well. The producing well becomes both a pressure and a fluid sink in the formation. The dashed lines (flow lines) shown in Figure B 2.2.5.1-1 represent the pathway followed by the leach solution as it flows from an injection well to the production well. The aggregate of flow lines indicates the portion of the production area which is contacted by leachate.

Several configurations for well field development may be employed and may include staggered line drive, direct line drive, seven spot, and inverted five spot (Figure B 2.2.6-1). In an effort to develop an understanding of these various configurations a typical five-spot leach pattern is discussed first. Second, there is a discussion of staggered line drive, the most probable configuration to be used and the one illustrated for initial well field development (Figure B 2.1-2). Finally, there is a description of other well field development configurations.

Within a single five-spot well pattern, the leachate solution first flows radially outward in all directions from an injection well. Due to the pressure sink created at the production well by pumping, the solution is drawn toward it to replenish the fluid continually pumped out. The distance which the flow lines extend away from the injection wells represents the areal extent of the leachate and is dependent upon the amount of fluid injected, the intensity of the pressure sink, and the formation characteristics. The pressure sink created during leaching operations confines the leachate within the production area. The pressure sink will be regulated so that a maximum area within the monitor well circle and ore body is contacted by the leachate.

In the staggered line drive well field development, the leachate will be injected into a series of typical five-spot patterns with injection wells spacing of 60 m (200 ft). The pregnant leachate will be extracted through the central production wells in each pattern; however, there is hydrologic communication between each pattern allowing for greater areal coverage of the ore body. As a result of the hydrologic communication between patterns the

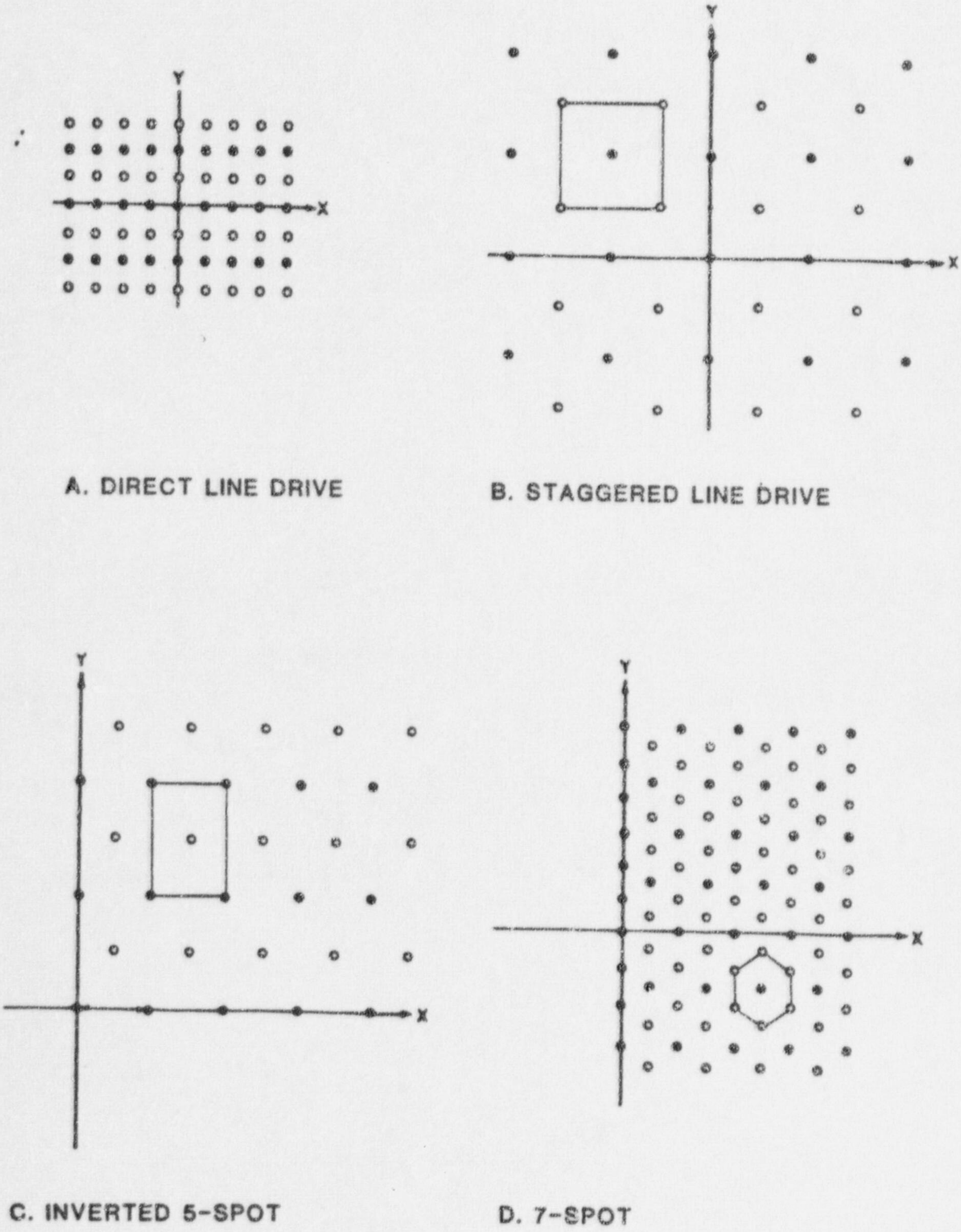


Figure B 2.2.6-1 Standard injection/production well arrangements for in-situ leach mining of uranium, ● producing wells, o injection wells.

volume of leachate injected per well varies with its location in the commercial well field. Injection wells within the center of each commercial pattern contribute one-fourth of their leachate to the surrounding production wells, wells located on the edge of the pattern contribute equal volumes of leachate to two production wells, and those wells on the corner of each commercial commercial pattern contribute all of the injected leachate to the nearest production well. To sustain the pressure differential between the injection and production wells and to balance chemical components in the reinjected solution, a small excess of liquid (one to five percent) is bled to the operating pond.

Each of the other well field development configurations also has hydrologic communication within the pattern. In the direct line drive pattern injection wells in the center of the pattern can be in hydrologic communication with six production wells. Injection wells on the periphery may be in communication with at least three production wells. Those at the corners provide leachate to two production wells.

The seven-spot configuration places six injection wells around each production well. Peripheral injection wells provide leachate to two production wells and the corner injectors supply at least one producer.

The inverted five-spot is essentially the reverse of a typical five-spot pattern. In this configuration, however, the injection wells become the producers and the production well becomes the injector. As there were four injection wells around each producer in the typical five-spot pattern, the inverted five-spot has four production wells around each injector.

In all of these commercial development patterns the volume of leachate injected per injection well is dependent upon its location within the pattern.

Figure B 2.2.6-2 is a side view schematic of the underground flow in a homogeneous, isotropic medium from an injection well to the production well. The solution moves radially out from perforations in the casing of the injector well with a component of flow in the vertical and horizontal direction

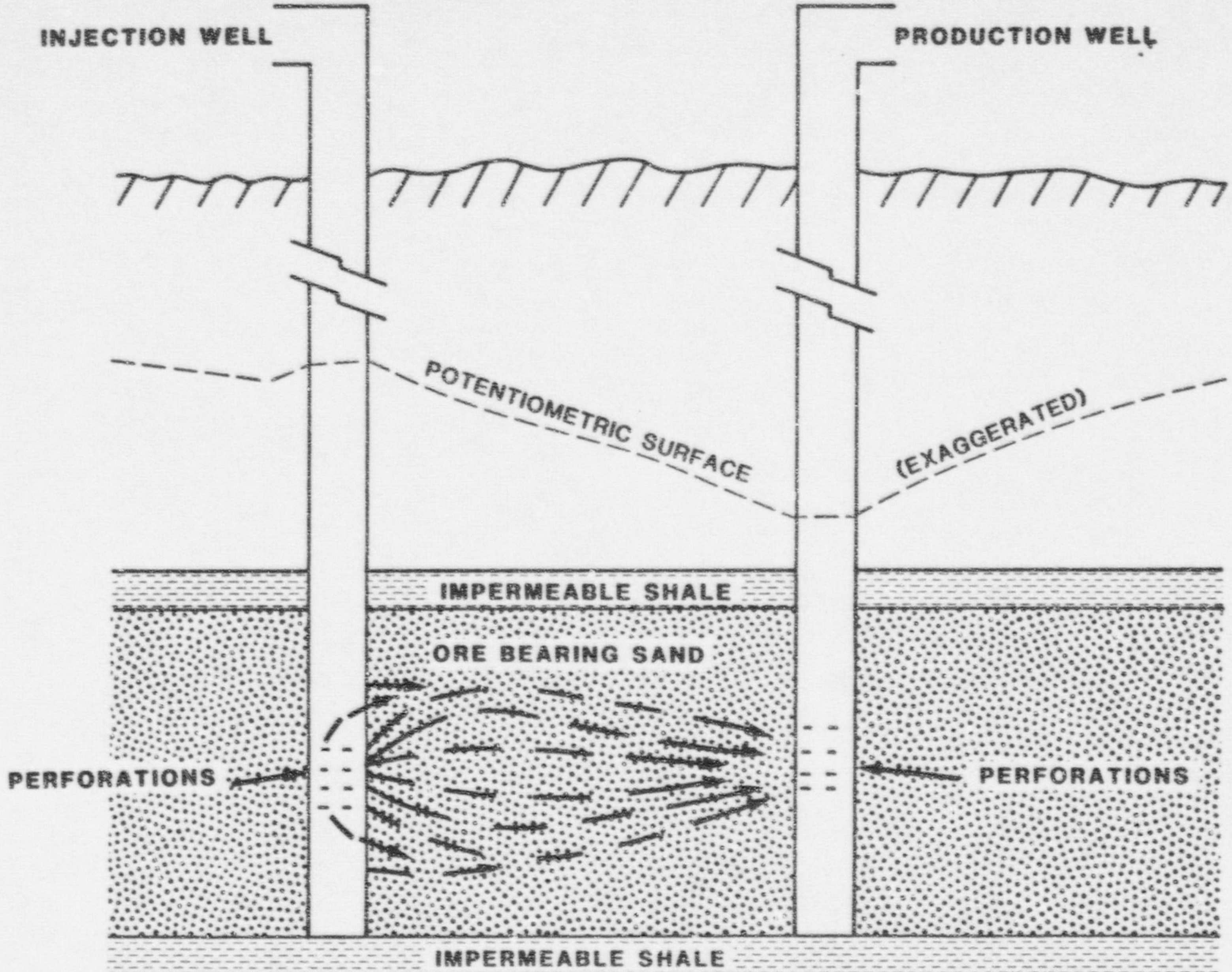


Figure B 2.2.6-2 SCHEMATIC OF LEACHATE FLOW - SIDE VIEW

IN-SITU URANIUM LEACHING PROCESS

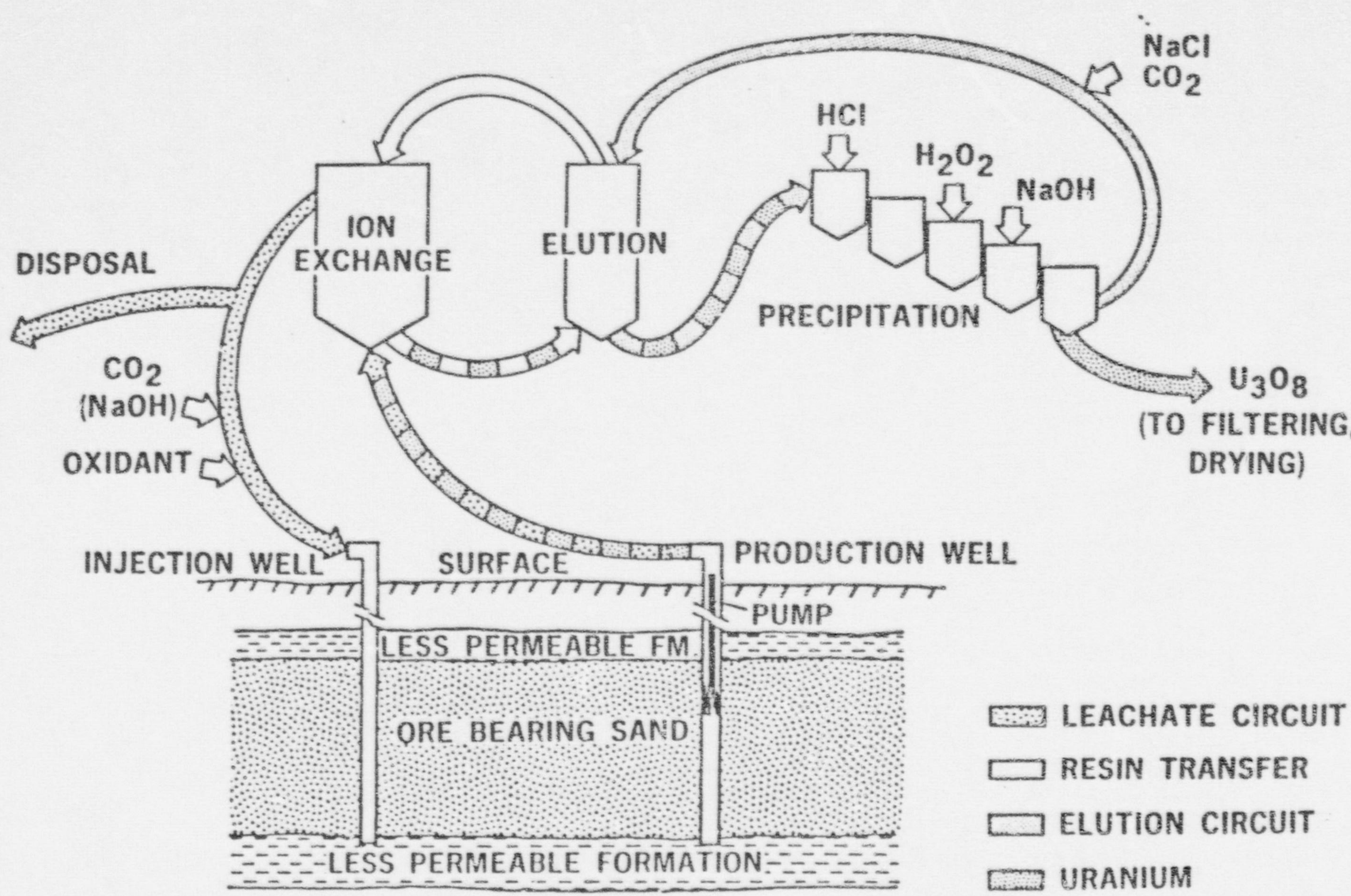


Figure B 2.2.7-1

toward the production well. The injected leachate solution moves fastest toward the producing wells along the radial flow lines, with the solution along peripheral flow lines, the slowest. The vertical envelope is established by the pressure differential, injection/production flow imbalance, and by the length of the perforated interval in the injection and production well casings. Additionally, the relatively impermeable strata above and below the leach zone provide geological control to prevent vertical excursions out of the production zone.

Monitor wells which surround the well fields allow for detection of any leachate movement outside the production area. As the commercial well fields are developed to include increased production requirements (2,100- and 3,000-gpm leach plants) and as patterns are solution mined and restored, some of the existing monitoring wells will be incorporated into the commercial well field pattern as injection or production wells. Restored production and/or injection wells may become monitor wells. New monitor wells will be drilled ahead of the advancing development. Excursions are unlikely due to the pressure sink which causes a net flow of groundwater towards the production area. In the unlikely event of an excursion, corrective measures will be immediately implemented (Appendix A). Injection/production rates will be adjusted to create a greater pressure sink at the appropriate production well(s) causing a greater influx of groundwater.

2.2.7 Recovery Process

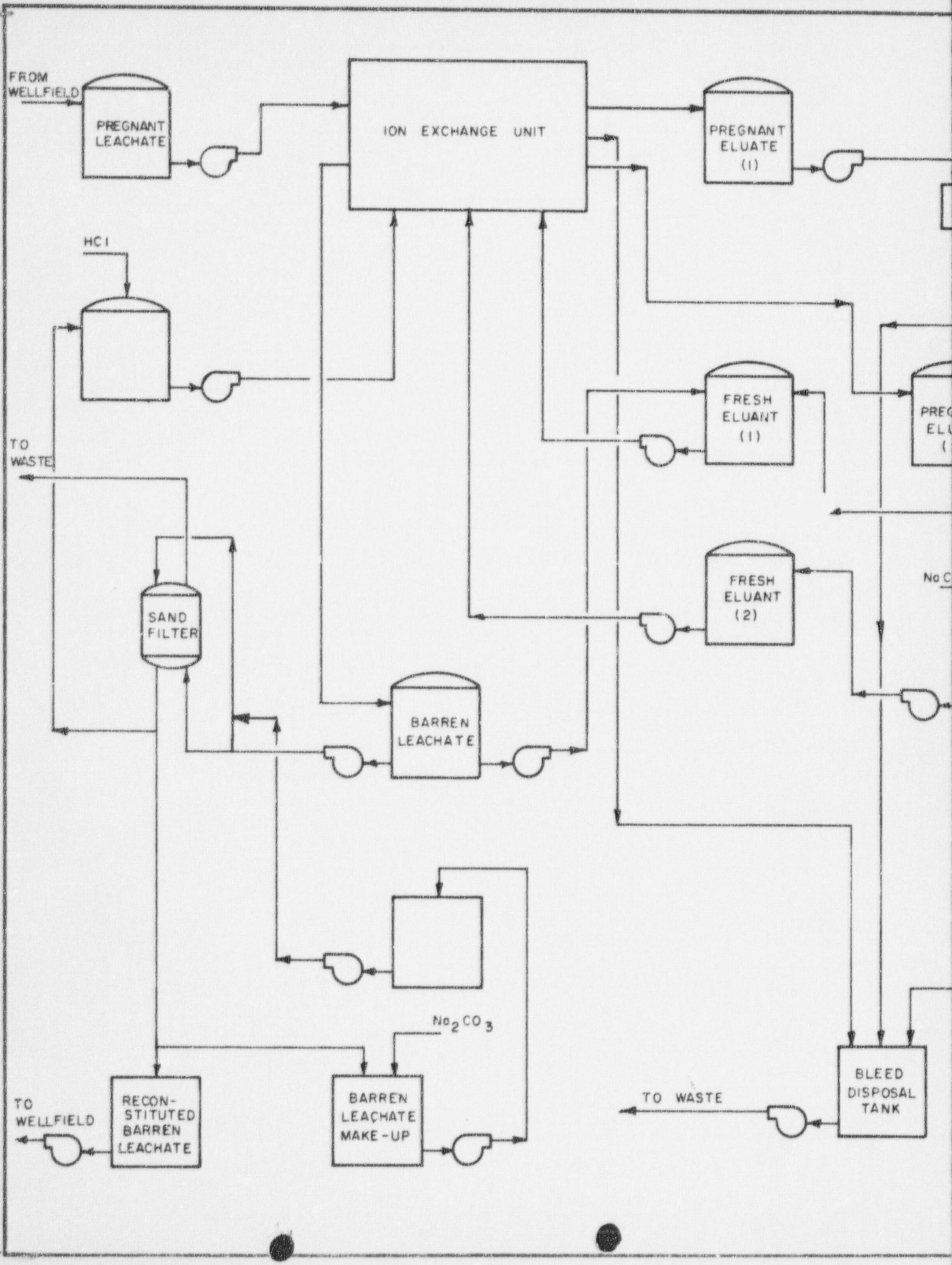
Figure B 2.2.7-1 is a simplified schematic of the in-situ uranium leaching process. A recirculating system will be established between the production wells completed into the ore-bearing horizon, surface equipment consisting primarily of ion exchange columns, and injection wells completed into the ore-bearing horizon. The injection wells in the initial well fields will be about 42 m (141 ft) from the production well. The leachate is an aqueous solution made up of formation water with increased bicarbonate (HCO_3) and an oxidant. These chemicals will be added to the water prior to injection. If necessary sodium hydroxide (NaOH) will be used to adjust the pH of the injected leachate. The lixiviant oxidizes the reduced uranium. The oxidized uranium then combines with the bicarbonate to form a water-soluble uranium carbonate complex $(UO_2[CO_3]_3)^{-4}$. This is pumped to the surface through the production well.

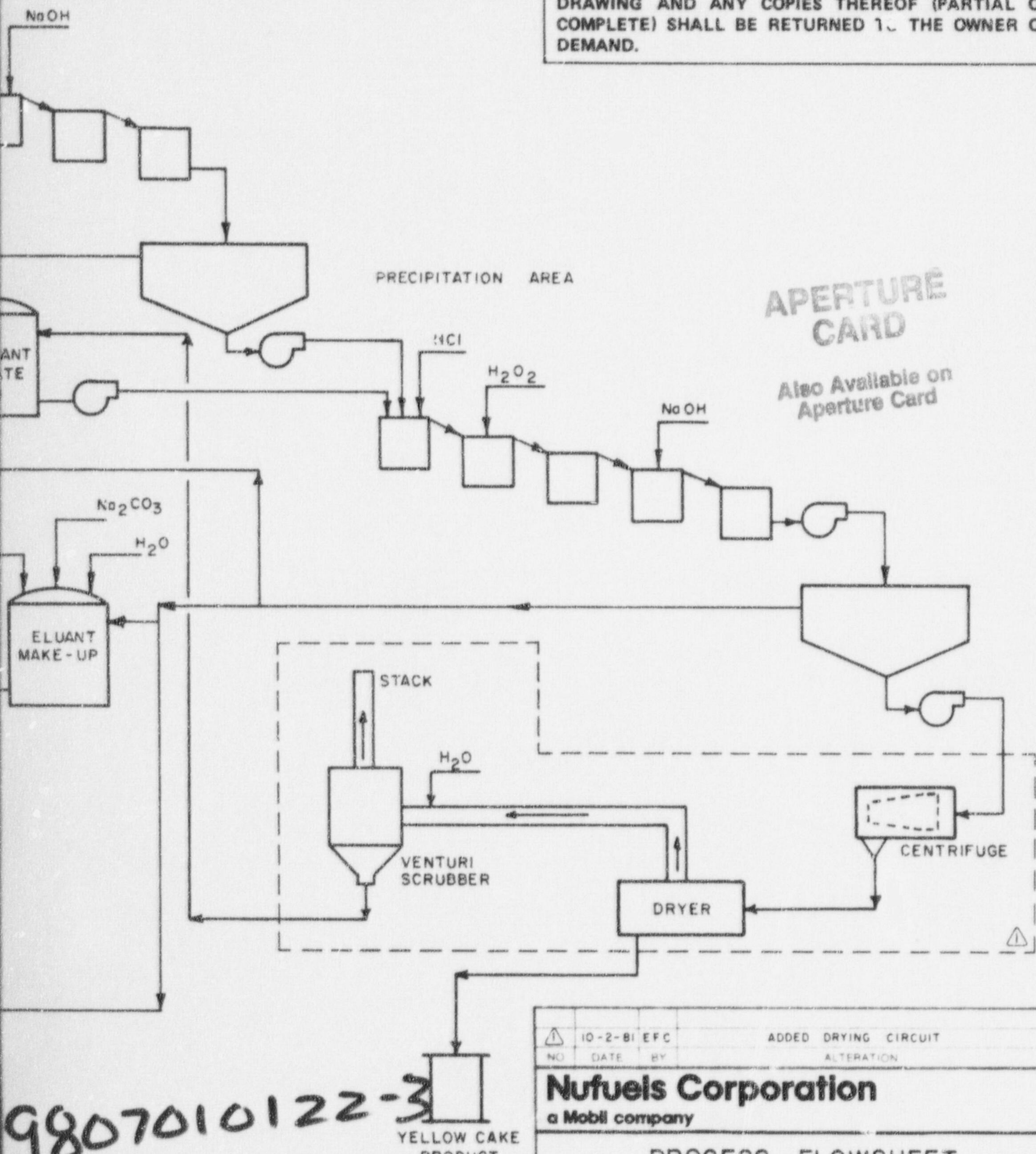
The solution containing the uranium is termed the pregnant leachate or lixiviant. It may contain up to about 300 ppm uranium. The pregnant lixiviant will be passed through an ion exchange column where the uranium carbonate will be adsorbed on the ion exchange resin resulting in barren leachate. The barren leachate or lixiviant will be recirculated back into the formation through the injection wells to continue the leaching operation after fresh chemical addition to restore required leaching concentrations. Figure B 2.2.7-2 is a schematic of the leach plant precipitation, ion exchange process.

The ion exchange system is almost a continuous operaton wherein the solution-resin contact is developed in a countercurrent fashion. As the uranium-rich leachate from the well field enters the base of adsorption column, barren resin enters the top of the column. With the countercurrent, stage wise operation, resin loaded with the uranium carbonate ion is transferred from the loading unit to the elution unit.

In the elution unit, the concentration gradient will be reversed. Loaded resin will be transferred to the elution unit where it is contacted with barren eluant. The uranium will be stripped from the resin, resulting in barren resin and a concentrated uranium eluate. Thus, both the loading and stripping columns will operate in a countercurrent process.

Both loading and elution units are closely coupled by a resin transfer system. Resin will be withdrawn simultaneously from each unit and transferred to the opposite unit, thus forming a closed resin loop. Automatic resin discharge and transfer will be accomplished at timed intervals by a hydraulic or other appropriate system.


FROM WELLFIELD
PREGNANT LEACHATE
ION EXCHANGE UNIT
PREGNANT ELUATE (1)
HCl
FRESH ELUANT (1)
FRESH ELUANT (2)
TO WASTE
SAND FILTER
BARREN LEACHATE
Na_2CO_3
TO WELLFIELD
RECON-STITUTED BARREN LEACHATE
BARREN LEAÇHATE MAKE-UP
TO WASTE
BLEED DISPOSAL TANK



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ENCLOSED AREA TO BE ADDED UPON EXPANSION FROM 600 gpm TO 2100 gpm

NO	DATE	BY	ALTERATION
1	10-2-81	EFC	ADDED DRYING CIRCUIT

Nufuels Corporation
a Mobil company

PROCESS FLOWSHEET
IN SITU LEACH PLANT
CROWNPOINT

DRAWN R.G.A
CHECKED
APPROVED W.K.Y.
SCALE NO
DATE AUG.

Figure B 2.2.7-2

B-173 (10/22/81)

In the anion resin loading column, the uranium carbonate ions ($UO_2[CO3]_3^{-4}$) displace chloride ions and are adsorbed by the resin. In the stripping (elution) column, this process is reversed with a high concentration chloride eluant displacing the uranium. In the ion exchange system, the uranium is concentrated to approximately 100 to 200 times the concentration of the original pregnant leachate from the well field. These reactions are summarized in Figure B 2.2.3-1.

The elution circuit consists of the stripping unit and an eluant makeup facility where fresh eluant is prepared. Clarified decant solution overflowing the yellowcake thickener is regenerated as fresh eluant by the addition of NaCl. The concentrated uranium solution (eluate) discharged from the elution unit will contain approximately 6,000 to 15,000 ppm uranium. The eluate, then, flows to a continuous six-cell precipitation circuit where the uranium carbonate complex is decomposed with acid and the uranium precipitated as UO_4. The resultant yellowcake slurry, is passed through a clarifier where the solution and solids are separated. The clarified decant will be recirculated to the barren eluant holding tanks for reuse.

For the 600-gpm leach plant facility, the solids will be filtered, washed, reslurried and shipped in bulk. A dryer and packaging facility for yellowcake will be designed, constructed, and operated at the South Trend Development Area process plant when production is increased to 2,100 gpm.

2.2.8 Recovery Facility

Site layout, including processing plant, wells, pipelines, and tankages will be located in such a way that no archaeological sites will be disturbed. (Figures B 2.1-2 and B 2.2.8-1). Figure B 2.2.8-2 shows the plot plan for the leach plant. Figure B 2.2.8-3 shows a simplified perspective drawing of the plant. The modular 600-gpm plant facility is illustrated in Figure B 2.2.8-4 a and b. Curbs are planned for the process area for containment of any possible spills. Because of the severity of winters at Crownpoint, insulation may be required on all exposed pipe surface lines. Collector pipe lines from the individual wells and from the well fields to the processing plant will be buried in the soil to a depth of about three feet.

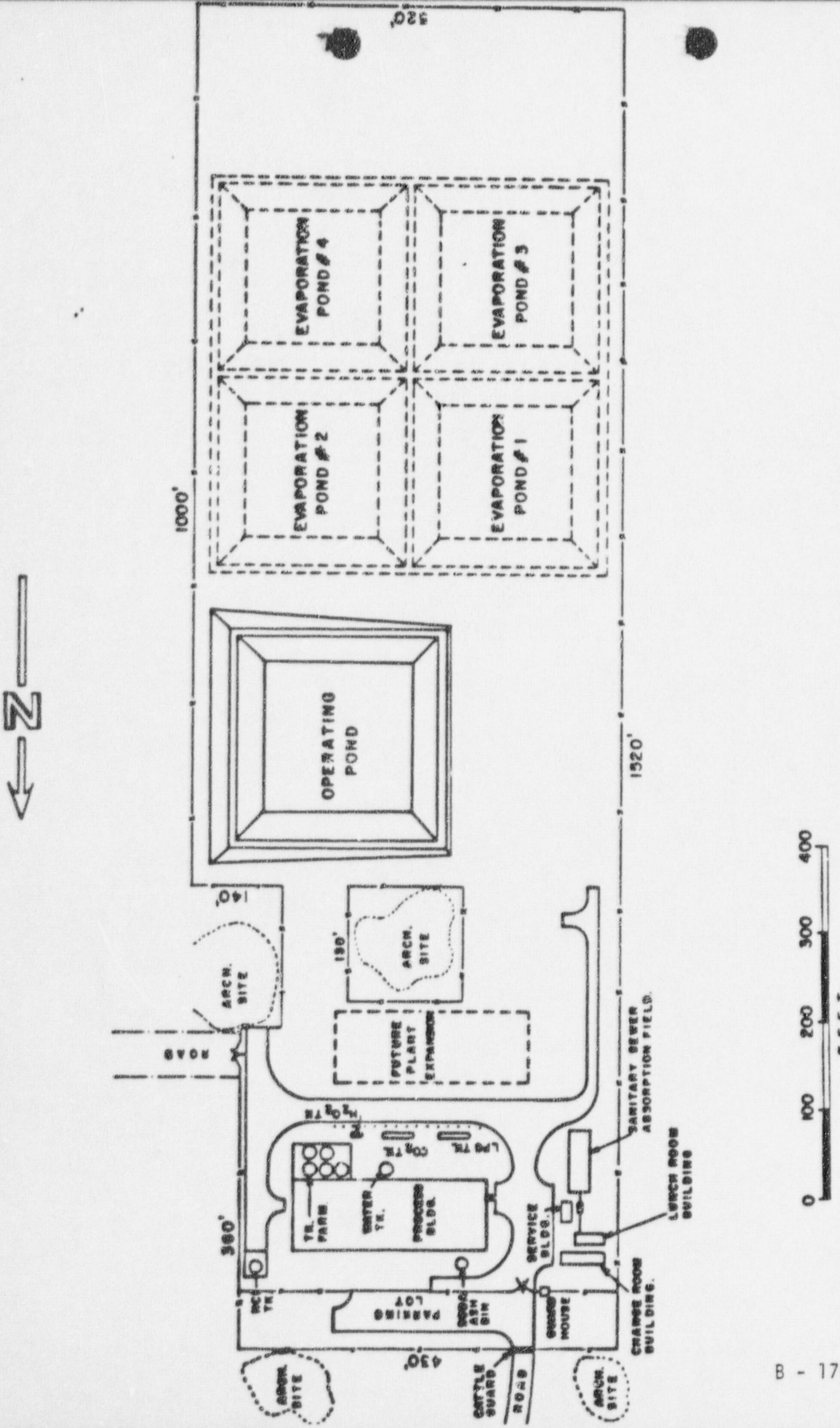


Figure B 2.2.8-1 PLANT SITE, OPERATING POND, and EVAPORATION PONDS

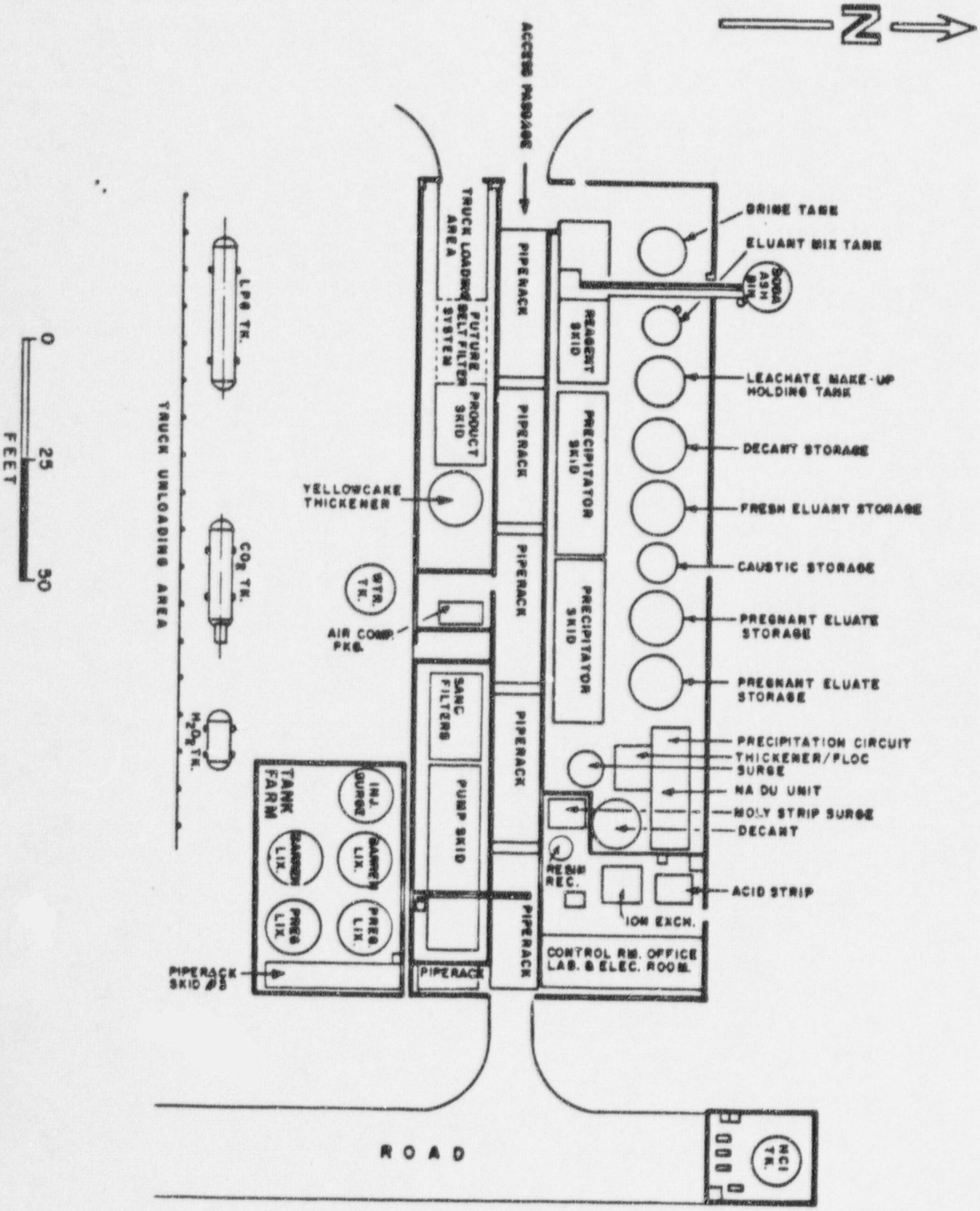


Figure B 2.2.8-2 SCHEMATIC of PLANT SITE

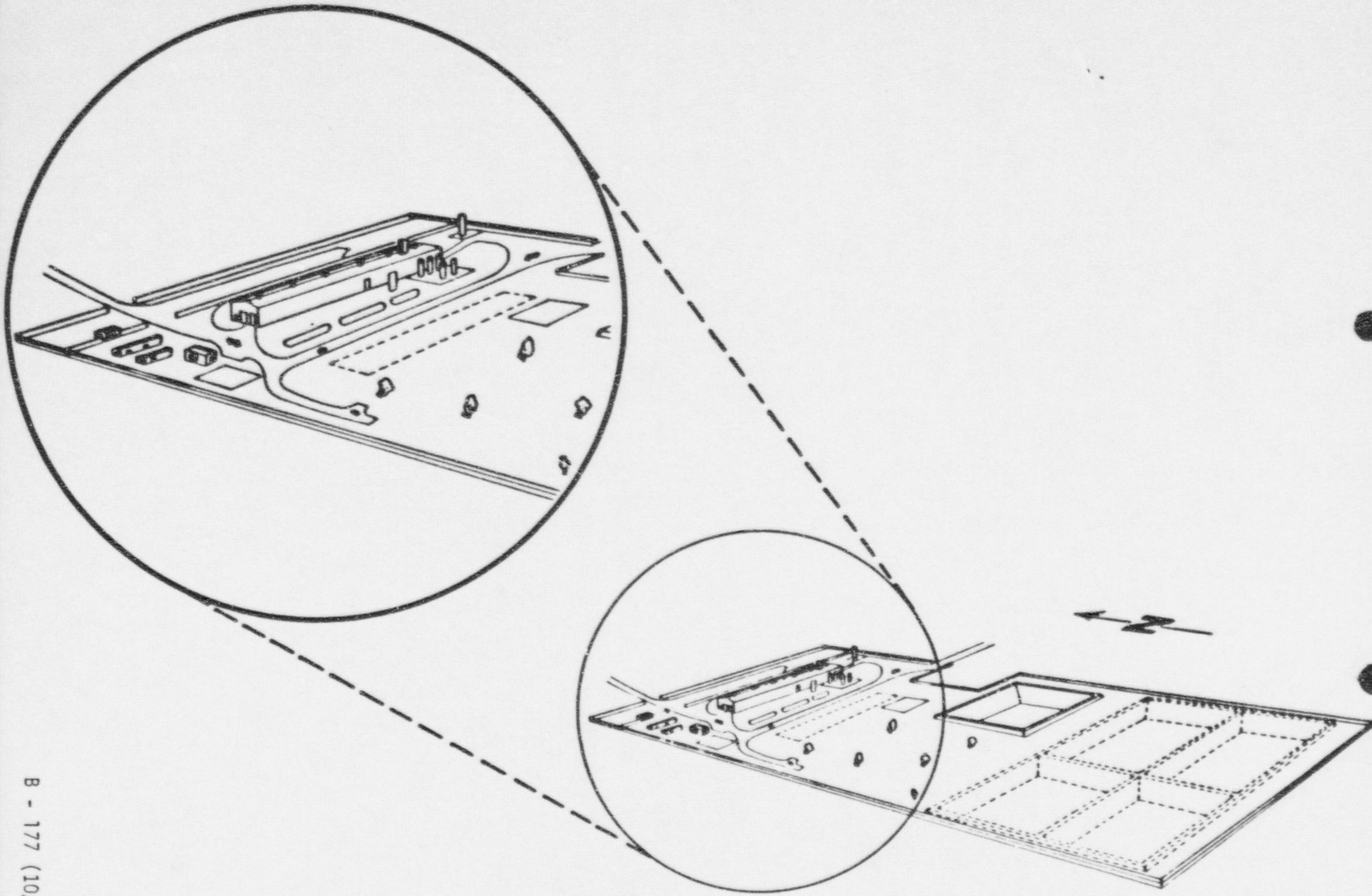
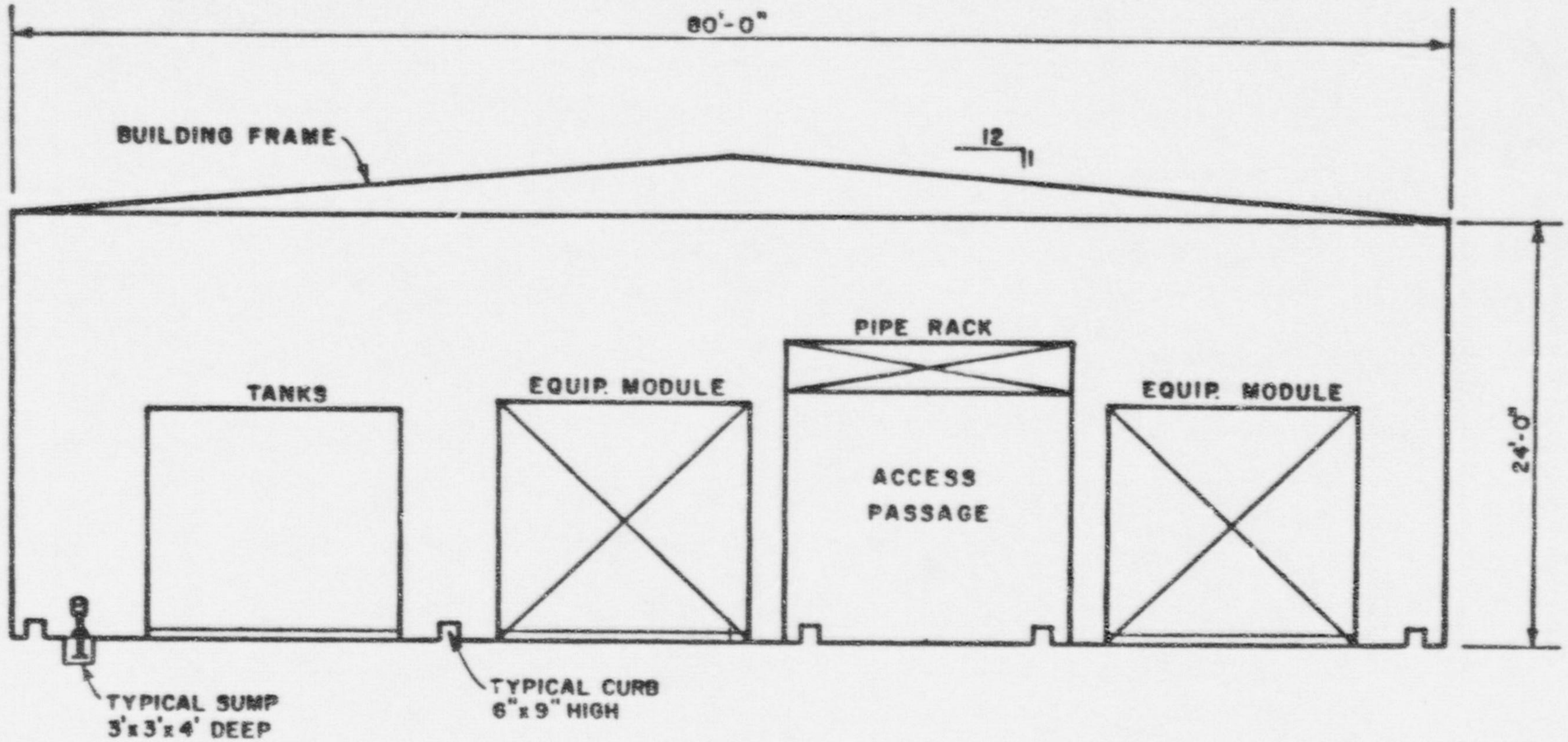


Figure B 2.2.8-3 SIMPLIFIED PERSPECTIVE OF THE PLANT SITE



TYPICAL SECTION

SCALE: 1"=10'-0"

NOTE:

1. ALL AREAS CURBED AND SUMPED.
2. EMERGENCY OVERFLOW TO POND BY GRAVITY.

Figure B 2.2.8-4a SCHEMATIC DRAWING of 600 GPM PLANT

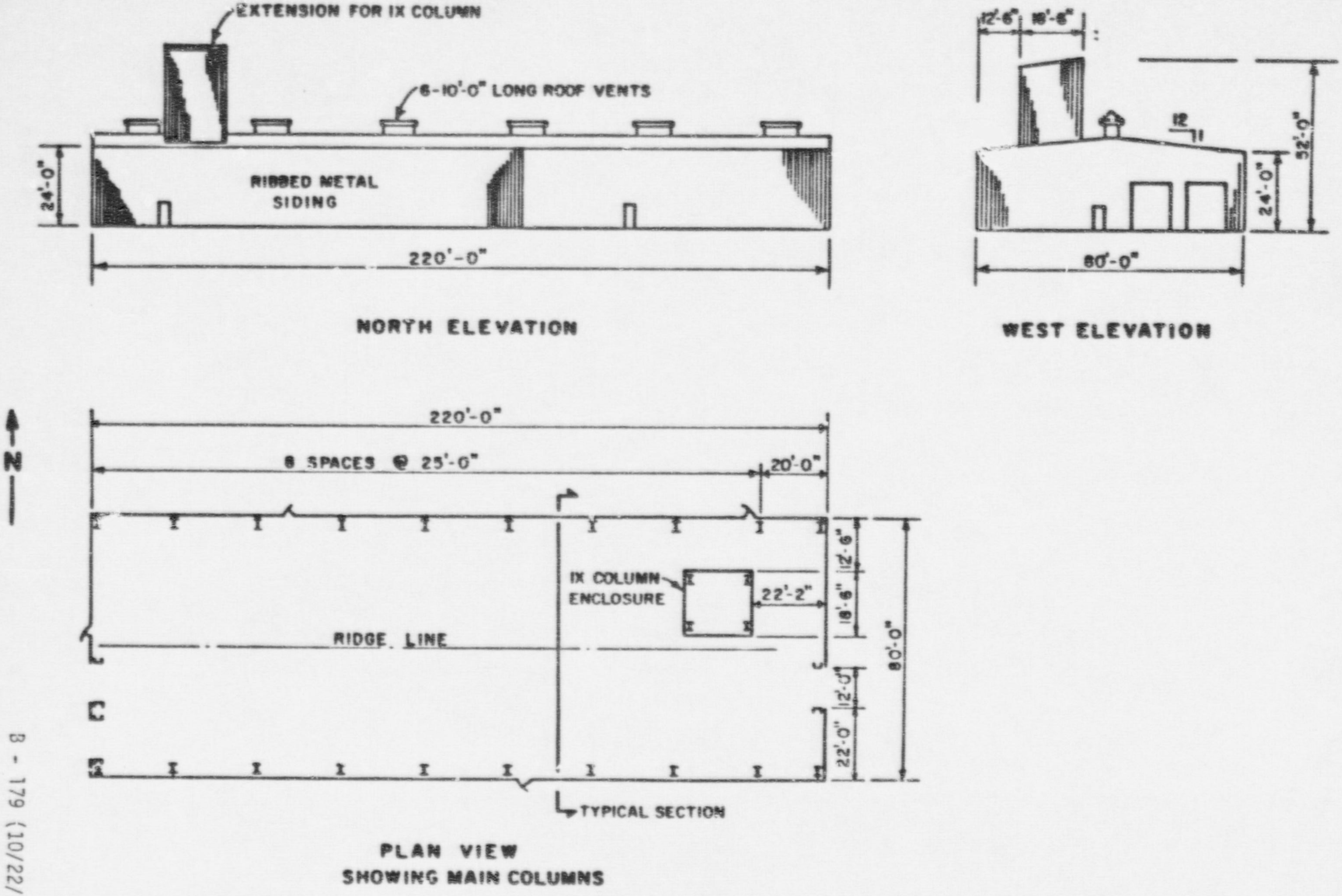


Figure B 2.2.8-4b EXTERIOR PLANS of 600 GPM PLANT

Related equipment located on-site consists of a storage shed for chemicals and spare parts and plastic-lined operating and possible evaporation (waste) ponds.

2.2.8.1 Security Areas

The fenced security areas will include the operating and possible evaporation ponds and the plant, storage, and work areas (Figure B 2.2.8-1). The yard within the fenced area will be graded for vehicle travel and parking.

2.2.8.2 Access Roads

Access to the site will be over a new road from Navajo Highway 9 (Figures B 2.1-1 and B 2.1-2a). The road bed will be graded and crowned, and will be surfaced with gravel or crushed rock. The road splits shortly after exiting from Navajo Highway 9, forming parallel routes which reconnect near the proposed plant site (Figure B 2.1-2a). Modifications to the road alignment are necessary to make it more compatible to traffic needs and to avoid archaeological sites. Since the South Trend Development Area is generally used for livestock range, cattle are restricted from Navajo Highway 9 by a cattle guard.

Other roads will be of a more temporary nature. These will be graded and provide access to the well fields during development, operation, and restoration. These temporary roads will have a finite lifetime and will be modified frequently to provide better access to new well field development. Likewise, as well fields are restored, unused roads will be reclaimed by cultivating and seeding. All temporary roadbeds will be reclaimed at the end of the project.

2.2.9 Waste Sources

During the solution mining process, both liquid and solid waste will be generated. The following sections discuss the waste sources and subsequent disposal plans for the wastes as they relate to the production portion of the in-situ leach operations. (Waste Sources developed during Restoration are discussed in Section 2.3.3.)

2.2.9.1 Solids

Solid waste generated during leaching will consist of:

- o alum sludge from the reverse osmosis pretreatment unit;
- o contaminated laboratory waste and equipment;
- o low-level radioactive solids in the evaporation (waste) pond; and
- o contaminated radioactive soils from accidental spills.

2.2.9.2 Liquids

Liquid effluents will be generated; however, there will be no liquid effluents released from the site. Liquid waste will consist of laboratory wastes, fluids collected within the curbed process area, and waste water from the reverse osmosis unit. The concentrates being produced by the reverse osmosis unit will flow to the fenced operating and evaporation ponds at a rate of about 10 - 15 gpm (600-gpm facility, with a maximum bleed of 100 - 150 gpm (3,000 gpm facility).

Some of the liquid effluent will be evaporated off. However, the majority of the effluent will be disposed of by injection into a waste disposal well. Eventually it will be necessary to remove the sludge which will collect in the pond, since the solids will contain very low level radioactive material. The sludge will be disposed of as outlined in Section 2.2.10.

2.2.9.3 Airborne Matter

No significant nonradiological airborne wastes will be emitted. Radiological emissions are discussed in Section 3.6.

2.2.10 Solid Waste Disposal

The solid waste described in Section 2.2.9.1 will be disposed of in accordance with applicable regulations. Radioactive waste will be disposed of at an approved burial site or by methods described in applicable regulations. The operating and evaporation ponds and pond liners will remain in use during the operation phase and restoration of the aquifer.

Radioactive waste will not be buried at the site. The specific final disposal site(s) have not been identified; however, on-site temporary storage facilities will be provided.

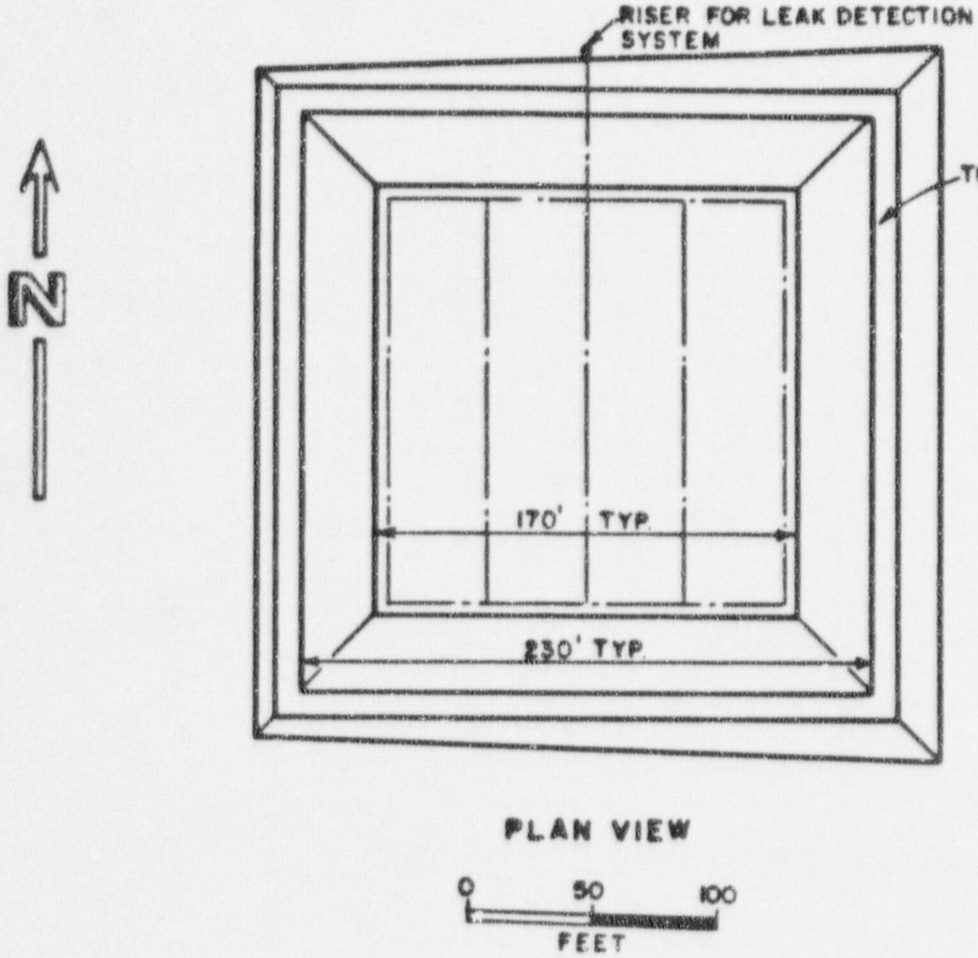
Contaminated equipment and low-level waste will be either placed in closed barrels, wrapped in heavy plastic to prevent airborne hazards, or decontaminated. These containers will be stored in a specifically designated restricted-access area within the test site security fenced area. The storage area will be posted as a radiation hazard site. Final disposal of the contaminated and decontaminated equipment and low-level waste will be in compliance with Federal and State regulations.

2.2.11 Operating and Evaporation Ponds

The operating pond (Figure B 2.2.8-1 and Figure B 2.2.11-1) is provided to handle all liquid effluents from the plant before they are disposed of down the disposal well. The bottom and slopes of the pond (Figure B 2.2.11-1) will be covered with select sand or an approved geotextile blanket. A leak detection system consisting of 4-in. slotted PVC pipe laid in gravel filled trenches, will be constructed. The sand is then covered with a 36 mil Hypalon plastic liner. There will be four shallow monitor wells located near each corner of the pond. These, along with the leak detection system, will be used to monitor the liner integrity.

The operating pond will be used to contain the bleed necessary to maintain a net influx of ground water into the leach area to facilitate underground leach control. It is also used to received any R. O. brine and to control buildup of undesirable ions (e.g., chlorides, sulfates) in the recycled lixiviant and elution circuits. The operating pond is sized to contain, under normal operating conditions, up to 50 days reserve capacity in case of disposal well shut-in. This is based on a bleed figure of 4%.

Evaporation ponds will be constructed only if the disposal well is not permitted. the location of these ponds is shown in Figure B 2.2.8-1. Sixty-two acres has also been set aside (Figure B 2.1-2) for future ponds which would



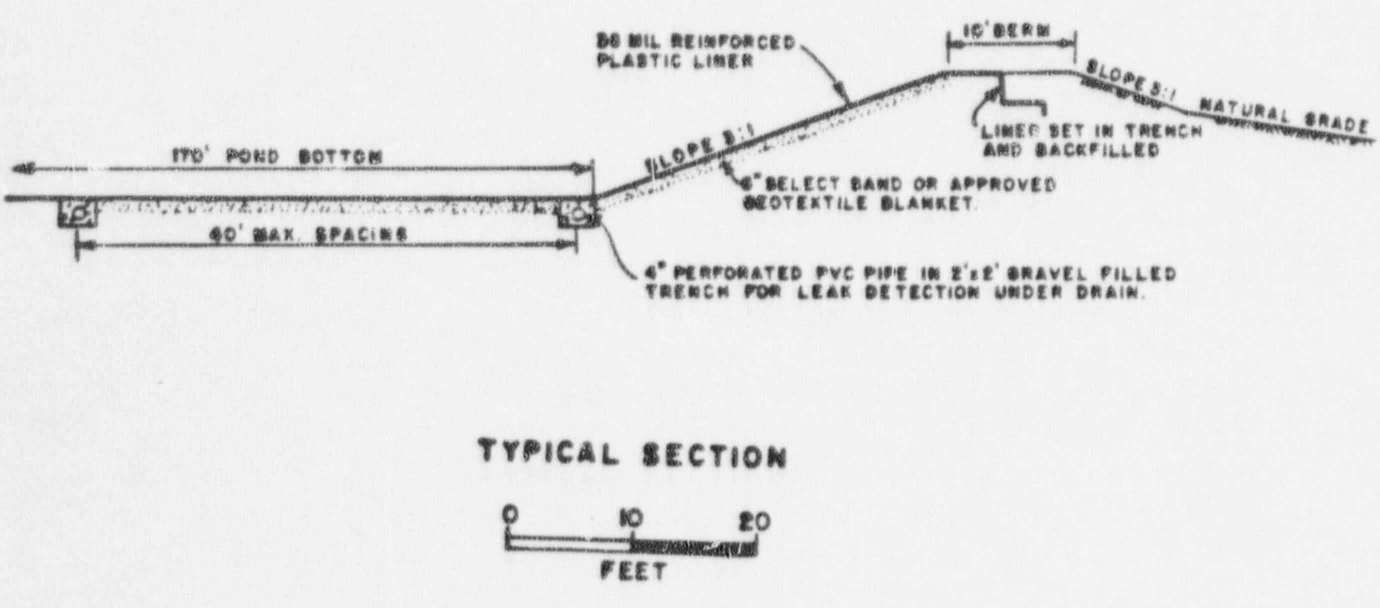


Figure B 2.2.11-1 OPERATING POND

be needed, when the plant is expanded, in the event waste disposal wells were not available for disposal purposes. Construction details for the evaporation ponds (Figure B 2.2.11-2) are similar to the operating pond. Monitoring of the evaporation ponds would be the same as for the operating p[illegible].

2.2.12 Disposal Well

Disposal of all liquid wastes is proposed to be via deep well injection into a zone below the base of fresh water that contains non-potable water. The application and technical report containing all supporting data concerning the proposed waste disposal wells will be submitted under separate cover. At this time Mobil plans to seek approval for two waste disposal wells to be used for liquid waste disposal at the South Trend Development Area Project. These wells will be located within the South Trend Development Area boundaries as defined in this application.

The advantages of utilizing waste disposal wells for disposal of liquid effluents are as follows:

1) Minimal surface disturbance in areas containing archaeological sites;

2) Safe and more secure from a pollution standpoint;

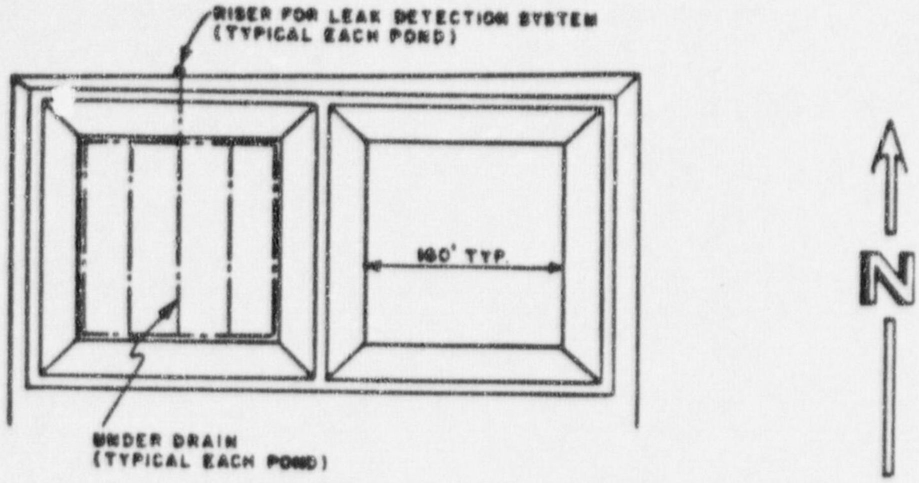
3) Contributes to a cleaner and more prudent operation with minimal visual disturbance to the area;

4) Requires simpler and more positive monitoring procedures; and

5) There would be no impact due to adverse weather conditions.

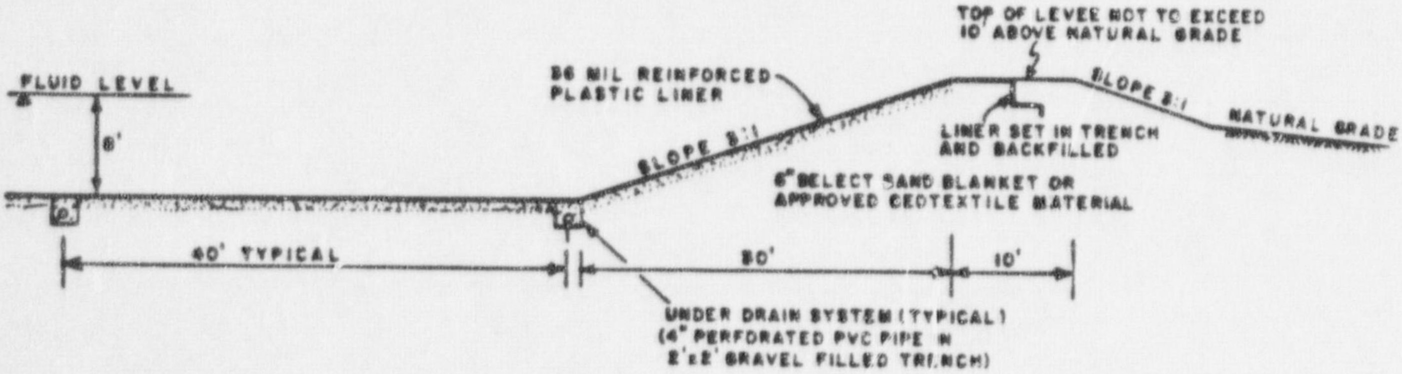
2.2.13 Dryer Operation

(Dryer will not be installed until production is expanded to 2,100 gpm.) After extraction and precipitation, the uranium concentrate will be washed to



PLAN VIEW

0 100 200
FEET



TYPICAL SECTION

0 10 20
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Figure B 2.2.11-2 EVAPORATION POND

remove soluble impurities, dewatered in a centrifuge, and dried in a furnace. Emission of particulates to the air during uranium concentration and drying will be controlled by a wet scrubber with the efficiency of 95 to 99 percent. The finished product will be packaged in 55-gallon metal drums, and stored until ready for transport.

2.3 RESTORATION

Operations at the South Trend Development Area consist of two components: Leaching and Restoration. The leaching operation is anticipated to commence during late 1982 and continue for 24 years, the expected commercial life of the ore body. Restoration of each operational area will begin after its commercial production life has been expended and continue until the required standards are met or baseline conditions attained.

Restoration of an area (Table B 2.1.2-1) will begin immediately after the leaching ceases. Non operational areas will serve as buffer zones to prevent communication with areas being leached.

In the following sections, restoration criteria and programs of aquifer restoration will be discussed. In addition, both waste sources and waste disposal with respect to restoration will be defined.

2.3.1 Restoration Criteria

The New Mexico Environmental Improvement Division (NMEID) recognizes the authority of the Water Quality Control Commission (NMWQCC) to promulgate regulations and standards in the area of water pollution. As such, the regulations outlined in Sections 3-103 and 3-109.D.1 of the NMWQCC regulations are applicable to the South Trend Development Area. These regulations are based on New Mexico Standards for Groundwater of 10,000 ppm total dissolved solids or less. Table B 2.3.1-1 lists the parameters and standards set forth by the MNWQCC which will be used to establish restoration criteria. When a chemical specie's baseline level is less than that listed in Table B 2.3.1-1, the aquifer will be restored to the concentration of that chemical

Table B 2.3.1-1

New Mexico Standards for Groundwater of 10,000 mg/l TDS Concentration or Less

Parameter	New Mexico Standard (mg/l)
Aluminum	5.0
Arsenic	0.1
Barium	1.0
Boron	0.75
Cadmium	0.01
Chloride	250.0
Chromium	0.05
Cobalt	0.05
Copper	1.0
Cyanide	0.2
Fluoride	1.6
Iron	1.0
Lead	0.05
Manganese	0.2
Molybdenum	1.0
Mercury	0.002
Nickel	0.2
Nitrate	10.0
pH	6-9*
Phenols	0.005
Radium 226 and 228	30.0 pCi/l
Selenium	0.05
Silver	0.05
Sulfate	600.0
Total Dissolved Solids	1,000.0
Uranium	5.0
Zinc	10.0

*Dimensionless (units)

species listed in this table. In ..tances when a chemical species whose baseline level is greated than that listed in Table B 2.3.1-1, the aquifer will be restored the the average concentration of that chemical species for all wells, except as provided in Subsection 3-109.D.1 of the NMEID Water Quality Control Commission Regulations. In the event that the provisions of Subsection 3-109.D.1 are to be taken into account to determine conformance, the weights and sources of contaminants in the diverted water will be established to the satisfaction of the NMEID. A demonstration that the contaminants in question where in the water before it was diverted and were not added to that water during leaching process will be presented.

In the unlikely event that the water at the test site is not returned to the NMWQCC Regulation limits/baseline concentrations except as provided in Subsection 3-109.D.1 at the end of restoration, an analysis of potential impacts for the constituents of concern will be performed and the data will be presented to the NMEID. Using this information, postoperational monitoring and remedial programs will be developed for the constituents that are outside the defined limits. Then, an agreed-upon program will be implemented to meet the requirements of the regulations.

2.3.2 Restoration Program

In order to meet the criteria described in Section 2.3.1, the aquifer in which the solution mining operation takes place will be restored by reestablishing the reducing environment. This will be accomplished by flushing the leach zone, sweeping natural oxygen-free groundwater through the production zone, and by producing without injection in the area to be restored. Production rates may be significantly lower than when mining.

The water withdrawn during restoration will be put through a reverse osmosis clean-up process in which the salts, and other constituents in the groundwater will be concentrated into approximately 10 - 20 percent (average 17 percent) of the withdrawn water. The remaining purified water will be reinjected at some distance from the restoration area into the aquifer. This process will continue until restoration is completed.

Procedures for restoration are listed in Table B 2.3.2-1. The first category addressed in aquifer restoration is total dissolved solids. The second category includes the heavy metals such as arsenic, cadmium, lead, mercury, nickel, and iron. The third category is radium-226 and 228 (combined).

In order to gain preliminary information of restoration of the aquifer, simulated restoration tests were conducted on leached Section 9, T17N, R13W, core. Testing was by flushing the leached core with water. Some of the results of core testing are shown in Table B 2.3.2-2. In the laboratory test, a few pore volumes of the synthetic groundwater were used to flush the leached core. The results showed that the concentration of total dissolved solids were reduced from 2,580 ppm during leaching to 225 ppm after overflushing with about 10.6 pre volumes. This reduced concentration of total dissolved solids was below the baseline value. Upon completion of the laboratory restoration tests, all parameter concentrations were reduced to near baseline values and below the New Mexico standards listed in Table B 2.3.1-1.

Requirements for restoration should include the consideration of groundwater composition changes due to intrusion of groundwater that differs in composition from that defined by the baseline groundwater quality analyses. For example, at the Crownpoint Pilot Leach Plant (Section 9, T17N, R13W) the existing baseline water quality data from the test wells (Table B 2.3.2-3) indicate there are significant differences in the groundwater composition even within the relatively small test area. These data suggest groundwater composition anomalies are localized and formation induced. (Similar findings were reported for the Monument Site, Section 28, T17N, R12W, MCC 1980.) These findings have great significance for restoration goals because of groundwater intrusion, both during the leaching phase and particularly during the restoration phase. Pulling regional groundwater into the test area could elevate baseline concentrations in the restored area, but would represent those occurring naturally in the groundwater exterior to the development pattern. This phenomenon can affect parameters for which baseline water quality analyses indicated background levels both above and below the limits set forth in the NMWQCC Regulations, Section 3-103. Because of this large variability in water

Table B 2.3.2-1

Aquifer Restoration Procedure

Parameter	Procedure
Total Dissolved Solids	Flush leach zone with ground water and discharge to waste disposal ponds
Heavy Metals (As, Ba, Bo, Cd, Cu, Cr, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, U, Va)	Flush leach zone with ground water and discharge to waste disposal ponds
Radium-226 and 228 (combined)	Flush leach zone with ground water and discharge to waste disposal ponds

Table B 2.3.2-2

Groundwater Restoration Laboratory Leach Tests - Crownpoint
(mg/l unless noted)
Section 9, T17N, R13W, Core Fluid
(Mobil 1978)

Parameter	Base Fluid	During Leaching	Restoration With Base Fluid Overflush
Aluminum	<0.1	<0.1	<0.1
Arsenic	<0.05	0.014	0.004
Barium	0.0	0.35	<0.1
Boron	<0.01	0.1	<0.1
Cadmium	<0.001	0.008	<0.006
Chloride	15.4	11.0	16.0
Chromium	<0.01	0.03	<0.02
Cobalt	<0.01	0.06	<0.02
Copper	<0.01	0.146	<0.04
Cyanide	<0.1	<0.005	<0.005
Fluoride	0.12	0.6	0.4
Iron	<0.02	0.18	0.11
Lead	<0.05	0.08	<0.005
Manganese	0.09	0.58	0.02
Molybdenum	<0.1	0.023	0.012
Mercury	<0.001	0.00161	0.00078
Nickel	<0.01	0.05	<0.05
Nitrate	0.08	<0.02	0.40
pH (units)	8.46	7.8	7.5
Phenols	<0.1	0.007	0.002
Radium 226 & 228	0 ± 2 pCi/l	141.0±22 pCi/l	14 ±4 pCi/l
Selenium	<0.01	1.7	0.062
Silver	<0.01	0.008	<0.02
Sulfate	24.3	720.0	62.9
Total Dissolved Solids	264.0	2,580.0	225.0
Uranium	0.0	--	0.0
Zinc	0.03	0.09	0.05

Table B 2.3.2-3 Baseline Groundwater Concentrations (mg/l) - Section T17N, R13W, Wells (March 13, 1978)

Parameter	Dakota	Westwater Canyon									
	207	208	210	213	214	215	218	220	221	222	224
Bicarbonate	195	208	177	170	213	204	182	207	217	219	200
Aluminum	1.6	1.2	1.6	0.8	0.5	0.6	0.9	0.8	0.8	0.8	1.1
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<0.1	0.14	<0.1	<0.1	0.13	0.14	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Cadmium	0.002	<0.001	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.003
Calcium	24.0	70.2	18.2	4.5	3.2	20.4	6.6	3.8	7.6	3.6	4.1
Carbonate	0	0	0	0	0	0	0	0	0	0	0
Chloride	56.8	146	61.2	12.5	25.1	96.7	15.1	16.1	13.1	10.7	15.6
Chromium	0.001	<0.001	0.001	0.004	<0.001	0.002	<0.001	0.004	0.004	0.002	0.003
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.017	0.003	0.002	0.002	<0.001	<0.001	0.001	0.010	0.002	0.002	0.003
Cyanide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoride	0.36	0.82	0.49	0.69	0.29	0.61	0.57	0.29	0.32	0.29	0.25
Iron	8.0	7.2	8.5	0.75	0.44	3.7	1.6	8.2	0.4	1.1	8.2
Lead	0.007	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001
Magnesium	15	2.7	3.1	0.47	0.36	1.3	0.73	0.49	0.22	0.55	0.92
Manganese	0.25	0.94	0.38	0.054	0.029	0.50	0.14	0.085	0.13	0.071	0.071
Mercury, Total	<0.0004	0.0050	0.0055	0.0053	0.0048	0.0025	0.0046	0.0048	0.005	<0.0004	<0.0004
Molybdenum	<0.001	0.013	0.002	0.004	0.003	0.005	0.004	0.003	0.001	0.003	0.004
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	0.012	0.012	0.057	<0.01	<0.01	<0.01
Nitrogen, Ammonia	0.26	0.04	<0.01	0.01	<0.01	0.02	<0.01	<0.01	0.03	<0.01	<0.01
Nitrogen, Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
pH	7.0	6.6	7.0	7.1	8.3	7.0	7.2	7.8	8.0	8.3	7.9
Phenols	0.008	0.004	0.010	0.044	0.005	0.006	0.003	0.014	0.002	0.003	<0.001
Potassium	3.6	1.4	0.9	0.8	0.7	1.0	0.7	0.8	0.5	0.5	0.5
Selenium	<0.01	0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica	28.8	25.7	27.4	36.7	22.9	28.3	28.2	22.5	22.8	24.7	25.1
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	120	95	80	62	100	88	91	100	100	110	89
Solids, Total Dissolved	676	536	380	331	398	522	381	347	367	350	330
Specific Conductance (umhos/cm)	930	823	502	483	465	800	438	378	454	447	443
Strontium	2.09	2.14	1.47	0.33	0.30	0.84	0.25	0.34	0.18	0.16	0.14
Sulfate	272	34	38	38	36	33	31	32	38	39	37
Titanium	0.09	0.34	0.44	0.21	0.11	0.14	0.12	0.077	0.06	0.06	0.08
Total Organic Carbon	2.5	1.7	1.4	2.0	0.3	6.1	12.4	1.4	1.7	23.3	0.3
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.04	0.02	0.02	0.02	<0.01	0.04	<0.01	<0.01	0.02	<0.01	<0.01
Anion/Cation Ration	0.81	1.10	0.92	0.95	1.13	1.09	1.10	1.02	1.02	0.99	1.18

quality parameters, the baseline values that will be used for restoration goals will be determined using the following method. Each production and monitor well will be sampled twice. The sampling will occur after two casing volumes are removed. After the samples are analyzed, baseline for a particular parameter will be determined using the arithmetic average of the concentrations measured in all wells sampled for baseline determination. If anomalous test results are obtained a third sample will be taken for verification and/or explanation purposes.

2.3.3 Waste Sources

During the restoration, as in the leaching process, generation of both liquid and solid wastes is anticipated.

2.3.3.1 Solids

The operating pond will be used to hold the solid wastes resulting from settling and the evaporation of liquid wastes (reverse osmosis reject) that is bled to the pond during the restoration period (approximately two years per developed pattern or well field) before being put into the disposal well. A bleed stream (10 - 20 percent of the total barren groundwater being recirculated) will be pumped to the operating pond. The liquid pumped to the pond(s) may contain small amounts of suspended solids which will settle out during evaporation.

After any excess liquid in the pond has evaporated, the solid material will contain low-level radioactive wastes, muds, clays, some heavy metals, and other chemical constituents. It is speculated that the amount of solids produced will during the leaching and restoration range from 25 to 35 tons per five-spot pattern (200 x 200 ft). Restoration tests being conducted at the Pilot In-Situ Facility on Section 9, T17N, R13W in Fall 1980 will provide a basis for estimating in the Crownpoint area the amount of solids produced. Additional experience will be gained during the restoration phase of the pilot in-situ leach test at the Monument Site, Section 28, T17N, R13W.

Disposal of these solid wastes is discussed in Section 2.3.4.1.

2.3.3.2 Liquids

No liquid waste effluents will be discharged to the surrounding soils or waterways. The reverse osmosis reject and bleed stream, discussed in Section 2.2.3, will be pumped to the operating pond and disposed of in the disposal well.

2.3.4 Waste Disposal

During restoration, as in the leaching process, generation of both liquid and solid wastes (dissolved and suspended materials in the bleed stream) is anticipated. The following sections discuss the disposal of these wastes.

2.3.4.1 Solids

When the use of the operating and evaporation pond(s) is terminated, the contents of the pond(s) will be allowed to dry. The solids will be disposed of at a facility licensed to dispose of low-level radioactive wastes. The evaporation pond liner will also be disposed of in accordance with applicable waste disposal sources.

Other equipment or wastes generated by operations including buildings, drilling slabs, gravel roads, power lines, etc., will be removed (unless uncontaminated and authorized by the owner of the lease which allows them to remain) and either reused or disposed of in compliance with applicable state and/or federal laws. The land will be reclaimed using stockpiled topsoil and seeded with a mixture of native vegetation types most appropriate to the soil type.

2.3.4.2 Liquids

All liquids will be disposed of through discharge to the operating pond and the disposal well or by other methods as specified in applicable regulations. At the termination of operations, all liquids in the operating, and any existing evaporation pond(s), will be allowed to evaporate and the solids disposed of as discussed above.

reevaluated based upon additional baseline data and may be changed prior to or during the operational phase of a specific production well field area to reflect actual known variations in a regional ground water.

Conductivity: a 25-percent increase above the highest baseline value measured for all the monitor wells.

Uranium: a 5-mg/l increase above the highest baseline value measured for all the monitor wells.

Sulfate: a 25-percent increase above the highest baseline value measured for all the monitor wells.

Molybdenum: a 5-mg/l increase above the highest baseline value measured for all the monitor wells.

Sodium: a 25-percent increase above the highest baseline value measured for all the monitor wells.

Monitor well sample concentrations showing two of the five parameters to be above these values for a well will constitute a potential excursion and the leachate excursion control plan (described in Appendix A) will be implemented. However, localized variations in ground water chemical concentrations may account for the increase and may not indicate the presence of leachate.

The configuration of the initial well fields have been previously described in Section 2.2. Each well field will be surrounded by monitoring wells. Initial Well Field 1 will have 18 monitoring wells located on the perimeter of the pattern. All monitoring wells will be perforated in the ore-bearing zone in a manner similar to the injection and prodction wells. In addition to that, two monitor wells will be located in the prodction well field area and completed in the aquifer overlying the ore-bearing aquifer.

The excursion monitoring program will consist of sampling all monitoring wells every two weeks and analyzing the water samples for conductivity, uranium, sulfate, molybdenum, and sodium. The samples for this excursion monitoring program will be analyzed for conductivity and then filtered prior to further analysis at the Mobil field laboratory.

Water level measurement will be made for all monitor wells. These data will be collected prior to pumping the monitor wells for excursion monitoring and will be reported with the excursion monitoring data.

EXHIBIT 9

APPENDIX A

EXCURSION CORRECTION PROGRAM

Once an excursion has been verified, an excursion correction program will be initiated. The objective of this program is to define the reason for the excursion and to expeditiously correct it. The program entails the following corrective actions:

A. Notify the New Mexico Environmental Improvement Division (NMEID) by telephone of the affected monitor well(s) and the nature of the excursion within 48 hours of detection. Written confirmation of tha above notification will be forwarded to NMEID. Confirmation will include a statement that the program in this Appendix is being initiated.

B. Initiate increased unbalanced production (production exceeding injection) in the vicinity of the affected monitor well to ensure ground water flow from the affected well to the production area.

C. Initiate twice per week sample analysis of the affected well for excursion parameters (conductivity, uranium, sulfate, molybdenum, and sodium) beginning the next day after the excursion is confirmed.

D. Mobil will use any method judged necessary and prudent to define the extent of the leaching solutions and to effect clean up in an expeditious and practical manner. This may include the installation of a secondary well(s) beyond the affected well. In the event it becomes necessary to drill an additional (secondary) well(s) for the purpose of defining the extent of an excursion, Mobil will notify the NMEID of the proposed location(s), depths, and proposed construction of the additional well(s) in advance of the initiation of any drilling.

E. The secondary well(s) will be completed in the same sand as the affected well and in a direction away from the production area.

F. Obtain a water sample from the secondary well(s) and analvze for excursion parameters after the well(s) has been completed.

G. If values obtained above indicate no leachates have reached the secondary well(s), continue corrective actions for the affected well until it it is returned to values below excursion levels for three consecutive sampling days.

H. If values obtained above indicate that the water quality analyses exceed excursion values in the secondary well(s), further adjustments will be made to the pumping rates within the well field. If further control is required, Mobil may initiate temporarily reducing or discontinuing the addition of leaching fluids in the injection well(s) only in the immediate vicinity of the monitor well(s) in excursion status. Routine injection in this well(s) would not be resumed until such time that at least the affected additional well is returned to values below excursion levels for three consecutive sampling days.

EXHIBIT 9 (Cont'd)

H. (Cont'd)
If a cleanup trend in the secondary well(s) has not been demonstrated and maintained for a reasonable period of time after the above actions, injection of leaching fluids will be temporarily terminated in the "five spot" pattern nearest to the monitor well(s) on excursion. Routine injection may be resumed once at least the affected additional well is returned to values below excursion levels for three consecutive sampling days.

I. Twice a week sampling of the affected wells will continue until the quality of water in the wells is less than the criteria for excursion in three consecutive analyses for all monitoring parameters.

J. Upon verifying an excursion, the operator will prepare and submit corrective action reports monthly, describing corrective actions taken during the period preceding the date of the report and following any such previous report for each and all wells showing significant increases. In addition, this report shall outline corrective actions to be taken in the subsequent periods for the affected well. This report shall include water analysis data for excursion parameters. If injection of leaching fluids has been terminated and clean up, as described in H above, has been completed, notification of intent to return to routine injection conditions on a proposed date will be forwarded to the NMEID. This notification to the NMEID will be provided to allow NMEID a reasonable time (at least 72 hours) to sample, not including chemical analyses and evaluation, the affected monitor well(s) before routine injection conditions are resumed. If NMEID sampling results do not confirm cleanup, a joint split sampling effort will be performed for confirmation of the actual status of the wells(s) previously defined as an excursion status.