04008943490E 40-8943

FERRET EXPLORATION COMPANY OF NEBRASKA, INC.

216 Sixteenth Street Mall, Suite 810
Denver, Colorado 80202

(303) 825-2266
(303) 825-1544 - FAX

X61097

June 7, 1993

Mr. Ramon Hall
U.S. Regulatory Commission
Region IV
Uranium Recovery Field Office
P.O. Box 25325
Denver, CO 80225

RE: SUA-1534
Docket 40-8943

Dear Mr. Hall:

License Condition 10 and 42 of SUA-1534 approves wastewater irrigation at the Crow Butte ISL facility. FEN has updated its proposal in the form of a NPDES permit application to the State of Nebraska to include additional information and requirements requested by Nebraska Department of Environmental Quality. FEN proposes to use land irrigation as a means of beneficially using the treated restoration and well development wastewaters from commercial operations. The wastewater to be land applied is required by NDEQ to meet rigid water quality standards as specified in 40 CFR Part 440, 10 CFR Part 20 or NDEQ Title 118 Groundwater Standards. The specific requirements are given in Table 2.5, on page 14 of the revised proposal.

Enclosed are two copies of the revised proposal for your review. FEN requests the USNRC amend License Condition 10 and 42 to reflect the revised waste water irrigation proposal dated September 4, 1992. FEN would like approval by August 1, 1993 so that well development wastewater could by land applied this Fall. This is provided that NDEQ has also given final approval of the land application.

Sincerely,

Steve Collings

Stephen P. Collings
President

Enclosures

93-0443

9306080344

NPDES PERMIT APPLICATION
FOR
WASTEWATER IRRIGATION
CROW BUTTE MINE
DAWES COUNTY, NEBRASKA

September 4, 1992

Submitted By: Ferret Exploration Company of Nebraska, Inc.
216 16th Street #810
Denver, Colorado 80202

Submitted To: Department of Environmental Quality
State of Nebraska

Prepared By: Resource Technologies Group, Inc.
3190 South Wadsworth Blvd #250
Lakewood, Colorado 80227

Modified By: Ferret Exploration Company of Nebraska, August 1992

93-0443

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INTRODUCTION

Ferret Exploration Company of Nebraska (FEN) operates a commercial scale in situ leach uranium mine (the Crow Butte Uranium Project) located in Dawes County, Nebraska pursuant to NDEC UIC Permit No. NE0122611 and NRC Source Material License SUA-1534. The process plant is located in Section 19, Township 31 North, Range 51 West. The wellfields and proposed irrigation sites are located within the permit area shown in Figure 1.1. The permit area encompasses approximately 2560 acres, of which approximately 500 acres of surface area will be affected over the estimated life of the project.

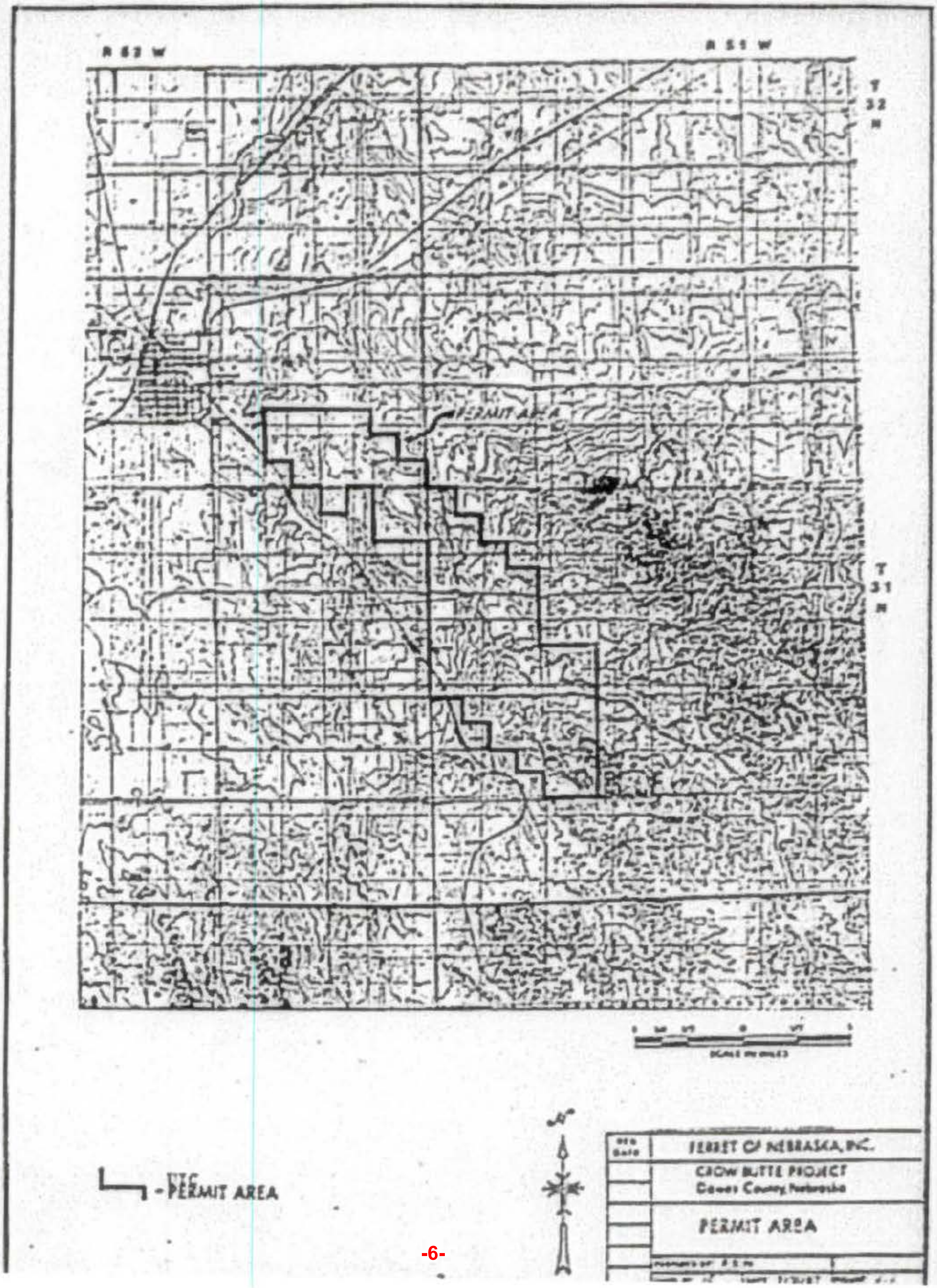
All land within the Permit Area has been leased or is owned by FEN.

FEN operated an R&D facility in the N2 SE4 of Section 19, T31N, R51W from July 1986 to August 1989. One of the objectives of the R&D project was to demonstrate satisfactory groundwater restoration following mining, which FEN successfully accomplished in August 1987. During the process of groundwater restoration, large quantities of naturally occurring groundwater and groundwater altered by the chemical leaching process are produced.

Uranium is recovered by in situ leaching from the Chadron sandstone at a depth which varies from 400 to 800 feet over the permit area. The overall width of the mineralized area within the aquifer which saturates the ore body varies from 100 to 5000 feet.

FEN is currently operating the uranium extraction process at an average flow of about 2300 gallons per minute (gpm) (not including restoration flow) and expects to recover 500,000 lbs of U_3O_8 per year. The process flow in the first year of operation was approximately 1150 gpm. It is expected that the process flow will be increased up to 2500 gpm in 1993.

Construction of the commercial scale facility was completed in 1991. Facilities include a nominal 30,000 square foot process building, wellfield, synthetically lined solar evaporation ponds, access roads and support facilities. FEN estimates that sufficient recoverable reserves are available for at least ten years to over twenty-five years of production operations.


R 52 W
R 51 W
T 32 N
T 31 N
PERMIT AREA
- PERMIT AREA
FERRET OF NEBRASKA, INC.
CROW BUTTE PROJECT
Dawes County, Nebraska
PERMIT AREA

The operation of the commercial facility results in four sources of variably contaminated liquid waste streams. These sources are (1) process waste water which includes filter backwash and wellfield bleed which can be treated in the water treatment system (WTS); (2) eluant bleed and water treatment brine which will normally be stored in an evaporation pond; (3) restoration waste waters which are treated by the WTS; and (4) naturally occurring groundwater from the Chadron formation recovered during well development activities.

Regardless of the source, the water treatment system produces a purified water stream that may be reinjected into the mining aquifer or meet applicable criteria for land irrigation use. However, FEN proposes that only purified water from restoration and well development activities be used for land irrigation. Two areas of approximately 60 and 40 acres each are proposed for use in the NE4 of Section 13, T31N, R52W and the SE4 of Section 19, T31N, R51W as shown in Section 3.0 of this application.

The following Wastewater Irrigation Proposal contains the information requested in the Nebraska Department of Environmental Control (NDEC) Guidelines for Treated Wastewater Irrigation System, February 1986 and responses to questions raised by the NDEC during review of an earlier wastewater irrigation proposal. Pursuant to discussions with NDEC staff, FEN is submitting an NPDES permit application concurrent with this proposal which will authorize land application of treated wastewater.

1.0 DESCRIPTION OF PROJECT

1.1 Name of Landowner/Lessor

The landowner is:	Ferret Exploration Company of Nebraska, Inc. (FEN)
Denver Office:	216 Sixteenth Street Mall, Suite 810
	Denver, Colorado 80202
Nebraska Office:	P.O. Box 169
	Crawford, Nebraska 69339

1.2 Method of Irrigation

The proposed method of irrigation is to utilize a conventional center pivot sprinkler or a gridwork of perforated plastic pipe to spray irrigate. FEN proposes to construct diversions as required to prevent irrigation runoff from entering navigable waterways and divert runon from the irrigated lands. Runoff diversion is discussed further in Sections 3.2 and 6.3 of this report.

1.3 Land Status

The land used for irrigation is either owned or leased by FEN. The wastewater treatment works is also owned by FEN.

2.0 IRRIGATION HISTORY AND PLANS

Wastewater that was generated during mining and restoration at the R&D facility was treated by reverse osmosis (RO) to purify the water. The brine from the RO was sent to an evaporation pond (the west pond) and the permeate (clean water) was sent to a holding pond (the east pond). FEN land applied the clean water to topsoil piles, waste dirt storage and other areas needing grass cover after analysis showed that the water met the Drinking Water Standards found in Title 118, NDEC Rules and Regulations, Chapter 4.002.

The land application was approved by NDEC by letter to FEN dated April 14, 1987. A copy of this letter is attached as Appendix A. NRC approval for land application during commercial operations is granted by Condition No. 42 of Source Material License SUA-1534, as amended.

From July 24, 1987 through August 7, 1987 FEN land applied 557,300 gallons of RO permeate to approximately two acres in the SE4 of Section 19, T31N, R51W. A typical chemical analysis of the RO permeate land applied during R&D operations is found in Table 2.1. FEN expects that water treated by the RO during commercial operations (regardless of source) would be of similar quality to that shown in Table 2.1.

FEN proposes to use land irrigation as a means of beneficially using the treated restoration and well development wastewaters from commercial operations. The potential volume of treated wastewater that would be land applied and the estimated application rate are found in Table 2.2. As can be seen from the data, FEN can land irrigate for 13-14 weeks/year at a rate of two inches/week with the available treated wastewater. Although irrigation will normally be done during the summer growing season, it may occasionally be necessary to land apply wastewaters during other times.

TABLE 2.1

ANALYSES OF LAND APPLIED RO PERMEATE

Parameter	Concentration (mg/l)
Calcium	1.5
Magnesium	0.14
Sodium	89.3
Carbonate	24.4
Bicarbonate	14.3
Sulfate	4.7
Chloride	129
Ammonia - N	0.17
Nitrate - N	0.17
Fluoride	0.1
Conductivity (umho/cm)	519
pH	7.94
Trace Metals	
Arsenic	<0.001
Barium	0.20
Boron	0.96
Cadmium	<0.001
Chromium	<0.005
Copper	<0.01
Iron	<0.03
Lead	<0.005
Manganese	<0.005
Mercury	<0.0002
Selenium	<0.001
Silver	<0.05
Vanadium	<0.1
Zinc	0.04
Uranium	<0.1
Ra 226/228	5 pCi/l
Gross Alpha (including radium-226 but excluding radon and uranium)	8 pCi/l
Gross Beta	16.6 pCi/l

Notes:

(1) RO permeate is usually less than 4 mg/l suspended solids. No measurement of suspended solids was made on the permeate.

(2) There are no organics used in the solution mining process and BOD or COD was not measured on the RO permeate.

TABLE 2.2

ESTIMATED VOLUME OF TREATED WASTEWATER AND ESTIMATED APPLICATION RATE

Source of Wastewater	Annual Volume Untreated Wastewater	Annual Volume Treated Wastewater
Well Development	$0.5\text{-}1.5 \times 10^6$ gallons	$0.5\text{-}1.5 \times 10^6$ gallons
Restoration Water	46.2×10^6 gallons	$23.1\text{-}37 \times 10^6$ gallons

- Maximum Annual Volume of Treated Wastewater = 38.5×10^6 gallons
- Proposed Application Rate is 2 inches per week.
- Two inches/week on 60 acres is equal to 9.99 acre-ft/week or 3.26×10^6 gallons/week.
- FEN proposes land irrigation for 13-14 weeks/year.

2.1 **Treatment System**

The wastewater treatment system is designed to provi... maximum operational flexibility while producing an effluent which can be used for land irrigation or re-injection. As stated earlier, the two sources of wastewater to be treated for irrigation use will be naturally occurring groundwater recovered during well development and wastewater from the aquifer restoration program.

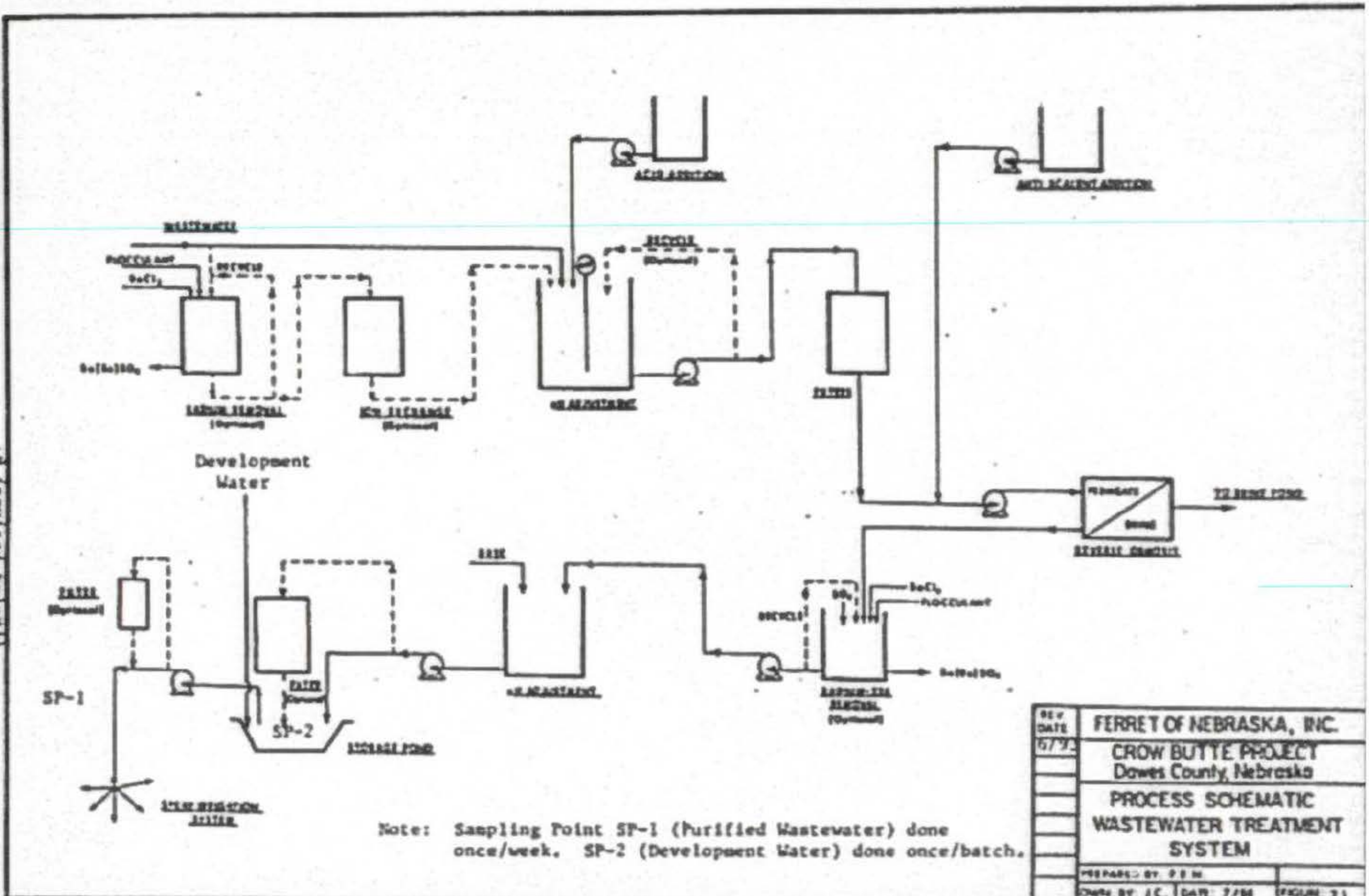
Analysis of well development water quality indicates that RO treatment will normally not be necessary. Most Chadron Formation water produced during well development will simply be treated to remove radium by barium chloride precipitation if ambient concentrations exceed 30 pCi/l. Determination of the radium concentrations and other constituents will be done on a batch basis while in the storage ponds. Before the contents of a pond are discharged, the water in that pond will be sampled and assayed to determine the radium content. If the radium concentration is above 30pCi/liter, the water will be treated with barium chloride and sulfate to allow precipitation of radium as described in section (1) below. A process schematic of the wastewater treatment system is shown in Figure 2.1. Water quality data from operation of the RO unit during R&D restoration indicates that uranium and radium can be removed to acceptable levels without pretreatment or post RO precipitation. Accordingly, the radium and uranium removal steps are shown on the process schematic as optional.

(1) Radium Removal

It may be necessary to remove radium by treatment with $BaCl_2$ to form an insoluble Ba (Ra) SO_4 precipitate, depending upon well development or RO permeate water quality and permit discharge limitations. If necessary, the precipitate will be allowed to settle and the clarified solution will then report to the pH adjust system. Radium may also be removed before RO treatment instead of after RO treatment depending upon the radium content of the wastewater feed to the RO unit.

(2) Ion Exchange Uranium Removal

It may also be necessary to remove uranium prior to RO treatment. The uranium content of the wastewater (as determined from routine sampling of RO feed and effluent) will determine the need for a



Development
Water
SP-1
SP-2
Note: Sampling Point SP-1 (Purified Wastewater) done once/week. SP-2 (Development Water) done once/batch.
FERRET OF NEBRASKA, INC.
CROW BUTTE PROJECT
Dawes County, Nebraska
PROCESS SCHEMATIC
WASTEWATER TREATMENT
SYSTEM

uranium removal system. If necessary, uranium will be removed by an ion exchange process. The exchanged uranium will periodically be transferred to the uranium processing circuit in the production section of the facility for processing into yellowcake.

(3) pH Adjustment/Filtration

The pH of the wastewater will be adjusted to the pH recommended by the RO manufacturer. The recommended pH range is typically between pH 4 and pH 9. The wastewater will then be filtered prior to treatment in the RO.

(4) Anti-Scalent Addition/RO Treatment

After filtration, a small amount (typically less than 5 mg/l) of anti-scalent is added to the wastewater. The purpose of the anti-scalent is to prevent precipitation of sparingly soluble compounds which can cause fouling of the RO membranes. The wastewater then is pumped into an RO unit where the majority of the soluble salts are separated from the wastewater. The soluble salts (brine) are transferred to a solar evaporation pond and the clean water (permeate) may go a pH adjustment system if the pH is not between 6.0-9.0. The permeate will be sampled and transferred to a storage pond or directly discharged, depending upon water quality. If the analysis on the sample indicates that all water quality parameters are within the permit limitations, the water will be suitable for land irrigation without further treatment. If the water quality does not meet permit limitations, the water will be further treated until the limits are met. Further treatment may include recycle through the RO system or treatment to reduce radium levels. Additional filtration of the treated water may be required and will be installed if necessary.

The filtered material referred to in the above discussions will be held on filter cartridges and disposed of in a licensed landfill or a waste facility licensed to accept uranium in-situ byproduct material. When a filter becomes fully loaded with material, the cartridges will be removed and replaced with new cartridges. The old cartridges will be held in a restricted area and a radiation survey will be done to determine where to dispose the filters.

2.2 Treatment Efficiencies

Reverse osmosis (RO) is a water purification process that uses a semipermeable membrane to physically filter contaminants from the feed system. Water, under pressure, is forced through a specially designed membrane which permits "pure" water to pass through the membrane pores while acting as a barrier to dissolved and suspended materials. The RO unit

separates the feed (water) stream into a permeate (clean) stream and a concentrate (brine) stream.

Recovery rates for an RO unit are typically set by the manufacturer based on the particular application of the unit. The recovery rate of the Osmonics osmo-43 RO used during pilot plant operations at Crow Butte was determined to be 82%, based upon a pre-operational test using feed water with a conductivity of 788 micromhos/cm. This percentage is a measure of the ratio of permeate flow to feed flow and will vary depending upon the water quality of the feed flow.

The removal efficiency of various salt ions as measured by percent rejection is given in Table 2.3. As can be seen, multi-valent ions tend to have less passage than mono-valent ions. If mono-valent ions are combined with multi-valent ions, passage through the membrane will be controlled by the multi-valent ion.

RO units are widely used in the water purification and wastewater treatment industries to purify water of widely varying quality. Regardless of RO efficiency, they are capable of producing a very clean product simply by recycling "dirty" feed water through the RO membranes. Table 2.4 illustrates water quality obtained through RO treatment at various stages during and following R&D restoration at Crow Butte. The post restoration data represents water quality obtained during treatment of pond wastewater for irrigation use.

Radium removal from water by coprecipitation with barium is also a proven wastewater treatment method. The basic principal involves the formation of an excess amount of dense barium sulfate ($BaSO_4$) precipitate simultaneously with the formation of radium sulfate ($RaSO_4$) precipitate. In the presence of an excess of sulfate ions (SO_4), the following coprecipitation reaction occurs:

$$BaCl_2 + Ra^{++} + SO_4^{--} \rightarrow (Ba\text{-}Ra)\,SO_4 + 2Cl^-$$

According to the International Atomic Energy Agency, a properly designed treatment system can remove over 99% of the radium. Bench tests performed at Crow Butte during R&D restoration indicated that a barium

TABLE 2.3

TYPICAL MEMBRANE REJECTIONS/PASSAGES[1]

Name	Symbol	Percent Rejection
CATIONS		
Sodium	Na^{+}	94-96
Calcium	Ca^{+2}	96-98
Magnesium	Mg^{+2}	96-98
Potassium	K^{+1}	94-96
Iron	Fe^{+2}	98-99
Manganese	Mn^{+2}	98-99
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}**	88-95
Copper	Cu^{+2}	98-99
Nickel	Ni^{+2}	98-99
Zinc	Zn^{+2}	98-99
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
Mercury	Hg^{+2}	96-98
ANIONS		
Chloride	Cl^{-1}	94-95
Bicarbonate	HCO_3^{-1}	95-96
Sulfate	SO_4^{-2}	99+
Nitrate	NO_3^{-1}	95-95
Fluoride	F^{-1}	94-96
Silicate	SiO_2^{-2}**	80-95
Phosphate	PO_4^{-3}	99+
Bromide	Br^{-1}	94-96
Borate	$B_4O_7^{-2}$**	35-70**
Chromate	CrO_4^{-2}**	90-98
Cyanide	CN^{-1}**	90-95**
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_2O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

* Must watch for precipitation, other ion controls maximum concentration.
** Extremely dependent on pH; tends to be an exception to the rule.

1 Source: Osmonics, Inc.

TABLE 2.4

RO ASSAYS
R&D RESTORATION DATA

	U	V	Total Carb	pH	Ca	Na	Cl	SO_4	Cond
02-11-87									
RO Feed	.6	4.4	54	6.74	44	1755	2382	528	7161
RO Perm	0	0	18	6.42	4	252	395	9	1295
% Removal	100	100	67	--	91	86	83	98	82
05-30-87									
RO Feed	.1	.5	19	5.63	51	1235	1184	961	5764
RO Perm	0	<.1	14	7.03	5	131	190	11	769
% Removal	100	>80	26	--	90	89	84	99	87
12-12-87									
RO Feed	1.5	7.2	--	6.53	430	5202	1082	10303	18086
RO Perm	<.1	0.4	--	7.45	21	280	309	196	1583
% Removal	>93	94	--	--	95	95	71	98	91
01-22-88									
RO Feed	.9	44	60	6.88	204	3101	817	6487	12039
RO Perm	<.1	.2	10	6.50	3.2	193	240	88	1007
% Removal	>89	95	83	--	98	94	71	99	94
05-20-89									
RO Feed	--	--	--	7.43	--	--	501	2306	5296
RO Perm	--	--	--	6.22	--	--	149	80	743
% Removal	--	--	--	--	--	--	70	97	86

NOTE: All units ppm except pH (s.u.) and cond (umhos)

chloride concentration of 91 ppm resulted in 98% removal of Ra-226 from solution.

2.3 Irrigation Water Quality

FEN proposes that the permit limitations for land irrigation be those found in Table 2.5, which are normally attainable using RO treatment.

The proposed limits are taken from the respective standards specified by the regulations cited in footnotes 1, 2 and 3. Because the land application activity will be authorized under an NPDES permit, the EPA *Effluent Guidelines and Standards for Ore Mining and Dressing* (specified at 40 CFR Part 440) are the most applicable standards. The discharge water quality limitations specified in 40 CFR Part 440 represent the New Source Performance Standards (NSPS) achievable through the application of Best Available Technology (BAT) for a specific industry or source category. For water quality parameters not addressed by 40 CFR Part 440, NRC standards for releases of radioactive materials in effluents to unrestricted areas (specified at 10 CFR Part 20, Appendix B) will be met. For those parameters not addressed by either 40 CFR Part 440 or 10 CFR Part 20, FEN proposes to meet the groundwater quality standards specified in Title 118 of NDEC regulations.

Treated water will be pumped from the treatment system or the storage pond to the land irrigation area for spray application. Spray irrigation will be carried out using either a center pivot arrangement or a grid of perforated pipe.

3.0 SURFACE DATA

3.1 Location

Figure 3.1 shows the features of interest to this permit application.

The pretreatment site will be located in the restricted area and the treated water may go directed to the irrigation area or may be stored. The treated water storage will be in either of the pond areas shown in Figure 3.2.

TABLE 2.5

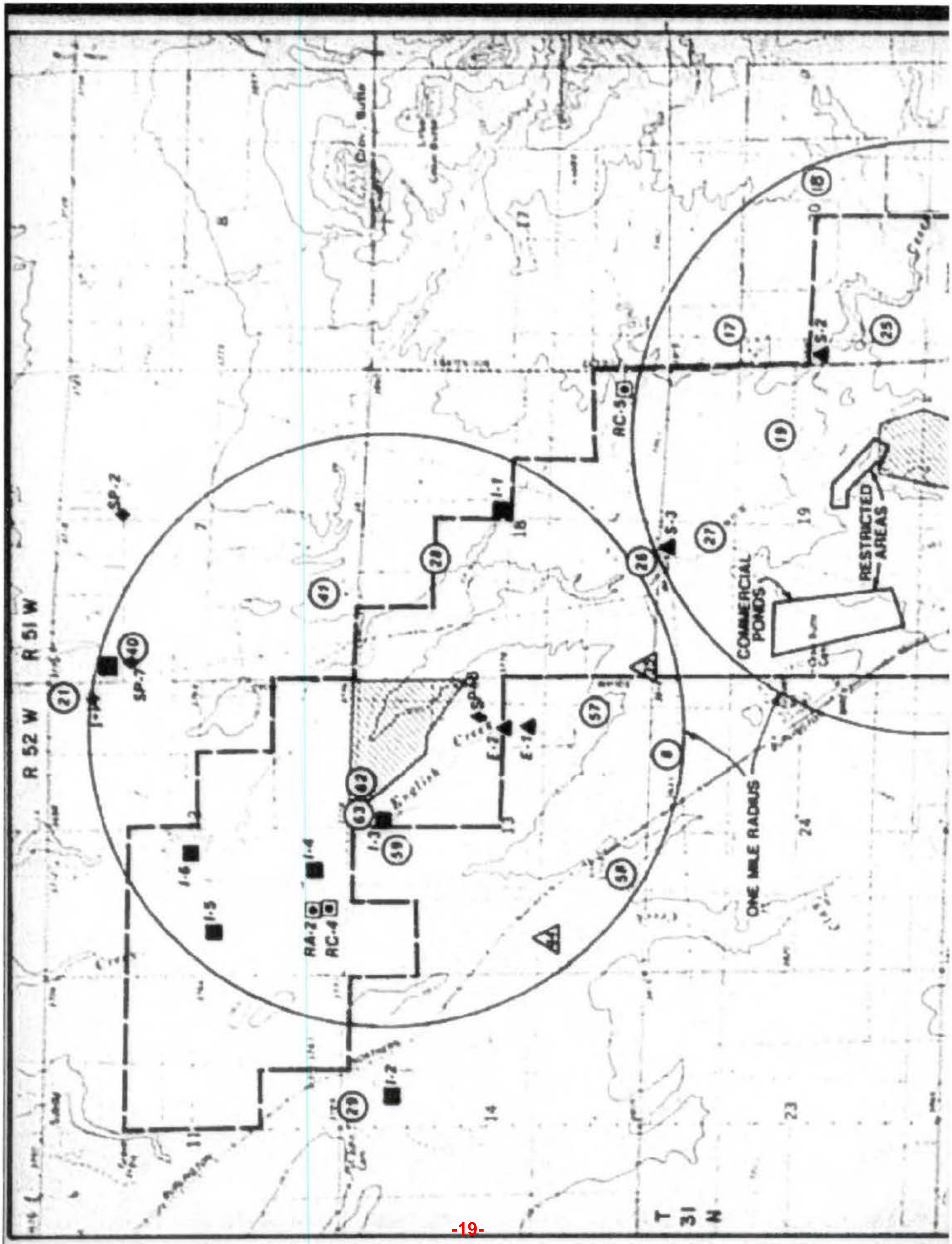
PROPOSED WASTEWATER IRRIGATION CONSTITUENT LEVELS

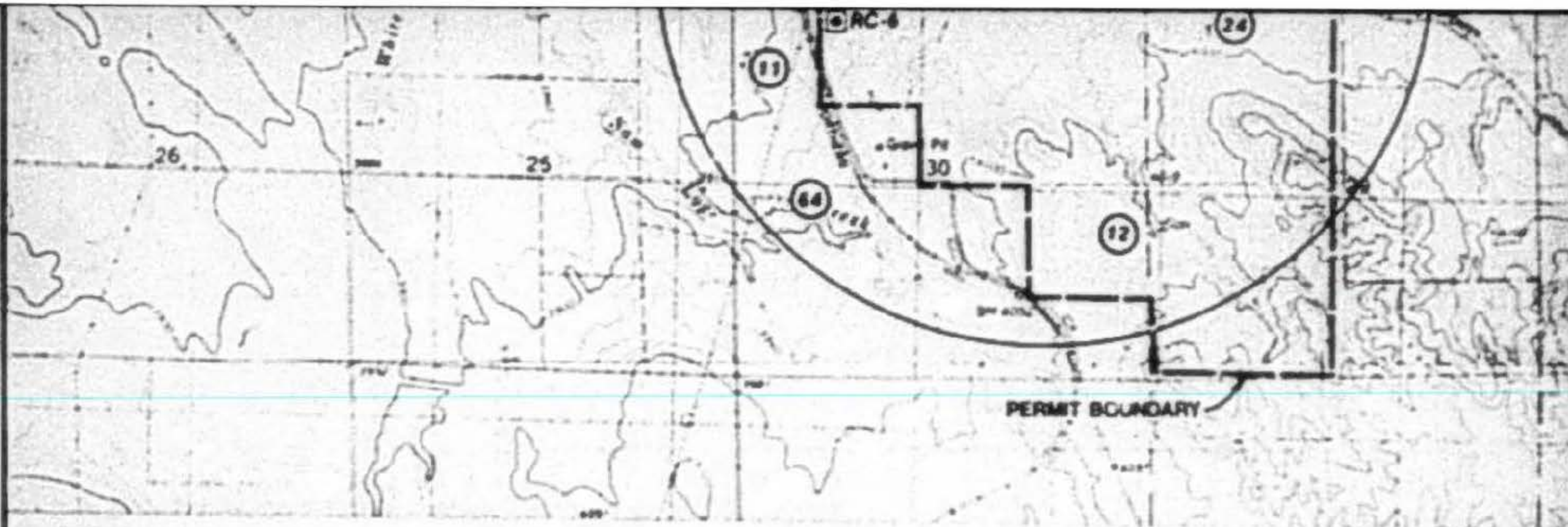
Parameter	Maximum Constituent Level for any one day	Average of daily values for 30 consecutive days[1]
Arsenic[1]	1.0 mg/l	0.5 mg/l
Barium[3]	1 mg/l	
Cadmium[2]	0.010 mg/l	
Chromium[3]	0.10 mg/l	
Fluoride[3]	4.0 mg/l	
Lead[3]	0.05 mg/l	
Mercury[3]	0.002 mg/l	
Nitrate - Nitrogen[3]	10 mg/l	
Selenium[3]	0.05 mg/l	
Silver[3]	0.05 mg/l	
Uranium[1]	4 mg/l	
Radium-226 (total)[1,2]	30 pCi/l	10 pCi/l
Chloride[3]	250 mg/l	
Copper[3]	1 mg/l	
Iron[3]	0.3 mg/l	
Manganese[3]	0.05 mg/l	
Sulfate[3]	250 mg/l	
Zinc[3]	5 mg/l	
pH[1]	6.0-9.0	
Total Suspended Solids[1]	30 mg/l	20 mg/l

1 Discharge effluent limitations specified in 40 CFR Part 440.

2 This is the constituent limit set by the USNRC for release to an unrestricted area. This limit can be found in 10 CFR Part 20.

3 NDEC Title 118 groundwater standards.


R 52 W
R 51 W
T 31 N
ONE MILE RADIUS
COMMERCIAL PONDS
RESTRICTED AREAS
English Creek
SP-2
RC-5
S-2
S-3
I-1
I-2
I-3
I-4
I-5
I-6
RA-2
RC-4
E-1
E-2



LEGEND

- PRIVATE WELL - CHADRON FM
- PRIVATE WELL - BRULE FM
- REGIONAL BASELINE WELL
- ABANDONED WELL
- SPRING
- STREAM SAMPLE SITE
- IMPOUNDMENT SITE
- IRRIGATION SITE

Scale 1:24,000
1" = 2000'

0 1000 2000 4000 6000 Feet
0 1/4 1/2 1 Mile

N

REV	BY	DATE	FERRET OF NEBRASKA, INC.	
			CROW BUTTE PROJECT Dawes County, Nebraska	
			IRRIGATION SITES FEATURES OF INTEREST	
			PREPARED BY	
			DWN BY DATE 9-1-92	FIGURE 3.1

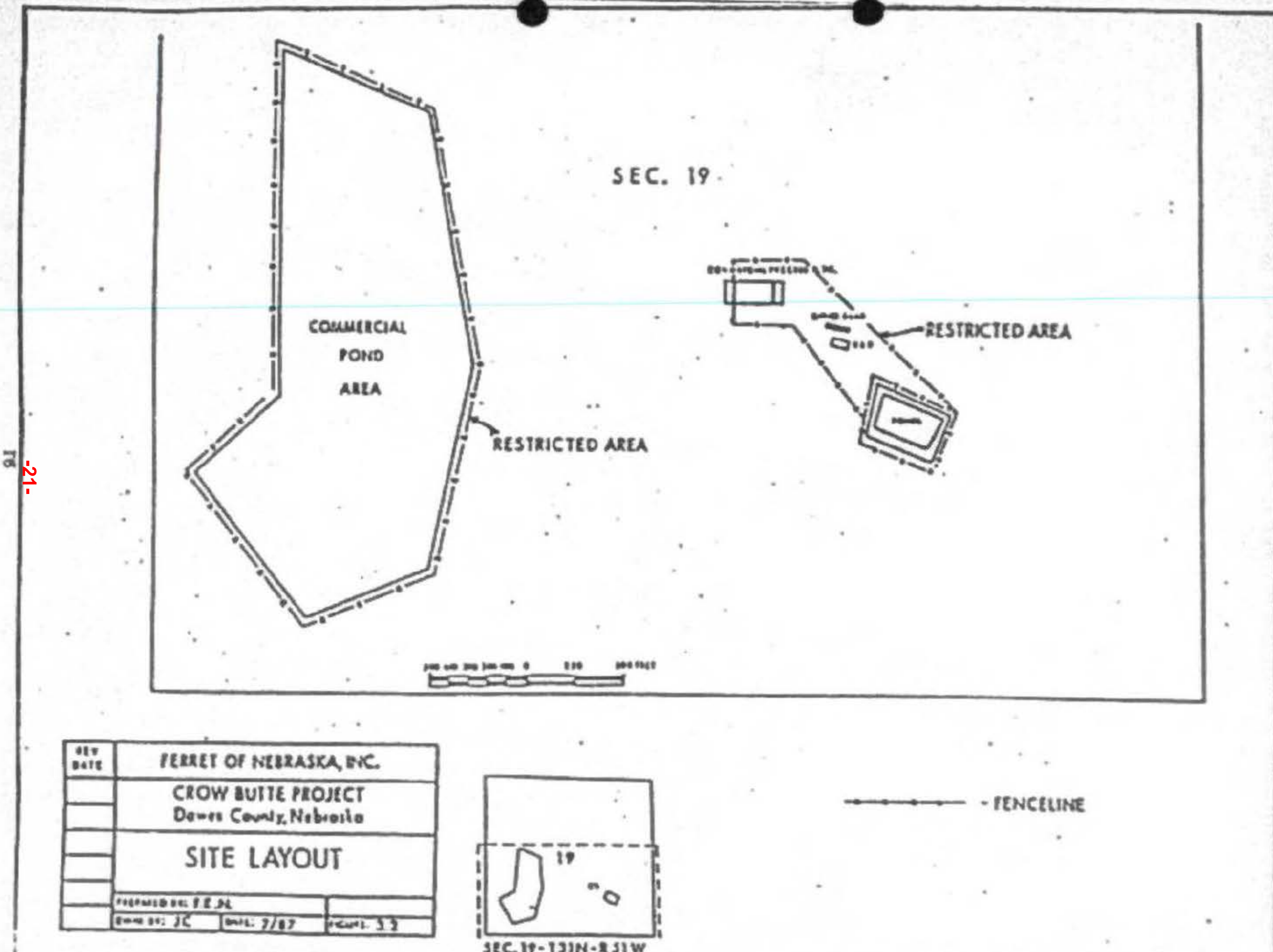

SEC. 19
COMMERCIAL
POND
AREA
RESTRICTED AREA
RESTRICTED AREA
FENCELINE
19
SEC. 19 - T31N - R51W
FERRET OF NEBRASKA, INC.
CROW BUTTE PROJECT
Dawes County, Nebraska
SITE LAYOUT
REV
DATE
JC
7/87
3.2

Figure 3.1 shows the proposed wastewater irrigation sites and a radius of one mile around the areas. Also shown in Figure 3.1 are:

1) active and abandoned water wells listed in Table 3.1,
2) residences within a one mile radius of the irrigation sites (listed in Table 3.2) as referenced by well number,
3) surface water features (Table 3.3) within a one mile radius of the proposed irrigation sites, including impoundments and springs.

There are no surface water impoundments within one mile of the Section 19 irrigation sites. Impoundment I-3, located on English Creek, is close to the western boundary of the Section 13 wastewater irrigation site and will be used to monitor surface water in the vicinity of the Section 13 irrigation site. Stream site S-3 on Squaw Creek is below the proposed Section 19 irrigation site and will be used to monitor water quality below Section 19.

FEN plans to sample Impoundment I-3 and Stream site S-3 prior to wastewater irrigation to verify the 1982 analysis and to establish a current water quality baseline. Table 3.4 presents water quality data from an I-3 impoundment sample while Table 3.5 summarizes water quality data for site S-3. The proposed monitoring program for surface water is described in Section 5.

There is one active road within one mile of the Wastewater Irrigation Sites. This road, which forms the section line between T31N, R52W, Section 13 and T31N, R51W, Section 18, is referred to as Squaw Creek Road or county Road HC-76. There are a number of unimproved roads within the one mile radius of the irrigation sites which have not been identified for this proposal.

3.2 Evaporation and Rainfall

The total average annual lake evaporation is shown in Figure 3.3. As can be seen, the average annual lake evaporation for the Crawford NE area will range from 60 to 70 inches.

The average precipitation (15.6") based on data from the Climatological Summary for Chadron, NE prepared by the U.S. Department of Commerce, is

TABLE 3.1

WATER WELLS WITHIN ONE MILE OF THE PROPOSED WASTEWATER IRRIGATION AREAS

ACTIVE WELLS

Well Number	Well Owner	Date Drilled	Bottom Depth (ft)	Type of Completion	Probable Screen or Open Interval (ft)	Water Level Below Land Surface (ft)	Probable Aquifer Unit	Usage*
8	M. Dyer	1954	75	Steel	50-75	----	Brule Fm	L
11	M. Dyer	----	110	----	----	64.7	Brule Fm	L
12	M. Dyer	----	135	----	----	75.6	Brule Fm	L
16	J. Paris	1960	80	Galvanized	60-80	----	Brule Fm	D,L
17	H. Gibbons	1960	80	Steel	40-80	46.5	Brule Fm	D,L
18	H. Gibbons	1946	120	Steel	80-120	40	Brule Fm	L
19	Daniels Est.	----	80	Steel	60-80	59.2	Brule Fm	L
21	L. Tagart	----	100	Galvanized	70-100	59.8	Brule Fm	L
24	F. Ehlers	----	80	Steel	60-80	592	Brule Fm	L
25	F. Ehlers	----	75	Steel	55-75	36.1	Brule Fm	D,L
26	O. Stetson	1890	80	Steel	19-80	----	Brule Fm	D,L
27	O. Stetson	1930	80	Galvanized	35-80	----	Brule Fm	L
28	O. Stetson	1981	80	Plastic	60-80	----	Brule Fm	L
29	W. Dodd	----	--	Steel	----	58.8	Brule Fm	L
40	M. Franey	----	60	Galvanized	----	19.8	Brule Fm	L
41	M. Franey	1900	100	----	----	----	Brule Fm	L
57	T. Brott	1920	25	Galvanized	----	----	Brule Fm	D,L
58	T. Brott	1980	35	Galvanized	16-35	----	Brule Fm	L
59	T. Brott	1970	25	Plastic	----	----	Brule Fm	L
62	FEN	1981	470	Plastic	430-470	35.2	Chadron Fm	L
63	FEN	----	--	----	----	----	Brule Fm	D
64	O. Davis	1946	30	Galvanized	10-30	19.7	Brule Fm	D

* D = Domestic; L = Livestock; I = Irrigation, C = Commercial; N = Seldom Used
---- Indicates information not available.

TABLE 3.1 - Continued

ABANDONED WELLS

Well I.D.	Location
35	31N 51W Section 18: 100N 200E
44	31N 51W Section 13: 1700N 600E

* Location coordinates are referenced in units of feet from the southwest section corner.

REGIONAL BASELINE WELLS

Well Number	Formation	Screen Interval (ft)	Depth (ft) to Bottom of Screen Assembly
RA-2	Brule	7-27	32
RC-4	Chadron	340-360	365
RC-5	Chadron	672-692	697
RC-6	Chadron	713-733	738

TABLE 3.2

RESIDENCES WITHIN A ONE MILE RADIUS OF THE PROPOSED WASTEWATER IRRIGATION SITES

Resident/Well Owner	Well ID(1)	Irrigation Area
Anna Stetson P.O. Box 471 Crawford, Nebraska 69339	26	Section 13
Tom Brott Route 1, Box 3 Crawford, Nebraska 69339	57	Section 13
Ralph Knode P.O. Box 72 Crawford, Nebraska 69339	63	Section 13
Beth Gibbons Rural Route 1 Crawford, Nebraska 69339	17	Section 19
Frank Ehlers Rural Route 1 Crawford, Nebraska 69339	25	Section 19
Lon Lemmon Rural Route 1 Crawford, Nebraska 69339	38	Section 19

(1) For location see Figure 3.3

TABLE 3.3

SURFACE WATER FEATURES WITHIN ONE MILE RADIUS OF THE PROPOSED WASTEWATER IRRIGATION AREAS

Streams

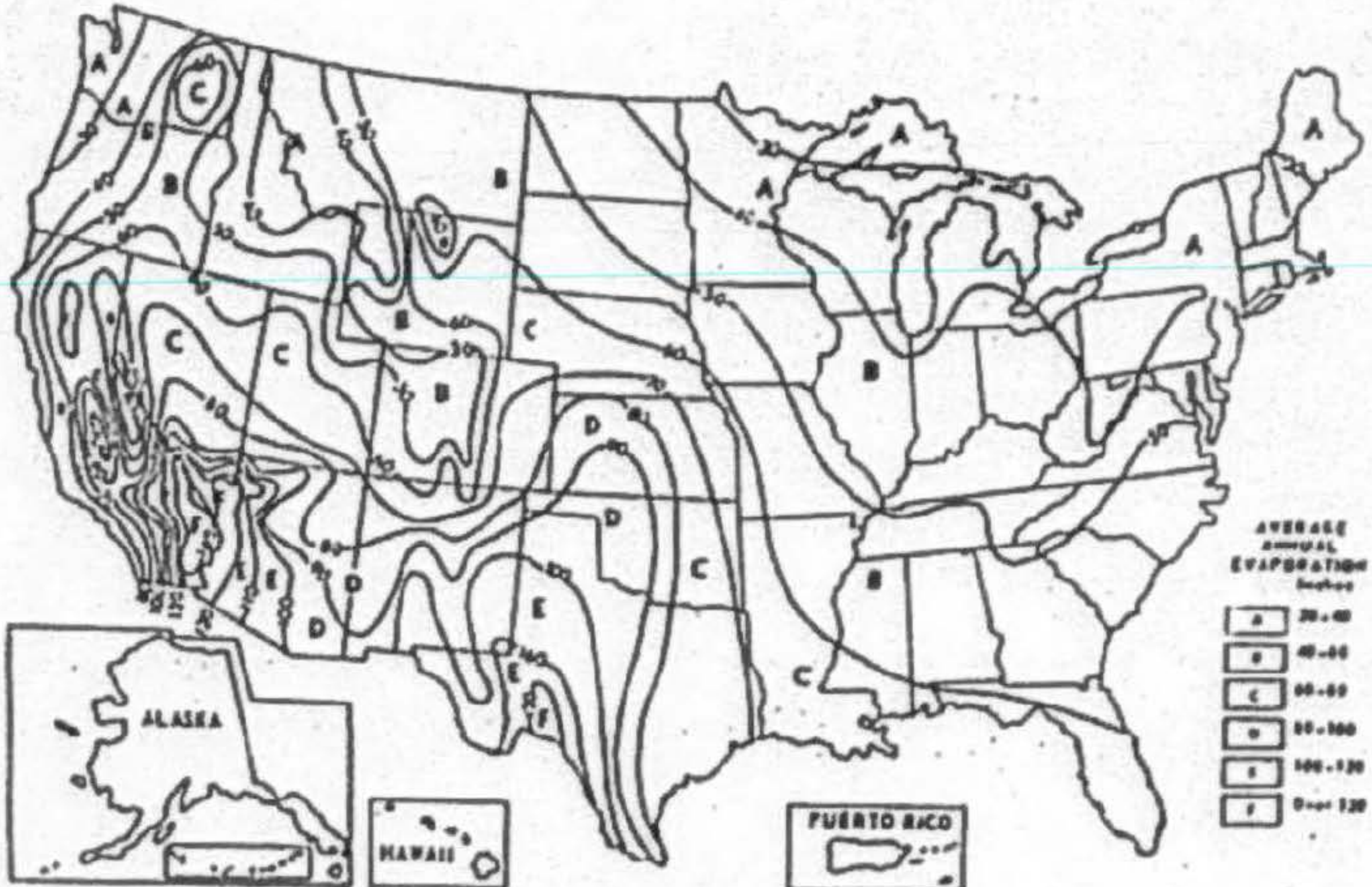
English Creek
White Clay Creek
Saw Log Creek
Squaw Creek

Impoundments

Impoundment ID #	Location
I-1	31N 51W Section 18
I-2	31N 52W Section 14
I-3	31N 52W Section 13
I-4	31N 52W Section 12
I-5	31N 52W Section 12
I-6	31N 52W Section 12
I-14	31N 51W Section 7

Springs

Spring ID #	Location
SP-2	31N 51W Section 7
SP-6	31N 52W Section 13
SP-7	31N 52W Section 7



Regional data not available

Regional data not available

Average annual lake evaporation.

FIGURE 3.3

TABLE 3.4

Impoundment I-3
June, 1982

FERRET EXPLORATION CO OF NEBRASKA
CROW BUTTE PROJECT
WATER QUALITY REPORT

Page No. 2 of 2

Sample Number: I-3
Distance from Wellfield: 9900 ft.

Sample Type: IMPOUNDMENT SAMPLE
Water System: ENGLISH CREEK

SAMPLE SUMMARY

PARAMETER	MINIMUM	MAXIMUM	MEAN	STD.DEVIATION
All values in mg/l unless noted				
Calcium	74	74	74	0
Magnesium	12	12	12	0
Sodium	25	25	25	0
Potassium	7.2	7.2	7.2	0
Carbonate	<2	<2	2	0
Bicarbonate	350	350	350	0
Sulfate	<5	<5	5	0
Chloride	<2	<2	2	0
Ammonia-N	<0.05	<0.05	.05	0
Nitrite-N	<0.02	<0.02	.02	0
Nitrate-N	<0.02	<0.02	.02	0
Fluoride	0.7	0.7	.7	0
Silica(as SiO2)	31	31	31	0
TDS-180•C	350	350	350	0
Conductivity (µmhos)	558	558	558	0
Alkalinity(as CaCO3)	280	280	280	0
pH (standard units)	7.9	7.9	7.9	0
Ion Balance				
TDS Balance				
Cond. Balance				
All values in µg/l unless noted				
Aluminum	100	100	100	0
Arsenic	3	3	3	0
Barium	400	400	400	0
Boron	500	500	500	0
Cadmium	<1	<1	1	0
Chromium	<1	<1	1	0
Cobalt	<1	<1	1	0
Copper	<1	<1	1	0
Iron	50	50	50	0
Lead	<5	<5	5	0
Manganese	200	200	200	0
Mercury	<0.1	<0.1	.1	0
Molybdenum	<2	<2	2	0
Nickel	<2	<2	2	0
Selenium	<2	<2	2	0
Vanadium	<1	<1	1	0
Zinc	12	12	12	0
Uranium (as U)	3	3	3	0
Radium-226(pCi/l)	0.6	0.6	.6	0

TABLE 3.5

FERRET EXPLORATION CO OF NEBRASKA
CROW BUTTE PROJECT
WATER QUALITY REPORT

Sample Number: S-3
Distance from Wellfield: 3400 ft.

Sample Type: STREAM SAMPLE
Water System: SQUAW CREEK

SAMPLE SUMMARY

PARAMETER	MINIMUM	MAXIMUM	MEAN	STD.DEVIATION
All values in mg/l unless noted				
Calcium	49	73	60.839	6.664
Magnesium	7.6	11.0	9.363	.832
Sodium	10.0	15.7	12.517	1.422
Potassium	2.3	6.7	4.347	.976
Carbonate	<1	3.5	1.909	.877
Bicarbonate	208.6	292	251.4	23.925
Sulfate	5	11.4	7.211	1.756
Chloride	0.6	3.2	2.094	.646
Ammonia-N	<0.05	0.07	.055	8E-03
Nitrite-N	<.001	0.02	8E-03	6E-03
Nitrate-N	<0.01	0.35	.171	.106
Fluoride	0.5	0.69	.605	.049
Silica(as SiO_2)	39.7	51.6	47.195	3.07
TDS-180°C	230	322	276.421	22.414
Conductivity (µmhos)	340	470	404.421	36.019
Alkalinity(as $CaCO_3$)	180	249	209.674	19.341
pH (standard units)	7.6	8.55	8.063	.299
Ion Balance				
TDS Balance				
Cond. Balance				
All values in µg/l unless noted				
Aluminum	<100	<100	100	0
Arsenic	2	6	3.909	1.221
Barium	200	250	216.667	20.416
Boron	20	<500	145.455	178.514
Cadmium	<1	<1	1	0
Chromium	<1	9	4.636	2.157
Cobalt	<1	<1	1	0
Copper	<1	<10	8.364	3.641
Iron	30	50	35.3	8.354
Lead	<5	<5	5	0
Manganese	6	<100	35.182	33.406
Mercury	<0.1	<0.2	.182	.04
Molybdenum	2	<10	8.091	3.36
Nickel	<2	<10	8.545	3.236
Selenium	<1	<2	1.182	.405
Vanadium	5	<10	9	2.108
Zinc	<2	20	12.273	6.872
Uranium (as U)	<1	7	2.875	1.962
Radium-226(pCi/l)	0.1	0.9	.322	.258

shown in Table 3.6. The period of record for this data is 30 years, from 1941 through 1970.

In keeping with SCS recommendations, FEN intends to contain potential runoff within the irrigated sites by constructing level diversions or berms around down gradient edges of the sites. In addition, potential storm water runoff from drainage areas above the irrigation sites will be diverted around irrigated areas.

3.3 Agricultural Practices

The Section 19 site will be left as native grass rangeland, while crops will be planted in the Section 13 site. The crops proposed for use in Section 13 include the following:

- Tall wheat grass
- Western wheat grass
- Orchard grass
- Alfalfa
- Reed Canary grass

These crops were selected after discussion with Mr. Leonard John of the Soil Conservation Survey office located in Crawford NE, and Mr. David Shanahan of the Soil Conservation Survey office in Scottsbluff NE.

FEN proposes to irrigate during the growing season (approximately April to September) and at other times, as appropriate. As noted previously, it may occasionally be necessary to irrigate at other times of the year. At the present time plans are to plow the crops under at the appropriate time. In the future, FEN may harvest crops from the wastewater irrigation sites.

3.4 Total Acres of Land Application

FEN proposes to conduct wastewater irrigation on (1) approximately 60 acres located in the NE4 of Section 13, T31N, R52W and (2) approximately 40 acres located in the SE4 of Section 19, T31N, R51W (see Figure 3.1).

TABLE 3.8

PRECIPITATION TOTALS
WATER EQUIVALENT
CHADRON, NEBRASKA

	Mean Precipitation	
	cm	in
January	1.04	0.41
February	0.94	0.37
March	1.78	0.37
April	4.24	1.67
May	7.57	2.98
June	8.43	3.32
July	5.49	2.16
August	2.46	0.97
September	3.38	1.33
October	2.11	0.83
November	1.09	0.43
December	0.99	0.39
Year	39.52	15.56

Period of Record: 1941 through 1970

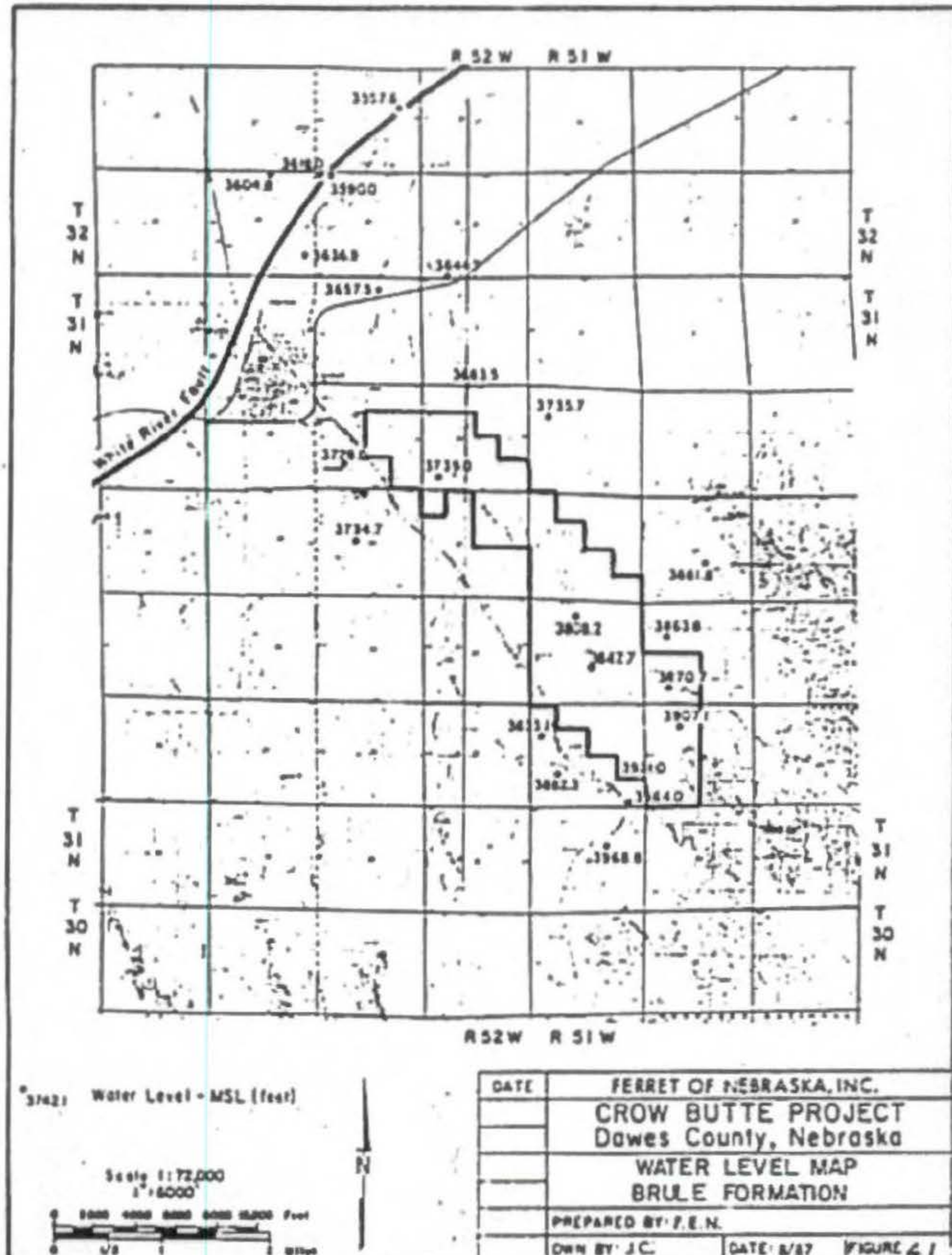
4.0 SUBSURFACE DATA

4.1 Groundwater Occurrence and Movement

In the vicinity of the proposed wastewater irrigation sites there are four potential sources of groundwater; an unnamed alluvial aquifer in the English Creek and Squaw Creek alluvium, the Brule aquifer, and the Chadron aquifer. Of these, only the Brule aquifer is suitable as a source of domestic water supply. The alluvial aquifers are not used as a domestic water supply within the proposed irrigation areas or within 1/2 mile down gradient. The Chadron aquifer is not suited as a source of domestic water supply because of its poor chemical and radiological quality.

Water producing zones within the Brule formation vary from about 40 to 130 feet below the ground surface at the proposed irrigation sites. Water level data from the Crow Butte Uranium Project Application and Supporting Environmental Report for USNRC Commercial Source Material License, show that the regional piezometric gradient of the Brule aquifer is toward the north-northwest. Therefore, the direction of regional groundwater flow in this aquifer is toward the north-northwest. Figure 4.1 shows regional potentiometric surface water levels within the Brule Formation.

It should also be noted that the Soil Conservation Survey (SCS) Dawes County Soil Survey describes the depth to the seasonal high water table within the proposed irrigation areas as greater than 10 feet. FEN intends to limit irrigation application amounts to a rate which would preclude soil saturation beyond a depth of one or two feet. Irrigation will therefore not affect or alter the shallow hydrologic regime within the irrigated areas.


R 52 W
R 51 W
T 32 N
T 31 N
T 30 N
White River Fault
3604.8
3636.9
3657.5
3735.7
3734.7
3808.2
3847.7
R 52 W
R 51 W
Water Level - MSL (feet)
Scale 1:72,000
1" = 6000'
Feet
Miles
N
DATE
FERRET OF NEBRASKA, INC.
CROW BUTTE PROJECT
Dawes County, Nebraska
WATER LEVEL MAP
BRULE FORMATION
PREPARED BY: F.E.N.
DWN BY: J.C.
DATE: 8/87
FIGURE 4.1